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# 1979 ANNUAL PROCEEDINGS – 1980 PRE-CONVENTION REPORT

## CONRAD HILTON HOTEL, CHICAGO, ILL.

## SEPTEMBER 22, 23, 24, 1980

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Official Discussion Record of 41st Annual Meeting

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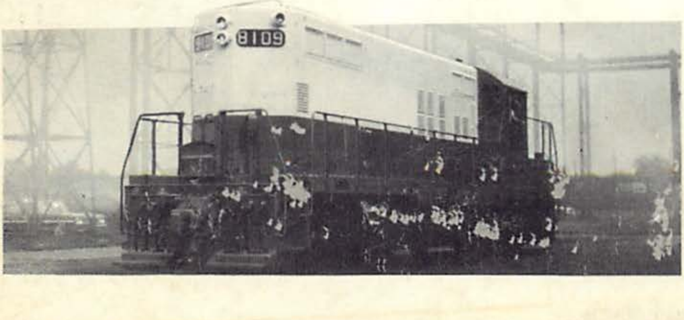

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# 1980 Advertisers Index

# INDEX

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# MONDAY MORNING SESSION
## September 17, 1979

**E. THOMAS HARLEY**
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## MONDAY MORNING SESSION

### September, 17, 1979

The Joint Meeting of the Air Brake Association, the Car Department Officers' Association and the Locomotive Maintenance Officers' Association convened at nine-thirty a.m. in the International Ballroom of the Conrad Hilton Hotel, Chicago, Illinois with Mr. M.D. Smith, President of the Air Brake Association presiding as Chairman.

CHAIRMAN SMITH: Will everyone please take your seats.

The Seventy-First Annual Technical Conference is now in session. Members of the Coordinated Association, honored guests, friends, on behalf of the officers and the executive committee of the Air Brake Association, it is a pleasure to have this opportunity to welcome each of you to this coordinated convention.

As has been in the past, this meeting will be opened by your rising for the invocation given by the Reverend Father Michael Lanning, St. Patrick's Roman Catholic Church, the Chicago Loop.

REVEREND FATHER MICHAEL LANNING: Let's pause for a moment and put ourselves in the presence of God who is with each and every one of us in this assembly.

Almighty God, we give You thanks. We give You thanks for all the blessings that You have given to each and every one of us, for our families, for our jobs, for our industry. We ask Your blessing on each and every member of this technical conference, that all of the efforts that are done here may be brought to a productive conclusion.

You have given us abundant resources from Your creation. Help us to use them wisely. You have given us potential beyond compare, intelligence and wisdom. Help us to put these gifts to the use and the service of our fellow man.

As we gather here this day, give us strength to see solutions to problems. Especially problems which face our industry and thereby face our country. Help us to work together in the spirit of fraternal concern.

Bless all of the members of our different organizations, especially their families, that they may be good parents, true friends, good citizens of our nation. Guide us always in Your service and in Your truth; You who are God forever; Amen.

CHAIRMAN SMITH: Thank you, Father Michael, for your comforting remarks. Keeping them in mind, our meeting should prosper and give us wisdom to improve ourselves, and to work with our fellow man.

It is a privilege to have a Joint Meeting for our opening address for we do have a very close relationship that exists between each of our groups. We do have a great deal in common as our activities do play a very vital part in our railroad system. It is appropriate, therefore, to join together in hearing remarks from an outstanding speaker.

Before our honored guest is inroduced, I would appreciate your meeting the gentlemen at the speaker's table. Will each of you stand and be recognized, and please hold your applause until they have all been introduced.

We have Mr. Mike Adams with the Santa Fe Railroad. He is the Chief Mechanical Officer and is the guest speaker for the C.D.O.A. this morning.

Mr. Charlie Montgomery is the President of the C.D.O.A. and Mechanical Assistant for the Santa Fe Railroad.

And we do have on my right the First Vice President of the Air Brake Association.

Thank you, gentlemen. (Applause)

This day highlights not only my being President of the Air Brake Association, but also my 40 years of service with the Santa Fe, and also my company's Chairman of the Board accepted an invitation to be your speaker.

His name is well-known in the Chicago area. He was born in Chicago on June 9, 1917, attended both grade and high school here. He received a Bachelor of Science degree in Industrial Administration from Yale in 1939, also an Advanced Management program from Harvard in 1955. He is married and has a family of five children.

He joined the U.S. Naval Reserve in the Summer of 1940, and attended the V-7 program at Annapolis. He was on the U.S.S. Nyblack DD424 on which he served as Chief Engineer Damage Control Officer Executive and briefly as acting skipper in the

North Atlantic, Mediterranean and the Pacific until he was released in 1946 with the rank of Lieutenant Commander.

He began his Santa Fe career in the test department in Topeka, Kansas in 1939. He did have many promotions. He was the Superintendent of the old Missouri in 1952. He was elevated to Vice President of Finance in 1959. In 1967, President and Chief Executive Officer, Chairman and President and Chief Executive Officer in 1973. In 1978 he became Chairman and Chief Executive Officer, Santa Fe Industry Incorporated and the Atchison, Topeka and Santa Fe Railroad Company, the position he presently holds.

It is indeed an honor for me to introduce Mr. John F. Reed. (Applause)

*John S. Reed*
*Santa Fe*

MR. JOHN S. REED: Thank you, Max. Members of the Coordinating Associations, I think that is the proper term to call you collectively.

I do welcome this chance to meet with you, although I sometimes wonder why I was selected. Possibly it is because of the fact that my original and continuing interest in transportation has really been with the actual movement of trains, of the design and maintenance of the equipment that is used in railway operations.

Just to try and establish a little special rapport with this group, I would like to say that I think you can understand why I have always had a special appreciation for the work of our railway mechanical departments when I tell you that my earliest exposure to railroading, as in the case of many other people, really stemmed from my fascination with the old steam locomotives.

Even as a small boy, thanks to the assistance of a mechanically talented adult friend of mine, I was the proud owner of several rubber-tired, imitation steam locomotives that could operate around the city streets of Chicago. Our final work product, incidentally, was a magnificent machine built on the chassis of an old Stanley Steamer automobile, which carried a steam pressure of 600 pounds per square inch with about 700 degrees superheat, and which exhausted up the stack of this engine just like a real locomotive. I can tell you that on a cool evening, laying down a heavy blanket of steam while traveling down Main Street in Lake Forest, my old home town, we really scared the hell out of many a local native.

When I was old enough to seek my first railway job back in 1939, I, like so many others, was frustated in my ambition to enter engine service due to the huge unemployment in railroading that existed in those days. In fact, I had to settle with what seemed at the time like the next best thing. Actually it proved to be a whole lot better, because it was a job in Santa Fe's mechanical department engaged primarily in locomotive testing work.

This was a job which found me alternating between taking my turn in the dynamometer car, or perched on top of the cylinder head of a giant steam locomotive taking indicator cards, or frequently riding on the seatbox behind the engineer who was a person that I still placed at that time on a general parity with God Almighty. In fact, I sometimes think the zenith of my railroad career occurred in those early days back when we were testing the EMD proto-type of the first 5400 HP FT freight diesel. I say that because on several occasions, I found myself in the cab of this engine with an old-time steam engineer making his first trip on this modern diesel power. He would turn to me and ask, "Say kid, do I take slack with this thing?" or "How fast do you think I ought to open the throttle?" So there I was, not only conversing with God, but actually telling the Almighty how to run his locomotive. (Laughter)

I can assure you that this old association with enginemen, road foremen, air brake and fuel supervisors, master mechanics and even chief mechanical officers led to a great friendship with many people in your branch of railroading. Beyond that it provided me with a deep respect for the competence and dedication of you people in getting the job done, and the realization, also, that there are many unsung heroes in the ranks. These are exemplified, I think, by the old-time roundhouse foremen, I suppose today you would call them servicing track supervisors, whose efforts are frequently unobserved, but which are nevertheless understood and appreciated, at least by those railway managers who have ever been exposed to the firing line of daily railway operations.

In thinking of an appropriate subject to discuss today, it occurred to me after looking at your various agenda, that there is really nothing I could suggest of a technical nature that you are not already thinking about and I am sure you are working on. I suppose I could challenge you once again, as has been done, I am sure, in the past, to come up with a better locomotive, one that you could always feel safe in shutting down. For example, one built like a Frigidaire with a sealed engine room to be opened only every 100,000 miles, or even one that could burn powdered coal in the manner originally contemplated by the great designer Rudolf Diesel himself.

But I decided perhaps it might be more appropriate to discuss one of the more general problems facing our industry. It is one that bothers me a great deal, and one in which I think you can all help, namely in going something to improve the poor public image which is enjoyed by the railroad industry today. And an old problem it is. Ever since I have been around the railroad, we seem to have been fighting it, and we seem to be making little progress.

Of course image, like personal reputation, is a mighty nebulous thing and to a great degree it has to be earned. As in the case of a good reputation, a good image is slow to be acquired and very easy and quick to lose.

Some aspects of our poor image are, of course, unfortunate hangovers of the distant past. I have in mind, for example, the history book and school room emphasis on the so-called robber barons of the Nineteenth Century railroading that led to the creation of the Interstate Commerce Act just to name a few examples. Then more recently we have generally been labeled with an unprogressive outlook on life, a lack of interest in performing good service, or in finding new ways to perform better service. All of these things confirmed in the public mind by the generally poor state of railway passenger service that existed before 1971, and the disappointing state of affairs that has prevailed since that time under Amtrak.

Then we have the unfortunately true image relative to some portions of our industry resulting from their sad state of property maintenance that have prevailed in certain parts. These have been highlighted by well-publicized, massive rehabilitation programs required in the East, and also by the bankruptcy of certain lines here in the Midwest. However, no one seems interested in analyzing or understanding the true causes of these misfortunes; people also tend to disbelieve the fact that there are really many other railways that have been kept in a most excellent state of maintenance.

On still another front, more recently we have been held responsible for creating a perpetual freight car shortage. This, notwithstanding the fact that we have been faced with record grain harvests, huge export programs and the fact that we have been setting all-time records in the volume of total transportation service performed. Most recently, as we face the legislative arguments in the campaign for railroad deregulation, we find ourselves pilloried in connection with charging allegedly excessive coal rates. And we face accusations of once again playing the role of monopolists, extorting the helpless consumer with unconscionable rates just as though we were an OPEC of the transportation world.

I think the important thing for all of us to do is to first sort out whatever bona fide charges exist and do wht is necessary to correct them. As for the rest, we should act as a team in an effort to correct the many misconceptions that exist in the public mind as to the true facts and accomplishments of railroads and railroaders.

As I have just suggested, I would be the first to acknowledge that reputations and public image in the long run must depend upon performance. No amount of advertising or Madison Avenue approach can permanently sell a bad product or develop an image which will stand up for long if it is not warranted. This reminds me of the story that I read yesterday about the thrice married lady who was appearing before the judge to seek her third divorce. The judge was very curious about the fact that each one of her divorces was based upon the unfortunate fact, as they say in the trade, that her husbands were unable to consummate the marriages. He asked her to tell him some of the details of their situations.

"Well," she said, "with my first husband, poor old Joe, it wasn't his fault, but he was just plain impotent. And the second one, on our wedding night, to my horror, I find out that he was a gay and didn't even want to look at me."

The judge said, "Well, that's too bad and I can really sympathize with you. But how about this case that is set before us today, how about your third husband?"

And she said, "Well, he is a little different. This fellow likes to talk. In fact, he is a public relations expert. And on our wedding night, he spent the whole night sitting on the end of the bed telling me how good it was going to be." (Laughter)

It seems to me performance is the key word for what counts. I think that American railroads really don't have much to be ashamed about when it comes to performance. We have had our troubles, yes, but we have also had to perform. We on the Santa Fe have tried to do our share both in performance and also in trying to publicize it throughout the years. For a moment you must pardon me for talking a little bit about the Santa Fe. I do so only because it is the company that I know the most about and its accomplishments.

For example, taking this first subject that we are criticized about, the passenger business. Right until the very end of 1971, we endeavored to furnish the very best passenger service in the world, realizing that passenger trains were one of the few contact areas that the public had with railroads. Almost every other exposure that they have to us such as waiting for long trains at grade crossings, was negative. Nevertheless when it came to passenger service we finally had to cry uncle when our annual passenger train deficit surpassed $40 million each year. Unlike other industries, we could not simply give up such service, we had to buy ourselves out, and in the year 1971 the Santa Fe alone incurred a charge of about $64.5 million just for the privilege of getting out of the passenger business. And I promise you there will be countless people who will come up to you as they do with me day after day and ask, why can't we have wonderful passenger service like we see when we go abroad? It is very difficult to explain to those people that we used to have that kind of service and we could have that kind of service today if we wished to pay for it. What they don't understand is that in those European countries they are operated as social welfare institutions. Each one of those beautiful passenger services is run at an annual deficit of billions of dollars each year. It is all quietly passed along to the taxpayer, and the poor citizens of those countries really don't understand what is happening to them.

Let's consider other areas of railroading modernization. We have had a tremendous but rather quiet change over the years. As a leader in dieselization, we on the Santa Fe helped to place railway motive power on a new and modern basis. It was our early introduction of the freight diesel that allowed motive power history to be made in the west, and few people recall that it was a former Santa Fe president's prescription for a dynamic brake which would duplicate the function of regenerative braking found on electric railways that prompted Electro-Motive to develop a proto-type brake of this design. Incidentally, this was a device whose grand debut I personally had the opportunity to witness at close range on the down grade of the Santa Fe near Mountainair, New Mexico. It was a debut that was spectacularly unsuccessful, but which only served to challenge us to an eventually happy conclusion.

In another area with which you are familiar, freight train equipment, the railroads have also made tremendous progress. Here again on the Santa Fe we helped pioneer the development of multi-level automobile cars which were instrumental in returning such traffic to the rails from the highways. In the realm of piggyback, we have offered the ten-pack skeletonized-articulated cars which are 35 percent lighter and which save about 15 percent in fuel costs or almost 6000 gallons of fuel for a transcontinental roundtrip trainload of this equipment.

When it comes to service which is really what counts, we have endeavored to set the pace in high-speed piggyback schedules as exemplified by the famous 40-hour freight train known as the Super C which ran daily between Chicago and California before we had to give it up. Just last week we inaugurated the first run-through coast-to-coast piggyback service in the United States with Conrail of a type which we had originally planned for the old Super C.

And finally in the area of the track itself, that I guess you people don't talk too much about but you are very much dependent upon, almost 40 years ago our company undertook the introduction on a broad scale of continuous welded rail and recognized the economies that it represented. We adopted a policy which since the year 1956 has seen nothing but continuous rail laid in Santa Fe main tracks. If there is any contribution that I have helped make for the railroad it has been we have kept this up year after year, the rails and ties, and have sacrificed many times trying to keep things at a high level, but I think it is beginning to pay off now as we are faced with more and more competition from our friends on the highways.

I have been talking about the Santa Fe because I am familiar with it, but I know there are many other railroads that have been equally progressive. Some have made more progress than we in areas such as data processing, electronic development, special fuel-saving devices and so forth. I truly believe that while the gauge between the rails has stayed the same and while the fundamentals remain unchanged, the techniques of railroading in America have been revolutionized in a manner for which our engineering and mechanical people can take just pride.

The point is, who knows all this or gives us any credit for it? Not the man in the street, not the gentlemen of the press, and not your legislators I assure you. Some of us have tried to reinforce accomplishment with advertising or public relations programs that endeavor to tell the world what we are doing, but we are not being very successful. In our case, we have sponsored regular TV advertising in major cities throughout the country including even New York City and Washington. Other railroads have followed somewhat similar programs usually using other media. Then, of course, there has been an on-again, off-again AAR advertising campaign including the present "Myth versus Reality" theme dedicated to straightening out some of the misconceptions that I have described. Next year I think we will get some help from a new organization, The American Railway Foundation.

Yet for one reason or another, we have been unsuccessful in convincing people of the facts and realities of railroading today. If your experience is like mine, you still find people relating railroads only in terms of some long-departed, highly varnished passenger train they may have ridden, and with no appreciation whatsoever of the major role that we play in the nation's commerce.

Despite our frequent efforts, few people yet understood the inequitable competitive conditions under which railroads operate. I refer to the fact that American railroads own and maintain their own rights-of-way at a cost of some $4 billion each year in maintenance costs and a half-billion dollars each year in state and local taxes. In fact, the American public, instead of being incensed at the monster tractor-trailers crowding them off the intercity highways and destroying their pavements, seems to have made folklore heroes out of these highway cowboys whose prime objective seems to be to violate speed laws and outwit the fuzz.

Complacency is the rule when taxpayers are informed that barge line operators use our nation's waterways completely free of charge despite the billions of dollars of taxpayers' money spent in improving the waterways' navigability. In fact, the usual response, and I am sure you have had this too—the response to such arguments is that our competitors are only getting their overdue share of the national treasury which the railways received in the form of land grants way back in the Nineteenth Century. This is one of the most prevalent misconceptions in the country today because our school history books still fail to describe properly the true railroad land grant story. It is one that you should know about and can help dispel the myths.

In the first place, our teachers fail to tell the students that only 8 percent of the nation's rail mileage received financial help through land grants, nor is there an adequate description of the role of the railways in opening up the wilderness when there was insufficient economic incentive to do so. But the most important shortcoming of all is the failure to explain that these land grants were not really grants at all, because they carried with them an important quid pro quo. This was, that for the next three-quarters of a century, until 1946, the railroads were required by law to haul government freight and personnel at approximately a 50 percent discount. When these bargain rates were finally discontinued by Act of Congress in 1945, these grants of lands which had an original valuation of about 125 million had produced railway contributions to our government of about a billion and a quarter dollars. In other words, the railroads paid for the original value of the land grants about 10 times over. This is something that is not generally understood.

Perhaps the most disappointing treatment that we are receiving today comes from the hands of people who should be our friends and fellow partners in solving the country's energy problems and in supporting a free enterprise solution to them. I refer to some of our good customers in the electric utility industry who have the notion that we are victimizing them by excessive rates because there is no one else around to haul their coal. The real facts of the matter are that we are providing that service far cheaper than anyone else is willing, and if it weren't for that, there would be plenty of people willing to do the job. Nor is any mention made by these people of the cost of the coal itself which has escalated many times in price since the period prior to the energy crisis. It is sad indeed that these customers fail to recognize the need for railways to produce the same degree of profit that they themselves are permitted to earn, and they fail to recognize that the nation's energy lifeline will be no stronger than its weakest link.

notion that we are victimizing them by excessive rates for hauling their coal vast distances of up to 1600 miles. In fact, we are accused of charging them excessive rates because there is no one else around to haul their coal. The real facts of the matter are that we are providing that service far cheaper than anyone else is willing, and if it weren't for that, there would be plenty of people willing to do the job. Nor is any mention made by these people of the cost of the coal itself which has escalated many times in price since the period prior to the energy crisis. It is sad indeed that these customers fail to recognize the need for railways to produce the same degree of profit that they themselves are permitted to earn, and they fail to recognize that the nation's energy lifeline will be no stronger than its weakest link.

Only last week, in a very unusual case, a major Midwest electric utility, after being denied a rate increase that it said it required, found it necessary to discontinue all work on a major new generating facility. That is what we must not let happen on the railroad. We cannot afford to be bled dry and not get the job done.

Furthermore, as we receive, as we are going to, more and more freedom in the setting of rates and in the relaxation of restrictions surrounding our operations, I have no doubt the railroads will able to continue the huge investments in track and equipment that are needed to beat the energy problems of this country. I think it is time that the country, including our customers, understands this.

I suppose all of us in the railway business have to accept some of the responsibility, in fact a lot of the responsibility, for failing to do better in this big game of public relations—and do better we must. All of the lack of knowledge and just plain misinformation tend to cast railroads as the fellows wearing the black hats at the very point in our history when I think our fortunes are finally taking a distinct turn for the better. It is high time that they did, because an industry that has earned less than 2 percent return on its assets for the past 3 years is in dire peril of acute financial anemia. I for one see a golden opportunity ahead for us as the cost of energy soars.

You know, some people have disparaged our continued emphasis on fundamentals, by which I mean the economics of the flanged steel wheel on the steel rail that makes railroading possible. But that is really what railroading is all about. You, who are directly in the business of moving trains, don't need to be told that this fortuitous combination has permitted us to creat one of the outstanding examples of automation and productivity in the history of American industry. I mean by that, of course, the American railway train. Each time that the price of energy in this country increases, we should gain a new competitive edge over other forms of surface transportation due to the inherent efficiency of railroads which gives us a three to four times advantage in the use of energy as compared with that which is required by intercity trucks.

This year for the first time in my memory, the cost of fuel required to move a train is exceeding the cost of employes and this can add further to our strength as the years go by. our competitors in other forms of transport are feeling this crunch far worse than we. Aside from the matter of fuel, there is still great room for improving the productivity of our railway employes and this can add further to tour strength as the years go by.

We will be effective, however, only if we can obtain truly equitable competitive conditions, and only if the rules of the game are made equal for all the contestants so that our inherent advantages will indeed prevail.

Beyond this I feel that our success will depend on something else. It will depend in large part on our ability to win the battle of public opinion and to overcome the out-of-date image that we have inherited, and in refuting the propaganda being encouraged by some people that would cast the railroads as continuing monopolies hell-bent on victimizing the American consumer.

Here I suggest is a role that each and every one of us in the railroad business must play much more vigorously than in the past. Let's each and every one of us take on the additional job of talking it up among our friends in the outside world, particularly among our acquaintances in the teaching profession, for those who work for the newspapers, and most important of all, let's get better acquainted with our legislators at both national and state levels. Let's let them know what our problems are, and what we are doing to solve them, but more importantly, tell them what is really going on in the world of railroading. In short, let's make certain that people know there really is such a thing as up-to-date railroading in America, that we are indeed operating high-speed and dependable service in many areas of the country, and that we expect a renaissance of traffic in American railroads that will once again make us the backbone of this country's transportation system.

There are a lot of railroaders who are still mighty proud of their profession, of their companies, and of their friends. There are a lot of voices in railroading families, and, by golly, I for one think it is about time they are being properly hear. I hope you will all join us in that area. Thank you very much.

(The audience arose and applauded.)

CHAIRMAN SMITH: Thank you, Mr. Reed, for that informative and educational presentation. If your time permits, you have a cordial invitation to join us with the rest of this morning's program. I understand that your schedule is very demanding, and if you must depart, I am sure that we will all understand.

# MONDAY MORNING SESSION

## September 17, 1979

### REPORT OF THE COMMITTEE ON DIESEL ELECTRICAL MAINTENANCE

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Supervisor Motive Power
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Montreal, Quebec, Canada

**R. G. CLEVENGER**
2nd VICE PRESIDENT
General Electrical Foreman
Atchison, Topeka & Santa Fe Railway
Kansas City, KS

PRESIDENT HARLEY: I would like to call the annual meeting of the LMOA to order and welcome you to a lovely day in Chicago. I welcome you all as prospective members of LMOA in case you are not already members. We have a lot of membership blanks at our headquarters downstairs, and we would like to have you go down and sign up and join the ranks of LMOA.

We have a very interesting program for you this morning. I would like to call on our Vice President, Bob Clevenger, who will serve as the officer of the meeting this morning.

MR. R. G. CLEVENGER [General Electrical Foreman, Atchison, Topeka & Santa Fe, Kansas City, Kansas]: Thank you, Mr. President.

This morning we are privileged to have the Diesel Electrical Committee open our annual meeting. This fine Committee is chaired by one of our neighbors to the North, Mr. Harold Stringer, who is with the Canadian Pacific Railroad.

[Mr. Clevenger introduced Mr. H. G. F. Stringer. Mr. Stringer introduced the members of the Diesel Electrical Maintenance Committee. Their report was summarized by Mr. Stringer, Mr. Westerfield, Mr.

Liban, Mr. D. I. Smith and Mr. Anderson.]

MR. H. G. F. STRINGER [Supervisor Motive Power, Canadian Pacific, Ltd., Montreal, Quebec]: Gentlemen, we would very much appreciate your serious consideration of our report. Don't treat it as just another report, because I feel there is a great deal to be gained by passing on this information. Some railroads spend a good deal of time and money developing modifications, and if they are truly to be of benefit they should be passed around.

That concludes our paper for this year, and we thank you for your attention.

We are now open for questions. Is there anything we have said that has stirred you up or excited or offended you? How about the manufacturers?

MR. H. W. PELZER, JR. [Halogen Insulator & Seal Corporation, Elk Grove, Illinois]: Last year I addressed your Committee in regard to teflon insulator bands. The Committee said they would report on it at this meeting. I understood one individual today mentioned that traction motors would be brought up at the next meeting. Will that be reported next year?

MR. STRINGER: I think you can assume that. We certainly are going to put the Canadian National to work on it. I think the other half of the Canadian railroad industry on this Committee has carried the load entirely too long!

On teflon bands, there is quite a controversy going on as to whether to use the split band or a solid one-piece band, or whether indeed you put on a teflon band at all. It will be a very good item for discussion, and is one in which we hope to involve the builders as well.

MR. PELZER: The reason I brought it up is that Halogen has taken steps to go even farther regarding the endless band. We have developed a band that can clear the commutator hub, and when you put the motor into the oven the band will shrink right into place and you will need no extra tooling out in the field. We brought a couple of small rings with us to demonstrate it, so if anybody at this meeting is interested they can stop and see us. We will demonstrate it.

MR. STRINGER: Do you still use a cement band on the face of the commutator riser?

MR. PELZER: Yes, we recommend it. We have been working with General Electric, and they use epoxy and a tape also. I guess EMD does the same thing.

MR. STRINGER: That certainly is the critical spot on any teflon or other band application to the front end.

MR. PELZER: The OEM manufacturer at this time is lowering the flange area so it is underneath the commutator bars. I think what they have experienced in the field is that you have insulation between the commutator bars and a thermal

expansion effect between the two materials, causing fatiguing of the teflon band.

MR. STRINGER: I am sure a good many people will be interested in your product.

MR. B. A. CUMBEA [General Manager Locomotive Maintenance-Engineering, Chessie System, Huntington, West Virginia]: The proposed new FRA regulations for locomotive inspection have a rule which states that "batteries shall not gas," period. Through the AAR it has been requested that this be changed to "batteries shall not gas excessively." Of course "excessively" becomes a matter of interpretation. Is there a battery available which will not gas?

MR. STRINGER: At one point in time I think there were some catalytic caps available that would convert the gas back into electrolyte.

MR. T. L. WESTERFIELD [Electrical Engineer, Chicago & North Western Transportation Company, Chicago, Illinois]: The so-called maintenance-free batteries or actually lead calcium cells that have been around for many years do have a much lower rate of water consumption, and it is gassing that consumes water. That is what causes the water to go down — the amount of gassing the battery does. The amount of gas that would come out would be smaller by perhaps ten times than what comes out of the lead antimony or what we called the standard battery.

Any rechargeable battery will gas to some degree during a full charge. On less than a full charge, it will not gas. Each type of cell has a particular voltage at which it begins gassing, and the normal voltage regulator settings that we use on our locomotives are below that gassing voltage. We would not expect any significant amount of gas to be produced by the batteries on the locomotive as long as the regulator settings are below, let's say, 75 to 76 volts.

MR. STRINGER: I see a couple of EMD representatives in the audience, Chuck Olson and Harry Quinn. I would be delighted to have an update on the present state of the new voltage regulator for the auxiliary generator, if someone from EMD would care to give it to us.

MR. CHARLES OLSON [EMD, LaGrange, Illinois]: I had hoped to be able to report to the Committee this year that we had our new flat VR11 on project; but as all good intentions go, we are slipping a little bit behind. Where we are right now is that we have a design and are awaiting printed circuit boards from our vendor. I hope we will have a project in the field within the next couple of months.

As well as the flat regulator which we are trying to achieve, we hope to have an option available that will give a voltage taper based on temperature, so that as the temperature goes down we will be able to charge at a higher

voltage. It would be an automatic feature applicable to both the VR10 and VR11. I think it would be optional, because there is a lot of mixed opinion as to whether you really do want to do this. Some battery manufacturers say yes, you do, and others say no, you don't. I think some railroads also have a mixed opinion on that. This is where we are. We are getting very close.

MR. STRINGER: Thanks, Chuck. Do you have any comment on how we are to handle this low idle option and still keep batteries charged? Is there anything in the works for that?

MR. OLSON: It is being looked at right now, Harold. The flat regulator is going to help. But again, with low idle, if you have the cab heat on, the headlights, and so on, the auxiliary generator right now is not going to be able to keep up with it, so we are going to either have to cut off some of that load or look at a larger machine. That is another answer. I really don't have a good definition right now. It is being looked at, however.

MR. STRINGER: Would one of the manufacturers be able to update us on the state of the radar speedometers at this time? We covered these in the paper, and they sound like an interesting breakthrough. Is there a manufacturer here?

MR. CLIFFORD BROEDER [CMI, Inc., Vintern Colorado]: We now have seven units operating in the field besides the test units we initially installed with EMD. We are pretty well satisfied with what has happened. We have had one electrical malfunction that I was made aware of yesterday evening. I think it is just a matter of getting them in the field and getting a little experience at this point.

We have a dedicated engineer on the project as well as a technician. We are pretty well satisfied with what we are seeing. A number of people have taken rides with it as well, and those who have used it seem to be happy and satisfied. That sounds like a sales pitch.

MR. STRINGER: Thank you. We are just looking for an update. As you know, our paper was put together early in the summer, and we are very much interested in any later developments.

I would also like to hear what Chuck Olson or one of the EMD people have to say. I believe their radar system also controls transition and wheel slip.

MR. OLSON: Our experience right now with the radar system is very good. We had some growing pains, as with all new projects, and we are working with CMI as well as others. As you know, the radar will become a basic part of our 50 series locomotive, and it is on the X series right now; so we are committed to make it work. We feel our latest version is a reliable device.

MR. WEYLIN R. DOYLE [Diesel Supervisor, Missouri Pa-

cific Railroad Company, Fort Worth, Texas]: Concerning the problem of speed indicators, I am sure we are not the only railroad that experiences a good deal of vandalism. I would like to see an indicator that would have an inexpensive display unit in the cab that can be quickly changed out, with the majority of the expensive mechanism hidden away from the crew so they can't get to it

MR. BROEDER: Are you going to replace everything totally within 30 minutes? That is if the man has a slow screwdriver.

MR. STRINGER: It also can be stolen in 30 minutes.

MR. BROEDER: I don't like that approach.

MR. STRINGER: We haven't incited the traditional speedometer manufacturers to rise. How about it, Vapor and Barco? Are you going to defend your product at this point? Do you have some thing in the works that we can look forward to? We just don't like what we see in the speedometer field. As was mentioned, we are very apprehensive about legislation that requires us to maintain them working, and working accurately, when they just don't last too long.

Any further questions? If not, I would like to turn it back to Bob Clevenger. Thank you very much for your attention.

MR. CLEVENGER: Thank you, Harold and gentlemen.

Last year after the regular meeting our Executive Board and Vice Presidents gave each of the committees an edict to see if their papers could suggest ways of saving fuel. I think you will agree that other than the talk on speed recorders this morning, Harold's paper and the Electrical Committee's report have done just that in talking about their battery charging systems, cold weather starts, load box testing, and modifications.

While that was the main topic of their paper, I don't intend to try to give any more in summary, but I would like to second Tom Westerfield's statement that he made at the beginning of his talk, and that is to use your Proceedings books and join the LMOA early enough in the year so that you can get the book. Take your book home. You will get the complete text of the report as presented by the Committee this morning. They have only hit the high spots this morning. If you take the book home and file it away, maybe five years from now you may want to look up something, and you will find it there.

I think Harold and his Committee have done an excellent job this year. We are looking forward to their report next year. Let's give the Committee a big hand. [Applause]

PRESIDENT HARLEY: I have just a couple of brief announcements. The session tomorrow morning will be suspended so that you will all be able to look at the exhibits. We would appreciate it if we can have as good an attendance as possible at these sessions. We have deliberately left a hole in the schedule for tomorrow morning so that you can attend the exhibits and still be able to get in on all of our sessions and hear all the committee reports.

Make sure that when you get the transcript of your remarks you correct it and mail it back to Mrs. Emmons as soon as possible. It takes just a few people who don't return their edited comments to her to hold up the whole printing process. We would greatly appreciate your getting your edited comments back to her as quickly as possible.

The afternoon session will begin at 2 p.m. I wish to thank you for your attendance today. We have two more important papers to be presented this afternoon.

[The meeting recessed at 11:45 a.m.]

# MONDAY AFTERNOON SESSION
## September 17, 1979

The meeting reconvened at 2 p.m., Mr. E. T. Harley, President, presiding.

PRESIDENT HARLEY: We have several Past Presidents in the audience today. Carl Stendahl in the red coat is easy to notice. We have George Bachman with us, who served as President a number of years ago. I don't see Ky Pruchnicki, but I know he is here. John Schroeder is around in and out of the sessions, another Past President. We are very fortunate to have these four Past Presidents attending this meeting.

Gentlemen, I stand before you this afternoon as a locomotive maintenance officer who has turned into a "car knocker" or, as they say on the Santa Fe, "car toad."

On May 15 of this year I joined Trailer Train Company of Chicago as Chief Mechanical Officer, and have since been elected Vice President - Equipment. While our total

**LMOA Past Presidents Carl Stendahl, BN 1974; Ky Pruchnicki, SP 1972; George Bachman, EJ&E 1968 and John Schroeder, BN 1976.**

locomotive fleet consists of only two 44-ton switchers and a Whiting "Trackmobile," our car fleet is something else — it is expanding exponentially.

In June of this year we celebrated our 100,000th car. We will have 108,000 cars by the end of 1979, and possibly as many as 126,000 by the end of 1980. While we already exceed all individual railroads in total annual car mileage because of the high-utilization flat cars that form the backbone of our fleet, we will probably equal the individual freight car ownership of the largest car-owning railroads some time in 1981.

While you are familiar with our flat cars and Railbox cars, you probably didn't know that we, subject to being granted permission by the ICC, are entering the gondola car business with 7,000 cars planned for 1980-1981.

We are also engaged in the construction of new repair shops for our growing car fleet, at the rate of about one shop per year. We completed a shop at Mira Loma, California, a few months ago and are now working on a shop of equal size at Bear, Delaware. These are very large facilities with 200,000 square feet under roof, and several miles of associated trackage.

Yet Trailer Train is an integral part of the railroad industry, being primarily owned by twenty-nine railroad companies. We serve these railroads, and all others in some respects, by supplying them serviceable, well-designed cars at a minimum cost; and that is the key to the success that we have enjoyed thus far.

While the success of Trailer Train is paramount to me, I cannot help but be concerned with the health of the railroad industry which we all serve. We have the safest, least polluting and lowest energy-use form of general transportation available. Yet we as an industry have faced a decline since World War I which was only interrupted by our all-out transportation effort in World War II.

We are the only form of transportation that can operate without critical petroleum fuel by the use of electrification; yet the last installation on a U. S. common carrier railroad was completed 41 years ago (in 1938), and much of the electrification that existed in 1938 has been torn down. This is totally contrary to trends elsewhere in the world where electrification is continuing at a rapid pace.

We have the technology to operate freight trains in an automated mode, yet the only automated trains in operation are utilized by a power company in southern Ohio, operating on private property. Even simple remote radio-controlled operation of switching locomotives is found only in industrial railroad applications.

The $700,000 locomotive units pulling our trains average less than 200 miles of service per day, and the $40,000 cars that they are hauling, less than 60 miles per day.

Finally, to add insult to injury, that $60,000 house on wheels at the end of the train, the caboose, is an anachronism from a long-gone era of railroading that no longer exists.

The fact that U.S. railroads have survived to within 21 years of the 21st century, however, is a tribute to the inherent efficiency of the steel wheel on a steel rail. Without that advantage, we would all have "gone under" long ago.

What can be done to return the industry to the rightful place that it deserves. I believe that the answer is one word — FREEDOM.

1 — We need the freedom to compete with other modes on an even basis, with everyone paying his own way or, if that cannot be accomplished, with equal subsidy to all.

2 — We need freedom from non-cost effective laws and rulemaking which may have been made with good intention but which have the effect of raising railroad costs, and diverting traffic to other modes.

3 — We need freedom to use railway equipment more effectively, with more two-way loaded movement and less delay — similar to what we see at Trailer Train in the 98 percent loaded movement of our Railbox equipment operating under its simple phrase, "Next Load — Any Road."

4 — We need freedom to set realistic rates in an economy where railroads have long since ceased to be a monopoly. And finally —

5 — We need freedom to bargain collectively and conclusively with labor on issues involving technology.

The railroad industry was probably the most important single factor in forming this country. It located most of our inland cities, and certainly was responsible for colonization of the West. We only want the opportunity to serve again.

I want to thank you for the opportunity to serve the LMOA for these many years, and I wish our new President, Jim Long, who will be installed in office on Wednesday, the best of everything. [Applause]

I will now call on Darrell Walker, who will be the officer of the session.

# MONDAY AFTERNOON SESSION
# September 17, 1979

## REPORT OF THE COMMITTEE ON DIESEL MATERIAL CONTROL

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

**D. M. WALKER**
6th VICE PRESIDENT
Diesel Superintendent
Southern Railway Co.
Atlanta, GA

MR. DARRELL M. WALKER [Diesel Superintendent, Southern Railway, Atlanta, Georgia]: May I ask the Diesel Material Control Committee to come forward, please.

SECRETARY JOSEPH J. T. KOERNER: While the Committee is assembling, I would like to give you an up-to-date figure on membership. As of this time we have 1,144 railroad members, 312 associate members and 120 advertisers, making a total of 1,576 members as of the start of this convention

MR. WALKER: Thank you, Joe.

[Mr. Walker introduced Mr. D. L. Ward, Chairman of the Diesel Material Control Committee. Mr. Ward introduced the members of his Committee. The report was summarized by Mr. Ward, Mr. Wall, Mr. Blessing and Mr. Cruise.]

MR. WARD: Are there any questions? If not, I would like to call on Regional Executive Jim Gregory and ask him to summarize our paper.

MR. J. J. GREGORY [Production Control Manager, Consolidated Rail Corporation, Altoona, Pennsylvania]: I think we should express our thanks to Mr. Ward and his Committee for a job well

J. J. GREGORY
REGIONAL EXECUTIVE
Project Mgr.-Heavy Repair Shop
Consolidated Rail Corp.
Altoona, PA

done. Compared to other committees, in terms of service this is a neophyte group that has been in operation for only eight or nine years.

One other thing I should mention is that this is the first time that all members not only showed up but actually participated in the preparation of the paper. This is the same Committee that brought to the forefront the importance of warranty. This is the Committee that said, "Let's put warranty labels on items we rehabilitate." It was Don Ward who several years ago gave Conrail the idea of developing a locomotive information system.

To summarize the discussion, it appears that the small and intermediate railroads have kept abreast of the times as far as their inventories are concerned, but the larger major railroads seem to have slipped materially.

I would like to pose some questions to the audience that you might mull over, and I hope other questions will be brought out at the What's Your Problem session on Wednesday.

One of them is: What effect did the deviation from scheduled overhaul maintenance that many railroads had in the 1960s have on the inventory today? Many railroads, due to financial conditions, were not able to bring their locomotives in every two, three or four years, as many of us did in the 1960s.

Up to 60 percent of all the repair/return material overhauled in the backshops is sent to the terminals. When you stop to think about it, we can do the job much cheaper in the backshops than in the terminals.

One thing brought up some time ago was that the Frisco Railroad set up their computerized system to determine the projected or predicted life of major parts. I think if railroads would make an analysis and determine what the predicted life of a major component is, so that these components could be replaced at the time of overhaul, you could reduce your inventory materially in the terminals. Total value of rehabilitated material runs into hundreds of millions of dollars.

In closing, I would like to thank Don Ward and his Committee for a job well done. Let's give them a big hand. [Applause]

MR. WALKER: Will the Committee on New Developments come forward, please.

PRESIDENT HARLEY: While they are coming to the platform I have a couple of announcements to make.

I would certainly like to thank the advertisers who have contributed to our success as far as the operation of the LMOA is concerned. We depend greatly on our advertisers, and we hope we return to them in equal measure their bringing of products before the people who make the decisions in the railway mechanical and storage functions. We appreciate you and love you, and we would like to see more of you advertising in our Proceedings.

We would like to make sure that as many of you members attend these sessions as possible, so therefore we respectfully request that you stay out of the supply rooms until our meetings are over. There will be plenty of time for the types of things you can do in supply rooms other than while we are holding our meetings.

The program tomorrow will begin at 2 p.m. During the morning you will have time to look at both the inside exhibits and those outside. They are well worth attending. A lot of money has been spent and a lot of time has been given to making these exhibits outstanding, and they are certainly worthwhile attending. We recommend that you attend them. For that reason we have modified our program so that you will have time to visit them tomorrow morning without missing any of our meetings.

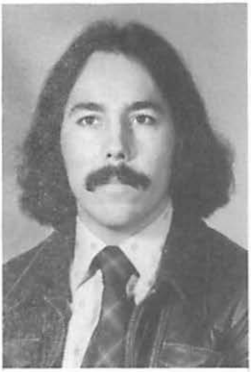
I would remind you to turn in your questions for the What's Your Problem session Wednesday morning.

Again we invite all of you to become members if you are not presently a member. All you have to do is to go to the registration desk and we will be happy to sign you up as a member of LMOA. We will be proud to have you join us.

Now I would like to turn the meeting over to our First Vice President, Jim Long, who will serve as officer of this part of the session.

# MONDAY AFTERNOON SESSION
# September 17, 1979

## REPORT OF THE COMMITTEE ON NEW DEVELOPMENTS



**CHRIS W. COX, Chairman**
Locomotive Gang Foreman
Atchison, Topeka & Santa Fe Railway
Kansas City, KS

**JAMES H. LONG**
1st VICE PRESIDENT
Manager Locomotive Dept.
Chessie System
Cincinnati, OH

MR. J. H. LONG [Manager Locomotive Department, Chessie System, Cincinnati, Ohio]: We will now have the report of the Committee on New Developments. The chairman is Mr. C. W. Cox.

[Mr. Long introduced Mr. Cox, who in turn introduced the members of his Committee. The report was summarized by Mr. Bang, Mr. Caulton, Mr. Goehring, Mr. Coles and Mr. Cox.]

MR. COX: The potential for new developments is endless, and it takes the efforts of all concerned to give feedback when problems are encountered, and to communicate and make changes and correct problems where they exist, in order to continue to allow new developments, and our industry to handle its needs and hopefully to exceed those needs.

Are there any questions from the audience?

MR. R. W. LEEDY [Contract Administrator, Illinois Central Gulf Railroad, Paducah, Kentucky]: I have a couple of questions. One concerns the quality control section of your paper on the in-process inspection. I need a little clarification on all of the things this would involve. I have in mind that this would actually take away the responsibility of the supervisor. If so, what effect would that have on the program?

MR. D. G. GOEHRING [Manager Motive Power Maintenance Planning, Amtrak, Washington, D. C.]: This same concern was discussed while this portion of the paper was being prepared. However, it was the opinion of the personnel on the railroad that was establishing quality control on the in-process line that a dedicated quality control supervisor would help the shop supervisor to better understand his responsibility in producing a well-maintained locomotive.

They [the railroad] reasoned that if a shop supervisor was receiving excessive quality control checks, the shop production would be held up. The shop supervisor would then have to insure his mechanics improved their adherence to proper maintenance procedures and keep the work moving smoothly. This in turn would strengthen the supervisor's skills and not detract from them.

MR. LEEDY: Is this geared more for running repairs as opposed to repairing components in major shops?

MR. GOEHRING: The in-process quality control was instituted in both the 30-day inspection process and the daily or trip maintenance locations. Repairing components in a major shop has traditionally been performed under some kind of a quality control program.

MR. C. W. COX [Assistant Roundhouse Foreman, Atchison, Topeka & Santa Fe Railway Company, Kansas City, Kansas]: Some of the other quality control programs are being used in major overhaul programs, component programs, and can be used anywhere in the maintenance of locomotives.

MR. LEEDY: Another question concerns the on-board diagnostic monitoring system. Unless someone has actual experience with this equipment other than for testing purposes, I can't imagine what benefit you would get that you couldn't get from the engineer's work report, or if the unit came in out of water, with low oil between trips or whatever the cause might be. I need a little more information on the actual practical preventive maintenance use of those devices.

MR. COX: The main goal behind those devices is to capture information during actual operation and measure information that will indicate the real performance of the locomotive that might help tell why the failure occurred or why that particular locomotive is not putting out full horsepower.

So, there are many items that can be measured on the road during locomotive operation that you would never see when a unit came into a shop failed, or you weren't even aware that the locomotive wasn't producing full horsepower. There are a lot of instances where an on-board diagnostic system could tell you something that you are not actually seeing after the unit arrives in the shop.

MR. ARNE J. BANG [Office of Freight Systems, Federal Railroad Administration, Washington, D. C.]: I couldn't agree more that the locomotive engineer can relate to the maintenance personnel a great deal, but there are many things that go on in a locomotive unit that the engineer has no knowledge of.

A hypothetical example is an overheating traction motor. How is the locomotive engineer going to be able to relate that to you? And, after the unit has been standing not under great load for a while, how are you going to determine that has occurred? Those unknown items are the things that simple diagnostics can alert you to before the unit travels too far and indeed burns out.

MR. LEEDY: Do you have any practical experience with this equipment on a railroad?

MR. BANG: Not as yet, except as noted in the report. This is primarily intended to be a report of new developments, items that are becoming available, and the span of equipment goes from the rather simple, rather low-cost, to the highly sophisticated.

The purpose of the particular unit [Locomotive Data Acquisition Package] that we are developing is what you alluded to. It is a research tool. It is nothing more than that. It is not intended to be on every piece of equipment, but some of the other devices are being developed with the idea in mind that they would indeed be on locomotives for use by the maintenance facility.

The more sophisticated ones are to be used just as you said. For example, someone comes along and says a new fuel additive is really great, fantastic and super, and that it doesn't harm the locomotive; so you do lab tests and other tests. Then you really want to find out what it looks like in the real world. You need some pretty sophisticated equipment to do that, and indeed at this stage of the game we have been carrying around railcar data acquisition systems with a whole research crew operating them. You could have a whole regime of these diagnostic tools at your disposal depending on what you are after.

That is why the big question mark was up on the screen. Do we go with simple annunciator panels? That is a simple concept. Do we go with fancy cathode ray tubes that tell the engineer something is going on in the locomotive that he should know about? These items are merely the new developments coming up, and that is what is being reported.

MR. LEEDY: I believe for testing purposes they are great; but when you start talking about expensive equipment and highly skilled, expensive people to install it and maintain it and interpret all the information, there are a lot of railroads that can't afford that, and they are having problems keeping skilled supervision now.

The other part of your paper that I would like to comment on concerns fuel savings. It seems that all of the goodies are slanted toward high horsepower locomotives — or most of the reports, at any rate. I think there should be more interest placed on low horsepower units that are five or six years old. We have a lot of those, too.

MR. COX: Bob, let me clarify this Committee's stand somewhat on diagnostic equipment. As we said, we are looking for better maintenance. We are looking for the simplest systems we can have. A lot of the more elaborate systems discussed in the paper are definitely for in-shop use and testing, such as a SEARCH situation where you are actually testing locomotive mechanical performance in addition to the electrical system. We are looking for the simplest system that will give the best results. As we stated earlier, we don't want to be measuring a lot of things that we will never use.

Concerning fuel saving devices on lower horsepower locomotives, the Set-A-Speed system is designed to be used with lower-horsepower normally aspirated engines.

MR. KENNETH H. SMITH [Chief Motive Power and Purchasing Agent, Belt Railway Company of Chicago, Chicago, Illinois]: Are any of these diagnostic test systems currently in service, or is it all in the developmental stage at this time? I understand SEARCH is operative.

MR. COX: Some of the systems are being tested and some of them are in use. The more elaborate diagnostic systems that were discussed — the IDEA system and the LDAP system — have been used on diesel engines, but to my knowledge presently they are not in actual use on a railroad.

MR. SMITH: At this time, then, they don't have sufficient experience with them for maintenance?

MR. COX: No. There is one system that has been used in the field, and they are still "ironing out" some of the results. GE has an onboard engine performance system. Maybe Tom can tell us what the current status of that system is.

MR. T. C. WHITTLE [Manager Product Planning, Locomotive Marketing Department, General Electric Company, Erie, Pennsylvania]: The system has proven to us that it will provide the information we require. It was developed as part of our turbocharger program to determine what causes high preturbine temperatures. We needed such a device because you can't have people ride locomotives 24 hours a day.

With this so-called "black box," the various things that can contribute to high turbo temperatures, such as filters, the ambient temperature, and so on, are monitored on a cycle basis. When a condition of a high temperature occurs, it might be that the unit was just coming out of a tunnel and five minutes later the system would

cool off. The system would deduce that it wasn't a turbo malfunction. That is the type of equipment we are working on.

We know the concept is sound. We are coming out of what we call the "breadboard" stage and are going to production hardware. We know this approach is what we will need in the future.

The fact was alluded to that you get good reports from the crews. We have seen too many reports that come in consistently on a given unit. We keep records on our units especially during the two-year warranty period. Reports may indicate that every four days or so a particular unit is reported not loading. It comes into the shop, no trouble is found, and it is sent back out. It is obvious things are happening on the line of road that you can't duplicate when you have the unit in the shop.

We are developing a device to monitor the type of things that can contribute to "not loading" reports. We believe this is another step in the development of onboard diagnostic equipment. We believe the development started when IBM and SCL began their program.

They appear to have had two main problems: First, they had to rely upon unreliable sensors. Secondly, they tried to take too much data. We are going to limit the amount of information recorded. Sensors continue to be a problem.

MR. C. H. DERNER [Master Mechanic Locomotive, Pittsburgh & Lake Erie Railroad Company, Pittsburgh, Pennsylvania]: One reason for support of this sophisticated diagnostic equipment: P&LE owns twenty-two U28 GE locomotives since 1966 and has suffered many low-water shutdowns. P&LE found out that it was not an 8th notch shutdown while pulling tonnage. Shutdowns happened when setting off cars and reversing and then widening out on the throttle. This year GE finally instructed P&LE to set the low-water shutdown as low as possible. This has eliminated similar low-water shutdowns. An onboard system would have detected this type of failure at an earlier period of the unit's life span.

MR. COX: I would like to bring out two very important points. First, I would like to thank the Southwestern Railway Club very much for allowing us to present our paper at Little Rock last April. We were very impressed with the Club. We had a very good turnout and it was well organized, and we would like to extend our thanks to all those members.

Another thing I would like to mention is that this year we are missing one of our hard-working members, Milton Crandall. I am sorry to report he passed away in January. I would like to take a moment to give our respects to his memory at this time.

Now may I call on Bud Cumbea to come up and summarize our paper.

MR. CUMBEA: I think Bob Leedy stole most of my thunder,

B. A. CUMBEA
REGIONAL EXECUTIVE
Gen. Mgr. Locomotive Maint.-Engineering
Chessie System
Huntington, WV

so my remarks will be very brief.

Last year I made the suggestion that the executive officer give a critique rather than a summary of the papers. Also, I alluded to the fact that this was much more difficult to do than to say.

I think this Committee has done an outstanding job in preparing an informative paper, but a paper which lacks a little bit in reaching definite conclusions or recommendations. I think they could have been a little stronger in that area. I also feel that perhaps the presentation of the paper took a little too long and it cut down on audience participation. To me, that is one of the maximum benefits to be derived from attendance at these conventions, and on the Chessie system we have to document the benefits received.

Floor discussion is included in the annual LMOA publication. The book will be pretty thin next year if it depends on the floor discussions we have had so far.

I think this Committee deserves a big hand, but first I would like to have Jim Long make some closing remarks.

MR. LONG: Mr. Cumbea, thank you for your excellent remarks. Smaller book, smaller price. [Laughter]

At this time I would like to turn the meeting back to President Harley.

PRESIDENT HARLEY: If there are any questions that have not been answered, please write them down and bring them up at the What's Your Problem session on Wednesday morning.

Be sure to see the exhibits, both indoors and outdoors, and be back here promptly at 2 p.m. tomorrow.

Now I would like to ask for a rising vote of thanks to the Committee for their efforts.

[The audience arose and applauded.]

[The meeting recessed at 5 p.m.]

# TUESDAY AFTERNOON SESSION
# September 18, 1979

## REPORT OF THE COMMITTEE ON FUEL AND LUBRICANTS

**J. D. SMALLING, Chairman**
Chemical Engineer
Southern Pacific Transportation Co.
San Francisco, CA

**R. R. HOLMES**
5th VICE PRESIDENT
Chief Chemist
Union Pacific Railroad
Omaha, NE

The meeting reconvened at 2 p.m., Mr. E. T. Harley, President, presiding.

PRESIDENT HARLEY: The report of the Fuel and Lubricants Committee is always one that has a great amount of interest and a lot of questions, and we hope after the paper is given you will ask as many questions as possible, because that is the whole purpose of our being here. You can read committee reports at your leisure, but the discussion that is generated after a committee report is really the most vital thing we can do.

The officer of the session this afternoon is Vice President Dick Holmes, of the Union Pacific.

MR. R. R. HOLMES [Chief Chemist, Union Pacific Railroad Company, Omaha, Nebraska]: I too have always considered the presentation of the Fuel and Lubricants Committee one of the highlights of the LMOA program.

[Mr. Holmes introduced Mr. J. D. Smalling, chairman of the Committee. Mr. Smalling introduced the members of his Committee. The report was summarized by Mr. Broman, Mr. Schackelford, Mr. Hudgens, Mr. Reed and Mr. Hoffman.]

MR. J. D. SMALLING [Chemical Engineer, Southern Pacific Transportation Company, San Francisco, California]: An error has been found in the printed report on page 258 near the top of the first column. It incorrectly reads, "The viscosity characteristics of HVI and MVI oils at 210° F. are 76 SSU and 82 SSU respectively." The sentence should read that they are in the range of 76 to 82 SSU, in the event you use this as a guideline in the future.

Gentlemen, that concludes the formal presentation of the report today. We have ample time for questions and discussion. There are a lot of experts on this Committee and in the audience who can answer questions on all phases of fuel and lube usage. If you have any questions, please feel free to ask them.

MR. T. J. PYKA [Assistant General Foreman, Elgin, Joliet & Eastern Railway, Joliet, Illinois]: Mr. Hoffman, we have been using spectrographic analysis on engine lube oil samples since 1975. I have been more or less affiliated with this. Our problem is that we get reports where discrepancies come along, and then we have our shop people check for either bearing wear or water leaks or whatever the results indicate, and then they come back to us and say, "Nothing found."

My questions are: First, how accurate is your spectrographic analysis? Second, at what point, where there is any appreciable change in the reading, would you take corrective action?

MR. J. G. HOFFMAN [Manager Combustion, Fuels, Lubricants and Emissions, General Electric Company, Erie, Pennsylvania]: I took the meaning of the first part of the question to be how accurate is spectrographic analysis in general. The accuracy is quite good, on the order of 5 percent or better, depending of course on specific procedures.

The one area of confusion that can exist is that because of different techniques, different instruments, different laboratories may obtain different values on the same sample. However, they will be internally repeatable. There is difficulty in the industry in comparing laboratory A with laboratory B and laboratory C. The values are often quite far apart, but this does not prevent the use of the technique.

This brings me to the next part of your question, at what change level would I take action. I am glad you asked it in the sense of what change level as opposed to a particular number. Because of reasons outlined in the first part of my response, I don't think one can give a specific number.

The change level that I ordinarily use is 3 to 1. In other words, if the mean value of the element established as typical for that type of operation on that railroad, or that lab engine, or whatever, is 10 ppm, and I get a value on the next sample of 30, I will take some action. The nature of action would be a function of what the element is and how confident I was of predicting a problem from that element. I hope that helps to answer your question.

MR. PYKA: We have been working more or less along those lines, and still have situations where you tell the shop people, "You have a water leak or a bearing problem," and then they come back and say, "There is nothing wrong."

MR. HOFFMAN: I only have to officially monitor seven lab engines, and I usually have the same problem. However, the cause eventually shows up.

MR. C. G. MacDERMOT [Assistant Chief Mechanical Officer, Delaware and Hudson Railway Company, Albany, New York]: I would like to generate a little discussion. I have been watching oil samples on a 100-unit fleet for seven or eight years, and I am going to be a radical and say that in that length of time I have never been able to predict a bearing or crankshaft failure from the results of lube oil analysis. Can I get a little argument started on that point?

MR. O. J. RIDER [Laboratory Supervisor, Chessie System, Cumberland, Maryland]: I am laboratory supervisor on the Chessie-B&O side of the Chessie system at Cumberland, and in the last six or seven years I have been at Cumberland. We have gone from an old Jarrel Ash spectrograph, I guess dated 1947, and in the last six years we have had their 750 atom counter hooked up to an 1130 IBM computer. Everything is automated.

In my twenty-plus years of being associated with spectrographic analysis of lube oil, a bearing or crankshaft failure cannot be predicted. For example: From the 38,900 spectrographic analyses performed on lube oil during 1978, six alerts were issued on suspected bearing or crankshaft failures. Of these, only one proved to be bad bearings.

From our experience at our lab, the spectrograph is rated as follows:

1 — Water leaks.
2 — Air filtrations and blowers.
3 — Rings — pistons — liners.
4 — Bearings and crankshafts.

MR. MacDERMOT: One thing we can spot from lube oil analysis is water leaks. We know that if we ignore a water leak from somewhere between 6 and 12 months (25,000 to 50,000 miles in our service), we will probably end up with a bearing or crankshaft failure. Other than through this indirect relationship, it is pretty hard to predict bearing failures from the wear metal concentrations determined by spectrographic analysis.

MR. K. D. REED [Director, Technical Service Laboratory, Consolidated Rail Corporation, Cleveland, Ohio]: I mentioned this a couple of years ago at the LMOA

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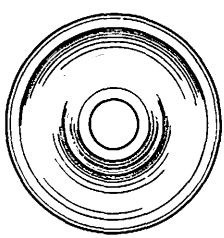

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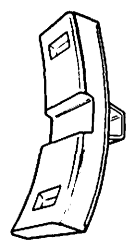

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meeting and suggested a little arithmetic problem you might want to toy with.

If you take a single bearing and take the condemning limit that EMD would suggest at which the bearing should be removed — by that I mean the amount of lead or copper that is worn — and if you actually measure this area and the depth, and calculate it to the number of grams of lead or copper, whichever you wish, and dissolve this in 350 gallons of oil, you will find you will come out to some portion of a part of 1 ppm. Maybe you are running 10 ppm on the locomotive as a normal thing. If one bearing gets to the point where it should be condemned, and you add to this another part per million, you are likely not to see it.

So, at least on a theoretical basis, anyone who has the idea you can find a bad bearing is certainly not basing it on facts or arithmetic but is basing it on some sort of phenomenon that I can't explain.

I have heard people say we can find a single bad bearing. We will get a raise of so many ppm of copper or lead, but it is just impossible. There is not that much worn off of a single bearing. If you have a whole set of bearings worn to that extent, you will be in the area where you can see something. So, I don't think it is a feasible thing to expect to find one or a few bad bearings on a locomotive by spectrograph. If you don't believe me, make this calculation sometime.

PRESIDENT HARLEY: I would like to make one brief comment on that subject. I talked to a test engineer at EMD a number of years ago. When they are running engine tests they may be running a dozen tests simultaneously, so they hate to lose a test. The test engineer told me that when he suffered a bearing failure he normally had his main bearing protected by thermocouples that were being read continuously. When a bearing failure did occur, the failure occurred so fast that he couldn't save the engine by shutting it down immediately. If you can't save it that way, there is no way, taking an oil sample every month and running it through a spectrograph, that you can expect to save an engine.

We should not lose sight of the tremendous value of spectroscopy for things like water leaks and dirt load and additive depletion and all the "goodies" that spectroscopy does give us, but catching a bearing failure by high copper or lead readings I am afraid is one thing that is out of the realm of the ability of a spectroscope to catch under normal conditions.

MR. HOFFMAN: Lest there be some misunderstanding, I concur 100 percent that bearing failure prevention is not what the spectrographic technique is all about.

MR. M. W. KWIATKOWSKI [Technical Engineer, EMD, LaGrange, Illinois]: When we think of a crankshaft failure and/or

bearing-related failure, they generally fail as a result of three problems: First, fuel dilution. Second, water contamination. Third, loss of support.

In the case of fuel dilution, we would expect you would be able to determine the actual fuel dilution by looking at the change in viscosity. We feel that from that standpoint you should be able to determine exactly how much fuel dilution you have. On the water contamination side, you should look at the water inhibitor. If you see 20 ppm chromium in the lube oil analysis you should take corrective action.

MR. HOLMES: The process of reclaiming oil has been with us for many years. Now that we have been told by the oil suppliers that we are soon going to receive some high VI base stocks — in fact, I think there are mixtures at the present time — do the members of your Committee feel that the reclamation of the mixture of high VI or medium VI oils will cause any problems either in subsequent blending or in control methods that are currently used?

MR. SMALLING: That is a very timely question and is something we will all be involved in in the near future. I think this is a good opportunity to hear reports from both of the engine builders as to whether they will have any effect on locomotive operation. I would like also to hear from a few of the oil suppliers. Who wants to start the discussion?

MR. KWIATKOWSKI: We realize the energy situation, and we will shortly be announcing in a POINTERS article a change in base stock oils. We are making the change. That is all I have to say.

MR. SMALLING: In other words, you will approve it?

MR. KWIATKOWSKI: Yes, we will. There are several major oil companies that have field tests going on right now, and some of them have already completed the field tests. Based on the information we are getting from these people, we will be changing our MI. It should most likely be happening before the end of the year.

MR. HOFFMAN: Our position has not changed over the years. That is, we have felt that high viscosity type oil formations are fine for the engine. As a matter of fact, overseas both our equipment and our competitors' equipment has been operating very extensively on high viscosity index oils for quite some time.

Further, our basic or standard lubricating oil in the engine lab has been a high viscosity index formulation for the past three years in recognition of the changing oil supply problem. It uses a standard, readily available railroad type additive. So, we forsee no problems of that nature.

I want to make sure that all of you understand, particularly those in the oil side of this industry, that it is as equally possible to make a bad high viscosity index

oil as it is to make a bad medium viscosity index oil. The additives which are around and have been used in MVI oil have been tested in certain specific, well-refined, well-put-together, high-viscosity index formulations. On that basis they can be made and used without fear, but obviously there are ways in which they can be fouled up. We trust the oil companies will maintain the high quality base stock blending they have done in the past with medium viscosity index stocks.

MR. V. E. BROMAN [Project Engineer, Atlantic-Richfield Company, Harvey, Illinois]: The question had to do with what processing might do. What you are doing with re-refining is to remove contaminants, additives, water, and so on. The processing then will really not be different, and what you will end up with is a base oil that will be equivalent to new oil if the processing is complete.

Again, the checks would be whether or not you have left metal in there, whether or not there are contaminants which would appear as insolubles, and whether or not the soot and other things have been removed. If all of these things have been done, then the use of high VI or processing of high VI oils will result in high VI new or nearly equivalent — substantially equivalent — base oils.

There is another part to all this. I believe one of our members will have a more complete statement to make about that. If you blend high VI oils with medium stock VI oils, the consequence is going to be some VI in between. One of the things we are beginning to notice is the drift up. If you have been working with a 60 to 65 or 75 VI oil you will be noticing that they are starting to creep toward 80 to 85. So, this is a relatively mild step in the process, and finally there will be little or no low VI type coastal stocks available. Then the high VI oils will start to predominate. In the meantime it will be this mixture, and this is something I think one of our members will comment about.

MR. E. A. GOFF [Industry Sales Executive - Railroad Sales, Mobil Oil Corporation, AMF O'Hare, Illinois]: I think most of you are aware that these papers are written well in advance of their presentation, and in fact tomorrow morning we will have our first meeting preparing the paper for next year. I think you saw this as evidenced in what Pat was talking about when he said he prepared his part of the paper several months ago and referred to 35 cent fuel.

When we started to write the paper for this year, people weren't even thinking about the mixture of high VI oils and medium VI oils. In order to take care of that, when you read the report you will notice at the end of the paper that we added a section headed, "Important Notice." This refers to the fact that now high VI oils will probably be more prevalent in use in the industry.

From some of the tests that you make, conceivably you would be throwing away, in error, good oil because of the change in viscosity. However, if you take your controls and check the viscosity at 210°, we have added a section here that we believe will be important to you. I would like to read this section:

"The Fuel and Lubricants Committee wants to make the industry aware of these potential and probable changes. They recommend that routine viscosity determinations be made at 210° F. rather than 100° F. because the lower 100° of viscosity of the high VI oils can coincide with condemning limits used when fuel dilution reduces the viscosity."

What that means is that if you do control it at 210° you will get such a little variation between a high VI oil and a moderate VI oil that you won't be able to detect it in most cases, and you won't be doing away with good oil.

We have Al Sarkis, one of our people from our technical department in New York, with us today. Al, I wonder if you would make a brief comment about the fact that there won't be any problems with the mixture of high and moderate VI oils.

MR. AL SARKIS [Mobil Oil Corporation, New York, New York]: I think the statement Earl made is pretty complete. The only thing I can add is the exact numbers we should be talking about.

As you know, the medium VI oils are blended at a viscosity of 210° over about 78 to 81 or thereabouts. The high VI oils, in order to minimize bright stocks, are sometimes blended at a little lower viscosity, usually somewhere between 76 or 75 to 78. So, within that point of view you will find yourself with a 5 percent dilution starting at 80 SSU at 210°. You drop down to around 69 SSU.

If you take a high VI oil at 76 and go down with 5 percent dilution, you come up with a viscosity very close to that of 68. So, the error is somewhere in the neighborhood of 1 percent dilution. On that basis we feel you are pretty close to making a proper diagnosis of the dilution if you were to use a viscosity of 210°.

MR. KWIATKOWSKI: I have two corrections to make in the paper. In the section on the effects of engine modifications on fuel and lube oil, there is an implication on page 252 that indicates that the injectors for both the 645 turbocharged and naturally aspirated engines are the same. That is incorrect. They are not. The part numbers are different. They are both low sac injectors.

Also, in the governor lube oil section of the paper it indicates that EMD recommends the use of a heavy SAE 30 or light SAE 40 turbine oil. Since the time the paper was published we have changed our specifications. MI 1764 which came out in July or

August indicates that the use of a multi-vis oil or straight weight oil is permissible, which somewhat correlates with those recommendations of General Electric.

MR. SMALLING: If there are no other questions, I would like to thank you very much for your attention.

I will call on our regional executive Dale Propp to summarize the report.

**D. H. PROPP**
REGIONAL EXECUTIVE
Director of Energy Conservation
Burlington Northern, Inc.
St. Paul, MN

MR. D. H. PROPP [Director Energy Conservation, Burlington Northern, Inc., St. Paul, Minnesota]: As always, this Committee has done a remarkable job. As John mentioned, the pre-convention meeting was held in Burlington, Iowa. In addition to our thanks and appreciation on behalf of the Committee to the Burlington Diesel Club, I would also like to thank Amoco Oil, Chevron Research and Motor Oils Refining for their part in the program.

In summary, you have heard the Committee report on re-refined oils and their continuing role in the future. The railroads have been active in that work for many years and certainly will continue in the future. The Committee, the locomotive builders, and the people associated with re-refining are working hard to identify and use the best new technology to continually improve refined oils in the future.

Your Committee has discussed recycling of chromates. Certainly, with the EPA regulations, recycling is mandatory. Besides, recycling will generate economic benefits.

In addition, disposal of oil through land farming was mentioned. This method is relatively new and soon will become more widely used. I know of some experiments that have taken place in Montana, and the process is favorable. We will be hearing more about land farming in the future.

Energy of course is always a critical subject. As the paper mentioned, the builders are working very hard to modify the engines to do whatever is possible to conserve every drop of fuel. I know that locomotive builders will continue researching for improvements.

We have talked about the new developments and recommendations concerning air compressor oils — the new car and journal oils. I had anticipated much more discussion of this subject. All of these subjects will continue, and with a Committee of this caliber I am positive that outstanding advances will develop for the railroad industry, and most of our questions will be answered.

I suggest that you do NOT return home and discard your spectrographic analysis programs as a result of hearing the discussion today. Think seriously that about 80 percent of the problems that you find in oil analysis are fuel and water leaks, and the spectrograph detects water leaks much more rapidly and scientifically than any other test. Consequently, it has to have helped save some of the bearing failures.

Silver wrist pins can definitely be detected by spectrographic analysis. Our laboratory people will find less than 1 ppm of silver in the oil, and the mechanical personnel will identify a failed wrist pin. So, I just wanted to add that bit of information regarding the use of a spectrographic program to the new techniques Jack Hoffman mentioned.

Now I would like to ask you to join me in a big round of applause and thanks to this Committee for a job well done. [Applause]

# TUESDAY AFTERNOON SESSION
# September 18, 1979

## REPORT OF THE COMMITTEE ON DIESEL MECHANICAL MAINTENANCE

**F. I. BURCHETT, Chairman**
Mechanical Assistant-Locomotives
Atchison, Topeka & Santa Fe Railway
Chicago, IL

**N. A. BUSKEY**
3rd VICE PRESIDENT
Asst. Gen. Mgr.-Operation
Chessie System
Huntington, WV

MR. HOLMES: Will the Committee on Diesel Mechanical Maintenance please come forward.

PRESIDENT HARLEY: While the Committee is coming up, I have a couple of announcements.

I want to thank all of the advertisers for their contributions to us in the form of advertising. On my right you will see a list of the LMOA advertisers. We are very happy to have these people as advertisers, and we certainly hope their advertisements have contributed to their well-being and success.

Remember, get your What's Your Problem questions in as soon as possible, because the success of that part of the program will depend on your getting questions to the panelists.

Now will the Diesel Mechanical Committee please come to the podium.

We have in the audience this afternoon one individual who attended all six of the pre-convention meetings that we held, and that is quite a job. I managed to attend five of the six. I would like to recognize Mr. Dick Goddard, of

Touchstone Railway Supply & Manufacturing Co. [Applause]

Now may I introduce Mr. Nelson Buskey, who will serve as officer for the rest of the afternoon.

[Mr. Nelson Buskey introduced Mr. F. I. Burchett, Mechanical Assistant - Locomotives, Atchison, Topeka & Santa Fe Railway Company, Chicago, Illinois. Mr. Burchett then introduced his Committee and acknowledged the warm acceptance of the Committee's preconvention presentation at the Southern & Southwestern Railway Club, Louisville, Kentucky.

[The report was then summarized by Mr. Kuhns, Mr. Thetford, Mr. Atkinson, Mr. Buffington and Mr. Burchett.]

MR. BURCHETT: Gentlemen, this concludes our paper. Are there any questions from the audience concerning its contents?

MR. PETER J. SASGEN [Triangle Engine Rebuilders, Chicago, Illinois]: Is there a figure for normal lube oil consumption for a compressor? Is there any difference in oil consumption on a compressor equipped with a circulating pump versus a compressor equipped with a rotary pump?

MR. BURCHETT: I don't have the answer, Pete. As we stated in our paper, we found last winter that many air compressors failed because they completely ran out of oil. I think there are some efforts being made at the present time to evaluate lube oil consumption to determine what it is. To my knowledge there is no conclusive information on that.

Does anyone on the Committee or in the audience have any information on that? I do know, Pete, that there are some studies being made.

MR. SASGEN: The reason I asked the question, Fred, is that we at Triangle are in the business of reclaiming crankshafts and we see as many shafts equipped with the rotary pump fail as the old reciprocating style pump crankshaft. We wonder, with the so-called extended maintenance compressor, why that failure happens so rapidly.

We feel the railroads are looking for a real extended maintenance compressor that will run, say, three months minimal before you have to add oil to it. We at Triangle have seen some of those compressors and we have built some that will run that length of time. We wonder if anyone else has done anything to reduce the oil consumption to stop these premature compressor failures.

MR. C. D. NORRIS [Supervisor Quality Control, Chessie System, Cumberland, Maryland]: We went to a Wabco breather. This helped eliminate the crankcase pressure that causes air compressor oil to migrate out through the seals and rings.

MR. SASGEN: That is a step in the right direction, but it isn't the total answer. A vacuum in an air compressor crankcase is beneficial. That is one step that should be taken. We would be happy to hear from anyone who might have an answer.

MR. BURCHETT: In our paper we did recognize that air compressors do run out of oil. We pointed out that all manufacturers and remanufacturers should work with the railroads to determine a method of adding oil to the compressor without shutting the engine down. It came to our attention last winter when people were afraid to shut the engine down to add oil to the air compressor. We had many failures. I am aware you are working on something along that line. A lot of luck, pal!

MR. SASGEN: Thank you. We are working on a method of adding oil to the compressor while it is still running, but it is quite a problem due to the vacuum pressure inherent in the crankcase. Unless you have some type of poppet valve arrangement you will never succeed. Even if you had one that would work and function perfectly today, as the compressor wears that again changes the ratio of vacuum and pressure in the crankcase, and that will affect whether or not the device will function properly. We are still working on it, Fred.

MR. BURCHETT: One of our Committee members reported last winter that his boss told him that it seemed a small item, letting an air compressor run out of oil, causing a locomotive to fail. He retaliated by saying that one of the other failures he had experienced that was gross was locomotives running out of fuel oil and shutting down and freezing up. He still has his job, but just barely.

Any other questions?

MR. MacDERMOT: I would like to comment on the portion of the paper that dealt with cooling radiators. It was stated that fan and shutter sequence and large temperature differentials may have an adverse effect on radiator performance.

I would like to describe two things we have tried on the D&H that should minimize any contribution these factors may make to radiator problems. The first is the installation of one additional temperature switch to control the shutters at a temperature below the lowest cooling fan switch. This switch is installed on the return side of the radiator piping. During operation the shutters will remain open about 99 percent of the time, and under normal circumstances will close only in dynamic braking or during prolonged periods of idling. System reliability is enhanced, and the duty on the shutter mechanism is substantially reduced, reducing wear on shutter linkages. These in fact were our objectives in making the change. However, the elimination of shutter closures with fan still running and other sequence malfunctions may be worthwhile from the standpoint of radiator life also.

The second thing we did was to move the first fan switch from the engine discharge pipe (radiator inlet) to the pump suction pipe (radiator return). The second fan switch remained in the radiator inlet or high temperature side. Given typical temperature control switches, each with on-off differentials of ten degrees and settings not overlapping, if both switches sense radiator inlet temperature and the high switch closes, fans will continue to run until the engine header temperature drops 20 degrees. Return side temperature will be even lower, by the temperature drop through the radiator.

With the first fan switch repositioned to sense return side temperature, the over-all water temperature change between high fan "start" and all fans "off" can be compressed to 12 or 14 degrees, including the delta-T across the radiator. Fan cycling is reduced, especially during low load operation.

On the rare occasions when fan operation is needed at idle, better temperature conditions are maintained by sensing the return side of the system, as this arrangement does. The narrower operating temperature band may also contribute to radiator life.

MR. FRANK L. JORSTAD [F. L. Jorstad Company, Palatine, Illinois]: I would like to comment to a limited degree on the paper's coverage of oil leaks in locomotives. Some five or six years ago I began application of a product on top deck frames on EMD engines as a running maintenance procedure with a solvent cure caulking material which has very high temperature tolerance, tremendous bond, and never cures 100 percent, so it tolerates vibration very well. It is applied by cutting away the exposed areas of leaking top deck frame gaskets as far back as possible. At this point in time when the gaskets are leaking that portion of the gasket is utterly useless anyway.

At this point flush the area with an electrical solvent to remove oil residue. Safety Solvent is also very good. Then when this area is free of oil seepage, immediately caulk in this material. We have successfully run with this application for three years without leaks.

Seven railroads represented by members of the Committee are using this product to a greater or lesser degree. Three have standardized on it in engine rebuild procedures. One member of the Committee found that it was also quite good in externally sealing turbocharger cradle gasket leaks. That was quite a problem for a while, and I think it has largely been licked now. The nature of the product allowed it to be applied externally in that area with a great deal of success.

Anyone desiring any additional information should give me his card upon recess of the meeting and I will be glad to send him complete information covering both running maintenance and engine rebuild procedures for applying this oil sealing caulk.

MR. BURCHETT: Mr. Jorstad, the Chair recognizes the efforts made by your company in sealing the leaks after they have started. They have been giant footsteps, as was brought out in our Committee meeting recently. We do recognize the need for the manufacturers to start applying something to prevent oil leaks before they start. However, we think perhaps your material may also do that for us.

Any more questions?

MR. NORRIS: I would like to direct a question to the Touchstone Company. How many times would they suggest repairing a radiator, and how old should a radiator be before considering scrapping it?

MR. DICK GODDARD [Touchstone Railway Supply and Manufacturing Company, Jackson, Tennessee]: In the preconvention report your Committee referred to an 18-year time limit, and repairs to the radiator only once after 10 years, I believe. From our studies we concur with the time period of 18 to 20 years as the life of a radiator, with no major overhaul of a radiator that is over 18 years old. We also find that it is not economical to completely overhaul a radiator more than once.

MR. BURCHETT: Does the Committee have any questions to ask the audience? If not, I will ask Mr. Buskey to summarize the report.

MR. BUSKEY: Gentlemen, this morning the Diesel Mechanical Maintenance Committee met to determine the subject and title for next year's paper. Fred made several remarks. Much to our dismay, he has chosen to resign from the Committee as its chairman. He wants to remain on the Committee, however. Fred made the remark that this is the finest group of people he has ever had the pleasure of working with, and I certainly agree.

In summarizing the paper, I am sure you will agree they have covered their subjects in great depth. We intend to expand on them in the coming year as we get more related information, such as welded crankshafts, which are of great importance to all of us.

Now I will return the meeting to President Harley.

PRESIDENT HARLEY: Thank you, Nelson. I appreciate very much your summary of the Committee's very important activities.

Once again I want to thank the advertisers. Their names are over here on our Honor Roll. We are very happy to have them, and we hope we are of equal benefit to them.

The What's Your Problem panel will be held tomorrow morning. Please turn in your written questions to them.

Again I want to thank the Power Parts Company and the Touchstone Company for their help over the years in committee activities. Their help is greatly appreciated.

This concludes the afternoon session. We will see you again at 8:30 a.m.

[The meeting recessed at 4:50 p.m.]

# WEDNESDAY MORNING SESSION
## September 19, 1979

The meeting reconvened at 8:30 a.m., Mr. E. T. Harley, President, presiding.

PRESIDENT HARLEY: We would like to call the final session of the LMOA to order. We have a little business to conduct, then we will have a paper, and after that we will have the What's Your Problem panel.

I can't stand before you without thanking our hard-working Secretary - Treasurer, Joe Koerner, and his wife Lou, who is out at the door, and all the people on his staff who have helped us so much over the years. Presidents come and presidents go, but Joe and Lou and the staff at the LMOA are the ones who keep this organization going. They are the ones who keep the continuity. I couldn't leave you as President without expressing my heartfelt thanks for all the help they have given us as Directors and officers and members of the official family year after year. Thank you so much. [Applause]

One other announcement. We are presenting an honorary life membership to Mr. J. J. Butler, Chief Mechanical Officer - Locomotive, of Conrail. Jim was here earlier in the meeting but had to leave, so unfortunately we will not be able to present it to him in person.

As you all know, Jim would have been President of the LMOA, replacing me, if it had not been for the press of his duties with Conrail. However, Jim has not forgotten the LMOA. He has been one of our best supporters behind the scenes. He is probably the best recruiter for LMOA in many a year, and we deeply appreciate this. We will present Jim at a later date with the locomotive desk set. From now on he will be an honorary life member of LMOA.

I would like now to call on Past President Ky Pruchnicki for a financial report.

MR. PRUCHNICKI: I will give you the financial report of the LMOA as of the present time.

**KY PRUCHNICKI**
(Retired)
Genl. Supvr. Loco. Maint.
Southern Pacific Transportation Co.
San Francisco, CA

LOCOMOTIVE MAINTENANCE OFFICERS' ASSOCIATION
STATEMENT OF REVENUES, EXPENDITURES AND
CASH BALANCES, CALENDAR YEAR 1978

| | | | |
|---|---|---|---|
| BALANCES IN FUNDS JANUARY 1, 1978: | | | |
| Checking Account — Security Bank | | $ 9,096 | |
| Reserve Account — Security Bank | | 10,355 | |
| Balance | | | $19,451 |
| REVENUES: | | | |
| Interest on Reserve Account | $ 642 | | |
| Active Membership Dues | 7,031 | | |
| Assoc. Membership Dues | 5,074 | | |
| Registration Fees | 1,796 | | |
| Advertising Revenues | 24,252 | | |
| Miscellaneous | 180 | | |
| Total Receipts | | $38,975 | |
| EXPENDITURES: | | | |
| Convention, Publication and Travel Expense | $21,945 | | |
| Office Expense, Office Assistance, Supplies, Postage, Stationery and Payroll Taxes | 19,065 | | |
| Total Expenditures | | $41,010 | |
| Excess Expenditures over Revenues | | | (2,035) |
| BALANCES IN FUNDS DECEMBER 31, 1978 | | | $17,416 |
| Checking Account Balance | $ 6,419 | | |
| Reserve Account Balance * | 10,997 | | |
| Total as Above | $17,416 | | |

* $5,000 transferred from the Checking Account to the Reserve Account in January 1978 was moved back into the Checking Account in June 1978.

APPROVED:

Edward T. Harley, President
James H. Long, 1st Vice President

Approved this 3rd day of April 1979, Chicago, Illinois.

PRESIDENT HARLEY: Ky, will you now present the Nominating Committee report, please?

[The report of the Nominating Committee was read by Mr. Pruchnicki as follows:]

LMOA NOMINATIONS
FOR THE YEAR 1979-80:

President: James H. Long, Manager Locomotive Department, Chessie System, Cincinnati, Ohio.

1st Vice President: R. G. Clevenger, General Electrical Foreman, Atchison, Topeka & Santa Fe Railway Co., Kansas City, Kansas.

2nd Vice President: N. A. Buskey, Manager - Planning and Work Standards, Chessie System, Huntington, West Virginia.

3rd Vice President: Frank D. Bruner, Assistant Chief Mechanical Officer R&D, Union Pacific Railroad, Omaha, Nebraska.

4th Vice President: R. R. Holmes, Chief Chemist, Union Pacific Railroad, Omaha, Nebraska.

5th Vice President: D. M. Walker, Diesel Superintendent, Southern Railway Co., Atlanta, Georgia.

6th Vice President: Kjell Axelson, Manager Machine and Tools, Burlington Northern, Inc., St. Paul, Minnesota.

7th Vice President: W. R. James, General Manager - Locomotive Department, Chessie System, Huntington, West Virginia.

EXECUTIVE COMMITTEE:

D. H. Propp, Director of Energy Conservation, Burlington Northern Inc., St. Paul, Minnesota.

**On hand to receive his LMOA Vice President's blazer was Swede Axelson of the BN. President Harley helps him.**

B. A. Cumbea, General Manager Locomotive Maintenance - Engineering, Chessie System, Huntington, West Virginia.

Mike Gogol, Chief Quality Control Officer, Southern Pacific Transportation Co., San Francisco, California.

E. R. Hafling, Assistant Mechanical Engineer, Atchison, Topeka and Santa Fe Railway Co., Topeka, Kansas.

J. J. Gregory, Project Manager - Heavy Repair Shop, Consolidated Rail Corporation, Altoona, Pennsylvania.

C. W. Cox, Locomotive Gang Foreman, Atchison, Topeka and Santa Fe Railway Co., Argentine, Kansas.

Secretary-Treasurer: Joseph J. T. Koerner, Chief Accountant - Mechanical, Chessie System, Huntington, West Virginia.

MR. PRUCHNICKI: Those in favor of these nominees, please raise your hand. Those opposed. Mr. President, they are elected unanimously.

PRESIDENT HARLEY: Thank you very much, Ky.

We would have presented Billy James with his blazer today, but he could not attend, so we will make the presentation in Huntington. Billy promises he will be here next year, complete with his blazer.

Now I would like to call on Secretary Joe Koerner for the Secretary's report.

SECRETARY KOERNER: I would like to update the membership report. Railroad members, 1,245. Associate members, 382. Advertisers, 120. Total membership as of this morning, 1,747.

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

Ky Pruchnicki couldn't read the poor copy of the financial report that I gave him. He had us in the hole by $12,000 last year. It wasn't quite that bad, Ky. We were $2,000 in the red last year. This year, for the first time, we are in the black. We finally caught up with inflation, so this year we should see us in the black.

Is Mr. Burke, President of USTEC, Inc., here? Tom has been a member for 36 years and we wanted to recognize that longevity of membership.

I don't think we should close our business session without commenting on the passing of our longtime Secretary, Charlie Lipscomb. We feel badly about it.

I want to thank the railroad membership chairmen for the excellent membership drive. We have already referred to the outstanding job Jim Butler did on Conrail. I appreciate all the work you have done in getting members and advertisers.

Are there any questions? If not, that is all I have to report, Mr. President.

PRESIDENT HARLEY: Thank you very much, Joe. Again may I say we greatly appreciate your efforts.

Now I have the honor of calling our incoming President, Jim Long, to the podium so we can present the gavel to him. Jim, it is with great pleasure that I present to you the gavel marking your presidency of the LMOA. [Applause]

[Mr. Long assumed the presidency of the Association.]

PRESIDENT LONG: Thank you, Tom. I like to feel that upon accepting the gavel as President of the LMOA, I can live up to the high standards that have been set by the many past Presidents who have stood before you in the past. In retrospect, these men, in my personal opinion, were some of the outstanding individuals of the various railroads in the country who found time from their very busy schedules to actively participate and make this Association what it is today.

I would also be very remiss if I did not reflect also on some of the great people in the supply industry who actively participate in the Association. They can help

Newly elected President Jim Long of the Chessie System is shown receiving gavel from Tom Harley. Looking on in approval is 1st Vice President Bob Clevenger.

make the maintenance officer's job in the field better, and give us more reliable and efficient locomotives. The supply people, if we make them aware of our problems, can help us to come up with a fix.

I also feel that this Association is one of the best training grounds for young supervisors that we presently have in this great country of ours. If they are allowed to attend and take an active part at the convention, they are given the advantage of associating with people from the various railroads. When they attend the pre-convention presentations and take advantage of idea training which the Association helps make available, they have an opportunity to see what other railroads are doing. When they go on the shop tours they pick up many ideas to take home to enhance the performance of their company, and are given the opportunity in open discussions to let their hair down to discuss problems, ideas, and in general find the solution that could save their own railroad many hours and much money in investments on tests and studies.

Looking back to the year 1953 when I first became a member of this Association, I feel I have picked up some good experience. I might tell you that in 1961, when placed on a committee, I was very much alarmed and felt I had nothing to offer. But after getting into committee work and helping in presentations, and later serving as Vice Chairman and Chairman, I could feel my own personal self confidence growing as I obtained the ability to speak in front of an audience. This, I might tell you, used to scare me to death — the idea of having to get up and talk and worry that someone would ask a question to which I might not have the answer.

Later, serving on the Executive Committee, and running the gauntlet of the Vice Presidents' line-up, I felt immense satisfaction by being allowed the privilege of associating with and talking to chief mechanical officers from all over the country, presidents and vice presidents and many people from the supply industry, and I solicit the support of the Vice Presidents, Committee Chairmen and each of you gentlemen to make this Association grow.

This is something no single individual can do. We need your support in membership and advertising, supply membership, and one of the important items we need is a good feedback from the various railroads as to what they would like to have presented at these conventions, such as what is the major problem in the industry today, and giving us these items to work on and assign to committees. These are to help the industry as a whole.

This is how we find out about problems that may not be affecting us today on our respective railroads, but that we have to look forward to in the future. I cannot overemphasize the importance of this particular item. Bring this kind of thinking to our preconvention planning. This helps the Association grow, and will help to receive favor in the eyes of your management, and will leave a good sound Association for those who will follow us when we step down.

This brings me to the matter of the gavel which was just handed to me by President Tom Harley. With your help and assistance, I will try to follow in Tom's footsteps. I might tell you I consider him one of the outstanding men in the railroad industry, and I think he is very deserving of a "well done" from each of you.

Tom Harley, on behalf of the Association, may I extend to you a sincere thank you for the great job you have done during 1979, and for your personal efforts which you put into this Association in advancing the membership. I am sure most of you are aware that Tom has recently gone to a new job. Our sincere good wishes for your future, and hope for prosperity in your new position.

At this time all of us again say, thank you. I would like a rising vote of thanks for Mr. Tom Harley.

[The audience arose and applauded.]

Now I would like to call on John Schroeder and Ky Pruchnicki to present the life membership award and some other goodies to Tom.

[Mr. Schroeder presented Mr. Harley with the LMOA desk set. Mr. Pruchnicki presented the 1978 Proceedings book and the Past President's pin.]

Past President John Schroeder presenting General desk set to outgoing President Tom Harley. Looking on is Vice President Dick Holmes.

MR. HARLEY: I really appreciate this, gentlemen, and it has been an honor and pleasure to serve you. I hope I will continue to see you in the future. Thank you. [Applause]

PRESIDENT LONG: I would like Joe Koerner to come up for a moment. Tom Harley made a little speech about Joe's untiring efforts and what he means to the Association. I would like to add that Joe is the power behind the throne.

We thought about presenting Joe with a little something. He has been due for it a long time. The question was how to pay for it. Joe watches the money pretty closely. I gave him a shock when I said that with the price of gold going up we would have to buy a lot of Past Presidents' pins so we could have them up to 1983 and save money for the Association in the long run. He still wouldn't buy it. I figured the next approach would be to approach him from the home angle. I said, "Lou, tell him we want to buy these pins and save money." I think she convinced him.

Joe, at this time I would like to present to you a special pin which is similar to the Past President's pin. It reads, "LMOA, 1979. Secretary-Treasurer." On behalf of the Association, may I present this to you and hope you will wear it in good health. [Applause]

SECRETARY KOERNER: I appreciate this very much, gentlemen. You didn't have to do it. Lou deserves to wear this as well as me. Thanks a lot.

Past President Ky Pruchnicki presents Tom Harley bound volume of LMOA Proceedings as Darrell Walker beams approval.

# WEDNESDAY MORNING SESSION
# September 19, 1979

## REPORT OF THE COMMITTEE ON SHOP EQUIPMENT

T. E. WHITTEN, Chairman
Asst. Superintendent Shops
Chicago, Rock Island & Pacific Railroad
Silvis, IL

KJELL AXELSON
7th VICE PRESIDENT
Manager Machine & Tools
Burlington Northern, Inc.
St. Paul, MN

PRESIDENT LONG: At this time I would like to call on "Swede" Axelson to serve as officer of the session. Swede has recently been promoted to the new position of Manager Motive Power-Mechanical.

MR. KJELL AXELSON [Burlington Northern, Inc., St. Paul, Minnesota]: Just a little special comment on Jim's elevation to the presidency of the LMOA. I would like to make special note, on behalf of the Committee on Shop Equipment, that due to the fact that Jim served for many years on that Committee as a member, vice-chairman and chairman, we are happy to say one of the Shop Equipment boys finally made it.

It is always a tough assignment to chair the anchor team on the last day of the annual meeting, especially in an exhibit year when competition for time is very keen. It reminds me of a story about a railroader who left work late one night and walked into the parking lot only to find the battery in his car was dead. The nearest building happened to be a sorority house. He explained the situation to the young woman who answered the door, and she let him in to use the phone. As soon as he entered a loud voice called down from upstairs, "Jennie, you know you aren't supposed to have male visitors after eleven o'clock!" Jennie replied, "It's okay. Its only a railroader, and his battery is dead." [Laughter]

I suspect that because of situations like this, the Committee on Shop Equipment was picked to recharge your batteries after a hard session and to help in your sense of purpose to the task that lies ahead. This Committee has proven once this year that they can stimulate interest, as attested to in a previous presenation of their paper to a tough, aggressive and progressive Union Pacific audience in Omaha last April.

This hard-working Committee has historically provided thought-provoking items of interest that will help all of you reduce maintenance over critical cost as well as lower your bad order ratio. At this time I would like to give a well deserved acknowledgement to Rock Island Assistant Shop Superintendent Tom Whitten, the Committee chairman, who is unable to be with us, and his Committee. Mr. Whitten is not here due to a condition we all recognize, called a strike.

[Mr. Axelson read Mr. Whitten's biography as printed in the Proceedings book. He introduced Mr. Tom A. Kessenger, Senior Engineer Facility Planning, Louisville & Nashville Railroad, Louisville, Kentucky, vice-chairman of the Committee. Mr. Kessenger acknowledged the pre-convention presentation by the Committee in Omaha, and introduced the members of his Committee. The report was summarized by Mr. Hoerath, Mr. Propp, Mr. Marler and Mr. Kessenger.]

MR. KESSENGER: I am told we have run out of time. Is there anyone who has a question on the items we have covered? There were quite a few items we could not cover because of the time factor, but they are covered very well in the report.

If there are no questions, I would like to ask Mr. Axelson to summarize the report.

MR AXELSON: Thank you, Tom. Unfortunately time does not permit a full presentation by this Committee of other interesting items in their report. Those matters are captured in the Proceedings, which you can review at your leisure when you get home.

Now I would like to call on regional executive Elmer Hafling to summarize the report of this Committee.

MR. ELMER R. HAFLING [Assistant Mechanical Engineer, Santa Fe Railway, Topeka, Kansas]: There is an old story about a man who had just been promoted to vice-president. He boasted so much to his wife that she finally said: "Vice-presidents are a dime a dozen. Even a supermarket has a vice-president in charge of prunes." [Laughter] Furiously, the fellow phoned a supermarket in expectation of refuting his wife. He asked to speak to the vice-

E. R. HAFLING
REGIONAL EXECUTIVE
Asst. Mechanical Engineer
Atchison, Topeka & Santa Fe Railway
Topeka, KS

president in charge of prunes. A voice said, "What kind of prunes, package or bulk?" [Laughter]

There is little doubt that we are becoming highly specialized in almost every field of human endeavor, and the Shop Equipment Committee is no exception. Their paper this year shows that the Committee are specialists in presenting an endless, ever-progressing look into new methods and processes and new tools. They have presented to us today new facets in journal box repairs, which I see not only brings new procedures but an ever-important aspect of cleaning. This also pertains to power assembly overhaul (which we didn't cover here), procedures, and to locomotives proper.

In the new tool categories we were shown new balancing equipment, new and improved diesel engine maintenance tools, kits, and digital readout gauges. Vibration has become an important aspect in rotating equipment maintenance. Railroads are also now applying computer control to machine shop equipment to bring greater productivity and product control. There are a lot of these tools, as Swede said, that are mentioned in the paper. I suggest you read it.

Thank you, Tom and your Shop Equipment Committee, for a job well done. Let's thank them by giving them a big hand. [Applause]

MR. AXELSON: Will the What's Your Problem panel please come up.

# WEDNESDAY MORNING SESSION
# September 19, 1979

## WHAT'S YOUR PROBLEM PANEL

**J. J. GREGORY, Chairman**
Project Mgr.-Heavy Repair Shop
Consolidated Rail Corp.
Altoona, PA

**F. D. BRUNER**
4th VICE PRESIDENT
Asst. Chief Mech. Officer R&D
Union Pacific Railroad
Omaha, NE

The Officer of the concluding session of our Annual Meeting will be Vice-President Frank Bruner of the Union Pacific.

MR. BRUNER: We will try to finish this session at 11:30. This is always a good session where everybody can air any questions they have that have come up during the meeting. For the panel today we have all the committee chairmen. At this time I would like to have the moderator of the What's Your Problem panel come up, Jim Gregory.

[Mr. Bruner introduced Mr. J. J. Gregory, Production Control Manager, Consolidated Rail Corporation, Altoona, Pennsylvania.]

MR. GREGORY: Thank you very much. As you all know, the highlight of the LMOA meeting as a rule has been the What's Your Problem session. This is the place where every member gets a chance to participate by asking questions relating to subjects that were presented, or problems that they might have of their own. We have found through the years that one railroad might have a problem that another railroad may have encountered and corrected.

Before we proceed, I would like to introduce the gentlemen who chaired the various committees this year.

[Mr. Gregory introduced Mr. Stringer, Mr. Ward, Mr. Cox, Mr. Smalling and Mr. Kessenger.] [Applause]

MR. GREGORY: We have had a multitude of questions turned in, and we will try to answer them. I will start with the first question. This is one of the items I got in the mail a month ago:

"What has been the average service life experienced in using EMD Type B and Type E cylinder heads reclaimed by the various vendors? Welding process, and what extent should cracked or overheated cylinder heads be qualified for reclamation?

When we gave our talk in Little Rock some months ago, we spent almost 45 minutes discussing this. I think it is an important item, and I would like to ask the various railroads represented, and also the manufacturers, to give their views. Which one of you gentlemen would like to answer the question? Don, do you have any information on the justification or service life of Type B and Type E cylinder heads that are reclaimed by the manufacturers?

Do any railroads in the audience have any information on their policies as far as reclaiming B and E heads? Do we have a representative from J&J or B&B here? This is a question we threshed out pretty thoroughly last year, and I am surprised we can't get an argument out of somebody on the pros and cons of using reclaimed heads.

Here is another question? "What length of services are railroads able to obtain with the GE long-life lube oil filter?" Mr. Smalling, does your group have anything on that?

MR. SMALLING: The Committee did not work on the GE long-life filter, per se. We do have them in service on my road, but not long enough to make any kind of judgment.

MR. HOFFMAN: The longest life that we authorize is six months, and that six-month life is dictated by structural considerations (gaskets and the like). There is one railroad that is using the long-life type of element on an exclusive basis that is currently using the six-month life limit.

The more typical and more appropriate from my personal viewpoint in 120 days. Everyone I know of who has tried it has been very successful at that life. I personally think that to go to the maximum allowable limit is a dangerous practice in the event the change was inadvertently missed. It offers the opportunity of staying in service for a long time beyond its safe life during which time gaskets are leaking, and the like; but six months has been demonstrated as possible.

MR. COX: I am going to reverse the direction of questions a little bit.

With the GE long-life type filter in measuring the pressure drops across the filter as the filter grows older in age, they don't appear to be what we are used to. In other words, a gradual change in pressure drop until you get near the end of the life, and then it comes up fast and then increases in pressure drop.

It seems that the long-life filter maintains a lower level of pressure drop, and then near the end it just collapses more or less. In other words, we are not seeing a high level of pressure which we would call a condemning limit in order to change the filter. Can you explain this, please, Mr. Hoffman?

MR. HOFFMAN: First of all, I think your evaluation or observation is valid and correct. I am not sure I like your choice of the word "collapse," because it implies physical collapse. I think you meant "finally reaching maximum pressure drop and doing it suddenly." I hope that is correct.

I can really only speculate on the mechanism involved. This filter element is a depth element, and there are major amounts of pores and cavities that can and do fill up, but leaving plenty of open spaces for oil to go through. That is normal operation, and ultimately when enough of those passages plug up, the pressure drop will increase.

Under abnormal conditions—and abnormal might be considered gross inattention to lubricating oil condition or gross contamination of lubricating oil from nondispersed sludge—when that occurs, the outer surface simply plugs up, closes off, and you will get very rapid pressure increase or short life. So, all of my comments, both now and previously, should be prefaced with the lubricating oil being maintained at normal recommended condition limits.

MR. GREGORY: A representative from the Milwaukee Road wanted to know, since we have gone through two severe winters. What are the economics and the effects of glycols used in the radiator systems during the winter. He asks: "How many railroads put antifreeze into the radiator system? What is the effect of it? What is the cost? What do you do with it when spring comes?

MR. BRUNER: Last winter the Union Pacific put ten GE locomotives on antifreeze as an experiment to determine problems that could arise. The locomotives were closely monitored by laboratory personnel at North Platte and Salt Lake, along with further oil analysis at our Omaha laboratory. The results of this experiment cannot be finalized at this time, since we started the test in February after the severe winter weather had started to subside.

We had made a number of calls to various engine manufacturers requesting their recommendations, and each had considerable caution as a result of their experience. As you know, the locomotive manufacturers do not recommend this approach for fleet operation, at least at this time.

I would like to have our Chief Chemist, Dick Holmes, who is in

the audience, give you a further rundown of our experience.

MR. HOLMES: We kept ethylene glycol in these locomotives from January until late spring, and we did have a couple known failures. However, investigation into those failures revealed that both of these specific cases I am referring to had large amounts of water in the crankcase.

So, in cooperation with GE (and I was talking to Jack Hoffman about it at this session), we looked at the bearings very closely. Metallurgical examination verified that none of the bearings showed corrosion, which means that there was no attack by ethylene glycol. So, other than that the locomotives did operate all right.

We had to continue additions of antifreeze during the entire time. We used lab controls, and when the units came onto the service track we specified how much to put in, and we kept it at about 50 percent. That is the way we ran it. Ethylene glycol isn't cheap. We all know what the going price is.

Mr. Hoffman, do you have anything to add? Did your company look at the bearings, and so on?

MR. HOFFMAN: Just one small point. First, with respect to experience and position, we have no greater in-service railroad experience than that which Frank and Dick have talked about to us. We have used it in lab engines—in one engine for several winters without problems. That, I think, is too small an experience to say that no problems will happen.

With regard to the bearings we analyzed and the oil samples we analyzed for Dick, we can confirm that there was no evidence that there had been any attack of any nature on the bearings by the ethylene glycol. Further, we could not find evidence of ethylene glycol remaining in the used lube oil samples, and I believe Dick's lab showed the same result.

We attempted to see if we could locate breakdown products of ethylene glycol, and our procedures were not sophisticated enough to do that. We don't think we ruled out the presence of organic acid breakdown products, but we couldn't find them, either. We do believe we are good enough in our techniques to have found ethylene glycol had it been present. So, there is a suspicion in Dick's mind and mine that ethylene glycol really doesn't stay in the lube oil very long in an operating engine if it leaks into the crankcase.

MR. SMALLING: Before we leave this subject I would like to make a clarification. I believe that ethylene glycol, when mixed with lubricating oil, creates an agglomeration and consequently causes a lubrication problem. What percentage of water dilution did you have in the lube oil? Was it enough to get the glycol into it? If so, it seems as if we would find some indication of that situation.

MR. HOLMES: We looked at the oil samples regularly out of all these units and we didn't find any high insolubles or any agglomeration to warrant draining the lube oil except as we do under ordinary circumstances in routine condemnation of lube oil.

We do know, as Jack said, that there were water leaks in more than just those two locomotives which we substantiated by a tracer test which is specified in ASTM. It is a standard kit. Usually we couldn't find any evidence of glycol in the oil although we knew the locomotives had had water leaks, and they did have some strength of ethylene glycol in the radiator system. At least while we were looking at it very closely they were close to 50 per cent concentration in the cooling water system.

MR. DAVID BURNS: Prior to working in the railroad industry I was in diesel engine research, and I had considerable experience running test engines with antifreeze. It is a major problem, because if you get a large amount of antifreeze in the oil you will have varnish, and your only choice is to strip the engine.

MR. BRUNER: I don't think anyone has had enough experience with antifreeze use at this time, which would include the Union Pacific, since we terminated the test when the warmer weather arrived. We did find that it can be expensive and requires close monitoring to keep the concentration at a safe level due to water leaks, either external or into the engine crankcase. Some bearings were removed from the test locomotives and sent to GE for analysis, and before we continue additional testing in the future we will thoroughly analyze the results of this inspection.

As stated before, the engine manufacturers do not recommend use of ethylene glycol in the locomotive fleet, since their experience has been limited and they are also aware of the problem associated with contamination of the lubricating oil.

I must commend our Laboratory forces for doing a good job of monitoring the locomotives during the test, and I would caution those who would consider the use of ethylene glycol to have the expertise and backup capabilities of a good laboratory.

We will no doubt consider continuation of a test in ethylene glycol use this next winter to gain further experience in a continuing effort to determine if the use of an antifreeze in locomotive cooling systems can be safely and economically used.

MR. WILLIAM CAIN [Santa Fe]: Since ethylene glycol is an organic compound and you have sodium dichromate in the cooling water, I wonder if there would be a reaction between the two, both of them tending to destroy each other. The glycol would become oxidized and you would also de-

stroy the chromate inhibitive properties. Do you have anything on that?

MR. SMALLING: One of the objections of dieselization in the early days was the use of antifreeze in the cooling system due to the sodium dichromate in the water treatment. Borates are used in some cases now, but not all. If there are any representatives in the audience who handle inhibitors for the cooling system, we would like to hear their comments on this matter.

MR. NICK ECKERLE [Nalco Chemical Company, Oak Brook, Illinois]: We make diesel cooling treatments of both the chromate and non-chromate types. Chromate and ethylene glycol antifreeze are incompatible. If you check with your friends in the trucking industry who use a lot of ethylene glycol in their diesel engines you will find that when they were using chromates they experienced sludge which they called "green slime." It was due to the reduction of the chromates with the ethylene glycol. It will cause a lot of problems.

I might add that the nitrate-borate types of treatment are compatible with ethylene glycol types of treatment.

MR. GREGORY: Wih the cold weather and the possiblity of engine failures, it would be a sad thing to be caught between a rock and a hard place using antifreeze or using something that might give you temporary protection and suddenly you find out that you have engine trouble. I think every railroad that operates in the northern region where there is snow has been confronted with this problem in the last two years, given the severity of the winters we have had.

I have another question: "Are railroads seeing a higher incidence of valve failures due to overheating in the GE air compressor located in its own compartment? If so, what plans does GE have to provide better cooling?"

We might throw this question out to the audience because I am sure everyone has GEs. Are you encountering any more valve failures due to the location of the air compressor?

MR. COX: On the Santa Fe we have a practice each year of preventing air compressor failures by taking the water out of the GE air compressor during winter operation. This is the old-style GE air compressor located back in the dynamic brake area. Inadvertently some of the newer style air compressors were relieved of water, and these air compressors had a very short life.

After that period we have noticed a higher incidence of air compressor valve failures with that type of air compressor. I think there is an indication there, due to the fact that they didn't live very long without cooling water, that we do have a more marginal case of cooling. I wonder if someone from GE could tell us whether

there are any plans to change that condition.

MR. NORMAN ISLER [General Electric Company]: We have no plans to change the design on air compressor valves. We believe the failures you referred to were brought about by running the water-cooled air compressors without water in them. That is a practice we really don't recommend.

As an alternative to the freezing problems that this group is well aware of, we have been running some air-cooled versions of air compressors. We have a number of them on the UP right now. So far, the reports that have come back seem to indicate that the test has been successful. In October we will be close to one year of field operation on them, and we plan to take a good, hard look at that time to see if this air-cooled version represents a more viable alternate to the water-cooled.

The air-cooled version is still located in the same separate compartment you referred to earlier, and we think it retains the advantage that led us to put it in the separate compartment.

As far as freeze-ups are concerned, it represents a better alternative than anything we have seen in the water-cooled.

MR. J. L. KUHNS [Superintendent Motive Power, Louisville & Nashville Railroad, Louisville, Kentucky]: We have been operating compressors for the last two years without water. We still operate them in the summertime without water. We have some compressors operating without water lines going to them. We have no troubles other than normally experienced. We have gone to air-cooled compressors across the board.

MR. COX: Is that with the new style GE air compressor? That is the one I am talking about now.

MR. KUHNS: We haven't had them long enough to tell. I think the oldest one is 5 months old. We will have the same thing happen to them.

MR. COX: Are you running any of them without water?

MR. KUHNS: Not the new ones yet, but next year we probably will.

MR. GREGORY: This is more of a technical question: "Are different procedures required to weld a nitrite hardened crankshaft compared to a TOCO hardened crankshaft?"

MR. KUHNS: As I mentioned yesterday in our paper, we do have five crankshafts running. We have one nitrited shaft that has a main welded. We are trying to stay away from nitrited shafts. There is a different rod used between the two for welding repair.

MR. GREGORY: While we are on the subject of crankshafts, here is another question: "How do crankshaft failures of welded crankshafts compare to chrome-plated crankshafts? I am sure we have railroads that have both the chrome-plated and welded, and probably they have some representatives here.

MR. KUHNS: We have five welded crankshafts. We have not experienced the first failure yet. That doesn't mean we won't, but we haven't yet. I believe there has been one occasion to my knowledge of one nitrited shaft that has broken. Whether it was the result of the welding or not, we don't know. We have not yet had a failure on a welded shaft on our railroad.

MR. GREGORY: I am surprised we don't have representatives from the various platers present. I can remember years ago when we first had crankshafts chrome-plated on the old New York Central and we would get an alligator pattern develop which would end up causing failures.

"Do you have any information on the possible electrolytic action between the tubes and headers of mechanical bonded 8-inch EMD radiators?" Are there any EMD representatives here? Mr. Smalling, did your Committee go into radiators?

MR. SMALLING: No, we did not.

MR. GREGORY: Have any of the railroads represented in the audience had any trouble with the new type EMD mechanically bonded type radiators? If not, that must be a minor item.

MR. BRUNER: The mechanically bonded radiator has been used by the Union Pacific in our 6900 class centennial locomotives which we received in 1969. Each of these locomotives has two engine sets of radiators of the mechanically bonded type. The radiator tubes are much larger than standard, and the construction is mechanically very sound. On these 47 locomotives running for the past ten years, we have not experienced a radiator bond failure, nor have we experienced problems with radiator plugging because of the large tube and design.

Granted, they are more expensive, but have required no rebuild or maintenance, and are still running in these locomotives.

MR. GREGORY: While we are on the subject of radiators, there is one question I would like to bring up. Unless I misunderstood the gentleman's statement yesterday, I believe he recommended a service life of 18 years on radiators. Some can be repaired after 10 years but the second time around they are scrapped.

What are the recommendations of EMD and GE and other railroads regarding service life of radiators? How often do you repair them? Do you have a certain age limit after which time you automatically scrap them? I will open that to anyone on the floor or on the panel.

MR. SUAREZ [Diesel Radiator Company, Melrose Park, Illinois]: We have been in the radiator repair business for ten years, and we find that assigning an age to scrap radiators is not the proper approach. We are able to reclaim radiators that have been in serv-


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ice for up to 25 or 30 years and we are getting 100 per cent recovery.

On the other hand, we are scrapping radiators that have been in service for two years because of tube leaks. It doesn't depend on the age of the radiator but on the year and the manufacturer. Some radiators that were manufactured in 1955 can be recovered 100 per cent. Some radiators manufactured in 1965 have to be scrapped 100 per cent. It all depends on the specific make and the year it was manufactured.

MR. COX: I have a question for you, sir. The treatment in cooling systems varies in locomotive operation. How do you determine the tube condition—the inner tube condition—as far as corrosion goes, in the process of repair? You are probably more liable to look at the joint condition and exterior condition, but how do you determine a radiator in service 25 years as to the condition of the tubes in regard to effective remaining wall thickness?

MR. SUAREZ: We test radiators at 60 pounds air pressure prior to repairs, and we are finding that some radiators manufactured as far back as 1948 are not experiencing tube failures. That is an indication that the tubes are holding up in service. Most of the radiator tube failures we find happen at the lock seam. That is due to manufacturing. I believe internal corrosion of the tube, if the tube is of the proper material, is not as important as lock seam failures.

MR. GREGORY: It was interesting to note yesterday in the presentation on radiators that the majority of leaks that were found were on the header section adjacent to the outboard fins where the greatest temperature differential will exist.

One other item in regard to radiators: What percentage of radiator tubes can be plugged before you have an improper heat exchange? You have the same volume that will go through smaller diameter, if you want to consider the tubes one diameter, because I remember that the velocity will vary inversely with the square of the diameter of the tube. So, the more tubes that you have plugged up, the faster the water will flow through there, and the less heat exchange you will have.

Do any of the railroads represented have specific limits on what percentage of the tubes they can plug before they scrap them? Or do any of the railroads have a specific time limit, as I mentioned before, at which time they scrap radiators strictly on a time basis?

If there is no discussion on this, we will continue.

"Why doesn't the crankcase overpressure device shut down a GE engine when they have as many as two cylinders with excessive blowby? Excessive blowby is determined by rolling the engine over with the crankcase covers open."

Who can give us an answer to the crankcase overpressure device?

MR. KUHNS: I wish I knew how you could operate it with two blowbys that won't shut it down. It is constantly being shut down. How do you operate the engine—with two cylinders?

MR. GREGORY: It says, "Why doesn't the crankcase overpressure device shut down an engine when they have as many as two cylinders with excessive blowby?"

MR. KUHNS: It will on our railroad.

MR. COX: We have inspected a number of GE engines and found that they do have excessive blowby. To describe this a little further, standard procedure is to roll the engine over and sometimes fire the cylinder to determine the blowby on the cylinder. We have continuously changed a large number of cylinders for this reason.

However, a number of locomotives come into the shop with this condition, with no previous road failure. In order to verify that they were loading properly in run No. 8, having the proper horsepower, some of them were load-tested with the cylinders in this condition, and the crankcase overpressure devices were checked for proper tripping. They did not trip.

MR. KUHNS: I will send you our crankcase protectors and you send me yours. [Laughter]

MR. F. A. MITCHELL [Manager, Product Service, General Electric Company, Erie, Pennsylvania]: I tend to agree with Mr. Kuhns of the L&N with regard to our customers' attitude toward the crankcase overpressure device. It is certainly the other way around with most of our customers, where it does trip more frequently due to false reasons than when you have one or two cylinders that do have blowby and the crankcase overpressure device does not trip. I don't know of one case where this has occurred.

You have to go back one step and remember the original intent in putting the crankcase overpressure device on the engine was to protect against catastrophic failure caused by cracked or broken pistons. It was not intended to detect other things. In diagnosing the failure analysis that our field service men send in, you have a multitude of reasons for the crankcase overpressure device tripping. Primary causes are the eductor tube plugging up, the screen under the turbo getting dirty, overfilled crankcases, and so on. There are valid reasons where you have a scored liner or cracked piston.

Most of our customers say that on many of the shutdowns they can find nothing wrong. So, we have quite a program going on with several customers in trying to determine cooperatively with them what the setting of the crankcase overpressure should be to eliminate the false shutdowns and still protect against a bona fide, real problem with a cracked piston.

Of key importance in this area is when a locomotive comes into

your shop with a crankcase overpressure shutdown. How do your people diagnose that engine to determine what to do to correct the problem? In several cases it is nothing more than the eductor tube carboned up and reducing the vacuum in the crankcase.

We have worked with customers in qualifying cylinder assemblies. When you are looking for something that causes the overpressure device to operate, it is critically important that the man know what he is doing when he checks cylinders.

We are revising our instruction books to list compression testing as our No. 1 qualification technique. The UP has recently been involved in their own testing with some of our people participating to determine the best technique to use, whether it be air test, flow meter test firing or compression testing, and they have now decided on compression testing as the best possible way to qualify a cylinder. As a result they have significantly reduced the number of cylinders that are pulled erroneously trying to find something that caused COP to trip.

MR. COX: That is very good information. What I am saying is that we definitely have problems with the crankcase overpressure failures, as you have stated. What I am talking about is a different problem. We have a problem with the eductor tube, and things like that causing crankcase overpressure failure. I am just wondering if the volume of one or two cylinders might not be enough to trip a device which is functioning properly in a dynamic situation. This problem should be investigated further by the manufacturers.

MR. HOFFMAN: I am not sure I can answer with numbers that you would perhaps like to have. However, this whole topic keys around what is an excessively blowing cylinder. This is part of the point that Mitch was addressing.

Many times cylinders that have been pulled by railroads (not necessarily yours) have been returned for inspection since somebody said they were scored or caused blowby, or whatever, and we could find absolutely no reason for them to have been taken out of service.

To demonstrate it, we actually place some of them on lab engines, and in some cases half an engine set. We go ahead and operate the engine, and they do not shut the engine down by COP or any other safety device. So, we are really getting into an area of the definition of extensive blowby. I think we could spend the rest of the day trying to iron it out.

MR. COX: That was the point I was trying to make. Thank you, Jack.

MR. MITCHELL: We are running tests now in our engine lab to try to develop the information Jack just mentioned, what crankcase overpressure you get with various defects in the engine. With that information we will then be

better able to set the right values on the protective devices.

MR. GREGORY: After the Diesel Material Control Committee gave their presentation we had quite a few questions. Five or six of them were more or less in the same vein, and rather than let Don Ward relax all morning I will ask him this one:

"In the Diesel Control Committee report the value of inventory appears to be very large for railroads having more than 1,200 locomotives. It was excessively large when compared to 1973 when we made the other study, I think almost to the extent of 300 per cent. Is this possibly an aberration caused by Conrail's very extensive repair program?"

MR. WARD: Not to avoid the question, but it is normally the policy of the LMOA committees, when they take a survey, not to specifically state what railroad gave what information. For that reason, when we send out a survey, if a chief mechanical officer or chief purchasing officer knew his railroad was going to be singled out as possibly being presented in a bad light, they would not send in any information. Therefore, we have always designated any survey results by type of railroad, A, B or C, or by size.

I am going to have to stick with this policy and not say whether Conrail or any other railroad is involved in the survey. The only thing I will say is that you should take the inventory investment on your railroad and compare it with the results we came up with in the final report.

MR. GREGORY: That was well put. It took almost ten years to have railroads submit data to us on surveys. In fact, when we were making the study on units held for material we finally got the railroads to agree on what can be defined as "unit held for material," and when we asked for the data three years ago I think thirty railroads replied. As Don said, you can take the information that is in the book, compare it to your own railroad, and you can say your inventory is good or your inventory is excessive.

Another question: "Was it a typographical error or an audio error, or does Conrail spend $4.5 million to haul material other than on their own railroad, that is, by truck and otherwise?

MR. WARD: I would like to ask Carl Blessing to enlighten us, since this was his report.

MR. C. V. BLESSING [Manager, Methods and Procedures, Consolidated Rail Corporation, Philadelphia, Pennsylvania]: No, there wasn't an overstatement of the fact that the cost in the paper of transporting materials was incorrect. This was a survey made and a study made by a task force which is presently putting them into the production control business and taking them out of the delivery business and utilizing trucks to deliver materials to terminals.

The costs that were mentioned in the paper were actual costs studied from the accounting department and material management department on the railroad. It has been increasing every year by using truck transport, and they are presently investigating what we could do to eliminate using trucks to transport all this material.

We must say it wasn't just handling production control material. There were other materials involved. That is what it cost this company to do that, because we hire an outside trucking concern to haul this material. That is all I can say on that, Jim.

MR. GREGORY: I did mention to the gentleman who asked this question that this was not the cost to haul mechanical department material.

MR. BLESSING: No, it was all costs.

MR. GREGORY: "What good is a spectrograph department and its chemists if they can't determine metal wear and save engine failures?"

MR. SMALLING: That is an interesting question that also came up this morning in our Committee meeting. I think we have a member of our Committee who can explain the whole situation more clearly than I. I will call on Ken Reed, if he will, to comment on this. If you will remember, yesterday Ken spoke on spectrographic analysis and mentioned some figures on bearing and crankshaft failure.

MR. REED: In the Committee meeting we held this morning we were afraid the impression was given that the spectrograph was not a useful instrument, and possibly other laboratory work. We didn't intend to give that impression; but we do feel (and I think every member of our Committee feels) that the spectrograph was possibly oversold originally as far as what it can do, not as to what its value is.

The spectrograph can detect ingested dirt and call for air filter inspections and changes. It can detect problems with piston liner ring wear through the iron levels. It has been of extreme benefit in detecting water leaks that wouldn't show up as free water but by the cooling water additives that have been left behind in the oil, and probably I could go on and name a lot of other areas. But we do feel it was oversold originally.

I know when I went with the railroad about the time the spectrograph arrived on the scene, generally the value or justification for the instrument was based on the number of crankshafts that were saved. It was very popular to say we saved so many crankshafts that cost so much, and that it cost so much to replace them.

We have saved 300 in a year; therefore, the spectrograph will pay for itself ten times over in the first year, and we were forgetting all the other things it would do. I discovered the fallacy of this myself one time when we had a

92 per cent record of finding bad bearings when the spectrograph had called for bad bearings, and we started to have the bearings sent in that were taken out as being bad, and I never saw such goodlooking bearings in my life. They were as good as new. Even some of the worn bearings that were sent in were not condemnable. They were new bearings to all intents and purposes.

Some mechanic either didn't know what was condemnable or wasn't concerned. He had been told by somebody that he was to inspect because the locomotive had bad bearings, and so he took out bearings and replaced them. When we started to be a little more circumspect we found we weren't finding bad bearings.

As I mentioned yesterday, if you look at a bearing and the amount of material worn off of it to be condemnable, it won't contribute enough to the spectrograph to be seen. This is a little arithmetic you can do for yourselves.

Sometimes, in this space age technology we are all involved in, we overlook the fact that some of the more menial tasks of the chemist may be as important or more important than what the spectrograph does. But the spectrograph can be automated, computerized, and can do a lot of work with few men, and therefore we overlook the viscosity measurements that are very important. The spectrograph can't touch that.

The free water identification can be very important because if there is free water in the locomotive it may be currently in trouble. A lot of us have quit doing pentane insolubles because they are labor-intensive. We got caught on this not too long ago on our road.

So, we feel as a Committee that the spectrograph is useful, and that the other tests the trained technicians do are useful and are saving the railroads money.

MR. HOFFMAN: May I make one additional comment to put the bearing question in perhaps a perspective many may have forgotten? In the era of Ray McBrian and the other pioneers, the type of bearing failures people were finding, and which brought the spectrograph into prominence, were failures caused by corrosion of the bearings. There was another episode of that, and it occurred in the early 1960s.

The spectrographic procedures that most of us use today can in fact detect that type of bearing failure. However, that type failure is very seldom found due to present-day technology of bearing construction and their metallurgy and due to better oil control.

The negative comments were really being addressed to the sudden catastrophic failure for whatever reason, and the spectrograph our Committee agreed is not adequate to do that job.

MR. GREGORY: That almost makes me feel like an old man. I am from the era of Ray McBrian. I came to the railroad from an oil company, and we were one of the

first railroads to purchase a Baird spectrometer and a Phillips electron microscope. Emphasis was placed on preventing crankshaft failures. It got to the point that Carl Miller used to say, "Hell, we have people working three tricks a day inspecting bearings at DeWitt because of the way you call it." I would say that if we could hit one out of ten and save a crankshaft we would feel justified.

The spectrograph truly has its place. We were finding high silicon, and the girl recording the data said, "It appears that the high silicon in the oil is more or less confined to Stanley assigned units." So we sent someone to Stanley to check their operations. Those were the days when the air intake filters were washed, spun, and a tacky oil applied.

What had happened was that the machine had malfunctioned. The fellow was washing the filters but he wasn't applying any oil, and of course with no oil to absorb the dust particles we were getting our Toledo units loaded with high silicon. So, here was a case where the spectrograph pointed at something that maybe the mechanical supervisor on location should have noticed.

The part that disturbed me was that yesterday it left the impression that the glory days of the spectrograph were over, that it wasn't really the piece of equipment it was intended to be. The spectrograph has its place, so we will leave it at that and will let poor Ray rest in peace.

"What is the current recommended procedure in inspecting diesel engines for water leaks at the top seal area, and for scoring? Is a boroscope used extensively for that purpose today? Does that indicate an instrument to check boron?" Can anyone answer that question?

MR. MITCHELL: The boroscope was originally used by GE to look for top liner seal leaks through the ejector hole with water pressure in the cylinder, and you could observe droplets of water between the liner and the head. You could also look for a scored liner, which was one of our prime problems in the days of chrome liner equipped engines. We have recommended that customers not use the boroscope on tufftrided equipped engines because of the visual appearance of a tufftrided liner compared to a chrome.

Going back to the basic question, which was how you check a GE cylinder for water leaks, our instruction booklet lists all of the techniques that have been developed, and you should choose the one that best suits your needs.

There are other techniques to do this. We talked about scoring a moment ago. I think the most effective way to check for scoring is the compression tests, looking for blowby past the scored surfaces of the liner.

MR. GREGORY: Air filtration has always been an interesting subject because it is related to proper combustion, and proper

combustion is related to fuel economy.

"Does the type of air intake filter have an effect on the fuel consumption on EMD and GE diesel engines?"

Here is a chance for filter suppliers in the audience to expound the theories of their filters. Who would like to answer that question on the effect of air filters on fuel consumption?

MR. F. A. DOODY [Farr Company, Oak Brook, Illinois]: I believe this was a topic for discussion last year or the year before. One of the major locomotive builders recently ran some rather extensive tests and determined that the air filter had practically no impact, possibly none whatever, on fuel consumption.

I believe they pointed out to a number of the railroad companies that they should look to maintaining their power assemblies, possibly keeping aftercoolers cleaner and look toward the turbo exhaust screen for plugging. They are much better qualified to comment on what they did than I am, but the work has been done.

MR. GREGORY: Thank you, Does anyone else wish to express his views on air filtration and its effect on fuel consumption?

MR. HOFFMAN: I will make one very brief comment that has nothing to do with type of air filter. Certainly if you have an air filter that is plugged, for whatever reason, to the point that you are starving the engine for air, you will surely find fuel consumption worse, and you will have smoke and all the other evidences of faulty combustion.

MR. GREGORY: Yes, without proper air filtration you do have those problems.

We are fortunate to have Mr. Hoffman here. One person we miss is Honlick, formerly with EMD. We used to take him over the coals, and he absorbed it good-naturedly. I hope wherever he is he is now enjoying good health.

Are there other questions from the audience?

MR. MacDERMOT: Since Harold Stringer of CP Rail is on the panel, I would like to talk about a problem we experienced last winter with a GP38-2. This unit had inertial primary and fiberglass bag secondary air filters. The secondary filters — that is, the engine air intake — plugged with snow, choking the engine to the entent that oil was drawn past the seals into the roots blowers and ignited. The resulting fire melted through one aluminum blower support allowing the fire to progress into the hood, where a substantial amount of damage was done.

I would like to ask Harold if they have experienced any filter plugging incidents like this during winter operation, and, if so, whether he has any suggestions as to what to do to avoid them.

MR. STRINGER: Thank you, Chris, I guess. I thought I was going to be able to rest easily at the end of the table.

No, we haven't had any problems to that extent, certainly nothing


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catching on fire, but there is a continuing problem with inertial filters under winter conditions, particularly when you have a sort of wet snowflake situation. Once the dustbin blower becomes inoperative you essentially take the snow right into the generator compartment, and there is no limit to where it can go, even up to the roof of the compartment. In many cases we have had to shovel them out.

I think there is a crying need for a good inertial filter that can effectively separate snowflakes. I don't know if anyone has been able to tackle this problem successfully. We have heard of everything from straight fiberglass filters to burlap bags being put on the outside of inertials. I believe this came over from Siberia or somewhere with one of the committees. We have tried them all, and I really can't say anything has worked very well under heavy snow conditions.

MR. JOHN GANN [Rock Island Railroad, Retired]: I am retired but am still very much interested in the railroad industry and its problems. There aren't many here to represent the Rock Island, so I will.

I have a question. Due to high material cost, what has been your experience with and what are the economics of re-profiling ring gears?

MR. WESTERFIELD: We have an extensive program of sending ring gears, which have profile wear but still have usable metal left in the tooth, to an outside vendor for re-profiling. The results have been excellent.

MR. BRUNER: The Union Pacific purchased an Arrowsmith traction gear re-profiler which has been in operation approximately one year with excellent results. Our production has been consistent and improved since its first installation, and a continuing study by our Mechanical Department indicates there is good economics in re-profiling gears.

It would be difficult to determine how many motors would have failed as a result of worn gears. However, the industry is certainly aware of the damage sustained in traction motor armatures, as a result of mechanical destruction when the gears are worn out of profile.

The economics of the use of the machine have been established on a limited basis, and after a more complete study is made of traction motor maintenance costs we are certain we will be able to put a better figure on the economics. So, to answer your question, John, we feel there will be savings in the future.

MR. GREGORY: I would like to pose a question that you might take home and think about, especially the major railroads. When you look at the high cost of inventory the question comes up: Why do you have such an inventory and why do you overhaul so many component parts?

The component parts we get in the backshop are those that have

failed. Sixty per cent of the components we repair go out to the field. Several years ago the Frisco Railroad was one of the first to have what we might call a locomotive information system. They listed the locomotive, the miles, the major components (in fact, 50 to 60 components), when they were replaced, why they were replaced, and whether they were new or reclaimed.

One thing the Frisco had was predicted life of many components. I don't know how many railroads are progressing in that manner, but I think the time will come when analysts will evaluate service life. By this I don't mean procedures where we will be drowned in a sea of paperwork. I do think the time will come when, with analysis by both the manufacturers and the railroad mechanical departments, we will bring the locomotive into the backshop at a certain time for specific repairs and replacement of parts.

It is a lot cheaper in labor to remove power assemblies, lube oil coolers, traction motors, and so on, in a backshop than it is at the terminal.

The day will come when terminals will fuel, sand, and make periodical inspections, instead of making repairs that belong in backshops.

That is just something for food for thought.

Another question: "Do you have any information on the possible electrolytic action between the tubes and the headers of mechanically bonded 8-inch radiators?" I don't know whether that is because of dissimilar metals. Can any railroad answer that?

MR. BRUNER: I thought we had answered this question before, when I previously referred to the mechanically bonded radiators in our 6900 class locomotives. We have not seen electrolytic action so far on the mechanically bonded radiators.

I would like to go back to the previous discussions about inertial air filters on locomotives. I don't think they are going to be replaced with something that will do the same job satisfactorily into the carbody and be relatively inexpensive. I say this for two reasons:

1— Due to our experience with rotary snowplows, we have three diesel engine powered snowplows on our property that are equipped with inertial air filters to remove the snow from the air prior to being drawn into the carbody of the snowplow. Prior to their application on the first plow, which was built in the late 1950's, the engine room and body of the snowplow would literally fill up with snow. After application of the inertial separator we have had no further trouble, and the walkways around the diesel engine remain clear of snow.

For those who have seen snowplows operate, it is really an exaggerated problem, much more serious than with standard diesel locomotives, since blowing snow from the plume from the rotary is

continually being blown back over the carbody when operating toward strong winds.

We have operated these plows on our system in snow depths of 17 to 18 feet and have done this for many years on our West Yellowstone branch. Our West Yellowstone Branch runs between Ashton, Idaho and West Yellowstone, Montana, a distance of 93 miles, and requires one to two days of continuous plowing, day and night, depending upon the average snow depth.

2 — Inertial filters were used on our large 8500 gas turbine locomotives which we operated for approximately ten years between 1959 and 1969. The inertial filter was quite successful in removing sand from the turbine inlet, and by so doing increased our compressor blade life by as much as 80 per cent.

In summary, I don't think it would be possible to replace this relatively simple and efficient method of removing heavy dirt particles and/or blowing dry snow. Granted, there may be conditions where wet and very sticky snow will be encountered where problems can still exist, and, when a condition of wet sticky snow exists, it may be necessary to remove the caked snow from the inertial filter manually.

Perhaps there are a number of people in this room who will remember the days when the old style oil-soaked carbody filters were the only primary filtration for outside air. I am still impressed with the over-all improvement of locomotives as a result of the development of the inertial filter which can provide primary protection in possibly 99 per cent of adverse sand and snow conditions.

MR. STRINGER: While I would certainly agree with Frank that the inertial is an excellent primary filter, and I would agree that under most circumstances we couldn't live without it, I would very much like to challenge the filter manufacturers to put something behind it to augment the separating capabilities of the inertial.

When you consider that this air has to go through all the electrical equipment as well as feed the engine, just a few snowflakes can do a lot of harm in the electrical machinery if it is in the wrong place.

I think inertials are a big breakthrough, but I would certainly challenge the manufacturers to improve on the secondary filtration and try to give us clean air. This affects a great many components in the engine and the electrical system, and we desperately need clean, dry air in the whole locomotive. I would like to throw out that challenge.

MR. GREGORY: The new Shop and Machinery Committee was the one that preceded us. When this subject was presented two years ago at Altoona there were three pieces of equipment that we learned something about, that we purchased and are using in our backshops.

I realize their report was somewhat abbreviated, and you haven't had too much time to review it, but are there any questions you might want to ask regarding the numerous slides and reports the Committee gave on new machinery · new equipment and new tools? Are there any questions from the audience regarding that?

MR. WALKER: I don't have a question regarding the machinery, but I can't help thinking back over the meeting, and what made the biggest impact on me was the report Chris Cox gave comparing the GP40X 35pp HP locomotive and the fuel savings of 7 per cent over a 3000 HP SD40-2.

We are aware of other things that EMD did with less percentage dynamic braking, low idle, and for some reason I can't sit here and not ask what GE is doing toward fuel savings. I am not taking a slap at them. If they have something to report I would be most happy to hear it. If they don't, we certainly would like to make this a challenge to them.

MR. GREGORY: I think that would be good to discuss, because Mr. Hoffman hasn't had to answer a question for three minutes.

MR. HOFFMAN: I think the response should come from Norm Isler, since fuel consumption efforts cover a broader spectrum than just engine efforts.

MR.. ISLER: Thank you, Jack. The answer is yes, we are doing a lot on fuel consumption. We would be remiss if we did not. The improvements take a number of forms.

Our principal improvements in the last year and a half that we have been seriously working on fuel consumption more actively consist basically of improvements in the accessory area.

We have modified the radiator fan to reduce the amount of cooling air, and after doing some cooling system studies we found we can get by with a lot less horsepower to drive the fan than we have in the past. There is a savings there.

We have looked at equipment blowers and found we are able to change the horsepower required in that area as well by changing the rotor and basically using the B rotor in the C housing. We are able to reduce air flow still within our component requirements for all the ventilation requirements, and thereby use less horsepower. We have put low idle on some units in the field. Instead of the 450 rpm idle we are down to 385, which is still enough to keep the battery charger operational. We have effected better than a 20 per cent fuel consumption saving in idle with that arrangement, and it seems to be working out quite well.

We have a dynamic brake speed schedule that now modulates the speed of the cooling fan to the dynamic brake need depending on what the brake call is. The fan used to run always at maximum speed, and depending on what type of duty cycle you have, that savings can be quite appreciable.

Those are some of the non-engine items we have worked on. There are a number of other items we are working on further, and I am a little hesitant to reveal them until they become a fact. The savings there are significant, and I think there are more significant ones to come. We are addressing the problem.

I guess I would be remiss if I didn't point out the inherent advantage we have on a 4-cycle engine. That is one of our big plusses. This is not to say that there aren't further improvements possible in this area as well.

Speaking of the engine, I neglected to point out that we have had a turbo air seal line used to seal the turbocharger oil seal. We now have a modified arrangement that does not require this external air line, and the feature of that air line was that it required the air compressor to cycle more frequently. That is another use of energy that doesn't directly help you in producing tractive effort. With the improved seal arrangement we no longer need that seal line, and that is another contribution toward furthering fuel consumption reduction.

Jack, is there anything further you would like to mention?

MR. HOFFMAN: There really are no other things that I think should be addressed at the moment. If anyone is interested in looking at the types of design changes which are usually ad-

**President Harley seated center and Vice Presidents: Jim Long, left; Bob Clevenger, right; standing left to right: Kjell Axelson, Darrell Walker, Dick Holmes and Nelson Buskey.**

dressed to improve engine fuel consumption, I can refer them to a paper I presented last year at the National Petroleum Refiners Association meeting that addresses that subject.

MR. MITCHELL: I would like to add one thing to Darrell's question. If you add up the things just described, we are now approximately 7.1 per cent better with the GE locomotive than we were in November, 1977. That is a pretty significant improvement, we believe, and we are going to continue efforts to make it even better.

MR. GREGORY: In the two seconds I have left I would like to read a brief statement:

"The LMOA members recognize the contributions of Mrs. Lou Koerner, who assisted us dumdums in filling out the LMOA form, and Elmer Hafling's wife Terry, who on her own set up the ladies' get-acquainted coffee section on Monday and was instrumental in many of the tours that were made." [Applause]

Now I will return the meeting to Mr. Bruner, and thank all of you for being here.

MR. BRUNER: Thank you, gentlemen, for your participation this morning. This is always an interesting session. Our time is short, and I thank all of you who participated. Let's give Jim and the panel a rousing vote of thanks. [Applause]

PRESIDENT LONG: I have a brief announcement. LMOA registration: Railroad members, 313.

Secretary-Treasurer Joe Koerner receiving special award from Jim Long and Tom Harley at the meeting's conclusion.

Associate members, 178 Total, 491. Ladies, 120. Grand total, 611.

Our membership renewals were railroad, 101. Associates, 70. Total, 171 at this convention.

I have been very impressed by the young officers on the various committees during this convention, and the fine presentations they have made. We thank the companies that sent them, and hope for their continued participation.

The meeting is adjourned until September 22, 1980.

[The meeting adjourned sine die at 11:30 a.m.]

# PRE-CONVENTION PRESENTATIONS

# INDEX

## LOCOMOTIVE MAINTENANCE OFFICERS ASSOCIATION

INTERNATIONAL BALLROOM (SOUTH)

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Our registration desk, located in the Normandy Lounge, Second Floor East of the Conrad Hilton, Chicago, will be open Sunday, beginning at 12 noon. Come in Sunday afternoon, register, and enjoy this special opportunity to visit with our officers and your other friends. THIS WILL SAVE YOU VALUABLE TIME ON MONDAY MORNING. KEEP YOU OUT OF THE REGISTRATION RUSH. **BRING YOUR WIFE WITH YOU.** She will enjoy the special entertainment planned for her!

**SPECIAL INSTRUCTIONS**

1. **STUDY these reports closely.**
2. **SEND OR BRING written questions to the Committee Chairmen.**
3. **BRING THIS BOOK TO EVERY SESSION OF THE ANNUAL MEETING! There are no extra copies.**
4. **BRING your 1980 LMOA Membership card for identification in registering.**

**ALL RAILROAD MEMBERS!** The ground rules of this Annual Meeting require:
"THAT ALL SUPPLY COMPANY HOSPITALITY SUITES MUST BE CLOSED TO AND OFF LIMITS TO **ALL RAILROAD PERSONNEL** WHILE THE MEETINGS ARE IN PROGRESS." ALL HOSPITALITY SUITES CLOSE AT 8:30 A. M., 1:45 P. M., 11:00 P. M.
Please do not **embarrass** your Supply Company friends by calling at their suites while the meetings are in progress; it will cause them:

1. **To remind you of this ground rule.**

   or

2. **To lose their reservation at this meeting, and to forfeit their right to attend future meetings.**

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You are urged to attend the meetings because:

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| | Advertisers | Associate | Active | Total |
|---|---|---|---|---|
| 1939 | 0 | 27 | 60 | 87 |
| 1940 | 34 | 48 | 162 | 244 |
| 1941 | 38 | 48 | 210 | 296 |
| 1946 | 103 | 187 | 676 | 963 |
| 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 |
| 1963 | 125 | 275 | 2345 | 2745 |
| 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 |

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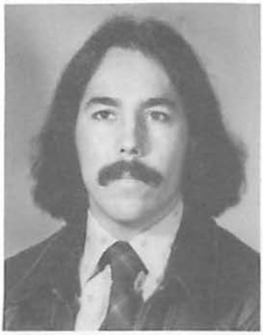

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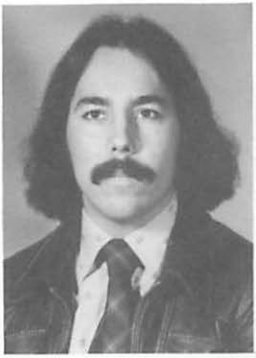

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1942-1946 Inc. — J. E. GOODWIN (Deceased), Exec. Vice-President, C. & N. W. Ry.

1947 — S. O. RENTSCHILER, Retired Chief Mechanical Officer, Bessemer and Lake Erie R.R., 2502 East Cass St., Joliet, Ill. 60432

1948 — C. D. ALLEN, Retired Asst. C. M. O. - Locomotive, C. & O. Ry. & B. & O. R.R., Star Route #1, Box 149, Dunnsville, Va. 22454

1949 — J. W. HAWTHORNE, Retired Asst. Vice-Pres. - Equipment, Seaboard Coast Line R.R., 8334 Lawfin St. (S), Jacksonville, FL 32211

1950 — G. E. BENNET (Deceased), Vice-Pres. - Gen. Purchasing Agent, C. & E. I. Railway

1951 — P. H. VERD (Deceased), Vice-Pres. - Personnel, E. J. & E. Ry.

1952 — H. H. MAGILL (Deceased), Master Mechanic, C. & N. W. Ry.

1953 — S. M. HOUSTON (Deceased), Gen. Supt. Mech. Dept., Southern Pacific Co.

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1957 — J. T. DAILEY (Deceased), Asst. to Pres. - Mech., Alton & Southern R.R.

1958 — F. E. MOLLOY (Deceased), Supt. Motive Power, Southern Pacific Co.

1958 — F. R. DENNY, Retired Mechanical Supt., New Orleans Union Passenger Terminal, 3229 Durango Road, Fort Worth, Texas 76116

1959 — E. V. MYERS, Retired Supt. Mechanical Dept., St. Louis - Southwestern Ry., 2700 Howard Drive, Pine Bluff, Ark. 71601

1960 — W. E. LEHR, Retired Chief Mechanical Officer, Pennsylvania R.R., 313 Hayden Street, Sayre, Penn. 18840

1961 — O. L. HOPE, Retired Asst. Chief Mechanical Officer, Missouri Pacific R.R.

1962 — R. E. HARRISON (Deceased), Manager Maintenance Planning & Control, Southern Pacific Co.

1963 — C. A. LOVE, Retired Chief Mechanical Officer, Louisville & Nashville R.R., Louisville, Ky.

1964 — H. N. CHASTAIN, Retired Gen. Manager - Mechanical, A. T. & S. F. Ry., Chicago, Ill.

1965 — J. J. EKIN, JR., Retired Supt. Marine & Pier Maintenance, B. & O. R.R., 8205 Tally-Ho Road, Lutherville, MD 21093

1966 — F. A. UPTON, Asst. Vice President Mechanical, C. M. St. P. & P. RR., Milwaukee, Wisconsin

1967 — G. M. BEISCHER, Retired Chief Mechanical Officer, National Railroad Passenger Corp., Washington, D. C. 20024

1968 — G. F. BACHMAN, Retired Chief Mechanical Officer, Elgin Joliet & Eastern Ry., 612 E. Bevan Drive, Joliet, IL 60431

1969 — T. W. BELLHOUSE (Deceased), Supt. Mechanical Dept., S. P. Co. - St. L. S. W. Ry., Houston, Texas

1970 — G. R. WEAVER, Retired Director Equipment Engineering. Penn Central Co., 516 Bryn Mawr Ave., Bryn Mawr, Pa. 19010

1971 — G. W. NIEMEYER, Retired Mechanical Superintendent, Texas & Pacific Railway, Ft. Worth, Texas, 215 South Tucker, Nevada, Mo. 64772

1972 — KY PRUCHNICKI, Retired General Supervisor Locomotive Maintenance, Southern Pacific Transportation Co., 423 W. 27th St., Houston, Texas 77008

1973 — W. F. DADD, Retired Chief Mechanical Officer, Chessie System, 805 Villa Drive, North Myrtle Beach, SC 29582

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1976 — J. D. SCHROEDER, Assistant C.M.O. - Locomotive, Burlington Northern Inc., St. Paul, Minn. 55101

1977 — T. A. TENNYSON, Retired Asst. Manager Engineering - Technical, Southern Pacific Transportation Co., 1528 Mallard Way, Sunnyvale, Ca. 94087

1978 — E. E. DENT, Retired Superintendent Motive Power, Missouri Pacific Railroad, 33 Deerfield Lane, Creve Coeur, MO 63141

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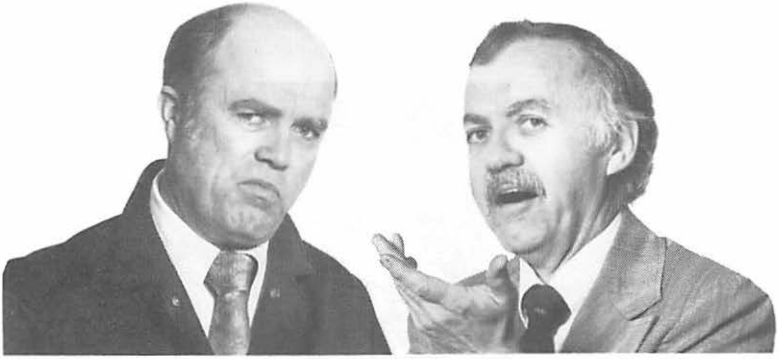



**J. J. BUTLER**
Chief Mechanical Officer
Consolidated Rail Corporation
Philadelphia, PA 19104

LMOA wishes to express its thanks to Consolidated Rail Corporation for again hosting Pre-Convention Presentation in the Altoona area.

Our Diesel Mechanical 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.

# Monday, September 22, 1980

**10:00 A.M.**

## REPORT OF THE COMMITTEE ON DIESEL MECHANICAL MAINTENANCE

**Pre-Convention Presentation: Consolidated Rail Corporation**

**April 1, 1980**
**heraton Motor Inn**
**Altoona, PA**

**J. L. KUHNS, Chairman**
Superintendent Motive Power
Louisville & Nashville Railroad
Louisville, KY 40203

**VICE CHAIRMAN**

W. A. Brown, Assistant Manager Motive Power, Burlington Northern, St. Paul, Minn.

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### 1980 TOPIC:

### "FUEL ECONOMY THROUGH IMPROVED MAINTENANCE IN THE COMING DECADE"

## PERSONAL HISTORY

### JACK L. KUHNS

Born in Clinton, Indiana, into a Railroad family on December 15, 1925. He attended public schools in Chicago, Illinois, and served aboard a destroyer in WWII. Upon discharge in the spring of 1946, began working for the former American Locomotive Company in Schenectady, New York, as a service engineer trainee. In February 1963 began working for the Louisville and Nashville Railroad as Chief Draftsman, Locomotives, in Louisville, Kentucky.

Has held various jobs including Assistant to General Superintendent-Motive Power, Assistant Manager-Quality Control, Manager-Quality Control Assistant Superintendent-Motive Power Maintenance, and presently has position of Superintendent-Motive Power Maintenance.

Has been a member of the L.M.O.A. since 1963.

Married to the former Valera Coble and they have four children and three grandchildren.

His hobby is flying, with emphasis on aerobatics.

## I.

## FUEL CONSERVATION

With the skyrocketing cost and equal concern over availability of diesel fuel, the subject of fuel conservation has become a byword. In the 1980's the United States' dependence on imported crude oil is expected to increase, further adding to cost and supply pressures.

Based on 1978 figures, the average gallon of fuel burned by the railroads generated 211 revenue ton miles, producing an average of $4.99 in revenue. During a period of fuel shortage, a 1% reduction in fuel consumption could add $7,479 per locomotive year in revenue. The forecast increase in demand, coupled with the uncertainty of supply of fuel makes fuel conservation increasingly important. Along with locomotive reliability and availability, fuel conservation has gained top priority with builder and user. Each has a dedicated responsibility to achieve the maximum in work performed for each gallon of fuel acquired.

Electro-Motive Division of General Motors and the General Electric Company, the major locomotive builders, have made great strides in increasing the fuel efficiency of their diesel locomotives. Improvement has come through engine design and the minimizing of power requirements of the locomotive support systems. We look at what each locomotive builder has done to improve fuel efficiency without sacrificing reliability and durability of the locomotive. Also included are recommendations for achieving greater fuel conservation without sacrifice of service or dependability with shipper and customer.

Government regulations can have a significant impact on fuel economy.

# DOES THIS LOOK LIKE A 25-YEAR-OLD LOCOMOTIVE?


Of course not. This locomotive not only looks new, but it also performs like new. In fact, the ICG GP-11 has many new locomotive features. It is the ultimate in remanufactured locomotives featuring everything you would want in a new locomotive but for a lot less money. Sure, this locomotive was once a tired GP-9 but after complete remanufacturing at ICG's Paducah facility we gave it a new lease on life. In the process we apply many of the latest "state of the art" engineering improvements that save maintenance and operating dollars while improving reliability and availability. A GP-11 features:

- Pressurized high voltage cabinet incorporating solid state circuitry and speed activated transition
- Centralized main generator/traction motor blower system
- AAR control console
- "Clean" cab
- Snow plow front end
- Collision post in nose for crew protection
- Optional anti-climb feature
- New modernized sand tanks with outside access

Additional information on the new GP-11 or other locomotives remanufactured by Illinois Central Gulf can be obtained from: Call or write E. B. Robertson, Regional Sales Manager, Manufacturing & Sales, Paducah Shop, 1500 Kentucky Avenue, Paducah, Kentucky 42001, Phone (502) 443-1446.

**Illinois Central Gulf**

An **IC Industries** Company

Government emission standards have the potential to wipe out anticipated fuel savings that result from improved engine efficiency. (See Fig. 1)

Regulations governing total emissions of diesel engines are anticipated and unless realistic guidelines are employed, future fuel savings can be offset or possibly completely eliminated. The railroads and builders must recognize that a joint effort will be required for enactment of reasonable standards.

Electro-Motive Division's current production is the 2-cycle 645 diesel engine available as roots blown or turbocharged.

The roots blown and turbocharged engines have experienced design changes involving top piston ring location, liner port width and low sac injector spray tips.

The most recent fuel economy improvement is in the turbocharged engine, which has a new design turbocharger and matched .500" injector which improves fuel efficiency.

With the introduction of the Dash-2 locomotive in 1972, Electro-Motive has had ongoing design changes to reduce exhaust emission levels and improve fuel consumption. Design changes to the piston, liner and injector have improved fuel efficiency and essentially provide smoke-free engine operation.

Using 1971 as a base year and a medium road duty cycle of a GP-38-2 locomotive equipped with dynamic brake and standard 315 RPM idle speed and 5th notch dynamic braking, EMD projects fuel savings of 11,840 U. S. gallons, or a 3.7% improvement.

Using 1971 base line and a medium road duty cycle, 315 RPM idle and 5th notch dynamic braking, the SD-40-2 has a projected 1.1% improvement of 4,400 gallons. By incorporating the low idle option and reducing dynamic brake engine speed to the 4th notch on a GP-38-2 and using the shut down option when ambient temperatures are at 50° F., the additional fuel savings would total 21,440 gallons, or 6.7% over 1971 base line year.

Also available on the new production locomotives is the controlled dynamic brake engine speed, which will allow the engine speed to remain at idle when grid amps are below 650 amps, and increase engine speed to 560 RPM when grid current is about 650 amps. Reasonable savings can be realized when favorable climatic conditions allow engines to be shut down in lieu of idling.

Several railroads contacted have some variance in operating instructions as to the ambient temperatures and length of time before the locomotive is called for service. Each railroad has to establish the criteria consistent with that road's operation.

The General Electric Company's current production is the FDL-12 and 16-cylinder turbocharged engine. General Electric's efforts have been aimed at improving

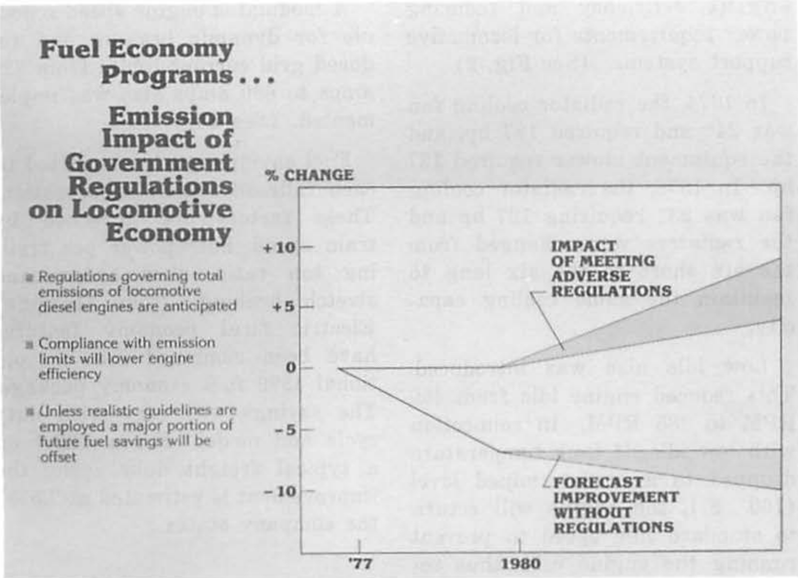

Fuel Economy Programs . . .
Emission Impact of Government Regulations on Locomotive Economy
Regulations governing total emissions of locomotive diesel engines are anticipated
Compliance with emission limits will lower engine efficiency
Unless realistic guidelines are employed a major portion of future fuel savings will be offset
% CHANGE
+10
+5
0
-5
-10
IMPACT OF MEETING ADVERSE REGULATIONS
FORECAST IMPROVEMENT WITHOUT REGULATIONS
'77
1980

Fig. 1

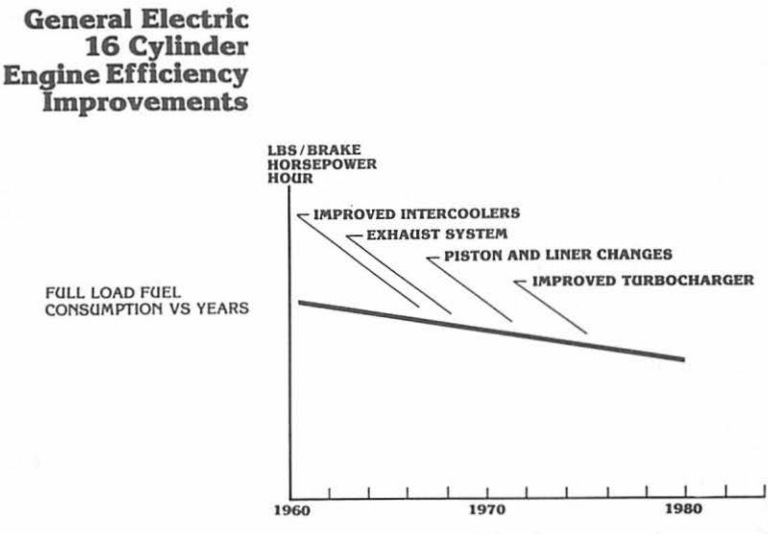

General Electric 16 Cylinder Engine Efficiency Improvements
LBS / BRAKE HORSEPOWER HOUR
IMPROVED INTERCOOLERS
EXHAUST SYSTEM
PISTON AND LINER CHANGES
IMPROVED TURBOCHARGER
FULL LOAD FUEL CONSUMPTION VS YEARS
1960
1970
1980

Fig. 2

engine efficiency and reducing power requirements for locomotive support systems. (See Fig. 2)

In 1974, the radiator cooling fan was 24° and required 187 hp, and the equipment blower required 137 hp. In 1978, the radiator cooling fan was 23° requiring 127 hp and the radiators were changed from the six short to the six long to maintain the same cooling capacity.

Low idle also was introduced. This reduced engine idle from 450 RPM to 385 RPM. In connection with low idle, if tank temperature dropped to a predetermined level (160° F.), the engine will return to standard idle speed to prevent running the engine cold, thus reducing engine wear. (See Fig. 3)

In 1979, further development toward fuel savings came about. The radiator cooling fan was changed to 20° along with gear ratio change in the fan drive gear box, which further reduced the fan horsepower from 127 to 104 hp. (See Fig. 4)

The equipment blower horsepower requirement also was reduced from 137 to 117 hp, increasing notch horsepower for traction formally used for support systems.

The turbocharger was changed in 1978 from the Elliott to the General Electric 1616-B1, which used compressor air for the turbo seal. In 1979, the 1616-B2 replaced the former and eliminated the need for compressor air seal. (See Fig. 5)

A modulated engine speed schedule for dynamic braking and reduced grid current limits from 720 amps to 690 amps also was implemented. (See Fig. 6)

Fuel savings are inter-related to each railroad's mode of operation. These factors are governed by train speed, horsepower per trailing ton ratio, slow orders and stretch braking. "The General Electric fuel economy features have been combined into an optional 1980 fuel economy package. The savings will vary with duty cycle and model. For a C30-7 on a typical freight duty cycle, the improvement is estimated at 7.5%" the company states.

## SUMMARY

Each locomotive builder has made fuel conservation a top priority by design changes in the engine, turbocharger, and reducing power requirements for the locomotive support systems. Considerable testing is now underway in the industry with a 4-cycle Cummins and Sulzer engines in locomotive application.

This Committee encourages each railroad to investigate the following recommendations:

1. Eliminate fuel spillage and intensify efforts to maintain onboard and wayside fueling equipment in good condition.
2. Low engine idle.
3. Dynamic brake engine speed control.

## Lower Engine Idle Speed*

**With water temperature at an acceptable level, centering the reverser or isolating the engine reduces idle speed from 450 RPM to 385 RPM**

- **Auxiliary load and idle fuel consumption reduced**

Fuel Consumption Gals/Hr

| | 16 CYLINDER | 12 CYLINDER |
|---|---|---|
| NORMAL IDLE | 4.3 | 3.6 |
| LOW IDLE | 3.4 | 3.0 |

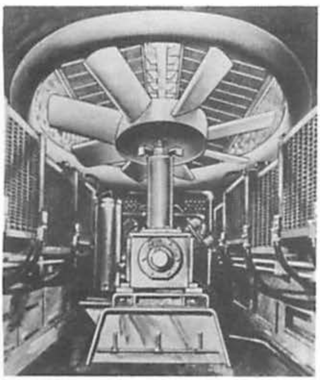
- **Idle noise level diminished**

RETROFIT
- **Kits for various models being developed**

*Optional

Fig. 3

## Decreased Radiator Fan Horsepower



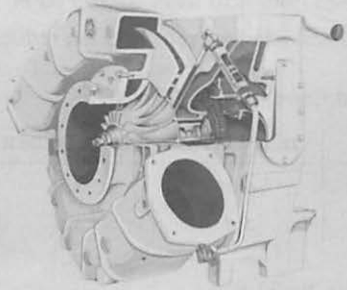
Fan horsepower/radiator area has been optimized to meet engine/dynamic braking cooling requirements

- Reduced auxiliary load
- Lower noise level

RETROFIT
- Required radiator/fan change out varies by model

Fig. 4

## GE1616B2 Turbocharger

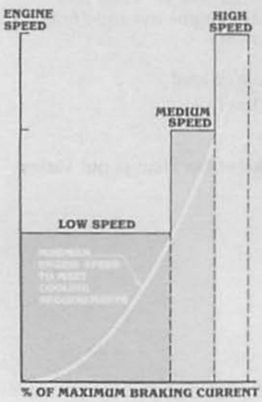


- Improved reliability and performance
- Increased altitude and temperature range
- Inherently more efficient turbine and compressor design
- B2 provides further gains in efficiency & fuel economy

RETROFIT
- As a complete turbocharger

Fig. 5

## Modulated Dynamic Brake Speed Schedule*




System has been designed to automatically provide engine speed/air flow for braking level cooling requirements

- Average auxiliary load reduced (radiator fan and equipment blower)
- Lower speeds reduce fan and blower noise
- Benefits in fuel efficiency will vary with individual railroad operating practices

RETROFIT
- Yes

*Optional

Fig. 6

4. Engine shut down when climatic conditions are favorable.
5. Maintain diesel engine and fuel injection equipment in good condition.
6. Maintain air filtration system in good condition to avoid excessive pressure drop across primary and secondary filters.
7. Dispatch proper horsepower per trailing ton ratio.
8. Train speed consideration.
9. Minimize stretch braking.
10. Reduce slow orders.
11. Proper throttle position for pumping up trainline air brake system.
12. Utilize yard air supply to charge train air brake system where available.
13. Potential fuel saver devices, particularly semi-automatic, depending on the railroad's individual operation.
14. Institute training program for locomotive engineers in proper train handling to conserve fuel.
15. Consideration should be given to isolating extra units on the return movement of unit trains.

## II.

## WINTERIZATION

The continuing severe winter weather conditions that have prevailed throughout the midwest and the northern states is continuing to plague locomotive maintenance personnel. To cope with these conditions, a regular and routine winterization program diligently adhered to will normally allow locomotives to operate without undesirable shutdowns.

Modification and retrofit to locomotives offered by the manufacturers that have been field tested and proven to increase reliability are:

### EMD Winterization

Fuel preheater: install fuel preheater with the capacity to maintain 25° fuel temperature in fuel tank at minus 40° ambient. Use Amot valve that will fully open at 100° F. fuel temperature and eliminate water shut-off valves for simplified maintenance and protection against freezing.

On locomotives equipped with low idle feature, apply automatic temperature control sensor in electric cabinet that returns engine to 315 RPM idle when temperature drops to minus 10° F. for effective fuel preheating at idle.

Clean air compartment winterization: to materially reduce problems caused by snow accumulation in clean air compartment.

Install a hood over the No. 1 cooling fan with a manual damper for summer/winter operation. The manual damper positioned in winter mode directs about 10,000 CFM of warm air from the No. 1 fan into the engine room, the air temperature is further increased by flowing over the engine exhaust manifold and air is mixed with about 6,000 CFM of generator cooling air at rear of engine.

Below 35° F., automatic shutters in the partition admit this air to the clean air compartment. Above 45° F., shutters are closed. Warm air admitted through the shutters mixes with the 50% of total air flow through the inertials. Resultant air temperatures are an average 50° F. above ambient, thereby protecting against snow accumulation in compartment down to approximately -15° F. (EMD Maintenance Instruction 9636).

Automatic cooling system drain: apply solenoid operated auto-drain valve, of flow-through design, to promote valve seat cleaning. Valve sized to drain cooling system at same rate as manual valve with thermostat mounted on auto-drain valve body (EMD Maintenance Instruction 9637.

System operation: engine shutdown energizes the automatic cooling system drain circuitry. When the cooling water temperature at the drain valve falls to 40° F. range, the thermostat trips, activating the auto-drain valve. The cooling system will drain completely with 10 to 12 minutes (250 to 300 gallons).

A cold water fill switch is provided to electrically override the auto-drain valve for refilling a drained engine. Restarting of engine "re-arms" the automatic cooling system drain circuitry.

Automatic service battery heating: operates only when the engine is running, drawing its electrical power from the engine driven auxiliary generator (74 VDC).

Stand-by battery heating: designed specifically for commuter locomotives to maintain warm batteries during overnight layover periods when the engine is shut down. This is a plug-in type system drawing electric power from the utility (480 VAC).

When ambient temperatures fall below 35° F., the heating system is activated and provides 1.5 KW of heating energy to batteries, and maintains the battery electrolyte temperature at 30° F. above ambient. The benefits gained are:

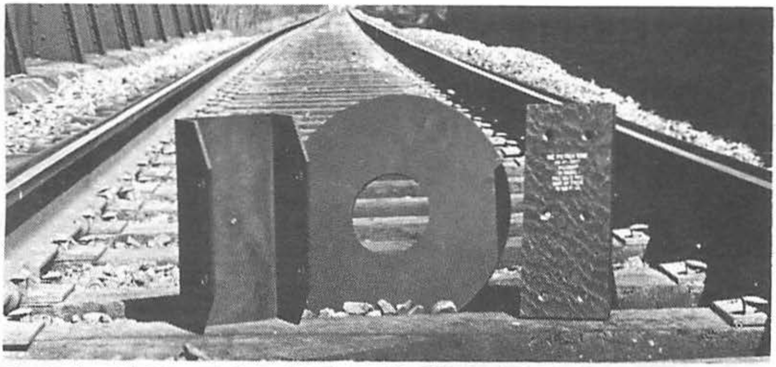
1. Increased engine starting capabilities and locomotive reliability—
   100% @ 77° F.
2. Increased battery capacity—
   90% @ 30° F.
3. Increased battery charging capabilities—
   75% @ 0° F.
4. Avoidance of battery freezing—
   48% @ 25° F.

Component hardware:

1. Two laminated battery heating pad assemblies
2. Double-pole circuit breaker
3. Two temperature sensing devices
4. One control contactor.

**GE Winterization**

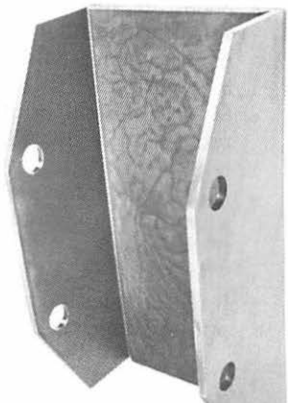
1. Automatic water drain system: in freezing weather, it is practically impossible to manually



# LET'S GET THE RIGHT PERSPECTIVE ON COST... AND ON PERFORMANCE.

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 disulphide right in the liner.
- Nylatron nylon liners generally outwear carbon steel 2½ times, and are at least equal to manganese steel liners.
- Nylatron nylon pedestal liners virtually eliminate wear on mating parts.
- Nylatron liners are one-piece construction. They eliminate problems with two-piece liner assemblies which can come loose and cause excessive wear on the pedestals that can require welding to rebuild.
- Nylatron pedestal liners weigh only 1/7 as much as manganese liners and are easier and safer to install.



And now, The Polymer Corporation makes two new products for the locomotive industry . . . .

drain a locomotive that shuts down enroute. As a result, a positive fail-safe system is needed that will automatically drain a locomotive cooling system whenever it is in danger of freezing. The General Electric automatic water drain provides a temperature sensor switch and valve for rapid drain of the locomotive water system if the engine shuts down in freezing weather. This is an extra item which can be applied to new and old GE locomotives. On the new automatic drain, the sensor to the most rapidly cooling part of the system and the electrical system was modified to allow cold water fill and automatic refilling. GE has also gone to a single flow-through valve incorporated for improved clog and freeze resistance. The last few items were incorporated in 1979.

2. Fuel oil heaters: locomotives operating in sub-freezing temperatures frequently need fuel heaters to prevent parafin or ice crystals from plugging the fuel filter element.

3. Lube oil coolers: 5/8" tube lube oil cooler bundle was introduced in 1979 and is retrofitable to all 16" lube oil coolers. The 5/8" tube will not retain water when water is drained from the unit. Replace the 16" diameter 1/4" tube bundle with a 16" diameter 5/8" tube bundle, along with new screens, as replacement is required. One road reports engine freeze up, but did not have a 5/8" tube bundle failure due to the freeze up.

4. Electric cab heat: electric cab heat was introduced in new series units and eliminates freezing or possible freezing of the old hot water heat. Old series units can be retrofitted with a new modular electric cab heat.

5. Frozen radiators: radiator venting has been increased in 1978 for faster draining and the fluid amplifier switchup was made more positive by orificing the inlet water.

6. Water drain: a second drain line has been added to new series locomotive oil coolers and the manual drain valve has been increased in size to 1½" full port. Both of these changes, when incorporated, reduce total drain time by 40%. Insulation was added to compressor water lines to increase the freeze margin.

7. Frozen air compressor: freeze plugs have been added to Gardner-Denver compressor heads and cylinders and the low-pressure head casting has been changed to eliminate pockets.

8. Fuel system: change to a 7 GPM pump and motor on all 16-cylinder engines; GE is testing a thermostatically controlled heater for the fuel oil. The strainer bowl now uses bolts instead of wing nuts for a tighter joint. It is possible to add a winter idle position to the start-run switch for units in the field as an option.

9. Emergency fuel cut-off switch: production units have recently been equipped with a new emergency fuel cut-off switch that

is enclosed and weathertight. This will eliminate the possibility of moisture getting in and creating grounds.

10. Engine air filter warm air supply: this modification changes the total configuration of the locomotive (adds coupling guards, door and panels) so that air can be obtained from the engine room during winter operation to help keep engine air filters free from ice buildup.

Winterization check list: winterization maintenance instructions recommended for locomotives during cold weather operation.

1. Inspect cabs for condition of weather stripping, windows and doors, all electric cabinet doors, seals, locks and latches and repair as required.

2. Check windshield wipers for proper operation. Check air horns, crossing bell, and clean moisture separators.

3. Inspect cab hot water heaters and defrosters for defects; clean dust and debris from heater cores. Check for leaks and proper operation. Clean, check and inspect electric heaters. Check hot water drain valves to insure proper draining.

4. Add antifreeze to recirculating toilets.

5. Apply to cab wall a sensitized water drain instruction decal and/or furnish each engineer proper draining instructions.

6. Drain condensate from main reservoirs. Check and maintain automatic drain valves in proper operating condition.

7. Drain condensate from fuel tanks when units are in shop for maintenance.

8. Use isopropyl alcohol with fuel oil mixed in a ratio of 1:1000 gallons for minimizing ice crystal formation, resulting in filter plugging.

9. In extreme prolonged winter conditions, use a blend of No. 1 and No. 2 fuel oil.

10. Check fuel pressure relief valve for proper setting.

11. Manually advance engine speed to maintain engine temperature when ambient temperature reaches 10° F. or lower to increase water circulation.

12. Clean fuel suction strainer. During extremely low temperatures suction strainer can be removed. GE locomotives replace strainer with new design, large mesh strainer.

13. Check fuel preheater operation.

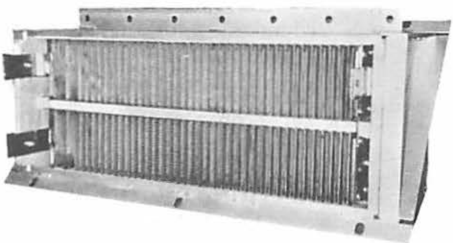
14. Inspect radiator shutters for free and smooth operation and tight seal in closed position.

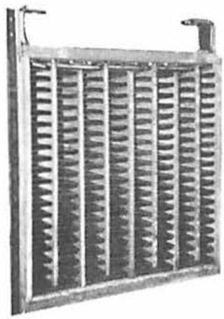
15. Place summer/winter switches and/or manually operated dampers in winter position.

16. Units equipped with EMD winterization system:

a. Check calibration of ambient air temperature switch by immersing probe in ice water (close @ 35° F., open @ 45° F.).

b. Check for operation of winterization shutters in parti-





tion by depressing test button on ambient temperature switch.

c. Check shutter linkage adjustment to insure full opening and closing of shutters.

17. Check cooling system pressure cap.

18. Cooling system water should be checked to assure properly softened and treated water is available and used.

19. Pressure test water system and check for leaks.

20. Insure that all radiator access covers are in place and in good condition.

21. Check automatic cooling water drain systems on locomotives equipped, for proper operation.

22. Apply all carbody blanking plates per individual railroad instructions and instruction manuals.

23. Clean all air inlet screens.

24. Inspect traction motor covers for tight seal, traction motor and carbody leads for proper seals and insulation. Traction motor connections utilize umbrella-type sleaves in accordance with builders' recommendation.

25. Check traction motor air ducts for damage. Repair and/or replace when defective.

26. Seal traction motor support bearing caps with RTV compound per builders' recommendations.

27. Inspect traction motor support bearing wick lubricators for wear and damage at start of winter season.

28. Periodically drain traction motor support bearing caps of accumulated water during winter snow season. Inspect and/or replace wick lubricator whenever water accumulation is noted.

29. Clean sediment from water-cooled air compressor liner water passages.

30. Apply insulating blanket to GE oil cooler to increase the freeze margin.

31. Connect all MU hoses to prevent ingestion of snow and provide redundant path in the event of freezing.

32. If battery heaters are used, check for proper operation.

## III.
## UTILIZATION OF ON-BOARD LOAD TEST

This portion of the committee's presentation will discuss utilization of on-board load test equipment.

Load testing of the locomotive power plant is a known prerequisite for successful performance of the locomotive during road operations. Load testing not only qualifies the locomotive power plant but also can be used as a measuring device to improve various heavy-repair shop operations or procedures and identifies areas in your maintenance programs that may require re-evaluation.

The Committee believes that conventional load testing—the connecting of the locomotive to stationary resistors—places an excessive, but necessary burden, in the

# MVI Caprinus® R Oil the hardworking oil for today's locomotives

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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 is *doubling* 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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**Come to Shell for answers**

*Caprinus is a trademark and is used as such in this writing form of labor and locomotive down time on the mechanical maintenance forces. Locomotives must be moved from various shop locations to the fixed loading resistor. This may result in serious delays owing to congestion in the shop areas or to unavailability of personnel responsible for moving the locomotives.

Load testing is limited to the number of stationary load test boxes available at the maintenance facility. Actual connection of the locomotive electrical system to the stationary loading resistors is, under the best of conditions, a difficult and time consuming task. Extreme weather conditions usually entail still more delays in the procedure.

A number of years ago, both major locomotive builders offered the on-board load test system as an optional feature on locomotives equipped with dynamic brakes. This option was well received by maintenance personnel since it eliminated some of the aforementioned problems. Load testing then could be accomplished at almost any shop location by merely repositioning one or two switches and operating the locomotive controller handles. In fact, load testing had become so easy that some maintenance supervisors endeavoring to furnish more reliable motive power included self load testing as a part of their routine maintenance procedure on every locomotive arriving or departing their shop. The benefits of this practice may be questionable. In the days of plentiful and inexpensive diesel fuel, indiscriminate load testing did no real harm although it is inefficient use of labor. Now fuel conservation is paramount.

A high-horsepower locomotive can consume up to 200 gal. of diesel fuel in one hour at full load. At today's fuel costs, this constitutes a substantial annual financial drain. As an example, one high-horsepower locomotive load tested for 30 minutes at cycles of two-week intervals would consume during tests approximately 2400 gal. of fuel annually. This figure multiplied by a fleet of 500 locomotives would annually use 1.2 million gal. of fuel in such testing.

The total U.S. railroad locomotive fleet now exceeds 27,000 units, the majority being road-type locomotives. With the exception of the recession years, 1975-76, U.S. railroads acquired new locomotives at a rate exceeding 1,000 per year since 1970. Assuming that one third of the total fleet, or 9,000 locomotives, are of the high-horsepower variety, load testing this group of units at 30-day intervals for one hour periods would require 21.6 million gal. of fuel annually on a nation-wide basis. Although these figures are hypothetical, they do indicate the potential for waste. Therefore, the need for proper management and scheduling of load testing in your maintenance program is obvious and we feel mandatory.

We must also, however, consider the need for certain levels of evaluation or maintenance of the loco-

motive to insure its maximum performance and reliability at minimum cost.

The railroads represented by members of this Committee have a wide variety of maintenance programs and schedules that have been adjusted to suit their individual operations. In spite of the wide spectrum of maintenance requirements, the Committee recommends that on-board load testing be incorporated in your scheduled maintenance program at intervals of not less than four times annually. The Committee agrees that this schedule should provide a highly reliable locomotive at a minimum expenditure of fuel.

On-board load testing can be a very useful time-saving maintenance tool when properly managed or programmed. It also offers similar benefits for troubleshooting locomotives experiencing a variety of on-line malfunctions. Its chief assets are mobility and a substantial reduction in labor time required to accomplish the total test. It is estimated an average savings of two to four locomotive hours and four to eight man hours can be realized for each individual load test performed by use of the on-board testing system versus conventional external load box methods.

Such savings easily justify the expenditure for retrofitting older locomotives or application on new purchases. Costs of retrofitting to new units equipped with dynamic brakes vary between $2,500 to $5,000 depending on make or model of locomotive. The Committee recommends installation of on-board load test on both older locomotives of 2000 hp and above undergoing rebuild programs and all new locomotives purchased with dynamic brakes.

Locomotive manufacturers offer publications outlining procedures and specifications for use by maintenance personnel as guidelines while performing load tests. Many railroads have modified those instructions to suit their own operational needs. With the wide variety of operational requirements, this Committee would hesitate to recommend any broad changes in load testing functions currently being performed on any individual railroad. It does, however, recommend adherence to OEM specifications.

## IV.

## NEW FRA RULES

After the 1979 convention, the Committee, selected various topics for its 1980 paper, one of which was to explain the proposed new FRA rules and their significance to the railroads. However, with the volumes that have been written concerning the various laws, we find it almost impossible to cover this subject. Therefore, we will only give the major changes as we know them to date.

The published book we now have is outdated, and we can only guess when the new book with all the changes will be printed. We are sure that there will be many

months of confusion by our line supervisors until they fully understand all these changes.

The FRA publishes a notice of proposed rulemaking and generally holds one or more public hearings with requests for views (written and/or oral) for each regulation prior to actual enactment. Railroads must take advantage of any opportunities to present arguments for or against proposed regulations. These arguments should cover cost of implementation and enhancement of safety by passage of regulation. It is too late to protest a regulation for its excessive cost after it has become effective. It is estimated, for example, that the cost of meeting safety glazing regulations will be about $1,000 to $1,500 for each locomotive. The cost for complying with locomotive safety standards will be dependent on each railroad's type of equipment and operation.

Safety glazing standards for locomotives (passenger cars and cabooses included) became effective on January 31, 1980. Key significant aspects of the regulations in final publication are:

1. New units and rebuilt units must be fully equipped after June 30, 1980.
2. All other units must be completely retrofitted after June 30, 1983.
3. Any unit requiring glass change account broken or damaged, must be shopped and completely equipped within 48 hours.
4. As units are equipped, cab must be stencilled "Fully Equipped FRA 223 Glazing" in one-inch letters.
5. Each piece of glass must show indications "FRA Type I" or "FRA Type II."
6. Glazing material certified by manufacturer must be installed in such a manner that it will perform its intended function, and this responsibility rests with the railroad.
7. During the three-year interval prescribed for retrofitting, any unit that sustains damage or broken windows must be placed in "designated service (not occupied by crew outside the yard) or removed from service within 48 hours until repairs are made with certified glazing.

Units strictly assigned to switching service within prescribed switching yards need not be equipped with certified glazing.

Any locomotive that will be retired or not in use on or before July 1, 1983, is eligible for a waiver of compliance. A waiver must be requested from FRA.

The revision of the Locomotive Inspection Act is the culmination of an AAR petition to FRA in 1973 requesting relief from the 30-day inspection requirement. It is a complete review and rewrite of 49 CFR Part 230, ostensibly to simplify wording, eliminate items relating only to steam locomotives, and do away with those requirements that were overly restrictive

and had no bearing on safety. Unfortunately, while a number of improvements were made in the content of the Inspection Act, several new requirements were added.

Briefly, the changes are as follows:

1. Elmination of the 30-day inspection requirement and the change of the 24-hour inspection to a daily inspection and the quarterly to a 92-day interval.
2. Elimination of the periodic orifice test for air compressors.
3. Elimination of the annual high potential insulation dialectric test.
4. Extension of interval for main reservoir test from 18 to 24 months and for servicing of filtering devices in main reservoir supply line from six to twelve months.
5. Elmination of some items covering steam generators, such as boiler washing, together with FRA Forms 1-B, 4-B, and 19-B which relate to steam generators.
6. Revision of Form F 6180.49 to record locomotive inspection and extension of filing period from six months to one year.
7. Addition of specific standards for locomotive headlights (200,000 candela for road units and 60,000 candela for yard units) and horns (96 dBA at 100 feet distance.)
8. Requirement for speed indicators on units that operate singly or as a lead locomotive at speeds in excess of 20 miles per hour.
9. Addition of cab sound level exposure standards the same as current workplace noise exposure levels provided by the Occupational Safety and Health Administration (OSHA) (90 dBA noise exposure for 8-hour duration.)
10. Addition of a provision to prohibit variation of wheel diameters in excess of ¾" within a six wheel truck and in excess of 1¼" between six-wheel trucks. Also, the back-to-back gauge of wheel sets with wide flange wheels must be between 53" and 53¼"
11. Requirement for what is termed an acceptable and permissible method for the movement of locomotives for repair that are not in compliance with the regulations.

All railroads are urged to keep abreast of each proposed regulation, particularly in the formative stage, and provide FRA with views in both oral and written form. This action may preclude the writing of unwarranted regulations or finalizing of regulations that do not actually promote safety. The FRA solicits comments, and properly documented comments may result in elimination of unnecessary cost burdens. Do not wait to protest final regulation—each railroad must comply with regulations regardless of cost.

**Brake Gauges**

Section 229.53 on brake gauges would require that a brake system pressure gauge be accurate to within three pounds per square inch. A literal interpretation of the proposed language could mean that the accuracy requirement would apply throughout the entire range of the pressure gauge, including both the maximum and minimum readings on the gauge. We believe that pressure reading accuracy is important only in the "operating" portion of the gauge. For the purpose of this requirement, a 160 psi gauge operating portion is between 110 and 150 psi, and a 200 psi gauge operating portion is between 100 and 160 psi.

Since the minimum and maximum ranges are outside the "operating" portion of the gauge, we do not believe the accuracy requirements should apply to these gauges. To impose accuracy requirements on the non-operating portion of the gauge would pose a difficult technical challenge as well as result in increased costs without any measurable safety benefit.

**Spring Rigging**

Section 229.65 of the proposed rule on spring rigging would prohibit use of any shock absorber that is broken or leaking oil. The presence of shock absorber fluid (oil) on the reservoir is not cause for replacement of shock absorbers.

Oil on the surface of shocks often comes from external sources. Moreover, the shock absorber seal is designed to permit "wetting" of the rod to maintain a thin film of oil to inhibit corrosion of the rod. The shock absorber design provides a reserve of operating fluid to allow a certain amount of seepage without deterioration of performance to an unacceptable level during its normal service life. Accordingly, we believe it is inappropriate to prohibit "leaking" shock absorbers unless they are also inoperative.

It is recommended that Subsection (c) of Section 229.65 be amended to read: "A shock absorber may not be broken or inoperative."

**Wheel Sets**

The present proposed language of Section 229.73 on wheel sets does not address wheel diameter variations on two different wheel sets within the same truck, if shimming is used between the journal box and spring seat to equalize axle loads. Electro-Motive Division maintenance recommendations allow diameter variations not to exceed 1¼ inches on two different wheel sets within the same truck if shimming is used for axle load equalization. Accordingly, we believe the language of this section should be amended to include wheel diameter variations which comprehend the use of shims.

This section further proposes that the distance between the inside gauge of flanges for wide flange wheels may not be less than 53 inches or more than 53¼ inches.

EMD currently mounts Unipoint wide flange wheels at 53¼ + 0$\frac{1}{16}$ inches. Accordingly, the proposed language of this section does not allow for deviation on the high side. Moreover, the AAR wide flange wheel contour is seldom used on locomotives and accordingly should not influence the criteria for Unipoint wide flange locomotive wheels. Therefore, EMD recommends that the maximum allowable dimension be 53$\frac{5}{16}$ inches.

**Safety Cut Out Valve**

Current EMD production locomotives with electric motor driven fuel pumps are provided with shutoff switches which we believe would comply with the requirements of Section 229.93 on safety cut out valves. However, it is not clear that the language of this section, as proposed, would comprehend such switches. Accordingly, this Committee recommends that this section be amended to read ". . . the fuel supply line will have a safety cut out valve or switch that (etc.)."

**Slip/Slide Alarms**

Section 229.115 on slip/slide alarms would require each locomotive to be equipped with ". . . a device that provides an audible or visual alarm in the cab of either slipping or sliding powered wheels." In addition, if the locomotives are coupled in multiple control, the alarm would be required to be shown in the cab of the controlling locomotive.

EMD's current production wheel slip/slide systems provide adequate protection under power and dynamic brake conditions. It should be understood that on many locomotives, under some conditions of service at extremely low throttle operation, the wheel slip/slide is very insensitive. However, it is generally held that a locked wheel condition cannot occur while the motor and wheel are rotating. That is, the wheel will only lock after a stop is made and the overheated parts have had a chance to cool and solidify. Therefore, after a stop, the operator will have to use the higher throttle notches to start and accelerate the train and the locked wheel could be detected.

This Committee believes that powered axles are more likely to experience wheel sliding than non-powered axles. The occurrence of wheel slide on non-powered axles is highly unlikely, particularly with no traction or braking load on the traction motor bearings.

Electro-Motive believes that unpowered locomotive axles tend to behave similarly to the many other trailing axles in the train and therefore should not be required to have either visual or audible detection of a wheel slip/slide condition.

**Speed Indicators**

Section 229.117 on speed indicators would require each controlling locomotive to be equipped with a speed indicator that is accurate to within plus or minus three miles per hour at speeds greater than ten miles per hour.

### Cabs, Floors and Passageways

In Section 229.119 the language is impracticable and inconsistent with the pending regulation concerning window glazing. The proposed language also fails to set forth specific definitions of impact requirements, such as the type of accident, speed at impact, type of flammable liquid, etc. The lack of specific definition of the parameters involved leaves the railroads in a rather untenable compliance position.

In addition, any significant increase in resistance against accessibility of flammable liquids into the cab is likely to compromise crew visibility through the forward windshield and ingress/egress through the forward door.

The proposed requirement would also impose a substantial if not prohibitive design and cost penalty. We, therefore, recommend that Sub-section (e) be deleted in its entirety.

### Locomotive Cab Noise

In Section 229.121 on locomotive cab noise, the sound level standards set forth are identical to the work place noise standards as prescribed by the Occupational Safety and Health Administration except that the exposure limit has been extended to cover a 16-hour day. Since the maximum railroad crew work day shift is one of a continuous 12 hours, the exposure limit should only be extended to cover a 12-hour exposure of 87 dBA.

### Audible Warning Device

Section 229.129 on audible warning devices would require a minimum horn sound level of 96 dBA, measured 100 feet forward of the direction of travel of a locomotive. For dual directional locomotives, the sound level would have to be measured from either end of the locomotive.

EMD's current roof mounted three-chime horn would meet the proposed requirements of 100 feet from the front end of the cab. However, at this time EMD is not able to meet the proposed requirement at 100 feet from the rear of the locomotive. EMD's current basic switcher and MP15 locomotives are equipped with a single chime and some road units have all chimes facing in one direction. The proposed requirement that at least one chime be facing in the direction of travel would impose an unnecessary burden. Since locomotives are designated with a front end and seldom are operated with the opposite end forward, we believe it is unnecessary to specify the direction or number of chimes used. We believe that a sound level of 92 dBA in the rearward direction is a realistic requirement and that the regulation should not involve the number of chimes and their particular direction.

The Committee realizes that some of these laws may or may not be changed before the convention meets in Chicago in September, however, it was all we had available at the time the paper was prepared.

## V.

## WELDED CRANKSHAFTS

Last year a section of our paper covered welded crankshafts as a procedure for salvaging scored crankshafts; here is an update in that procedure.

At the time the paper was presented, crankshaft prices were:

| | | | |
|---|---|---|---|
| EMD | 12 | cylinder | $ 9,740.50 |
| EMD | 16 | " | 15,950.00 |
| GE | 12 | " | 16,524.00 |
| GE | 16 | " | 19,300.00 |

One year later the prices for these shafts were:

| | | | |
|---|---|---|---|
| EMD | 12 | cylinder | $11,444.00 |
| EMD | 16 | " | 18,968.00 |
| GE | 12 | " | 17,680.00 |
| GE | 16 | " | 20,650.00 |

Since our last report, several additional welded shafts in the journal area have been placed in service. We are pleased again to report that these shafts are in most cases operating satisfactorily. There have been one or two to our knowledge that have broken; however, in all instances they had been nitrided.

The nitride hardened crankshafts appear to be prone to breaking after welding, but not necessarily as a result of the welding procedure. The hardening process for these shafts is accomplished by placing the entire shaft in a gas nitriding furnace. This, of course, includes the filet area. The nitride treatment contributes to fatigue resistance in the filet area and provides a hard journal surface. At the time the journal is ground down to prepare for the welding process, a stress point can develop, which in turn can cause the shaft to break after operating for a relatively short time. Two shafts have broken during load testing and both had been nitrided. The committee does not know whether it has any bearing or not, that nitrided shafts are a different steel from that used in induction hardened shafts.

Nitrided shafts are made from AISI 4130 steel, while induction hardened shafts are made from AISI 5046. Both steels are vacuum degassed. Both steels are weldable if the normal precautions for welding medium carbon, low alloy steel are observed.

Nitrided shaft failures are usually caused by nitrogen gas porosity in the weld runout at the filet. The porosity can be eliminated by a two-step grinding process. The strength of nitrided filets can be restored by shot peening. These process improvements have been described to crankshaft reclaimers in a preliminary specification.

The welding process, as outlined in our paper last year, has remained the same, other than the preheating temperature. Our paper last year stated a preheat temperature of 450 degrees; this has been increased to 650° F. The reason for the increase is to insure that the journal does not cool off during the welding process.

Reclamation of crankshafts for the General Electric diesel engines is a very serious concern recognized by GE. When a bearing failure occurs (normally a rod bearing), the shaft is usually damaged beyond GE recommended repair limits. Railroads have not been able to buy new shafts due to OEM supply limitations. This has forced railroads to either exceed GE's standards by plating to a greater thickness or welding.

GE currently recommends a limit of .015 on chrome plate and a power reduction to 172 BPH per cylinder, or 2750 hp from a 16-cylinder engine and 2065 hp from a 12-cylinder engine.

GE presently has one running crankshaft that has been welded by the process described last year (one not applied to an engine) that is undergoing tests in its engine laboratory. After these tests have been completed the shafts are to be offered to railroads for field testing. This shaft is currently running at 312 BPH per cylinder on an endurance test.

The Chrome Crankshaft of Illinois has been very active in the development of the welding process. During the last several months it has been welding two to three crankshafts a week. Altogether its has more than 100 EMD shafts and more than 30 GE crankshafts that have been salvaged by the welding process.

The Committee believes that the locomotive manufacturers should be very active in this reclamation process. Several member roads on this Committee are actively engaged in the welding process. However, General Electric Company, to our knowledge, has not officially contacted any of those railroads directly. Several years ago, EMD had a welding procedure for crankshafts, but it was rescinded. We hope it is reconsidering its decision on this very important reclamation procedure.

# Chicago Railroad Diesel Club

**F. I. BURCHETT**
PRESIDENT
Mechanical Assistant - Locomotive
The Atchison, Topeka & Santa Fe Rwy.
Chicago, IL

We of the Chicago Railroad Diesel Club were again pleased to be hosts to the Locomotive Maintenance Officers Association for their April 7, 1980 Pre-Convention Presentation.

**Meetings:** We meet on the first Monday of each month except May, June, July, August and September.

**Monthly Publication:** Issued to all members.

**Membership:** We welcome all railroad and railroad supply personnel. For further details please contact our Secretary-Treasurer.

**CHARLES R. LOUGH**
SECRETARY-TREASURER
Manager Locomotive Maintenance Planning
Chicago and North Western Transportation Co.
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Lombard, IL 60148

# Monday, September 22, 1980

2:15 P.M.

## REPORT OF THE COMMITTEE ON DIESEL MATERIAL CONTROL

**Pre-Convention Presentation: Chicago Railroad Diesel Club**

**April 7, 1980 Midland Hotel Chicago, IL**

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

M. L. Wall, Superintendent Motive Power, Missouri Pacific, St. Louis, Mo.

**COMMITTEE MEMBERS**

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**1980 TOPIC:**

**"LOCOMOTIVE MATERIAL MANAGEMENT: WHAT LIES AHEAD IN THE 80's?"**

## PERSONAL HISTORY

### DONALD L. WARD

Donald L. Ward was born in St. Louis, Missouri, March 27, 1945. He attended grade school and high school in St. Louis, Missouri, graduating from high school in 1963.

Mr. Ward received Bachelor of Science degree in Engineering Management from the University of Missouri-Rolla in 1969 and a Master's Degree in Business Administration from Drury College, Springfield, Missouri in August 1979.

After receiving his undergraduate degree, Mr. Ward was employed by General Steel Industries-Castings Division in Granite City, Illinois. While at General Steel, he served as a Management Trainee and Production Control Analyst.

He began his railroad career in 1972, when he joined the St. Louis-San Francisco Railway Company as an Assistant Engineer Motive Power.

Mr. Ward is married to the former Jean Duggan, and they have two daughters.

He has been a member of LMOA since 1972.

## INTRODUCTION

The LMOA Diesel Material Control Committee's paper, titled "Locomotive Material Management: What Lies Ahead in the 80's?" is divided into four parts.

- I Robbing material — its consequences to the railroad
- II Cyclical and seasonal demand for material — some counteractive methods
- III Improved Mechanical Department and Material Department Communications —one step to more efficient locomotive maintenance.
- IV Uses and service life of reclaimed power assembly components.

Now well into the new decade of the 80's, events at home and abroad indicate that locomotive maintenance officers will have to be ever more diligent so as to make the most of every maintenance dollar. The combination of high inflation and scarce, expensive energy will demand every ounce of the locomotive maintenance officer's expertise to be able to maintain his locomotive fleet within necessary economic parameters.

With this in mind, the committee looks this year at locomotive material management and the challenges it will present in the new decade. Specific suggestions to aid the locomotive maintenance officer in making those crucial decisions are offered.

Part I looks at the consequences of robbing material from one locomotive to use on another. Although this practice will get a locomotive back into service quickly, what problems will it cause a locomotive maintenance program in the future when the robbed locomotive is ready to be put back into service?

Part II looks at both the cyclical and seasonal demand for material,

and the planning nightmare these types of demand cause for both the Material and Mechanical Departments. The committee's study of these types of demand included one railroad's method of attacking such planning problems.

Part III looks at the apparent communications gap existing between the Mechanical Department and the Material Department, and the problems this gap causes to effective material management. We will present what the committee feels has caused the communications problem, along with concrete suggestions to help narrow the gap.

Finally, Part IV examines the use and service life of reclaimed power assembly components. Herein are provided specific decision criteria in deciding where to use such components.

## I

## ROBBING MATERIAL— ITS CONSEQUENCES TO THE RAILROAD

The term "robbing material" refers to the use of locomotives as a source of replacement parts to return another locomotive to service. Another term for this is "cannibalizing." Continued cannibalizing can turn a locomotive into a skeleton that is incapable of productive use.

Robbing material is a symptom of a basic problem. That problem is the lack of material at the right place at the right time. In other words, the storehouse cannot supply the needed part upon request, and since the part is not available to the maintenance man, the locomotive cannot be returned to service.

Many reasons can be offered as to why the material is not available. It may not have been ordered because:

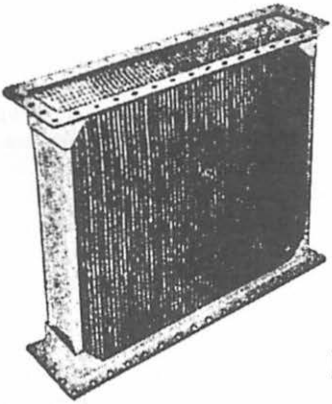
1. failure was not predicted,
2. adequate storage space not available,
3. expense constraints on inventory.

Or the material may have been ordered but is not on hand because:

1. supplier unable to provide or out of stock,
2. part is enroute,
3. removed from stock without record,
4. builder's recommended spares were not considered.

Regardless of the reason, if the locomotive needs a part to return it to service, a source must be located. The most common reaction is to rob the part from another locomotive. This could be a stored locomotive, or even a locomotive out of service for routine maintenance work.

The robbed part returns a locomotive to service, but what was the cost? To start with, someone had to take time to locate the proper type of locomotive having the desired part. When the part is located, it must be removed and then applied. If the maintainer is very thorough, the part will be inspected and possibly tested before reapplication. All too often



this is not done, and the calculated risk is accepted. The risks are that:

1. the part may be in a state of failure,
2. the part may be damaged on removal,
3. the part may be due for overhaul.

These conditions may well take the locomotive out of service prematurely.

When you consider that the robbed locomotive must eventually have that same part applied, the problem is compounded. These questions arise:

1. was the storekeeper advised to reorder?
2. will the part be promptly applied to the robbed unit?
3. will the part be damaged when applied or improperly applied?

It is obvious that robbing material is an inefficient utilization of manpower. At least double the labor hours is required. If any unit is continually cannibalized, it does not take much imagination to determine what happens when the cannibalized unit is required for service. This is particularly true if there was no record kept of the robbed parts, and, in turn, the parts were not ordered. An urgent need of power now creates a lot of aggravation. Quite possibly another unit may have to be robbed. It seems that when this practice starts, it is difficult to stop. This added cost in dollars, time, and inconvenience must be considered.

No one would ever state that robbing material should never be done. However, when there is no alternative, it is essential that there be no loose ends. The shop should immediately record the material that must be replaced, and the storehouse should arrange to order the replacement parts. Upon receipt of the part or parts, it should be reapplied to the locomotive involved.

Stored locomotives are the prime target for cannibalizing since they have no immediate use and future requirements are not considered. It appears to be an economic advantage under some conditions. However, as the TV automotive oil filter commercial says, "You can pay me now or pay me later." —the implication being that the later costs will be greater, not only in dollars but in time, inconvenience, and aggravation in getting back on track.

There are other consequences. When parts are removed, there is a probability that dirt and moisture then can be introduced in the remaining components and systems. Needless to say, this could result in a serious problem when the unit is returned to service. Obviously, care must be taken to protect the stored unit when parts are removed.

Both General Electric Company and Electro-Motive Division have publications that may be helpful when storing locomotives. They cover both the "Preparation of Locomotive for Storage" and the

"Removal of Locomotive from Storage." It is essential that the locomotives receive adequate attention when stored and later when prepared for service. Those publications are available upon request.

Prolonged storage of locomotives, plus their use as a source of replacement parts, creates additional problems. With fewer orders for replacement, the shelves in the shop storehouse become bare, while the builder's shelves get full. Nobody wants excess inventory. When the builder recognizes the inflated inventory and the lack of orders, the reaction is obvious: the inventory must be changed to satisfy the new requirements. Inventory is based on usage over a period of time.

Invariably the time comes when the stored locomotives are needed. Sometimes there is sufficient time to prepare for the routine parts requirements, but what about all the parts that have been robbed and not recorded and reordered? Each unit must be thoroughly inspected for immediate parts requirements. You may well recall this very situation a few years ago. It is apparent that even though you accept the additional costs, it would pay to plan for the day the units return to service.

Good records should be kept of the needed parts for each unit. Give the builders as much lead time as possible by placing orders as early as possible. Advise the builder of your expected needs. Remember, the builder stock may not be able to meet a sudden increased demand.

In order to minimize the risks of robbing material, the ideal requirement would be to supply all parts off the storehouse shelf. In order to do this, it would be profitable to consider the following:

1. forecast the parts requirements for a 12-month period;
2. use rate orders to insure continuous flow of material;
3. establish minimum stock level for reordering to allow for normal lead time;
4. consider the builder's recommended spares.

The locomotive builder will be happy to discuss your problems and offer recommendations. All the parts required to maintain the railroad fleet are not used in current production, which is sometimes a source for emergency requirements.

In summary, robbing material is really the result of not having the right part at the right place, at the right time. This results in:

1. increased maintenance cost,
2. increased failure risk,
3. increased material handling cost to the railroad and builder.

To insure minimal inefficiency, cost and risk:

1. avoid robbing material;
2. reorder and replace robbed material promptly;
3. forecast your parts requirements for 12 - 18 months;

4. place scheduled rate order to satisfy monthly requirements for 6 - 12 months;
5. consider the stocking of non-current production parts;
6. be sure the builder has adequate lead time to fill your orders.
7. contact your builder representative for help in planning your requirements.

## II

## CYCLICAL AND SEASONAL DEMAND FOR MATERIAL — SOME COUNTERACTIVE METHODS

Every locomotive maintenance officer recognizes that the availability of material on a timely basis is critical to the success of any effective locomotive maintenance program. Providing the material required would be a relatively simple matter if what is needed were always identified in advance, and if the usage remained constant. Unfortunately, material requirements are not always readily predictable, and usage is frequently sporadic.

Through research and advance planning, the Burlington Northern Railroad has been able to minimize the problems that occur when large amounts of material are required on a seasonal basis.

BN utilized computer history to determine quantity of material used in the past two years and the months in which it was used. Further research determined whether there had been any unusual circumstance that may have been responsible for more or less usage during a given period. Special care was taken when there was low usage during a period, when it normally should have been high, to ascertain if the low usage was due to a stock-out condition. If this was the case, then an estimated amount was used for the period.

After the record of previous usage had been developed, the Mechanical Department was consulted to determine if they were aware of any significant factors that might affect the material requirement during the period for which material was being ordered. Factors that were considered were: age of locomotives; number of locomotives that were being maintained, compared to the number maintained during the period when the usage history was developed; modifications made or anticipated to the locomotives; and if any new locomotives were to be delivered.

After determining the quantity that would be needed, BN contacted vendors to determine the necessary lead time for shipment of the material. Consideration was given to order processing time, transit time from vendor's warehouse to point of acceptance, transit time from point of acceptance to field location, and price breaks for various quantities. Orders now are placed in sufficient time to assure that the required material is on hand when needed. The railroad's capital is not tied up in inventory for long periods of time.

It was further determined that many items critical to locomotive maintenance were cyclical in nature. Usage was relatively constant. However, because vendors were unwilling to tie up their capital in inventory or gamble on the quantities that they would sell, the lead time required after order receipt was so long that the railroad was frequently in a stock-out condition. Vendors were contacted to determine what was needed from the railroad for them to be able to furnish a continued supply of material on a timely basis. The answer was an order for an entire year's supply, with monthly shipments in increments as specified. This enables the vendor to plan production schedules accordingly.

The same procedure used in conjunction with the seasonal items was used to determine the projected material requirements by month for a year. Orders are placed specifying the quantity that is to be shipped each month. These orders are closely monitored to assure that shipments are made according to schedule.

As a result, since the change in procedure, a significant reduction has been made in the number of locomotives held out of service awaiting material, and the procedure is being expanded to cover additional problem items. These continued shipments spaced throughout the year help to keep the inventory at a minimum level, leaving capital free to be used for other purposes.

## III
## IMPROVED MECHANICAL DEPARTMENT AND MATERIAL DEPARTMENT COMMUNICATIONS - ONE STEP TO MORE EFFICIENT LOCOMOTIVE MAINTENANCE

The common goal of both the Mechanical Department and Material Department is to "satisfy the inventory needs of the company at a cost that will allow the company to earn a reasonable profit."

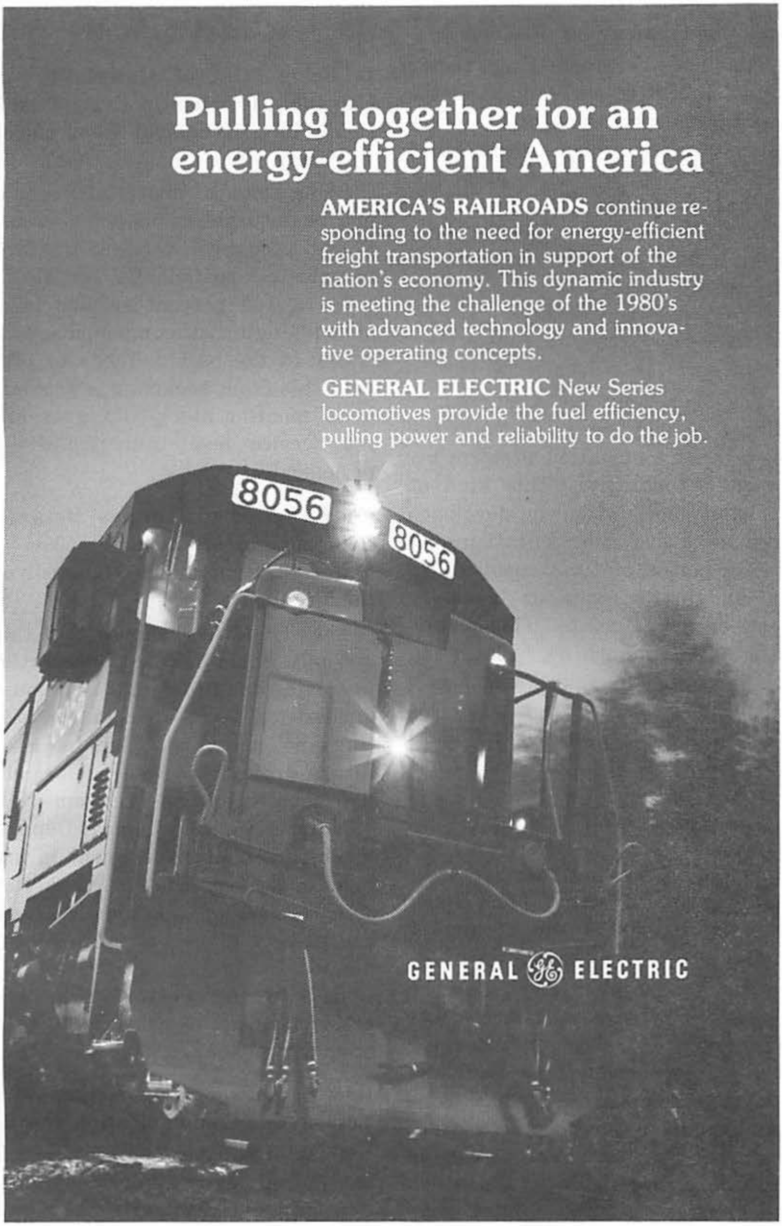
Poor communication, which results in a lack of understanding of the complete picture, often leads to such thinking as:

The Material Department —
Through minimizing inventory investments, more profit can be made.

The Mechanical Department —
Through increased inventories, we can repair locomotives more quickly and, therefore, generate greater revenues and increase our profits.

Do these conflicting goals or statements sound familiar? Through improved communication, resulting in a better overall company viewpoint, both goals can be balanced to meet the common company goal.

The following are questions the committee has developed relating to communication problems between the Mechanical and Material Departments. By answering them, the committee feels that both departments will be able to take the first steps toward improved communications.


Pulling together for an energy-efficient America
AMERICA'S RAILROADS continue responding to the need for energy-efficient freight transportation in support of the nation's economy. This dynamic industry is meeting the challenge of the 1980's with advanced technology and innovative operating concepts.
GENERAL ELECTRIC New Series locomotives provide the fuel efficiency, pulling power and reliability to do the job.
8056
8056
GENERAL ELECTRIC

**What Really Has Caused the Bad Communications Problem?**

The basic underlying factor found in most companies is the lack of understanding of the other department's problems. Also, when we do recognize these problems, we have a tendency to view them with "blinders" on, seeing only what is best for our situation.

**Do "Personality Conflicts" Between Departments Cause Problems?**

Yes, but only as a secondary nature, usually resulting from the overall communication problem between departments. This kind of problem most often is developed because of bad communication over a long period of time, resulting in an imaginary fence or boundary between departments. This results in statements such as, "That's my job, you handle yours and I will handle mine.", or "Don't tell me your problems, I've got problems of my own." When such situations develop, there cannot be much, if any, mutual understanding.

**Does Going Around the Established "System" Lend Itself to Solving Any of the Problems?**

No! This kind of action compounds the problem and results in conflicts between departments. The Mechanical Department, when expediting locomotive repairs involving material stock-outs, often ships material from one shop to another without involving or informing the Material Department, and then fails to recognize at a later date why the Material Department's records of usage are so low.

**Is Being "Out of Material" Causing A Problem in Every Case? Could the Mechanical Department Be Using That as an Excuse?**

Being "out of material" should not be a problem in some cases. We all recognize we cannot afford inventories sufficiently great to cover a 100 percent service level of our high-cost components.

One of the best methods to prevent this from becoming a problem is to monitor stock-outs, measure the service level and publish it periodically.

**Could Periodic Meetings Between Personnel in Mechanical and Material Departments Help Solve the Problem?**

The committee believes that this not only would help but is essential in solving the problems. This must involve top level officers for setting policies and planning for future projects as well as locomotive acquisitions and retirements.

Material and Mechanical Department personnel involvement in annual, quarterly, monthly, weekly or daily production planning sessions has proven to be one of the best methods of improving communications between departments, as well as offering greater insight to each other's problems.

**Has Data Processing Helped Lessen the Communication Gap?**

Most often, data processing has not helped lessen the communication gap, but contrarily has con-

tributed to it. A data processing system developed for and by one department only is by nature a communication system for that department only and will do very little, if anything, to lessen the communication gap between departments. A data processing system developed for and by both departments will lessen the communication gap.

In summary, most of the problems between Mechanical and Material Departments are a result of a breakdown or barrier in the communication systems. The industry has entered an era in which high inventory levels and excessive locomotive "out-of-service" time cannot and will not be tolerated, creating a greater need for improved communication between departments.

As locomotive maintenance officers, we must review our "formal" inventory and scheduling systems. Are they really being used in our daily routines, or are we using "informal" systems. If your formal systems are not really being used, it is most likely that you have had a breakdown in communications also.

## IV

## USES AND SERVICE LIFE OF RECLAIMED POWER ASSEMBLY COMPONENTS

The rising cost of new component parts has made railroad rebuilding of components almost a necessity. As a general rule, rebuilt cost averages about two-thirds the cost of new. With this in mind, most U. S. railroads are currently rebuilding at least some of their power assemblies. There is, however, one question that looms large: "Is using railroad rebuilt components as reliable as using new components?" Here are the committee's findings.

A survey was conducted on EMD 645 power assemblies in order to determine the service life of railroad-reclaimed assemblies versus new assemblies.

Of the railroad-rebuilt assemblies (i.e., assemblies with all railroad reclaimed parts), failures started to occur in the first month of service, and 50 percent of those assemblies had failed within 20 months. On the other hand, the majority of new power assemblies were still in service at the end of 75 months.

Comparing power assemblies using vendor-repaired components (i.e., power assemblies using chrome liners, welded heads, etc.) to railroad-reclaimed assemblies, shows a dramatic increase in service life in these types of assemblies for the vendor-repaired units. Of the assemblies using vendor-reclaimed components, failures started to show within seven months, with 50 percent of those assemblies still in service at the end of 60 months.

The most predominant type of failure occurring on railroad-reclaimed assemblies was head seal leaks, which possibly could have resulted from a failure to thoroughly clean all components. Valve blow was the second most predominant failure on railroad reclaimed assemblies. On new power assemblies, the most predominant failure occurred from excessive lead readings, with broken rings ranking second.

Bear in mind that by using new or utex power assemblies, the cost of early failures can be reduced simply by claiming warranty. On the other hand, with shop-reclaimed assemblies, there is no way to claim warranty, except of course if new sub-components were used in the reclaimed assemblies.

The greatest cost savings associated with the use of reclaimed power assemblies comes from having a central reclaim point. The railroad can reduce the cost of inventorying parts at several locations, while at the same time better control the quality level of the assemblies. With constantly rising prices, excess inventory can be a drain on profit.

In conclusion, this committee feels that rebuilt power assembly components furnished by vendors and shop-reclaimed power assembly components can provide the needed service life at a considerable savings, as compared to buying new. However, it must be a firm policy that at the rebuild center only OEM specifications are acceptable. If these specifications are closely adhered to, it can be safely assumed that reclaimed power assemblies will both reduce costs and at the same time provide the necessary service life required by the railroad.

LMOA wishes to express its thanks to Union Pacific Railroad for again hosting Pre-convention Presentation in Omaha.

Our Fuel and Lubricants Committee's presentation was well received in what we trust was a mutually beneficial experience.

Our thanks again to Messrs. F. D. Acord and J. F. McDonough and others responsible for and participating in this activity.

# Tuesday, September 23, 1980

**9:00 A.M.**

## REPORT OF THE COMMITTEE ON FUEL AND LUBRICANTS

**Pre-Convention Presentation: Union Pacific Railroad**

**April 8, 1980
Hilton Hotel
Omaha, NB**

**J. D. SMALLING, Chairman**
Chemical Engineer
Southern Pacific Transportation Co.
San Francisco, CA 94105

**VICE CHAIRMAN**

B. C. Cain, Chemist, Atchison, Topeka & Santa Fe, Topeka, KS 66616

**COMMITTEE MEMBERS**

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| V. E. Broman | Product Engineer | ARCO | Harvey, Ill. |
| J. P. Fite | Engineer of Tests | St.LSF | Springfield, Mo. |
| E. A. Goff | Industry Sales Executive | Mobil | Chicago, Ill. |
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| S. P. Spargo | Engineer of Tests | B&LE | Greenville, Pa. |
| J. L. Wilkison | Products Application Engr. | Shell | Houston, Texas |

**1980 TOPIC:
"FUEL AND LUBRICANTS — NEW DECADE"**

## PERSONAL HISTORY

### JOHN D. SMALLING

A native Arkansan, Mr. Smalling began his career with the St. Louis Southwestern Railroad in 1947. Prior to this he had served in the U.S. Air Force and following discharge from service attended Louisiana Polytechnic Institute for two years. He later resumed his studies at the University of Arkansas at Little Rock and received his Bachelor of Science Degree in Chemistry by attending classes evenings and weekends while working in laboratory operations in Pine Bluff.

While most of John's railroading has been in Arkansas and California, he and his wife, Betty, did enjoy a brief sojourn in Mt. Pleasant, Texas, early in his career in which their only child, Barbara, was born. Barbara is now married and lives in Houston and has an architectural practice there.

In 1969, Mr. Smalling was transferred to San Francisco to work as a special assistant in the Mechanical Department of the Southern Pacific Transportation Company. He is presently assigned as Chemical Engineer in the same department in San Francisco.

John has been active on the LMOA Fuel and Lubricant Committee for many years.

## HIGH VI DIESEL ENGINE OIL IN THE RAILROAD INDUSTRY

—

### INTRODUCTION

The purpose of this section is to discuss the use of railroad engine lubricating oils which have a viscosity index number that is greater than 75. Historically railroad engine crankcase oil has been limited to 75 viscosity index.

The presentation is the result of opinions of the committee and is intended to be neither prophetic nor suggestive, i.e. promotional. Rather, it may serve as a guide for railroad management and mechanical officers. For some it may serve as a crash course in "What you need to know about high VI oil as it is related to railroad engines."

We have members on our committee from several oil companies. Some say their companies have an ample supply of medium viscosity index oil and will continue to market this type. Representatives from other oil companies report they have diminishing availability of naphthenic base oil, and foresee a more reliable source of paraffinic oil stock, from which high viscosity index oils are manufactured.

World conditions make predictions difficult and we find that some suppliers also find it difficult to supply their brands of oil in volumes required, 100% of the time. This makes it seem probable

that no single supplier could furnish the railroad industry with its entire requirement for engine oil. Many railroads have experienced at one time or another the inconvenience of an "out of oil inventory" when depending on a particular supplier for a specified brand or specific additive.

**Definition:**

In order that we understand the products that are interchangeably referred to as high VI and/or paraffinic, let's look at the definitions.

By definition, the viscosity index of an oil or its VI describes the rate at which the mineral oil thins out, determined by a mathematical relationship between its viscosities at 100 degrees F and 210 degrees F. Oils with a high VI exhibit less viscosity change with temperature than oils with a low VI. A lubricant that is expected to perform over a wide temperature range should have a high VI. For instance, in the selection of a hydraulic oil for equipment which operates in cold atmospheres and is also exposed to milder temperatures, a near constant viscosity is important. In airplane hydraulic systems this characteristic is critical, and also in automobile brake systems used in summer and winter conditions. Further, the VI of a 10W30 auto engine oil is controlled to make the engine easy to start in cold weather—but retain enough body to provide a protective film at the engine operating temperature.

**Historical:**

The advent of high VI oil for use in railroad diesel engines is not related to its ability to resist change in viscosity. Other factors are involved. These can best be explained by a discussion of reasons why some authorities in the railroad industry considered high VI oils unsuitable.

At least two of the reasons why high VI oils were not generally used in railroad engines are no longer valid. These reasons were:

(a) Naphthenic oil results in softer carbon deposits than paraffinic oil when used to lubricate internal combustion engines.

(b) There were unlimited supplies and therefore economic advantages of naphthenic oil in the U. S.

The first premise has been challenged by the fact that paraffinic base oils are now used to formulate, as just one example, some of the finest gas engine oils on the market. Gas engines have notoriously generated hard carbon deposits. Through the selection of stocks (crude oil), improved and modern refining processes, and use of appropriate additives, refiners can produce paraffinic oils which exceed some naphthenic oils in performance. Paraffinic oils are used today to blend high grade railroad engine oil and other quality products.

The second reason is challenged by the previously referred-to world conditions. Not only has there been

a reduction in naphthenic stock availability particularly outside the U. S. but also petroleum supplies worldwide have become jeopardized.

The oil companies which expressed concern for diminishing volumes of medium viscosity index oils may have others agreeing with their position now. Some companies are using their available naphthenic stocks for products other than engine oil, and this will further reduce the available supply of naphthenic oil for manufacturing engine oils.

**Description:**

Some description of the interchangeable terminology paraffinic-high VI oils may be helpful. Chemically, paraffin series hydrocarbons are described by a formula.

While crude oils found in different geographical locations can be of one kind or the other, most petroleum products consist of a portion of each type of hydrocarbons previously described, plus other hydrocarbons.

From this point, we will refer to high viscosity index oils as high VI oil and medium viscosity index oils as medium VI oil. While the terms paraffinic and naphthenic still slip into our references, remember that petroleum products are a complex mixture of hydrocarbons which can have molecules of either of the formulas to which we referred.

As stated earlier, the advent of high VI oil for use in railroad diesel engines was not related to its ability to resist change in viscosity. While such introduction was slowed down in the United States, the availability of such oil in foreign countries probably contributed to its earlier introduction in those locations.

Several railroads in the United States and Canada have been interested in high VI oils and at least three railroads have evaluated them successfully in field tests.

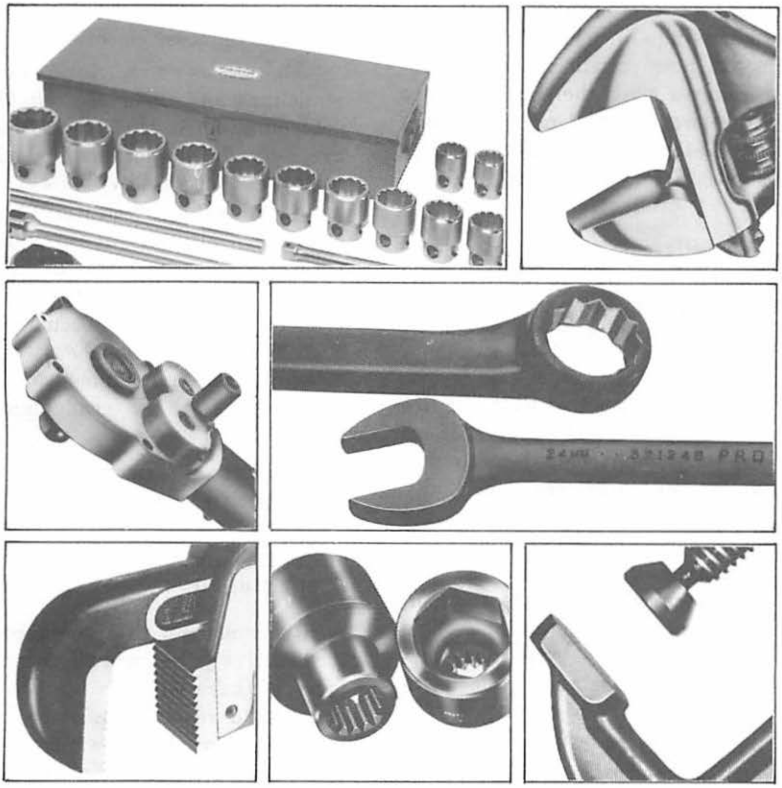
We are aware that at least six major oil suppliers have been furnishing diesel engine oil compounded with paraffinic products to foreign railroads for some time. This has been done with the approval of major engine builders.

The engine builders in the United States have indicated to us that many railroad engine oil additive packages have been looked at extensively in paraffinic oils and found to be satisfactory in laboratory tests. Several of these formulations are providing satisfactory performance in field service.

Regarding such products, at least six major suppliers of diesel engine oil have indicated they plan to market a diesel engine oil with paraffinic base. Presently a tested and approved high VI oil is being sold to Class I line haul railroads in the United States.

**Laboratory Control:**

Since the intent of this paper is to discuss the use of high VI oil



in the railroad industry, we will cover its compatibility with the products now in use. Also, we will discuss how it will affect control procedures when there is a mixture of the two types of oil in the system. Later we will show evidence of satisfactory performance of a high VI product.

We believe it is well to include, in part, the addendum we read into our paper last year regarding viscosity patterns. This reads as follows:

> "Certain types of base oils are currently in short supply. These are the naphthenic low to medium VI lubricants normally used in railroad oils. As the naphthenic stocks become less available, high VI (90-95) oils will be used to replace them in crankcase oil formulations. This will change the viscosity patterns you are accustomed to using.
>
> "Medium VI railroad oils have an SUS viscosity at 100 degrees F of about 1000 seconds and 77-80 at 210 degrees F. The high VI oils will retain the 77-80 second viscosity at 210 degrees F but will have a lower 100 degree F value, i.e. 700-800 SUS.
>
> "Your Fuels and Lubricants Committee wants to make the industry aware of these potential and probable changes. They recommend that routine viscosity determinations be made at 210 degrees F rather than 100 degrees F because the lower 100 degrees F viscosity of the high VI oils can coincide with condemning limits used when fuel dilution reduces viscosity.
>
> "All of us now need new guidelines and the most reliable determination is that at 210 degrees F. At 210 degrees F, both high and medium VI oils will have the same viscosity. Any changes in viscosity at this temperature (either down or up) will be an indication that dilution or oxidation is occurring. Your committee members will develop new guidelines which can be used as condemning limits.
>
> "Builders information show their specifications as:
>
> | | EMD | GE |
> |---|---|---|
> | SUS Viscosity at 210 degrees F | 72-85 | 70-85 |
>
> "Remember, with interchange locomotives, the amount and type of base oil mixing being done could result in a viscosity at 100 degrees anywhere between the two values cited; so, the preferable way to determine viscosity is at 210 degrees F. A flash point determined on questionable samples is another tool in confirming fuel dilution."

EMD has provided an excellent bulletin, Pointers #11-L-79, on "Revised Engine Oil Specification." We highly recommend study of this information.

The engine builders have approved high VI oil. GE has such products on its published list of approved products. EMD has described such a product in its M.1.1752 Bulletin (Lubricating Oil for Domestic Locomotive Engines).

Specifications are available for existing high VI diesel engine oils. These products are being used by at least five railroads in the United States. Foreign railroads have been using this type of product in locomotives for more than seven years.

## FIELD EVALUATION:

The following data and observations were substantiated by a year-long field evaluation of a high VI oil. This was a 10 TBN oil compared to an existing MV-1 oil herein referred to as ramp oil (7 TBN):

1) The oil was lab tested and approved for field trial by GE and EMD.
2) The oil had previously been in foreign service more than a year.
3) Oil stability was maintained for 12 months.
4) Top ring zone wear was satisfactory.
5) Piston deposits in lower ring and land zones were satisfactory.
6) Silver wrist pins were protected against corrosion.
7) Power assembly was given adequate anti-wear protection.

The following data are given in illustration form with editorial comment. They document some of the data from this field evaluation.

**PARAFFIN SERIES — HIGH VI**

$C_n H_{2n+2}$

**NAPHTHENES — MEDIUM VI**

$C_n H_{2n}$

Fig. 1

Comment:

This figure identifies the oils we are talking about as hydrocarbons. The diagrams shown earlier in the paper show their structure. The blend is by percentage and can be natural. It is dictated by the crude oil source, it can be man made.

**OIL BLEND EXAMPLE**

| Type Oil | % | Viscosity @ 100 F | VI |
|---|---|---|---|
| Naphthenic | 25 | 1500 | Medium |
| Paraffinic | 75 | 200 | High |
| Combination | 100 | 304 | Medium |
| Naphthenic | 100 | 304 | Medium |
| Paraffinic | 100 | 304 | High |

Fig. 2

Comment:

Quality or similarity is not defined by the type or viscosity index (VI).

**MODERN PARAFFINIC ENGINE OILS (HIGH VI)**

A) Current Manufacturing Techniques
B) Base Stock
C) Additive Technology

Fig. 3

Comment:

These factors result in:

—Stable product

—Improved lubrication

—Minimal carbon deposits

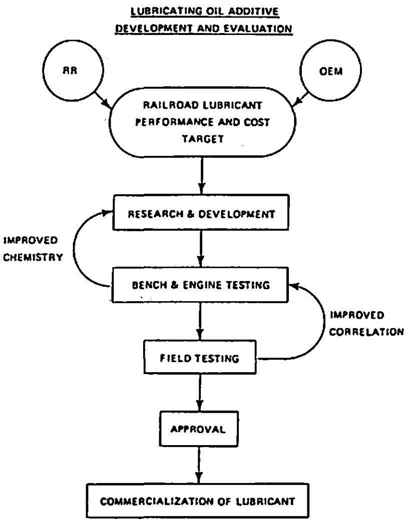



Fig. 4

**Comment:**

If you visualize that each rectangular space represents one year of time—you can estimate that it takes approximately 5 years to develop a railroad engine oil. This indicates that since High VI oils are now on the market, they have been looked at for quite a few years.

GE "GEMS" EMD "POINTERS"
"M. I. BULLETINS"
Fig. 5

**Comment:**

These documents are well known to railroad mechanical people. At least one high VI oil is on GE's list for domestic use—and in foreign railroads there are at least six such oils in service in GE equipment. A most significant point in current EMD bulletins is the viscosity index for engine oil listed as 60-100. This is a new devolopment in this builder's position. Also in "Locomotive Pointers 11-L-79" EMD gives some guidelines, as follows:

**LUBRICATING OIL TEMPERATURE**

| | 100° F | 210° F |
|---|---|---|
| 1. Recommended limit for viscosity rise (lube oil oxidation): | +30% | +11% (approx.) |
| 2. Recommended limit for viscosity reduction | —15% | —7% (approx.) |

**FIELD EVALUATION RECORDS**

| | New Oil<br>High VI<br>(10 TBN) | Ramp Oil<br>(7 TBN) |
|---|---|---|
| Viscosity @ 210 degrees F | 76.8 | 78-82 |

**Test Period Viscosity @ 210 Degrees F.**

EVALUATION UNITS (xxx2)
Control Unit (xxx8)

| Date | Viscosity @ 210° F | |
|---|---|---|
| 2-2-76 | 78.3 | |
| 2-3-76 | 81.0 | 81.3 |
| 2-10-76 | 80.3 | |
| 2-12-76 | 80.4 | 82.6 |
| | Test Started | |
| 2-16-76 | 77.0 | |
| 2-19-76 | 76.8 | 82.6 |
| 3-2-76 | 77.2 | 79.4 |
| 3-15-76 | 77.4 | 80.7 |
| 2-15-77 | 80.8 | 82.5 |
| AVERAGE | 77.6 | 81.4 |

Fig. 6

**Cómment:**

The oil supply to each unit was completely separated and monitored regularly by standard routines. These data demonstrate that the viscosity of high VI and medium VI oil at 210 degrees F can be controlled within the same range. The oil in use at the location where this evaluation took place is referred to as ramp oil.

**TEST DATA**

**4 Test Units**

| | |
|---|---|
| Total Mile Average | 210,300 |
| Average Oil Consumption | 107 miles/gal. |

**4 Control Units**

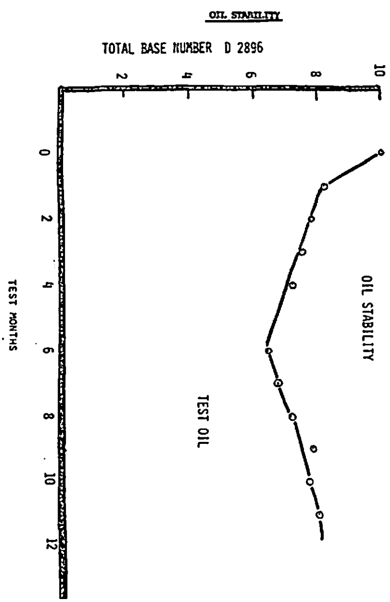
| | |
|---|---|
| Total Mile Average | 169,000 |
| Average Oil Consumption | 92 miles/gal. |

**Fig. 7**

## Comment:

These data are self explanatory. The differences in consumption are not necessarily the result of the differences in TBN of the oils in service. These figures are included only to show some of the data secured in the evaluation.

**OIL STABILITY**




**SUMMARY OF RESULTS OF EVALUATION**

1) General Electric/EMD Lab. tested and approved.
2) International Field tested.
3) Oil Stability maintained 12 months.
4) Top ring zone wear was satisfactory.
5) Piston deposits in lower ring and land zones were satisfactory.
6) Silver wrist pins protected against corrosion.
7) Power assembly given adequate anti-wear protection.

**Fig. 15**

## Comment:

This summarizes the performance of a high VI oil.

## Conclusion:

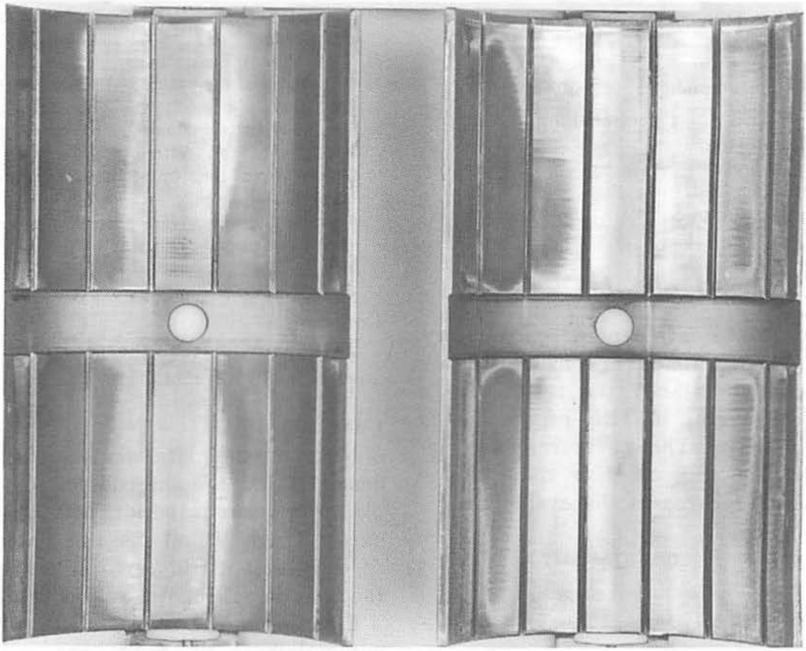
None of the data discussed or demonstrated are intended to imply or indicate superior performance of high VI oil per se. They do show that it will perform satisfactorily in railroad diesel engines.

Experience and data which will accumulate in the next year will be available to the industry from the railroads who are now using high VI oil in their systems. Some of the data developed as guidelines by other railroad industry organizations are as follows:

### Viscosity of New Lube Oil

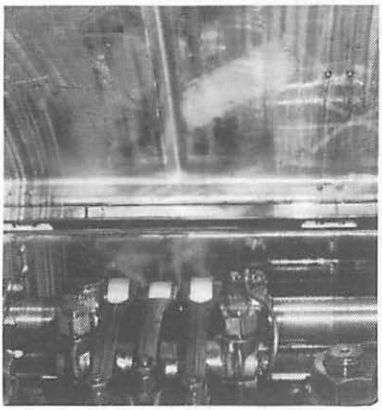
The suppliers of diesel lube oil are requested to control the viscosity at 210 degrees F between 78 and 80 SUS. A variation of one second on each end of this range is allowed without complaint if the variation is not repeated. All oil companies have been able to furnish lube oil within this limited range without undue problems.

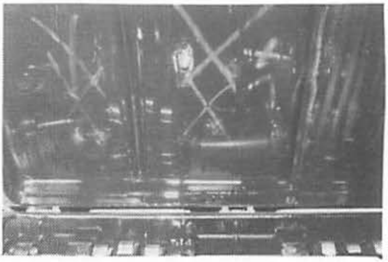
SOME PHOTOS OF EQUIPMENT DURING TEST
CARRIER BEARING INSERTS — ONE YEAR IN SERVICE



(10 TBN) Test Oil - 207,000 Miles        Ramp Oil - 161,000 Miles

Fig. 9 — Carrier Bearing Inserts





(10 TBN) Test Oil        (7 TBN) Ramp Oil

Fig. 10 — Covers and Backwall

Test Oil | Ramp Oil

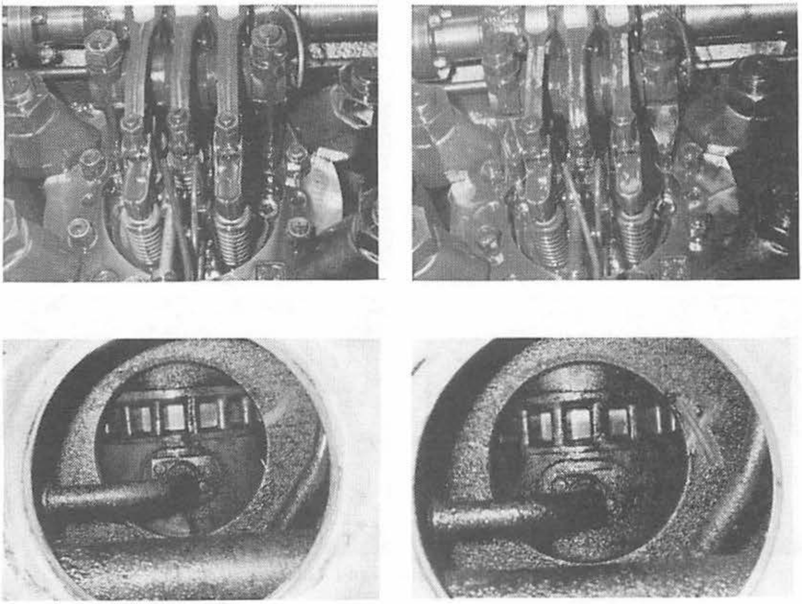


Fig. 11 — Heads and Air Boxes

(10 TBN) Test Oil | (7 TBN) Ramp Oil

Fig. 12 — Crankcases

(10 TBN) TEST OIL | (7 TBN) Ramp Oil

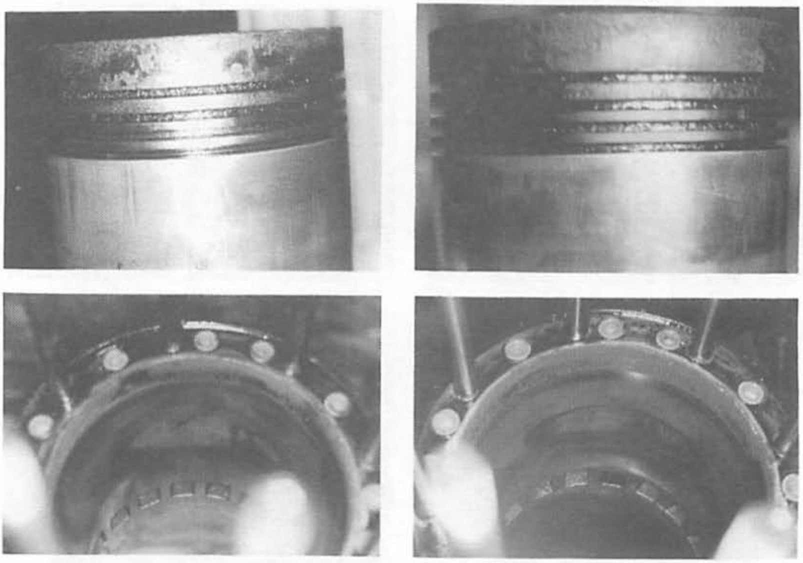


Fig. 13 — Pistons and Liners

Test Oil | Ramp Oil

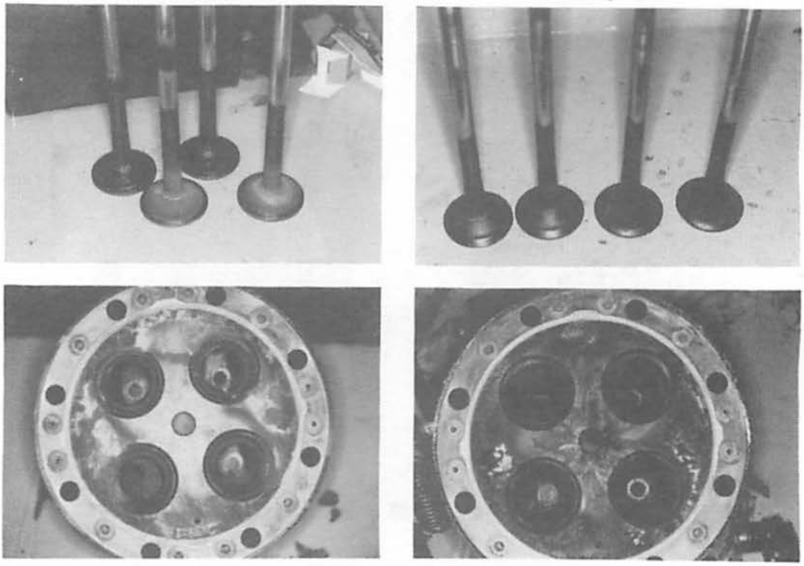


Fig. 14 — Valves - Cylinder Heads

### Limits and Interpretation Of Results

Our interpretation of viscosity measurements is tabulated below:

| | Viscosity at 210° F SUS | Approx. Fuel Content, % |
|---|---|---|
| Satisfactory | 74 | up to 1.5 |
| Moderate dilution | 74-71 | up to 3 |
| Excessive dilution | 71-68 | up to 5 |
| Extreme dilut'n | below 68 | over 5 |
| Oxidation | over 90 | ... |

Conditional reports for fuel dilution are issued if the viscosity is above 68 SUS. The oil need not be changed but fuel leaks should be located and repaired.

If the lube oil is extremely diluted (over 5%) with the viscosity below 68 SUS, the oil must be changed and the fuel leak repaired.

If the viscosity indicates the oil to be severely oxidized, additional tests are generally made to verify the condition and an oil change requested. The engine should be checked for high temperature operation.

**Comment:**

In each area inspected, the paraffinic/high VI oil proved that this type of oil was fully qualified for use in diesel locomotive engines.

## ASSESSMENT OF FUTURE FUEL SUPPLY & QUALITY

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### INTRODUCTION

Fuel cost and availability are both vitally important to the operation of the nation's railroads. The year 1979 saw an increase of about 100% in the cost of No. 2 diesel fuel. Some railroads could not obtain all the fuel needed through contractural agreements with major suppliers, and they had to resort to the spot market for up to 10% of total purchases. This in spite of the general knowledge that rail transportation is three to four times more efficient than highway transportation. Spot market fuel is subject to fluctuations in both quality and price, with the price usually being higher than for fuel from conventional sources.

Railroads in the Class I category consume approximately 4 billion gallons of fuel a year. The railroad industry's 1979 allocation was about 90% of the fuel consumed in the previous year. With the traffic up over 9 billion ton miles, to an all time record level in 1979, the fuel gap was closed for the most part by fuel conservation and purchases from the spot market. The increase in ton miles was due largely to a 17% increase in the movement of coal and unit trains. At the same time, automotive traffic was down about 10%. This contributed largely to balance the total fuel usage between 1978 and 1979, as the fuel usage of the unit trains is less than that of the automotive traffic. If a shortfall of fuel is experienced in any areas, some railroads first try to obtain fuel from suppliers. If this fails, they shuttle fuel from lower-usage-points inventory in order to prevent the interruption of traffic.

In January 1979, the average price of fuel was 38¢ per gallon.

In January 1980, the average price of a gallon of fuel was 77¢ per gallon. The price of the spot market fuel purchases in 1979 was about 25¢ per gallon higher than contract price. However, at present the difference between the contract price and the spot market is narrowing. At the time of this writing, it was about 8¢ per gallon.

It appears from the information available that only 5 to 10% of the fuel purchased by railroads is from the spot market. This seems to be concentrated in the Northwest and South Midwest. At present, the middle distillate situation on the supply side appears to be good. The reasons for this are due in part to conservation, a mild winter, and the fact that refineries are concentrating on middle distillates

## OIL DEMAND IN THE TRANSPORTATION MARKET BY PRODUCT AND MODE

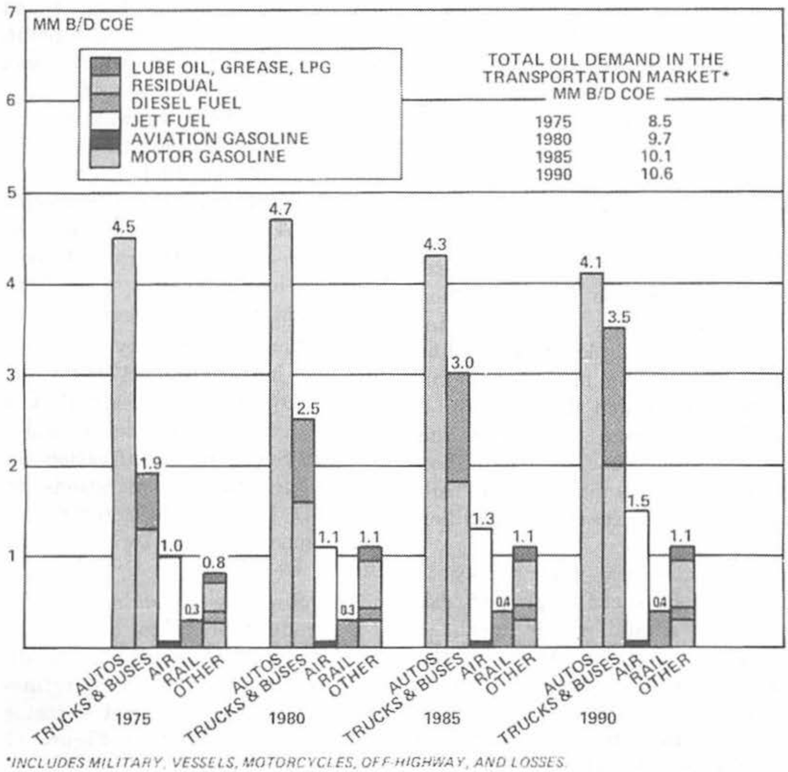


Fig. 16

at the expense of another widely used product.

It is of the utmost importance that other classes of fuel that could be used in diesel locomotives be researched in order to extend the supply of available fuel.

One of the major oil companies has published in an energy report a projection of fuel demand in the transportation industry through 1990. Figure 16 shows projected demand by fuel type and end use. It will be noted that total demand increases 9.3%, from 9.7 million B/CD COE (crude oil equivalent) to 10.6 million B/CD COE during the decade of the 80's. However, gasoline usage is projected to decline because of the greater fuel efficiency of new cars mandated by Congress. Gasoline consumption has already peaked and is beginning to decline.

Middle distillate demand is expected to increase by 1.1 million B/CD during this decade, an increase of 45%. Aviation turbine fuel (jet fuel) is projected to increase 0.4 million B/CD. No. 2 diesel fuel usage in trucks and buses will increase by 0.6 million B/CD and consumption by the railroads will increase 0.1 million B/CD.

While distillate fuel supply is just about balanced at present, due in part to a mild winter, localized shortages have occurred in the past and will no doubt return as consumption increases. It is by no means certain that the U. S. oil industry will be able to meet the projected distillate fuel demand without resorting to imported fuel.

Limited jet fuel (kerosene) supplies prompted a recent relaxation in jet fuel specifications to increase availability. The lower boiling components of No. 2 diesel fuel are being diverted into jet fuel that has a higher product value. Very little kerosene is available for "climatizing" diesel fuel to prevent fuel line blockage in cold areas. Cold flow improvers are used that substantially lower the fuel's pour point, the temperature at which the fuel becomes solid, but no additive has been found that will lower a fuel's cloud point, the temperature at which wax crystals begin to separate. Only kerosene will keep the wax in solution at low temperatures. The shortage of jet fuel is not expected to ease in the foreseeable future. A greater burden will be placed on manufacturers and operators to install heating equipment to prevent fuel line freeze-ups.

The American Society for Testing and Materials (ASTM) Committee D-2 has proposed that a No. 3-D grade diesel fuel be added to D975 Standard Specification for Diesel Fuel Oils. Specifications for No. 3-D fuel are less restrictive than specifications for No. 2-D fuel.

The objective of adding the No. 3-D grade fuel is to extend the total volume of distillates available by allowing the use of refinery streams that are not suitable for use in No. 2-D fuel. Figure 17 lists the proposed No. 3-D fuel specifications along with the other

DISTILLATE DIESEL FUEL SPECIFICATIONS

| Property | ASTM No. 1D | ASTM No. 2D | ASTM No. 3D (Proposed) |
|---|---|---|---|
| Viscosity SUS @ 100°F | 34.4 | 32.6 to 40.1 | 32.6 to 50.4 |
| Cetane No. | 40 | 40 | 37 |
| Sulfur % WT | 0.5 | 0.5 | 0.7 |
| Distillation: | | | |
| 90% Min. °F | | 540 | 510 |
| 90% Max. °F | 550 | 640 | 680 |
| Ash % Max. | 0.01 | 0.01 | 0.01 |
| Carbon Residue (10% Residum) % Max. | 0.15 | 0.35 | 0.40 |
| Typical C/H Ratio | | 8.25 | |

Fig. 17

three D-975 diesel fuel grades. Properties that have been relaxed are cetane number, sulfur content, viscosity, 90% distillation range, and carbon residue.

An early consideration of ASTM Committee D-2 was to merely relax the No. 2-D specifications. However, this proposal met with valid objections. Many of the small high speed diesel engines (2500 rpm and higher) require a fuel of the quality defined by current No. 2-D specifications. No. 3-D fuel is intended for use in those engines that normally use No. 2-D fuel but whose appetites could tolerate a higher boiling range, lower cetane fuel. It is believed that distillate fuel availability can be increased by 7-10% if No. 3-D fuel is adopted by ASTM.

Your committee strongly recommends that the railroad industry support the adoption of ASTM D975 No. 3-D fuel as a means of extending available distillate fuel supplies. It is believed that with slight modifications, current locomotives can burn No. 3-D fuel with no adverse effects.

Because of the changing economics and the deteriorating supply situation (especially since 1973), both the railroads and the locomotive builders have contributed to reducing the usage of diesel (middle distillate) fuel. As described in several LMOA and other technical organization papers, the railroads have modified their train handling procedures and have greatly reduced spillage at the same time that locomotive builders have improved the efficiency of the diesel engine. LMOA reports from 1975 thru 1978 have contained information concerning alternative fuel sources. Within the past year considerable progress has been made toward defining what alternative fuels might be used. This portion of the 1980 LMOA technical report should be considered a progress report on alternative fuels for railroad diesel engines.

**Supply Forecast**

A number of factors point clearly to the fact that between the present (1980) and 1985 the competition for available high quality middle distillate fuel oil will become increasingly intense and the price will probably increase more rapidly than the price of gasoline.

Information provided by a major oil company member of this committee indicates that by 1985, the available crude petroleum from the lower 48 states and southern Alaska will decrease approximate-

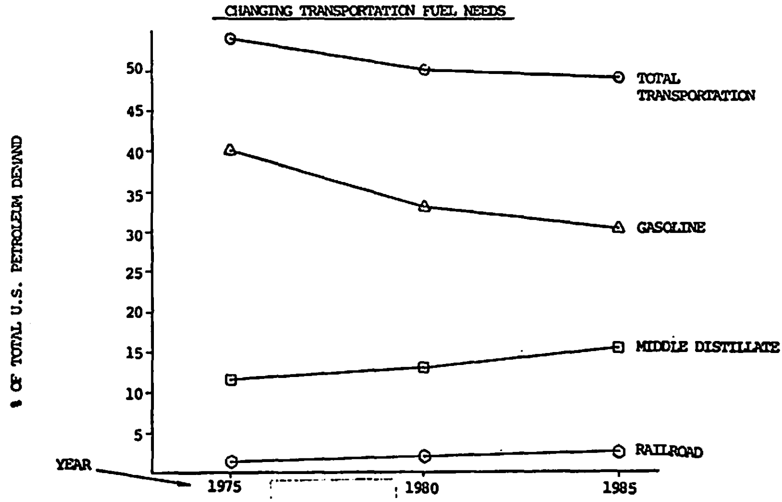


Fig. 18

ly 25% compared to 1975. During this same time period, the total demand for petroleum will increase by approximately 30%. As shown in Fig. 18, while the percentage of U. S. petroleum required for transportation needs will remain at approximately 50%, the portion required in the form of gasoline will decrease while the portion which historically has been middle distillate will greatly increase. During the same time period it is expected that railroads will require 25% more fuel.

These statistics indicate clearly that by 1985 the railroad industry should be prepared to fill part of its energy needs with a product other than the present American Society for Testing materials (ASTM) No. 2-D.

## Alternatives

Based on published information, the only alternative which can be available in significant quantity in the near term will continue to be derived from petroleum. It must be recalled that U. S. railroads currently require approximately 4 billion gallons of fuel per year to operate their locomotives. A modest substitution of 10% represents 400 million gallons. One of the reasons that the demand for middle distillate shows an increase while gasoline demand decreases is the expected increase in the use of diesel engines for highway transportation (both trucks and automobiles). In general, the types of diesel engines utilized for highway transportation are more critical of fuel quality than the larger, slower speed diesel engines used in, for example, ship application. It would be logical to expect that the medium speed diesel engines utilized in the railroad industry and certain portions of the marine industry would require fuel types in

between these two extremes. With this philosophy in mind, significant work has gone forward in the past 12 months to define the bounds of the railroad type diesel engine diet.

Longer range alternatives include alcohol, liquids derived from coal, and liquids derived from shale. Research work with these long range alternatives is progressing both under the auspices of the Department of Energy (DOE) and privately by engine manufacturers around the world.

The Association of American Railroads (AAR), the Federal Railroad Administration (FRA) and the DOE have been and continue to be jointly sponsoring work at the Southwest Research Institute to define alternative fuels for railroad engines. The fuels studied in this work include off-specification distillate petroleum products, heavy petroleum, simulated coal derived liquids, and methyl alcohol. Work to date has been accomplished using the two cycle, two cylinder railroad engine. Future work will be conducted in both the two cylinder engine and full size two cycle and four cycle railroad engines.

**Modified Petroleum Fuels**

The principal, but by no means the only, properties of fuel which predict performance in a diesel engine are: viscosity, cetane number, 90% distillation point, the quantity of ash, the amount of sulfur, and the amount of carbon residue. Other major properties are the 10% and 50% distillation points, the gravity, and the heating value. It will be noted that the cetane number will be allowed to go lower, the viscosity will be allowed to increase, and the 90% distillation point will be allowed to increase. The sulfur content and, to a lesser degree, carbon residue will increase.

The effects of viscosity, cetane number and distillation range have been studied in the two cylinder Southwest Institute work. The range of properties studied was far beyond No. 3-D fuel.

The AAR and the DOE have granted permission to the LMOA to present a synopsis of the test work to date. It must be understood that the data being presented here are based on the preliminary report of Southwest Research Institute and represent an interpretation of the data by the LMOA which is not necessarily endorsed by Southwest Research Institute. Further, we wish to make it clear that the test data were obtained only on the two-cylinder research engine and should be interpreted as a direction of engine response. The total program envisioned by the AAR embodies 5 years of work. In addition to research engine investigations, full scale EMD and GE engines will be utilized. The multi-cylinder engines are now being installed at the Institute. Since, as mentioned above, petroleum-derived fuels are expected to be the only viable alternatives in the near term, this report will deal only with the SWRI data concerning those fuels.

### Cetane Number

The cetane number is a fuel property of major importance in diesel engines. It is a measure of ignition delay. That is the interval of time between fuel injection and the commencement of combustion. The higher the cetane number, the shorter the ignition delay. This property is of relatively little significance in slow speed engines since there is normally ample time for complete combustion. However, the higher the engine speed, the more important this property becomes. If ignition is delayed for too long, too large a quantity of fuel will have been injected which will fire all at once producing a rapid pressure rise. On the other hand, when ignition delay is short, combustion will commence when relatively little fuel has been injected; and the remaining fuel will burn in a controlled manner as it enters, producing a smooth pressure rise.

The level of cetane number or ignition delay is most significant with respect to engine starting and engine idling. Under these conditions the air temperature is low which means the fuel oil is more difficult to ignite. Below some cetane number value, which varies from engine to engine and is a function of compression ratio, ambient temperature, and other conditions, the engine will simply fail to start. At the higher load points, too low a cetane number will cause uncontrolled burning resulting in inefficient utilization of the energy released. On the other hand, above the critical value for a specific engine, higher cetane numbers alone do not improve performance. It must be pointed out that other performance properties of the fuel may change simultaneously with changing cetane number; and these changed properties could result in changed engine performance.

Actual engine starting tests have not yet been completed in the Southwest Research Institute test series. However, engine performance tests on a range of fuels from 17 cetane to 55 cetane have been completed. Note that present ASTM number 2-D fuel stipulates a minimum cetane number of 40 and the proposed ASTM number 3-D fuel spec. will lower the allowabel minimum cetane number to 37.

While the cetane number experiment was quite complex and even more information needs to be obtained; the most significant preliminary conclusions are as follows:

A. Diesel fuels with a cetane number above 30 could be used in the test engine without significant penalties in: engine power output, fuel consumption, thermal efficiency, cylinder pressure characteristics and exhaust smoke density.

B. The EMD test engine could tolerate a cetane number as low as 17. Knocking occurs in mid range notches, but all notches were run.

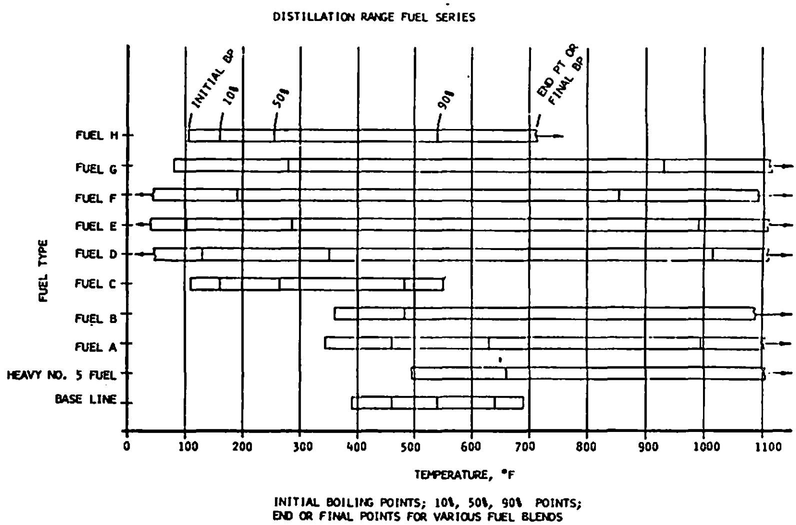


Fig. 19

## Distillation Range

The Southwest Research series of tests covered 11 fuels having different distillation characteristics. Figure 19 displays the distillation characteristics of the 10 test fuels compared to a baseline ASTM No. 2-D fuel. One of these fuels (so marked) is a "heavy" No. 5 fuel oil. It will be noted that the fuel composition was changed so that the upper end of the distillation curve was changed independently of the lower end of the curve in some cases and simultaneously with the lower end of the curve in other cases. Note that the ASTM specification defines only the 90% boiling point. The preliminary conclusions from this experiment were as follows:

A. No single fuel property can be classified as a primary variable which affects engine performance and exhaust emissions when all properties are varied simultaneously.

B. A multivariant statistical analysis indicated that cetane number, API gravity, and fuel heating value most significantly influenced brake horsepower and thermal efficiency. Note that neither API gravity nor fuel heating value is specified in either existing ASTM specifications or proposed specification.

Based on performance data understood at the present time, the proposed ASTM 3-D fuel specification change with respect to distillation temperature would not be expected to cause any measurable engine effects in service.

## High Viscosity Testing

In this series of tests with the two cylinder engine, a fuel made from a heavy lubricant stock was used. The fuel had a cetane number of 46. As initially formulated, the test fuel exhibited a viscosity of 672 seconds at 40 degrees C (104 degrees F). Note that the suggested ASTM No. 3-D viscosity specification is a maximum of 50 Saybolt Seconds at 100 degrees F. The preliminary conclusions from this test series are as follows:

A. The 672 Saybolt second test fuel had to be reduced in viscosity to 487 Saybolt seconds. It was eventually reduced to 178 Saybolt seconds requiring a temperature of 154 degrees F. which was achieved with a water heat exchanger.

B. The test engine could operate reasonably well with a fuel having a viscosity at the injector of 487 Saybolt seconds only if operation was restricted to notch 6 or below.

C. In order to obtain normal full load operation, fuel viscosity had to be limited to approximately 306 Saybolt seconds which, with this fuel, required a temperature of 131 degrees F.

D. Performance was independent of viscosity in the operating range below the "limiting" viscosity.

The test personnel emphasized that the below normal performance at higher throttle notches was due to limitations in the engine fuel system's ability to handle the high viscosity product. That is, the entire fuel system (filters, etc.) could not handle it. In short the engine could not ingest enough fuel to develop normal performance at the higher power conditions simply because it would not flow through the system.

**Sulfur Content**

The effect of sulfur content in the fuel was not studied in this particular Southwest Research investigation. However the effect of this fuel property has been known for many years and has been addressed several times by the Locomotive Maintenance Officers Association. Most recently, one of the figures displayed on page 252 of the 1977 transactions of the LMOA displays the effect of sulfur content on power assembly wear rate and shows the mollifying effect of increased alkalinity of the lubricating oil used. Whether diesel fuel oil in the U. S. will ever be permitted to rise from 0.5% (present ASTM No. 2-D) to 0.7% (proposed ASTM No. 3-D) is a matter of conjecture. The expected general rise in sulfur content was one of the principal purposes of the development of Generation 4 lubricating oils. In short, the detrimental effect of increasing sulfur content can be met by improved lubricating oil quality, attention to used oil condition, and by maintaining engine cooling water temperature at higher levels.

Imported No. 2-D diesel fuel sold on the spot market contains up to 1.0% W sulfur. If shortages of No. 2-D fuel leads to greater volumes of imported distillate fuel, sulfur content can be expected to rise.

| PROPERTIES OF NO. 2 DISTILLATE MADE FROM SYNTHETIC CRUDE | |
|---|---|
| API Gravity | 30.3 |
| Specific Gravity | 0.874 |
| Viscosity, SUS @ 100°F | 37 |
| Cloud Point, °F | —19 |
| Sulfur, %w | 0.04 |
| Aromatics, %v | 44 |
| Cetane Number, D613 | 34 |
| ASTM Distillation, °F | |
| IBP | 315 |
| 10% | 378 |
| 50% | 525 |
| 90% | 625 |
| FBP | 633 |

Fig. 20

### Fuel from Canadian Tar Sands

Beginning in the early 1970's a synthetic diesel fuel was produced from Athabaska tar sands. Figure 20 lists typical properties of this fuel. It is highly aromatic (44%v) and it has a lower cetane number (34) than No. 2-D diesel fuel. After a few years of experimentation in locomotives, the major Canadian railroads began using the synthetic fuel extensively in Alberta where it is produced. During the last 6 years, the Canadian National Railways has consumed about 4 million gallons of the synthetic diesel fuel: Although the intention is to burn the pure synthetic fuel, distribution logistics and plant interruptions limit the fraction of synthetic diesel fuel to 70-75% of total fuel consumption in the Alberta area. The Canadian Pacific also uses synthetic diesel fuel in the ratio of about 50/50 with No. 2 diesel fuel on the western end.

Both the major Canadian railroads use large quantities of the synthetic diesel fuel essentially undiluted. No modifications have been made to the locomotive engines to accomodate this fuel. Use of the synthetic fuel has caused no adverse effects or operating problems.

### Residual Fuels

The subject of residual containing heavy fuel oils is an entirely different topic. It raises different questions than those discussed above. The AAR, DOE and FRA program at Southwest Research at this stage contained a very minimal amount of investigation in this area. It will not be reported on at this time.

Residual fuels may be considered as colloidal dispersions of high molecular weight materials (left over from the refining process) in a lighter vehicle. Since these fuels are primarily intended for use in burner applications rather than in diesel engines, an entirely different ASTM specification defines them. This specification is D-396. No. 4 fuel, No. 5 light, No. 5 heavy, and No. 6 fuel are residuals. They do not contain requirements for sulfur content, cetane number, carbon residue and distillation range. Therefore the use of ASTM specifications for these fuels does not predict their performance in a diesel engine even as well as D-975. In addition to having the above mentioned properties, the residual materials can contain such disturbing elements as vanadium and sodium which can cause corrosion problems. There can also be problems in mechanical stability. As a residual fuel is diluted with paraffinic cutter stock, a



point is reached where the asphaltenes precipitate. In addition, in the event that existing residual fuels were to be blended with other fuel oils in order to provide more acceptable viscosity, compatibility between the fuels is a potential problem. Some of the factors which determine if this type fuel oil could be used as an adjunct energy source are: the crude source, the refining process which generated the residium, and the choice of the cutter stock used to suspend the high molecular weight components.

In recent times, relatively little work has been done in the U. S. with respect to the utilization of residual fuels and blends of residual heating oils and diesel fuels for use in medium speed railroad engines. However, considerable work with this type fuel is going on in Europe, oriented toward marine application of medium speed engines. The April 1978 issue of "Diesel Gas Turbine Progress" contains a report of a 500-hour test in the Alco 4-cycle diesel engine with a residual fuel of approximately No. 5 light. Engine starting and stopping was done with good quality No. 2 distillate fuel oil. Figure 21 is a display of typical 1978 U. S. residual fuel properties.

At present the 4-cycle railroad engine manufacturer is experimenting with a 10% blend of a particular No. 6 heating oil and 90% diesel fuel oil. Figure 22 displays the analysis of this particular fuel mixture. Results of this investigation are not available at this time. Fuels of this nature will be considered in the program at Southwest Research Institute.

Between 1955 and 1966 there was considerable residual-distillate fuel work performed by the railroad industry. Figure 23 exhibits the properties of 3 different residual blends with ASTM 2-D fuel used during that time. The fuels

**TYPICAL 1978 U. S. RESIDUAL FUELS**

| Property | No. 4 | No. 5 Lt. | No. 5 Hvy. | No. 6 |
|---|---|---|---|---|
| API Gravity | 23 | 18 | 14 | 7 to 11 |
| Viscosity SUS @ 100°F | 190 | 233 | 825 | >900 |
| Sulfur % WT. | 0.8 | 1.3 | 1.4 | 1.5 |
| Ash % WT | 0.03 | 0.01 | 0.03 | .04 |
| Carbon Residue % WT (Wh'l fuel) | 1.5 | 10 | 7 | 9 |

Fig. 21

**10% No. 6 OIL + 90% No. 2D FUEL**

| Property | Analysis |
|---|---|
| API Gravity @ 60°F | 32.1 |
| Sulfur % WT. | 0.54 |
| Distillation °F | |
| 10% | 428 |
| 50% | 522 |
| 90% | 642 |
| % Recovered | 91 |
| Calculated Cetane No. | 44 |
| Viscosity @ 100°F, SUS | 38 |
| Pour Point °F | —5 |

Fig. 22

**RESIDUAL/DISTILLATE FUEL BLENDS U. S. RAILROADS 1955-1965**

| Property | Blend 1 | Blend 2 | Blend 3 |
|---|---|---|---|
| API Gravity @ 60°F | 21.5 | 13.2 | 17 |
| Sulfur % WT | 1.1 | 1.0 | 3.3 |
| Distillation °F | | | |
| 10% | 510 | 465 | 462 |
| 50% | 640 | 600 | 576 |
| Calculated Cetane No. | 36 | 16 | 25 |
| Viscosity @ 100°F, SUS | 123 | 157 | 300 |

Fig. 23

identified as Blend 1 and Blend 2 were used at all power settings except idle, whereas blend 3 required a dual fuel system that allowed the heavy fuel to be used only at upper throttle settings No. 5 and above). In all of that early test work, many engine problems surfaced. Many of the design changes which have been made to the engines since that time would have overcome a number of the earlier problems. Modern day lubricating oil would have helped. It must be recalled, of course, that engines have also been uprated since that time.

In spite of difficulties, this type fuel oil should be considered a potential energy source. It must be understood, of course, that the use of such fuels would require a modification of handling practices, better lubricating oils, and undoubtedly modified maintenance practices. For example, fuels would have to be kept warm. This is not an insurmountable task considering the fact that Blend 3 fuel oil was operated for an entire year through the Sierra Nevada mountain range. As will be seen in later sections of this report, some of the longer range alternative fuels will also require heating and special handling.

**Alcohol**

Alcohol fuels, whether methyl or ethyl, will not autoignite at normal compression ratios. Thus, some other fuel would have to be used for pilot ignition of the alcohol, as well as to provide a significant portion of the energy needs for the engine. Obviously, it would be most convenient to mix the alcohol with a petroleum fuel. Unfortunately this is not possible today. Anhydrous ethyl alcohol is soluble in diesel fuel. However, as little as ½% of water will permit the alcohol and diesel fuel to separate into two phases. Methyl alcohol is not soluble in petroleum at all. Research work is in progress at a number of locations to find an agent which will permit emulsification of diesel fuel and methyl alcohol. There is one such chemical available; but its cost is completely prohibitive (for each 10% alcohol added to the diesel fuel the price of the mixture doubles when using this particular chemical). Therefore, either a dual fuel system of some type or unstabilized emulsions must be used.

Utilization of alcohol in diesel engines must be considered at the research stage whereas alternative petroleum products are at the developmental stage. Further, alcohol is far more valuable for use in gasoline engines than in diesel engines, for example, the addition of some alcohol as an octane improver in no-lead gasoline.

It must be further recognized that the energy content of alcohol on a volumetric basis is very low compared to petroleum. To obtain the equivalent energy of one gallon of diesel fuel oil requires two gallons of methyl alcohol.

With present manufacturing techniques, more than one gallon of petroleum fuel is required for every gallon of alcohol produced.

## Shale Oil

Oil bearing shale formations represent a potential resource base for petroleum that surpasses the existing natural petroleum resource base of the U. S. The extraction and processing of oil shale and the production of synthetic crude oil is, however, a vast logistical problem. The production of synthetic crude oil from oil shale involves finding and processing enormous amounts of material — 1.4 tons per barrel of oil recovered on the average.

Although development corporations have supplied thousands of barrels of shale oil derived fuels to the U. S. Navy and other military services for tests, large scale commercial production would appear to have many legislative, environmental and economic hurdles yet to be crossed. No substantial quantities of syncrude oil shale are expected to augment refinery feed stocks prior to 1985.

Presently there are two shale products available for research. One is a distillate fuel having properties exhibited in Fig. 24. The other is characterized as a residual whose properties are displayed in Fig. 25. It will be noted that the distillate material exhibits properties which would qualify it as a top quality distillate petroleum derived diesel fuel. The residual material, in addition to having a very high distillation range (90% at 931 degrees F), is high in wax content (11%). This of course explains the extremely high pour point of 78 degrees F. On the other hand, it has a low sulfur content of 0.02%, low carbon residue of 0.18% and moderate viscosity of 115 SUS at 100 degrees F.

**SHALE DISTILLATE ANALYSIS**

| Property | Analysis |
|---|---|
| API Gravity @ 60°F | 38.2 |
| Sulfur % WT | 0.02 |
| Distillation °F | |
| 10% | 446 |
| 50% | 506 |
| 90% | 560 |
| END POINT | 580 |
| CETANE Number | 50 |
| Viscosity @ 100°F, SUS | 35 |
| Pour Point °F | —10 |

Fig. 24

**SHALE RESIDUAL ANALYSIS**
**(Selected Properties)**

| Property | Analysis |
|---|---|
| API Gravity @ 60°F | 29.5 |
| Sulfur % WT. | 0.02 |
| Distillation °F | |
| 10% | 590 |
| 50% | 776 |
| 90% | 931 |
| END POINT | 1024 |
| Calculated Cetane No. | 75 |
| Viscosity @ 100°F SUS | 115 |
| Pour Point, °F | 78 |

Fig. 25

The DOE in conjunction with the Navy Department is in the process of contracting for research work with these two fuels in medium speed engines. The work would begin in the second half of 1980 and run thru 1981.

## Coal Derived Liquid

Coal is the nation's most abundant fossil fuel source with a demonstrated reserve base more than 14 times greater than petroleum. There are more than 150 processes patented for the liquidfi-

**COAL DERIVED LIQUID ANALYSIS**
**(Selected Properties)**

| Property | Analysis |
|---|---|
| API Gravity @ 60°F | 13.8 |
| Sulfur % WT. | 0.2 |
| Distillation °F | |
| 10% | 390 |
| 50% | 430 |
| 90% | 490 |
| END POINT | 545 |
| Cetane No. | 0 |
| Viscosity @ 100°F, SUS | 36.5 |
| Pour Point | Below —45 |
| Nitrogen % WT | 1.0 |
| C/H Ratio | 9.5 |

Fig. 26

cation of coal. Methodologies differ greatly; but most involve hydrogenation to produce a combination of liquid, gases and solids. At least 10 liquefaction processes are being developed in the U.S. with a number of others in the laboratory development stage. At least one of these processes is at a pilot plant stage. As a result, there is product available for research. The DOE has issued contracts for research with a coal-derived liquid in medium speed railroad diesel engines.

None of the processes used in the U.S. is based on the Fischer-Tropsch process which is in commercial operation in the Republic of South Africa. This process, which was developed in Germany, is relatively inefficient as a source of liquid fuel. It is considered too costly for U.S. needs.

Fig. 26 is a partial analysis of the "middle distillate" type coal-derived liquid currently being researched. Note that the viscosity is essentially that of No. 2 petroleum fuel (36 SUS at 100 degrees F) and the distillation range approximates a middle distillate fuel. Note, however, that the API gravity is less than half that of petroleum middle distillate. This is the result of the different hydrocarbon makeup of the coal-derived product and is also reflected in the extremely low (approximately 0) cetane number. Fortunately, it appears that this material is quite soluble in petroleum distillate fuel. Thus, there is a genuine possibility that a material such as this could be used as a fuel supplement in railroad diesel engines.

**Conclusion**

While it is apparent that a significant amount of research has been carried on in the search for alternate fuel sources for railroad diesel engines, it is also obvious that a great amount of work remains to be done if 10% of railroad needs are to be provided by an alternative source by the year 1985. The Fuels and Lubricants Committee will continue to keep the LMOA advised of progress in all these areas of research.

It appears that fuel of the ASTM No. 3-D type offers great promise. Durability information is needed for fuels of this specification. In this context the committee encourages the AAR to continue its work.

**Acknowledgement**

The LMOA Fuels and Lubricants Committee wishes to express appreciation to the Research Division of the Association of American Railroads, DOE and FRA for permission to use the alternate fuels data which have been developed in their program.

LMOA wishes to express its thanks to the newly formed Kansas City Railroad Diesel Club and the Santa Fe Railway for hosting Pre-Convention Presentation in Kansas City.

Our New Developments Committee's presentation was well received in what we trust was a mutually beneficial experience.

We look forward to future appearances there.

# Tuesday, September 23, 1980

**10:30 A.M.**

## REPORT OF THE COMMITTEE ON NEW DEVELOPMENTS

**Pre-Convention Presentation: Kansas City Railroad Diesel Club and Santa Fe Railway**

**April 10, 1980**
**Gold Buffet**
**Kansas City, KS**

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

**VICE CHAIRMAN**

R. E. Carter, Engineer-Mech. Dept., Southern Pacific, San Francisco, Ca.

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## 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.

## INTRODUCTION

The New Development Committee has selected four topics for its presentation that will have significant impact on the railroad industry during the new decade and for years beyond. At the beginning of the 1980's, the computer has come into its own, on-board diagnostics is becoming an invaluable maintenance tool, and the new 92-day FRA locomotive inspection rule is suddenly upon us. The Committee has taken a look at these new developments, has identified areas where they are currently in use, some of the pitfalls, and developed suggestions for future applications and benefits.

The fourth section of the paper deals with the art of planning and carrying out an effective program of applying modifications to locomotives. Too many modification programs are unnecessary, and many are begun and few completed. Here is one approach which contains procedures that will help fulfill the needs of successful modification programs.

The paper sections are listed as follows:

I. 92-Day vs. 30-Day Locomotive Inspection, Service and Maintenance.

II. Procedures for Handling Modifications.

III. Locomotive On-Board Diagnostic Systems.

IV. Computer Innovations for Increased Reliability and Availability.

## I.

## 92-DAY VERSUS 30-DAY LOCOMOTIVE INSPECTION, SERVICE & MAINTENANCE

The long overdue proposal to eliminate the existing 30-day Federal inspection and modify some of the related tests in the current quarterly inspections, along with other rule changes covered in the Federal Register of May 21, 1979—Volume 44, Number 99, are at this writing soon to become incorporated into the Locomotive Inspection Act.

The railroad industry has for years felt that the existing schedule for locomotive periodic inspections long ago ceased to be safety related and has cost the railroads a significant amount of money in shop costs, energy consumption and loss of productivity.

This committee gives its full support to the proposed rules changes, but at the same time takes the stand that some new thinking must be directed at the everyday running maintenance now practiced by most roads.

The proposals have brought about the necessity for us to examine closely the quality of the current 230-203 daily inspections and the capability and conscientiousness of persons conducting them.

The importance of a quality daily inspection and follow-up cannot be overemphasized. Good record-keeping and a constant flow of information to the people and places requiring it will be the basis for our success in obtaining the maximum benefits from the forthcoming move to the 92-day or periodic inspection system.

It is a certainty that FRA inspectors will be paying closer attention to the degree of faithfulness practiced by railroads in complying with the new rulings. We must avoid any tendency towards laxity.

It is true that the modern electric or diesel electric locomotive is well designed, a reliable machine and capable of running for 92 days without a major inspection, but a machine it is nonetheless. Experience has taught us that failures will occur, failures that have beginnings and telltale signs. Early detection will help prevent a situation from further deteriorating and allow a potentially bad component to be replaced before it actually fails.

A vast majority of these undesirable conditions are detected by visual inspection or by a report from the operating crew that something had apparently malfunctioned. Additional information is usually very limited.

There is today, for those railroads who can afford it, a selection of sophisticated on-board elec-

tronic diagnostic equipment being developed that can eliminate much of the hit and miss detection. This type of "electronic inspection" tied into a computer system can furnish valuable early warning data.

It is noted in the Federal Register of May 21, 1979 that several railroad commentors stated that each railroad is in the best position to develop a maintenance plan for its own locomotives because each road is aware of its own special operating conditions. Another commentor, the American Short Line Railroad Association, favored different regulations for different types of service. The distinction between low speed yard power on short runs and high speed freight engines on distance runs merited varying treatment and required a different approach to a daily inspection and maintenance plan.

All of this is true. The effort and work load at each facility must be tailored to meet the demands of the service, the maintenance requirements to keep power functioning properly and in compliance with FRA rules.

The railroad industry has no intentions of slacking off on good maintenance practice. Some roads have made plans to go on a 46-day basis, the periodic inspection being done on one stop and carrier maintenance on the other.

A number of other roads are satisfied with their current 30-day systems and plan to continue on that basis even though a locomotive may be in the shop only briefly. Their scheduling systems does not merit revamping.

One Class I Midwestern Railroad has been on a 28-day schedule for about 13 years and does not plan any major changes in its system. Its CMO office also stresses the importance of a good thorough daily and quarterly inspection. Another important point brought out by its Mechanical department was a frequent pit inspection of all road power.

Pit inspections are probably the most important inspections made on a road unit for various reasons, the main one being the finding of running defects, which have a direct relationship between locomotive failures, major or otherwise. Defects or potential defects below the frame are more readily found during a pit inspection. Even the most experienced eye cannot detect all of the possible cracks in truck frames, broken support bearing cap lock washers, tears in the bottom of gear cases, broken brake hanger pins, cracked upper motor nose lugs, etc., the list being endless.

Usually it is inconvenient, impractical and frequently impossible to get a unit over a pit, particularly when no specific trouble has been reported. But case histories over the years have shown that a proper pit inspection prior to the last trip might have averted a failure.

Another important item that will have to be planned into the new

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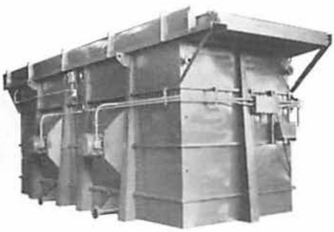

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maintenance schedule is cleaning. With the 30-day system, a reasonable amount of cleaning was done while a locomotive was in for inspection. This was generally true though some railroads had a more elaborate cleaning program than others. With the advent of the 92-day inspection rule it is possible or even probable that locomotive cleaning practices will suffer. This should not be permitted. Care must be taken to prevent oil, water and debris from accumulating under hoods, on walkways, fuel tanks and trucks. Many older units leak, some types are traditionally leakers and others just spring a leak now and then as hoses or gaskets fail. Where required, frequent wipe-ups should be performed to prevent heavy accumulations and cleaning performed as part of the daily or trip inspection.

It would be advisable to clean a unit thoroughly at least once every 30-days and plan a cleaning shortly before the scheduled quarterly inspection to facilitate a more thorough examination throughout the locomotive. The quarterly inspection will be the time to take care of problems that have been developing for the previous 90 days, some of which may not be detected on a dirty locomotive.

The coming rules change makes it increasingly important to maintain a complete, up-to-date and accurate running record on each locomotive. Particular attention should be paid to wheel wear, traction motor support bearings, bearing caps, bolts, wick assemblies, gear cases and gear lube content. All of these and more must be checked on the pit inspection. Again we emphasize the necessity of a top-quality inspection by competent personnel and the proper handling of pertinent data for processing and distribution.

At this writing there is a mountain of printed matter on proposed rule changes for all railroad rolling stock engaged in moving freight and or passengers. There are proposals by the FRA, counter proposals by the AAR, proposals from individual railroads and proposals from individuals, plus proposals to modify proposals already submitted.

It is not the intent of this committee to get into the actual changes of each part and subpart of the Locomotive Inspection Act as set out in the Federal Register, Vol. 44, No. 99, 5-21-79. They are printed for all to read, and you will have to read them to understand how the law will affect your particular railroad. As you now know, the new law became effective on May 1st of this year.

What we have tried to do is bring to your attention the fact that there will be changes from which we can reap benefits. However, it behooves us to continue our high standards of locomotive maintenance. We must strive for greater locomotive reliability and availability through better planning and scheduling of maintenance. This will be possible with the added flexibility of the ex-

tended interval for federally mandated inspections. By utilizing good communications, the capabilities of the computer and a conscientious effort by all personnel directly involved in the front line inspecting and maintenance, the railroads can convince shippers, the public and the governments that service and safety can improve with less, not more government regulation.

These are what it will take to make it all work for us.

## II.

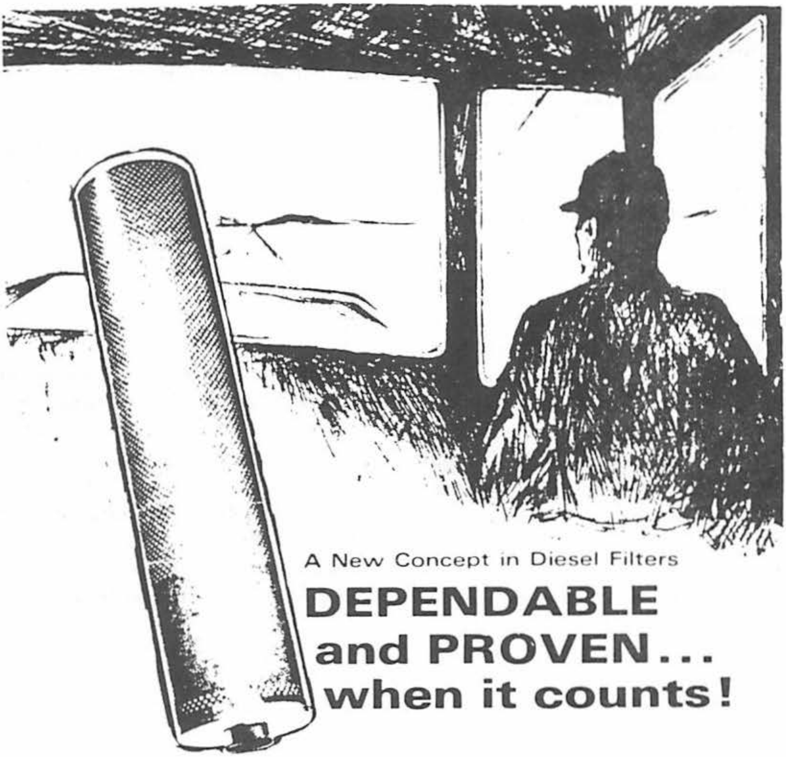
## PROCEDURES FOR HANDLING MODIFICATIONS

Most railroads are constantly confronted with the need to apply modifications to their locomotives. These may be the result of government regulations (two examples are the cut lever and side switching step modifications which recently became effective). The requirements for more reliable, safer locomotives, and changes in operating procedures also necessitate improvements. New products, recommendations from locomotive builders, and operating experience are only a few of the many reasons for change.

A modification must be justified and fully investigated so as to provide a change for betterment. In many cases time is an important factor (particularly where government regulations or safety factors are involved). In all cases, however, these modifications must be effectively and efficiently applied to the locomotives. This portion of our paper deals with methods and procedures for attaining this goal.

First it must be determined who will apply the modification, and when and where they will do it. This will be determined to a great extent by the magnitude of the project and by the time factor. Prior to a modification program being entered into it should be determined if it can be handled on the priority level required. In some cases it may be necessary to defer or change priorities of current modifications in order to maintain an effective modification program.

It must be determined which shops or maintenance facilities have the capability for doing the job. Will it be necessary to perform the work only at central shops or can it also be done at running repair facilities? What tooling is required and where is it available? Where is manpower available? Will the time factor permit restricting the project only to major repair facilities or will it require performance of the work at outlying points as well? These are all questions that must be answered during the initial planning stages of the project. Once the points which will perform the work have been selected, supervisors within those shops must determine the most efficient methods of application.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At small points this should prove no problem. By definition, these facilities are limited in space, personnel, and capabilities, and in most cases would be expected to perform only those projects which are relatively simple or those which because of a time factor (deadline) must be done wherever the locomotive can be captured.

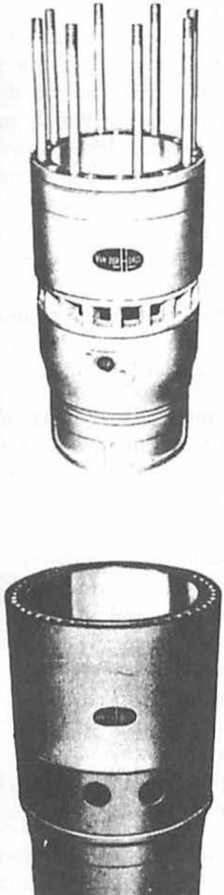
Larger projects will necessarily be performed at facilities which possess the tooling and personnel to apply them. Within these larger facilities (or central shops), it must be determined in which area the work will be performed. Many projects, while too large for outlying points with limited mechanical facilities, may be applied in the running repair section of a major shop. Projects requiring major electrical or mechanical applications and/or changes may be best suited for back shop or heavy repair areas.

In any case, it is important that a definite location for application of the project be established (again, depending on the type and scope of the modification) and that someone at that location be made responsible for seeing that it is applied. If time is of the essence, deadlines and dates for completion must be established. Daily, weekly, or monthly quotas may be set in order to assure that the established date for completion is met.

Close monitoring by supervision is required to ascertain that quotas are met and that the modifications are applied according to the pre-established schedule. Failure to meet quotas must be handled promptly if the project is to be kept on schedule.

Once the location for application of the modification has been established, material requirements must be determined, material ordered and, finally, distributed to the points of application. In this day of material storages and long lead times for delivery, it is important that dates for receipt of material be anticipated and that enough material be accumulated prior to beginning the applications to assure that the project can be completed without running out of material. Material shortages, more than anything else, will result in a loss of project momentum. There is no more simple excuse for not applying modifications than "We ran out of material" or "We don't have the material in stock." Once a project has been bogged down because of material shortages (or for any reason for that matter) it is difficult to re-establish momentum.

Along this same line, if any special tools are required for applications of the modifications, it is important that sufficient quantities be on hand prior to beginning the project. When a number of individuals or groups are involved in the applications, it is essential that each be supplied with any special tools required. In many cases special tools or methods may



be developed during application of modifications and these should promptly be made available to all concerned.

Once the project material has been received, it may be advantageous to package it in a kit form, particularly if a number of different items are required for the modification. Each kit should include all material needed for application of the project. For example, modifications involving changes in piping should include all fittings, brackets, clamps, nuts, bolts, and other hardware required. Packaging material in kit form will expedite applications of the project by eliminating the need for the mechanic to search throughout the shop for this bolt or that nut.

Application of wiring modifications can be expedited by having wiring harnesses made up in advance. In most cases, these harnesses can include all wiring associated with the project and can be pre-labelled in order to speed application.

Another essential items in the applications of modifications is a clear, concise set of instructions. These should include all pertinent information and should be kept as simple as possible. Drawings, sketches, or photographs which illustrate the modification will also prove helpful when used in conjunction with a step-by-step written instruction. Electrical projects may require schematics showing "before" and "after" configuration of the locomotive. In addition to schematics, a wire-by-wire running list of what is to be removed, added or changed is helpful. These instructions should be distributed to all those responsible for making the application. This can be done through a cover letter which may detail the reason or the necessity for the modification. If personnel are informed of the reason for making the change, they will often be motivated to make the application, particularly if it will solve a problem they have experienced or if it will make the performance of their jobs easier.

A set of instructions may also be placed with the work sheets or maintenance sheets of each unit affected. This should include a sign off sheet which provides space for listing date of application of the modification, person making the modification, and person approving the work, as well as any other information pertaining to the modification which supervision may wish to record. By tabulating the information provided on the sign-off sheets the status of the project is readily available.

In most cases it will be necessary to provide an individualized set of instructions for each locomotive model (or each series of units within a model) receiving a particular modification. Differences in the wiring diagrams, piping, location of components, etc. require that instructions be tailored to each group of locomotives affected. In any case, the important thing is to have a good

set of instructions for the unit on which the modification is being made.

In summary, in order to achieve timely, efficient application of modifications it must be determined who will apply and where, material (packaged in kit form when possible) and tooling must be on hand, and personnel responsible for making the modification must be provided with a complete set of instructions. After completion, the modification must be made a part of the locomotive's record and the project record.

## III.

## LOCOMOTIVE ON-BOARD DIAGNOSTIC SYSTEMS

SEARCH, a concept of locomotive diagnostics utilized by the railroads, is being brought inside the locomotive. Miniature electronics that make possible the pocket computer are slowly enabling the capabilities of SEARCH to be incorporated into a portable package that can be carried onto a locomotive consist. This portion of the paper will give a broad overview of present activities of on-board diagnostic systems and identify goals being sought by the railroad industry.

**Federal Railroad Administration**

We begin by discussing FRA's efforts and accomplishments in this field.

The FRA contracted the Lawrence Berkeley Laboratory of the University of California to develop a Locomotive Data Acquisition Package (LDAP). LDAP is a complete system for recording and analyzing data from diesel-electric locomotives being used in normal operation.

The LDAP system is comprised of a mini-computer and is designed for unattended use on locomotives. The device is portable and capable of recording, onto magnetic tape, signals received from transducers placed to sense critical locomotive functions.

FRA set down rugged design criteria to which the LDAP had to be built:

1. operate in temperature range -40°F to 140°F
2. withstand shock of 10G for 30 msec (half-sin. wave)
3. vibrations of 1.5G in all directions over a range of 1-10 hz
4. protection from high voltage transients.

During 1979, LDAP was tested in locomotive operation at Pueblo and on the Boston & Maine Railroad. On the latter, it accumulated over 3000 hours of use. During these tests a representative set of transducers was used which measured 17 functions at the time intervals shown below. A single magnetic cartridge can record, under these conditions, for 36 continuous hours.

| Measurement | Sampling Interval |
|---|---|
| Distance (speed) | 2 Seconds |
| Throttle Setting | " |
| Direction | " |
| Motor Current | " |
| Buff/Draft Force | " |
| Train-Line Brake Pipe Pressure | " |
| Independent Brake Pipe Pressure | " |
| Turbo-Charger Pressure | " |
| Grade | " |
| Slip/Spin Indication | " |
| Fuel/Flow (in) | 1 minute |
| Fuel/Flow (out) | " |
| Fuel Temperature (in) | 3 minutes |
| Fuel Temperature (out) | " |
| Engine Oil Temperature | " |
| Ambient Temperature (long-hood) | " |
| Accelerometer | 0.1 second* |

*Recorded only upon significant change.

The initial LDAP package cost $600,000, and copies are expected to cost $100,000 apiece. It is considered a research tool only and commercial application is not expected.

### Association of American Railroads

For a number of years, the AAR has been conducting a Track-Train Dynamics program to determine what is happening on-board a train under varying operating conditions and what effect the train, its speed, make-up, mode of operation, etc., has on the track structure. The program has resulted in considerable information about the forces acting on a train and has simultaneously developed ways of monitoring locomotive performance and operation. This latter ability will eventually be used to assist preventive maintenance schedules and detect events that precede major component failures.

A paper prepared by W. G. Ambrose, S. M. Kiger and S. H. Patel and presented at the AAR Track-Train Dynamics Conference in Chicago on November 22, 1979, begins as follows:

"This paper describes a microprocessor based instrumentation system which will acquire data and display information, in real time, to assist the locomotive engineer in monitoring and controlling the locomotives and the train. When installed on a train and locomotive consist, it will provide information regarding each locomotive's response to propulsion and dynamic braking commands and an indication of selected electrical and mechanical conditions of the locomotive. It will also provide the status of the locomotive and train air brake systems including telemetered air brake information from the rear of the train. This allows the system to automatically perform the initial terminal air brake test."

The potential for improved locomotive maintenance from use of this system, or variations of it is considerable. Again, the high cost of these prototype systems prohibits general locomotive application but as technology is advanced the cost /reliability ratio should improve and permit more on-board

diagnosis to be applied to locomotives.

### Present On-Board System

As a logical step following SEARCH, for diagnosing locomotive circuit malfunctions, the industry pressed for systems of self-annunciation to be designed integral with the individual circuits. In pre-solid state days, the popular techniques used were the latching relays, the latching flip-flop with LED read out, or simulator. Solid state permits warning indicators to be located close to, or a part of, the circuit indicator. Extensive use of this is found among the plug-in cards in EMD Dash-2 and GE locomotives.

Amtrak is now operating an EMD electric locomotive, the AEM-7. The AEM-7 utilizes components of the Swedish RC-4 locomotive which employed the prototype of a separate fault panel developed by ASEA. The panel is located in front of the engineer's station above the windshield. Rather than provide "go" status information, the panel is designed to display both warning and "no-go" circuit status of 20-25 vital systems on the locomotive. The indicators are a modern version of the relay-flag concept.

Rather than push-to-test of each indicator, a single push-to-test button is provided which lights all indicators for a check of all bulb filaments. Certain indicators, such as ground relay, can be reset from the panel. Amber color is used for "warning" and red for "no-go." Elsewhere the fault panel uses white for status indicators that circuits are "OK." The panel is intended for use by the engineman to take action or to alert maintenance personnel. LED readouts are also used to monitor individual circuits to assist maintenance personnel. Some of the circuits monitored by the RC-4 panel include the transformer coolant pumps, air blowers and main diodes.

### The Locomotive Builders

From practical considerations, the major locomotive builders have not made on-board diagnostics available as an integral part of their diesel locomotives. They are aware that microprocessors and mini-computers are available to do on-board diagnostics. Their reluctance to incorporate on-board diagnosis as an integral part of the locomotive stems from the sensors themselves. To date, commercially available sensors have been inadequate for locomotive service. Those sensors that are presently most reliable, function on an inductive pick-up basis and are primarily electrical devices. To make these live in locomotive service, the builders must package the commercially available sensing components into a device rugged enough for railroad applications. To date, for example, they have not succeeded in developing and packaging a transducer for measuring temperature and pressure. The problem is the relatively short service life of the sensors.

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**What is available and how it might be used**

Since on-board diagnostic systems have long been a part of aviation and marine vehicles, it is not surprising that suppliers to those industries are attempting to bring their technology to the railroads. Some may eventually be successful. One such manufacturer is Avicon of Richardson, Texas. Its model AMS 201 is currently being tested by an Eastern railroad. The primary function of the AMS 201 is to measure fuel flow and display this information for the engineman to observe. The AMS 201 will measure:

net fuel consumed

engine speed

ground speed

gallon/mile consumed

The device has the capability of measuring gal/hp/hr, which the railroad's and Avicon engineers are planning to do. One problem is to find a means of accurately measuring the horsepower hours. This, of course, refers to the previous comment as to why locomotive builders have not made on-board diagnosis a part of their locomotives, i.e., finding reliable and accurate monitoring and sensing components that can be applied to a locomotive at a price the railroads can afford to purchase and maintain. As one builder's representative stated "We believe the life cycle cost (of on-board diagnostic devices) would show that the maintenance dollars were merely being transferred from the locomotive to the diagnostic equipment."

As was discussed in our 1979 technical paper, the railroad industry is already using on-board event recorders, generally installed for the purpose of monitoring train handling techniques. Much of the data being gathered and recorded can be used as a resource for the benefit of those responsible for locomotive maintenance. One railroad's Equipment Engineering department has taken these data and has begun to study information gathered from a Pulse system installed to monitor train handling on a mountainous, heavy freight operation. Here are some of the uses this railroad is developing from the recorded data.

1. Establish duty cycles for locomotive models in specific services. Analyze parameters of speed ranges and throttle notch range for an operating period to establish specific duty cycles. Scheduled maintenance could then be planned according to the duty cycle of the locomotive model.

2. Traction motor amperage—analysis of data may provide insight into motor environments and provide a correlation to failure rates for different locomotive models and service.

   It was demonstrated on the strip chart of an SD 9 locomotive that traction motor current was maintained at 1250 amps for a period of

20 minutes while negotiating a 2.5% grade. This event is a daily occurrence on this mountainous run. Excesses of minimum continuous speed ratings can be easily detected.

3. Air compressor and air brake equipment usage. Comparisons may be devised to relate air compresor cycling (throttle notch duration) and work demand (brake applications) with air compressor utilization rates. In the same way, air brake equipment wear rates may be correlated with air brake utilization.

4. Establishment of duty cycle by tabulations of throttle notch changes and duration within each notch may provide a correlation to governor wear. Governor failure modes are electrical (solenoid and cable/plug) and mechanical (linkages, settings, diaphragm, etc.). Solenoid life should be a function of throttle changes which essentially energize and de-energize the solenoids.

   This action may also manifest itself in linkage wear and resultant maladjustment. Engine cycles during the locomotive duty cycle would also be proportional to governor cycles and may have a relationship to governor utilization rates.

   Comparisons of engine component failure rates, e.g., power assemblies, and duty cycle characteristics of locomotive models in specific services may be possible.

5. Dynamic brake utilization during the locomotive duty cycle would provide more insight into traction motor service requirements and would establish an accurate proportion of dynamic brake within the locomotive duty cycle. Dynamic brake usage may also correlate with dynamic brake failure rates and grid utilization rates.

### Goals and Challenges

Today's goals relate to monitoring energy consumption and train dynamics. Dollars that can be saved from fuel conservation and the prevention of derailments are of such magnitude that the cost of developing on-board diagnostics as they relate to these areas is well justified. As these programs become successful, the third priority will be to tell the engine house mechanic what is going wrong with his locomotive, where the trouble lies and, hopefully, what caused it.

The present method of tabulating strip chart data is manual. Where data, in its present form, is to be used for Equipment Engineering department studies an automated tabulation system will be necessary. Our suggestion is an analog-to-digital converter, programmed to tabulate pertinent

data directly from a magnetic tape to build a workable data base.

The Committee challenges the builders, suppliers and interested Equipment Engineering departments to work together to develop an economical, and a reliable onboard diagnostic system. It recommends that the AAR act as a clearing house to assemble and distribute information and introduce standardization for data gathering, recording and tabulation systems, where possible.

The railroads need a recording system that will—

—trouble-shoot selective locomotives

—identify parameters at the time of a mechanical or electrical failure

—not, itself, be a maintenance problem on the locomotive, and

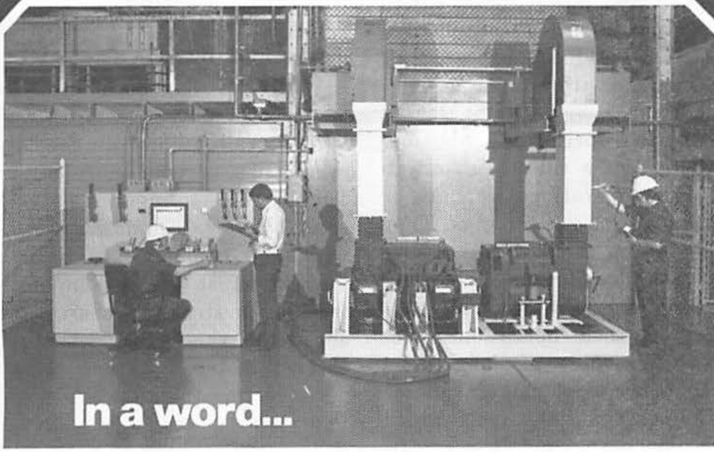
—be affordable, $3,000 to $5,000 per locomotive.

## IV.

## COMPUTER INNOVATIONS FOR INCREASED RELIABILITY AND AVAILABILITY

The past thirty years, generally referred to as the "Nuclear Age" has been aptly renamed the "Computer Age." With the technical advancements made in this area, and with innovations in hardware and software practically falling over each other, it is very difficult for the average railroader, the guy who "turns the wrench," so to speak, to comprehend the benefits. It has been said by more than one railroad executive, in trying to sort out the proliferation of dual density drives, bi-syne lines, baud rates that have increased from Teletype rates of 130 bits, or pieces of information, per second to 9600 bits per second, and the myriad other advances in the computer field, "What is in it for me? How are these advancements going to help my operation?" And well they might ask this question, for this is really the sole reason for computerization. If technical advancements, no matter what the field, do not help those they are supposed to assist, of what real value are they?

As computers and their utility gained acceptance, the widely held concept was to gather as much information as possible. There was little if any thought as to what this information could do, once gathered. With the reduction in hardware costs and the new "throwaway" software technology, the question of usefulness of the data gathering took a back seat. It has only been recently that subdepartments within our railroads have hired personnel who, having a computer background in addition to mechanical experience, are now called upon to determine how this computer explosion can best be used for their purposes. The idea that a computer wizard, with little if any technical expertise in railroad operations, can determine what you "need" is passe.


In a word...

Present day railroad operations, especially Mechanical department operations, with more complex equipment and larger diesel facilities servicing larger consolidated fleets, have a dual purpose they must address with computer technology. First, with the increased costs of their operations, chief mechanical officers cannot afford to base future operational changes or expenditures on gut feelings. They must be given the necessary computer tools to assist them effectively and efficiently in the management of their operations. Second, while aware of long term benefits, they must make available to field personnel the tools which will make daily operations efficient and effective. These two purposes really contain the same thought — what are my problem areas?

The past decade has proven that this dual purpose can be served. Railroads have moved away from the concept of central batch processing alone, and have placed real time terminals in the hands of the wrench turners. It is here that daily operations can best use these huge data bases to assist in the diagnosis and repair of our locomotive and car fleets. This is really what we, as mechanical officers, need.

Our respective railroads have identified many problem areas that need computer assistance. Of these we will explore the following: Train failures — identification and reduction; performance indices; locomotive utilization; stress analysis; component reliability/replacement before failure; and locomotive repair scheduling.

**Train Failures**

With the increased complexity of our locomotive fleets, the problem of train failure diagnosis and repair has become more difficult. The longer hauling distances covered by our locomotives coupled with their complex nature dictates that we must use a computerized tracking system if we are to stay ahead of the game. There are several methods in use today to perform this function.

As one example, MoPac generates a report twice daily, to all mechanical locations, of units reported to be dead-off-line or having mechanical/electrical difficulties. Any of these locations having information as the the cause or repair of the problem inputs this information by telephone to personnel in the St. Louis office. This information is then compiled each month in a locomotive failure report that helps identify problem areas from which maintenance practices may be modified to correct the situation.

Another example, Southern Pacific, also utilizes daily train failure reports to produce monthly statistics on reported road failures by model versus confirmed failures, confirmed failures within 30 days of last maintenance, and the most frequent failure symptom reported. This information is also

used to define those locomotives having four or more train failures as ones needing special attention. This report is produced on a daily and monthly basis.

Also Conrail has recently initiated a new train failure tracking system. With the use of real time train failure reports, input to the TABS system from movement directors throughout the system, an automatic train failure message is sent to the next location the train will pass, defining train consist information, time of failure and the failure condition reported. This information is sent both to the next transportation location as well as the mechanical facility. With this information, decisions on changeout or repair of the suspected locomotive can be made. Also the train failure is automatically fed to the locomotive history file which can be accessed with real time remote terminals. Anyone requesting locomotive history will receive, in chronological order, both shop repair and train failure events. In addition to the initial tracking, each train failure must be responded to by a mechanical location as to the conditions found and the repairs made upon arrival at any of the diesel facilities. This information is input and becomes locomotive history, available to all departments. Monthly train failure statistics, similiar to those produced by the Southern Pacific, are generated in order to identify poor performing locomotives and classes that need special attention.

**Performance Indices**

With more corporations moving towards "management by objective," attainable goals must be produced with which to measure their operations. It is no different in the railroad industry. Whether or not you use MBO (or personal performance measurement, PPM) as Conrail has done, each of our railroads needs to measure where it is and where it is going. It doesn't matter whether these indices and their use are elaborate or not. Their objective is similar—to reduce failures, thereby increasing reliability and availability.

Let's look at some of the indicators that are used and why.

To gauge how our locomotive fleet is operating, the ability to judge one locomotive or class against another is needed. This is necessary in order to make sound corporate decisions on acquisition of new locomotives, based on past performance, and also to achieve the greatest return on investment when selective repair or overhaul is necessary.

Performance indices can basically be split into two categories—those that are of immediate (i.e. monthly) use both for shop management and corporate headquarters, and those that are useful for long term analysis. These indices fall into two subcategories—those that are locomotive/class oriented and those which are terminal oriented. They include, but are not restricted to:

1. Failures per serviceable month (fleet, class, locomotive)
2. Mean shop time (terminal, class, locomotive)
3. Percent available (fleet, class, locomotive)
4. Inspection / repair reliability (terminal)

Failures per serviceable month is very simply a ratio of the number of locomotive failures (for whatever reason) versus the number of serviceable days available for train operations during that month. This index is calculated for each locomotive/class. When any locomotive or class performs lower than a fixed number (usually class/fleet average) further analysis can be done as to the reason.

Mean shop time is the average amount of time a locomotive remains in repair status. This calculation is maintained for both scheduled and unscheduled repairs. Units undergoing major overhaul are not calculated, as the length of time necessary for this type of repair would exaggerate and nullify this statistic. This calculation is computed for individual locomotives and classes and by repair location.

PAI (percent available index) is calculated, again, for locomotive, class and fleet. This is a straightforward calculation based on out of service time versus serviceable or available time for train operation.

The above calculations are used primarily by the chief mechanical officer to identify those locomotives, system-wide, that are causing the most problems in order judiciously to effect repairs. They are of immediate value because only the last 30 day history on each locomotive is necessary for calculation purposes. Placed in a matrix these indices are invaluable when used for trend analysis.

To ascertain how effective each locomotive repair terminal is when repairs and inspections are performed and as a basis for Conrail's management - by - objective program, two new performance indices were generated, Inspection Reliability and Repair Reliability. These indices are produced on a monthly basis and allow the CMO and each locomotive terminal (Conrail has nine major repair terminals, 18 smaller repair terminals and two heavy overhaul locations) to point out how each terminal is performing in relation to all others. At the beginning of each year, goals are set in accordance with these indices and are the bench marks for each shop manager for the following year. Unlike many computer reports, they are relatively small, for ease of reading (approximately two pages each), yet detailed enough to pinpoint areas of weakness within a terminal. For example, a typical report has a summary sheet which lists, in order, the worst to best terminal, its ranking for the month (between 0 - 100%) and a detail sheet, listing the locomotives and reasons for subsequent failure. With this detail sheet, shop man-

agement can pinpoint specific areas needing special attention.

What are the actual benefits of these computer reports?

The MoPac, using its locomotive failure/repair data base, found a very high incidence of air box water jumper failures occurring at the #4-13 positions. Using this information it decided to follow the EMD pointer relating to the stiffening of the air box water manifold and has nearly eliminated this problem.

Conrail noticed a much higher incidence of train failures relating to loading/wheel slip problems on its fleet of GP-35 locomotives, compared to other classes. To reduce these failures a reliability improvement program was begun aimed at these problem areas. After minor rework, costing an average of $5,200, it has been shown through Conrail's performance indices and train failure analysis that the reliability of the GP-35 fleet has increased by 1.7 times and loading/wheel slip problems on the modified locomotives have been reduced by 50%. Similarly Conrail's retirement program is geared around these indicators, showing which units are the best candidates for retirement due to continual poor performance.

Both the SP and MoPac use computer reports to determine wheel wear characteristics. Using this information, the MoPac is able to better schedule wheel changeouts. As of this writing, Conrail is initiating a wheel wear program as an aid to field terminals in assessing possible wheel true/change tasks prior to the locomotive arriving for scheduled service. Also, this data base will be made available to CR's heavy overhaul shops on a real time basis, so that projected wheel requirements by location and type can be used to build and ship the necessary TM combos before they become needed. It is felt this will appreciably reduce the out-of-stock condition for needed combos that sometimes occurs.

### Locomotive Utilization

With new locomotive costs escalating each year, improving locomotive utilization has gained new urgency. Several railroads are actively pursuing this problem with the aid of sophisticated computer programs.

The Southern has been using a program that matches consist size to locomotive requirements necessary for further train operations at the destination point. This has helped to alleviate power shortages and light power moves from one location to another. Using computer simulation this package also assists the Train Operations department when train scheduling changes are necessary.

With a model similar to the Southern's, Conrail in 1979 began simulating its train operations in an attempt to accomplish the same goals. From this simulation, a real time train monitoring system within the TABS computer, was proposed. This system is scheduled

for implementation during 1980 and will encompass the real time running of all Conrail freight trains, including locomotive consist preparation, train blocking make up and actual train operation over its large system.

### Engineering Applications

In the past, many of our railroads have been unfortunate enough to buy equipment that had an unacceptable service life due to poor quality. With this in mind, Mechanical Engineering departments are using computer simulation models to prevent this from occurring. Basically what these simulation models do is to imitate the actual conditions that will be encountered by the equipment, thus allowing the engineers to insure that correct specifications are met by the manufacturer. Although this is a fairly new area, as far as individual railroads are concerned, significant accomplishments have occurred.

During a recent simulation, at Conrail, of fatigue analysis of car truck bolsters containing known voids, the estimated service life of the bolster was found to be less than four years. This analysis was then verified by the AAR, resulting in rejection of the unacceptable truck bolsters. Without this simulation capability, Conrail would have acquired poor quality bolsters thereby creating a dangerous and costly situation.

Using the locomotive data base, which contains monthly spectrographic oil history for each of Conrail's locomotives, the Engineering department was able to analyze this information, and was able to redefine critical spectrographic limits so that 500 fewer oil drains per month were realized. These changes in spectrographic limits have not increased oil engine/air compressor failures and have saved Conrail in excess of $60,000 / month in actual costs while increasing the availability of its fleet.

Using computer simulation of train handling characteristics, Conrail's Engineering department was able to give scientific testimony before the FRA proving that a proposed new cab signal and automated train braking system, scheduled for the Northeast Corridor, was dangerous and posed a hazard to corridor traffic.

### Component Reliability/ Replacement Before Failure

The question of preventive component replacement before failure has been given some attention by many railroads in the past. But it is only recently, in an attempt to increase locomotive reliability/ availability that this concept has been approached seriously. As railroads acquire the computing power and expertise to analyze the current situation, more component replacement policies will be changed.

Southern Pacific has been giving this area much attention. Computer programs are being developed to analyze individual component life cycles for use in SP's

strategies of equipment maintenance/operation. Refinements in the TOPS reporting system are being developed for greater accuracy in analysis of component failure causes and responsibility.

Conrail also has a similar program in effect. A major addition to the LIS (Locomotive Information System) was initiated in August, 1979 which effectively tracks several major components from receipt from vendor through scrapping.

Using this system two main benefits are envisioned—(1) component and subcomponent life cycles will be made available so that preventative repair strategies can be initiated to reduce the incidence of locomotive train failure, and (2) a more accurate warranty control system for premature failure of components will allow Conrail to recover warranty monies. It has been estimated that this portion of the system will create an annual saving to Conrail in excess of one million dollars, over a manual system.

**Locomotive Repair Scheduling**

One of the most effective ways to increase availability is to schedule locomotive repairs. This scheduling concept involves more than just getting the right locomotives to the proper terminal. It involves scheduling of periodic maintenance based on business predictions so that peak availability of locomotives meets the demands of the Transportation department. Also involved is the accurate prediction of material needs and the efficient movement of this material to the respective locomotive shops. As material managers consolidate material stock points this phase becomes critical to a smooth and efficient work flow. It must also be noted that in order to have sufficient manpower to repair these locomotives, the scheduling of personal vacations also plays a big role in this function.

Several railroads have pieces of a complete scheduling operation in place and appear to be moving to a total system. Among them are MoPac, SP and Conrail.

The MoPac utilizes a five-day forecast sheet, broadcast by its computer system to a number of predetermined repair locations. This report shows the locomotives and types of inspections required. Another version of this report is used by system level personnel in the planning of orderly locomotive changeout requirements. This system allows for the predetermined movement of annual/biannual inspections to a particular maintenance location prior to becoming overdue. Air brake kit material, necessary for these inspections, is prepackaged and stenciled with the appropriate unit number, and sent to the proper terminal beforehand, thereby allowing for a smoother inspection process.

Once the locomotive is shopped for the inspection, a computer printout is generated detailing all work that is required both, by Federal regulation and MoPac maintenance regulation for that inspection. In addition, the last wheel measurements are attached to this report showing the date of measurement and the wheel sizes. This report is approximately three pages long and is an excellent tool for shop management.

The SP production scheduling personnel use daily reports of maintenance due and overdue for pool locomotives. Similar programs are used by personnel at general headquarters to "bird dog" units to their maintenance destinations. Material personnel are actively using computer programs to track material from vendor to the facility. Using the material arrival projection dates allows each maintenance facility to plan orderly and sequential locomotive shoppings.

Conrail has each of the above capabilities at its disposal. But even with all of these, the system is not complete as each function relies on human interaction with the others. This becomes a very large problem when you realize Conrail has 68 different locomotive classes and approximately 4500 active locomotives. It has become apparent that in order to schedule each locomotive successfully Conrail must have a computer system that incorporates all of the above pieces, and then will generate an individual shop, as well as a system, schedule based on business curve needs, material and force requirements. This will be used by

Conrail's work scheduling forces and shop management to insure sufficient locomotive availability to their Transportation counterparts.

Although this system is not complete Conrail has made significant progress in locomotive availability. In the initial stages of the program, management desired to match fleet availability with locomotive inspection requirements. A program to plot upcoming locomotive Federal inspections against the business curve was initiated. Noting a discrepancy between the two, Conrail moved certain Federally mandated inspections ahead to match the projected business curve, thereby reducing mandatory shopping during peak business periods, while allowing more heavy periodic inspections to be done during slack periods. This simulation allowed CR to maintain locomotive availability at or above the mandated levels, assuring adequate road haul locomotives for customers' goods. MoPac also has a similar program which schedules the periodic inspections so that an even distribution of the "heavy" types of inspections is realized throughout the year.

In summation, we as Mechanical officers can take pride in the computer usage we have made so far. Judicious use of a valuable resource has given us a means with which to identify our individual problem areas and ways in which to effectively manage our operations. Through the use of computer technology we have become more competent to handle the problems that confront us today. Positive gains have been made, and future accomplishments in these areas will further our goals of increased locomotive reliability and availability. Mr. James Bailey, Vice-President Management Information Systems, Family Lines challenged each of us when he said, "While a computer can handle five million instructions per second, the human brain can handle 150 million instructions per second. Probably the capacity of the human brain is our best resource. There are almost unlimited opportunities for the railroad industry to produce significantly better customer service at reduced costs, by capturing the full potential of the computer age."

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## Continuous Operation Since Organization in 1890

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# Tuesday, September 23, 1980

**2:00 P.M.**

## REPORT OF THE COMMITTEE ON DIESEL ELECTRICAL MAINTENANCE

**Pre-Convention Presentation: The Southern and Southwestern Railway Club**

**APRIL 17, 1980**
**Holiday Inn (Gateway)**
**Huntington, WV**

**T. L. WESTERFIELD, Chairman**
Electrical Engineer
Chicago & North Western Transp. Co.
500 West Madison St.
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**COMMITTEE MEMBERS**

| | | | |
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| O. W. Aten | Regional Sales Mgr. | M-K Co. | Blue Springs, Mo. |
| R. P. Chambers | Mgr. Diesel Loco. | Amtrak | Washington, D. C. |
| R. T. Gill | Diesel Elect. Maint. | SP | San Francisco, Ca. |
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**1980 TOPIC:**

**"DIESEL ELECTRICAL MAINTENANCE — LOOKING AHEAD"**

## 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

## TRACTION MOTORS

After so many years of improvements and experimentation with new insulating materials, traction motors still are one of the major headaches of the locomotive maintenance officers. With the fantastic advances of technology in so many different fields, one would expect a traction motor to run at least 500,000 or 600,000 miles before it is necessary to drop it from a locomotive for a basic overhaul. In actuality, traction motors seem to fail much more frequently.

If we look at new motors as received from the locomotive builder and normally working under new locomotives, we note that very few motors fail during the warranty period. Depending on the railway, the type of service and the locomotive model, traction motors will last from 450,000 to 600,000 miles, or four to seven years.

Most railroads estimate that the average life of a unit exchange motor is in the order of 350,000 miles, or three to four years (motor rebuilt by the original manufacturer). Many railroads have their own traction motor repair shops. Data collected from many of the major railways indicate that traction motors repaired in the railway shops too often have a life not exceeding 250,000 miles, or in the order of two to three years, and sometimes even less than that. The average life of the motors repaired in our shops can be as low as 125,000 miles or 18 months. It is quite common to see 5 to 6% of the motors we repair in our shops fail in their first month in service. Infantile mortality is high. There is room for improvement in motor life.

One improvement advocated by this committee is better testing methods.

**New procedure for testing an overhauled traction motor**

Experiments recently carried out by a few railways indicate that many weak motors could be weeded out while still in the repair shop by utilizing more appropriate testing methods. In particular, a new traction motor test console has been developed and is available

from either the General Electric Co. of Cleveland, Ohio, the Hipotronics Co. of Brewster, N. Y. or Cam Industries of Hanover, Pa.

The common method used today by most railway traction motor repair shops is to connect the field in series with the armature circuit and run the motor as a series motor. To keep within the safe speed at no load approximately one-tenth only of the maximum voltage in service is impressed on the motor being tested. The electrical test therefore is too low to be adequate and the test becomes a simple bearing run. It is therefore not surprising to see so many motors fail when subjected to full voltage during the first few miles after being returned to service.

The other extreme is the full load test requiring two motors to be connected back-to-back, aligned and rigidly secured to a floor test plate. Such a test is very time consuming and therefore too costly for a maintenance shop.

This committee recommends a simplified modification of this test which provides a running test on bearings and simultaneously applies full operating voltage on the insulation and full core loss in combination with centrifugal test. This test console does not require any mechanical alignment or coupling of one motor to another. It requires only a minimum of shop floor space and can be made portable if desired.

The test goes as follows—

a) Connect the exciting field leads of the traction motor to the high current, low voltage supply of the test set, and apply normal load current.

b) Connect the armature cables of the traction motor to the high voltage supply of the test set. Close the circuit breaker and bring the motor up to speed by gradually increasing the voltage until the maximum operating voltage of the motor is obtained.

c) To obtain maximum speed and maximum voltage simultaneously, weaken the traction motor field by gradually decreasing the exciting field current from normal load current to a value which will give the desired speed, while the armature voltage is held at its maximum value.

d) Run motor for desired time to check core loss, bearings, vibration, commutator roughness, brush riding, etc. Shut down motor, and repeat test in reverse direction of rotation.

**Results of Test**

a) The traction motor is separately excited from the high current source. This makes it possible to control the speed and keep it within safe limits, even though the armature is impressed by the maximum operating voltage.

b) The maximum voltage on the armature stresses the insulation between conductors and commutator segments as in

service, while at the same time the unit is subjected to centrifugal force at maximum speed.

c) The high speed run with ample field excitation heats the armature by core loss and without forced ventilation. There is an appreciable temperature rise so that the insulation is subjected to operating voltage while it is hot.

d) When the test reveals a defect, it is subjected to far less power than if the same defect occurred in service, so that the extent of damage is minimized and can frequently be quickly repaired whereas a simple failure in service may be so destructive that a major repair would be necessary.

The following specification is recommended for a traction motor test console:

Armature Power Supply:
1600-1800 Volts d-c
50 Amperes
Ripple 5% maximum
Continuous Duty
Regulation 15-25%

Field Power Supply:
12 Volts d-c
0-2000 Amperes
Ripple 5% maximum
Continuous Duty
Regulation 15-25%

Impedance Test Supply:
50 Volts a-c
50 Amperes
Continuous Duty
Regulation 15-25%

Additional Features:
—Surge and transient protection on d-c power supplies.
—Digital tachometer 0-3000 RPM with non-contact type pick up.
—Two digital temperature indicators with thermocouples and magnetic mounts.
—Three channel vibration monitoring meter with magnetic pick-up attachment.

**Core Loss Tester**

The testing procedure described above is likely to pick up quite a few armatures with abnormally high core losses. To minimize these occurrences, the armature cores should be checked in advance, even before the armature is wound in the case of a stripped armature. This can be done by connecting an a-c power supply to both ends of the armature shaft — one lead at each end. The voltage is raised to 8 volts and the current is measured. The maximum permissible current is 275 amperes for a GE-752 armature and 175 amperes for an EMD armature. It is the committee's opinion that no railroad can afford not to test its armatures for core losses.

## II.

## PERFORMANCE EVALUATION OF TRACTION MOTORS

To assess the quality of the work performed on traction motors by various repair shops, it would be advantageous for the railways to use a uniform method of calcula-

ting the performance of various groups of motors. By exchanging and comparing this information each road could benefit, particularly when contracting out. The quality of work from a given repair shop could be estimated and taken into account, along with the price tag, when contracts are awarded.

This Committee would like to propose a method which provides a fairly accurate evaluation of the life of the motors repaired in a given shop. It highlights the frequency and nature of the premature failures experienced by this population of motors. The method can also be used for evaluating the performance of new motors received from the original manufacturer. This information would provide the builder with a better understanding of the problems affecting his motors after the warranty period. The builder could then take corrective action and introduce improvements that would make the next generation of motors more reliable.

This information would also be useful to a railway trying to establish the optimal traction motor repair policy. Should a motor be automatically overhauled after so many months or miles in service? What are the expected benefits of such a policy? How many months or miles in service can one expect from a motor overhauled at Repair Shop A as compared to one overhauled at Shop B? What are the principal causes of premature failures? The survivorship curve method will answer many of these questions.

It should be noted that the procedure described can be used for any serialized component and will equally provide the life expectancy of main and auxiliary generators, engines, compressors, cooling fans and so on.

The following description is that of a manual information recording and processing system. However, the system lends itself naturally to computer operation. It would be up to each railway to decide which way to go. The computer eliminates a lot of routine work but, on the other hand, it may be easier to lose control of the system. The quality of the reports produced can only be as good as the quality of the data fed into the system. With a manual system a sharp clerk can spot suspect data and correct it before proceeding further with the calculations.

### Description of the System

Two source documents are required — a traction motor inspection report for each motor sent to a shop for repair and a monthly list of motors repaired for each shop.

a) Traction motor inspection sheet (Exhibit 1). This report must include the following information:

—type of motor

—frame serial number

—date of inspection (or removal)

TRACTION MOTOR PRELIMINARY INSPECTION REPORT *Cracked Arm*

TYPE: *D 77* FRAME NO: *75H1037* DATE: *FEB. 29-80*

REMOVED FROM UNIT *6637* AT ........ POSITION ........

REASON FOR REMOVAL ... *BROKEN ARM* ...

MONTHS ..... *9* .... LAST OVERHAUL *MAY 30-79* SHOP *H.Q.* ...

VISUAL INSPECTION & CHECK

| | | |
|---|---|---|
| Brushes New | (O.K.) | SHORT Frayed PIG TAILS BURNT LOOSE CONNECTION |
| Commutator | (O.K.) | FLASHED SCORED HIGH BARS MISSING Worn |
| String band | ~~(O.K.)~~ | BURNT CRACKED DIRTY (TEFLON) MISSING (NEW) |
| Brush holders | (O.K.) | BURNT LEADS DAMAGED FLASHED (*CRACKED*) |
| Armature band | (O.K.) | C.E. FAILED WIRE RESIGLASS CRACKED |
| Armature band | (O.K.) | P.E. FAILED WIRE RESIGLASS CRACKED |
| Internal leads | O.K. | FLASHED BURNT CONNECTION OPEN (*WORN AT*) |
| External leads | (O.K.) | CUT INSULATION DAMAGED BURNT Lug (*RISERS*) |
| Shaft | (O.K.) | SCORED BROKEN BURNT BY TORCH |
| Nose suspension | (O.K.) | WORN PLATE LOOSE Missing |
| Pinion | (O.K.) | WORN CHIPPED MISSING CUT No Teeth DRY |
| Gearcase arm | O.K. | (CRACKED) BROKEN OFF WORN LOOSE PLATE |
| Axle bore | (O.K.) | OVERHEATED C.E. PE WORN |
| Ground lead | (O.K.) | MISSING WRONG TYPE DAMAGED |
| Gearcase lugs | (O.K.) | WORN BROKEN OFF LOOSE PLATE |
| Threads stripped | (O.K.) | |
| Air duct cover | O.K. | MISSING DAMAGED |
| Bolts | (O.K.) | LOOSE MISSING |
| Bearings seized | (O.K.) | YES C.E. P.E. Worn |
| Other visible defects | | |

1000 VOLTS MEGGER — HIGH POT

| | | | | | |
|---|---|---|---|---|---|
| ARMATURE CIRCUIT | O.K. | OPEN | SHORTED | | |
| INTERPOLE " | O.K. | OPEN | | | |
| FIELD " | (O.K.) | OPEN | | *100* | |
| ARMATURE & INTERPOLE | (O.K.) | | | | |

| | | | | |
|---|---|---|---|---|
| RUN TEST - CE | BEARING | O.K. | NOISY | |
| PE | BEARING | O.K. | NOISY | |
| | BRUSHES | O.K. | JUMPING | ARCING |
| | VIBRATION | GOOD | BAD | |

| MOTOR NOT TO BE STRIPPED | TO BE STRIPPED | NO- *10212* |
|---|---|---|
| CLEAN OUTSIDE | FRAME | ARMATURE |
| REPLACE PINION | | |
| BLOW OUT INSIDE | | |
| WELD CRACKED ARM | BASIC | BASIC |
| CLEAN INSULATORS | | |
| REPLACE STRING BAND | | |
| REPLACE AXLE CAP | (LIGHT) | (LIGHT) |
| GROUND LEAD REPLACE | | |
| CHANGE BRUSHES | | |
| PATCH LEAD | REBUILD | STRIP |
| APPLY LUG TO | | |
| OTHER | | |

REMARKS · FRAME OR ARMATURE NEEDS VARNISH

USE SAME PINION AND BEARINGS

*A.H.L.*

EXHIBIT 1

- —locomotive removed from (and position)
- —reason for removal
- —visual inspection and check —the inspector ticks or circles the appropriate defects found
- —megger readings
- —run test results (if applicable)
- —action to be taken—strip, don't strip, class of repairs for the frame and armature.

b) Traction motor production report. Each month a list must be submitted by each repair shop to provide the following information for each motor overhauled during the month:
- —frame serial number
- —type of motor
- —type of repair (test only, light repair, basic overhaul, complete rebuild job)

Step 1

The traction motor analyst will prepare for each type of motor (752, D-77, etc.), for each shop and for each classification of repair a list of the motors repaired on a month-by-month basis (Exhibit 2). The left-hand side is filled as the motors are shopped; the lines are numbered consecutively starting at "one" at the beginning of each year. The right-hand side of the page is left blank for the time being.

Step 2

A master file must be created and kept up to date to show all the traction motors listed in numerical order; for each motor show where and when this motor was last shopped, or purchased, also the type of repair.

Step 3

For each inspection sheet received get from the master file the shop, time and type of the last repair. With this information go to the appropriate list (as made in Step 1) and fill in the right-hand side of the page for each motor that has failed (Exhibit 2 — RH side).
- —date of failure
- —months (miles) in service since last shopping
- —locomotive No. from which the motor was removed
- —cause of failure

Step 4

For each list produced in Step 1 a summary sheet is made (Exhibit 3). It has a column for each number of months after shopping (or mileage intervals) and a line for each of the main causes of traction motor failures. At the bottom, additional lines are provided for — total failures, motors removed for months or miles, motors from derailments or wrecks, motors found good, motors still in service, total motors, cumulative sum of motors, percent failures, percent survivors, and finally the survivorship curve.

Each time a failure is entered on the list, the corresponding line number is written in the appropriate block of the summary sheet (cause of failure and time after shopping).

TRACTION MOTORS SIGNED OFF

YEAR: 1978 SHOP: ABC TYPE: GE-752

| | SERIAL NUMBER | TYPE OF REPAIR | DATE RECEIVED | MONTHS IN SERVICE | FROM UNIT | FAILURE OR REASON FOR REMOVAL |
|---|---|---|---|---|---|---|
| | JANUARY 1978 | | | | | |
| 1 | 502127 | BASIC | Apr./78 | 3 | 2338 | Interpole Grounded |
| 2 | 502882 | " | Feb./79 | 13 | 2531 | Interpole Grounded |
| 3 | 687980 | " | | | | |
| 4 | 869860 | " | Oct./78 | 9 | 2023 | Open Field |
| 5 | 869884 | " | Sept./78 | 8 | - | Armature Grounded |
| 6 | 899928 | " | | | | |
| 7 | 900089 | " | | | | |
| 8 | 900091 | " | | | | |
| 9 | 900101 | " | Jan. /79 | 12 | - | Armature Grounded |
| 10 | 900665 | " | | | | |
| 11 | 946619 | " | | | | |
| 12 | 963758 | " | Feb./79 | 13 | 3673 | Flashover |
| 13 | 963784 | " | | | | |
| 14 | 963787 | " | Mar./79 | 14 | 3707 | Lead Burnt Off |
| 15 | 963838 | " | | | | |
| 16 | 963889 | " | Feb./78 | 1 | - | Hot Suspension Bearing |
| 17 | 991583 | " | June/79 | 17 | 2013 | Armature Grounded |
| 18 | 1008621 | " | | | | |
| 19 | 1008646 | " | May/ 78 | 4 | 2313 | String Band Off |
| 20 | 1008714 | " | Sept./78 | 8 | - | Armature Grounded |
| | FEBRUARY 1978 | | | | | |
| 21 | 504183 | " | May /78 | 3 | - | Field Open |
| 22 | 687322 | " | June /79 | 16 | 2326 | Damaged PE Cap |
| 23 | 687950 | " | | | | |
| 24 | 869879 | " | | | | |
| 25 | 900016 | " | Mar./79 | 13 | - | Teflon Band Lifting |
| 26 | 900390 | " | Feb./79 | 12 | 2577 | Armature Grounded |
| 27 | 900453 | " | | | | |
| 28 | 900594 | " | June/78 | 4 | 3681 | Armature Damaged |
| 29 | 900597 | " | | | | |
| 30 | 900620 | " | Apr./79 | 14 | 2031 | Bearing Failure |
| 31 | 946618 | " | June/79 | 16 | 2315 | External Lead Damaged |
| 32 | 963749 | " | | | | |
| 33 | 963804 | " | | | | |
| 34 | 963920 | " | Nov./78 | 9 | 2306 | Burnt Leads |
| 35 | 963938 | " | | | | |
| 36 | 963952 | " | Dec./79 | 22 | 2016 | Ext. Lead Burnt |
| 37 | 991638 | " | July/78 | 5 | 2316 | Armature Grounded |
| 38 | 991650 | " | Apr./78 | 2 | 2309 | Armature Flashed |
| 39 | 1008667 | " | Oct./79 | 20 | 2012 | Open Field |
| 40 | 1011413 | " | | | | |

EXHIBIT 2

SURVIVORSHIP CURVE - WORKSHEET

SHOP= ABC YEAR= 1978 TYPE= 752 - BASICS

| NO. OF MONTHS AFTER SHOPPING | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLASHOVER | | [illegible] [illegible] | | | | | | 94 | | | | |
| COMM. DAMAGED | | | | 97 | | | | | | | | |
| SCORED COMMUTATOR | | | [illegible] | | | | | | [illegible] | | [illegible] | |
| BRUSHES TOO SHORT | | | | | | | | | | | | |
| COMM. OUT-OF-ROUND | | | | | | | | | | | | |
| HIGH, MISSING BARS | | | | | | | | | | | | |
| STRING BAND B.O. | | | | 19 | | | | [illegible] | | | | |
| ARMATURE GROUNDED | [illegible] [illegible] | [illegible] | [illegible] [illegible] | [illegible] | 3 [illegible] [illegible] | [illegible] [illegible] [illegible] | | 5 [illegible] 20 | [illegible] | | [illegible] | 9 [illegible] |
| ARMATURE OVERHEATED | [illegible] | | | | | | | | | | | |
| ARM. DEFECTIVE (OPEN-SHORTED) | | | | 28 | | | | | | | | |
| RESIGLASS/STEEL BAND FAILED | | | | | | | | | | | [illegible] | |
| GRD. BRUSH HOLDER | | | 71 | | | | | | | | | |
| GRD. INTERPOLE | | [illegible] [illegible] | 1 [illegible] | [illegible] | | | | | 72 | | [illegible] | |
| OPEN INTERPOLE | | | | | | | | [illegible] | | | [illegible] | [illegible] |
| GRD. FIELD | | | | | | | | | [illegible] [illegible] [illegible] | | | [illegible] |
| OPEN FIELD | | | [illegible] [illegible] | [illegible] | | [illegible] | | | 4 | | | |
| DAMAGED LEADS | | | [illegible] | | | [illegible] | | | [illegible] | | | [illegible] |
| ARM. BEARINGS SEIZED | | | | | | | [illegible] | | | | | |
| NOISY BEARING (S) | | | | | | | | | | | | |
| SHAFT NUT THROUGH COVER | | | | | | | | | | | | |
| DEFECTIVE PE CAP | | | | | | | | | | | | |
| HOT SUSPENSION BEARING | 16 | [illegible] [illegible] | [illegible] | | | | [illegible] | | | | | |
| WORN DEFECTIVE PINION | | | | [illegible] | | | | | [illegible] | | | |
| SLIPPED PINION | | | | | | | | | | | | |
| GM BROKEN/CRACKED ARM | | | | | | | | | | | | |
| BROKEN/CRACKED LUG | | | | | | | | | | | | |
| BROKEN/LOOSE BOLTS | | | | | | | | | | | | |
| STRIPPED THREADS | | | | | | | | | | | | |
| FLASH RING B.O. | | | | [illegible] | | | | | | | | |
| OIL SOAKED | | | [illegible] | | | | | | | | | |
| OTHER | | | | | | | [illegible] | [illegible] | | | | |
| NOT DETERMINED | [illegible] | [illegible] | | | | | | | | | | |
| TOTAL FAILURES | 5 | 8 | 11 | 8 | 3 | 5 | 3 | 7 | 9 | 0 | 5 | 5 |
| STORED/SOLD/LEASED | | | | | | | | | | | | |
| MILEAGE | | | | | | | | | | | | |
| DERAILMENTS/WRECKS | | | | | | | | | | | | |
| FOUND GOOD | | | | [illegible] | | [illegible] | [illegible] | [illegible] | | | | [illegible] |
| MOTORS IN SERVICE | | | | | | | | | | | | |
| TOTAL MOTORS | 5 | 8 | 11 | 9 | 3 | 6 | 4 | 8 | 9 | 0 | 5 | 6 |
| CUMULATIVE TOTAL | 199 | 194 | 186 | 175 | 166 | 163 | 157 | 153 | 145 | 136 | 136 | 131 |
| % FAILURES | 2.5 | 4.1 | 5.9 | 4.6 | 1.8 | 3.1 | 1.9 | 4.6 | 6.2 | - | 3.7 | 3.8 |
| % SURVIVORS | 97.5 | 95.9 | 94.1 | 95.4 | 98.2 | 96.9 | 98.1 | 95.4 | 93.8 | - | 96.3 | 96.2 |
| SURVIVORSHIP CURVE | 97.5 | 93.5 | 88.0 | 83.9 | 82.4 | 79.9 | 78.4 | 74.8 | 70.1 | 70.1 | 67.5 | 65.0 |

EXHIBIT 3

SURVIVORSHIP CURVE - WORKSHEET

SHOP = ABC YEAR = 1978 TYPE = 752 - BASICS

| NO. OF MONTHS AFTER SHOPPING | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLASHOVER | (12) | | | | | | | | | | | |
| COMM. DAMAGED | | | | | | | | | | | | |
| SCORED COMMUTATOR | | | | | | | | | | | | |
| BRUSHES TOO SHORT | | | | | | | | | | | | |
| COMM. OUT-OF-ROUND | | | | | | | | | | | | |
| HIGH, MISSING BARS | | | | | | | | | | | | |
| STRING BAND B.O. | (25) | | | | | | | | | | | |
| ARMATURE GROUNDED | | | (119) | (43) | (17) | (50) | | | | | | |
| ARMATURE OVERHEATED | | | | | | | | | | | | |
| ARM. DEFECTIVE (OPEN-SHORTED) | | | | | | (46) | | | | | | |
| RESIGLASS/STEEL BAND FAILED | | | | | | | (51) | | | | | |
| GRD. BRUSH HOLDER | | | | | | | | | | | | |
| GRD. INTERPOLE | (2) | (13) (17) | | | | | | | | (52) | | |
| OPEN INTERPOLE | | | | | | | | | | | | |
| GRD. FIELD | (38) | | | | | | | | | | | |
| OPEN FIELD | | | | | | | | (59) | | | | |
| DAMAGED LEADS | (27) | (14) | | (31) | | | | | | (36) | | |
| ARM. BEARINGS SEIZED | | (30) | | | | | | | | | | |
| NOISY BEARING (S) | | | | | | | | | | | | |
| SHAFT NUT THROUGH COVER | | | | | | | | | | | | |
| DEFECTIVE PE CAP | | | | | | | | | | | | |
| HOT SUSPENSION BEARING | | | | (15) | | | | | | | | |
| WORN DEFECTIVE PINION | (18) | | | | | | | | | | | |
| SLIPPED PINION | | | | | | | | | | | | |
| GM BROKEN/CRACKED ARM | | | | | | | | | | | | |
| BROKEN/CRACKED LUG | | | | | | | (57) | | | | | |
| BROKEN/LOOSE BOLTS | | | | | | | | | | | | |
| STRIPPED THREADS | | | | | | | | | | | | |
| FLASH RING B.O. | | | | | | | | | | | | |
| OIL SOAKED | (24) | | | | | | | | | | | |
| OTHER | | | | (21) | (63) | | | | | | | |
| NOT DETERMINED | | | | | | | | | | | | |
| TOTAL FAILURES | 7 | 4 | 1 | 4 | 2 | 2 | 2 | 1 | 0 | 2 | 0 | 0 |
| STORED/SOLD/LEASED | | | | | | | | | | | | |
| MILEAGE | | | | | | | | | | | | |
| DERAILMENTS/WRECKS | | | | | | | | | | | | |
| FOUND GOOD | | | (55) | | | | (45) | | | | | |
| MOTORS IN SERVICE | 14 | 16 | 11 | 8 | 6 | 2 | 7 | 5 | 8 | 4 | 8 | 9 |
| TOTAL MOTORS | 21 | 20 | 13 | 12 | 8 | 4 | 10 | 6 | 8 | 6 | 8 | 9 |
| CUMULATIVE TOTAL | 125 | 104 | 84 | 71 | 59 | 51 | 47 | 37 | 31 | 23 | 17 | 9 |
| % FAILURES | 5.6 | 3.8 | 1.2 | 5.6 | 3.4 | 3.9 | 4.3 | 2.7 | - | 8.7 | - | - |
| % SURVIVORS | 94.4 | 96.2 | 98.8 | 94.4 | 96.6 | 96.1 | 95.7 | 97.3 | - | 91.3 | - | - |
| SURVIVORSHIP CURVE | 61.3 | 59.0 | 58.3 | 55.0 | 53.1 | 51.1 | 48.9 | 47.6 | 47.6 | 43.4 | 43.7 | 43.7 |

EXHIBIT 3 (Cont'd..)

At the end of the year, the following calculations are performed:

a) Count the number of entries in each column and write the result on the "Total Failure" line.

b) For each month on the list of motors repaired count the number of motors still in service (no entry on the right-hand side) and enter the result on the "motors in service" line. For example, if 9 motors repaired in January '78 were still in service at the end of January '80 when the calculations were done, then write "9" in the column "24 months after shopping." 8 motors repaired in February '78 were still in service, enter "8" in the column "23 months after shopping," and so on.

c) For each column the "Total Motors" is equal to — Total Failures + Motors in Service + Number of entries on the "Stored/Sold/Leased," "Mileage/Months, Derailment," and "Found Good" lines.

d) To establish the Cumulative Total, work backward from the last column on the right-hand side. For the last column the Cumulative Total is equal to the Total Motors. For the other columns, each "Cumulative Total" is the sum of the "Total Motors" in same column and the next "Cumulative Total" on the right-hand side.

e) The "% Failures" is the "Total Failures" divided by the "Cumulative Total" in each column, multiplied by 100.

f) The "% Survivors" is the difference between 100 and the "% Failures."

g) Survivorship Curve—for the first column on the left, same as % survivors. For the other columns, the "Survivorship %" is the "% survivors" multiplied by the previous "Survivorship %" divided by 100.

h) Plot the survivorship numbers on a graph as a function of time (or miles) (Exhibit 4).

The Committee recommends the "survivorship" concept as a useful tool for comparing the performance of various shops and various years of production. The failures occurring during the first few months after shopping are easily identified, and therefore guidelines are provided for corrective action in the shops.

To conclude this section, let's look at some typical survivorship curves that were derived for three groups of new traction motors received from the builders:

1—A group of "D-77" motors received under SD-40-2 locomotives (3000 HP 6 axles)

2—A group of "D-77" motors received under GP-40-2 locomotives (3000 HP 4 axles)

3—A group of "752" motors received under M-420 locomotives (2000 HP 4 axles)

(Exhibit 5).

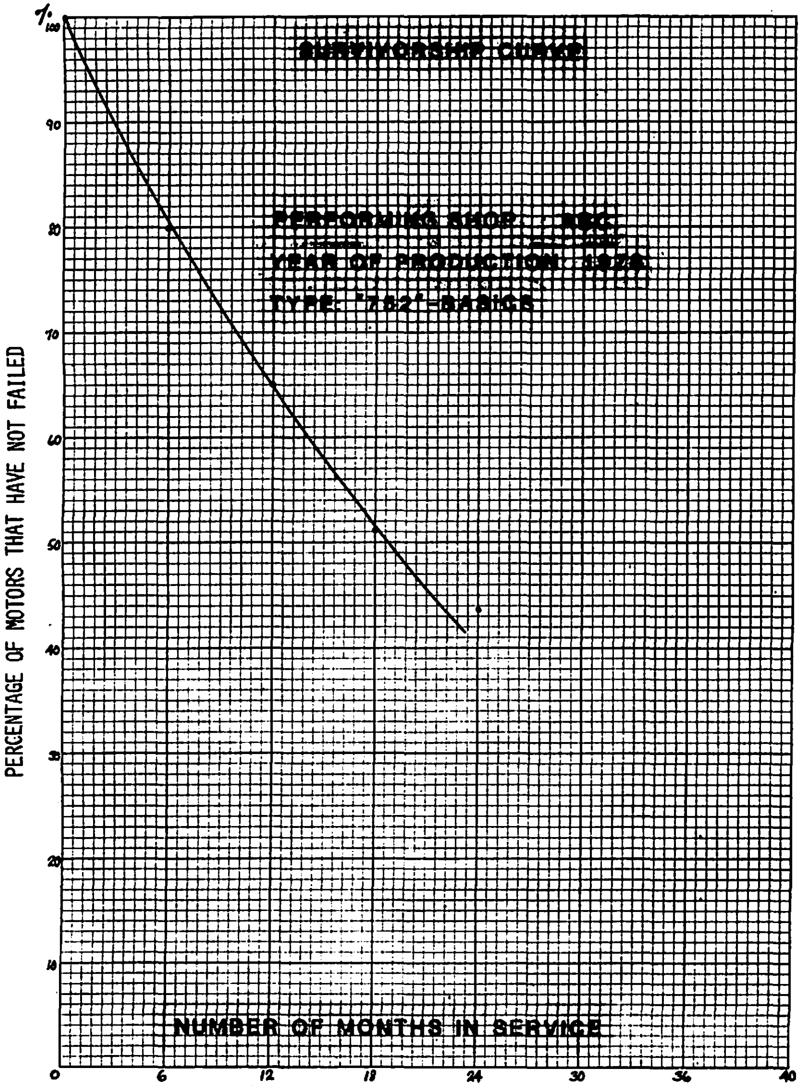

SURVIVORSHIP CURVE
PERFORMING SHOP:
YEAR OF PRODUCTION:
TYPE:
PERCENTAGE OF MOTORS THAT HAVE NOT FAILED
%
100
90
80
70
60
50
40
30
20
10
NUMBER OF MONTHS IN SERVICE
0
6
12
18
24
30
36
40

EXHIBIT 4

SURVIVORSHIP CURVES

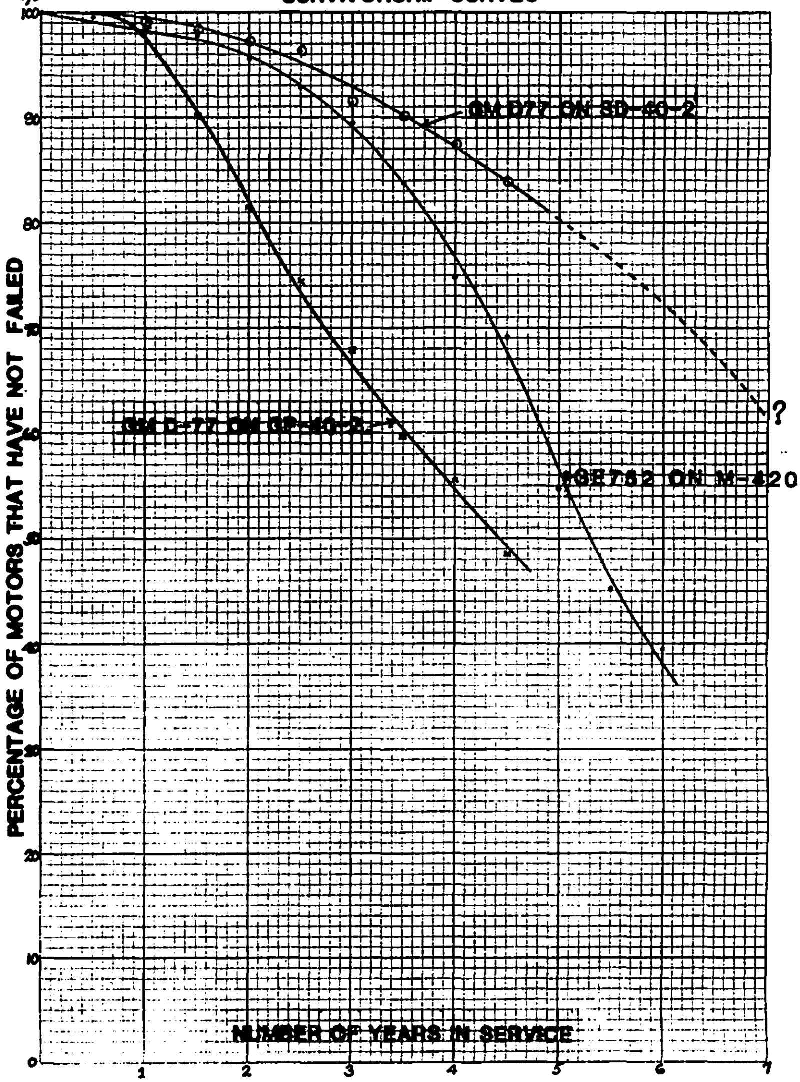



EXHIBIT 5

NEW D-77 MOTORS ON GP-40-2 LOCOMOTIVES

| NO. OF YEARS AFTER SHOPPING | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| FLASHOVER | | 2 | | | | |
| COMM. DAMAGED | | | | | | |
| SCORED COMMUTATOR | | | | 3 | | |
| BRUSHES TOO SHORT | | | | 1 | | |
| COMM. OUT-OF-ROUND | | | 1 | 7 | 2 | |
| HIGH, MISSING BARS | | | | | | |
| STRING BAND B.O. | | 1 | 1 | 1 | 2 | |
| ARMATURE GROUNDED | | 2 | 1 | 1 | | |
| ARMATURE OVERHEATED | | | | | | |
| ARM. DEFECTIVE (OPEN-SHORTED) | 1 | | | | | |
| RESIGLASS/STEEL BAND FAILED | | | | | 2 | |
| GRD. BRUSH HOLDER | | | | | | |
| GRD. INTERPOLE | | | 3 | 2 | | |
| OPEN INTERPOLE | | | 1 | 1 | 2 | |
| GRD. FIELD | | | 1 | 1 | | |
| OPEN FIELD | | 1 | 2 | 2 | 1 | |
| DAMAGED LEADS | | 1 | | | 2 | |
| ARM. BEARINGS SEIZED | | 3 | 3 | | 1 | |
| NOISY BEARING (S) | | 1 | 6 | 8 | 1 | |
| SHAFT NUT THROUGH COVER | | | | | | |
| DEFECTIVE PE CAP | | | | | | |
| HOT SUSPENSION BEARING | 2 | 14 | 3 | 11 | 1 | |
| WORN DEFECTIVE PINION | 2 | 37 | 27 | 6 | 4 | |
| SLIPPED PINION | | 8 | 3 | 3 | 1 | |
| GM BROKEN/CRACKED ARM | | | | | 1 | |
| BROKEN/CRACKED LUG | | | | | | |
| BROKEN/LOOSE BOLTS | | | 1 | 2 | | |
| STRIPPED THREADS | | | | | | |
| FLASH RING B.O. | | | | | | |
| OIL SOAKED | | | | | | |
| OTHER | | | | | | |
| NOT DETERMINED | | | | | | |
| TOTAL FAILURES | 5 | 70 | 53 | 49 | 20 | |
| STORED/SOLD/LEASED | | | | | | |
| MILEAGE | | | | 4 | | |
| DERAILMENTS/WRECKS | 3 | 1 | 1 | | 1 | |
| FOUND GOOD | | 5 | 5 | | | |
| MOTORS IN SERVICE | | | | 2 | 189 | |
| TOTAL MOTORS | 8 | 76 | 59 | 55 | 210 | |
| CUMULATIVE TOTAL | 408 | 400 | 324 | 265 | 210 | |
| % FAILURES | 1.2 | 17.5 | 16.4 | 18.5 | 9.5 | |
| % SURVIVORS | 98.8 | 82.5 | 83.6 | 81.5 | 90.5 | |
| SURVIVORSHIP CURVE | 98.8 | 81.5 | 68.1 | 55.5 | 50.3 | |

EXHIBIT 6

NEW 752-PC6, MOTORS ON M-420 LOCOMOTIVES

| NO. OF YEARS AFTER SHOPPING | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| FLASHOVER | | | | | 1 | |
| COMM. DAMAGED | | | | | | |
| SCORED COMMUTATOR | | | 1 | 4 | 5 | |
| BRUSHES TOO SHORT | | | | | | 1 |
| COMM. OUT-OF-ROUND | | | | | | |
| HIGH. MISSING BARS | | | | 1 | | |
| STRING BAND B.O. | | | 1 | 2 | 2 | |
| ARMATURE GROUNDED | | | 1 | 2 | 4 | 6 |
| ARMATURE OVERHEATED | | | | | | |
| ARM. DEFECTIVE (OPEN-SHORTED) | | | | | | |
| RESIGLASS/STEEL BAND FAILED | | | | 1 | 3 | 1 |
| GRD. BRUSH HOLDER | | | | | | |
| GRD. INTERPOLE | | 1 | 1 | 6 | 3 | 1 |
| OPEN INTERPOLE | | | | | 5 | 9 |
| GRD. FIELD | | | 1 | 3 | | 2 |
| OPEN FIELD | | | | 1 | | |
| DAMAGED LEADS | | 1 | 2 | 1 | 7 | 1 |
| ARM. BEARINGS SEIZED | | | 1 | | | |
| NOISY BEARING (S) | | | | | | |
| SHAFT NUT THROUGH COVER | | | | | | |
| DEFECTIVE PE CAP | | | | | | |
| HOT SUSPENSION BEARING | 1 | 3 | 4 | 2 | 3 | 2 |
| WORN DEFECTIVE PINION | | | | | | |
| SLIPPED PINION | 3 | 2 | 2 | 5 | 8 | 8 |
| GM BROKEN/CRACKED ARM | | | | | | |
| BROKEN/CRACKED LUG | | | | | | |
| BROKEN/LOOSE BOLTS | | | | | | |
| STRIPPED THREADS | | | | | | |
| FLASH RING B.O. | | | | 1 | 1 | |
| OIL SOAKED | | | | 4 | 1 | |
| OTHER | | | | | 1 | |
| NOT DETERMINED | | | | | | |
| TOTAL FAILURES | 4 | 7 | 14 | 34 | 45 | 31 |
| STORED/SOLD/LEASED | | | | | | |
| MILEAGE | | | | 2 | 5 | 7 |
| DERAILMENTS/WRECKS | | | | | 2 | |
| FOUND GOOD | | | 2 | | 1 | |
| MOTORS IN SERVICE | | | | | | 52 |
| TOTAL MOTORS | 4 | 7 | 16 | 36 | 53 | 90 |
| CUMULATIVE TOTAL | 236 | 232 | 225 | 209 | 173 | 120 |
| % FAILURES | 1.7 | 3.0 | 6.2 | 16.3 | 26.0 | 25.8 |
| % SURVIVORS | 98.3 | 97.0 | 93.8 | 83.7 | 74.0 | 74.2 |
| SURVIVORSHIP CURVE | 98.3 | 95.4 | 89.4 | 74.9 | 55.4 | 41.1 |

EXHIBIT 7

NEW D-77 MOTORS ON SD-40-2 LOCOMOTIVES

| NO. OF YEARS AFTER SHOPPING | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| FLASHOVER | | | | | | |
| COMM. DAMAGED | | | | | | |
| SCORED COMMUTATOR | | | | 1 | | |
| BRUSHES TOO SHORT | | | | | | |
| COMM. OUT-OF-ROUND | | | 1 | 1 | | |
| HIGH, MISSING BARS | | | 1 | | | |
| STRING BAND B.O. | | | | 1 | | |
| ARMATURE GROUNDED | | | 2 | 3 | | |
| ARMATURE OVERHEATED | | | | | | |
| ARM. DEFECTIVE (OPEN-SHORTED) | | | | | | |
| RESIGLASS/STEEL BAND FAILED | | | | | | |
| GRD. BRUSH HOLDER | | | | | | |
| GRD. INTERPOLE | | | 1 | | 1 | |
| OPEN INTERPOLE | | | 1 | | | |
| GRD. FIELD | | | | | 1 | |
| OPEN FIELD | | 1 | | | | |
| DAMAGED LEADS | | | | | | |
| ARM. BEARINGS SEIZED | 1 | | 2 | 1 | 1 | |
| NOISY BEARING (S) | | | | | | |
| SHAFT NUT THROUGH COVER | | | | | | |
| DEFECTIVE PE CAP | | | | | | |
| HOT SUSPENSION BEARING | 1 | | 3 | | 1 | |
| WORN DEFECTIVE PINION | | 3 | | | | |
| SLIPPED PINION | | 2 | 1 | 1 | 1 | |
| GM BROKEN/CRACKED ARM | 1 | | | | | |
| BROKEN/CRACKED LUG | | | | | | |
| BROKEN/LOOSE BOLTS | | | 1 | 1 | 1 | |
| STRIPPED THREADS | | | | | | |
| FLASH RING B.O. | | | | | | |
| OIL SOAKED | | | | | | |
| OTHER | | | 1 | | | |
| NOT DETERMINED | | | | | | |
| TOTAL FAILURES | 3 | 6 | 14 | 9 | 6 | |
| STORED/SOLD/LEASED | | | | | | |
| MILEAGE | | | | 1 | 2 | |
| DERAILMENTS/WRECKS | | | 2 | 2 | | |
| FOUND GOOD | | | 2 | 2 | | |
| MOTORS IN SERVICE | | | 88 | | 181 | |
| TOTAL MOTORS | 3 | 6 | 106 | 14 | | |
| CUMULATIVE TOTAL | 318 | 315 | 309 | 203 | 189 | |
| % FAILURES | 0.9 | 1.9 | 4.5 | 4.4 | 3.2 | |
| % SURVIVORS | 99.1 | 98.1 | 95.5 | 95.6 | 96.8 | |
| SURVIVORSHIP CURVE | 99.1 | 97.2 | 92.8 | 88.6 | 85.9 | |

EXHIBIT 8

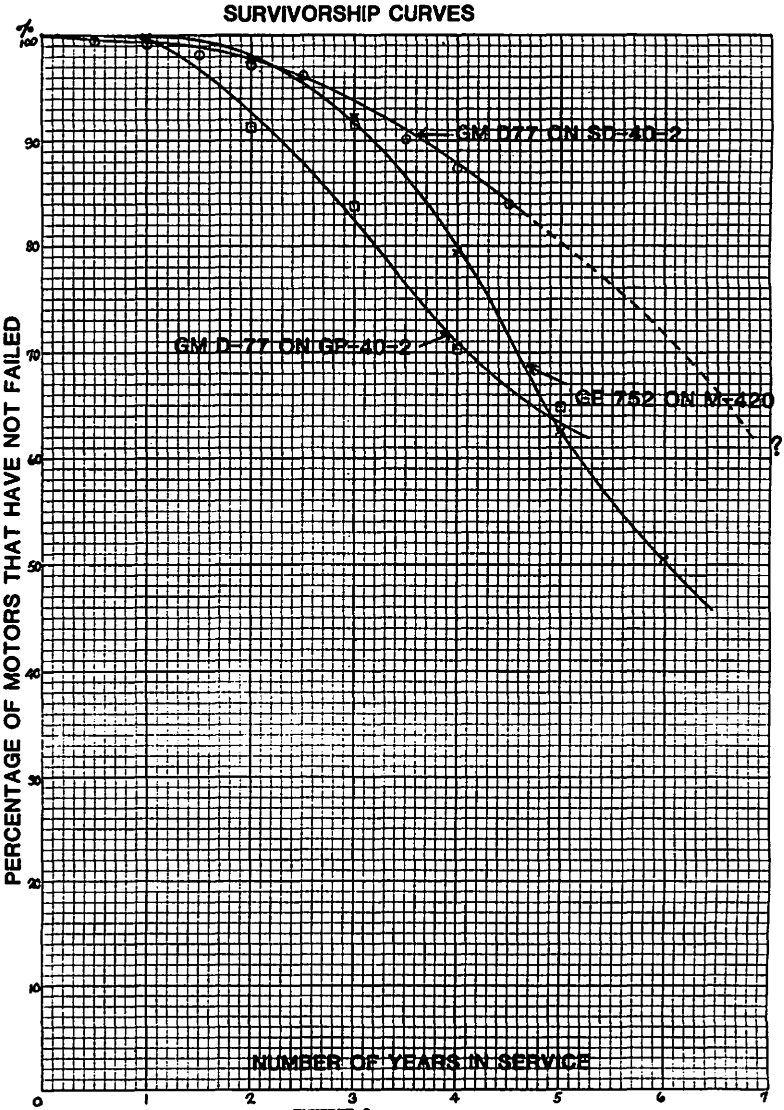
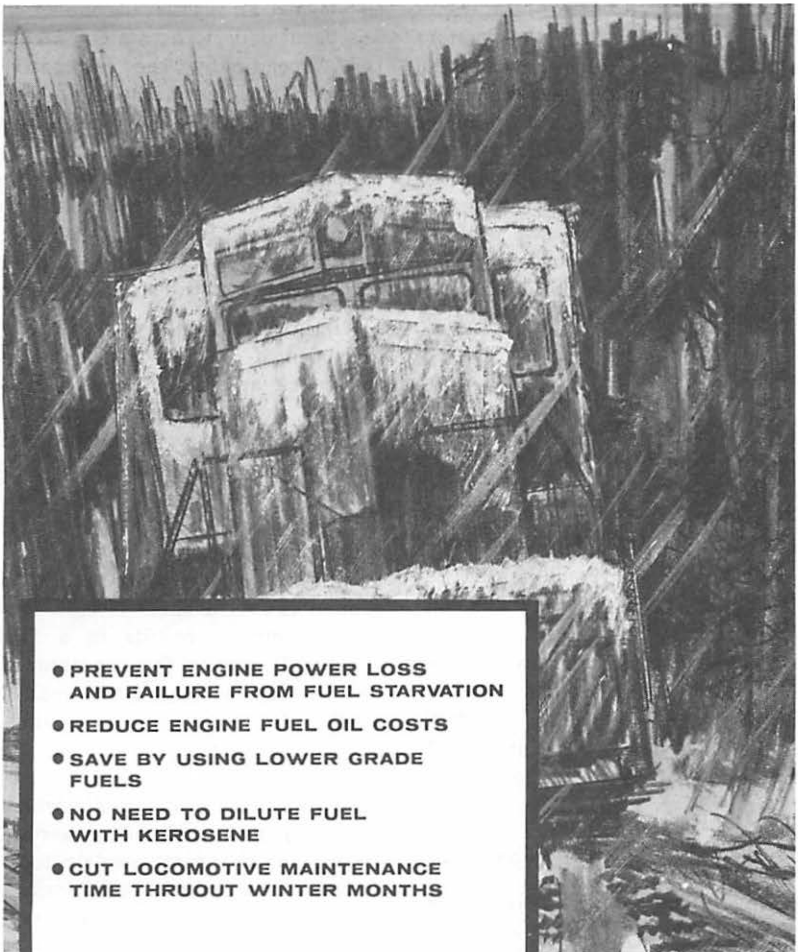

SURVIVORSHIP CURVES
%
100
90
80
70
60
50
40
30
20
10
PERCENTAGE OF MOTORS THAT HAVE NOT FAILED
GM D77 ON SD-40-2
GM D-77 ON GP-40-2
GE 752 ON M-420
?
NUMBER OF YEARS IN SERVICE
0
1
2
3
4
5
6
7

EXHIBIT 9



We note that, after four years in service, 13% of the motors under the SD-40-2's have failed, 23% of the motors under the M-420's and 45% of the motors under the GP-40-2's. What went wrong, especially with the GP-40-2 units? Exhibit Nos. 6, 7 and 8 summarize the worksheets that we used to arrive at these survivorship curves. In the case of the GP-40-2 units, we see a very high incidence of worn or defective pinions in the second and third year. This problem was traced back to leaking gear cases and lack of lubrication for the pinions and gears. Slipped pinions contributed significantly to the total failures of the GE-752 motors. As far as the SD-40-2 units are concerned, there does not appear to be any predominant type of failure.

The survivorship curves were recalculated to exclude the effect of the worn pinions on the GP-40-2's and the slipped pinions on the M-420's. They appear in Exhibit 9.

## III.

## GROUND RELAY SYSTEMS

Any discussion of electrical maintenance problems inevitably gets around to a particularly baffling case of "ground relay trouble." A better understanding of the function of this important protective device will make future developments in this area more understandable.

The term "grounded" has different meanings to different people. For this discussion, "grounded" means an electrical connection has been made to a common structure, specifically the locomotive frame. Grounded is not to be confused with "earthed" which means an electrical connection to the mother planet. A diesel-electric locomotive on track with ties and ballast in good condition is earthed by the lightning arrestors in the track circuits of the signal system!

All electrical systems are grounded, if only by the insulation resistance and distributed capacitance of the wiring and equipment. A system with no intentional ground connection has been considered to have a greater availability due to the ability to continue operation with one accidental ground. However, since a second ground causes a short circuit, and a short circuit results in a fire which will destroy the generator if not the locomotive, the so called ungrounded system has its limitations. Industrial and commercial systems have overcurrent protection which clears any faults which occur as a result of a second ground, much as an electric locomotive has a circuit breaker which disconnects the unit from the system in the event of a fault. Since diesel electric locomotives have not had overcurrent protection applied to the generator, it has been necessary to shut down the unit on the first ground fault.

"Grounded" systems can be further divided into three categories:

1. Solidly grounded systems which have no intentional im-

pedance in the ground circuit. Locomotives which operate directly from d-c or low voltage a-c catenary fall into this category. In higher voltage a-c designs, only the transformer primary is solidly grounded; the traction circuits are similar to diesel electric locomotives.

2. Reactance grounded. An impedance is inserted into the ground path to limit fault currents—applies only to a-c systems.
3. Resistance grounded. This can be further subdivided:

   Low resistance—fault current limited to approximately 400 amp. Common in distribution systems.

   High resistance—fault current limited to approximately 5 amp. Used on diesel electric locomotives. Can be set to alarm on first ground if overcurrent protection is available, otherwise must trip on first ground.

American National Standard C114.1-1973 (IEEE Std 142-1972) lists the following as reasons to use resistance grounding:

1. To reduce burning and melting effects in faulted electric equipment such as switchgear, transformers, cables, and rotating machines.
2. To reduce mechanical stresses in circuits and apparatus carrying fault currents.
3. To reduce electric-shock hazards to personnel caused by stray ground fault currents in the ground return path.
4. To reduce the arc blast or flash hazard to personnel who may have accidentally caused or who happen to be in close proximity to the ground fault.

In conjunction with item 3, the electrical connection between enclosures and ground (i.e. the locomotive frame) must be reliable to obtain this benefit. This is recognized by rule 243 of the Locomotive Inspection Law, which requires that "All unguarded non-current-carrying metal parts subject to becoming charged which are not thoroughly insulated shall be grounded."

To insure optimum control of the transient overvoltages the connection of the grounding system should be as near the midpoint of system voltage as possible. In EMD d-c generators this is accomplished by connecting the ground relay approximately 100 ohms from either generator bus. This limits nominal fault current to approximately 5 amp. On alternator-equipped locomotives, the alternator neutral provides the ideal connection point. Resistance is inserted to limit fault current.

On GE locomotives, the ground connection has traditionally been made to the negative generator bus. However, recognizing the limitations of this system, a GEMS article of 2-24-76 recommends re-

locating the ground connection to gain sensitivity to negative bus grounds. The committee heartily recommends this modification.

Alternator systems without a neutral connection can be equipped with a grounding transformer to improve ground fault detection. The transformer can be either a delta-wye connected or preferably a "zig-zag" connected autotransformer. The zig-zag transformer carries current only under fault conditions, minimizing losses but still providing protection.

To sum up, the ground relay circuit performs an extremely important function. Unlike diesel electric units, where grounds are anathema, electric locomotives require a ground for proper operation. In either case, the insulation must be maintained to achieve reliable operations. The actual trip level of the ground relay is rather arbitrary. The resistance in the circuit is selected to limit maximum current on the first ground to a safe value. Decreasing the sensitivity of the ground relay may make the locomotive more tolerant of poor maintenance or moisture, but will also increase the probability of an undetected ground resulting in a fire. Maintenance officers should never lose sight of the fact that the function of the ground relay is fire prevention. Strict use of seals, education of operating personnel, and use of automatic resets are ways to ensure that operational flashovers are detected and cleared and that the equipment is protected.

## IV.

## MODIFICATIONS

With ever-increasing diesel fuel costs and a real prospect of future shortages, it is appropriate that this Committee address itself to fuel conservation. While our prime objective is a reduction in fuel consumption, sizable operating cost reductions can be realized in almost every instance.

One area receiving attention recently has been reduction of engine RPM at idle throttle position. Both major locomotive builders offer a low idle feature on current production models. EMD now offers, and GE will soon issue, material lists and modification instructions to retrofit some older model locomotives. Studies have shown that fleet average locomotive duty cycles can consist of over 40% idle time. Based on the duty cycle of an SD 40-2 locomotive, savings of 2,800 gallons annually can be realized. A lower horsepower GP unit used as a switcher at an outlying location was found to have an idle time of 71.8% of actual calendar time; another study shows 1.2 gallons per hour savings while in low idle. Through tests and continued monitoring of working locomotives, it has been established that considerable fuel savings and cost reductions can be realized with a low idle modification. There are still questions concerning undesirable side effects of low engine RPM. Low battery charging rates, engine vibration, cold cabs, and fuel oil waxing due

to a drop in fuel preheater efficiency are problems in some localities with some locomotive models. A thermostat can be wired to nullify low idle at low temperatures. This will effectively reduce those problems aggravated by low engine RPM during low temperatures. The problem of excessive engine vibration at low idle has been alleviated by a further reduction in RPM of the affected locomotive model; however, low charging rates again become critical requiring more corrective work in this area.

For those railroads using dynamic braking, a modification of brake grid cooling systems can result in fuel savings up to 1 to 2% annually. Basically, the modification consists of changing present single speed dynamic brake cooling systems to multi-speed systems. This will require replacing or modifying the present control and a change in high voltage wiring. When modification is completed, the control will regulate dynamic brake current as before and have the additional ability to reduce engine speeds when dynamic brake and traction motor currents drop below specified levels. At higher current levels, the new control will cause the governor to increase engine speed to provide sufficient cooling air to traction motors.

Along with numerous fuel saving devices and modifications, shutdown of locomotives not needed, weather permitting, remains a most effective means of energy conservation. Damage to locomotive components when started after long periods of shutdown due to engine hydraulic lock or prolonged cranking continues to be a problem. To protect the diesel engine during cranking in the event of hydraulic lock, an engine purge control has been developed. The purge control regulates cranking speed to 25 to 30 RPM for at least one revolution. Damage from hydraulic lock will not occur at cranking speeds less than 30 RPM. To reduce starter motor speed, resistance is inserted and removed from the starting motor circuit by the EPC relay. EPC is regulated by a magsense amplifier that senses current-voltage ratio of the starting motors and operates when this ratio exceeds a value representing engine speed of more than 30 RPM. A timer is used to open the magsense amplified circuit after 6 seconds (engine will have made one revolution) to allow normal cranking speeds during the remainder of starting period. To protect electric starting motors from damage due to prolonged and/or repeated cranking, a thermal overload device has been developed. The device consists of a stainless steel bar placed in the starting motor circuit and designed to heat at a rate equal to starting motor temperature. Mounted on top of the bar is a bi-metallic switch that will trip due to heat buildup from prolonged engine cranking. Tripping of switch will cause termination of engine crank-

ing. Normal engine starting is not affected, but protection is provided against motor burn-up due to operator abuse.

## V.
## METERS

### Introduction

Continuing improvements in locomotive electrical systems have increased the need for a wide range of test equipment. No longer is a six watt test lamp adequate for locomotive troubleshooting. It is our hope that this presentation will generate an understanding of meters which could pass on a cost savings to the individual railroads.

### History

Edward Weston developed the first permanent-magnet meter shortly before 1900. Weston, a holder of 139 U. S. patents for an amazing variety of electrical, mechanical, and chemical inventions, recognized a need for accurate and thoroughly practical devices with which to measure electrical quantities. He found that this was a question of the magnetic circuit rather than the magnetic material. Weston developed the permanent magnet; he continued by placing a jeweled bearing centered above and below the concentric core in pole structure of his improved magnet system. Next, he developed alloys for nonmagnetic, low-resistance instrument springs. These springs conducted electricity to and from his instrument's moving coil and yet produced controlled torque of lasting reproductibility. He devised the manufacture of malleable aluminum from which he could make coil dampening frames and two tubular pointers.

In addition, he was the first to devise the principal of bypassing known portion of current, in what he called a shunt, in order to measure current beyond the carrying capacity of the springs and movable coils. No electrical instrument has ever been made which does not incorporate many of the basic details and principles first devised by Edward Weston.

Two modifications of this have evolved over the years. The first is the core magnet. In recent years, with the advent of improved magnetic materials, it has become feasible to design a magnetic system in which the magnet serves as a core. Such magnets operate at their highest energy product with minimum lengths, thereby making the core magnet mechanism a practical reality. These mechanisms have the obvious advantage of being relatively resistant to external magnetic fields thereby allowing for the elimination of magnetic shunting effects in a panel or the need for magnetic shielding in the form of iron cases.

A second modification concerns the mounting (pivot-jewel) arrangement. It is replaced by a suspension type mechanical system called a taut band. The heart of this system is the suspension ribbon which performs three distinct functions: (1) it provides the restoring torque for the movable element, (2) bearing support for

the movable element, and (3) electrical connections to the movable core.

The suspension ribbon replaces control springs, pivots, and jewels of the conventional instrument in performing the above functions. The taut band suspension system and indicating instruments provide three major advantages: (1) increased electrical sensitivity (2) reduction of friction in the movement and (3) improved service life.

The first real dramatic change in electrical measurement came with the introductory of the digital meter. In the relatively short time that digital multi-meters (DMM) have been available, they have attained great popularity.

They are solid state devices which means they have no moving parts. By reputation, these digital meters offer better accuracy in resolution than the analog types while also being more reliable and easier to use. These virtues are available to the buyer if he can intelligently evaluate the instrument's capabilities and match it to his needs.

## Categories of Meters

To start, let's categorize meters into purpose groups:

1. General purpose digital
2. General purpose analog
3. Special purpose analog.

Some of the examples of general purpose digital meters are Beckman Model 310, Fluke Model 8024A, and Triplett Model 3400. These are small hand held meters. An example of the specifications follows:

1. Accuracy
   1% of the reading ± one digit
2. Input Impedance
   22 Megohms
3. Ranges
   DC Volts
   AC Volts
   Resistance
   DC Current
   AC Current
4. Battery Power
   9 Volt transistor battery
5. Read Out
   LED, light emitting diode
   LCD, liquid crystal device
6. Battery Life
   LED, 200 hours
   LCD, 2,000 hours
7. Temperature
   0° to 30°C battery only
   -20° to 40°C solid state components

Some larger versions of general purpose digitals are as follows: Simpson Model 360-2, Hickok Model 3300B, Weston Model 6000. These meters are about 8 inches by 11 inches by 3 inches deep. They are, of course, portable but definitely larger and heavier than the hand held ones. Although traditionally we, as railroads, prefer bigger to small, there are no specification advantages to the larger meters. They have the same range, the same accuracy, and the same reliability.

All the digital multi-meters have a full range of options. They in-

clude the following:

1. Readout hold feature.
2. Adapter kits for:
   (a) tachometer reading
   (b) temperature readings
   (c) RF probe
   (d) current clamp
   (e) high voltage, 25 KV
3. Low battery indications
4. Audio continuity indication

Note that the LCD readout meters have about 20 times the battery life of the LED readout. This is due to the current requirements of the LED circuit. Further, the temperature specifications are due mainly to battery life and not the temperature sensitivity of the solid state components. It should be remembered that in most cases battery condition will not affect accuracy. As long as the meter is operating, it is accurate.

Some general purpose analog meters are as follows, Simpson Model 260, Triplett Model 630, Weston Model 660. This is probably the largest single class of meters used by the railroad industry. There have been many of these purchased over the years. An example of their specifications is as follows:

1. Accuracy
   2% of full scale
2. Input Impedance
   20,000 ohm per volt DC
3. Ranges
   DC Volts
   AC Volts
   Resistance
   DC Current
   AC Current
4. Battery Power
   1—9-Volt NEDA Battery
   1—1.5-Volt D Cell
5. Battery Life
   Very Long
6. Temperature
   No definite temperature specification

These general purpose meters have average accuracy, good reliability, and a more rugged case than the digitals. The only note of caution on this type of meter is those cases in which accuracy is required. If it is desired to read 74 volts on a Simpson 260, which has an accuracy of 2% full scale, the accuracy obtained is 74 volts ± 5 volts. But for other less accurate situations, these are fine meters.

### Special Purpose Analog Meters

These meters are made by many manufacturers. They are instruments that read only one scale of a quantity or a very limited number of scales of a quantity, such as d-c or a-c ammeters, voltmeters, millivoltmeters, and milliammeters. In general, they are quite accurate. They are normally used only in special applications, and are very good for these situations. They should be calibrated and cleaned on some consistent basis.

It should be noted that although these meters are fine for their purpose, in many cases the multipurpose digital meter can be substituted very nicely and still have all the above-mentioned advantages. As analog meters are re-

placed, a digital meter might be considered.

A subset of special purpose analog meters is panel meters. Again, these are made by a variety of manufacturers. They have very limited uses. Meter rooms, train control test rooms, module test and repair rooms are examples of railroad applications. The same relative advantages and disadvantages of digital versus analog apply. Points to be considered are that (a) the panels are fixed in place so little or no consideration needs to be given to ruggedness; (b) the environment is generally clean so packaging is not as important, and (c) accuracy should be a high priority.

**Analog Versus Digital**

What are the advantages and disadvantages of the digital meter versus the analog meter?

A. Advantages of the digital meter

1. Accuracy to 1% of reading ± 1 digit. This would be sufficient for locomotive shop application. For example, if one were reading 74.0 volts, the meter would be accurate to ± 1.245 volts.
2. High input impedance of 22 megohms. This means that the current used by the meter will be insignificant in comparison to the current in the circuit being measured.
3. Direct readout. There is no need for interpolation. The reading is exact.
4. With the proper holding circuit option, the reading can be locked in.
5. Compact. They come in very small sizes. Size and the multipurpose meter in general do not affect any of the other electrical characteristics. In other words, a large multimeter does not buy you better meter specifications.
4. Light weight. The new digital meters are light and in general as easy to use as a hand-held calculator.
5. Require less maintenance.

B. Disadvantages

1. Since they are powered by batteries, they are temperature dependent. The batteries can run down quickly at or below 20°C. In most cases, they will affect operation and not accuracy. As long as the meter is operating, it is accurate.
2. Integrated circuits are small by their very nature. They will not take a lot of dropping and being thrown around.
3. If not properly filtered, they can be affected by noise such as that generated by a locomotive.
4. Very cold temperatures (-20°C) will affect the solid state components.

**Summary**

The digital meter today offers the most cost effective solution to the accuracy requirements of locomotive testing. Looking ahead to the next generation of locomotive control systems, digital meters will be the only type capable of supplying the required accuracy and input impedance. Analog meters can continue to provide some measurements in power circuits, but will not work on the control systems.

# Southwestern Railway Club

**D. J. RODERIQUE**
PRESIDENT
Superintendent of Cars
Missouri Pacific Railroad Company
St. Louis, MO 63103

**G. W. LINKER**
SECRETARY-TREASURER
Supervisor of Mech. Equip. D/S
Missouri Pacific Railroad Company
St. Louis, MO 63103

Started in 1946, the Southwestern Railway Club this year is celebrating its 34th anniversary.

The organization consists of 231 Railroads and 365 Railroad Supply members who co-operate to discuss locomotive and freight car maintenance and other aspects of the Railroad Industry.

Railroad personnel and Railroad suppliers and builders are welcome members in the Southwestern Railway Club. Meetings are held three times a year at which various presentations are given — 4th Thursday of October in Ft. Worth, TX; 4th Thursday of January at Houston, TX; 4th Thursday of April at Little Rock, AR.

Application for membership should be directed to the Secretary-Treasurer, Southwestern Railway Club, P. O. Box 716, St. Louis, MO 63103.

# Wednesday, September 24, 1980

8:30 A. M.

## REPORT OF THE COMMITTEE ON SHOP EQUIPMENT

Pre-Convention Presentation: Southwestern Railway Club

May 1, 1980
Camelot Inn
Little Rock, AR

T. E. WHITTEN, Chairman
Asst. Supt. Heavy Repair Loco. Shop
Chicago, Rock Island & Pacific Railroad
Silvis, IL 61282

VICE CHAIRMAN

T. A. Kessenger, Senior Engineer Facility Planning, Louisville & Nashville Railroad, Louisville, Ky. 40232

COMMITTEE MEMBERS

| | | | |
|---|---|---|---|
| K. O. Anderson | Mgr. Mtce. Eng. & Ed. | General Electric | Erie, Pa. |
| Merrill Anderson | Shop Engineer | D. M. & I. R. | Proctor, Minn. |
| G. B. Sweeney | General Foreman | Southern Railways | Atlanta, Ga. |
| N. J. Nielson | Shop Supt. | C. M. St. P. & P. | Milwaukee, Wisc. |
| T. F. Kelly | Supt. Loco Shops | C. R. I. & P. RR | Silvis, Ill. |
| R. P. McFarland | Mgr. Industrial Engr. | SP | San Francisco, Calif. |
| P. F. Hoerath | Supt. Plant Maint. | Conrail | Altoona, Pa. |
| R. V. Propp | Shop Supt. | BN | Burlington, Iowa |
| M. G. Marler | Mech. Supt. Shops | UP | Omaha, Neb. |
| W. R. Doyle | Diesel Supervisor | Mo-Pac | Omaha, Neb. |
| L. G. Salts | Engr. Asst. | Santa Fe | Topeka, Ks. |
| J. J. Wheelihan | Supvr. Prod. Install | EMD | LaGrange, Ill. |
| J. R. Snowden | Industrial Engr. | ICG | Paducah, Ky. |

## 1980 TOPIC:

## "NEW TOOLS FOR A NEW DECADE"

## PERSONAL HISTORY

### THOMAS E. WHITTEN

Tom came into this world in Memphis, Tennessee on November 17, 1948. He attended public schools in Memphis, Tennessee and Hernando, Mississippi, graduating from Hernando High School in 1966. He entered the University of Mississippi (Ole Miss) in 1967 and was graduated in 1971 with a Bachelor of Science Degree in Mechanical Engineering. Entering the University of Mississippi graduate school in 1971, Tom acquired a Master of Science Degree in Engineering Science in 1973.

In August of 1973, Tom started his railroad career with the Illinois Central Gulf Railroad as a Facility Analyst in Chicago. He was promoted in 1974 to Coordinator Research and Planning at ICG's Paducah Shop, Paducah, Kentucky. He was progressively promoted to Supervisor of Manufacturing, Engineering and Planning Department, to Supervisor Mechanical and Industrial Engineering, to Assistant Manager Production Control and then to Manager Production Planning and Control.

In July 1979, Tom moved to the Chicago, Rock Island and Pacific Railroad in his current capacity as Assistant Superintendent Heavy Repair Locomotives Shop, Silvis, Illinois. Tom has been an active member of LMOA since 1973 and a committee member since 1974. He is an avid outdoorsman (hunting and fishing) and enjoys spectator sports (football and baseball (Old Miss) and auto racing). He is an active member of the University of Mississippi Alumni Association.

Tom was married to Pamela A. Refkofsky of Bridgeport, Connecticut on June 30, 1972. At present, they have no children.

## INTRODUCTION

We face a new decade of opportunity for the railroad industry. To take advantage of the opportunities, railroad management must be able to rely upon dependable, efficient rolling stock, maintained at reasonable costs. To accomplish the goal of good rolling stock, railroads must have modern efficient locomotive repair and service facilities. The locomotive shops must produce quality rebuilt components at increased production levels and lower rebuild costs.

The advances made in railroad technology over the last decade, were tremendous but they cannot stop here! We must, as good maintenance officers, continue to search for a better way, and easier way, a less expensive way, because if we don't, we haven't done our job properly.

The Shop Equipment Committee here presents new tools, machines and processes that will give railroad management the ability to keep the industry moving ahead. We ask you to carefully study this informative paper for an insight into the "New Tools for a New Decade." This committee presents the following:

I. Traction Motor Lines
   a. Update on traction motor shop equipment.
   b. Traction Motor Basics —Southern.
II. Fuel Saving Thru Security and Reclamation.
   a. Security
   b. Reclamation
III. Wheel Machinery, Automated for Diesel Wheels.
IV. Governor and Injector Room Fuel Savings.
V. New Developments in tooling.
VI. Locomotive Running Repair Shop.
VII. Sulzer Diesel Engine—New Tools.

## I.
## TRACTION MOTOR OVERHAUL

### A. Traction Motor Shop Equipment

The Shop Equipment Committee is always in search of new equipment to clean mechanical parts, particularly electrical rotating equipment. The Typhoon Washer by Proceco Machinery of Quebec, Canada, is an unbeatable asset to a repair and maintenance facility. The machine works on the same principal as a household dishwasher. The committee has found that users are very satisfied with this type of cleaning and the equipment used to perform it. In fact, we have seldom run across such enthusiastic approval by users in the shop.

The purpose of the Model 72-72-S-100000-C-3 (see photo 1) is to automatically prewash, wash, and rinse locomotive traction motors, locomotive generators, and alternators with three separate solutions in the same machine.

This machine uses a cleaning solution consisting of hot water with 2% to 4% detergent (Oakite STC or equivalent). The mild caustic solution does not attack the varnish coating of the windings. Owing to the mechanical action of the jets, carbon dust and road soil are easily removed. Any greasy deposits including the lubricant on the pinion are dissolved by the hot detergent solution.

Model 72-72-S-10 will accept the following work pieces per charge:

1 only completely assembled traction motor,


Photo 1

1 only traction motor frame,
6 only traction motor armatures,
1 main generator frame or alternator frame,
1 main generator armature or alternator armature.

With the fabrication of holding racks, the selection of items to be washed is unlimited, for example, traction motor brush holders, bearings, bearing covers and caps. The work is placed onto a turntable which swings out of the spray cabinet for loading by overhead crane or by lift truck. The turntable is rotated by a Eurodrive parallel gear motor via a roller chain. To facilitate loading and unloading, it can be jogged left and right. The turntable is pivoted in and out of the cabinet by hydraulic cylinder. The door, equipped with an all steel, maintenance-free, labyrinth seal, is attached to the turntable arm. Therefore, it opens as soon as the turntable swings out and closes as soon as the turntable swings in.

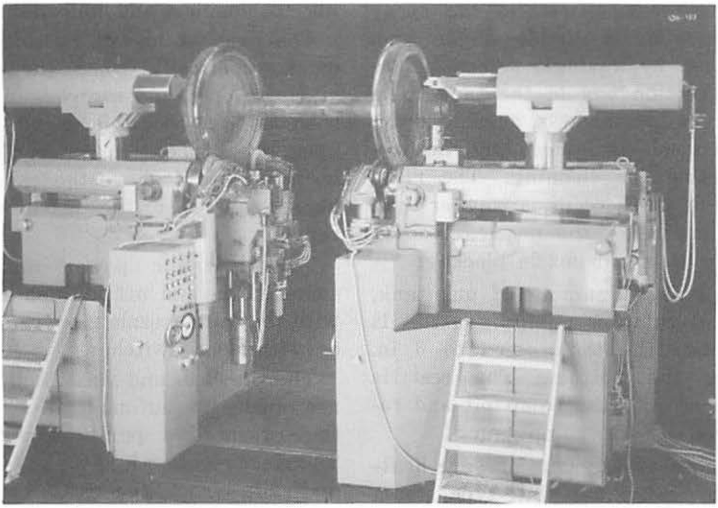
On all of the wash operations, the operator has the choice of using either the sequence: Prewash, wash, rinse, or the sequence: Wash, rinse.

The machine has three liquid circuits for prewash, wash and rinse. Each circuit has its own solution storage tank with independent heating, circulating pump, C-shape and oscillating centernozzle pipe. All three stages of the cleaning, however, take place in the same cabinet. The solutions are collected at the bottom of the cabinet and returned to the appropriate storage tank by an automatic, pneumatically controlled movable spout. The carryover from one solution to the next is minimal since the cabinet is drained completely, and tanks, piping and pumps are separate.

All pumps are Proceco vertical-process pumps. The wet end is submerged in the cleaning solution and the bearings are above the solution levels. Since it uses no contact seals but a chokering, which has no wearing surfaces, this type of pump eliminates all shaft seal problems. Each pump's discharge is connected to its respective C-shape nozzle pipe and centernozzle pipe.

There is one C-shaped nozzle pipe for each of the three circuits; upper horizontal arms spraying vertically down, lower horizontal arms spraying vertically up, and vertical arms spraying in two vertical planes. The angle between these two vertical planes is adjustable.

There is one centernozzle pipe for each of the three circuits that spray radially horizontally, radially 45° down, respectively. In addition, centernozzle pipes will oscillate vertically between adjustable limit switches allowing adjustment of stroke, as well as position of stroke relative to workpiece. The oscillation is generated by a hydraulic cylinder. The centernozzle pipes are fed via manual bail valves which, are only opened if a centernozzle pipe is used.



While circulating, the solutions are screened—first, in the spray cabinet by a double screen and, second, by a single screen before the suction box in the tank. The screens are made of durable stainless steel wire mesh and are removable for cleaning. The mesh size of the screens is smaller than the orifice of the nozzles used in order to avoid nozzle blockage.

For fast dumping of one tank, the circulation pump is used. It empties the tank down to 6 in. from the bottom. The rest is drained into the sump pit and removed by the sump pump.

The cleaning solutions are heated by individual plate-type steam coils. Each tank has its own solenoid valve to allow each stage to be operated at the required solution temperature. Each steam coil is equipped with a steam trap that empties into the tank of a condensate return pump, or into the sump pit.

**Operation**

Operation can be started in prewash, wash, or rinse and will automatically sequence operation in direction rinse. Sequence can be interrupted by pushing the "System Off" button.

If a centernozzle pipe is used, the operator opens valves to the centernozzle pipe, sets the stroke by positioning the adjustable limit switches, and pushes the centernozzle pipe push button.

Turntable drive is automatically switched with pumps. However, push button is provided for "Turntable Jog" for convenient positioning for loading and unloading.

The exhaust blower is switched on automatically when the door starts to open and switches off as soon as the door is completely open. The selector switch can also be positioned to have the exhaust blower on when the machine is running.

The hydraulic power unit is switched on and off automatically with the centernozzle pipe switches or with door switches.

The prewash and wash solutions are made up automatically from their respective pump discharge. The rinse solution is made up automatically from the fresh water supply.

The recommended procedure to conserve chemical heat and water is to:

1. Dump prewash solution only.
2. Transfer solution from wash tank into prewash tank. This is done by switching return spout into prewash tank and pumping with wash pump.
3. Transfer rinse water into wash tank. This is done by switching return spout into wash tank and pumping with rinse pump.
4. Fill up rinse tank with fresh water. Fresh water is piped to rinse tank only. To fill wash and prewash tank, solution is transferred out of rinse tank.
5. Adjust chemical concentration by adding chemical into cabinet of machine and circulating respective solution.

The purpose of the arrangement described above is to keep the rinse and wash stages as clean as possible and concentrate the soil in the prewash tank.

Answers to some of the questions concerning this equipment are:

1. The typical cycle for six armatures is 12 minutes wash, 6 minutes rinse #1, and 4 minutes rinse #2.
2. Sludge settles to the bottom of wash and rinse tanks and is removed by hand.
3. The temperature of the equipment is 180° F.
4. Average wash tank solution change is 5 days.
5. Solution is biodegradable.
6. Nozzle pressure is 70 pounds.

The washer appears able to wash anything if a rack can be designed to hold it in the chamber. However, using STC chemicals, it will not wash aluminum parts because the alkaline solution will attack the aluminum.

Washers are available to handle special items such as gear cases, bearings, etc. (See photo 2)

The water-type washer is particularly effective in cleaning electrical equipment and clearing grounds in rotating equipment when used in conjunction with a vacuum dryer.

**Vacuum Dryers**

The vacuum dryer together with the Typhoon washer is an excellent combination to return electrical equipment to service. There have been many reports of grounded traction motor armatures, frames, or complete motors that were washed and then immediately placed in a vacuum dryer. This process cleared the ground in many cases.

Vacuum chamber dryers are available in a variety of configurations including rectangular, cylindrical, vertical, and horizontal. They have either hinged, side-sliding, or vertical-lift doors or top-opening hinged covers.

Various types of heating can be provided, such as electric, steam, water, oil and high-temperature fluids. The heat is distributed via jacketed walls, internal coils, or heated platens.

The vacuum dryers are found to be faster than the oven, allowing a more complete drying cycle in a shorter time element. The Devine Vacuum Dryer presently in use in railroad traction motor shops, operates at approximately 180° F. with a vacuum of 27 inches of mercury. These dryers will dry a traction motor washed in hot water in 25 to 30 minutes.

When economics dictate the shortest possible drying time, regardless of the heat sensitivity of the products, vacuum drying is significantly faster than air drying, and uses less energy.

**Brazing Equipment**

The "Tocco" Brazing equipment was adopted for rewound armatures to achieve better quality and efficiency (O. E. M. quality).

E.M.D. armatures, pinion end coil connectors can now be brazed without repeated bending, spacing one by one the individual coil connections. Winding shorts and breaks during winding operations, and later in service, are reduced.

After the coils have been applied in the winding operation, the armature goes to the "Tocco" machine. The induction heating head operates from a high frequency (10,000 CPS), at 12 volts supply. A single rotation of the armature passes the 210 clip connections through the induction heating head. The clips that slip over the coil ends are pre-filled with brazing/flux material. An armature pinion end can be done in as little as 15 minutes brazing time, as compared to 8 hours by the old hand method. (See photo 3)

The pinion end coil connection area is drenched with water before and after the induction heat is applied, using city tap water for this cooling. The water used in cooling the induction heating heads is pre-softened in a closed and recycled 125-gallon system.

After the brazing operation, the armature goes to an oven at 325° for absolute drying and preheat for remaining operations.

**B. Traction Motor Overhaul Basics—Southern Traction Motor Inbound Inspection:**

Inspection and testing includes a visual check of the frame, nose support wear plates, pinion gear and a check of the armature axial bearing clearance. Motors are then placed on a test and receive a

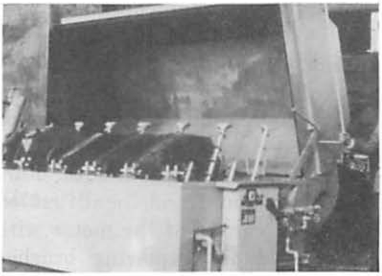


Photo 2

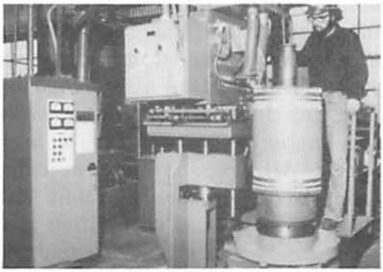


Photo 3

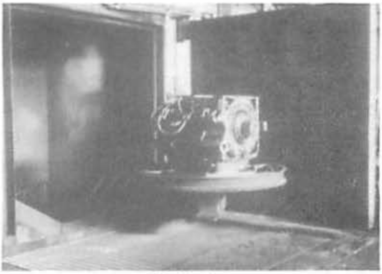


Photo 4

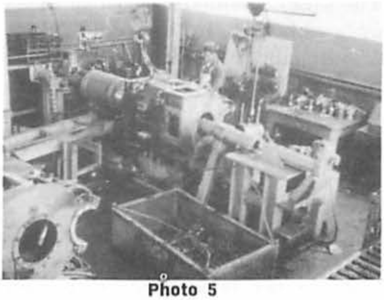


Photo 5

thorough electrical check utilizing the meg ohm and high potential testers. In order to qualify for further inspection, all leads must read a minimum of 10 megohms and must accept a 1500 volt high potential test for one minute. Further inspection and qualification includes cleaning of the motor with compressed air, replacing brushes and brush holders as required, minor repairs to leads and cleaning / smoothing the commutator surface with a polish grade honing stone. Brushes are also seated by using an Ideal Brush Seater while the motor is turned at a high speed. All traction motors including basic overhauled, unit exchanges, new, and requalified motors receive a vibration analysis prior to release for wheel/axle application. This test is accomplished using an International Research and Development Vibration Analyzer, which contains three independent channels to permit testing at three different points on the traction motor at the same time. Two channels are used to measure vibration in a radial plane, one near the commutator end and one near the pinion end. The other channel is used to measure vibration in an axial plane. Maintenance, repair and historical information is recorded on a form for input into the computer master file, on each motor released for wheel/axle application.

**Traction Motor Disassembly (Motor Basic Overhaul Line):**

Prior to disassembly the complete motor is cleaned in a high-pressure washer using hot water and a light caustic cleaner. The motor is then disassembled on a disassembly machine and all components except bearings are again washed in the high-pressure washer. All armature bearings are returned to bearing manufacturers on a condition 2/new replacement program. After cleaning, armatures and stators are placed in a drying oven for 12 hours at 320° F. to remove moisture. Frames go down one side of the rebuild line and armatures go down the other. (See photos 4 & 5)

**Traction Motor Stator (Frame) Basic:**

Stators are checked for frame condition and are electrically checked by use of a meg-ohm tester, D. C. high potential tester, and a ductor tester. An A. C. high potential tester and light set is used to pin point problem areas. Frame field coils, interpole coils, baffles, leads, brush holders, connecting lugs, etc., are replaced as required. Stator field coils are subjected to 1,100 amps current for 30 min. to further test condition and to heat the frame prior to a varnish dip. After the varnish dip, the frame is baked for 5 hours at 145° C.

**Traction Motor Armature Basic:**

Traction motor armatures are electrically checked with a meg-ohm tester and an automatic bar to bar ductor tester. Commutators are closely inspected for overall diameter, high or loose bars, banding and insulation condition. Arma-

tures not qualified for continued service are unit exchanged for new or rewound armatures. Qualified armatures are vacuum impregnated with varnish and oven cured. Further processing of the armature includes turning the commutator, qualifying the shaft in accordance with O.E.M. recommendation, balancing and undercutting the commutator mica. After all processing is complete, the armature receives a surge test using a 7 bar span at 2800 volts.

**Traction Motor Assembly:**

Traction motors are reassembled on a horizontal assembly machine similar to the disassembly machine. Prior to assembly, armature bearings are fitted to the armatures with the recommended quantity and type of lubricant (Shell Cyprina). Assembly of the armature into the stator includes measurements of bearing clearances, run out, axial clearances, etc. This information is recorded and retained in the motor history file. After assembly, brushes are applied, brush holders adjusted, covers applied and the pinion gear is installed on the shaft.

**Traction Motor Test:**

Assembled motors are given a two-hour test run beginning at 500 rpm and increased to 1500 rpm. During test run, various checks are made and recorded, including bearing temperatures each 1/2 hour, brush seating, noise and vibration, etc. After completion of the test run, motors are transported to the inbound inspection room for a vibration analyzation before final release for wheel/axle application.

## II.

## FUEL SAVING THRU SECURITY & RECLAMATION

**A. Security.**

This report focuses on fuel oil receiving facilities and inventory control within the Railroad Industry.

Fuel oil is input into the locomotive by one of two methods:

1. Directly from delivery vehicle, or
2. Directly from storage.

Fuel oil can be input into storage in various ways:

1. Transport truck unloading,
2. Tank car unloading,
3. Pipe line,
4. Barge,
5. Tanker (boat).

Fuel issued directly from storage and transport truck unloading will be considered in this report.

In order to properly account for fuel oil consumption, an accurate type of measuring system must be employed.

Major fuel oil distributors use in-line fuel meters to monitor fuel sales. A counter and ticket printer unit is usually attached to the meter to show actual fuel output from the terminal. After the transport truck receives fuel at the terminal, a fuel ticket is printed showing amount of fuel loaded in net units and/or gross units (usually gallons for railroad use). The net units are obtained by correcting for temperature and volume of fuel.

The American Petroluem Institute (API) standard for universal measurement is 60° API. Therefore, net gallons reflects the volume of fuel at 60°. This fact is extremely important if proper fuel accountability is to be maintained.

A unique type of fuel control system is being incorporated by one railroad. It includes the following:

1. Fuel receiving facility,
2. Fuel storing facility,
3. Fuel-issues facility.

The first component of the fuel control system — Fuel Receiving Facility — consists of the following:

A pump skid (approximately 5 feet square) and separate meter skid (approximately 2 feet wide and 7 feet long) are installed at the inbound fuel receiving area. The skids are mounted on a concrete apron approximately 6 feet wide and 14 feet long) adjacent to truck unloading spill pad (approximately 16 feet wide and 40 feet long). The spill pad includes a central drain, allowing for recapturing the fuel for removal at a local pollution abatement plant.

The two skids are installed side by side and interconnected with a flexible metal hose. The main reason for independent skids is to isolate the vibrating effects of the pump unit from metering equipment.

Diesel fuel oil is unloaded from transport trucks at a rate of 300 GPM. Once the carrier operator makes the transport-to-skid connection, a manually operated valve (combination input and check valve) must be opened to permit fluid flow into the receiving system. Once this valve is opened and the pump motor starter button is depressed, fuel will enter the system and pass through a basket-type strainer, then into and out of a positive displacement pump. The pump is powered by a direct drive motor unit. After leaving the pump, the fuel enters a bulk plant air eliminator tank.

The air eliminator tank is the first component on the metering skid. It is basically a reservoir onto which two float valves are attached. The purpose of this reservoir is to decrease the velocity of the flowing stream and bring the liquid to a state of relative calm so that air bubbles or vapor will rise and be exhausted through a vent. A water detection probe is attached to the air eliminator tank. An internal probe will monitor the conductance of incoming fuel for 0-10% water content. Should water be detected, the pump meter is shut down and a remote alarm sounded. Upon leaving the air eliminator tank, fluid will continue until a control or "blocking valve" is reached. This blocking valve will not allow fluid passage until a "go-ahead" signal is received from the air eliminator float valve.

When the fuel level in the air eliminator tank raises the first float (mounted on the eliminator tank sidewall), a signal is transmitted to the blocking valve. The blocking valve reacts to this signal and opens to allow fluid passage to the fuel meter. A second float valve is mounted atop the eliminator tank. When the fluid level reaches the upper float, the float will rise and cause the vent line to close.

Once fuel leaves the blocking valve it then enters the fluid metering unit. This unit will monitor fluid flowing by means of a positive displacement rotating rotor arrangement. This rotating motion will translate through a gear reduction and be displayed on a counter register and ticket printer device.

The counter mechanism is mounted on the meter and reflects total gallons through the meter. This unit has an 8-digit accumulative totalizer display and is non-resettable.

The ticket printer device is mounted directly to the counter. It consists of a 5-digit visual register (resets with each load) and a 7-digit printer which is accumulative. This device is mechanical and is manually operated by turning a crank. The 7-digit printer reading is stamped onto the meter ticket before and after each fuel delivery. A load counter, location code, and identifier are also incorporated into the printer. The load counter counts each load separately, and stamps this information on the ticket, along with the location code and identifier. The meter ticket consists of one original, plus two detachable copies, complete with carbon blanks (one copy is detachable and kept by the carrier).

A meter proving loop is also included in the piping system. This loop consists of two lock-type butterfly valves and one isolation valve. Fuel is essentially removed from the system at the output side of the meter, sent through an external master meter or proving tank, and returned to the system. The meter is calibrated within .1% or .5 gallons per 500 gallons.

After the fuel is metering at the receiving point, it continues its flow to storage. The storage tank includes a condensate drain for periodic water removal, an accurate float gage (Moorman type), and remote readout (Scully type) for fuel level determination and security checks. Also, a temperature readout is attached for correcting fuel volumes to 60°.

The fuel issue point also includes a fuel meter, temperature compensator and counter/printer unit. A meter unit is installed at each issue point. The temperature compensator includes a 60° lockout for gross fuel checking purposes. The compensator temperature bulb is installed upstream of the fuel meter. The incoming product temperature is monitored, and the correction for temperatures other than 60° is transmitted through a bellows and gear train system inside the compensator, thereby re-

flecting net fuel issues at the counter.

Since each location — inbound, storage and outbound — is corrected to 60°, an accurate perpetual inventory can be maintained. The results of inventory level is simply:

Receipts minus Issues = Inventory.

It should be noted that a water detection device and security seals are installed on the inbound receiving facility. The rising costs of diesel fuel has made the theft of fuel oil a threat. It is necessary to continually monitor fuel deliveries, security seals, lock valves, etc., to prevent unnecessary fuel losses.

**B. Reclamation**

In view of ever increasing energy costs and the present world oil crisis, railroads are taking significant steps to conserve and efficiently utilize all types of petroleum products in all facets of their operations.

One significant step taken by some railroads to conserve fuel is through the reclamation and utilization of waste oil as a part of their energy requirements whenever possible.

Sources, quantity and quality of waste oil varies somewhat with each railroad. Some of the typical sources are:

1. Fuel and lube oil spillage which occurs at refueling and lube oil dispensing facilities.
2. Oil spillage, oil and grease generated from parts cleaning, and oil and grease washed from service area floors at locomotive maintenance facilities.
3. Oil and grease removed from locomotives at laundry facilities.

When discussing fuel spillage it is very important to note that many railroads are taking positive action to minimize fuel and oil spillage. Eliminating all fuel and oil spillage is the ultimate, but no matter how carefully the operation is carried out, some spillage does occur.

One railroad is recovering waste oil throughout its system using various methods and utilizing the oil as a supplemental steam boiler fuel at a centrally located power house on its system.

To recover the fuel spillage which does occur at its fueling stations, the railroad has installed under the track collection pans that are sloped to drain through a pipeline to gravity oil-water separator tanks. The collection pans have been designed to cover the minimum area practical in order to reduce storm water runoff.

The oily water is retained in the separator tank and gravity separation of the oil and water allows the oil to be skimmed or pumped from the waste water surface. The waste oil is pumped from the separator tanks to waste oil loading stations and into railroad tank cars.

The waste oil is shipped to the centrally located facility where the quality of the oil is analyzed. If found suitable for boiler burner fuel, it is unloaded into a 100,000 gallon boiler burner fuel supply tank and is blended with new fuel oil.

No pretreatment of the waste oil, prior to blending with the new fuel oil is required, except filtration for removal of any solids. If the waste oil contains an excessive amount of soilds, it is filtered twice prior to blending with the new oil, but most of the waste oil only requires one filtering process.

If the quality of the waste oil is not suitable for boiler fuel, it is sold to oil reclamation companies.

Waste oil is shipped to this facility from as many as 74 different locations on the system. Some of the oil is also reclaimed from pollution treatment ponds.

They have reclaimed approximately 700,000 gallons of waste oil during 1979. Approximately 372,000 gallons were suitable to be used as boiler fuel, and 328,000 gallons were unsuitable and sold. The 372,000 gallons of waste oil constituted about 12% of the total fuel oil consumption at the power house.

**New Defueling and Purging Facility**

In addition to its waste oil reclamation facilities throughout its system, that railroad recently completed construction of a new locomotive defueling and fuel tank purging facility. As one of its long term commitments to pollution control, the primary function of the facility is to prevent soil contamination that could occur during the process. But the system also will supply the railroad with an additional benefit, another source of usable waste oil. It is located at the same facility as is the power house that utilizes the system-generated reclaimed waste oil.

**General Construction**

The facility consists basically of a concrete pad, defueling pump system, steam supply lines, drainage/access pits, an oil/water separating tank and a salvaged oil loading station. It is conveniently located adjacent to the shop building where the subsequent initial repair operations are performed.

The pad is constructed of reinforced concrete 52 ft. wide x 46 ft. 6 in. long in between and around two shop yard tracks. Built into the pad is one 4 ft. wide x 3 feet 2 in. deep x 41 ft. long main pit running 90° to and under both tracks. A cross pit 3 ft. 9 in. wide x 3 ft. 2 in. deep x 12 feet 8 in. long is constructed parallel to and between the rails of each track and interconnected with the main pit. Removable steel hand rails and tread cast iron manhole steps are installed at each end of the main pit for easy access to the pit. The pits are illuminated by three steel wire guarded lamp fixtures. The floor of the pits are sloped to drain wastes to one end of each of the smaller cross pits which contains 6 in. drains. The pad is also sloped to drain into the pits. All pits are covered with removable or hinged heavy steel grating for safety reasons.

The oily wastes and storm water runoff are drained from the pits through a 6 in. pipe to an underground 11,500 gallon capacity steel salvaged oil tank, which is a gravity oil-water separator tank. The separator tank is a typically designed oil-water separator that functions by taking advantage of the difference in specific gravity of oils and greases versus water, thus allowing the lighter oily material to float on the surface of the waste water. The tank is piped to the shop industrial waste water system which handles the water discharged from the tank. Extending from inside the tank and directly above it (above ground level) is a suction pipe with a valve and fittings to receive an auxiliary mobile pump to remove the waste oil from the tank.

Located adjacent to the above ground level end of the tank suction pipe and extending above ground level is the receiving end of the pipe system, which runs underground to a salvaged oil loading station. The waste oil is transferred from the separator tank via a portable auxiliary gasoline powered pump which is connected to the suction line from the tank and to the receiving end of the salvaged oil loading station pipe line.

The salvaged oil loading station is a typically designed fuel loading column with a swivel boom that can be easily positioned over a railroad tank car for convenient loading of the salvaged oil.

The steam, which is used for purging the fuel tanks, is generated at the powerhouse and is carried in overhead steam lines to shut-off valves at a centrally located area on the pad. Two 1½ in. steam hoses with locomotive fuel tank fittings are piped to the valves.

The defuel pumping system is installed on the pad and consists of a spring return hose reel containing 45 ft. of 1½ in. hose which is piped to a 70 GPM capacity air-operated pump. The pump discharge is connected to an underground piping system that is connected directly to the 100,000 gallon fuel storage tank, which supplies boiler fuel to the powerhouse.

**Operating Procedures**

The locomotives are positioned on the pad so that the complete fuel tank is located over the pad and as much of the pit area as possible.

It is possible to defuel the locomotive fuel tanks from various places on the tank or locomotive depending on the type and design. Two readily accessible places are the fuel tank filler line and the emergency fuel shut-off valve. If the fuel tank filler line is used, the filter is removed and the defueling hose is inserted into the filler line as far into the tank as possible. If the emergency fuel shut-off valve is used, the defueling hose is fitted with standard pipe fittings and attached to the valve after the fuel line has been disconnected from the discharge side of the valve. The defueling pump is turned on, and the fuel is pumped from the tank through the pipeline directly to the 100,000 gallon tank.

The defueling time will vary depending on the amount of fuel oil in the tank and the viscosity of the oil which will be affected by the outside temperature at the time of pumping. The capacity of the pump varies from 70-GPM to 25 GPM depending on viscosity of the oil.

When the flow of fuel has ceased, the pump is turned off and the defuel hose is removed or disconnected from the tank. It is important to note that regardless of how the tank is defueled, a small amount of fuel oil will always remain in the tank. Naturally, more fuel will remain in the tank when the fuel is removed through the filler line.

The drain plug or plugs are then removed from the fuel tank, and the remaining fuel is drained into the pits.

Before a locomotive enters the shops for remanufacture or certain extensive repairs, safety standards require that all fuel is removed and the fuel tank is purged with steam for 72 hours.

The steam hose is attached to the fuel tank filler line, and the steaming process begins. During the steam purging process, the fuel oil residue from the tank is emulsified with the water created by the condensation of steam and is drained into the pit and through the drain piping system to the oil-water separating tank.. After the steam purging process is complete, the locomotive can be moved into the shop.

The facility has the capacity to defuel one locomotive and purge one locomotive fuel tank simultaneously, or purge two locomotive fuel tanks simultaneously.

The total volume of oily waste and water existing in the separating tank is monitored regularly by an environmental engineer. As stated previously, the difference in specific gravity of oil and water allows the oily waste to float to the surface of the water and when the total liquid reaches a predetermined level in the tank, the waste water flows into the industrial waste water system. This process continues until the majority of the fluid contained in the tank is oily waste and the environmental engineer determines that the oil is to be removed. The constant monitoring of the oil and water contents in the tank insures that the oil is removed at the proper time, thus preventing the discharge of concentrated oily waste into the industrial waste water system.

The waste oil is removed from the separator tank by connecting the mobile pump to the suction line and to the salvaged oil loading station piping system. The salvaged oil is then loaded into a railroad tank car.

The reclaimed oil is analyzed after it has been pumped into the tank car and if it is satisfactory for use as boiler fuel, the car is moved to the 100,000 gallon tank unloading station. As explained previously, the salvaged oil is filtered prior to blending with the new fuel oil. If the waste oil is unsuitable for boiler fuel it is sold to an oil reclamation company.

The railroad has been utilizing the fuel oil reclaimed from the initial defueling of the locomotive fuel tanks for a few years prior to the installation of the new facility, but the oil-water separator is an additional source of reclaimed usable fuel oil. This facility is another step taken thus adding to the benefits already realized through the program of fuel savings through reclamation.

## III.

## WHEEL MACHINERY, AUTOMATED FOR DIESEL WHEELS

Automated machinery is available for many of the handling, cleaning, mounting, demounting, and machining operations required in the repair of diesel wheel sets.

Wheel boring is usually done on a boring mill or on a vertical turret lathe (VTL). The machine can be controlled manually or by one of the following controls: relay logic, programmable controllers, numerical control (NC), computer numerical control (CNC), or computer.

The direct labor involved with wheel machining can vary from 2.2 man hours per wheel on a manually operated machine to .2 man hours per wheel on a computer numerical control machine with an automated wheel handling system interfaced with the CNC.

When a railroad is considering upgrading its wheel machining system, a computer-controlled machine should be evaluated. Also, the use of an automatic wheel handling conveyor system should be considered.

The boring mill should be equipped with an automatic chip guard, chuck orientation and adjustable chuck jaws. On a boring mill with a side arm, a four-sided turret is advantageous, especially if angles and radiuses are to be generated by the computer (linear and circular interpolation).

Radius-type tooling can also be used. Radius-type tooling greatly simplifies the control system of the machine. The boring mill should be finished with a chip conveyor. Coolant is another item to be considered, flooded or mist.

The boring bar can be controlled by the computer with the operator entering the bore data by a keyboard. The bore size can be stored in internal memory. If a large number of wheels are machined, an automatic measuring station might be justified. The measuring station determines the axle wheel seat size and feeds this informa-

tion directly to the computer, thereby controlling the finished wheel bore size. Interference fit information is usually entered separately. Wheel bore data can be entered in either absolute (actual wheel seat diameter) or incremental (difference from the last size) mode. Anti backlash compensation should be built into the control system.

The feed system would be computer controlled and would have a servo drive coupled to a ball screw and nut. The feedback as to position would be furnished by a rotary encoder or a linear encoder. The rotary encoder would be mounted on the servo drive motor.

The computer system would consist of a central processing unit, memory analog and digital input/output facilities. A CRT and keyboard with printer can be furnished for program loading, editing and system maintenance. Program information can be stored and entered by one of the following systems: paper tape, magnetic tape, flexible disk (floppy disk), or manually by a keyboard.

The different wheel machinery configurations can be stored in Read Only Memory (ROM) or Random Access Memory (RAM). Any one of the programs can be selected by the operator at the console with a selector switch. Additional programs may be developed and stored on a tape or disk.

The program should also provide for the use of standard qualified cutting tools, and also a method for the machine to return to the last block of machining if a tool fails and is replaced during machining.

The following is a list of wheel boring machine manufacturers:

| Manufacturer & Location | Type of Mach. |
|---|---|
| Farrel, Rochester, N.Y. | Boring Mill |
| Hegenscheidt, Troy, Mich. | VTL |
| Gidding & Lewis, Fond DuLac, Wisc. | VTL |
| Bullard, Bridgeport, Ct. | VTL |
| Simmons-Niles Albany, N.Y. | Boring Mill/Side Arm |
| G. A. Gray, Cincinnati, Ohio | VTL |
| Snyder Corp., Detroit, Mich. | Boring Mill |

Simmons manufactures a device called a Double-End Destacking and Inverting Wheel Manipulator, which incorporates a destacker for destacking multi-level stored wheels; a wheel loading arm to handle wheels from the input conveyor to the machine; and a wheel inverting device to turn wheels from flange up to flange down. The double-ended device is advantageous since it has the ability to handle two wheels, which greatly reduces the load and unload cycle time. The loader and machine cycle is usually arranged so that one complete cycle provides two finished wheels. This arrangement is best suited to do the flange side up and flange side down machining.

The following is a description of one railroad's diesel wheel repair facilities:

**Shipping, Receiving, Cleaning**

The wheel shop is located within the complex of a central shop. Traction motor/wheel assemblies are received in the stripping building in specially equipped gondolas. Using a pendant-controlled overhead crane, each assembly is set onto a wagon. The wheel assembly is removed from the motor and is transported automatically via a small rail cart to the wheel pair cleaning room. Wheel assemblies are handled through a Proceco high-pressure water cleaner equipped with a timer that permits variation of cleaning cycle timing as desired. After completion of the automatic cleaning cycle, the assembly is transported to the inspection station in the wheel shop by a second rail cart.

**Inspection**

Inspection includes ultrasonic testing of the axle for possible cracks or flaws, gaging of the wheels and axle gear, and a visual inspection of the inner journal bearing races. The ultrasonic tester presently used is a Kraut Kramer Model USM-2 coupled to a special Kraut Kramer Locomotive Axle Probe containing one straight and two angle crystals. The probe is rotated 360° to inspect the wheel and gear seat areas with the angle crystals. Cracks are pinpointed on the scope. By using cutout switches provided on the probe, the inspector can determine which crystal is indicating the defect and therefore the location of the defect. After inspection, wheel assemblies with reusable wheels and gears are moved to a track leading to the wheel truing lathe. Assemblies with scrap wheels and/or gears are placed on tracks leading to the demount press.

**Wheel Demounting**

At the demount press, scrap wheels are removed from the axle, placed in an elevator and raised to overhead gravity-feed conveyors that move the wheels out of the shop and into a scrap wheel gondola.

**Axle Qualification**

Axle qualification includes magnaglow inspection of axle and gear, inspection of bearing surfaces, and machining of wheel, gear and bearing surfaces in an axle lathe as required. Machined bearing surfaces are burnish rolled. Axle/gear assemblies qualified for return to service are placed on a storage axle rack until wheels are machined for application.

**Re-Profiling**

Wheels with wear metal remaining are reprofiled in a Niles 52 inch tracer-equipped tread lathe. While in the tread lathe, axles are inspected for run-out or bent conditon, and a general inspection is made of the assembly. After reprofiling, wheel assemblies are transported to the final inspection track.

**Wheel Boring and Machining**

New wheels are received stacked horizontally in gondolas and are placed on a stub track outside the wheel shop. Wheels are removed from the cars and are placed into three overhead storage conveyors having a total capacity of 60 wheels (40-inch diameter). A Hegenscheidt Computer Numerical Conrtol (CNC) Vertical Turret Lathe is used for wheel boring/

machining. All wheel handling equipment is interfaced with the CNC to provide a fully automatic system. The sequence of operation is as follows:

At start up, the elevator/turnover unit travels up to one of three overhead storage racks, picks up a wheel, travels downward and places it on the supply table.

The double-arm loader picks up the wheel and places it onto the boring table. (See photo 6)

The CNC is programmed with four separate programs, one for each side of a pair of wheels.

The functions of these programs are as follows:

Program One:
Bore, hub machine, and burnish roll suspension bearing flange surface of first wheel (wheel flange up).

Program Two:
Bore and hub machine second wheel (wheel flange up).

Program Three:
Machine second side of first wheel (wheel flange down).

Program Four:
Machine second side of second wheel (wheel flange down).

Photo 6

As program one is being accomplished, the elevator supplies the second wheel to the supply table. When program one is complete, the double arm loader places wheel number one onto the supply table and wheel number two onto the boring table. While program two is being accomplished, wheel number one is turned over in the combination elevator/turnover device and is returned flange down to the supply table. After completion of program two, the loader places wheel number one onto the boring table (flange down) and wheel number two onto the supply table for turnover. When program three is complete, the loader places wheel number one (completely machined) onto the discharge table and wheel number two (flange down) onto the boring table. While program four is being accomplished, wheel mounting compound is automatically applied to the bore of wheel number one at the discharge table. After application of the mounting compound, wheel number one is pushed into a wheel transport cart. Also during this time, the elevator selects another wheel from the storage conveyors. After completion of program four, the loader places wheel number two onto the discharge table and places a new wheel onto the boring table. The cycle beginning with program one then is repeated.

Although the above sequence is fully automatic, the system is designed for manual (push button) operation if desired. The operator's console includes all switches and push buttons necessary for manual control and a decade switch which allows the operator to change bore size of a wheel simply by dialing in bore size desired to an accuracy of .0001 inch. The General Automation Computer is equipped with a CRT screen which indicates the tool position offsets continually throughout the operation. A keyboard for making minor program changes such as hub thickness and diameter is also provided. Dial switches are provided to accomplish feed and speed changes. Complete program changes for different wheel sizes and machining requirements can be accomplished by use of a master program tape.

For ease of maintenance the CNC System is equipped with electronic fault detection. If a malfunction occurs with the machine or interfaced handling equipment, a digital code number is displayed on the operator's console. By cross referencing this number with a fault indication chart, the location and probable cause of a malfunction is pinpointed.

This system is capable of forty plus complete EMD type wheels in one eight hour shift (.2 man hours per wheel); however, with normal maintenance and retooling, the average is thirty-six wheels per eight hours (.22 man hours per wheel).

**Wheel Mounting**

Interfaced with the boring machine CNC, the discharge table is equipped with a wheel mounting compound applicator brush. After a wheel bore has had mounting compound applied, the wheel is pushed horizontally into a wheel transport cart. The cart transports the wheel to the correct position, tilts it to the vertical position and releases it into a mounting press wheel supply chute. Axles are placed onto the mounting press axle supply rack, which automatically centers the axle, applies wheel mounting compound to wheel seats and sequences axles into the press as directed by the press operator's console. Wheels are also sequenced into mounting position as directed by push button control on the operator's console. A swing-down gage block mounted on the top press tension bar provides for correct positioning of each wheel on the axle. (See photos 7 & 8)

Time involved in mounting a pair of wheels averages four minutes (.066 man hours) per pair. The three-hundred-ton single cylinder mounting press, gage block and axle-handling rack were designed and built for this railroad by the Farrel Company. Wheel chutes, wheel escapements, wheel cart, discharge table, and wheel mounting compound applicator were designed and built in the railroad's shop.

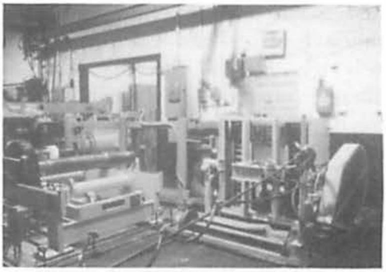


Photo 7

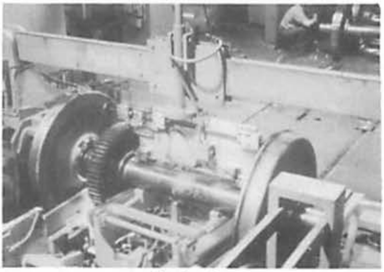


Photo 8

### Inner Race, Water Guard Application and Final Inspection

Wheel sets are discharged from the mounting press onto rails which transport them to the final inspection station. At this location, roller bearing inner races and water guards are applied, and the assembly receives a final inspection. Wheel assemblies released from the re-profiling lathe also receive a magnaglow inspection at this station. To facilitate this final inspection, an underfloor, foot-operated wheel assmbly rotator (shop built) is used to rotate the assembly in place while it is inspected. After inspection is completed, wheel pairs are placed on one of six storage racks from which they are selected for application to a qualified traction motor.

### Other Equipment

The following equipment also is located in the wheel shop:

—A gap lathe for machining, burnish rolling and magnaglowing axles with friction journals.

—A shop-built handling device and press for axles with all purpose (AP) bearings (used on GE Locomotives).

—A Betts manually operated boring mill used as a back-up for the Hegenscheidt Machine.

## IV.
## GOVERNOR & INJECTOR ROOM FUEL SAVINGS

Most railroads have central repair shops for their Diesel Locomotive Governor and Injection Equipment. More than ever, these repair facilities are vital to the efficient operation of diesel locomotives. Due to the cost and shortage of fuel, plus the strict enforcement of air pollution laws, fuel injection maintenance is of prime importance today.

Properly operating fuel injection equipment promotes fuel savings, improved engine performance and reduced air pollution. It also reduces engine maintenance and loss of engine components due to improper fuel injection operation.

Most railroads have central repair and test facilities for injection and governor work. Some of the more special work might be performed by outside vendors, i.e. nozzle valves, barrel and plunger reconditioning. The items usually repaired and tested by railroads are pumps, nozzle holders (4 cycle), injectors (2 cycle) and governors. The workflow can usually be divided up into the following categories: Incoming storage, pre-inspection, disassembly, cleaning, pretest, assembly and final inspection test—calibration, then to finished storage and shipping.

Adequate incoming storage should be provided, and the parts should be arranged according to type. Some shops must gear their production toward immediate needs owing to limited pool stock. Some items need to be worked as soon as received. If items are stored and classified by type, production also can be batched for a more efficient operation. Some railroads have shipping containers arranged so that a complete set of pumps and nozzles or injectors from a particular engine can be kept together for further evaluation after being pretested by injection room personnel.

The disassembly area is best kept separate from assembly, owing to the cleanliness required during assembly. It is also advantageous to climate-control (fixed temperature—air conditioning) the assembly area and not the disassesmbly and cleaning area. The cleaning equipment usually produces a considerable amount of heat. The work can be batched using the same personnel for both disassembly and assembly, in two different areas.

Special benches equipped with specific fixturing for each component should be provided for disassembly. Automatic cleaning should be considered, because of the variety, of different parts, dirts and required cleaning techniques. Since fuel injection equipment is so easily damaged during cleaning (by incorrect chemical washing and wire brushing of orifices), and is also very costly, the assurance of proper cleaning requires automatic operation.

Special types of cleaning equipment must be provided for injector equipment owing to the varied cleaning required. Some items are aluminum, some steel with coatings, and some items require rust to be removed. One railroad has found that most of the items cleaned will fall into four basic processes:

1. Ferrous wash, water rinse, remove rust, water rinse, rust preventative — 77 min.
2. Non-Ferrous wash and water rinse — 38 min.
3. Ferrous wash, water rinse, rust preventative — 40 min.
4. Solvent wash — 30 min.

Here are specific items and their related wash process:

| Item | Process |
|---|---|
| Governors | 1 and 2 |
| Pumps | 1 and 3 |
| Nozzles | 1 |
| Injectors | 4 |

Special pallets were designed to specifically hold items of a given process. The pallets have a mast that identifies them to the control system of the cleaning equipment, and how it is to be processed. Top loading washing machines were designed to provide one stage for each of the various washing processes. The six washers used are —steel, aluminum, rinse, rust remover, rust preventative and solvent. Each washer has its own time cycle. A special transfer device was designed to handle the pallets from the incoming conveyor washers and out-going conveyor. A computer routes the pallets through the washers according to their own particular process.

Each process has been assigned a priority number according to complexity and total length of cycle. Washing chemicals are heated if required. The water rinse tank is automatically dumped, rinsed, and recharged each night. The heaters are on seven day clocks. The heaters are turned off each night and turned on two hours before the work shift is started. Each washer has an elapsed timer for preventative maintenance scheduling. (See photos 9, 10, 11 & 12)

When the pallet has completed the washing cycle, it is put on a conveyor through an automatic roll-up door into the climate controlled assembly and calibrating room. Once conveyorized into the room, the pallets are taken manually, using a cart, to their respective assembly bench. There is a specially designed bench for each type of injection equipment—pump, nozzle, injector, governor, nozzle valves and electrical. Injector and nozzle holders have the valve and tips removed during disassembly. These items are cleaned in a small hot tank with special carbon removing chemicals. The valves are taken to a nozzle Multi-

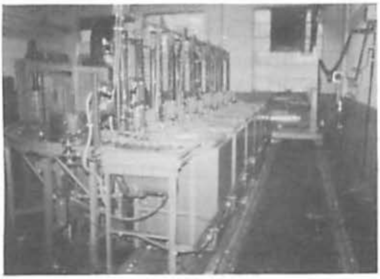


Photo 9

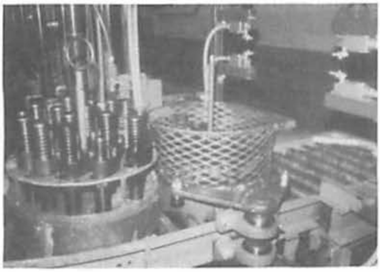


Photo 10

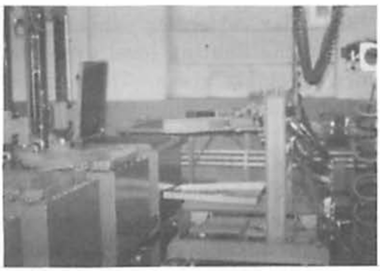


Photo 11

Photo 12

clean* and are double-flushed with oil and air. The needles are ground on a nozzle reconditioner*. The body's seat is ground on an Injectomatic One*. Again the valves are cleaned on the Multiclean. The seat can be visually checked on a nozzle viewer* (or Otoscope) and the needle lift can be checked on a lift gage*. The orifices of the nozzle should be checked on an air flow gage against a master nozzle. The Multiclean can also be used to check the flow pattern of each nozzle. Both the flow pattern and the air flow test are vital to engine performance and fuel usage. All lapped surfaces should be checked for flatness using a monochromatic light and optical flat. A lapping machine should be provided for repair lapping of parts.

After the nozzle holders are assembled, they should be pop-tested and leak tested. The injectors should also be pop-tested and leak tested. The injectors are then checked on a calibrating machine for proper fuel flow.

An exhaust and drain system should be installed at each location where pop-testing is being performed. A bowl can be designed with a drain for capture of the spent calibrating oil and also a suction air take-off can be provided to capture the small mist and fumes of the calibrating oil. The drains can be piped to a central collective point. The suction take-off (hoods) can be ducted to a central fan and be exhausted outside the building. The exhaust and

* Leslie Hartridge Ltd.

Photo 13

drain system will help to hold the fuel oil smell to a minimum acceptable limit.

Injectors are also flow tested and calibrated. The flow calibrating machine must have masters for their own calibration. These master nozzles and pumps should be kept in a safe place and protected from damage. (See photo 13)

After assembly, the injector pumps must be calibrated. The rack should be checked for freedom of movement.

A separate calibrating room is recommended since these operations involve a considerable amount of noise. The room can be tested for sound attenuation.

Governors can be precleaned in a solvent spray cleaning booth and be pretested prior to disassembly. In some cases, a governor that has had limited service might need only adjustment on the governor test stand. A crane can be provided for movement of the governor into the test stand. Usually the test stand and the assembly bench should be kept together since some time is spent "warming up" governors prior to testing. One man can assemble a governor while another governor is being run on the test stand.

It is very important that ample repair parts are on hand at the assembly area so that no time is wasted during the assembly process. The parts should be stored in individual compartments according to type so that the minimum and maximum levels of stock can be maintained.

Particular attention should be given to the lighting level over the bench assembly areas. The correct number and placement of lights will help maintain an adequate light level. It should be over 150 f. c. for inspection of parts. Also, a large number of windows will take advantage of available sun light. The windows can be

Photo 14

treated with special film to reduce the sun's heating effect during summer. The ceiling should be the suspended type with a good grade of sound absorbing material to reduce the noise level of the various machines, i.e., governor test stand, grinders and pop-testers. (See photo 14)

Finished storage is also an important area so that an ample supply of repaired injection equipment can be maintained for the diesel shops when the stores departments are not manned.

## V.
## NEW DEVELOPMENTS IN TOOLING

A. **From Manufacturers**
   1. Tame Inc. (Tools and Maintenance Equipment Co., Inc.)
      a. Model 70 hydraulic ratchet wrench (traction motors).

**Wrench Description**

1. The Model 70 wrench assembly is a hydraulic ratchet wrench, equipped with a torque reaction arm for use on EMD and GE traction motor support cap bolts. In operation, the torque arm sleeve is positioned around the bolt head adjacent to the bolt being removed or installed. Although the Model 70 wrench is designed primarily as a torque wrench, it can be used to remove TM cap bolts if necessary. The socket may be inserted into ratchet gear opening from either side, and the words "LOOSEN" and "TIGHTEN" are stencilled on OPPOSITE sides of wrench body control box. To reverse the wrench rotation, remove the socket and knurled handle from the drive gear and reinstall from the opposite side of wrench. Also remove lock pin and torque arm handle, reinstall on opposite side of wrench.
2. To tighten and torque TM cap bolts, position wrench onto bolt head with "TIGHTEN" side UP (or facing you, if underneath locomotive). To remove bolts, position wrench onto bolt head with "LOOSEN" side UP.
3. Operation of wrench is controlled by 2 push buttons located in wrench body control box. The words "TIGHTEN" and "LOOSEN" are stenciled on the wrench main frames adjacent to the push buttons. Either push button will start pump motor and wrench operation. When "LOOSEN" button is pressed, motor will start and wrench will ratchet continuously until push button is released. Wrench torque output will be limited only by an adjustable mechanical pressure regulator located in top of hydraulic pump oil reservoir. Regulator is preset at 5500 PSI, which should be sufficient pressure to remove cap screws torqued up to approximately 1500 foot lb. Pressure may be adjusted as required up to 7500 PSI. However, use of lowest pressure consistent with bolt breakaway torque requirements

will aid in keeping hose and hydraulic pump maintenance to a minimum.

4. When "TIGHTEN" push button is pressed, pump motor starter relay is energized through contacts of normally closed pressure switch. In operation, as wrench begins to tighten a bolt, hydraulic pressure will increase as torque required to tighten bolt increases. When bolt torque requirements and hydraulic pressure reach a given point, the pressure switch opens, de-energizes motor starter relay and stops pump. If push button is held closed, pump motor will cycle on and off until push button is released. Pressure switch has been pre-set to open at 4200 PSI, or 1100 ft. lb. This pressure may be adjusted as required up to 5500 PSI by a set screw located inside of switch body.

   Due to slight variations in pressure gauge calibrations, wrench torque output should be confirmed by tightening a traction motor support cap bolt with this tool and checking torque obtained with reliable torque wrench. Readjust pressure switch if necessary to obtain the desired torque output.

5. Model 70-DP wrenches are equipped with TWO pressure control switches and a 2-position toggle switch to select desired torque range. Toggle switch is located on top of motor starter relay box and is labeled "HI-TORQUE" and "LO-TORQUE." When wrench is operated with toggle switch in "HI-TORQUE" position, sequence of operation is as described in Paragraph 4 and top mounted pressure switch (set at 4200 PSI) is in series with motor starter relay coil. When wrench is operated with toggle switch in "LO-TORQUE" position, sequence is the same with the exception that motor starter relay coil is in series with bottom mounted pressure switch, which has been pre-set to open at 2250 PSI, or approximately 600 ft. lb. Pressure adjustment is made with set screw located inside of switch body. (These switches may be readjusted and relabeled EMD motors and GE motors if desired.)

   CAUTION: When adjusting pressures of wrenches with DUAL PRESSURE CONTROLS, low pressure switch must be adjusted first.

**Electrical Requirements**

1. The wrench is powered by a hydraulic pump equipped with a 1⅛ HP, 115 volt, single phase, 60 cycle electric motor. It is recommended that the electrical supply circuit have a capacity of 30 amperes. Also, for safety, a three wire GROUNDED receptable should be used. (240 or 480 volt systems available on request.)

**Wrench Operation**

1. To observe wrench operation, connect power cord to electrical

supply and start motor, using either of the two push buttons. Allow wrench to ratchet for a minute or so and check pump and hose connections for leaks. Operator should observe rotation of ratchet gear and become familiar with location of "LOOSEN" and "TIGHTEN" push buttons.

NOTE: Wrench may be operated by use of either push button. However, for **Automatic control of wrench torque output,** the "TIGHTEN" push button MUST be used during tightening and torquing operation.

2. The hydraulic wrench power cylinder is single acting, with a 1/2 inch stroke. Piston is spring loaded for return. Cylinder reciprocating movement is governed by a solenoid-controlled two-way valve, #70-135, located on hydraulic pump reservoir. Oil from hydraulic pump flows to two-way valve. If solenoid is energized, oil flows to wrench hydraulic cylinder. Two-way valve solenoid is controlled by cylinder stroke limit switch, #70-26, located inside of wrench body control box. This switch is a "maintain contact" type and is normally closed when power cylinder piston and ratchet pawl are fully retracted. When pump motor is started with either of two push buttons, two-way valve solenoid will be energized through the "normally closed" cylinder stroke limit switch. Oil will flow through two-way valve to wrench power cylinder, extending piston and ratchet pawl, thus rotating ratchet gear and socket. This movement will continue approximately 1/2 inch until cylinder stroke limit switch is actuated, opening switch. This action de-energizes two-way valve solenoid, bypassing oil back to reservoir and allows spring-loaded piston and ratchet pawl to return to normal position. This movement closes cylinder stroke limit switch and restarts released and/or hydraulic pump. Pressure switch is actuated as outlined in Paragraph 4 under "Wrench Description."

**Torquing of EMD Traction Motor Support Cap Bolts**

1. Position wrench with "TIGHTEN" side UP. Install socket into ratchet gear from opposite side of wrench. Swing Torque Arm to the LEFT or RIGHT of the socket end of wrench, depending on which support cap bolt is to be torqued. Place Torque Arm Sleeve over the bolt head adjacent to the bolt to be torqued. Place wrench and socket onto bolt to be torqued and rotate socket with knurled handle to align with hex of bolt head. After socket and torque arm are securely in place on both bolt heads, press push buttons marked "TIGHTEN" When the "TIGHTEN" push button is used, the hydraulic pump pressure switch

will stop the pump motor when the selected torque output has been reached. Operator should keep wrench in position on bolt, hold push button closed and allow pump motor to start and stop 3 to 4 times to insure that no further movement of bolt can be obtained.

Remove wrench from bolt, swing torque arm to opposite side of socket and reinstall on adjacent bolt. (CAUTION: If after pressure switch stops pump motor, the torque arm and socket are tight on the bolts and cannot be removed easily, JOG the "LOOSEN" push button momentarily, and allow socket to move approximately 1/4 inch. This should relieve the torque arm so that wrench may be removed from bolts easily. (On Model 70-DP wrenches, position torque selector switch #70-104 to LO-TORQUE position before starting pump motor. After all bolts on the traction motor support cap have been tightened in LO-TORQUE position, move torque selector switch to HIGH-TORQUE position and repeat tightening operation.) (CAUTION: In operation, wrench body will move sideways against TORQUE ARM with considerable force. Operator should make use of wrench handles to position and operate wrench.

KEEP HANDS CLEAR OF SOCKET AND TORQUE ARM SLEEVE AT ALL TIMES.)

**Removal of Traction Motor Support Cap Bolts**

2. To remove traction support cap bolts, position wrench with "LOOSEN" side up. Install socket into drive gear from opposite side of wrench. Position wrench and torque arm on bolt heads as outlined in Paragraph 1 of "Torquing of EMD traction motor support cap bolts." Press "LOOSEN" push button and allow wrench to loosen bolt one to two turns, or until bolt is loose enough to be removed by hand. Leave bolt in place to absorb wrench torque when loosening adjacent bolt. When "LOOSEN" push button is used the wrench torque output is limited only by the pressure regulator, part #70-127 located in top of reservoir cover plate. This pressure regulator has been preset to limit the hydraulic pressure to approximately 5500 PSI, which should be sufficient pressure to remove bolts torqued up to about 1500 ft. lb. Pressure may be adjusted up to 7500 PSI. However, it is recommended that bolts requiring more than 1500 ft. lb. of torque to loosen be removed with air impact wrenches.

**II.**

**TESCO (Transportation Equipment Supply Co.)**

A. Compression Testers used in engine sets for GE, EMD & ALCO 251 engines.

T13681 Compression Testers for GE

T50210 Compression Testers for EMD

T50021 Compression Testers for ALCO 251

These Compression Testers are equipped with quick release adapters, that can be installed on the engine in sets (8, 12, 16 and 20). The engine is then rolled over via the batteries to blow debris clear. The bodies of the Compression Testers are now engaged on the adapters. The engine is rolled over again for approximately 10 seconds thus giving each assembly a few firing strokes. Engine must not be allowed to fire. The Compression Tester traps the peak reading. Normally, cylinders recording 250 PSI are candidates for removal. Each railway has its exact limits and procedures, but in general the the above describes the operation. We believe these Compression Testers will eventually eliminate borescroping and blow-by testing on GE engines. The EMD application is catching on rapidly. One additional way these are used on GE and ALCO engines is when engines are pulled in with oil out the stack, a compression test is given. If all readings are good, the turbo is changed.

Experience to date proves that cylinder changeouts on GE and ALCO engines can be reduced significantly and that they are quicker and more accurate than a blow-by test on EMD's.

B. T50301 Tool Carts for GE Power Assembly and Turbo Changeouts.

This cart was designed to house all the tools required for a power assembly and turbocharger changeout as determined by the GE instruction book and railway maintenance instructions. When this cart is fully equipped, it is wheeled up to an engine, and there is no excuse for shortcut maintenance. The key to its success is supervision—making sure it is utilized.

**T50301 Tool Cart**
**For GE Engines**
MAJOR FEATURES:

- —Free running ball bearing wheels—2 fixed, 2 swivel
- —Fork lift pick-up on all 4 sides
- —Mounted air manifold to power 3 air tools
- —Bracket to mount regulator—Oiler cage
- —Snap action cart brake
- —Provision for all the tools required for a power assembly and turbocharger changeout. (See photos 15 & 16)

## VI.

## TOOLING A MODERN LOCOMOTIVE SHOP

Owing to the increase in unit coal trains, Burlington Northern was faced with the need of a locomotive and car facility capable of handling repairs for the equipment necessary to move possibly 150 trains per day. (See photo 17)

The facility was built at Alliance, Nebraska, located to accommodate trains from Wyoming's Powder River Basin to the east through Lincoln, Nebraska, and to

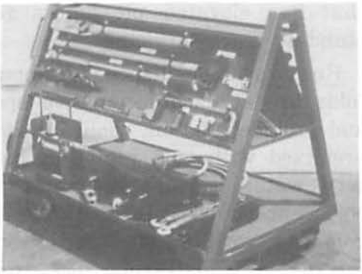


Photo 15

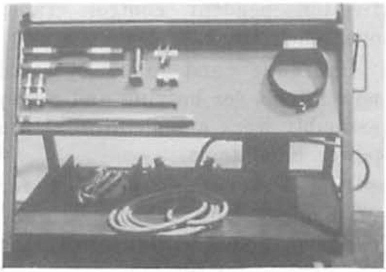


Photo 16

the south through Denver, Colorado.

With a 156' x 265' four track one spot car shop, 150' x 500' material store section, 191' x 324' light heavy four run through track locomotive facility, a five track 183' x 324' light repair with an adjacent 32' x 177' wheel truing facility, 92' x 176' five track start-up section, and a two track eight locomotive service facility, it has the capability to maintain 650 locomotives.

Support facilities include: a bulk storage facility under the unloading dock; heating plant that is coal fired with oil fired stand-by boilers; wheel storage tracks with ten-ton overhead crane; oil control laboratory; and waste water treatment plant. (See photo 18)

The locomotive repair section is a well planned layout with the utmost in tooling.

The service facility has lube oil and cooling water hose reel dispensers at each locomotive spot in heated huts that provide storage for all other locomotive supplies. Fuel tanks are filled from hose reels with automatic shutoff.

Sanding is done from overhead stationary storage tanks with gravity flow hoses over each locomotive spot. Sand is delivered from hopper cars to the overhead tank with IMCO machines. An auxiliary tower on an adjacent track services switch engines. The facility is controlled from a tower office overlooking the service tracks that has necessary communications equipment and supervision. A small office for the pit foremen is on the service platform. (See photo 19)

Below the tower office is an Oil Control laboratory with spectograph and water test equipment.

The locomotive light repair section has five tracks with ramps and pits that hold four locomotives each. The work platforms have sectional steel ramps hinged for lift-up so side doors below deck of locomotive can be opened. Sectional guard rails that hinge like gates line the platforms on the locomotive side for safety Work platforms are wide enough to permit a forklift to be driven up the slope ramp and turned around safely on the platform, and to service the below ramp area

Photo 17

Photo 18

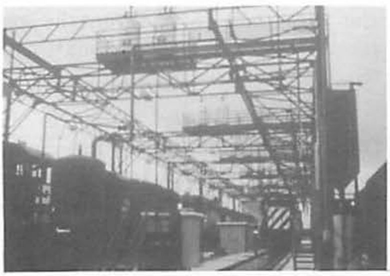


Photo 19

Photo 20

that has elevated pit tracks for stand-up truck servicing.

Hose reels or dispensing manifolds are at each locomotive spot and provide lube oil, cooling water premixed with rust inhibitor, battery water, rinse water (hot or cold), premixed detergent for locomotive washing and for cleaning the work platforms, also a reel with cutting torch, two overhead five-ton pendent control cranes over each track.

Hydraulic and air operated power tools for bearing and power assembly work are plentiful as are power hand tools.

Tool lockers are provided for mechanics' individual tools, and each is supplied with a set of hand tools suited for his job.

Three of the tracks are served by a single wheel drop table that conveys a wheel and motor assembly through a tunnel to the truck repair section in the light-heavy section.

The light-heavy section is a four track level floor operation with a 125-ton full truck or single wheel drop table, a truck repair section, wheel and traction motor assembly area, and a metal fabrication welding and accident repair area. (See photo 20)

One double hook 35- and 10-ton, four ten-ton, and three two-ton jibcranes provide the lifting in this section.

A vat room with two large hot vats and smaller cleaning equipment is served with a ten-ton overhead crane.

The overhead cranes in this area are combination pendent or radio control. The light-heavy section has a tool room well stocked with power tools and special equipment.

A combination governor test room and electric shop tooled with a Woodward test stand and modern digital readout electric test equipment is adjacent to the tool room.

The General Foreman's office is on a balcony overlooking this shop.

The wheel truing bay is equipped with a Hegenscheidt Model 106 machine that does not require the use of wheel centers. (See photo 21)

A conveyor moves metal shavings through the wall and into a scrap car outside the building.

A cable winch at floor level moves the locomotive to spot on wheel machine.

The five track start-up section has deck height work platforms with all locomotive supplies on hose reels in heated huts, built-in battery chargers, a hydro-vac that cleans cabs and puts the rubbish in hoppers for disposal. Forklifts can drive up on work platforms with room to turn around. (See photos 22 & 23)

The work platforms have a roof over the area between locomotive stalls and infra-red heaters for the comfort of workmen below.

A load test track with four load test grids is adjacent to the start-up section.

A heavy-duty trackmobile moves locomotives in and out of the main shop and no locomotive engine is ever allowed to run in shop.

Photo 21

Photo 22

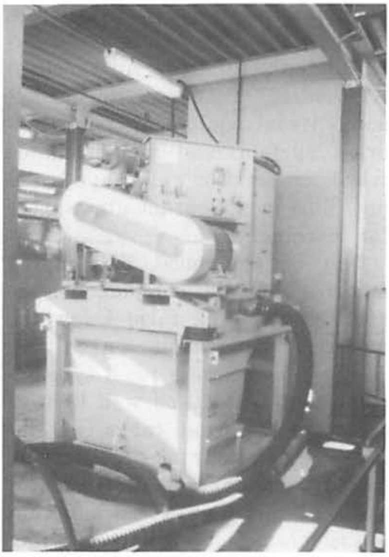


Photo 23

A mobile power manlift capable of reaching the ceiling is provided for maintenance of cranes and lighting.

A truck pedestal milling machine, lathe, press brake, shear, press, radial drill, and modern welding equipment complete the tooling in the shop.

To enter the shop complex, it is necessary to pass the security building and enter a tunnel to the center of the complex where an elevator or stairway leads up to the shop level or the offices three levels above.

The tunnel also serves as a conduit from the power plant and steam water and air piping is routed to the main shop.

Theft of tools is kept to a minimum with this type of access.

On the upper level, Mechanical and Material Department Offices, lunch and locker rooms are colorful and well lighted. An excellent Apprentice Training Room has audio visual equipment, public address system, and wall mounted television sets for vidio tape training films in a pleasant atmosphere for learning.

One of the most outstanding features of the complex is the underground tank farm below the material department unloading dock. In a concrete vault-type installation, heated and well lighted, are several storage tanks containing lube oil, journal box, support bearing, and car oil. Also radiator water premixed with rust inhibitor, detergents for locomotive cleaning and floor cleaner premixed, and all are pumped to the work areas of the shop.

Battery water and reclaimed cooling water are piped from the power plant to the shop complex.

Alliance Maintenance Facility is a modern well tooled plant.

## VII.
## SULZER ENGINE SPECIALIZED TOOLS

The basic principle of threaded fastener system is to stretch studs* by turning a nut without exceeding their elastic limit. The studs attempt to return to their original length, and this forces the two mating surfaces together and holds them tight. The most common method used in the railroad industry is to to turn a nut on the stud using box wrenches, socket wrenches, and impact wrenches. The nuts are then tightened to a particular load using various types of torque wrenches. The geometry of the threads causes the stud to stretch until the desired holding force is achieved.

* NOTE: For the purpose of this paper, whenever the word stud is used, the word bolt could be substituted in its place.

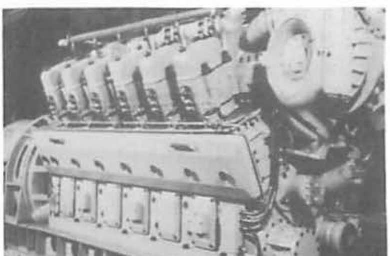


Photo 24

In order to obtain the desired load, it is necessary to measure the force (torque) required to turn the nut. This method is generally satisfactory if conditions are carefully controlled. However, it has a disadvantage of having to work against a considerable amount of friction. The torque, measured by a torque wrench, includes the force required to:

(1) Stretch the bolt,
(2) overcome the friction between the mating threads, and
(3) overcome the friction between the nut being turned and the part it bears against.

In addition, the magnitude of friction is a function of the materials involved, the surface condition of each part involved, and any lubricants which may be present.

All of these factors are taken into consideration when determining how much torque will be required to produce the required load in the stud. Each of these factors must be controlled with reasonable care during the application of the nut to ensure the proper stud stretch is obtained. Otherwise, the result is a fastening system which may not be tight enough.

The stud must be sized to withstand both torsional and tensile stress resulting from the tightening process. Torsional shear is a major cause for stud failure resulting from over-torquing nuts in the fastening system. Also, deformation and improper seating is a result of over-torqued nuts.

The fastening system used on the Sulzer engine overcomes the problem associated with the torquing of nuts on studs. The bolt is stretched hydraulically so the nut can be threaded into place by hand. Once the nut is seated against the part to be held, the external force on the stud is released and the load will be held by the nut. The function of friction at this point is to prevent the nut from turning once the load has been applied to the fastening system. The result is a stud loaded in tension with minimal torsional stress rather than high stresses in both directions.

The most innovative parts of the specialized tools used on the Sulzer engine are those pertaining to the removal and application of main bearing caps, connecting rod bearing caps, and cylinder heads. The hydraulic jacks used to remove and apply these parts take advantage of a principal in fluid mechanics to increase the stud load accuracy during the application, and increase the speed and efficiency in which these components can be changed.

The principle of fluid mechanics is that the pressure in a closed hydraulic system under static conditions with no fluid flowing is the same throughout the system except for the unavoidable variation due to elevation differences. Since the critical parts of the system in this case are at nearly the same elevation, pressure variations from this source are insignificant.

Therefore, because all of the studs on the cylinder head, main bearing cap, or connecting rod cap are loaded simultaneously by the same pressure, the force on each is equal. Therefore, it is possible to stretch the bolts using hydraulic pressure until the required force is reached and then thread the nuts down by hand until they are seated. When the hydraulic pressure is released, the nuts will keep the bolts stretched to retain their holding force.

The basic process for use of hydraulic jacks on the Sulzer engine starts by placing the hydraulic jack over the stud and connecting it to the stud by a screw-on sleeve. The sleeve is threaded on until it bottoms-out the hydraulic piston. This firmly holds the hydraulic jack against the pushing surface. Then hydraulic fluid is pumped into the cylinder. This forces the piston away from the bottom of the cylinder. Since the screw-on sleeve rests against the top of the piston, they move as the piston moves. This stretches the stud and pulls the round stud nut away from the bearing surface. At this point the round stud nut can be backed off either by hand or by a 10mm diameter bar that is approximately 6¼ inches long. The pressure on the hydraulic jack is released, and the screw-on sleeve is backed off to remove the hydraulic jacks. The round stud nut can then be removed by hand.

The remainder of this paper describes the three hydraulic tools used to remove the main bearing caps, connecting rod bearing caps, and cylinder heads.

### Main Bearing Caps

Before the main bearing caps can be removed, the two horizontal bolts which join the engine frame and bearing cap have to be removed. The two hydraulic jacks shown in figure 25 are applied to the main bearing cap studs by turning the screw-on sleeve into place. The hydraulic lines to the two jacks are connected to the hydraulic pump. The hydraulic pump can be either manually operated or electronically operated. The pressure of the hydraulic jacks is raised to 685 bars (9935 psi).* The round stud nut is backed-off a few turns by using a 10mm diameter pin and the jack pressure is released through the unloading screw on the pump. The hydraulic jacks are then removed by unscrewing the screw-on sleeves. The round stud nuts can then be turned off by hand and the main bearing cap can be lowered.

* NOTE: The Sulzer Service Instruction Manual specifies pressure in terms of bars. A bar is equal to 14.5030 psi. For the purpose of this paper, both bar and psi figures will be shown.

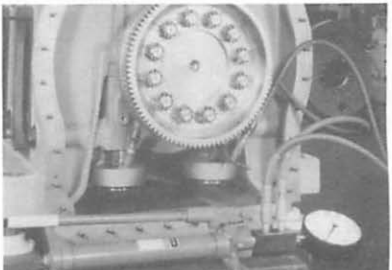


Photo 25

The top main bearing is removed by placing a tool in the journal oil hole, and when the crankshaft is turned, the upper main bearing is pushed out. The top main bearing is installed in the same manner to push it into place. The main bearing pushing tool can be removed from the journal oil hole by using a grip screw.

Once the main bearings have been replaced, the bearing cap is raised into place and the round nuts are threaded up to the bearing surface. The two hydraulic jacks are threaded into place using the screw-on sleeve. A pressure of 675 bars (9790 psi) is applied to the jacks and the round stud nuts are tightened with the 10mm bar until they are snugly seated on the bearing cap. The pressure on the jacks is released and the jacks removed.

### Connecting Rod Bearing Caps

To remove the connecting rod bearing caps, it is necessary to support the piston by attaching a holding device through the fuel injector hole.

Two hydraulic jacks, as shown in figure 26, are applied to the connecting rod bearing cap studs by turning the screw-on sleeves until the jacks are secured to the connecting rod cap. A pressure of 560 bars (8122 psi) is applied to the jacks to stretch the connecting rod cap studs. The round stud nuts are backed-off one turn using the 10mm diameter bar. The pressure is released, and the screw-on sleeves are turned off the connecting rod bearing cap studs to remove the hydraulic jacks.

To ease the removal of the connecting rod bearing cap, it is desireable to remove the connecting rod bearing cap studs. This can be easily done with any Allen wrench, and the studs can be turned out by hand. However, it is not absolutely necessary to remove the connecting rod bearing cap studs, but it is more convenient to do so.

Once the top and bottom bearings have been applied to the crankshaft, they are aligned using a fitting gauge which automatically aligns the two bearings laterally. Then the cap is applied and the studs are screwed into place and tightened with an Allen wrench. The round stud nuts are run up to the distance bushings. The hydraulic jacks are applied and the pressure is raised to 185 bars (2683 psi), and the round stud nuts are tightened with the 10mm bar. The pressure is then raised to 550 bars (7977 psi), and the round stud nuts are tightened 1/8 of a turn with the 10mm bar. The pressure is released and the hydraulic jacks are removed.

It is not necessary to remove and apply the hydraulic lines when the jacks are being applied or removed from the main bearing cap studs or connecting rod bearing cap studs. The hydraulic lines do not interefere with the application and removal of the screw-on sleeves.

### Cylinder Head

Before the cylinder head can be removed, the cooling water outlet, air intake, exhaust outlet, and fuel line must be disconnected. The piston is brought to the ignition top dead center so the air inlet and exhaust outlet valves are fully closed before the cylinder head is removed. The cylinder head removal and tightening device (see figure 27) is placed over the four cylinder head studs and lowered until the stop pins contact the upper longitudinal edge of the cylinder head. The four screw-on sleeves are threaded onto the cylinder head studs until the top of each hydraulic piston is flush with its respective stop ring. The hydraulic pump is actuated until a pressure of 685 bars (9935 psi) is achieved. The four round stud nuts are backed-off using a 10mm diameter bar. The pressure on the hydraulic pump is released and the cylinder head removal and tightening device is moved. The four round stud nuts are turned off by hand, and the cylinder head can be removed.

To reapply the cylinder head, the piston must again be in the ignition top dead center position. The cylinder head is lowered into place until it comes to rest on the cylinder liner. The cylinder head removal and tightening device is placed over the cylinder head and lowered until the stop pins contact the upper longitudinal edge of the cylinder head. The four screw-on sleeves are threaded on the cylinder head studs until the top of each

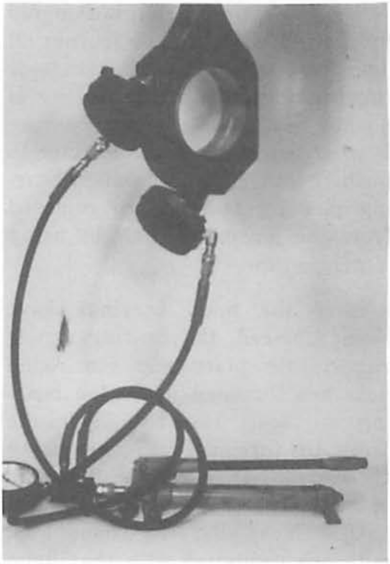


Photo 26

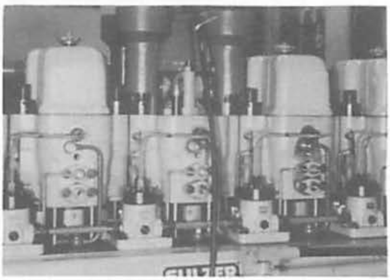


Photo 27

Photo 28

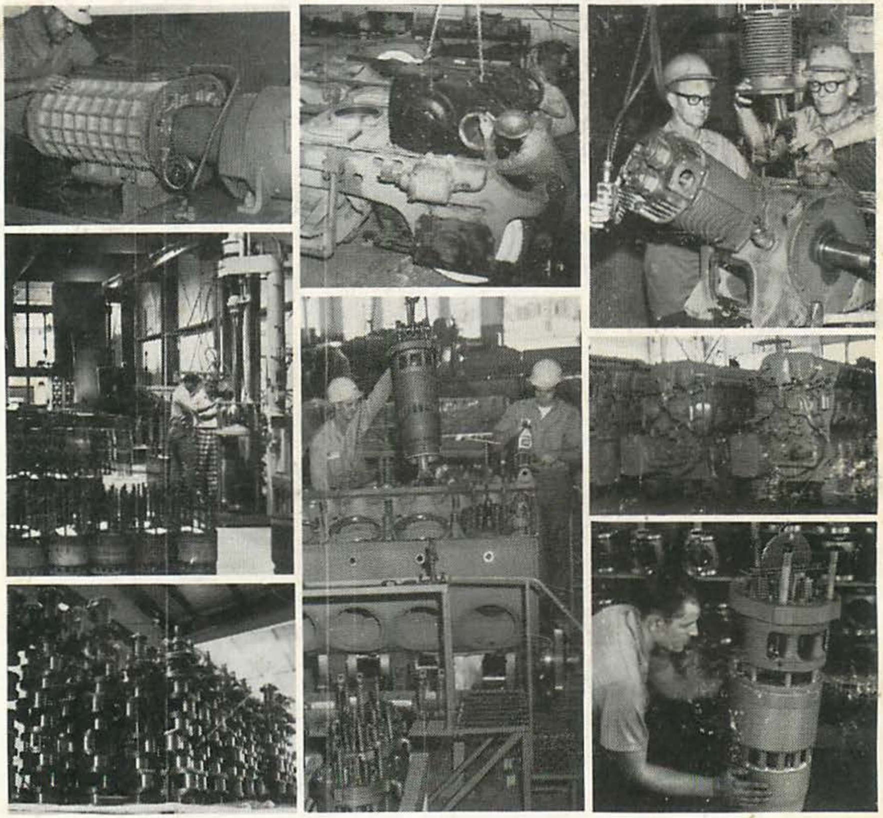
hydraulic piston is flush with its respective stop ring. The hydraulic pump is actuated until a pressure of 675 bars (9790 psi) is achieved. The four round stud nuts are tightened with a 10mm diameter bar until they fit snugly on the cylinder head. The pressure on the hydraulic pump is released. The screw-on sleeves are turned off the four studs and the cylinder head removal and tightening device is removed. The fuel line water outlet, air inlet, and exhaust outlet are then reconnected to the cylinder head.

Sulzer offers two versions of the cylinder head removal and tightening device. The "standard version" acts on only two studs at a time, while the "special version" acts on all four studs. For that reason, the "special version" is recommended to increase the productive efficiency for the removal and application of cylinder heads, and to assure equal loading of all four studs. (See photo 28)

**Shown here is 7th Vice President W. R. James being assisted into his LMOA blazer by 2nd Vice President N. A. Buskey.**

# NOTES

# What'a You Need?



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