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SEPTEMBER 28, 29, 30, 1981

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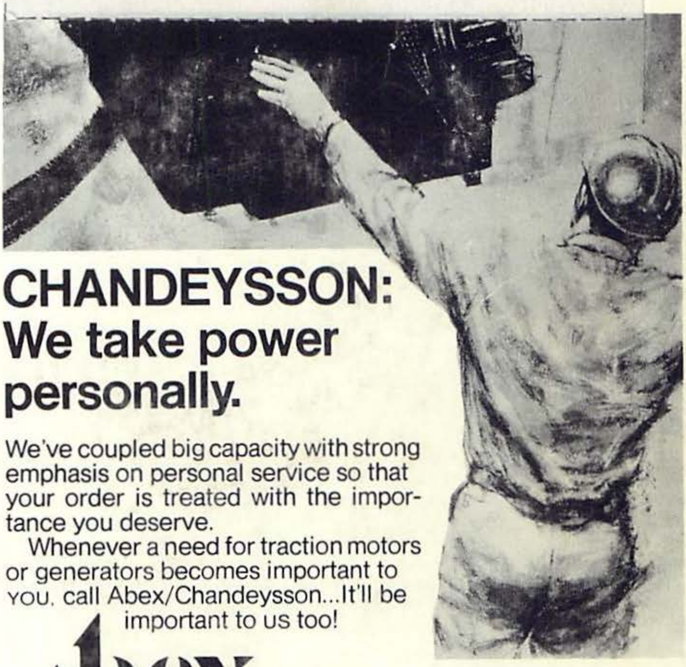
Official Discussion Record of 42nd Annual Meeting

LMOA

LOCOMOTIVE MAINTENANCE OFFICERS ASSOCIATION



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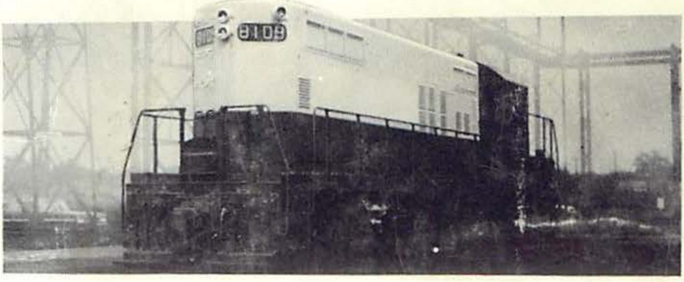

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1981 Advertisers Index

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MONDAY MORNING SESSION
September 22, 1980

J. H. LONG
PRESIDENT
Manager Locomotive Dept.
Chessie System
2815 Spring Grove Ave.
Cincinnati, Ohio 45225

MONDAY MORNING SESSION

September 22, 1980

Everyone please be seated.

I am Bill Wilson of the MoPac R. R. and President of the Railway Fuel and Operating Officers Association.

The 72nd Annual Technical Conference is now in session.

Members of the Coordinated Association, Honored Guests and Friends—On behalf of the Officers and Executive Committee of the Air Brake Association, Car Department Officers Association, Locomotive Maintenance Officers Association and the Railway Fuel and Operating Officers Association, it is an honor and a privilege to have the opportunity to welcome each of you to this coordinated conference.

As in past conferences this meeting will be opened by you rising for the invocation to be given by Reverend Monsignor John Farrell of St. Leonard's Roman Catholic Church in Berwyn, Illinois.

Thank you Reverend Farrell for your remarks. Keeping them in mind, our meetings should prosper and give us knowledge to improve ourselves and to better work with our fellow man.

It is a privilege to have a joint meeting for our opening session as there is a very close relationship that exists between our association, and our combined efforts do have a vital part in our railroad system.

Before our honored guest is introduced, I would like to introduce the gentlemen at the speaker's table.

Will each of you stand and be recognized. Please hold your applause until they all have been introduced.

Mr. H. S. Hubbard of the Canadian National Railways, President of the A B A;

Mr. E. S. Spafford of the Chicago & North Western Transportation Company, President of the CDOA.

Mr. J. H. Long of the Chessie System, President of the LMOA.

Ladies and gentlemen and guests, we are honored to have as our keynote speaker, Mr. James W. Gessner.

James W. Gessner was elected president and chief executive officer of the Missouri Pacific Railroad in May, 1979, after having served as president since May, 1978. The bulk of his career has been devoted to railroad operations and has covered a wide range of assignments.

Mr. Gessner joined the Missouri Pacific Railroad in 1969 as assistant to Vice President-Operations at St. Louis. Two years later he was named General Manager of Mo-Pac's Eastern District with headquarters in Little Rock and then returned to St. Louis as General Manager-Transportation. In March 1974, Mr. Gessner was elected Vice President-Operations, and was elected Executive Vice-President in September, 1976.

Mr. Gessner began his railroad career in 1955 with the Southern Railway after earning both a bachelor's degree and a master's degree in Civil Engineering at the University of Michigan at Ann Arbor. He served in the U.S. Army from 1952 to 1954.

At the Southern, Mr. Gessner served in the positions of Track Supervisor, Assistant Trainmaster, Trainmaster, Superintendent, Manager-Customer Service Engineering, Director-Transportation Engineering and Director-Planning and Development.

JAMES W. GESSNER
President & Chief Executive Officer
Missouri Pacific Railroad

"MANAGING TODAY FOR TOMORROW"

Good morning and thank you very much for the opportunity to share a few thoughts with you. This annual gathering of experts in the key technical areas of railroading you represent has come to be regarded as among the most prestigious meetings in our industry. To be invited to address any single one of your individual meetings is an honor. To be asked to address this joint session is therefore a most singular honor and one that will be cherished in my memory for all the years to come.

As a former inhabitant of the operating department, I have a keen interest in many of the topics, really all of the topics, you will address between now and the close of your meetings on Wednesday. I am sure those sessions will provide important learning opportunities and offer new insights for each of you. At the same time, over coffee or whatever, you will also have many opportunities to talk shop and exchange ideas in an informal atmosphere. **Meetings such as these are absolutely essential to the professional growth and renewal of the railroad person and to the continued progress of our industry.** Your program chairmen and officers are to be congratulated for their efforts in planning such high-quality conferences.

As I understand the role of a keynote speaker, the task is to identify the common interest that binds together all those in attendance, to establish a theme, to provoke, challenge and stimulate. That is quite a task for anyone, even a professional orator. I most certainly am not an orator. I am a man, a railroad man, a railroad manager. The fact that we are all railroaders, that we are all railroad managers . . . that is our common identity, our common interest.

As people and as railroad managers, we probably all share an interest in the future. We are, of course, frequently admonished to live in the present, forget the past, and not dwell too much on the future. But that is not the way of human nature. I feel the ability to think about the future, to plan and to take steps to assure that future, are among the beneficial traits that separate man from the rest of his fellow animals. I believe also that there are many lessons to be learned from history.

In recent months, I have been thinking a good deal about the future, particularly the future of my railroad and the railroad industry.

I feel generally optimistic about the overall future of our railroads. There are several major developments either underway today, or anticipated in the near future, that may have a profound impact on the course of our railroad industry. Among the more important developments are the emergence of new technology, deregulation and the railroad merger movement.

At the present moment, no one knows with any certainty how the final results of these developments will affect our industry. For this reason, we must be careful to temper our enthusiasm and optimism to a degree. We cannot wholly rely on any single development in itself, or all the developments collectively, being an absolute guarantee of a new era of growth and prosperity for the railroads. We cannot fall into the trap of simply waiting for a glorious future to arrive on our doorstep without effort on our part. We must take action now. We must manage whatever resources are available to us today. Just as important, we must analyze emerging change and plan ahead if we are to take advantage of the new opportunities opened to our industry. We must manage, and manage effectively today, for tomorrow. We must mold and shape both present and future events to the greatest degree possible to our advantage. The opportunities exist. But it is railroad people who must turn promise into reality.

The deregulation legislation passed earlier this month by Congress poses a challenge for our industry. For many years, the railroad industry has petitioned Congress and the Interstate Commerce Commission to remove from our shoulders many of the punitive regulations that have been imposed upon us since 1887. We have been regulated on the premise that we hold a transportation monopoly when in fact that is hardly the case. The transportation marketplace of 1980 is not the marketplace of 1887. Our position in that marketplace has eroded severely as a result of competition from other modes of transport.

It seems certain that the traditional principles of collective railroad ratemaking will be abandoned in favor of more intensified market competition. Far more responsibility and economic decision-making will be thrust upon the individual railroad. Corps of railroad managers, brought up in an atmosphere of rate bureaus and multi-line negotiations of rates, must now perform with great independence in behalf of their individual railroads. Their ability to manage will be tested and the test may well be the future financial success of each of their railroads.

Regardless of how deregulation impacts us, the railroad manager has numerous opportunities to develop effective and innovative combinations of price and service that will benefit the shipping community as well as the railroads. There will be healthy competition to make one railroad a more attractive alternative than another. But the real thrust of competition, the area of most emphasis, should be to make the railroad industry a more attractive alternative than truck or barge. Our industry cannot increase its present share of the transportation market simply by shifting traffic from one railroad line to another. Instead, we must grow through diversion of traffic from other modes of transport to the railroads.

The ability to originate and terminate more traffic within a single system, the prospect of diverting service-sensitive piggyback traffic from the highway through improved service, and the opportunity to provide attractive rate/service programs within a single system, are a few of many important factors behind the current railroad merger movement. Mergers and consolidations, present and proposed, would result in a massive restructuring of the railroad industry.

Since I represent a railroad deeply involved in a consolidation, I obviously believe our consolidation will be of great public benefit. The benefits to our customers would be substantial. We will gain significantly in our efforts to control expense through economies of scale. Equipment utilization, transportation efficiency and reliability should show marked gains. I know we are going to have a better railroad if our consolidation is approved and I assume the same opinion is held by the management of other railroads engaged in the same process.

Once again, however, the success of any consolidation will depend upon how well managers involved at all levels seize new opportunities and adjust to change. Human chemistry, the ability to work in a cooperative spirit with your new fellow managers, is also highly important in a consolidation.

For a variety of reasons, some of the new consolidated systems are probably going to operate more effectively than others, just as the individual roads differ today. One system may be able to reduce its operating ratio by three or four per cent and another may reduce it only one per cent. One system may show an eight percent gain in freight car utilization while another increases utilization only two percent. There may be several factors involved — some beyond human control — but a major factor is and will be management skill. Some managers are going to manage more effectively than others, again at all levels in the company. Those of us involved in merger or consolidation will find new challenges in our quest to produce the efficiencies and the savings possible in the new system.

The new technology will also test our managerial skills both today and tomorrow. Nearly everyone in this room utilizes computer systems to some degree in the course of daily work. I know that the various computer systems have had a major beneficial impact on virtually every phase of our operations. We must remember, however, that computers do not run any railroad. The computer provides us with new and improved management tools. However, the tools must be utilized by people. We as managers must learn how to achieve maximum advantage from the computer tools provided to us in making sound decisions, in improving productivity within our area of responsibility and in seeking new applications of existing computer technology in our work arena.

New technology is not confined to the computer by any means. The supply industry and the people working within the railroad industry are continuously developing more effective products, new processes and applications. You will be exposed to many new ideas here this week. A good manager will not simply listen politely but will take these ideas back to his railroad and analyze how they may be used in his operation. I think it is a terrible mistake to adopt an attitude that "if it wasn't invented here, it doesn't exist." We have a great deal to learn from one another and we have an excellent forum through our many railroad organizations for gaining new knowledge.

Most emphatically, I believe that we are facing a future filled with opportunity. That future is a little uncertain now as it pertains to such developments as mergers, deregulation and technology. However, I have great confidence in the ability of our industry and its managers to turn uncertainty into success. Most of all, what happens to us as railroad people tomorrow will depend in large part upon what we do today. Ours is an evolutionary industry which has been formed through a long succession of generally modest increments rather than through revolutionary developments. Our industry has been shaped to a large degree by the accomplishments of individuals at all levels of management, not by a handful of people of genius.

Nearly all in this room today represent some of the more technical areas of railroading. Your work takes place at a point distant from the customer's office and from the books of account. As a result, it is easy to become immersed in your daily work and to lose sight of the railroad as an overall mechanism and as a business.

A railroad is a dynamic system representing the intermeshing of thousands of given physical events and thousands of individual decisions. It is not a machine to be turned on with a switch and set in motion for the production of a single product at a single location. It is a system that operates on the principle of cooperation among thousands of individuals, nearly all of whom have a measure of autonomy not commonly found in general industry. They are guided by a general plan of operation administered through a chain of command. In the final analysis, however, the success of the operation depends upon individuals, each of whom in some degree has the power to enhance or undermine the system. No single person can control the railroad as a dynamic organism. The railroad is a collection of microcosms, small groups working within the framework of the whole with each group and each group member playing a significant role in support of the system. It's just as the cells and cell clusters of the body maintain our lives.

Second, a railroad is a business. It is supported by customers, people who pay money for the product offered by the railroad. That product is service. The railroad mission is to provide a service that is reliable and efficient at a fair price. As a business, a railroad must produce a profit. It must meet its operating expenses, pay its employees, pay its taxes, reward financially the people who have invested their money in it or who hold its loans. The railroad must show a profit if it is to renew itself through maintenance of track and equipment, through capital expenditures for a new fleet and facilities. That is a very difficult assignment.

For the railroad industry, the margin between profit and loss is extremely small and growing steadily smaller. Many industries routinely post profit margins of 10 per cent or more. That's far better than the railroad industry does. Last year, our average revenue per ton-mile was 2.617 cents while our expense per revenue ton-mile was 2.581 cents. That is a margin of about 1.4 per cent. In 1969, our margin was nearly 7 per cent. However, since then, revenue per ton-mile has increased only 94 per cent while expense per ton-mile has increased 106 per cent. On the expense side, it is interesting to note that employee payroll expense rose 244 per cent and employee fringe benefits rose 299 per cent for the period 1969-79. There was not a sufficient increase in productivity to offset the escalating costs. For the same period, freight revenue ton-miles per employee increased only 27 per cent while freight revenue ton-miles per dollar of employee compensation increased only 36 per cent. Obviously, our industry faces a shortfall in the area of employee productivity.

Your role is important both as a part of the overall railroad system and as a contributor to its financial success. First, you possess skills which make you a highly valuable person in the overall railroad mechanism. In varying degrees, depending upon your area of skill and the scope of your operation, you definitely have an impact on the efficient operation of your railroad. Second, in nearly all cases you are also managers: managers of people, money and machinery. Your managerial skills are every bit as important as your technical qualifications.

As I mentioned before, our industry's margin of profit is measured in unit terms of fractions of a single penny. Fortunately, ours is also a high-volume business dealing with billions of units — revenue ton-miles. Thus, with leverage on this scale, it is possible to realize substantial gains through relatively minor improvements in control of expense, efficiency and productivity. The reduction of an operating ratio by just one-half of one point translates into millions of dollars on a large railroad.

The key to achieving such results is superior management at every level of the railroad operation. It is certainly not a very glamorous or dramatic concept, certainly not a magic silver bullet, but it works. You, through superior management in your daily operations, can help guarantee a better tomorrow for our industry. The opportunities exist in abundance on every railroad, no matter how large or small, no matter how profitable the railroad may be.

A good place to begin is in establishing definite objectives for yourself and those you supervise. We all have annual or monthly goals and objectives. Perhaps we can go a step or two farther and deal in daily and weekly objectives. You should establish consistent and realistic standards of measuring progress in meeting objectives. Share your objectives with those around you, making them an integral part of the process. I believe railroad people still take pride in their work and respond well to being recognized by their supervisors. At Mo-Pac, for example, I have been greatly impressed with the competition that exists among our tie gangs in setting daily production records. I assure you it is competition both real and spirited.

Objectives might center on standards of cleanliness and housekeeping in the shop. Employee morale, safety and production do improve in a clean, well-maintained shop. Or you might consider placing more stress and generating more activity in the area of overall safety. You may aim at an increase in daily and weekly production.

Employee productivity most certainly can be improved in virtually any operation. Observe your people and their work habits. How much idle time exists because parts and tools are not available promptly or because poorly-maintained machinery breaks down? Are the men ducking into the locker rooms early to wash up before going home or hanging around at the beginning of a shift to smoke a last cigarette? Have you established levels of performance and acceptable quality work for your employees and are you maintaining the proper level of discipline to insure that performance standards are met? You may find it beneficial to take the time to carefully analyze work flow patterns and identify time-and-money wasting applications.

All of us are concerned about conserving energy, not just for patriotic reasons but because energy and fuel expenses have risen so sharply. Frequent checks are necessary to insure that energy-saving measures already instituted are being maintained. At least once a month, make an energy inventory of your operation to determine if further savings are possible.

It is important to be receptive to new ideas, new processes and new technology. Frequently, a newcomer or transfer in your operation can identify ways to improve work efficiency or even develop a machine or process toward that end. Listen to them. Give them credit. Your value as a manager depends in large part upon your ability to get results through those you supervise.

Our railroad supply industry annually provides us with new technology, more efficient machinery and tools. Many of these new products are of benefit while others are marginal. As a manager, you must analyze the needs of your operation and weigh the benefits to be derived from a new product against cost and the ability to adapt it to your system. These items represent an investment on the part of your railroad. Like any other investment, it must offer a potential return that can be measured.

However, my purpose here today is not to dwell in detail on the way you perform in your various areas of railroading. Your ability to recognize opportunity in your area of expertise is far greater than mine.

I do want to remind you once again how important you are as an individual to your railroad, especially in your capacity to operate as an effective manager of the resources available to you. I believe in the future of our industry and I am optimistic about our future course.

We must continue to manage to the utmost levels of our abilities today if we are to reap the benefits of tomorrow. We must continue to embark upon a journey of seemingly small successes because in the aggregate they will be significant not only in the daily operation of the railroad but in the future as well. It's a tired cliche perhaps, but true, that a journey of a thousand miles begins with a single step and, I might add, is reached only after thousands of steps.

My appeal to you is to develop your management abilities to the fullest extent possible. Much has been written about management style. I doubt though if anyone has ever said it better for our purposes than the late scientist-philosopher Alfred North Whitehead, who wrote:

"Style is the ultimate morality of the mind. The administrator with a sense of style hates waste. The engineer with a sense of style economizes his materials. The artisan with a sense of style prefers good work."

Thank you.

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MONDAY MORNING SESSION
September 22, 1980

REPORT OF THE COMMITTEE ON DIESEL MECHANICAL MAINTENANCE

J. L. KUHNS, Chairman
Supt. Motive Power Maint.
Louisville & Nashville Railroad
Louisville, KY

N. A. BUSKEY
2nd VICE PRESIDENT
Asst. Gen. Mgr.-Operation
Chessie System
Huntington, WV

The annual meeting of the Locomotive Maintenance Officers Association, held at the Conrad Hilton Hotel, Chicago, Illinois on September 22-24, 1980, convened at 10 a.m., Mr. J. H. Long, Manager Locomotive Department, Chessie System, Cincinnati, Ohio, President of the Association presiding.

PRESIDENT LONG: At this time I would like to call on Vice President Nelson Buskey to serve as the officer of this session.

MR. NELSON A. BUSKEY: Good morning, gentlemen. It is a great pleasure to introduce the chairman of the Mechanical Maintenance Committee.

[Mr. Buskey introduced Mr. J. L. Kuhns, Superintendent Motive Power, Louisville & Nashville Railroad, Louisville, Kentucky. Mr. Kuhns then introduced the members of his Committee. Mr. A. K. Jordan summarized Part 1 of the report.]

MR. JORDAN: Are there any questions on this first part of the report?

MR. J. J. BUTLER [Chief Mechanical Officer, Consolidated Rail Corporation, Philadelphia, Pennsylvania]: What does EMD intend to do about the low idle on the GP 15 where the batteries will not charge when in low idle?

MR. L. F. TURNEY [Manager Technical Section, EMD]: EMD is working on modification 8005 which will be released shortly. The modification involves minor changes in the relay system.

MR. C. R. MEDOVICH [Superintendent Locomotive Maintenance, GE, ALCO and Electric Locomotive, Philadelphia Pennsylvania]: We just finished some extensive testing, comparing an E3 and E3B turbo, and found a fuel advantage from .5% to .7%. Is anyone contemplating making a switch for fuel management reasons?

MR. TURNEY: EMD Engineering is deeply involved in this right now.

MR. J. L. KUHNS: Don't quote me on this, but I believe if you have a basket-case turbo it will be about $1,500 extra. If you want to convert a running turbo it is about $4,000 extra. Is that close, Lou?

MR. TURNEY: That is relatively close.

MR. MEDOVICH: Why is there such a big difference when you have a basket case and everything is scrap inside? Why would it cost more than the E3 turbo?

MR. TURNEY: I can't answer that. This might be a good question to ask at the What's Your Problem session. I will be prepared to cover this in more detail then. Mr. Dunteman, do you want to address this?

MR. N. RICHARD DUNTEMAN [EMD, LaGrange, Illinois]: The major difference between the E3 turbo and the E3B turbo is the turbine wheel assembly. This assembly has an improved turbine blade air foil shape for improved aerodynamic efficiency and a revised turbine blade serration for reduced blade operating stresses. The new turbine wheel assembly is the major difference in price between these two turbocharger models. In addition to the improved turbine wheel, there is also an improved compressor diffuser for increased aerodynamic efficiency which also contributes to the price differential between the two turbocharger models.

MR. WILLIAM LAURO [Motor Coils Manufacturing, Braddock, Pennsylvania]: I would like to address this to GE, if I may. I understand in your program to reduce the horsepower on your auxiliary equipment you are taking a step on your cooling fan and thinking about going to an eddy current clutch type of repairs. Is that correct?

MR. A. C. HILLHOUSE [General Electric Company, Erie, Pennsylvania]: We do have fuel tests running on a GE Y70.

MR. LAURO: How are you going to protect the rest of the system from the spikes when the eddy current clutch collapses? What do you do to protect the rest of the collapses because of the spikes?

MR. HILLHOUSE: I don't have the answer.

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MR. JOHN SEPHAN [General Electric Company]: Protection on the system? We still have the fluid amplifier controlling the water flow to the radiators, and even if the clutch were turning continuously you would still operate at good water temeratures.

MR. LAURO: In the old days you will remember all the difficulties we got into when the eddy current collapsed. We were wiping out complete systems. How are you protecting against collapse of the clutch when it disengages?

MR. SEPHAN: Predominantly we put the clutch in the radiator fan. This is not on the input shaft. Anything we have seen on locomotives previously. We do have approximately 1,600 of these in service. We don't have all the problems that have been encountered with it on the input shaft.

MR. LAURO: What is the saving in horsepower now?

MR. SEPHAN: The saving in horsepower is of course dependent on the locomotive model and the duty cycle under which it operates. Depending on the model, there will be an anticipated 2% to 2.5% fuel saving. Horsepower-wise, today if you are running at about 104 horsepower your nominal would be down to around 40 horsepower.

MR. HUGH A. WILLIAMS, JR. [Supervisor, Product Development, EMD, LaGrange, Illinois]: With respect to the fuel conservation chapter as it appears on pages 134 to 141 [1980 LMOA book], I have reviewed this presentation and would offer the following comments:

On page 136 the presentation omits some very important information relative to total fuel consumption improvements for GP-38-2 and SD40-2 locomotives.

The following statements describe EMD improvements in fuel economy of GP38-2 and SD40-2 locomotives respectively.

GP38-2 Locomotives

Using 1971 as a base year and a medium road duty cycle, a GP38-2 locomotive equipped with 5th notch dynamic brake, and standard 315 rpm idle speed would have a projected fuel savings of 11,840 U.S. gallons or a 3.7% improvement from engine design changes only. These changes include the fire ring piston, wide port liner, and low sac spray tips released in 1972-1974. By incorporating these engine design changes with the low idle option, a dynamic brake engine speed of 4th notch, and using the shutdown option when ambient temperatures are 50°F or above, the fuel savings for a 1980 GP38-2 locomotive would total 21,440 gallons, or 6.7% over the 1971 base line year—for equal work accomplished.

SD40-2 Locomotives

Using the 1971 base line and a medium road duty cycle, 315 rpm idle, and 5th notch dynamic braking, the SD40-2 has a projected 1.1% improvement of 4,400 gallons per year from Model 16-645E3 engine design changes only. These changes include the piston with the top ring located 1¼" from the piston crown, wide port liner, and low sac injector spray tip released to production in 1972-74. By incorporating the low idle option, reducing dynamic brake engine speed to a combination of notches 1 and 4, using the shutdown option when ambient temperatures are 50°F or above and the present Model 16-645E3B engine, fuel savings for an SD40-2 locomotive of 28,000 gallons per year per locomotive or 7.2% over the 1971 base year are projected. The Model E3B engine was introduced into production in mid-1979.

With respect to conclusion #15 (page 141), "Consideration should be given to isolating extra units on the return movement of unit trains," I would offer the following comments. EMD has performed a computer simulation to determine the effect of isolating trailing units on a locomotive consist. The results of this study indicate that isolating trailing units does not conserve energy; rather, the amount of fuel expended to generate 1 Kw-Hr. is increased.

MR. KUHNS: We will include that in the 1980 Proceedings. However, I think each railroad is going to have to make its own test as far as taking a unit off the line and isolating it, as to whether it is beneficial to its operation or not. On our particular railroad we do isolate units, and do shut them down in the summertime, and we find it saves fuel. As I say, each railroad will have to decide for itself on that subject, but we will be glad to include Mr. Williams' comments in our 1980 Proceedings.

Any other questions on that portion of the report? If not, we will ask Mr. Buffington to cover the next part of the report.

[Mr. L. M. Buffington, Assistant Superintendent Locomotive Shops, St. Louis-San Francisco Railway, Springfield, Missouri, summarized Part 2 of the report.]

MR. KUHNS: Are there any questions on this particular portion of the report? We are trying one thing on our railroad, just as a matter of information. It was after we came out with this paper. I am sure almost everybody has had problems with cab heaters on GE locomotives. We are putting a strainer right in the water outlet manifold. We plan on taking the strainer element out. It is something like a fuel suction strainer. We are planning to take it out every 60 days and clean it. I believe this may eliminate a lot of the problems we have had with scale plugging up the heater course. We have only one unit so equipped, but from what we have seen so far it shows a lot of promise.

MR. FRANK D. BRUNER [Assistant Chief Mechanical Officer, Union Pacific Railroad, Omaha, Nebraska]: I might advise the group that we on the Union Pacific are installing a winterization system which departs considerably from that offered by the manufacturers. Patent considerations did not allow us to make a presentation for this meeting; however, they will be available next year. I feel it is proper to give the group a preliminary of the system now, in case some of the railroads present are interested in our system.

We were one of the railroads that were affected severely by the 1979 winter freeze-ups which accounted for expenses approaching $7 million in equipment and lost availability to our fleet. Even though we had preheaters installed on all of our locomotives, we still had a problem with plugged-up suction lines in the tank. Unfortunately, #2 diesel fuel characteristics create a problem in that as the temperature drops below the cloud point, wax is formed in the fuel which will plug filters. A fuel preheater ahead of the filters can normally raise the temperature above the cloud point, at which time the fuel is dissolved back into the fuel providing the fuel heat exchanger has sufficient capacity.

Over and above this problem is the problem of plugged suction lines in the fuel tank, which will choke off the fuel supply to the fuel pump and heat exchanger and still shut down the engine. This problem is encountered when the ambient temperatures reach -40°F and -50°F and remain this cold for several days. This is the case in many winters in Wyoming, Idaho, parts of Utah and Nebraska. When these temperatures are encountered, fuel exposed to the tank walls will cloud and after a period of time will drop below the pour point of the fuel, at which time it will solidify similar to the formation of ice on the tank walls.

Experience had shown us that in many cases, shortly after fueling the units at an intermediate fueling station, the high velocity fuel from the fuel inlet would break chunks of frozen fuel away from the tank lining which would collect at the bottom of the tank and be drawn to the suction area and would immediately plug the suction line. If mechanical forces could get to the unit before a freeze-up occurred, they were normally able to attach an air hose to the fuel line with a special connector in the suction strainer housing and utilize engine air to blow the frozen fuel from the suction. Unfortunately, in too many cases engines froze up before they could be properly drained, with the detrimental freeze-up of components and serious engine damage occurred.

A complete investigation of several locomotive failures indicated, as would be expected, that in most cases the tank had a considerable amount of warm fuel in the major portion of the tank. However, due to the very poor heat conductivity of fuel, a temperature gradient existed from the tank surface which would allow the formation of the fuel crystals on the tank surface as thick as 2½ inches. This was confirmed by laboratory tests.

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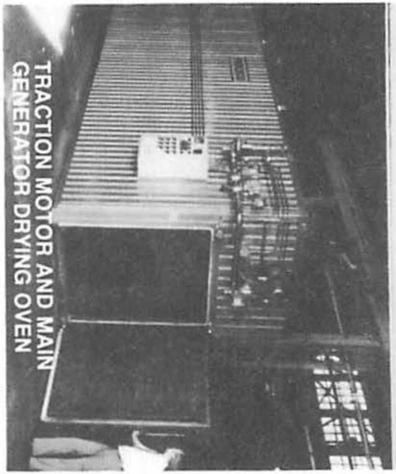

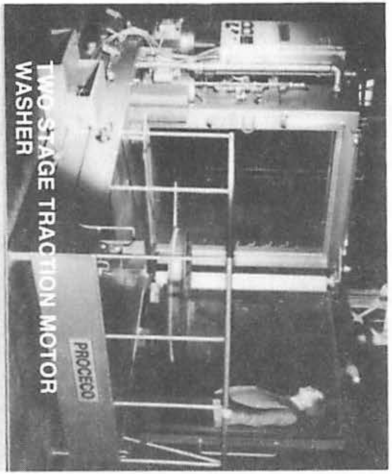

and Development Department which solved the problem of the suction line freezing and also provided sufficient warm fuel mixed with the tank fuel to melt the wax prior to reaching the filter. The principle of this system is to provide a device which can be screwed into the center drain plug which provides for the suction and return line to pass parallel and adjacent to one another. It further provides a "U" shaped deflector which, by its position and location in regard to the return fuel line, provides that a portion of the hot return fuel will be directed back to the suction line and direct the unneeded hot fuel back to the tank to provide tank heat. The device also provides that in the upper throttle notches, where the return fuel is substantially reduced, the deflector is placed a sufficient distance from the return pipe to allow all of the hot return fuel to return and mix with the tank fuel. This mixing and dividing ratio varies with throttle and load position for the notches in between the top speed and idle.

By utilizing this system, we could eliminate the use of an amot valve which is subject to failure, and provide one manual changeover valve to change from summer and winter operation. The design, as applied to Union Pacific locomotives, was calculated to provide suction line and fuel filter plugging portection for tank temperatures as low as -30°F and would still not overheat fuel with fuel tank temperatures of +60°F. Having this wide variation allows that the valves are placed in the winter position some time in late November prior to the sub-zero temperatures that can be expected in December, and be left in this position until some time from the middle of March until May when it would be expected that normal ambients are far above any possible freeze-up potential.

Another advantage to this system is that the heat exchanger can be placed in the return line where it can provide the greatest amount of heat to the mixer-divider which, of course, is desirable. The placement of a 60,000 BTU heat exchanger on the primary or inlet side of the engine may add 60,000 BTUs to the fuel; however, the ratio of about 2 to 1 in fuel burned to fuel returned means that approximately 40,000 BTUs will be burned and go out the stack. With the heat exchanger on the return side, all heat produced by the heat exchanger is available to prevent suction line freeze-up and still provide return heat to the tank.

We have not reached agreement with the manufacturer on this system, since they desire to market a system which is automatic and does not require a changeover valve. We elected to take this approach knowing the failure rate of temperature control valves, which the manufacturer recommends being changed every two years, and knowing the problems associated with changeout of components on a mandatory two-year

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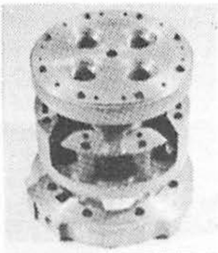

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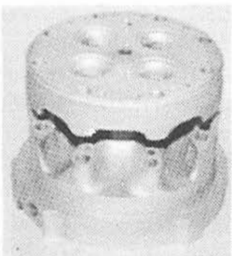

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basis. Secondly, a failed valve is not readily detected and could either overheat the fuel or provide no protection depending on its failure mode.

Our Research and Development Department tested this concept in April by building a tank around the locomotive fuel tank with approximately 6" clearance. The outside tank was filled with isopropyl alcohol, and utilizing six tons of dry ice we were able to take the tank temperature down to -26°F. The mixer-divider system worked very well and provided a minimum fuel temperature of +34°F at all throttle and load positions and even at low idle, with all cooling fans blocked in operation to hold the water temperature below 100°F throughout the test. Part of this test included a changeover to the EMD system which unfortunately had a streak of bad luck on their test apparatus when it was noted that the thermal valve had stuck and had to be struck with a hammer to start it functioning. The object of this test was, of course, to prove the capability of the mixer-divider system which we elected to apply to all of our locomotives. Before this coming winter is upon us we should have all of our locomotives so equipped.

Thank you for giving me this time, and we will present a more thorough explanation with drawings for next year's meeting.

MR. KUHNS: Thank you. I have read considerable about that system, and it sounds like it has a lot of merit. We appreciate your remarks.

Any other questions? If not, I will ask Mr. Brown to tell us about Utilization of On-Board Load Test.

[Mr. W. A. Brown, Assistant Manager Motive Power, Burlington Northern, St. Paul, Minnesota, summarized Part 3 of the report.]

MR. KUHNS: Any questions?

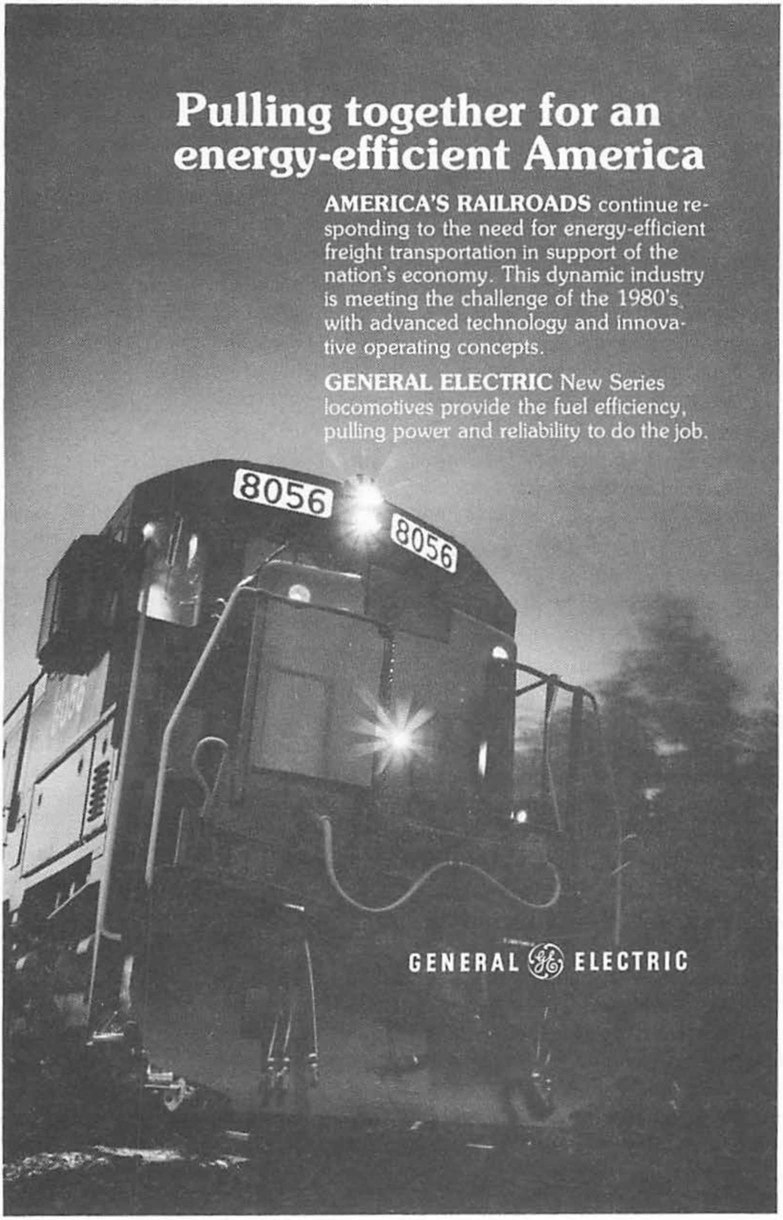
MR. LAURO: I would like to ask the Committee how extensive is the retrofit program being done now across all the railroads. Does anybody have any feel for that—equipping locomotives with self-load box?

MR. KUHNS: I can't answer you. Would anyone on the Committee care to comment? Mr. Brown says the Burlington Northern is into it on a limited basis. Do you have any idea what the time or manhours would be?

MR. LAURO: That was my next question—manhours.

MR. KUHNS: I am sure if Burlington Northern is doing it, we can come up with a ballpark figure. If you give your name to Bill Brown he will try to find out for you, Mr. Lauro.

MR. R. G. CLEVENGER [General Electric Foreman, Atchison, Topeka & Santa Fe, Kansas City, Kansas]: Jack, we are presently doing that on some of our SD45s at San Bernardino. I can't give you any figures on the cost, but we have 100-odd units that aren't equipped, and we are equipping them with self-load. At the same



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time we are making modifications to the shunting on these locomotives.

MR. KUHNS: I am sure it will come up more and more, as more people get into more work on older locomotives. It seems the Santa Fe and Burlington Northern are doing some of it.

Any other questions? If not, I will ask Mr. Morrison to cover our next section. This was a real problem for us a year ago with the new FRA rules, so bear with us.

[Mr. B. B. Morrison, Superintendent Motive Power, Illinois Central Gulf Railroad, Chicago, Illinois, summarized Part 4 of the report.]

MR. KUHNS: Any questions on this part of the report?

MR. R. P. NEELEY [Mechanical Superintendent — Locomotive, Union Pacific Railroad, Omaha, Nebraska]: I would like to ask someone to explain to me why the FRA made it a mandatory regulation to match wheels on 3-axle trucks. I don't think anybody can tell me why. It is a lot of wasted dollars, as far as I am concerned.

MR. KUHNS: I agree with you. However, this is one of the things we pointed out in the paper. It is too late to complain after the law is passed. We have to make noise before the law becomes effective. I couldn't agree with you more, but I don't know what we can do about it now. It would mean a lot of argument to get that law repealed.

MR. K. H. SMITH [Chief Motive Power and Purchasing Agent, Belt Railway Co. of Chicago, Chicago, Illinois]: We have one proposal presently that to my knowledge we haven't seen any finalization on, and that is the status of the warning lights proposed for locomotives. This is one area that represents high maintenance for the mechanical people.

The FRA held hearings a year ago in Chicago. Can you advise us as to what the very latest status is of this proposal?

MR. KUHNS: I don't believe anything has occurred on it as yet. I can only sympathize with you. We have taken delivery on some SD40s and some C30-7s from the builders that are equipped with them. We have had them for about three months, and I don't know if we have any of them operating now.

We have had a lot of trouble with the power supply from the strobe lights. We have had trouble with the strobe light bulb itself. These happened to be Whelen strobe lights. It seems to me before they are put on the locomotive all these problems should be corrected. Those are the two biggest complaints—the power supply and the strobe light bulb itself. What the latest status is on the law, I don't know.

MR. SMITH: This would be one area where the maintenance people could be relieved of a very heavy burden of maintenance on locomotives if we could get this proposal killed.

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MR. KUHNS: I agree. It is a dangerous problem. We have received several complaints so far. I don't know how many railroads have strobe lights, but we have had trouble when they go through yards and cuts. The crews complain about them. They want to know what the rules are.

I am also acquainted with some of the hazards of strobe lights as far as airplanes are concerned. One of the things is that when you get in clouds you turn a strobe light off because you can get vertigo very quickly. This may have a bearing on strobe lights with our train crews, I don't know what the status is.

MR. SMITH: This is one area where we could give sound support to any of the operating people on the respective roads that may be involved in this.

MR. KUHNS: This is the time to do it, before it becomes law.

MR. B. A. CUMBEA [Manager Locomotive Maintenance-Engineering, Chessie System, Huntington, West Virginia]: I believe this matter has been referred to another high-level study group. I know some of the attorneys involved in the study now. I think one of the biggest controversies involves who is going to pay for it if it does become a law.

MR. KUHNS: I will cover Part 5 of the report, Welded Crankshafts.

[Mr. Kuhns summarized Part 5 of the report.]

MR. KUHNS: Are there any questions on this or any other part of the report?

MR. THOMAS ROCHE [L&M Radiator, Inc., Hibbing, Minnesota]: I have a comment on the section covering winterization of GE locomotives.

L & M Radiator, as you well know, manufactures replacement cores for all EMD, GE, Alco and Baldwin locomotives. Because of what we have been hearing on these GE cab heaters and the problems involved with them, we have now designed a cab heater core for GE locomotives. We will be testing this on one railroad. We invite anyone else to test these cab heaters on their railroad. If you have any further questions or would like any information, we have displays available in our suite, Room 2106.

MR. KUHNS: Thank you.

If there are no other questions, I would like to express the Committee's appreciation and thanks to Mr. Butler and Conrail for hosting the Committee in Altoona this year. Thank you, Jim.

Mr. Gogol will summarize the paper.

MR. MIKE GOGOL [Chief Quality Control Officer, Southern Pacific, San Fransciso, California]: Thank you, Jack. This is another fine presentation by the Diesel Mechanical Maintenance Committee. I spent about three years as its chairman, and I know what Jack has gone through.

They have had five timely and interesting topics this year—Fuel

M. GOGOL
Chief Quality Control Officer
Southern Pacific Trans. Co.
San Francisco, CA

Conservation, Winterization, On-Board Load Test, New FRA Rules, and Welded Crankshafts. There is much interesting information in this report, and many different ways railroads can make savings in fuel costs. Fuel costs have probably risen at the highest rate of all costs on the railroads today. Next to fuel, there is labor. Some of the suggestions and recommendations presented by the Committee can be immediately incorporated into the day-to-day operations and maintenance of locomotives. Other items will require individual railroads' economic analysis to determine if they fit their operations. Some items will require capital investment, and others are available only on new locomotives.

As an example, under Fuel Conservation, fuel spillage, low engine idle, dynamic brake engine speed control, engine shutdown at 50° or higher (some railroads use 40°), maintaining engine fuel injection equipment in top condition, reduction, and minimizing stretch braking, utilization of fuel saver devices, and proper training of train crews and train handling.

Under Winterization, this is an update for both EMD and GE units. The Committee has come up with a revised checklist.

On railroads with power that is not equipped with self load test, application of self load is worth consideration for use in day-to-day quick evaluation of units that are reported in trouble or failed. It saves a number of unit hours and manhours, and allows the unit back on the road, working, sooner.

The new FRA rules have been published. There are possibilities, through proper changing in maintenance practices by the railroads, for potential savings. The FRA is training their people in enforcement of the new rules. All railroads should keep in close communication with their FRA people to keep abreast of their new rule interpretations.

Welded crankshafts are another area for potential savings in material costs. Crankshaft prices have increased with inflation, and with proper controls by the railroads they can take advantage of the possible savings.

I think each of us can take back with us to our individual railroads a number of potential cost saving ideas, especially in fuel conservation and on-board load tests.

If you have any questions between now and Wednesday morning, pass them to the Committee members and they will try to answer them in the What's Your Problem session. Some of your questions may be carried over for next year's topic. If you have any subjects that you would like to see included in future papers, let the Committee chairman know.

Now I will turn the meeting back to Mr. Buskey.

MR. BUSKEY: Thank you, Mike.

Gentlemen, much of the material you have heard this morning was generated by the questions asked at the Altoona meeting in April. I am really disappointed that we didn't have more questions from the audience. Don't be bashful. If you have any questions on your mind concerning our report, or if you disagree with any of it, stand up and tell us so. That is how we all learn.

Now I will return the meeting to President Long for his closing remarks.

PRESIDENT LONG: Gentlemen, the good attendance at this meeting is gratifying. I urgently request that you stay out of the supply rooms during the meetings. We would like you to attend the meetings and get as much as you can out of them. Take the information back to your railroads, and participate in the discussions. This will get your name in the Proceedings, and your CMO will know that you attended these meetings. He will know you are taking part and are active. It pays dividends.

As you go about your various activities in the next three days, be sure to thank the advertisers. They are the lifeblood of this organization, along with your membership. Solicit memberships. Do all you can to make this organization grow.

Mr. Buskey told me that Ernie Lehr, who is present today, was President in 1960, twenty years ago. I remember Ernie very well. He was one of the giants of this Association. I would like to have him stand and take a bow. [Applause]

Now let's give a rising vote of thanks to this fine Committee, after which we will recess until two o'clock.

[The audience arose and applauded.]

[The meeting recessed at 11:25 a.m.]

MONDAY AFTERNOON SESSION
September 22, 1980

The meeting reconvened at 2 p.m., Mr. J. H. Long, President, presiding.

PRESIDENT LONG: I would like to call the meeting to order. I would like to call your attention to the following Past Presidents who have been in attendance: Ky Pruchnicki, Ernie Lehr, G. F. Bachman and Tom Harley.

Will you now stand and observe a minute of silence in honor of those association members who have passed away since our last meeting.

[Silent standing tribute to departed members.]

PRESIDENT LONG: Thank you.

I am very pleased with this year's attendance and membership, as well as the support we have received from the supply industry. For many years my company has allowed me the privilege of attending and participating in

Left to right: LMOA Past Presidents Tom Harley, Ernie Lehr, George Bachman and Ky Pruchnicki.

the LMOA. This I greatly appreciate, and I believe I have benefitted in my job from this association.

This year it has been an honor to represent the Association as its President. As such, I have had personal contact with the Vice Presidents, Executive Committee and technical committees. Based on these contacts, I know this Association will continue to grow and thrive for many years to come.

Our agreed-upon theme for the year 1980 is "Decade of Progress." Now, we could say to ourselves, just what progress could take place that hasn't already taken place throughout the years? In this Space Age in which we all live and thrive, the future holds promise for progress.

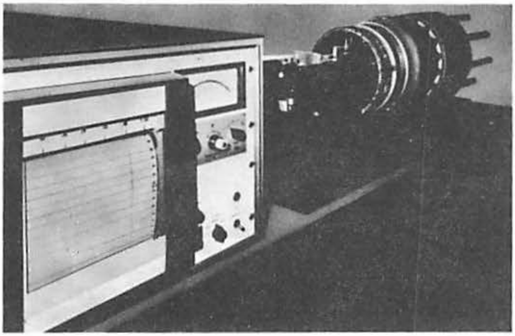
If we just took time to review the technology that has come into being in the last three decades, we would say that the future is our greatest challenge. The railroad industry is continuously working for a better way to improve service and reliability to its customers. This is an area in which we, as maintenance officers, must do our best. This Association can provide a guiding light to maintenance officers throughout the country in this regard.

The railroad industry, like many other industries throughout the world, must do its part in the conservation of fuel and other petroleum products. The one thing that should be foremost in our minds is what we can do on a day-to-day basis to cut down the use of energy.

We look to the supply industry to assist us in providing reliable and effective methods of disbursing fuel by giving us equipment built to withstand rigorous railroad use, but it should also devise and progress new practicable methods of fueling and more rigid standards.

In retrospect, if we review the technology that has come into use in the last three decades in the modernization of our motive power, we find that we have progressed from conventional type relays to modernized snap-in minicircuit cards. We have adopted advanced speed recorders, more modern cooling systems, upgraded wiring, transistorized equipment, analytical equipment for solving problems on board and in the shop. We progressed to better, more modern tooling, more modern and efficient shops, and better stores material management procedures.

Not to be overlooked is the evolution of training that has taken place in our modern times, when training has been given in all areas of both management and first-line supervision. This is a continuing process, making better officers, training line supervisors for future promotions, and bringing about more modern shop procedures, scheduling of locomotives by computer, having computer runs on historical data for both locomotive and material, and also a more comprehensive system of control to effectively produce more



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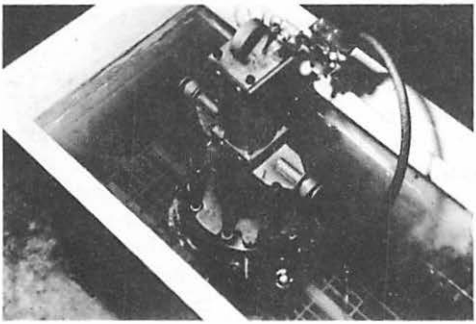

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For me to stand here and predict what is ahead in the 1980s would require either the wisdom of Nostradamus or a crystal ball, but in this new decade we shall all be seeking a better way to efficiently perform our jobs; and this is one area where the LMOA can take a vital part by seeing that the preparation of good, sound technical papers dealing with every-day railroad problems are brought before us by the railroaders of this country.

We must continue to have the LMOA officers sit down, analyze these papers, and bring out good guidelines for the preparation of these papers for pre-convention and convention presentations.

In looking back over the years, I think of some of the great railroad and supply industry officers who have given so much to this Association by their active participation. Their combined efforts have brought about many of the evolutions which have taken place in the industry.

We have attempted, in the preparation of our papers, to make them good ready-reference books to be referred to on every-day problems.

I can say one of the most gratifying things that I have experienced is to hear a foreman make the statement, "I picked that little thing out of the LMOA Proceedings." Many railroad officers have kept their copies of the LMOA Proceedings and have them available for ready reference. When we see these items in every-day practice we know our papers are being properly presented and recorded, and that they do not become just some other periodical that is read and tossed aside.

I personally am going to look back upon this LMOA experience as one of the highlights of my railroad career.

I never dreamed, back in 1953 when I attended my first meeting, that I would some day stand before this Association as its President. In 27 years I have acquired many good friends in the railroad and supply industry through this Association, and many things I have been able to accomplish were made possible through this Association.

It has been very interesting and very gratifying to watch the Association grow in stature.

One of the very sad things has been the passing of the various diesel clubs and the lack of interest that has brought about their demise; but in spite of this, our Association has continued to thrive and grow. With the fine line-up of officers who have served with me, I forsee nothing but an improvement in the Association in future years.

One thing I would like to see is more top management railroad officers selecting and sending representatives to the various technical committees and continue in their active support, so that these representatives can be progressed through the line into the Executive Committee and Vice President line-up.

We would like to have a more diversified group of railroad officers representing more railroads, so that some day you will look at the line-up and there will not be a duplication of representatives from any one railroad. The only way this can be done is for top management officers to give us young personnel who can progress through the various stages of committee chairmen, executive Committee, Vice President and President.

We urge top management officers to give their reperesentatives their problems to bring before this Association so that we can work on them as a group, in order that we can give them to the supply industries if need be and they can work to give us a product or piece of equipment to bring about the necessary improvement and solution to the problem.

In closing, I would like to thank each of you for the active support which you gave this year in your membership and your advertising.

I would like to extend my personal thanks to the fine corps of LMOA support officers I have been privileged to work with; and for the benefit of the newcomers to the Association, who start out and go through the chairs, it takes considerable time.

It is now my privilege to ask all of you to give the same kind of support to those who follow me in the future as you have given to me. Progress often comes through times of adversity. I expect there to be adversity, opportunity and accomplishment for this railroad-related organization during the decade of progress ahead. Let's make certain that all of us are ready to make our contribution.

Thank you very much. [Applause]

At this time I would like to call upon Frank Bruner to be the officer of the session.

MR. BRUNER: Thank you, President Long. I thought I was the only one who was an eloquent speaker, but I see I have lost my title in a hurry. That was a splendid address. It is a real pleasure to hear your very interesting words and thoughts.

At this time I would like to call on Mr. Holmes for the Membership Report.

MR. R. R. HOLMES [Chief Chemist, Union Pacific Railroad, Omaha, Nebraska]: These membership figures are as of yesterday, and for the purpose of the annual Proceedings we will insert updated figures as of the close of this annual meeting.

According to these figures we still have some work to do, and I would urge any of you who know of anybody or meet anybody who is not a member of LMOA, to solicit their membership.

I am going to give you just the bottom line and not a lot of details. As of yesterday the total railroad members to date were 1,112. Last year, 1979, the total was 1,251. That is a decrease of 139. Hopefully we can bring that figure up and exceed last year's figures by the end of these meetings.

Associate members to date: 349. Last year there were 391, with a decrease of 42 needed to be made up.

Advertisers to date: 112. Last year, 120, or 8 less.

Grand total to date: 1,573. In 1979 the total was 1,762, a decrease of 189.

Before I end my report, I want to mention again that Conrail certainly deserves special recognition for their membership drive. As of yesterday they have a total of 182 members. Of course all the other railroads certainly deserve recognition for their drives and membership, but I believe Conrail's efforts have been outstanding. Thank you.

MR. BRUNER: Thank you, Dick.

I would now like to call on Past President Ky Pruchnicki to give the report of the Nominating Committee. I see our Secretary-Treasurer will give the report in Ky's place.

MR. KOERNER: Ky doesn't have his reading glasses with him, so I will give the report of the Nominating Committee and the financial report.

This is the Nominating Committee's report for the year 1980-81:

1980-1981
LMOA OFFICERS' LISTING

President: Robert G. Clevenger, General Electrical Foreman, The Atchison, Topeka & Santa Fe Rwy. Co., Kansas City, KS

1st Vice President: N. A. Buskey, Assistant General Manager, Chessie System, Huntington, WV

2nd Vice President: Frank D. Bruner, Assistant Chief Mechanical Officer, R&D, Union Pacific Railroad, Omaha, NE

3rd Vice President R. R. Holmes, Director Chemical Labs and Environment, Union Pacific Railroad, Omaha, NE

4th Vice President, D. M. Walker, Diesel Superintendent, Southern Railway Co., Atlanta, GA

5th Vice President, Kjell Axelson, Manager Motive Power-Mechanical, Burlington Northern, Inc., St. Paul, MN

6th Vice President, W. R. James, General Manager-Locomotive Department, Chessie System, Huntington, WV

7th Vice President: D. H. Propp, Asst. Chief Mechanical Officer, Burlington Northern, Inc., St. Paul, MN

Secretary-Treasurer, Joseph J. T. Koerner, Chief Accountant-Mechanical, Chessie System, Huntington, WV

MR. KOERNER [continuing]: That is the proposed slate. Are there any other nominations? If not, all those in favor of the slate, please say "aye." Any opposed? The slate is approved.

Now may I read the financial report.

LOCOMOTIVE MAINTENANCE OFFICERS ASSOCIATION STATEMENT OF REVENUES, EXPENDITURES AND CASH BALANCES CALENDAR YEAR 1979

BALANCES IN FUNDS JANUARY 1, 1979:			
Checking Account — Security Bank		$ 6,419	
Reserve Account — Security Bank		10,997	
Balance			$17,416
REVENUES:			
Interest on Reserve Account	$ 685		
Active Membership Dues	11,020		
Associate Membership Dues	6,268		
Registration Fees	2,520		
Advertising Revenues	23,085		
Miscellaneous	231		
Total Receipts		$43,809	
EXPENDITURES:			
Convention, Publication and Travel Expense	$18,964		
Office Expense, Office Assistance, Payroll Taxes, Supplies, Postage and Stationery	20,968		
Total Expenditures		39,932	
Excess Revenues Over Expenditures			3,877
BALANCES IN FUNDS DECEMBER 31, 1979			$21,293
Checking Account Balance	$ 4,612		
Reserve Account Balance	16,681		
Total as Above	$21,293		

APPROVED:
James H. Long, President

APPROVED:
Robert G. Clevenger, 1st Vice President

Approved this 7th day of April 1980, Chicago, Illinois.

MONDAY AFTERNOON SESSION

September 22, 1980

REPORT OF THE COMMITTEE ON DIESEL MATERIAL CONTROL

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

F. D. BRUNER
3rd VICE PRESIDENT
Asst. C.M O.-R. & D.
Union Pacific Railroad
Omaha, NB

MR. BRUNER: Thank you very much.

That concludes our business session. Will the Diesel Material Control Committee please come to the podium at this time.

[Mr. Bruner introduced Mr. Donald L. Ward, Chairman of the Diesel Material Control Committee. Mr. Ward then introduced the members of his Committee. The report was summarized by Mr. M. L. Wall, Mr. F. A. Blundon, Mr. L. C. Showers and Mr. M. G. Dinius.

MR. WARD: This concludes our paper, but before I open the floor to questions I would like to take this opportunity, on behalf of all the members of this Committee, to thank the Chicago Railroad Diesel Club, the officers and members, for the opportunity they gave us in April to make our preconvention presentation. They were most attentive, and we thank them for the opportunity. We will now open the floor to questions.

MR. DAN TURNER [SAB Harmon Industries, Inc., Grain Valley, Missouri]: I would like to know what the effect of robbing parts from locomotives has on the parts warranty.

MR. D. L. WARD [Engineer Motive Power, St. Louis-San Francisco Railway, Springfield, Missouri]: That section of the paper was written by Bob Hall, of GE. Unfortunately Bob is in school this month and is unable to be here. I wish he were present. We also don't have a representative from EMD on the platform today, but I asked Bob to let me know, because we had a suspicion that warranty might be questioned.

He wrote me concerning this matter, saying that robbing material from a stored locomotive that is under warranty, and applying it to an old locomotive, will cause the part to automatically lose warranty. If a customer, let's say GE, maintains records of new parts applications and the robbing of parts from one locomotive and applying them to another, if the records are not often kept, this tends to destroy warranty also. Finally, he said that application of old robbed components to an in-warranty locomotive, one that is running and in warranty, the fact that you put the robbed parts on it could possibly affect the warranty, and GE would deal with these cases on an individual basis. I have no definite answer as to how badly robbing materials will affect warranty.

Any other questions?

MR. D. G. GOEHRING [Manager, Maintenance Planning, National Railroad Passenger Corporation, Washington, D. C.]: You mentioned the reasons for robbing a locomotive of parts. The report says, "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."

I agree with that, but I think there is one other point. I think another reason why parts are robbed is because people in the shop don't take it upon themselves to try to find in the storehouse the part that they need. Many times I have had experience where parts have been in the storehouse and not drawn out for application to a locomotive because it was easier for the employee to take the part off an adjoining locomotive. Then when that adjoining locomotive was to be returned to service it also had to be repaired due to the missing part, sometimes unknowingly. So, some of the onus belongs to the mechanical people for the robbing of parts, not to just the material people.

MR. BUTLER: I have a suggestion. Right now we have over 800 serviceable locomotives stored, and three weeks ago we had over 1,000. To prevent anybody from robbing, we banded the locomotives with steel banding, and we had over 1,000 locomotives banded. We had people checking the bands as they went through the yards. We didn't lose anything. You just have to break them of the habit of cannibalizing locomotives. It is too much trouble to cut the bands and re-band them.

VOICE: Can you give us some

examples of seasonal and cyclical items?

MR. F. A. BLUNDON [Regional Manager - Material, Burlington Northern, St. Paul, Minnesota]: Some examples of seasonal items as pertains to locomotive maintenance are carbody air filters, antifreeze, methanol, water coolers, cab heater cores, other radiator cores, and washing chemicals that are used for carbody cleaning.

Cyclical items are items used more or less continuously, such as piston rings, cylinder heads, repair parts for traction motors, air compressor parts, and power assemblies.

MR. R. G. CLEVENGER [General Electrical Foreman, Atchison, Topeka & Santa Fe, Kansas City, Kansas]: I would like to ask the Committee if they have ever given any thought to how much the cost of an item should be before it is claimed for warranty. A point in question is the modular cards on all of our new locomotives. They have quite a bit of solid state equipment on them which is quite cheap if you buy it yourself. Because of this, sometimes it is not worthwhile to claim warranty on an item such as this. I just wonder if anybody has a feeling on how much you should pay before it is worthwhile to claim warranty.

MR. WARD: Four years ago the Committee had a paper on warranty, and the fact that a lot of railroads failed to claim warranty on a great number of items that they removed or replaced on locomotives. We never set a lower limit. We were looking at major items. We have never really looked dollar-and-cents-wise at where you would cut it off, where it would no longer be economical to claim the warranty. We might study that next year in our paper.

MR. CLEVENGER: One card on GE locomotives has to do with the modulator card. It has a particular multiplier item on it that runs roughly $300, yet if you lose a transistor on that card, it might cost you $1.50 to replace it. Does that void the warranty? If it is the multiplier that went out, I would say sure, turn it in on warranty. But I questioned them on whether it is really worthwhile to turn all of those in on warranty.

MR. WARD: Would anybody from GE like to comment, since we don't have anyone from GE here and there is a specific question?

MR. FOREST MITCHELL: [General Electric Company]: Bob raises a very good point that you have to consider individually. On the cards he mentioned, for example, if you did unit-exchange it, you would be charged a basic charge, and only the failed component would be replaced, which in this case would be the cheaper transistor. If, however, the larger component was damaged, then obviously the charges would be to the General Electric Company.

There would be a basic charge, Bob, which would include the labor to take it apart and put it together

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again, but no charge for material. So, it would be to your advantage, if you had a card with many defective components, to claim the warranty. If, however, you know that the component that is defective is a minimum expense, you probably would be better off replacing it yourself.

I am speaking as objectively as I can, because there is a basic charge on each individual card. You could carry this example all the way through to a major component if you wanted to.

MR. BRUNER: Concerning warranty on electronic parts and the repair of those components, I believe it would be dependent upon the capability of the individual railroad. On the Union Pacific we have a very good electronics department located in our shops at North Platte that is very capable. We have two card testers which are used for routine checking and also for finding failed components on defective cards. A railroad may consider a local electronics house to perform running and routine maintenance, which may reduce the cost and turn-around time in component repairs. These decisions would necessarily have to be made by each individual railroad.

MR. WAYLAND DOYLE [Missouri Pacific, Kansas City, Missouri]: I would like to suggest an alternative to robbing material, and that would be borrowing from other railroads. I know Mr. Clevenger has helped us in Kansas City from time to time. I trust we have helped him, too. That may be a less expensive way of getting material.

MR. W. R. JAMES [General Manager Locomotive - Operations, Chessie System, Huntington, West Virginia]: Mr. Ward, I would appreciate further comments from you or your Committee with regard to the reclaimed power assemblies using vendor-repaired items, and specifically has your Committee recapped the principal defects that contributed to the premature failures? I notice in the report you referred to a percentage of them having failed within seven months.

MR. M. G. DINIUS [Superintendent Locomotive - Mechanical, Illinois Central Gulf, Chicago, Illinois]: Mr. James, I don't really know how to answer your question. I am not sure what you are looking for. The vendor-repaired chrome-plated liners and welded heads started to fail for head seal leaks and valve blow in the first seven months. If it was a defective head or liner he could return it to the vendor for warranty. Does that answer your question?

MR. JAMES: No, it doesn't really. What we are looking for is improved performance. I am trying to get an expression as to true cost. Did your Committee recap and identify those premature failures upon teardown, pinpointing the exact reason that caused the failure?

MR. DINIUS: No, I don't think we did, Mr. James.

MR. WARD: If there are no other questions, I will call on Bud

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

Cumbea, Regional Executive, to summarize the paper.

MR. CUMBEA: First of all, I would like to mention that I am kind of a last-minute substitute for this job. I would also like to congratulate the Committee on an excellently prepared and presented paper.

The audience participation this year so far has been much better than it was last year, and I compliment the audience for this.

Having the proper material at the right place at the right time is certainly among the top problems facing the locomotive maintenance officer. The approaches offered here are a step in the right direction. Good communication and cooperation between mechanical department and material management people cannot be overemphasized. This is probably the single most important point of this paper, and offers a topic for future continued discussion.

I might comment on a couple of the questions that were asked, and give you the benefit of some previous experience.

One is on the matter of value on warranty material. About 25 years ago on the C&O we had a policy of not claiming warranty on anything less than $100. The paper work, the extra handling, and so on, we felt overrode that cost. With today's inflation I am sure that is a pretty conservative figure.

Regarding Bill James' question on premature failures of power assemblies, this is an area that takes an excellent computer to properly document and determine what the real problems are, and the advantages of shop overhaul procedures.

I will now turn the microphone back to Frank Bruner.

MR. BRUNER: Thank you very much, Bud. You filled in very well for Mr. Gregory.

I want to congratulate the Committee on doing a very fine job on this paper. It was a difficult paper to cover. However, the speakers were able to bring out audience participation, which was also outstanding.

Material handling and material inventory, and at the right place and time, must be followed closely to keep rolling stock going at the least cost. The sharing of information between the railroads and the suppliers being involved in forecasting material needs is going in the right direction, and I hope will continue.

I will now turn the microphone back to Mr. Long.

PRESIDENT LONG: That was a very good presentation, and a fast one, too.

I have a few announcements. When you get the transcript of your remarks, correct them and return them immediately to the reporting company. Stay out of the supply hospitality rooms during meetings. Let's enroll every supply member we can.

On Wednesday morning we will have the What's Your Problem panel. If you have any unanswered questions, please turn them in to any of the officers and they will see that they are presented to the Committee. Let's not forget that our first and most important meeting of the new Association year is scheduled for Wednesday afternoon in Room 418.

At this time we will call the session recessed. I would like to ask for a rising vote of thanks to this Committee for its fine presentation.

[The audience arose and applauded.]

[The meeting recessed at 3:10 p. m.]

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TUESDAY MORNING SESSION
September 23, 1980

REPORT OF THE COMMITTEE ON FUEL AND LUBRICANTS

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

R. R. HOLMES
4th VICE PRESIDENT
Chief Chemist
Union Pacific Railroad
Omaha, NE

The meeting reconvened at 9 a.m., Mr. J. H. Long, President, presiding.

PRESIDENT LONG: At this time I would like to call on Vice President Dick Holmes to act as officer of the session.

MR. HOLMES: We are starting right on schedule. We have a good representation here. We are now ready for the 1980 report of the Committee on Fuel and Lubricants. Mr. John D. Smalling, Chairman.

[Mr. Holmes introduced Mr. Smalling, Chemical Engineer, Southern Pacific Transportation Company, San Francisco, California. Mr. Smalling then introduced the members of his Committee. Mr. E. A. Goff, Industry Sales Executive, Mobil Oil Company, Chicago, Illinois, summarized Part I of the report.]

MR. SMALLING: We will open the floor to discussion. Are there any questions?

MR. MEDOVICH: We on Conrail don't want to mix high VI oil, because of the way we measure viscosity. My question is directed to the oil suppliers.

If we wanted to switch in the near future across the board to a high VI oil, 8 to 10 million gallons a year, would it be available? Secondly, what is the cost differential?

MR. J. F. HILLARD [Senior Product Engineer, Texaco, Beacon, New York]: Let's repeat the question so we are sure we all understand it. The question is that Conrail does not want to mix medium and high VI engine oils, and they want to know if 8 to 10 million gallons of high VI oil would be available to them next year. Secondly, what would the price differential be?

The second part of the question I will not answer because I honestly don't know what the pricing situation is. I don't know if there would be a price differential or not.

The first part of the question I should answer in a broader sense than just Conrail. I am sure there are suppliers who could make 8 to 10 million gallons of high VI oil available to Conrail or any other given railroad. The problem that will come up if all railroads decide they don't want to mix oils, and go strictly to high VI oils, is that those oil companies that now have adequate supplies of high viscosity naphthenic base oils which they are putting into their railroad oils will then have to switch from these to high VI stocks which are now being used in other areas.

Regardless of the situation today, which is that in most cases there are adequate supplies for all lubricants and fuels, the future is not going to be that way. In order to let the railroads have the best possible availability, the only way you are going to do it is to accept mixing of medium and high VI oils. This is the way you are going to get the maximum available for the longest length of time.

I, as an oil company representative, would hate to see people across the board go to demanding strictly high VI oils. I am sure one or more companies would probably, in that case, have to get completely out of the diesel engine oil supply field.

There is nothing inherently wrong with mixing oils, and I say this with all due respect to EMD and their position, that they would not like to see a given railroad mix these types of oils. As a matter of fact, for years what you have been receiving is a mixed oil. You end up with a 70 VI oil in most cases by taking a nominal, very low VI and nominally very high VI oil and mixing them together to produce a 70 VI oil. So, what you are talking about, as far as mixing oils is concerned, is not very different from what you have been getting in the past.

So, I think the answer to the Conrail question is that undoubtedly someone could supply the 8 to 10 million gallons they are looking for. If the entire railroad industry went this way, it would be a negative factor in trying to make sure you had an adequate supply of lubricating oils.

As to the price, I am sorry I can't answer that. I am sure if you talk to some of our Texaco representatives who are in the marketing end of it they will be able to help you, but I can't answer that question.

MR. SMALLING: Are there any other oil suppliers who would care to speak to this? Since we are on the subject, I would like to hear the engine builders' views on the mixture of medium and high VI oils.

MR. THOMAS PRATT [EMD, LaGrange, Illinois]: EMD's view is not that we object to the mixing of high and medium VI oils. That is stated in one of our POINTERS (11L-79). The objection comes from the difficulties that we feel would be encountered by the railroad labs in determining even smaller viscosity increases or decreases due to the fact that this would have to be done at 210°. That is the main problem we see with it.

MR. SMALLING: As you may recall, the subject of viscosities was covered in last year's paper. There are two types used to check for fuel dilution and oxidation on the railroads.

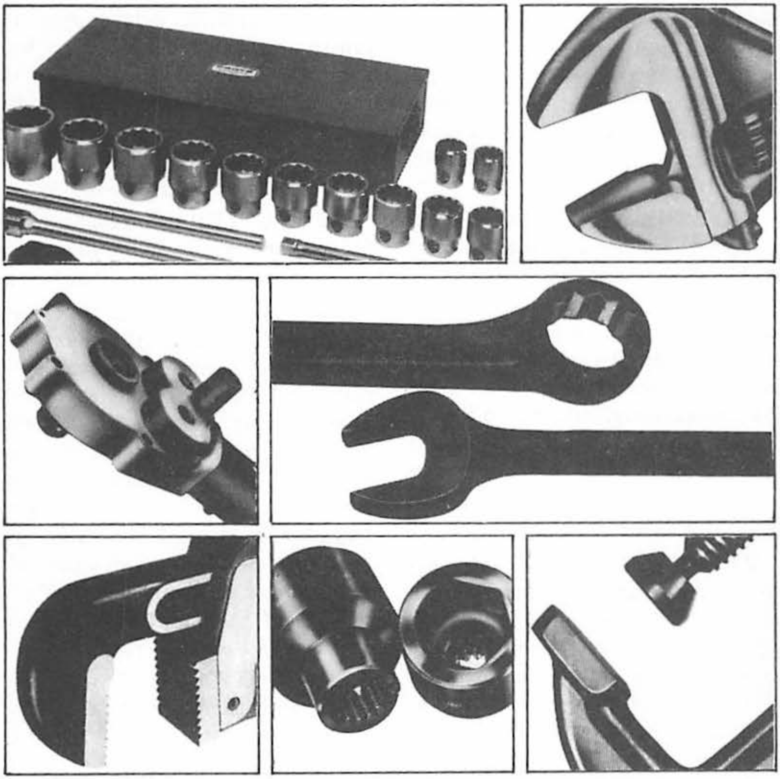
The high VI oils may be determined by the viscosity at 210°F with no problems, but if you get into a mixture of the medium and high VI oils you may encounter difficulties while running the viscosity at 100°F.

MR. CHARLES LENZINI [Engineer of Tests, Missouri Pacific Railroad, St. Louis, Missouri]: I would like to say that the Missouri Pacific has been testing lube oils at 210°F for 30 years without problems, and for the last year we have been mixing high VI and medium VI oils without problems.

MR. J. G. HOFFMAN [Manager, Combustion Engineering, General Electric Company, Erie, Pennsylvania]: From GE's point of view with respect to mixing and using high VI and medium VI oils, we recognized what Tom is saying: It definitely causes difficulty in lab control.

In our view, with respect to whether it will or will not work in the engine, there is no problem. Certainly Jack Hillard's point, that the majority of medium VI oils being obtained today are mixtures of high and medium VI, is not 100 per cent true. The real problem that I think the industry has to recognize is that even if railroad A, B or C decides to use all high VI or all medium VI, as the case might be, in today's world of railroading locomotives do not remain on railroad A, B or C. Thus, the real problem is not with an individual railroad controlling viscosity on its own locomotives, but rather the question which develops when railroad A examines a sample of lube oil from some other road's locomotive, not knowing what is in the crankcase, and then tries to make a judgment of what the determined viscosity means.

It is a real problem, but one which is amenable to a solution of using 210°F viscosity as the check point. The 210 viscosity really is the more important value,



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anyway. The problem arises in remote oil control stations rather than the main lab. The attention to details of the test temperature is in fact quite vital. A change in temperature of the bath by a tenth of a degree upsets the whole picture.

MR. LENZINI: The basis of our success and control of the viscosity at 210°F is that we specify the viscosity of the new oil to be 78 to 80 Saybolt Seconds at 210°F. We will take one second over and one second under occasionally, but not consistently, and the oil companies have been able to supply us with oil in this viscosity range.

[Mr. Hoffman summarized Part II of the report.]

MR. BUTLER: Jack, you spoke about the tests on some of the fuels used in the early 1950s. If my memory serves me, in those days we were using fuel on some of these tests that had cetane as high as 48 or 49, and we had tremendous problems keeping rings in the 4-cylinder engine. Would a higher cetane have any effect on today's locomotives?

MR. HOFFMAN: I am not sure I remember the incident you are talking about. Generally speaking, the answer is no. Nor, generally speaking, will you receive any benefits with very high cetane number except as a blending stock for something like some coal-derived material which has a zero cetane number.

On the other hand, a very low cetane like 16 or 17, because of its poor ignition characteristics or long ignition delay, does not ignite until too much fuel has been injected. When it does ignite, the rate of pressure rise in the cylinder is excessive, and an audible knock develops which certainly could lead to ring breakage.

MR. BUTLER: I probably had that cetane reversed. It must have been the low cetane. Thank you.

MR. PROPP: In your report you mentioned that in the next five years, with limited availability of fuels, we should be considering the heavier residual fuels. I know work was done by railroads some years ago, and a few roads consumed some heavy residual oils. What is the current status? What are you as engine builders or oil companies doing today in using blends of 10% to 25% of these heavier fuels, and what have been the results?

MR. HOFFMAN: I will reply first, and then I will ask EMD or anybody else to address the question.

The question is, "Is there any current work going on with blends of residual materials and diesel fuel?" The answer is yes. From our position, there is. We have recently completed a 100,000 gallon full-scale multicylinder evaluation of a 10% No. 6 oil in 90% distillate fuel. No special handling was required with the particular products that were blended. No heating was required. The pour point was approximately zero. No problems were encountered, either. I recognize that 100,000 gallons compared to the use of fuel on a railroad is a small quantity. By the same token, 100,000 gallons is a relatively long lab durability test.

MR. D. M. LAMBERT [Technical Engineer, EMD, LaGrange, Illinois]: Presently EMD is in the process of looking at certain residual blends. However, I think you will find that because of the nature of the residuals it is not well defined as to what those residuals are. If you get a residual fuel from one location as compared to another, there could be some drastic differences.

There are some extensive evaluations required in terms of vanadium and sodium content, in these fuels, as compared to what it will do to the durability of our engines. Because of that, you have to approach it slowly. That is what I am saying. The work is in process, however.

MR. SMALLING: This question was just passed to me, and it is a very timely one. You will remember the slide chart Jack presented proposed Grade 3 diesel fuel. The ASTM committee has never given a specification for this fuel. Would someone on the LMOA committee comment on Grade 3 fuel?

MR. J. L. WILKISON [Staff Engineer, Shell Oil Company, Houston, Texas]: Much to the surprise of many people, the proposed #3D fuel got a rather poor reception in the ASTM D-2 committee. Some oil company representatives as well as some railroad representatives voted against the proposed #3D specification. Some oil companies objected because of logistical problems associated with the manufacture and distribution of another fuel. Some railroads objected because they do not want to use a #3D type fuel.

One may question whether or not these are valid objections. For example, a #4D specification exists, but many of the oil companies do not distribute this product nor is it used very much in diesel engines. The proposed #3D, at least for this year, is not going to be approved by the ASTM. However, it is not dead, as I understand it.

The representative of my employer, who is a voting member of the ASTM D-2 committee, says it will come up again next year, and hopefully, maybe by the end of 1981, it will eventually become an ASTM standard. But I believe very definitely there is a need for this type of fuel, as Jack Hoffman has indicated, so that when the #2D crunch does come again, like it did in 1979, a viable alternative to #2D will be available for the industry.

MR. HOLMES: I might expand a little bit on that. I was at the ASTM meeting at Chicago where the ballot was taken and the committee turned down the proposed #3D spec.

In addition to the points that Jim Wilkison has made, there are some serious questions to be considered. One of the questions was whether, indeed, a #3D or degraded spec would increase the availability of the fuel oil. A little bit of background on that:

It is my understanding that even with present capabilities, refinery flexibility with present type crudes will allow some of them 11% or even more variation in the production of various cuts. In other words, right now some refineries can produce possibly 11% more of distillate fuels. Of course that means a barrel of crude is still just a barrel of crude in quantity. If middle distillate produced is increased 11%, the gasoline and other products will be decreased. With the gasoline use decreasing, that may be a possibility.

Also, for heavier crudes that are coming out of the Rocky Mountain Overthrust Belt area, refinery additions or modifications have been been made to increase the efficiency of the production of certain cuts from this crude. In other words, they can get more out of that barrel of the desired cuts; more gasoline, more distillate and less asphalt. So, that is possibly a potential increase in available distillate from that area.

As Jim said, some oil companies took a negative attitude about stocking two types of fuel oil. Right now, if a #3D specification were put on record, there is a strong possibility that some oil companies are going to produce #2D or they will produce #3D, not both. Refineries may not have the storage capacity to store these two types of products which are that close in characteristics.

These views are supported by some of our Committee members and were conveyed to ASTM. Why should the railroads buy a degraded product now that they don't want, and that isn't really necessary at this point in time? Having a #3D specification on the books would be acceptable to be used as an available alternative to #2D if adequate supply of that became short. A serious concern is that some suppliers may limit their production to a single specification distillate, which could be less desirable #3D. An emergency specification may be more appropriate.

A concerned company in this regard is one of our major suppliers.

The other serious exception that was taken—and this was by GMC Research—was in regard to small diesel cars. I think Mack Truck was one other, for truck diesels. In regard to the 90% distillation level being increased, they are seriously concerned about possible increase in smoke produced. With improvements in diesel engine design at the present time, the smoke level is low in a good operating engine.

Considering a significant change in the 90% level raised a question about potential increase in the smoke. Considering cetane number reduced to 37—sure, a diesel

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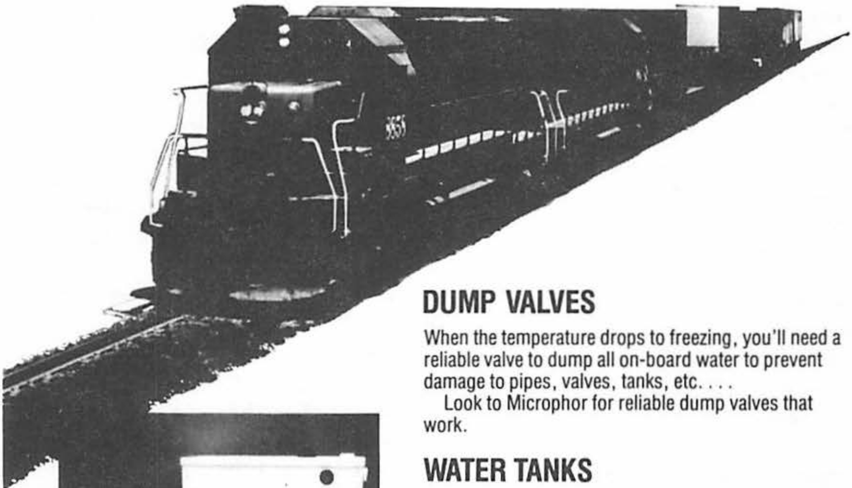

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engine would run on that. However, in allowing that to degrade along with the other parameters, it could contribute to trouble starting a locomotive in the wintertime, or other undesirable side effects such as poor injector lubrication and pumping the fuel oil.

Another thing is that #3D specification would allow deeper cut into the gas/oil fraction. This means that the wax content is going to increase measurably, and that is one of the banes of the railroad's existence during deep-freeze periods in the wintertime. There again, this isn't what we want.

I don't think there have really been any firm forecasts made beyond 1985, but barring significant reduction in foreign crude I believe our supply of diesel fuel oil is going to continue for railroad use generally much the same as it has been into the foreseeable future, even beyond 1985.

Characteristics of fuel oil for railroads should closely resemble present product or with predetermined deviations, even from other sources, as shale oil, and so on. Much of this depends upon economics and the extent to which products are refined. There are other areas where alternate fuels are much more suitable, such as gasoline extenders, refinery feedstock, boiler fuel, and the like. This would relieve pressure on availability of fuel for transportation.

This doesn't mean to say that we cannot make significant gains for the industry by research in alternate fuels. In fact, as a member railroad we are supporting the AAR-SwRI Work in which Jack, too, has been an active participant. We are in complete agreement with everything he said about that.

Testing is going on, but it is my impression from what I have heard from the builders so far that we are going to have to continue to use, with their engine as presently designed, distillate fuel or something that looks close to it in the foreseeable future, because use of a radically different product would require design modification in the engine itself. This takes longer range development. Immediate research is appropriate to determine "how bad" a fuel can be used in the diesel engine, and what are the tradeoffs.

MR. HILLARD: Dick was talking about the #3D spec. I don't know whether he got off onto something else or not, but maybe I misunderstood him. I think he just said the diesel engine builders would not say their engines will operate properly with #3D. Did I misunderstand what you said?

MR. HOLMES: No, I am sorry. What I meant to say was that we would be operating on distillate fuel or something that looked like it for some time. Nobody says an engine won't run on the #3D spec. It will not run as well, and with more potential problems in maintenance or environmental effect.

Research data should be obtained first to show extent of adverse effects.

MR. D. M. LAMBERT [Technical Engineer, EMD, LaGrange, Illinois]: As far as EMD is concerned, we feel that with minor modifications of our engines we could burn a #3D fuel, but there is quite a bit of question as to what finally #3D is going to be when and if it is accepted. So, until that time we have to wait until #3D is in existence. It is not a question of acceptability or usability in our engine.

MR. PRATT: I would like to clarify a few things about the #3D fuel. It does not represent a fuel that cannot be burned in the EMD engine, nor in the GE, I am sure. The #3D spec does allow for higher sulfur content, and that will naturally cause increased component wear and will probably require a higher alkaline reserve lube oil, but it can be handled.

As Dick pointed out, I believe there could be some cloud point problems with this product.

The other thing with regard to the alternate fuels, such as alcohols, and depending on the properties of coal and shale derived syn fuels: If these products are not fully upgraded they could require rather drastic engine modifications if, in fact, they had to be burned in a state where they reflect very low cetane characteristics.

I believe as Dick does, that down the road I would expect the diesel engine will be seeing shale-derived fuels which will be quite similar to the #2 product that is being used today.

MR. HOFFMAN: I don't intend to get into a debate with Dick concerning points of view with respect to fuel specifications. The proposed #3D specification falls within GE's broadest fuel spec at the present time. I think the real point is not whether ASTM adopts that specification or some similar one, but rather that most railroads (or many railroads) in this audience are using fuel oils that are well beyond their present specification right now. This is not because either they or we want to, but at times of supply crunch it is necessary for them to take whatever they can get. Oftentimes those fuels approach or go beyond the suggested #3D spec.

I personally don't care whether #3D is adopted as a particular spec, or not. I think it might expedite additional product being available. The message I want to leave with you is that we can expect changed fuel quality to what we have been used to in the recent past: sulfur contents of .3, cetane numbers of 45 and greater, and very moderate end points of 600°F. We are going to see changes. We had better continue to work at defining just what can be used with a minimum amount of maintenance changes.

MR. G. H. BARKER [Chief Mechanical Officer, Soo Line Railroad, Minneapolis, Minnesota]: In addressing the question of availability of petroleum products, could your Committee give us an update on the use of synthetic or the high performance lubricating oils that are now being marketed for automotive use?

MR. SMALLING: Would anyone on the Committee care to comment on the synthetic type oils at this time? Synthetic lubricants were covered in a paper by this Committee three or four years ago. I don't know if there has been an update or not. Possibly the oil suppliers might like to comment.

MR. E. A. GOFF [Industry Sales Executive, Mobil Oil Corporation, Schaumberg, Illinois]: As John said, we covered this in a previous paper. In our Committee meeting this came up, as to whether or not we ought to talk more about it this year.

Regarding the use of synthetic lubricants, one of the things that you have to face is that synthetic lube oils cost a great deal more than the lube oils you are using now. The plain economics of it will probably retard the use of synthetics, plus the practice of controlling your operating costs. We heard some numbers in our Committee discussion that Jack Hoffman gave us, as to the amount of money that it costs to operate locomotives per mile, and yesterday in the keynote address Mr. J. W. Gessner talked about the cost per ton mile.

If you start to use synthetic lube oils in your locomotives and are comparing round numbers—if your present lube oil costs you $3 a gallon and you will raise that to $9 a gallon, you then are going to increase the cost of the ton mile operations of your railroad, and that is one of the reasons why we haven't given it much space in our Committee paper.

MR. BARKER: Along with an increased cost of lubricating oil, at least the manufacturers of synthetic lubes are claiming offsets in the use of fuel. So, until we have those figures in front of us, I don't think we should make a judgment as to whether or not it will increase the cost of operating the railroad.

Your answer did not address the high performance type lube oils that are now being marketed. Arco graphite, for example.

MR. V. E. BROMAN [Product Engineer, ARCO, Harvey, Illinois]: The first name you mentioned is ARCO graphite. Of course it arouses a lot of sparks of interest as far as ARCO is concerned.

Basically, ARCO graphite performs best in high speed engines where rubbing is a factor. Large, slow speed engines with built-in clearances have less need for friction modifiers. Graphite forms a bond with cylinder walls or other moving surfaces. This requires about 700 miles in an automotive engine. The graphite layer reduces

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friction by shearing a laminar layer when two surfaces make contact.

In the case of high speed engines there is a lot of rubbing, and the need for a friction modifier has a great deal of potential. So, in high speed trucks and in automotive engines ARCO graphite has worked very, very well. The average fuel savings are about 5%. A recent Department of Energy report confirms this savings. They found in their own independently run tests about a 4.6% savings.

When you start applying fuel savings ideas to a diesel engine such as a locomotive, the problems are unique to these engines. The lubricant is quite different compared to either truck or automotive engine oils. We can, however, apply diesel truck engine oil developments to the locomotive and find a fuel saving potential.

One distinct possibility is multigrading. Multigrading can give about 2% - 3% fuel savings. Even if the savings were 1%, that would be a very sizable amount of fuel as far as the railroads are concerned.

The reason multigrading might work is that it allows for the use of a lower viscosity base oil, and this lower viscosity base oil requires less engine energy than a higher molecular weight base oil such as is used in SAE40.

Let's consider the properties of a VI improver. When it gets cold it contracts, and when it is hot it expands. As a consequence of this property of expanding and contracting, a multigraded oil can be built with the viscosity of a 10 or 20 SAE grade at low temperatures and those of a 40 or 50 grade at engine temperatures. When the multigrading principle is applied to a locomotive oil there is a lower energy demand required to operate the engine, and this can be translated into fuel savings.

There are reasons why this idea hasn't been put into practice in locomotive engines as yet. The available additives when not thermally stable, as a consequence gave high groove fill which was unacceptable. Now new technology has come along with very good, thermally stable VI improvers which allow the multigraded oils to be used in diesel engines.

Currently 15W-40 oils are gaining wide acceptance in truck engines. The choice in railroad engines would be a somewhat higher viscosity oil, such as a 20W-40 or 20W-50. An important part of any such test would be very accurate fuel consumption records. Fuel consumption records are needed to document whether the change in multigrade oils is going to be economically worthwhile.

Now, to answer the rest of your question, concerning high performance oils. High performance oils have been made using a very new technology as far as locomotive engines are concerned. This new technology allows over-

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based additives (products with a great deal of alkalinity) to be used in the presence of a silver insert bearing. Normally, silver insert bearings would be destroyed by the presence of high alkalinity. This technology has resulted in very low top groove fill in both the 2- and 4-cycle engines, and in the availability of a great deal of base or alkalinity. This alkalinity handles combustion products that would normally degrade or shorten the crankcase life of an oil.

As you all know, there are plenty of engines that use one gallon of oil per 100 gallons of fuel still running around. Make-up oils allow fresh oil to be added to refortify the additive system. Once that refortification has occurred, the crankcase oil can continue to function, thus extending its life. With the newer low oil consumption engines that control the amount of oil that is used, we no longer have this make-up oil advantage or privilege (whichever it is). Therefore, the higher alkalinity oils are needed in these low consumption engines in order to continue to get reasonable crankcase life.

These oils have the potential for good performance under severe operating conditions. They add 10 or 13 total base number to the crankcase compared to 7 to 9 for current technology oils.

MR. NEELY: I would like to address my remarks to Mr. Lambert of EMD. Prior to 1978 I ran gears in my traction motors for a distance of 3,000 miles and had no problem with lubrication. On the EMD's recommendation I changed to a lithium based grease. Within one year's time I ran into major crises on my railroad because I was running out of lubrication.

I ran tests on old gear cases—in other words, the ones that had been in for a long time—and found that my maintenance practices weren't up to what they should be, so we tried to correct that problem. Then we found that this lithium based grease wouldn't last in the old gear cases, so we tested the lithium based grease in new gear cases, and found we could barely make 1,500 miles without running out of gear grease. So, we went to the gear grease manufacturers and they supplied us with a lithium based heavy type grease which we are now getting.

I know the Burlington Northern is having the same problem. I saw a paper the other day from them. I wonder how much of a problem there is in the industry with this lithium based grease.

MR. D. M. LAMBERT [Technical Engineer, EMD, LaGrange, Illinois]: You have caught me unaware. I am not very familiar with that particular problem. I hope one of my people who is here is a little more familiar with the situation.

MR. BUTLER: We are having the same problem, Bob, and we have adapted the GE special lithium based grease. We are hoping that will get us out of trouble. Our trouble started when the 90-day inspection came in. We are trying to stretch everything out to meet the inspection. We have a 15-day inspection and a 45-day inspection. On our GP40 and GP40-2 units we are adding grease on the 15-day inspection, and on the 2000 horsepower and above we are adding it on the 45-day inspection, but we do think the GE spec is a better spec. There was a meeting in Chicago two weeks ago between EMD and GE on this very subject. However, to date I haven't heard any of the results of that meeting.

MR. D. M. WALKER [Diesel Superintendent, Southern Railway, Atlanta, Georgia]: We changed over in February and would consider we are into a major problem already.

MR. HOFFMAN: There was a meeting in Chicago called by the AAR to address that particular problem about a week ago. There were GE and EMD representatives there. The AAR has asked the American Society of Lubrication Engineers' railroad group to try to help them define the specification or whatever else needs to be done to solve the problem. Beyond that, I really can't comment.

MR. KJELL AXELSON [Manager Motive Power, Burlington Northern, Inc., St. Paul, Minnesota]: We are having a problem with lithium based grease in our gear cases. We have retention problems. We are fearful of migration to the traction motor armature bearing. As a matter of update, I think we are all in the learning curve at this point. We are looking for feedback.

To update everyone here, this matter is getting high priority attention in the AAR Locomotive Committee jointly with the AAR Lubrication Committee, so I think at this point everybody is blue-skying it and guessing, and hopefully within the next year we will have some facts and figures to develop a good, sound base for lithium grease.

I think the intent was to improve gear lubrication, and we expected benefits with less channeling and cold weather operation, which the Burlington Northern as well as others are faced with, as well as to satisfy the southern operating sector. It is generally known that lithium is supposed to have a better EP quality for gear wear reduction, so I think we shouldn't give up on it but should continue to pursue it, and hopefully solve that problem.

MR. JOHN HAYDEN [EMD]: I would like to suggest that the question be deferred to the What's Your Problem session. I think with the number of people who have expressed themselves on this problem, we can expect a pretty good attendance and discussion.

MR. SMALLING: That is a good suggestion, because we have run out of time. It does seem to be a big problem with not one or two railroads but nationwide. We will have the majority of this Committee present tomorrow morning at the What's Your Problem session, and that question plus many others I am sure will be asked. Hopefully we can come up with some answer to it.

Gentlemen, before closing our report I would like to thank the Union Pacific Railroad for having this Committee at their preconvention meeting. It was a very nice turnout and it was very active, and there were many questions and much discussion. This is where we go to present our problems and maybe discuss things and come up with some good solutions.

Now I will turn the session back to Dale Propp for summation.

MR. PROPP: As always, this Committtee has done a commendable job presenting a paper to us here at LMOA. As shown in our program bulletin, this Committee's theme for the 1980 report is "Fuel and Lubricants, A New Decade." It is obvious we are in a new decade. I know many of us, during the last ten years, have heard some of the subjects discussed today on high and medium VI oils and associated high and low TBN. As we look to the future, certainly we will be discussing the same subjects, but increasing the numbers with TBN's up to 30. I understand some of those high TBN oils are being utilized. Maybe it sounds extreme, but with the advent of lower quality fuels our industry will require these changes.

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

You heard your Committee say the fuel shortage is real, even though the supply is greatly improved over last year. It is obvious we in the railroad industry must continue to research the alternatives for a means of providing fuels to the industry.

The Committee said that in the next five years we may be utilizing residual oils or lower grade #2s, #3s, light #4s, or blends of these types of oils. We did hear some opposition, so obviously this is going to be a debatable question. However, all of us will have to be willing and ready to accept some product changes in the event of another fuel crisis.

In the long term, five or ten years, shale oils and tar sands will be approved alternatives. The Committee noted that research will continue into the synthetic fuels and alcohols from coal. Certainly we can look forward to a decade of change in petroleum lubrication products.

Again, I would like to thank John Smalling, Earl Goff, Jack Hoffman, and every member of this Committee for their splendid presentation today. I would like to suggest to the new chairman, and challenge him with, the subject of traction motor lubricants. It is a current subject on all our minds which is critical and must be resolved in the next few months. A status report by next year would certainly be very worthwhile.

Now I would like to ask you to give this Committee a big hand for a job well done. [Applause]

MR. HOLMES: Will the New Developments Committee come to the podium, please. I will turn the meeting back to President Jim Long.

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TUESDAY MORNING SESSION
September 23, 1980

REPORT OF THE COMMITTEE ON NEW DEVELOPMENTS

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

D. M. WALKER
5th VICE PRESIDENT
Diesel Superintendent
Southern Railway Co.
Atlanta, GA

PRESIDENT LONG: I would like to call on Darrell Walker to act as chairman of this session.

MR. WALKER: It is my honor today to introduce the chairman of the New Developments Committee.

[Mr. Walker introduced Mr. David G. Goehring, Manager, Maintenance Planning, National Railroad Passenger Corporation, Washington, D.C. Mr. Goehring introduced the members of his Committee. Mr. Tom Enns summarized Part I of the report; Mr. T. L. Scott summarized Part II; Mr. T. C. Whittle summarized Part III and Mr. M. E. Kane summarized Part IV.]

MR. GOEHRING: That completes the formal presentation of the paper. Because this is the New Developments Committee, there are a number of things that were talked about here and that were written about approximately 8 months ago, on which developments have gone beyond what we have talked about here today, so really as a New Developments Committee we are just as interested as you are in learning and extending what we have already been able to tell you.

So, at this time I would like to open the meeting to questions and comments or anything you people have had in your personal experience that could add to what has already been said.

MR. JOHN FERGUSON [Avicon, Richardson, Texas]: In response to what Mr. Whittle said about on-board controls, our company manufactures the Avicon system that he spoke about. Since the time the information was presented to this Committee we have successfully completed testing on this system, and it is in full production.

Several things we have discovered we felt were important in engine management systems, as Mr. Whittle said. We do monitor speed, the fuel flow, the remaining fuel, the different things we think are important in monitoring an engine and fuel management, but one of the most important discoveries we made was the importance of monitoring fuel temperatures because, as stated this morning, the change in fuels and alternate energy sources that people are going to go into, our systems do not automatically monitor and take into consideration the temperature of the system.

We make changes due to specific gravity and density giving an extremely accurate fuel consumption management. We also have developed systems which monitor and measure critical temperatures in the engine and critical pressures. All of our systems do dialoguing. This can be outputted to a magnetic tape system and can be used for study by management-level personnel to go back and look at certain runs and certain arrangements of the locomotives, and what- have-you, over certain periods of time, as to the most effective way to set up and run the locomotive.

Due to the microprocessor, as Mr. Whittle said, there are changes that need to be made in the devices that are used, such as horsepower measurement. One of the nice things about a microprocessor is that units that we now have in production can be changed with minor software changes at little or no charge to the customer. Our particular systems sell for about $9,000. We have successfully completed these tests on railroads, and they will be in use throughout 1981.

MR. JOHN KOPER [Office of Research, Federal Railroad Administration, Washington, D. C.]: I would like to amplify Mr. Whittle's report about the locomotive data acquisition package.

As Dave indicated a few moments ago, this is a New Developments Committee topic. Our current expenditures today on the development of this system, which is a research tool, as was pointed out in the paper, is a little over $1 million. We hope in the future to be able to procure additional LDAP systems at between $100,000 and $200,000 a copy. These will be research devices also, and we plan to make them available to the railroads (under cooperative agreement(s) for testing purposes.

In addition to the testing that was mentioned in the paper, at Pueblo and on the Boston & Maine last year, the system is currently in the field being tested on the Union Pacific Railroad. It has been out there since the end of June. It will probably remain there until sometime next month, at which time we plan to remove it, and then on the 3rd and 4th of December we are planning to put on an LDAP Workshop.

It will be our second Energy-Management Workshop in Denver. I left some preliminary announcements on the table in the back of the room the other day. We will be mailing out a more formal program agenda in about a month.

This Workshop will cover the field testing that is underway currently; a discussion of how the system is installed on the locomotive, how it operates, and all the details and specifics of the system.

In case everyone is not aware of what that $1 million represents, it represents the design specification which was alluded to in the paper. It also includes the fabrication of the first pre-prototype. It also includes quite a bit of test support for the field testing that has been going on in the last year or so, and in addition it also includes the sensors, the transducers, the minicomputer, the signal and power conditioning equipment, as well as some of the preliminary analyses software which is necessary to analyze this copious amount of data the system is capable of providing.

It was not mentioned in the paper, but those 17 parameters only actually represent about one-third of the capability of the system as it is designed. It is actually a 48-channel system, and we are currently going through a value engineering process right now in order to optimize some of the different configurations of the equipment from the original design. The design is now 3 years old, and we are quite aware of the evolving technology in this computer field.

Thank you.

MR. C. W. COX [Assistant Superintendent of Shops, Atchison, Topeka & Santa Fe Railway, San Bernardino, Calinfornia]: I would like to know if anyone is here from the Union Pacific who can give us some more details on the newly developed transducer which will offer a longer life than the ones presently available.

MR. A. A. CHACON [Assistant General Mechanical Engineer, Union Pacific Railroad, Omaha, Nebraska]: We are working on a pressure - temperature transducer. It is made by National Semiconductor, and it is a completely solid state device. There are no moving parts in it. It can operate from a 15 to 74 volt power supply, and provides a linear output signal for both temperature and pressure. We have had one for only a short time, but from what we see so far it looks very good.

MR. GOEHRING: If there are no further questions regarding the paper, the Committee would like to thank the Santa Fe Railroad for their participation at the Kansas City Diesel Club in Kansas City of our presentation in April.

Now I would like to ask Mr. Bud Cumbea to summarize the report.

MR. CUMBEA: Once again this Committee has done an outstanding job in highlighting some of the new developments in motive power, and they deserve proper recognition on your part for a job well done.

In reviewing the topics presented, there are several comments which may create some further discussion at the What's Your Problem session tomorrow, but which may be expanded on in some future papers.

First of all, the 92-day federal inspection requirements are now a reality. However, gear case lubrication and motor support bearing lubrication require having a locomotive over a pit on a more frequent basis. We challenge the builders and suppliers to concentrate on new developments which will allow a locomotive to run the full 92-day period without scheduled attention.

Maintaining the status of modification projects continues to present a problem at staff or headquarters locations. We would like to have further discussion on methods for insuring integrity of records covering modification progress and status.

On-board monitoring is certainly a promising area, and offers a never-ending topic for future discussion.

Finally, all industry is becoming more and more goal-oriented. Computers offer the means for developing and monitoring goals in areas where manual systems are not feasible. One area where goals are definable and measurable concerns manpower efficiency. Perhaps the Committee would like to tackle this in a future paper.

Once again, this Committee has presented a very timely and interesting paper, and deserves our thanks. However, before you give them your recognition our President, Jim Long, has some closing announcements. Thank you.

PRESIDENT LONG: This Committee has made an excellent presentation, and we thank them.

I have a few announcements. Correct your transcripts immediately and return them to the reporting company. Stay out of the hospitality suites while meetings are in session. Let's go after every supply member we can get, and remember the What's Your Problem session tomorrow morning. If you have any questions, turn them over to any of the officers.

Now I will call for a rising vote of thanks to this Committee, after which we will recess until two o'clock this afternoon.

[The audience arose and applauded.]

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

TUESDAY AFTERNOON SESSION
September 23, 1980

The meeting reconvened at 2 p.m., Mr. J. H. Long, President, presiding.

PRESIDENT LONG: Will the meeting please come to order, and will the Past Presidents and Vice Presidents please come to the podium.

The first order of business is to hear from Bob Clevenger. Bob, it is a pleasure to present to you the gavel, and we welcome you as the new President of the LMOA. [Applause]

[Mr. Robert G. Clevenger assumed the Presidency of the Association.]

PRESIDENT CLEVENGER: Thank you, Jim. It is with great pleasure that I accept this gavel as President of the LMOA, and hope that I will be able to carry on the fine work performed by you, Jim, and your predecessors.

Some years back one of our former Presidents said that the main job required of a President of the LMOA or, for that matter,

Bob Clevenger accepts gavel and presidency of LMOA from Jim Long. First Vice President Nelson Buskey looks on in admiration.

the president of any organization, was the promoting of the basic requirements that are necessary for the successful operation of the organization. With the LMOA these basic requirements are a continuing membership that will support the programs of the Association and the presentation of technical papers that are related to current railroad problems, these problems to be dealt with by the committees, and solutions suggested and presented to the railroads for consideration.

If you compare these two basic requirements you will see that to achieve both of them it becomes a so-called vicious circle. You need good technical papers to entice more members, and you need an adequate membership to provide the working committees to produce the papers.

In reviewing the membership totals for the LMOA through the years, I noticed our 1939 membership was comprised of 60 active railroad members and 27 associate members, for a total of 87 members. In 1953, we had 3,288 active railroad members, 597 associate members and 118 advertisers, for a total of 4,003 members. Since 1953, our total membership has steadily dropped to 1,762 in 1979, with the greatest decrease being in the active railroad group.

As you can see, a total membership increase is going to be the prime target for the official family of the LMOA in the coming year, and I am asking each and every one of you to return to your home points and help us in any way you can to get more members. Our committees are going to do their utmost to present technical papers that are informative, and to offer solutions to any problems that are confronting our railroads.

An editorial written by Mr. Tom Shedd in the May issue of MODERN RAILROADS magazine pointed up the plight of the railroads in regard to the low rate of return on their investments, and why many roads cannot take the risk of adopting costly new technology that might not work out. Mr. Shedd's closing statement was: "Our industry needs a lot more companies and people who are willing to be first, not waiting to be second."

That is what the purpose of the LMOA is all about, and we are going to strive to be one of the leaders to help further the railroad industry. There is an old saying that if you are always getting kicked in the rear, there must be someone behind you.

We welcome the railroads to keep kicking the LMOA in the pants and urging our committees on to better and better technical papers. They can do this by appointing good working members to our committees who can bring out their railroad problems for review by the LMOA as a whole.

Again, I want to congratulate Jim Long and all of the LMOA official family for a job well done during the past year. Thank you. [Applause]

As you can see, we have a couple of our Past Presidents on the podium. We have a little chore for them to perform. I would like to call on Ky Pruchnicki.

MR. PRUCHNICKI: Gentlemen it takes a long time to become a President. You get into the ranks and work your way up. Jim Long really worked hard to get the job, and he has done a good job. We have a little token to remember us by. Jim, we want to present to you this pen set for your desk so you will remember us and all the hard work you have done. Also, may we present this book of Proceedings that you may refer to every once in a while, so you can look at it and think it covered some of the hard work you did. [Applause]

MR. THOMAS HARLEY: Jim, it gives me great pleasure to present to you the Past President's pin. It is a particular honor because Jim is actually the designer of this pin. It is something that we as Past Presidents of the LMOA are justly proud to wear, so it is a particular honor to present Jim with this pin. [Applause]

MR. LONG: I would like to thank everybody in the Association. Tom Harley told me the other evening that I was about to get the best job of all in the LMOA, the one he is leaving. He said, "In this job you won't have to do anything." [Laughter]

Jim Long, left, is shown accepting the coveted "General" desk set, and life membership, awarded to past presidents of LMOA. Tom Harley does the honors, with Frank Bruner looking on.

Here Jim Long is the recipient of the Past President's Pin being handed him by Ky Pruchnicki. Darrell Walker witnesses the presentation.

Past President Ernie Lehr, right, is shown here presenting Jim Long with red leather bound copy of 1980 Annual Publication. Dick Holmes center.

PRESIDENT CLEVENGER: Last year we failed to give Tom Harley his bound volume of the Proceedings. May we do that now, Tom. [Applause]

MR. PRUCHNICKI: Mr. Chairman of the Board, may I present to you this volume so you can read it and remember your good days with this organization. [Applause]

MR. HARLEY: Thank you very much, Ky. It has been a great honor to serve the LMOA. Going through all the chairs to the chairmanship of the Board represents a lot of years of hard work. I will admit the last year is certainly the easiest.

It is a great pleasure to be able to look back on the years of work in this organization. This is a marvelous group. It serves a real place in the railroad industry. It is a group that is needed and wanted. So, keep going, fellows. You are a marvelous organization. Keep on doing the wonderful things you have been doing for the industry. Thank you again. [Applause]

PRESIDENT CLEVENGER: These volumes that have just been presented to Tom and Jim are copies of the same book that all of you can get if you become an LMOA member prior to the preconvention meetings in April. Their copies are a little fancier, but inside the proceedings are the same.

Tom Harley. immediate past president, receives his bound copy of the 1980 Annual Publication from veteran past president George Bachman, right. Swede Axelson adds his smiling approval.

TUESDAY AFTERNOON SESSION
September 23, 1980

REPORT OF THE COMMITTEE ON DIESEL ELECTRICAL MAINTENANCE

PICTURE
NOT AVAILABLE

T. L. WESTERFIELD, Chairman
Electrical Engineer
Chicago & North Western Transp. Co.
Chicago, IL

W. R. JAMES
7th VICE PRESIDENT
Gen. Mgr. Loco.-Operations
Chessie System
Huntington, WV

PRESIDENT CLEVENGER: Now, I would like to ask the Electrical Committee to come to the podium, please. I will ask Mr. W. R. James to act as chairman of this session.

[Mr. W. R. James introduced Mr. T. L. Westerfield, chairman of the Committee on Diesel Electrical Maintenance. Mr. Westerfield then introduced the members of his Committee. The report was summarized by Mr. Westerfield, Mr. E. G. Kitchen, Mr. Frank Upton and Mr. N. Thibodeau.]

MR. WESTERFIELD: This completes our summary of the paper. We will now open the floor to questions.

VOICE: What meters does the Committee recommend be used?

MR. T. L. WESTERFIELD [Electrical Engineer, Chicago & North Western, Chicago, Illinois]: Particularly in view of the fact that the General Motors Super-series locomotives and GE's equivalent group have not as yet given us the fancy name they are going to call them, these locomotives are going to require that digital meters be used. The pricing and quality of digital meters have improved greatly. The usability of digital meters has improved greatly too, in the last two years, and the Committee's general feeling is that the digital meter is the way to go as the primary shop meter.

There are some instances where there are digital meters that are not really suitable for the task—things like making power settings when you are trying to catch a moving reading. A digital meter is next to useless on this type of testing unless it has some kind of a peephole feature. We really haven't seen anything successful along these lines yet, although I suspect it is one of the next gadgets that will be added by the builders.

The Simpson 260 type meter is useful for general troubleshooting, but it does not have the accuracy to properly eliminate power voltage settings, power settings or load boxes.

MR. R. J. DONOVAN [Supervisor Diesel Maintenance, Chicago, Milwaukee, St. Paul & Pacific Railroad, Milwaukee, Wisconsin]: This is in reference to your traction motor subject. Speaking of the test procedure described in detail, does this replace impedance or surge testing?

MR. N. THIBODEAU [Senior Electrical Engineer, Canadian National Railways, Montreal]: With that tester you do have an impedance tester as part of the console, so it is part of the test.

MR. DONOVAN: What about the field coil stator test? For example, let's say a shorted or partially shorted turn existed. I seem unable to understand, from the description of the new console traction motor tester, how this condition would be detected using the new tester.

MR. HENRY LIBAN [Senior Electrical Engineer, Conrail, Philadelphia, Pennsylvania]: It does not supersede the impedance test. This test will tell you whether you have impedance tested it correctly. You have a field current limit. When you reach the rated speed for the motor, you have a field current limit to reach at that speed. If you have exceeded that limit you have a motor problem. This test will help you to qualify that problem. You are still required to impedance test when the motor is disassembled.

MR. HENRY V. VAUGHAN [Electrical Engineer, Chicago & North Western, Chicago, Illinois]: Does this test machine adapt itself well to testing motors during a truck overhaul?

MR. THIBODEAU: Do you mean testing a motor in a running shop when you assemble traction motors and wheels? There is no problem. I don't see why that tester could not be used there. As we see it, the main purpose of the tester is to test the motors as they leave the main shop where they were overhauled.

For example, if you were to assemble the wheels to the motors in the same shop and the machine is not busy all the time, sure, that would probably be a very good test, because then you could meas-

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ure the vibration maybe due to pinions and gears, and so on. It probably would be a much better test than what we are doing now, running it for half an hour and just listening to the bearing.

MR. VAUGHAN: It hasn't been tried yet?

MR. THIBODEAU: Not to my knowledge, no.

MR. VAUGHAN: Would you have to de-rate some of the values you are looking at on the tester?

MR. THIBODEAU: It may be the parameters would have to be modified, because if you take a motor that has been in service a couple of years maybe you won't get the same megger readings or Hypot readings, and things like that. You don't expect as much of a motor that has been in the snow as compared to a motor just out of the backshop.

MR. WESTERFIELD: One point regarding test equipment is that any time you are running a DC motor as a separately excited motor, it is necessary to provide protection against loss of field. If you were to lose your field excitation to a motor with the armature excitation on it, the motor will run away. All three of the manufacturers that we mentioned provide this as part of the test set, but if anyone was considering building their own homemade test set you would want to consider that safety feature as part of the test set.

MR. JOSEPH KUZELA [Union Pacific]: Your chart showed that you had a lot of armatures grounded. We on the Union Pacific made a study about a year and a half ago, and took 58 EMD armatures that had to be rewound on account of grounded armatures. Our study showed that 75% of those 58 armatures in the study had definite stall burns, and we showed that the coil had moved or the commutator had actually grounded and was the definite cause of those armatures going to ground prematurely. Did you have anything like this in your study?

MR. THIBODEAU: A few years ago we looked in more detail at what was actually running with the armatures coming in and grounded. I would agree, we found probably 75% of them had the problem in the commutator. In particular it was the back Nomex V-ring that was burnt. We could see some trace of carbon getting on the V-ring there, because the seal between the commutator and the armature itself was gone. Now I understand they use a double seal, but in those days they were using some sort of a silastic that was being destroyed by the degreaser we were then using for cleaning our armatures.

On the GE armatures I think most of our problems are in the back end of the armature, in the area of the U-pieces. The patterns are quite different.

MR. KUZELA: Our armatures were all EMD in the study I was talking about.

MR. THIBODEAU: With EMD armatures I would agree we do seem to have a problem in the commutator area.

MR. WESTERFIELD: I have some questions that were submitted beforehand in writing to the Committee, and I would like to toss one of them out right now.

We mentioned in our paper the GEMS article of a few years ago which described reconnecting the ground relay to provide protection for negative grounds. We understand there may be something further in this area from GE. Would Mr. Smith like to comment on this?

MR. D. I. SMITH [Senior Service Engineer, General Electric Company, Erie, Pennsylvania]: The over-all subject of ground relay protection is a very active one today. It has the basic hazard that the place you connect the ground relay itself has no protection. As such, you try to find the place that needs the least protection, and use that one point. In doing this you frequently have to make a decision as to what is easy and what is hard.

We are also continuing to study another version of the ground relay, where an active ground relay actually measures the passage of current to the ground from an external power source. This determines the ground at any point in the system, because current will pass through the ground relay coil.

We are also field testing other areas where the ground relay circuit reduces the voltage prior to tripping the relay. If it is a moisture ground and if you run at reduced performance, you can run the ground out and continue to operate the locomotive. At the moment our current production is still as described in the GEMS article.

MR. KUZELA: Mr. Smith, what is GE's feeling on doubling the pickup current on that ground relay? Have they done any more testing on that?

MR. D. I. SMITH: We have two railroad customers talking about this subject at the same time. One wants to double it and the other wants to cut it in half. The pickup value of the ground relay mechanism is open for discussion. We don't know the over-all best answer to the pickup value. The railroad industry typically has selected this number. Some like it higher and some like it lower. Some railroads have been known to put a small fuse across the ground relay coil so that the first 2 or 3 amps don't go through the coil. This might be a temporary moisture ground and will dry it out. When the fuse blows the relay will trip. There is no one right answer to the ground relay trip, Joe. It is a tough question.

MR. LIBAN: I would like to amplify one of the other questions concerning meters. From our own experience we find that if you specify overload on your meter, and you can specify even on the 260 260P, which has overload protection, it will save you a lot of servicing time. It has a button, and when the electrician misuses it he doesn't burn up anything; the button just comes up and you can reset.

As for our own experience (and I can't speak for anyone else), the 3010 and the 3300B are pretty good digital meters. You can read up to 1500 volts with them. That is the advantage of these meters (Beckman and Hickok). The Hickok 3300B is listed in both the EMD and GE tool catalogues.

MR. WESTERFIELD: I have another question that was submitted in writing. "What is being done to provide battery charging in low idle on the GP15 locomotive?" Would the EMD representative like to handle that one?

MR. T. G. WINFIELD [EMD, LaGrange, Illinois]: I assume they are talking about locomotives with an AC auxiliary generator, Tom. Is there any clarification on that question?

MR. WESTERFIELD: No; it just says GP15.

MR. WINFIELD: In our early experiences with the GP15 with DC auxiliary generators we did not see a battery charging problem during the winter. With our AC auxiliary generator and the 235 low idle (and most of our locomotives are at 255 low idle) last winter, we had some problems with Conrail locomotives, so we have come up with a new circuitry which will add a second field resistor to the AC auxiliary generator, giving us an effective 5 ohm resistance in the field. This is in no way detrimental to the machine. Our testing indicates there is no damaging field overheating because of this higher field current.

The fuel heater temperature switch in this system helps us a little, too. When we get into very cold temperatures, where battery charging is marginal at best, this will keep us at a normal idle speed. This is required for the fuel preheater and does aid us in the auxiliary generator charging.

There are many things that our ongoing engineering program is developing as we go into lower and lower idle speeds. These are things that hopefully we can offer you at a later time with improved fuel economy of lower idles. Right now we are not prepared to talk about those things because they are in the thought stage. There is some hardware being tested, but we would like to get some experience before we can say we are ready to go to a lower speed.

MR. BRUNER: In the last year we at Union Pacific have had too many traction motor failures due to overheated interpoles. A representative number of these interpoles were inspected at our laboratory, and it appears that the problem of grounding is due to a deteriorated condition of the insulation wrapping as a result of slight overload and the formation of hot spots on the exterior of the interpole. The failure progresses from this hot spot in stages.


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When the excessive heat in a small area deteriorates the bond between the wrapping and the interpole, the heat rejection path is lost and the failure mode progresses around this hot spot until it has covered a wide area in successive steps. More heat is generated, and the wrapping loses its integrity as it is forced out into the normal air cooling path where the air velocity causes separation between the individual wrappings. This allows moisture and dirt to penetrate the layers of wrapping and provides a ground path.

I would like to challenge the manufacturers to come up with a better insulating material or system for the interpole field. Obviously, it is the fuse in the traction motor today that can't take the heat. I believe with some effort the manufacturers can develop a better insulating system and greatly reduce this problem. Maybe they are doing something; if so, we would like to know about it.

MR. WINFIELD: We are actively involved with the UP on this problem. We have made several trips to your shop and have investigated several failed pieces with you, so there is an ongoing investigation with the Union Pacific in particular.

MR. WESTERFIELD: I have another question that falls into the category of leftovers. There was a question asked in an earlier session this week about a problem with a collapsing eddy current clutch, and the question wasn't really answered at that time. There has been some research done, and we feel we have an answer for you now. I will call on Mr. Smith.

MR. D. I. SMITH: Thank you. We are currently applying eddy current clutch to the radiator fan control in some applications for testing and evaluation. The problem that existed in Alco in prior days was one about the collapsing field. When you de-energize the coil, the inductive voltages cause high stress in some electrical components. In the days when the troubles existed, the Alco spike protection circuits that we have now did not exist. Today it is a simple problem, and we have applied spike protection against the field itself, and we find no problem at all. The problem is easily solved with today's solid state components.

MR. WESTERFIELD: Are there any other topics for discussion from the floor?

MR. WALKER: I don't have a question on this year's paper, but if I remember correctly last year's paper devoted considerable time to new experimental locomotives being put on the market. Is it possible that someone could give us an update on what has happened on these locomotives, and how they stand today?

MR. WESTERFIELD: I believe you are referring to the General Motors Super Series GP50 specifically. Tom Winfield told me this

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MR. WESTERFIELD: That information was on new purchases, so there was a particular class that was watched closely, with two new purchases at the same time.

MR. THIBODEAU: That is correct. We have the serial number of all the motors received on the GP40-2 units, and another group on the SD40-2. I agree that to some extent some of the motors went from a GP40 to an SD40, and vice versa. We are aware of that, but that is less than 20% of the total population, mainly because the engines were assigned to different shops, so the migration of motors from one group to another was minimized.

Since we are talking about D77 motors on the GP40-2, I would like EMD or GM to comment on the possibility or feasibility of using the D87 traction motors on GP40-2's as a way of reducing our failures.

MR. QUINN: I must have missed something. I thought the majority of your reason for taking motors out on the GP40s was because of the pinions and gears; is that right?

MR. THIBODEAU: Yes, we did have quite a few problems with pinions and gears, but now we have a problem in particular with the older D77 motors, the ones received for basic overhaul in a shop that are not new any more, and now the average life of these motors under GP40-2 is down to something like 18 months.

MR. QUINN: The primary improvement in the D87 is its improved thermal rating. It is a higher current motor. If you are having a temperature problem it certainly would help solve that problem. It also has a different number of interpole turns on it. It has more turns on the interpole to improve commutation at the high current end. It also has a large bearing to take care of the high stresses, primarily those that we saw in the Super Series operation. I believe on the CN you use a PTC wheel slip system.

MR. THIBODEAU: Yes we do. However, we also have PTC on a group of 125 GP38 locomotives, and the failure rate on these units is just about the same as the SD40 or 40-2 locomotive that do not have PTC.

MR. QUINN: Of course you hit on the two problems. One, you are looking at low horsepower per motor for the two applications. The GP38 and SD40 are essentially the same horsepower per axle. On the GP40 you are looking at a much higher horsepower per axle.

Again, in the Super Series system the gears take the highest stress in that system. The electrical system is completely capable of tearing the mechanical system apart, and I think I would look into the PTC system. Letting the wheels have high creep can cause gear and pinion problems. Don't look only at the horsepower. That is my opinion. It is just what we know about the two systems.

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MR. THIBODEAU: The second problem area on our new GP40-2 was hot suspension bearing. There is no change there. The D87 is exactly the same as the D77.

MR. QUINN: Suspension bearings are out of my category.

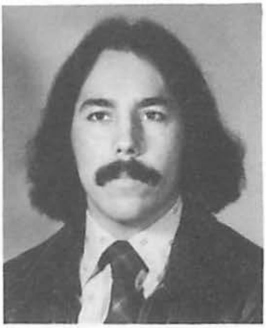
MR. D. R. JOHNSON [Superintendent Locomotives, Kansas City Southern Railway, Shreveport, Louisiana]: In regard to the SD40X's, we have four that have been tested on our railroad for approximately 12 months. We ran into very little mechanical trouble or problems. We did have control circuit problems and wheel slip problems.

MR. F. I. BURCHETT [Mechanical Assistant-Locomotives, Atchison, Topeka & Santa Fe, Chicago, Illinois]: In your paper I believe you referred to traction motor anticipated mileage — something like 600,000 miles. You had another figure of 550,000 miles. Later in the paper you referred to an 18-month 50% failure rate. Can you relate those 18 months to mileage.

MR. THIBODEAU: Roughly, you could say on the mainline locomotive maybe 10,000 miles a month, so in 18 months that would be less than 200,000 miles.

MR. BURCHETT: Were these rebuilt or new motors?

MR. THIBODEAU: Are you talking about the 18-month ones? These are old motors. Some of them have been completely rebuilt in our own shops, Some of them were given a basic overhaul only,



CHRIS W. COX
Asst. Superintendent Shops
Atchison, Topeka & Santa Fe Rwy. Co.
San Bernardino, CA

so they still have the original coils in them.

MR. WESTERFIELD: If there are no other questions from the floor, I would like to call on Chris Cox to summarize the Committee's paper.

MR. C. W. COX [Assistant Superintendent Shops, Atchison, Topeka & Santa Fe, San Bernardino, California]: Thank you, Tom. I would like to compliment you and the Committee on a very fine paper. It generated a lot of good questions.

To review the title of the paper, "Diesel Electrical Maintenance—Looking Ahead," as we do this we must look at where we are today. Looking at our locomotive road failures, I think many of us will find that the two largest categories fall into the area of ground relay failures and traction motor cutouts. These two subjects were addressed by this Committee in a very good manner. The ground relay subject was clarified, and traction motors were discussed in a way so that we can improve testing methods prior to releasing the motors from the shop.

Other subjects covered were modifications, getting into low idle, dynamic brake, and surge control systems for fuel economy. These suggest that before you get into any of these modifications, using some of the recommendations discussed by the New Developments Committee, you fully evaluate their effectiveness and economics before you go into them.

The Committee made some very definite recommendations on the types of meters that should be used to check our electrical systems.

The subject that I think was most impressive to me was the one on traction motors. We need to look at this and take it farther than this in the future. The area of comparing railroad rebuilt traction motors with ones that are new from the manufacturer gives us a definite goal, but we must realize and clarify that we are not comparing apples and apples. It would be well to compare Utex motors from the manufacturers with the ones produced by the railroads. I think this is done in one part of the report.

The performance that was mentioned did not show what I believe any of us would call a truly good performance of a traction motor, but again we have to review the economics of the traction motor produced. It would let us all take a good look at the future of those putting out traction motors, as to what we can do to improve the final product.

I would suggest that possibly next year's paper would address this subject, and get into the actual construction of the traction motor, and what areas we can get into to improve that. I do think the paper was fine.

Now I will turn the meeting back to Mr. James.

MR. JAMES: Thank you, Chris. I too would like to extend my congratulations to Tom and all the members of his Committee for selecting very timely subjects that each mechanical officer is deeply interested in.

Now I will call on Bob Clevenger to conclude the session.

PRESIDENT CLEVENGER: I would also like to extend my compliments to Tom Westerfield for the fine work done by his Committee today. Tom was called upon late last fall to take over this Committee because we lost our other chairman. I think Tom has done a great job.

Don't forget the meeting at 8:30 in the morning. We will have the report of the Shop Equipment Committee, and immediately after that we will have the What's Your Problem session.

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

[The audience arose and applauded.]

[The meeting recessed at 3:40 p.m.]

WEDNESDAY MORNING SESSION
September 24, 1980

REPORT OF THE COMMITTEE ON SHOP EQUIPMENT

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

KJELL AXELSON
6th VICE PRESIDENT
Manager Machine & Tools
Burlington Northern, Inc.
St. Paul, MN

The meeting reconvened at 8:30 a.m., Mr. R. G. Clevenger, President, presiding.

PRESIDENT CLEVENGER: Good morning. I would like to welcome all of you to our Wednesday morning session. This morning we are going to hear first from the Shop Equipment Committee, chaired by Mr. Tom Kessenger.

Before we get into the business of the morning, I would like to deviate a bit from our program. I would like to say something about advertising. As you know, advertisers are one of the backbones of our Association, and at this time I would like to personally thank every advertiser in the LMOA Proceedings book for what they have done this year, and welcome them to continue to advertise and work with us as they did last year.

You know, with all advertisers you always have at least one or two that go a little beyond what they do in normal advertising. This morning we would like to pay tribute to one of them, the Power Parts Company. Unless you have been a member of the official LMOA family you really don't know exactly what Power Parts does, and when I say "does" I mean they do a lot for the LMOA.

They have always come forward when we have asked for volunteers and any requests made by the officers. Their involvement with the LMOA has been on a personal basis, and for that reason, I would like to ask Mr. Power Parts himself, Marty Hausman, to come up here, please.

Marty, on behalf of all the LMOA official family, who have probably eaten dozens of meals with you and listened to hundreds of your jokes, we would like to present to you this symbol of Honorary Life Membership in the LMOA. [Applause]

Mr. M. C. HAUSMAN [Power Parts Company, Chicago, Illinois]: While having breakfast this morning somebody said to me, "Congratulations!" I thought, what am I to be congratulated for? I am the oldest guy in this room, and that's not exactly an achievement. I thought, well, you have to be recognized for something. Now I understand what he was talking about

I am genuinely surprised and pleased, and want to thank you all very sincerely. Don Roberts always takes care of the necessary and important details, and I asked him if I could sit in here this morning. He said sure, so here I am.

I suppose the thing to do would be to say thanks and then sit down and let it go at that, but I will

Everyone is all smiles as Past President Jim Long, left, and President Bob Clevenger, right, join to present Marty Hausman with the "General" desk set, and Honorary Life Membership, in recognition of his years of generous, voluntary assistance to LMOA.

never get another chance to be up here, so I'm not going to blow it. [Laughter] I feel badly that I don't know more of you. Before this meeting is over I hope to meet everybody.

I have no commercials, nothing to sell. I am here just to tell you that I am very flattered. I once went to a meeting where a man was given some kind of recognition, and he said, "I don't really rate this; but I've had arthritis for 15 years and I don't rate that, either." In all truth, I think this is fine, and I appreciate it.

If you haven't been over to see us, I would like to invite you. They say as you get a little older first you get honest and then you get honored. I am in the "getting to" stage. I do want to extend an invitation to everybody here to come over and see us. When we first started, about 40 years ago, we were scared to death that one of you fellows would come over to see us. We were in the back of a vinegar factory, and I thought, my God, if anybody sees what we have we'll be in trouble. Now we have something to show you, and we are proud of it.

By all standards we are a small company. My background is in purchasing. I was employee No. 13 at EMD in December 1935, and I stayed there until I went into the Army in 1940, and after that I started this business in 1945. I am purchasing department-oriented. That is where I started and that is where I do my work. A little later I found that the name of the game was you fellows. We can go to purchasing and to stores, but the action, the authority, the approval comes from you fellows. That is why we don't have any fancy advertising plans and we don't have any big public relations programs. We just like to go where the action is. If we didn't behave ourselves with you fellows we would be dead.

If you think we are doing well, come in and see us. Thank you very much. [Applause]

PRESIDENT CLEVENGER: Mr. Jack Dwyer has a couple of words to say.

MR. J. J. DWYER [Director, Railroad Safety Division, Public Service Commission of West Virginia, Charleston, West Virginia]: I don't see too many people in the audience in my category, but sooner or later some of you are going to retire. Marty Hausman has an extracurricular activity that he didn't mention, called the Dead Horse Club. I have been a member of it for six or seven years. After a fellow retires Marty doesn't forget him. He's one fellow who never forgets you just because you retire. Marty Hausman! [Applause]

PRESIDENT CLEVENGER: I think we should all rise and give Marty a big vote of thanks.

[The audience arose and applauded.]

PRESIDENT CLEVENGER: Now may I present Mr. Axelson.

MR. AXELSON: I think we have some car department people in the audience, which indicates we will have a good meeting. It is certainly a pleasure and privilege to be associated with an aggressive Committee that looks for a challenge instead of just accepting a challenge.

Attesting to that fact, we have a Committee here that will tackle an 8:30 a.m. last-day meeting with a promise to sustain high interest levels, in spite of the fact that you have already put in three days and nights of hard work. That is quite a challenge to accept, and it is certainly gratifying to see so many survivors in attendance at this early morning meeting.

There are many definitions of an expert, but two that come to mind seem rather appropriate at this time. First, an expert is anyone over 50 miles from home with a briefcase. The second definition of an expert is a person who can take something he already knew and make it sound confusing, which again may be lightly applicable to this technical committee. But at least these two definitions should put you on an equal footing at the outset.

In a more serious vein, I would like to take you back to Mr. J. W. Gessner's keynote address at the opening of the joint meeting Monday morning. In brief summary, Mr. Gessner very pointedly charged us with being receptive to new ideas which will bring about increased productivity and efficiency through the use of new technology, new machines, and innovative tooling, all aimed at offsetting our constant adversary, increased operating costs.

At this time I would like to present a committee that not only meets Mr. Gessner's charge but works very hard to exceed that charge. This fine committee is chaired by Mr. Tom Kessenger.

[Mr. Axelson introduced Mr. T. A. Kessenger, Senior Engineer Facility Planning, Louisville & Nashville Railroad, Louisville, Kentucky.]

MR. T. A. KESSINGER: I was very pleased to see we are honoring our vendors and supporters, because this particular Committee on Shop Equipment really needs vendors' help because so many of the areas we cover are equipment type oriented, and we rely heavily on slides and information they can give us. So, we really appreciate their help, and look forward to continuing with them in those areas.

I would also like to thank the Southwestern Railway Club for having the Shop Equipment Committee and allowing us to make our pre-convention report at their Little Rock meeting. They were very attentive, and brought out a large group that was very supportive.

[Mr. Kessenger introduced the members of his Committee. The report was summarized by M. G. Marler, Paul F. Hoerath, G. B. Sweeney, J. R. Snowden, R. V. Propp and W. R. Doyle.]

MR. KESSENGER: Looking around the room this morning, we have a rather large attendance. I think somebody must have told all the vendors not to open their hospitality suites this morning because we might be talking about their competition, so there wasn't anywhere else to go.

This completes our paper. If there are any questions in regard to any of the subjects we have covered, we would like to hear them now. Are there any questions? If not, I will turn the floor over to Mr. Elmer Hafling, who will summarize our report.

MR. E. R. HAFLING [Assistant Mechanical Engineer, Santa Fe, Topeka, Kansas]: Thank you, Tom. I am going to deviate from the norm by presenting three unrelated items. First, I would like to put into the record the fact that a long-time and faithful Shop Equipment member, Nelson Nielson, shop superintendent of the Milwaukee, retired this past summer. We would like to thank him for his services on the Shop Equipment Committee. He has been a valuable member for a number of years. He will be missed by this Committee and the Association. We would like to congratulate him and extend our best wishes on his retirement.

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

Second, I have always had to follow a speaker who injects a little witticism, so I got into the habit too, so here's mine. A man was driving his car with his wife in the back seat, and he purposely stalled on a railroad track as a fast-moving train was approaching. His wife yelled, "Go on, go on!" The husband replied casually, "You've been driving all day from the back seat, I've got my end across, now see what you can do with yours." [Laughter]

Third, the Shop Equipment Committee has presented to you some new ideas in machines, processes, and new tools for the new decade. These machines, such as traction motor cleaning and drying equipment, automated wheel machinery, and processes such as fuel saving through security and reclamation, governor and injector fuel savings, and locomotive running repair shop, and tools such as new developments in tooling. Again we would like to have you read this Committee's report, because each year the paper is full of tools, jigs and machine operations.

Sometimes, to get the best use of this equipment, there are certain procedures to follow; but they are too lengthy to describe in the presentation, and they are just brought to your attention. In order that you get its complete operation, you have to read the report to fully understand its application and full usage, and then you will be able to understand how some railroads keep their rolling stock in such good working order.

This Committee has done an outstanding job in their presentation, and I think they deserve a big hand for a job well done. [Applause]

I will now turn the meeting back to Mr. Axelson.

MR. AXELSON: Thank you, Elmer.

I will now ask the What's Your Problem Committee to come to the platform.

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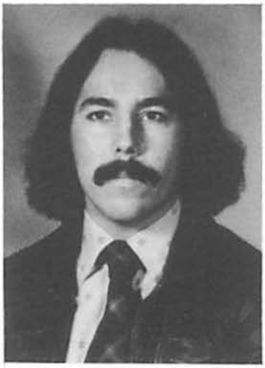

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PRESIDENT CLEVENGER: This morning we have the What's Your Problem Committee presentation, which is one of the meatiest parts of our convention. I will call on Mr. Dale Propp to serve as officer of the session.

MR. PROPP: Good morning, gentlemen. It is good to see such a fine turnout.

This morning I have the pleasure of presenting to you the chairman and Committee members who will be the panel on the What's Your Problem session. This has always been an excellent opportunity to summarize the events that have taken place during the past two days, and in listening to some of the questions and activities that have preceded, I am sure this session today will be interesting, informative and enjoyable for all of us.

[Mr. Propp introduced Mr. C. W. Cox]

MR. COX: Thank you very much, Dale. It is a real honor to be chairman of this Committee. Every since I began working in the LMOA and became a member it has been one of my favorite sessions. I think it is one of the sessions that many of us learn quite a bit from, and I hope today we can keep generating that interest.

Before we start, I would like to present the panel of committee chairmen who will be answering some of the questions during this part of the program.

[Mr. Cox introduced D. L. Ward, J. L. Kuhns, Tom Westerfield, John D. Smalling, David Goehring and Tom Kessenger.]

MR. COX: Before we start the questions and answers, I would like to get into an area that I think has prevailed during this year's meeting. The subject has been brought up a number of times in committee meetings and in past meetings, and it is something we need to address and hopefully solve at some point. It has to do with the rate of return on the investment of railroads.

Last year in the joint meeting Mr. Reed addressed this subject, and I would like to quote from his address: "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% 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."

Mr. Gessner, again in the joint meeting, addressed this same subject, and discussed the low rate of return that we in the railroad industry are getting on our assets. I think we should give this serious consideration in the future. As mechanical officers we can play a great role in doing this. We can play a great role in reducing our maintenance costs and learning new ways to do things, and increase the productivity of our employees. I hope some of the questions and answers that are brought out during this part of the meeting will help transmit information to all of us that sometimes only a few of us are aware of. I hope this will be a good meeting and that we will be able to disseminate this information to the proper channels.

I have a number of questions, some of them typewritten and some of them handwritten, given to me during this meeting. We will open the discussion with this question:

"In the past decade the EMD cylinder assembly has undergone many changes in the type of liners, the type of plating, from the hardened bore to the port configuration, different ring configurations, and still we are undergoing many tests in this area. What is EMD's recommendation for the best combination that will offer the greatest service life?"

I think that question should be directed to some of the people from EMD, and possibly someone in the audience can handle it.

MR. WALTER WECK [Assistant General Service Manager, EMD, LaGrange, Illinois]: The answer to the question is always the latest and the best, our present offering being the laser hardened May West area on the liner, the present configuration on piston rings being the shot peened stainless steel chrome faced ring, and the diamond 4 head.

I don't really know how to get too deeply into the question, because apparently somebody has a reason for asking it. Those are our 645 assemblies. We are talking in terms of the latest offering. If there is a specific that goes with the question, perhaps we can deal more with that.

MR. COX: Does anyone from the railroads have anything to add to that, possibly a comparison of reconditioned parts that can compare service life to the current EMD new cylinder assembly arrangement?

Are there any questions other than this that someone would like to bring up at this time? If not, I will ask another one:

"Recent discussion among various chrome platers indicates that there is a problem with the wear limit on EMD liners, this being at the bottom of the cylinder liner on the OD at the seal area. How many railroads are having problems in this area, and if so how extensive are they?"

Jack, can you speak to that subject? Are you having any problems in that area?

MR. KUHNS: I don't believe on our railroad we have had too much trouble with that. However, you said the question was asked by some of the platers, as to what was happening with the lower end of the liner. Where we have had problems has not been on the EMD liner but on the GE jacket. Maybe one of the platers would like to comment on that. Are there any platers in the audience? Maybe Walter could comment?

MR. WECK: As you are aware, we are not in the plating business. What I am hearing is that you are talking about the inserts on the OD of the liner into the lower portion of the crankcase—excess wear. I imagine you are talking about extremely old liners and/or liners that ran loose in crankcases, and you are looking for a reclamation process. That would be the function of the reclaimers people who do that.

MR. KUHNS: I agree. I would like to make one comment on the previous question about limits as far as cylinder components are concerned.

I think on our railroad we are still using EMD's tolerances as far as all material we recondition. However, I think maybe we need to have two sets of limits, one for running repair type operation and the other for engine rebuild. I don't know how many other people are having this problem, but we try to stick with the maximum wear limits on all components, and I believe we are going to change to two sets of limits, one for running repair and the other for rebuild.

MR. JAMES: In response to the question relative to the lower liner fit at the insert, I would like to hear some response from other railroad people.

To comment on Chessie's experience, we have not found excessive wear at this location. I might add that in the early days of the GP30s and 35s we were having problems in that area, and in discussion with EMD we decided that annual retorquing was essential. We adopted that policy and we have had minimum wear in that location. In the early days we were having P pipe breakage and cylinder head set ring wear in the top deck of the engine. However, we were not experiencing loss of air box pressure into the crankcase as a result of lower liner seal leakage.

MR. KUHNS: Along with what you are saying, Bill, one thing we do whenever we reseal or do a top deck overhaul is to replace the lower liner insert. If you don't do that I think you will end up with a big snowball. The liner has more chance to vibrate.

MR. COX: Thank you, gentlemen. It is possibly an area that some of us should look into in the future.

We on the Santa Fe are presently running a study on this particular area because of recent discussions, and in comparing the wear limits of EMD's new wear limits we are finding a number of them that do not meet the specifications here. However, it has not yet been determined whether or

Dale Propp, of the BN, newly elected vice president is helped into his LMOA officers blazer by Jim Long and Bob Clevenger.

not this is causing a problem in the area of lower liner water seal water leaks.

"With the ever-increasing inflationary cost of parts, there are certain crankshafts that are being reclaimed by a submerged welding process to save others that are not reclaimable. What are the advantages; disadvantages, and recommendations for future consideration in this area?"

I have a number of questions on this same subject. The other questions suggested that we determine from the various railroads how long some of the earliest submerged arc-welded crankshafts have been in service. The question is directed at how many GE nitrided hardened crankshafts have been welded, and what success have we found in this area. I would like to hear first from some of the railroads that have been involved with the crankshaft repair companies in this area, to give us some information on the kind of service we are receiving from these repairs.

MR. KUHNS: I can only speak for one railroad. I would like to have someone else in the audience perhaps comment.

First, the question was asked, how long have we had some of these shafts in service? I know our railroad is one of the leading proponents of welded crankshafts. We have a 12-cylinder crankshaft that has .300 weld on a journal. I believe it has been in service since November, 1978. I can't give you the miles, but we operate in the neighborhood of 8,000 to 10,000 miles a month.

I think there is a tremendous advantage. On Monday in our paper we quoted the price of crankshafts. On the GE shaft a 16-cylinder shaft costs over $20,000, so you can do quite a bit of welding for $20,000. We have not had too much experience with welding nitrided crankshafts because we haven't had them running. Maybe they will operate satisfactorily.

On our railroad we have had one shaft break that was welded. It did not break in the welded area. It happened to be a nitrided shaft. As we mentioned in the paper, according to what the manufacturer tells us, nitriding can be welded just as well as induction hardened. One thing we have been trying to do is that next year we will have a specification on welding crankshafts. Right now I think each railroad has its own specific specification for welding crankshafts. We will have one for our paper next year.

Are there any other comments from any other railroad that is trying welded crankshafts?

MR. COX: Jack, how many crankshafts total have you turned in for this process and that are returned and are in service?

MR. KUHNS: Eight.

MR. COX: Are they GE or EMD? Have you mixed them up?

MR. KUHNS: Seven of ours are GE and one is an Alco. So far

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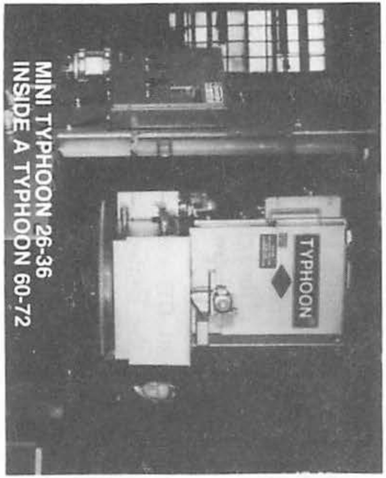

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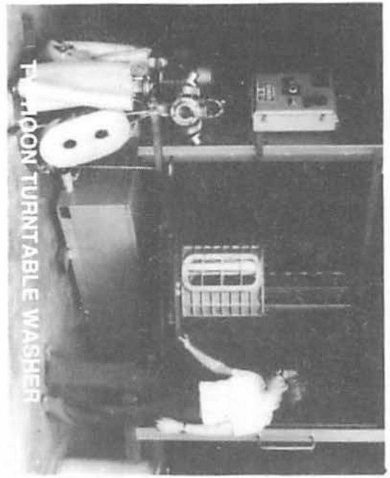
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we haven't welded any EMD shafts, but we will.

MR. COX: We would like to hear from other railroads involved in this process. Are there any in the audience who can speak on this subject?

Next, we would like to hear from the chrome platers. This will possibly give us a better idea of the total number that have been in service. Do we have anyone here from the crankshaft chrome platers who can give us a little information on the subject?

MR. KUHNS: I can only comment on what little I know about one plater. We have worked very closely with Chrome Crankshaft of Chicago, and I thought Lawrence was going to be here but I don't see him. I believe altogether there are about 30 GE shafts running throughout the United States, and about 100 EMD shafts that have been welded. I know the ICG has a welded EMD shaft that has been running in the neighborhod of 8 years. Is Billy Morrison here?

MR. COX: Is there a representative from Chrome Crankshaft here? Evidently not.

We would like to hear from the builders and their recommendations on this type of repair, and possibly some of their experiences in this area. I would like to ask a representative from GE to speak on this subject, please.

MR. MITCHELL: Chris, we have had an evaluation program on crankshaft reclamation with two reclaimers for the past several years. It is getting close to culmination at this point in time. We have a preliminary specification that has been written but not issued, and hopefully will be very shortly.

We have in our lab in Erie one crankshaft that has been repaired in three throws and one main. That was machined .180, welded back up, and then .005 chromeplate on top of that. This crankshaft has been operating now for over 2,000 hours with no distress whatever, and it has been operating at 25% over normal horsepower.

We inspected the crank last week at the throws that have been repaired, and they look in excellent condition. The crank will be removed this week and given a complete magnaflux inspection. We have three other crankshafts at this time that we are going to give to the market place on a no-charge basis for further field evaluation. While we have a high confidence level in this technique, we would just like to be sure before the spec is actually published.

The experience is very difficult to follow, and Mr. Kuhns has been sort of critical, and rightfully so. Remember, the reclaimer does a crankshaft, and we have no way of knowing when he has done it or what railroad it is going to. But we would like to work jointly with the customers who have those cranks on an inspection program or any other basis, to determine how well they are doing.

The one thing we have found that is extremely important is the quality level maintained when you reclaim the crank. To the best of our knowledge, crankshafts that have been welded and chrome-plated have not failed in the area of the repair. They have failed at some other location, probably due to an inadequate inspection in detecting a flaw. A quality inspection is one of the extremely important things.

MR. COX: Thank you, Forrest. That is a good point to look at in our evaluation of this program. When we see one that has been repaired and has failed, we need to know where it has failed. It is possible it might have failed in another area.

I would like to ask someone from EMD to speak on the subject of reclamation of crankshafts through the welding process.

MR. WECK: You are going to get very little input from Electro-Motive on welding of crankshafts, simply because we don't weld crankshafts. Our experience is with chrome plating, which we do, and we do have crankshafts plated for us by others to our specifications. But in the weld reclamation process we don't have any input to give you. It is something we do not do.

MR. COX: Thank you, Walter. It appears we have a number of crankshafts that have been repaired through this process and service that can be followed, and it appears that thus far it has had some success, so it is something that deserves future evaluation.

The next question: "What is the current experience of railroads using lithium traction motor gear grease?" This is a subject that has been of much interest during some of the meetings here.

Before we get too deeply into it, I would like to ask EMD to give us some of their background on this subject, and to determine what recent changes have been made in the gear lubricator toward their recommendation.

MR. WECK: I didn't think you would ever ask. [Laughter] We actually have come prepared to talk at length about this, due to the fact that it is an EMD recommendation, and we have had a great deal of input on the subject at the various meetings.

I would like to handle this in two parts. I will address one aspect of it, and Mr. Paul Bien, from our Engineering Department, will address the lube spec experimentation background, along with our hopes and aspirations for this product.

My input into this would be to those of our customers who are experiencing a problem with retaining lithium lubes in the gear cases. Of paramount importance in this particular situation is gear case and gear case maintenance. I am not here to say that the problem totally is gear cases, but before you look too long and hard at deficient lube, please look at what you are doing with your gear cases and the manner in which you are maintaining them.

The gutters are an absolutely essential part of the gear case, and sealing is absolutely necessary. The material must be retained within the case before you can attempt to evaluate the material. If you say you have good gear cases and you still have a problem, we would like to take this a little farther.

Mr. Bien, will you come to my assistance at this point?

MR. PAUL BIEN [Engineering Department, EMD, LaGrange, Illinois]: The background that I have on the development of our current specification goes along these lines, Chris:

In the early 1970s only sodium soap thickened lubricants were readily available. Our locomotive field inspections indicated that improvements were needed in several areas. One was the area of water resistance. We saw instances of complete film stripping from the teeth by a little bit of water penetration into the gear case from a wheel-washing operation or from melting snow, so we thought that was one area that needed work.

Another area we thought was lacking was the extreme pressure properties of the available lubricants, and this tended to result in more scoring and galling of pinion and gear teeth than we liked to see.

A third area we thought needed improvement was the control of Brookfield viscosity, in that during the 1960s we had experienced several instances of either grease migration into armature bearings or extremely rapid gear wear in winter operation, both of which were associated with very high Brookfield viscosity of the lubricant being used.

Those were the areas that we thought should be worked on, and our work began in earnest in about 1973. We did considerable testing over about a 4-year period, both full-scale bench tests at our plant followed by field tests, and these included such things as full load testing, water resistance tests, leakage tests, and compatibility tests of lithium soaps with currently available sodium soaps.

Our interest had centered on a lithium soap lubricant because it has greatly improved water resistance. This same lubricant had better extreme pressure properties, and the supplier we were working with demonstrated an ability to closely control the Brookfield viscosity.

This 4-year series of testing resulted in revision to our gear lubricant specification in 1977. This revision, known as EMS 1027B, describes a lithium soap gear lubricant with Brookfield viscosity at 200°F of 5,000 to 10,000 centipoise. This, incidentally, duplicates the viscosity specified for the previous sodium soap lubricant. Base oil viscosity is specified at 800-1100 SUS. This specification, I have to quickly tell you, is in-

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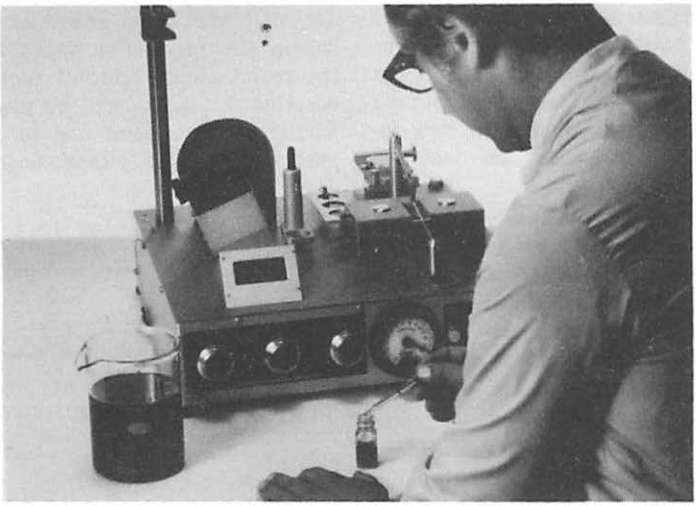

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complete, because we don't feel we are capable of completely describing a gear lubricant.

So, in addition to our specification we rely on source approval, and the one product we had carried out through both lab testing and field testing was a product manufactured by Texaco, called TMGL7500, and that is the one product that has received our source approval. It is the only product we have used in new locomotives for about the last 3½ years.

We rely on the integrity of our supplier to produce a consistent high quality product, and we use the specification as a quality control check, knowing full well that it doesn't completely describe everything that makes lubricant work in the application.

We have tested other lithium soap greases in our lab only. We have found that some of these do indeed meet the requirements of EMS1027; but we have not carried these into full-scale field testing, and therefore they are not on our source approval sheet.

As I understand it, the current problem which we are hearing from many parts of the country is excessive leakage, particularly during the hot summer months. Our maintenance instructions call for checking for sufficient lubricant in the gear case on a weekly basis or 3,500 miles, and we think from our experience that the EMS-1027 Type B manufactured by Texaco will indeed meet that schedule, provided gear cases are maintained as Walter described to you a moment ago.

There may be others that will also meet that maintenance interval, but we have not conducted field tests of other products. If there is reason to believe the Texaco product that we have approved and use in our production won't meet the maintenance interval that we describe for it, we will be glad to participate in a joint test to demonstrate that it either does or doesn't.

I think that is about the extent of the background I can offer, Chris.

MR. COX: Thank you, Paul. Before we get into the area of input from railroads as to the type of service we are getting, will you repeat the viscosity test again, please?

MR. BIEN: The Brookfield viscosity is specified at 200°F. There is a spindle size and rpm associated with that also, but the test temperature is 200°F, which is not the highest temperature a lubricant can reach in service, but is fairly close to it. It is probably weighted toward the high end of the normal operating range.

MR. COX: When we grade some lubricating oils we talk about a VI number or viscosity index and relate to how it changes with temperature. Does the gear lubricant we are speaking of here have an effective constant viscosity, or do we see drastic changes over the temperature range in which it operates?

MR. BIEN: There are drastic changes over the temperature range it operates in, and the Brookfield range we have selected is certainly a compromise range. We are selling locomotives all over the country in all kinds of climatic conditions, and this viscosity was selected with that in mind—that we can tolerate only minimal leakage in the summertime, and in the wintertime we would like to have something that is still fluid. Even the product that we have described in our specification is not fluid at temperatures below about 20°F, and there is an addendum in our maintenance instructions that in prolonged cold weather operation it may be necessary to occasionally add small quantities of car oil. I believe this is done as a matter of practice by some railroads in the northern part of the United States. So, even with the best lubricant we know of, there is quite a wide viscosity range over normal operating temperatures.

MR. COX: Thank you, Paul.

Are there any railroads that could give us some input information on the service we are now receiving from this new gear lubrication specification? When I say "new" I mean 1977.

MR. AXELSON: Like many other roads voiced the other day in the Committee on Fuel · and Lubricants, we have experienced a lot of field problems, and it appears we have gotten off to a bad start. I agree in principle that it is time we looked for an improved gear lubricant.

There has been a lot of attention given to the burning of downgraded fuels. We still have problems in that area. There has been a lot of attention given to engine lube oils, and I think in both areas we have come a long way. So, relating to those factors, I don't think we are in any worse shape with our bad start on an improved gear.

I don't think the problems will be insurmountable. However, due to the very extended FRA inspection regulations, I would like to call to your attention that if we are going to live with that gear that is down in the basement and hasn't had much attention over quite a few years, we need an improved lubricant. So, I would caution you before you back off, because of a poor start, that we should continue to pursue improved lubrication for the basement and the severe operating environment that that gear sees down there.

MR. KUHNS: I agree with what Swede says. I also agree with what Walter said. I remember in the late '50s and early '60s on our railroads we ran some F7 locomotives with the present gear case that was sealed and had oil in it. So, I agree with what Walter said.

I would also make one other comment. Most of us have been complaining about EMD's gear case. Our men don't have near the trouble with the GE gear case, I think the reason being that it is stronger and heavier and doesn't leak as much. We might be approaching this from the wrong direction. We need a little better gear case. That is what we are saying.

MR. COX: Recently EMD had a field test on an improved gear case. Some of these were on the GP40X's and probably earlier than that. What is the current status of that? Can EMD answer that?

MR. BIEN: The gear case you refer to was one that was used in the GP40X locomotive with the D87X traction motor. It was indeed a heavier gear case. It had fairly unique labyrinth axle seals, and it was side-mounted to the motor frame. They ran successfully for two years or so with the GP40X's. However, there was not good acceptance from a number of railroads, first because of the inceased assembly time associated with this gear case because of its greater weight, and second because of additional fasteners to apply it. That was one objection.

A second objection was the selling costs that had to be associated with that assembly. It was judged not to be cost effective, and it is currently not available.

MR. COX: While you are still at the microphone, Paul, in regard to the information you received during the field testing of this gear case, are you currently undergoing any changes to the test gear case, or is the decision to go back to the original gear case design?

MR. BIEN: The D87X gear case is essentially a closed subject. What is being done is to take the sealing concept that was built into it with these labyrinth seals, and try to incorporate them into something that is a lot closer to our standard gear case which would retain the relatively quick and easy assembly, would retain the limited number of fasteners that are necessary, and would maintain interchangeability with gear cases that have been built for the last 30 years.

So, to quickly summarize, we are trying to take the good features we demonstrated in the D87X gear case and build them into a more acceptable gear case, both from our manufacturing standpoint costwise and from a railroad assembly standpoint.

MR. BUTLER: I would like to emphasize what Mr. Axelson said. For 20 years we fought for a 90-day inspection, and we got it. The grease doesn't make it. All this trouble started, as far as we are concerned, from May 1 on. What we would like to have is a gear grease that will go at least 90 days. To bring an engine in every 30 days is ridiculous. Let somebody work on a gear grease that will last for the length of the inspection period.

MR. SMALLING: First, I would like to agree with both Mr. Axelson and Mr. Kuhns. There is definitely a problem involving gear case lubricants. Secondly, perhaps there is a need for a new design, as the EMD representative suggested.

May we hear from the gear grease manufacturers on the subject? Are the sodium and lithium base greases the most effective compounds available? What about molybdenum disulfide, for example? I understand this is an excellent lubricant with outstanding ability to get into the pores of the metal and stay there. May we hear some comments on this?

MR. COX: Any comments? We must have some oil people here. Is there anyone here from Mobil who would like to address that subject?

MR. WILLIS SCHICKRAM [Conoco, Inc.]: As far as the lithium and sodium grade greases are concerned, I think the lithium is by far the better choice for use, as Paul mentioned. The reason we went to it was because of the better water handling characteristics. EP characteristics are also important.

As far as viscosity of the grease is concerned, I have to agree with Paul that good gear case maintenance is important and should not rely on grease viscosity to eliminate leakage problems. We have looked at EMD's specification, and make a product to meet it. We also make a product that is approximately twice the Brookfield viscosity at 200°F, and we have seen that gain acceptance especially this past summer. We are selling quite a bit of that to a

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number of railroads, and to my knowledge we have not seen any significant problems. It seems to minimize leakage and so on. It does use the same viscosity base oil as the EMS 1027 spec requires.

In regard to the use of moly in the grease, we have not done any work in that area. At the present time moly is becoming more available than it was. We have had great difficulty in getting molybdenum for any use, and it was terribly expensive. The price appears to be moving downward right now, and the availability is increasing.

I think we would see a considerable increase in the price of the grease. Whether or not it would be cost effective, I don't know. Here again, though, it is important that we keep the grease in the gear case. If we can't keep it there, or don't put it in there initially, and don't maintain the cases, we can't hope to lubricate anything. That is about all I can say on that matter.

MR. PROPP: Just to bring this subject into perspective, we are certainly in favor of the improved product, the lithium over the sodium. However, since Burlington Northern began using lithium this year we have experienced viscosity problems which caused loss of grease. With the sodium grease, channeling problems were obvious during the cold winter months.

I am wondering if EMD has seriously looked at upgrading the specification to a higher viscosity range. It seems to me that 5000-10,000 Brookfield viscosity is not sufficient to support the average gear case in the field. I know our gear cases are not perfect, but the majority are in good shape and represent the current state of the art. The product must be more viscous to stop leakage.

MR. BIEN: We certainly have felt a lot of pressure in that direction over the past year. I think the first thing I will have to ask is, do you know the product you are using actually meets the Brookfield requirement as it now stands in the spec?

MR. PROPP: Paul, we are certainly investigating all possibilities in that regard. We did find that in some of the cases there was one product especially that tended to decrease in viscosity when it was mixed with the sodium compound during the first stage. In other words, a lithium grease at 5000 Brookfield when blended with 50% of the sodium product during the interface, actually decreased below the 5000 minimum specification. We are certainly testing to control this condition. We are further specifying a heavier product in traction motor gear cases.

MR. BIEN: I would say that the mixing of sodium and lithium greases from time past has been considered and demonstrated to be hazardous. This information was developed primarily with bearing greases where the soap content is quite a bit higher than the greases

we are talking about here. The bearing greases might typically be 10% to 15%, whereas in these gear greases the soap content is closer to 3%.

As I mentioned, in our development work we did run full-scale tests where we made 50/50 mixtures of the lithium grease we were testing along with several different sodium soap greases that were available, and found insignificant changes in Brookfield viscosity.

To answer your question as to whether we are going to move on changing the viscosity specification, I think at this point we are a minor user of this product, and so we don't carry a lot of weight here. If the railroad consensus is that a heavier product is necessary, we will probably be forced in that direction.

We think, however, there are several hazards in moving that way. We have experienced over past years several instances of very severe motor problems associated with too high viscosity. One of them occurred about 8 years ago on the Burlingon Northern. We had delivered a group of new locomotives in January or February of that year, and in a matter of 2 or 3 months the gears were worn out. Investigation showed that it resulted from very severe channeling of the lubricant, and the Brookfield viscosity of samples we obtained was about 20,000 centipoise. This is one of the experiences that caused us to set the specification at 5000 to 10,000.

In another instance, in the 1960s a major western railroad asked a grease manufacturer to formulate a leakproof lubricant. They did just that, and it didn't leak, but it plugged up all the drain passages in the armature bearing area, and gear lubricant then found its way into the pinion end armature bearing area, and there were literally several hundred motors that had to be removed from service and at least partially disassembled to correct the problem.

So, if it is the consensus that in spite of the best gear case maintenance and gear case assembly techniques that can be provided, that a heavier lubricant is still needed, I would urge you to keep those cautions in mind. There are a number of serious problems that can be encountered with these higher viscosity lubricants.

MR. COX: I would like to summarize this topic so we can go on to some other subjects. It really is disheartening to come here year after year and hear the same topics brought up, and hear that we are continuing to have the same troubles that are so costly to the railroads not only in drive gear failures but traction motor failures from running with improper gears.

When we brought it up in the Committee it was like it was a new subject. We will all agree we hear the same problems year after year. We have one manufacturer who has a gear case that is giving us somewhat acceptable service, but we still continue to have problems with the gear case and the gear case lubricant, and it is our hope that we will make greater efforts to improve this situation and bring about a more acceptable maintenance program that will allow us to run without as many gear problems as we have had in the past.

I have another subject that might change the pace of the meeting: "Has a reliable static test been developed to qualify locomotive speed radar systems?"

Do we have a testing system available to qualify a locomotive speed radar system?

MR. BRUCE MEYER [EMD, LaGrange, Illinois]: At the present time we do not have a test fixture for use under the locomotive to check the calibration of the radar speed system. We are working on the development of a test fixture, and other manufacturers are also working on the development of this type of test fixture. The test fixture will probably end up being the type of device that you put on under the radar that measures both the angle of the radar and gives you an accurate speed reference.

We have tried a number of devices where an attempt is made to simulate the ground moving. These devices seem to be somewhat impractical. They are too big, and if the moving ground type devices are made smaller they won't provide the correct speed signal from the radar. That is the present

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status. Test devices are being developed.

MR. COX: Are there any other manufacturers of electronic equipment that are working on a device in this area?

MR. KESSENGER: In the Shop Equipment Committee we have talked about a lot of the new equipment that has been brought about by some of the new laws that have been enacted. Next year we hope to get permission to cover a lot of the test equipment that will be needed to check this eqiupment. The radar gun was one of them, so we would appreciate any information that a manufacturer or railroad might have and will direct to our Committee for possible insertion in the paper next year. Maybe we will have a good answer to the question next year.

MR. COX: "What is the status of the art of reclaiming used lube oils, and what are the results other railroads have had in using these reclaimed lube oils?

MR. SMALLING: This is a most important question due to the savings realized from recycled oil. That is the No. 1 reason. No. 2, disposal of used oil has become a major problem. No. 3 would be conservation.

I have looked into this briefly in the last couple of months. We can sell the used oil or have it recycled using the additives that we normally use, and under the proper control the recycled oil, in my opinion, is as good as some of the new oil that is on the market today. In one location alone, using up to 20% of the complete change of oil in the locomotive, we saved in the neighborhood of $12,000, and that was just one location. If we can do this system-wide there would be an enormous savings.

I would like to ask if anyone in the audience would care to comment on what the potential of going system-wide with recycled oil would be. I would like to hear what the engine builders think about it, and also the refiners who do this sort of work.

MR. HOFFMAN: It has long been our policy that re-refined lubricating oils can be made to be, as John said, equal in performance to the original product. Over the years we have looked at a considerable number of the re-refiners in this country, and find that they do in fact do an excellent job. We don't have any way to control their quality, so our own guidance in the railroad industry is to set up quality control procedures that will assure that the additive put in is at the appropriate level and that it has been refined completely. If one does that, using the type of re-refiners that are in the business today, one can certainly use the product as one would use the new oil. We do not specify against the use of re-refined oil, again done in the manner which John mentioned: the original railroad type product fully re-refined and with the same additive in the same quantity that the oil originally had blended into the re-refined oil.

MR. COX: Would a representative from EMD speak on the subject of the use of reclaimed lube oils?

MR. WECK: I can only echo what Jack said. He has nailed the entire subject down quite well.

MR. G. J. HUEMMRICH [Superintendent Locomotive Staff, Consolidated Rail Corporation Philadelphia, Pennsylvania]: We have made it a policy this year to salvage all of our waste lube oil and have it re-refined for reuse. We find that per gallon it is about 50% the cost of new oil. We have been into this on a system-wide basis for about 4 months and have experienced no problem.

Furthermore, we have started a limited test on high mileage locomotives, GP40-2s, using reclaimed journal oil in traction motor support bearings. We have been into this test for about 60 days and see no problems. This will be a system-wide policy on Conrail, and we expect significant savings.

MR. K. D. REED [Conrail]: Just a brief comment. I am surprised that this subject even came up. The history of reclaiming oil on many railroads is as old as the diesels themselves.

On our railroad, going back to the Pennsylvania, we reclaimed our own oil for years. Later the AAR came out with a manual, MR305, which was a very extensive test procedure for testing crankcase lube oil. The Pennsylvania ran a reclaimed oil against a new oil at that time, and this whole test was published by the AAR.

I just can't believe there is still anybody around who doesn't believe that, as far as quality is concerned, reclaimed lube oil done by a reliable reclaimer and under quality control is not as good as new lube oil. The question of cost, of course, is something that can vary from time to time.

MR. COX: Another question from another railroad: "We have experienced difficulty with GE cast iron engine blocks, wherein we have had failure in one of the main bearing bores, making it necessary to rebuild this with some material in order to achieve proper main bearing support. What are the recommended procedures for rebuilding the GE engine block back to standard to offer proper main bearing support in the line boring process?"

MR. MITCHELL: It is written up. Primarily, you rebuild the area that is in distress or damaged with a cold weld process, and then line bore back to the original dimensions. It will include replacing the main bearing cap at the same time to achieve the original dimensions. The process is written up and is available to anyone who wants it. We will be glad to supply it. GE provides UX frames and recommends customers use UX rather than repair seriously damaged frames.

I would like to put in a plug on another topic. You mentioned the need for development work in gear cases. We do have a new GE 752 gear case. It is designed and developed and on field test. There are several out in the railroad industry. We have a new design gearing. Our only recommended lubricant for gear cases at this time is the original Jet Lube TM. We have shown that at least in our gearing the lithium creates some scuffing problems, and we have not recommended the industry go to this yet. We will continue working with some companies in developing that lubricant.

MR. COX: Any other comments on GE cylinder block repair? We have had some recent experience on the Santa Fe with this repair and trying to find a method that is a little bit more economical than the cold weld process. The cold weld process is effective, but it does take a tremendous amount of time and expense to take the block back to standard with cold welding and repairing.

We have experimented with some plating processes on the main bearing bore, and to date we have not successfully found a method that will give the right kind of adherence to allow for machining of the metals.

I would like to see some plating manufacturers and some metal spray manufacturers get into this area and possibly develop a good system to repair the GE cylinder block. I believe there is a great need for work in this area to produce a more economical method to repair the GE cylinder block.

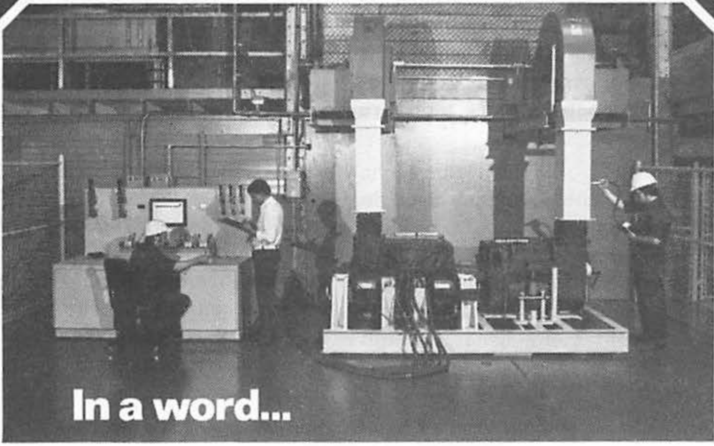
Are there any other comments on that subject, or any questions from the floor?

MR. HOLMES: In regard to traction motor gear lubricant, I wonder how many railroads stock a different gear lubricant for GE and EMD locomotives, and whether there is an aggravated problem with the GE gearing with the lithium grease. It seems to me that today the major objective is standardization in all areas. It doesn't seem to me very practical that one grease would not be compatible with both systems.

I understand that variance in mechanical design sometimes presents different lubrication requirements. Are the requirements for GE and EMD really that much different, so that one lubricant cannot be made suitable for both?

MR. COX: Are there any railroad members who could speak to that, or give us their experience with GE traction motor gear failures? John, can you give us a little information on that? He says no. Any other questions from the floor?

MR. HUEMMRICH: In the recent past we have had approximately 900 diesel locomotives stored, and we are concerned about moisture accumulation in the electrical cabinet in those locomotives. We have been advised by EMD POINTERS to put chemical dessicants in the cabinets. This is effective, of course, but it is also expensive and labor intensive be-



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cause you have to continually monitor the condition of the dessicant and replace it when it is expended. I wonder if there is anyone in the room or on the Committee who could advise a more economical means of protecting cabinets from moisture damage.

MR. SMALLING: I have no comment on the dessicant used in electrical cabinets, but I do have the problem of cleaning the electrical cabinet, the traction motors and the generators. In addition to this dessicant being used, I would like to hear of a good method for cleaning.

Down through the years we have researched many samples of various types of cleaners, and the most satisfactory compound we have found is the chlorinated hydrocarbon. Now, however, environmental regulations in many states are creating serious problems in the use of the material. In some locations we are reduced to attempting removal of dust and dirt particles through the use of forced air. In other instances involving creepage of oil and grease, stoddard solvent is used by saturating shop towels. Are there any comments on good methods for cleaning electrical parts?

MR. COX: Are there any comments on that, please?

MR. KENNETH O. ANDERSON [General Electric Company, Erie, Pennsylvania]: I won't comment on a proper way to clean electrical cabinets, but I will spell out specifically another danger if chlorinated hydrocarbons are used—in addition to the hazard to men.

Chlorinated hydrocarbons are "sudden death" to the blue fronts on the electrical control cards used by GE, as well as to their sockets. I tried an experiment a year or two ago. I put a commercial cleaner, a chlorinated hydrcarbon, on a shop wiping cloth and wiped the blue front of a card. It crumbled in my hand. Also, if you get an overspray of chlorinated hydrocarbon onto cab windows made of Lexan, figure on buying a new set of windows.

MR. CLEVENGER: In reply to John's question, on the Santa Fe we have had pretty good luck cleaning electrical cabinets with a combination of Vythene and Lix 540. It is a mixture of about 10 to 1. That is 10 parts Vythene to one part Lix 540.

In reply to George's problem with stored locomotives, several years ago we stored several GE locomotives and had an awful problem with the interlocks after we took them out of storage. We used a product called Zepreserve. It is obtained from the ZEP Manufacturing Company, Atlanta, Georgia. All you have to do is spray the complete interlock with it and it will last for a long time.

MR. WESTERFIELD: There are a number of materials such as Mr. Clevenger mentioned that are available primarily for use by television service people or auto repair men to try to dry out wiring harnesses and controls. The exact chemical bases are usually proprietary. Generally they are either silicone compounds or combinations of alcohol and hydrocarbons.

Because of the many new synthetic materials that are being used in current devices, there is always the danger of a material's incompatibility with any kind of cleaner, around electrical equipment in particular, and I would caution everybody to be extremely careful about using any of these kinds of materials on any kind of basis without some very careful testing. Clean, dry air is still about the best friend we have.

MR. COX: Any other comments or recommendations on the use of cleaning materials? Are there any chemical manufacturing companies here that could give us some recommendations on that subject? If not, we have this question:

"We are experiencing an unusually high number of turbocharger failures on EMD locomotives. Does EMD have plans for improving the performance and life of the turbocharger? We understand Arrowsmith, REA Machines, and now Hunt-Spiller will be manufacturing these on the West Coast. Do any of the railroads have experience with these turbochargers?"

Do we have a representative from Arrowsmith in the audience who could speak to turbochargers?

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MR. WAYNE EWING [Arrowsmith Industries, Inc., Los Angeles, California]: I don't know that our company has made any particular changes recently. We have improved some of our methods.

When we started in turbo repair 12 years ago we immediately saw the need for Inconel blades, and we made that change. We also saw a need for flash chrome plating on clutch ramps, and we still do that today. Mainly we have installed N.C. machining equipment to increase our volume. In turbocharger repair we like to put the parts back into the same turbo whenever possible. There was a time when we put like parts in a box and didn't pay any attention to which unit they went back into. We have since done away with that. We have tried to keep together the parts that go with a particular turbocharger, and have found considerable improvement in the life of the turbo —maybe not its performance, but its life. I think that is the main thing we have done here, to try to keep like parts together whenever possible, and the Inconel blades from the beginning.

MR. COX: Do we have a representative from EMD who can tell us what recent changes have been made in the turbocharger to improve its life and performance, and possibly its fuel economy?

MR. WECK: It is a little bit like the question on repairing the crankcase. We could stay here all afternoon and talk about repairing crankcases, and we could stay here all afternoon talking about turbochargers.

I would like to talk about areas external to the turbocharger and the effects they have on turbocharger failure. Someone says, "I have a lot of failures on EMD turbochargers. What are you doing to solve this?" We are attempting to keep foreign material pieces generated by engines, engine failures, rings, valve portions, and so on, from passing through the turbocharger. As you are aware, we are working with new screens. The present screen with a parts trap collects foreign material in this area and keeps it out of the turbocharger. Foreign material is high on the list of causes of turbocharger failure.

Another thing we are attempting to do is to give to our customers who are having repeated failures as much help and instructions as we can in looking at the engine so that they don't have a repeat problem. We have a high number of overspeed overheat failures. So, we stress engine maintenance to keep the turbocharger itself from failing again.

All of the mechanical departments represented in this room are made aware of 100% of those causes for failure of turbochargers on their railroads. We present to them on a quarterly basis a total summary of turbocharger failures. We do a complete detailed analysis of failure on any turbocharger that is returned to us for rebuild, and we are attempting to give to the

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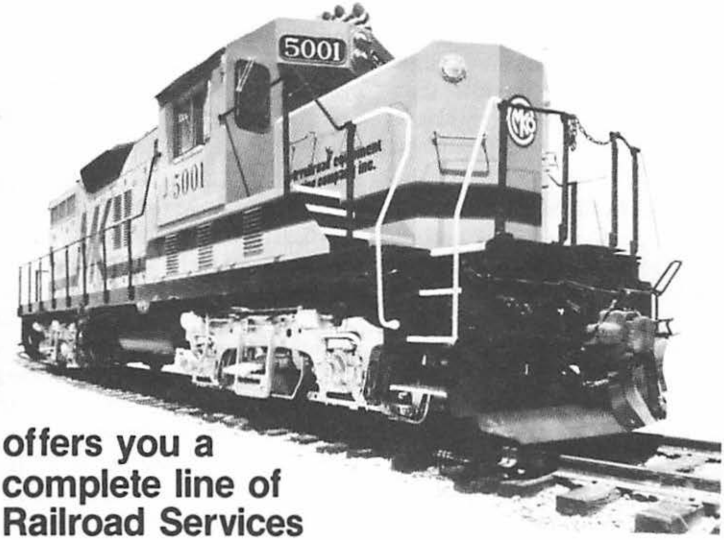

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customer better ways of controlling the atmosphere that the turbocharger itself has to live in.

Not to go too much farther into the internal design, but speaking in terms of efficiency and economy, we indeed do have what we refer to as an economy turbine or more economical turbine. If we have some of the turbine design people here we could go into that discussion, but I don't think it would be valuable in a maintenance subject such as this.

MR. COX: Is there a lot of work being done on the internal design of the turbocharger, and possibly changes in some material that will help to improve its life in the environment it operates in?

MR. WECK: Talking in terms of changes in material and design, we try to design ourselves out of any problem. Any manufacturer would. Speaking of those that are specific, at this point I have no input on that.

MR. COX: Walter, are you involved in any external systems that will help protect the turbocharger from some of the types of failures it is experiencing?

MR. WECK: As I mentioned, the trap, the exhaust manifold, the trap that goes with the screen, inspections, inspection procedures. Those are the areas we are into. We have attempted to detect a turbocharger 'that is getting itself involved with overspeed-overheat, but that has not borne fruit to date. We have run many tests on several properties that you gentlemen represent, and to catch a turbocharger going up to destruction in the short period of time that we have, and getting it stopped, presents a problem to which we don't have a solution as yet.

MR. COX: We would like to hear from other railroads as to their experience with the extent of failures and possible average life they are receiving from this turbocharger.

MR. NEELEY: I can give you some experiences on our railroad. The EMD turbocharger is a good machine. What is wrong and what happens to it is the external environment in which it lives. The larger percentage of our failures are due to what I term garbage coming from the exhaust stack, going through the turbo.

The second major cause of failure is that when a turbocharger fails due to a bad bearing, the air impeller explodes and goes out in the air filters. If the mechanics don't clean it out, that garbage goes through the machine.

Overspeed - overheating is another big problem, and that is caused by some defective part in the engine itself. So, if the railroads clean up those three environments they will cure the biggest problems with the EMD turbocharger.

MR. FRANK CONTE [Assistant Chief Mechanical Officer - Motive Power, National Railroad Passenger Corporation, Washington, D.C.]: One of the major issues to save fuel has been to shut down the diesel engine. I think in many cases (and we have witnessed some of this) they pull a main battery switch and knock out the filter. What we are doing is modifying so that we have the pump motor go direct to the battery on the other side of the main battery switch so that it will shut down of its own accord by the timer after 20 or 35 minutes. We definitely feel that is one of the problems everyone is experiencing, and we would like to recommend that you take that under consideration.

MR. BARRY HOLMES [Santa Fe]: During yesterday's discussion of traction motors, regarding the short life of rebuilt motors and different types of new motors not lasting as long as others, all of this relates to inferior insulation in the interpole areas. I wonder what developments in the area of improved insulation are being made.

MR. COX: Is there anyone who can comment on what developments are being made in improving insulation for traction motors primarily in the area of interpoles, where we are experiencing a lot of problems?

MR. BEN LIEBENTHAL [EMD, LaGrange, Illinois]: We have been studying this question with regard to traction motors, and now have some experimental interpoles on test. We feel one of the major long-term problems is having the coil secured on the pole piece. We

Secretary-Treasurer Joe Koerner, right, presents President Jim Long special engraved gavel at the start of 1980 Annual Technical Conference in recognition of Jim's added service to the Association. Jim serves as "official tailor", seeing that each incoming officer is outfitted in a new, form fitting blazer. He also serves as the procurer of the blazer emblems and the attractive past presidents' pins, both of which were designed under his direction. Looking on is Bill James.

are testing a system to better secure the coil on the pole piece to prevent this condition.

MR. MITCHELL: As far as I know, Chris, based on our reporting system, we do not have a problem with the interpoles in the 752 motor. You are well aware of the bearing design changes we are making jointly with Santa Fe to improve bearing life particularly at high speeds. We are also working on a 752-AF motor which does have an improved insulation system both in the armature and in the fields. We also had a quality problem generated in some motors produced in 1979. We isolated this to a 6-week time period, where we believe the difficulties have also been corrected.

MR. COX: In the improvement area, Forrest, as far as your insulation goes, are you using a different material basically or a different method of application? Exactly what are these improvements?

MR. MITCHELL: I wish we had an expert here, because he could tell you more than I can, Chris.

MR. COX: "As far as insulation is concerned, can you tell us if you have made any actual material changes?" I have a little more extensive question here, too: "In the past we have had problems with asbestos and other carcinogens in this area, and we have had some recent changes and required changes to prevent those types of materials from being involved in traction motors. Has this created any further changes?"

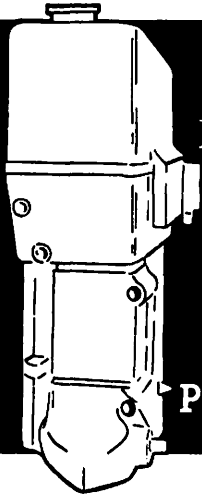
MR. LIEBENTHAL: Concerning insulation, we feel the silicone rubber system we use on our stator coils is an excellent system, and it is not the reason for any problems. As I mentioned earlier, we feel the problems are probably more in areas of vibration causing the coils to move, and causing ultimate grounds. We are, of course, experimenting with other systems, but at this point we do not have a change in mind.

As to your question about asbestos, we have a program to completely eliminate asbestos in our traction motors, and this will be done by January, 1981. We have already eliminated most of it from our products.

MR. COX: "We are experiencing an unusually high failure rate with all types of air conditioning systems, both Prime and Vapor. What are the vendors doing to improve the quality of the products, and what improvements can we expect to see in the near future?"

Is there anyone here from the air conditioning manufacturing companies who could speak to this subject?

MR. D. M. CAMPBELL [Vapor Transportation Systems, Chicago, Illinois]: Recently we had a call from Jack McFarland mentioning this subject. I suggested to Jack that you folks get in touch with EMD and that we have a joint meeting between the Santa Fe, EMD and Vapor. We are not



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aware specifically of the problems, and we would like to have more details. We have one unit that has just come back from Cleburne, and we are going to look at it shortly. That doesn't answer the question, but we don't know the details and we would like to get information.

MR. COX: "We are not achieving our expected life cycle after installation of power assemblies. The principal reason for early replacement is due to water leaks at the head to liner gasket area. We use EMD's premium seals. We have our liners and head set areas brought back to OEM specifications during remanufacture. What do you recommend for improvement?"

Jack, would you like to comment on that?

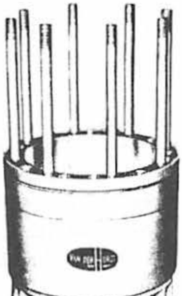
MR. KUHNS: I don't know what to say on that. I believe the first thing I would look for would be proper installation. Are all railroads experiencing a large number of water leaks between head and liner seal? I don't mean to say we don't have water leaks, but apparently this gentleman is talking about something more severe than run-of-the-mill leaks. That is about the only comment I can make. I am sure Walter would say the same thing. Put it together right.

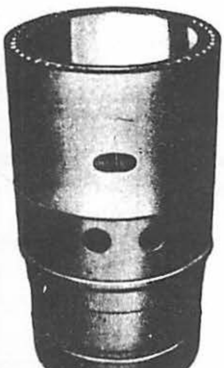
MR. COX: The first thing that comes to mind is torque values. Then there are a lot of other areas we could get into in the area of installation, where the information is readily available. Could the person who submitted this question tell us where the problem areas are?

MR. KUHNS: Tommy just mentioned that we would appreciate it if the man would be a little more specific about his problem. Tommy might comment on the way we test ours when we put them together. We try to change the complete cylinder assembly, and before we put it in it is tested. Tommy, do you want to comment further?

MR. KESSENGER: Yes. One of the machines we tried to build was a liner tester, and during that same period we toured EMD. They were using a drop test, as we called it. They would put compressed air on the complete assembly in the water jacket area and look for a pressure drop over a certain specified time. We found that was a good test, and have been using it since then. We don't use our liner tester, since the drop test gives us the same results. So, I might suggest that the gentleman look to his assembly procedures and the quality control methods he uses.

MR. COX: "EMD cylinder liners that have been laser-hardened present some alleged problems in the area for certain chrome platers. They state it is apparently necessary to use different honing processes in order to properly plate these laser-hardened liners. Can we hear some comments from the railroads that have had enough





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mileage on these laser-hardened liners and have had them in service long enough and then replated them?"

Would some of the chrome platers like to comment on their experience with chrome plated laser-hardened cylinder liners?

MR. JOHN GAREY [Van der Horst Corporation, Olean, New York]: We have processed laser-hardened liners on test and find that with the Van der Horst Pre-Plate treatment we have experienced no problems whatsoever. We have performed destruct tests on several laser-hardened liners we have plated, and find the bond of Van der Horst chromium to the base metal to be excellent. No additional "special processing" was added or needed, and we are chrome plating them quite successfully.

MR. COX: Is there a representative here from another electroplater who has had experience in this area?

MR. PATRICK McCALL [Electro-Coatings]: We are involved with the chrome plating of liners, but it is done at our West Coast facility. Since I am relatively new in the Midwest, I can't comment on the exact problems or things they are doing currently.

MR. COX: We have a question on fuel tanks. I might direct this question to some of the chemical manufacturing companies:

"What can we do about locomotive fuel tanks that are contaminated with rust and algae and possibly water? Is there a chemical available to clean the tanks and possibly purge them and service them without going through a long process of draining and steaming?"

MR. N. C. ECKERLE [Nalco Chemical Company, Oak Brook, Illinois]: Are you talking about problems that may be solved chemically? Are you talking about bulk storage tanks or locomotive fuel storage tanks?

MR. COX: Locomotive fuel storage tanks.

MR. ECKERLE: The main recommendation, as far as water is concerned, is to try to drain them and get the water out. I know that is a problem. There are products available (and Nalco has one) that contain a microbiostat to control the build-up or growth of bacteria or fungus in fuel, whether it is in the bulk storage tank or the locomotive tank.

As far as cleaning these tanks is concerned, there are chemicals that might possibly be used. We have been working on some of these things from an experimental standpoint with one or two railroads.

These methods are somewhat complicated by the structure or the baffling that you find in the locomotive fuel tank. It is a problem of recirculating any cleaners or solvent or dispersants in the system to adequately disperse the sludge or other waste at the bottom of the tank. As I said, we have done a great deal of cleaning in large fuel oil storage tanks.

MR. COX: We are getting near the end of our time, so I would like to ask Mr. Dale Propp to summarize, please. I want to thank all of you for your participation.

MR. PROPP: Please join me in giving Chris and his Committee of experts a round of applause. [Applause].

Certainly the What's Your Problem session is a continuing effort to keep us all informed and to coordinate our thoughts with the builders, other railroads and suppliers, so throughout the coming year please continue not only to look for problems but remember to bring your problems and questions back to this session.

I also want to thank each of you for being so attentive. That certainly is what makes a panel discussion of this type so successful.

PRESIDENT CLEVENGER: Thank you, Dale. I want to echo my thanks, too, to the panel for a job well done.

I have two or three announcements. We ended up with 1,705 total membership in the LMOA. We had 369 railroad and associate members register for the convention and 81 ladies, which shows a pretty good attendance at our convention.

When you receive your transcribed remarks, be sure to edit them promptly and get them back to our recorder. If you are in any

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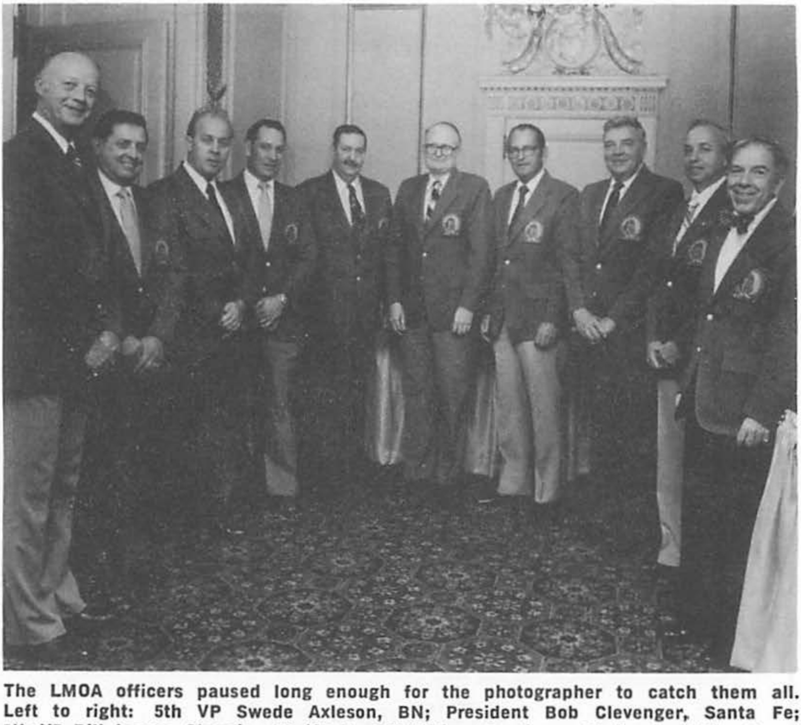
of the rooms or see any of the advertisers, thank them for their participation. Along that line, I think most of you know that one our best advertisers in the LMOA, Mr. Roy Touchstone of the Touchstone Supply Company, took sick here Sunday and is presently in the hospital in Chicago. I am sure all of us wish Roy a speedy recovery.

With that I would like to adjourn this meeting until September 28, 1981, when we will meet again in this hotel. Thank you. [Applause]

[The meeting adjourned sine die at 11:45 a. m.]



The LMOA officers paused long enough for the photographer to catch them all. Left to right: 5th VP Swede Axleson, BN; President Bob Clevenger, Santa Fe; 6th VP Bill James, Chessie; 4th VP Darrell Walker, Southern; Chairman of the Board Jim Long, Chessie; Past President Tom Harley, TT; 2nd VP Frank Bruner, UP; 1st VP Nelson Buskey, Chessie; 3rd VP Dick Holmes, UP; and Secretary-Treasurer Joe Koerner.

PRE-CONVENTION

PRESENTATIONS

INDEX

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MONDAY, SEPTEMBER 28, 1981

TUESDAY, SEPTEMBER 29, 1981

WEDNESDAY, SEPTEMBER 30, 1981

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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 1981 LMOA Membership card for identification in registering.**

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"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.
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   or

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

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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
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1956 — T. T. BLICKLE (Deceased), Retired General Manager - Mechanical A. T. & S. F. System

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.

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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

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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

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

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1975 — L. H. BOOTH, Retired Assistant C.M.O. - Locomotive, Chessie System, 906 13th Ave., Huntington, W. Va. 25701

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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

1979 — E. T. HARLEY, Vice President - Equipment, Trailer Train Co., 300 S. Wacker Dr., Chicago, IL 60606

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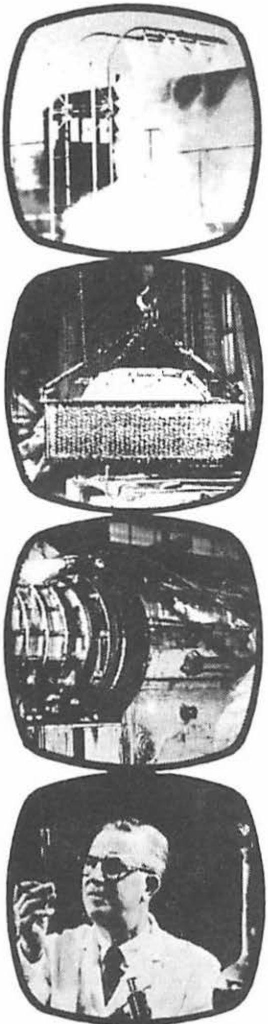

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We of the Chicago Railroad Diesel Club were again pleased to be hosts to the Locomotive Maintenance Officers Association for their April 6, 1981 Pre-Convention Presentation.

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.

Monday, September 28, 1981

10:00 A.M.

REPORT OF THE COMMITTEE ON FUEL AND LUBRICANTS

Pre-Convention Presentation: Chicago Railroad Diesel Club

April 6, 1981
Midland Hotel
Chicago, IL

B. C. CAIN, Chairman
Chemist
Atchison, Topeka & Santa Fe
Railway Co.
Topeka, KS 66616

VICE CHAIRMAN

D. D. Hudgens, Manager-Field Laboratories, Union Pacific Railroad, North Platte, NE 69101

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1981 TOPIC:

"PROBLEMS, SOLUTIONS AND NEW TECHNIQUES IN FUELS AND LUBRICATION"

PERSONAL HISTORY
B. C. CAIN

AGE: 34
BIRTHPLACE:
Fort Worth, Texas
MARITAL STATUS:
Married with two children
EDUCATION:
Graduated with BS degree in chemistry from the University of Texas at Arlington in 1970. Graduate work in Inorganic chemistry at Texas Tech University.
WORK EXPERIENCE:
Research Assistant at the University of Texas.
Teaching Asst. at Texas Tech.
Chemist for Santa Fe from 1973 to present.

Jack Hoffmann

I.
EFFECTS OF USING ALTERNATE FUELS ON EXISTING DIESEL ENGINES

Introduction

In 1980 this committee presented a report entitled "Assessment of Future Fuel Supply and Quality." This year's paper is an update and deals specifically with two broad topics: Emergency Fuels and Alternate Fuels. In the context of this discussion, the principal differences between these two categories are duration of use and severity of need. In the emergency situation, the use of the fuel would be for a limited (though possibly long) time and a national fuel shortage would exist.

The U. S. Department of Energy (DOE) sponsored a multi-year investigation of potential "emergency" fuels. The principal results of this investigation are reported in Society of Automotive Engineers (SAE) paper Number 810-444. This study considered fuel extenders for both gasoline powered vehicles and diesel powered vehicles. The possibilities considered ranged from gasoline as a diesel fuel extender and diesel fuel as a gasoline extender through vegetable oils, crude oils and gases. Stated assumption in the tabulation of possible emergency fuels is that available supplies of potential fuels "would be allocated to key transportation functions on some priority basis." Thus, using gasoline to extend diesel fuel and vice versa could be an emergency scenerio though not one which would relieve a general petroleum supply shortage without, at the same time, disrupting the normal flow of activities and introducing some risks.

As shown in Table 1, the transportation industry consumed 55% of the oil used in the United States in 1979. Table 2 displays the fact that the railroad industry consumed 3% of the 55% charged to transportation or 1.65% of the total U. S. oil consumption. The data for both of these figures are quoted from SAE paper 801342 by Mr. E. D. Cain of the Standard Oil Company of California. This small percentage (1.65) represents a high quantity of product — approximately 4 billion gallons per year. Incidentally, the price of this 4 billion gallons of fuel has escalated 900% since 1967.


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U. S. OIL CONSUMPTION BY USE (1979)*

Transportation	55%
Residential/Commercial	14%
Non Fuel	14%
Industrial	9%
Electricity	8%

*Source SAE Paper 801342

Table 1

U. S. TRANSPORTATION FUEL USE 1979*

Motor Gasoline	69%
Aviation	11%
Highway Diesel	8%
Marine	6%
Rail	3%
Other	3%

*Source SAE Paper 801342

Table 2

In an emergency, it would be expected that the railroad industry would be one of those to receive high priority fuel allocation. The previously mentioned study conducted by Southwest Research Institute (SWRI) for DOE examined the following materials as principal candidates for emergency diesel fuel blend constituants: unleaded gasoline, medium naphtha, heavy naphtha, jet fuel, kerosene, marine diesel fuel, No. 4 fuel oil, No 5 burner oil, No. 6 fuel oil and filtered South Texas crude oil. SWRI also examined a number of other materials including alcohol. The examination consisted of wear tests, stability tests and various engine tests. Their work indicates that a gasoline blend up to 50% and an alcohol blend up to approximately 30% could be used to extend diesel fuel under dire circumstances. They warned, however, as others have, that "at low concentrations of either gasoline or alcohol in diesel fuel an extremely explosive condition exists. Vapors over these mixtures could be ignited by a static discharge or any other source of ignition causing a catastrophic explosion; extreme caution must be used when dealing with these fuels."

The SWRI study also indicated that naphthas, jet fuel and a particular No. 4 fuel showed promise for use as an emergency fuel without blending. The No. 5 fuel tested in the particular engines involved could not be effectively used above 60% to 80%.

Alternative Fuels

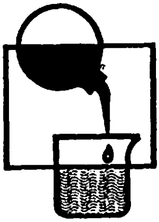
Before seriously discussing fuel alternatives it is necessary to define the fuel for which an alternative is sought. Table 3 is a tabulation of important fuel oil specifications. The three American So-

MAJOR DISTILLATE PETROLEUM FUEL SPECIFICATIONS

PROPERTY	ASTM 1D	ASTM 2D	ASTM 3D* Proposed	ASTM 4D	EMD	G. E.	AVG. RR
Vis. Sus @ 100°F Max.	35	40	50	125	45	50	43
Cetane No. Minimum	40	40	37	30	40	37	43
Sulfur % Maximum	0.5	0.5	0.7	2.0	0.5	1.0	0.5
10% B.P. Typ. °F	400	470	470	—	—	—	469
90% B.P. Max. °F	550	640	680	—	650	680	640
Carbon Residue	0.15	0.35	0.40	—	0.35	0.35	0.22
Distillation Recovery % (Min.)	—	—	—	—	99	99	97-99

*Presently Voted Down in ASTM.

Table 3



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ciety for Testing and Materials (ASTM) diesel fuels are listed along with a previously proposed "compromise" ASTM diesel specification. Also included are G. E.'s specification, EMD's specification and the average of present U. S. railroad specifications. The principal properties are recorded. It should be noted in some areas (such as boiling range) that the ASTM specifications have no limits defined. The same is true for "distillation recovery." Nearly all of the railroad specifications list a value for "maximum pour point" and in many cases "maximum cloud point." The ASTM specifications state that these properties should be such that they cause no problems.

The engine builder's specifications and the railroad specifications list a minimum distillation recovery of between 97% and 99%. In effect, these specifications limit the fuels to be considered to "all distillate" products. Both ASTM 1D (intended for high speed engines) and 2D (intended for medium speed engines) are defined as distillate products. Number 4D does not contain such a statement and, therefore, could contain some residual material. Note the major upward jump in viscosity and sulfur content between No. 2D and No. 4D, these values changing from 40 to 125 and 0.5 to 2.0 respectively. On the other hand the proposed ASTM No. 3D allowed a viscosity of only 50 seconds and sulfur of only 0.7% A similar situation exists with respect to cetane number (an ignition quality property). The No. 2D cetane number minimum is 40 and No. 4D minimum cetane number is 30, while the 3D minimum cetane number proposed was 37. Work at SWRI indicates that the minimum cetane number requirement for present EMD and GE multi-cylinder engines is somewhere between 30 and 40. Thus, the minimum value cetane number suggested for ASTM 3D was judiciously selected.

An examination of fuel "specifications" is only one way of determining the "fuel being used." At the committee's request, a survey was conducted by the National Association of Railroad Engineers of Tests in an attempt to determine the average and worst case fuel being used by the railroad industry. Table 4 lists the average railroad fuel specification and the "worst case" fuel actually being used. From this comparison it may be seen that the average fuel used is: lower in viscosity than the maximum specified, higher in cetane number than the minimum specified, lower in sulfur content than the maximum required, and generally has a lower boiling range than the limits allowed by specification. The "worst case" fuel is lower in cetane number, lower in viscosity but much higher in sulfur content (above proposed 3D), and generally lower in boiling range. When considering alternative fuels trade-offs, it is necessary to consider specifications, "worst case," and average fuel used.

The DOE is the sponsor of a major study entitled "Future Propulsions Systems for Railroad Locomotives." The holder of the contract is the Jet Propulsion Laboratory (JPL). Future fuel is major consideration of Phase B of this project. In the spring of 1980 JPL reviewed its preliminary findings of the Phase B section with the Department of Energy, Association of American Railroads, Federal Railroad Administration, and locomotive builders. The study evaluated (from the literature) every conceivable logical substitute or extender fuel for locomotive diesel engines. The evaluation ranged from gaseous fuel through slurries of solid coal particles in diesel fuel. Table 5 is a display of JPL's top 12 candidates. It should be noted that alcohol does not make the top 12. Ethanol and Methanol rank No. 18 and 19 respectively. They received bad marks for combustion, engine operation, storage and safety. At this time, your committee eliminates "propane" and "10% water/6% emulsifier in diesel No. 2" from consideration. There is no doubt that diesel engines can be designed or converted to operate on propane; however, design changes are significant, supply is questionable, and there are major safety problems associated with handling propane. The water and emulsifier proposal is very expensive and of unknown energy trade-off value for railroad diesel engines. There is little doubt about the ability of today's diesel engines to operate on at least a partial diet of heavy naphtha, medium naphtha, kerosene, gasoline in diesel No. 2, Jet A, or 30% gasoline in lube oil. However, there are very serious safety and supply concerns about some of these products as long term alternatives. Certainly, they deserve consideration as candidates for emergency fuel with appropriate safety precautions.

The remaining candidates on the list are displayed differently in

U. S. RAILROAD FUEL USED

	Aver. Spec	Worst Case	Avg. Used
Viscosity at 100°F, SSU	43	35.2	34.9
Cetane No.	43	40	45.6
Sulfur %	0.51	0.74	0.31
10% Boil. Pt. °F	469	392	402
90% Boil. Pt. °F	641	602	559
Carbon Residue	0.22	—	
Cloud Point °F		+5	—14

Table 4

RANKING OF ALTERNATIVE FUELS BY JET PROPULSION LABORATORY

Broadcut Fuel Oil
Oil Shale Distillate
Heavy Naptha
Medium Naptha
Kerosene
50% Gasoline in Diesel No. 2
Jet A
30% Gasoline in Lube Oil
Coal Derived Distillate
No. 4 Fuel Oil
10% Water - 6% Emulsifiers in Diesel No. 2
Propane

Table 5

RAILROAD ALTERNATIVE FUELS

Short Term (Petroleum Derived)
— Broader Diltillation Range
— Permit Some Residual Components
Longer Term (Non Petroleum Derived)
—Shale
— Coal

Table 6

Table 6. The term "broader distillation range petroleum" in essence defines "broad cut fuel oil." If the distillation range were broadened on both the low boiling end and the high boiling end, some of the components listed as "naphthas" as well as some of the components in "No. 4 fuel oil" would likely be included. No. 4 fuel oil has a maximum allowable viscosity of 125 Saybolt Seconds at 100°F and a minimum allowable cetane number of 30. It may or may not contain residual components.

In the longer term category, products from shale and from coal remain as candidates. The materials which can be derived from coal range from products with extremely good diesel characteristics to products which, by themselves, are very unlike diesel fuel.

As discussed last year, the railroad engine fuel research work being conducted at SWRI has shown clearly that the two cycle railroad engine can operate on fuels with a broader distillation range than is currently being defined by railroad fuel specifications, and quite possibly beyond the range of the formerly proposed ASTM Number 3D. The four cycle engine builder's current fuel specification already allows fuels substantially beyond ASTM No. 2D and at least equal to the proposed 3D.

As discussed at some length in last year's report, railroad diesel engines have been operated in the past and recently with fuel oils containing residual components. Table 7 displays the analysis of a residual-distillate fuel blend which was tested successfully in the four cycle railroad diesel engine in 1980 (50,000 gallons). Also displayed in Table 7 is the latest GE distillate fuel specification for comparison. It should be noted that with the exception of the amount of fuel recovered on distillation, the 10% No. 6 fuel analysis complies with the specification. However, when dealing with residual fuels other things must be taken into account.

Recently a U.S. railroad obtained a blend of No. 6 fuel and No. 2 fuel which had an analysis almost identical to that shown on Table 7. However, filtration problems were such that the "over-the-road" test planned could not be conducted. The filtration difficulties resulted from incompatibility between the particular No. 6 fuel and the particular No. 2 fuel. There are tests which can be con-

10% No. 6 OIL + 90% NO. 2D FUEL COMPARED TO G. E. SPECIFICATION

Property	Analysis	G. E. Fuel Spec.
API Gravity @ 60°F	32.1	1.0
Sulfur % Weight	0.54	—
Distillation °F		—
10%	428	—
50%	522	—
90%	642	680 Max.
% Recovered	91	99
Calculated Cetane No.	44	37 Min.
Viscosity @ 100°F, SSU	38	50 Max.
Pour Point °F	—5	—

Table 7

AEROQUIP LEADERSHIP IN THE RAILROAD INDUSTRY MEANS . . .

TEAMWORK

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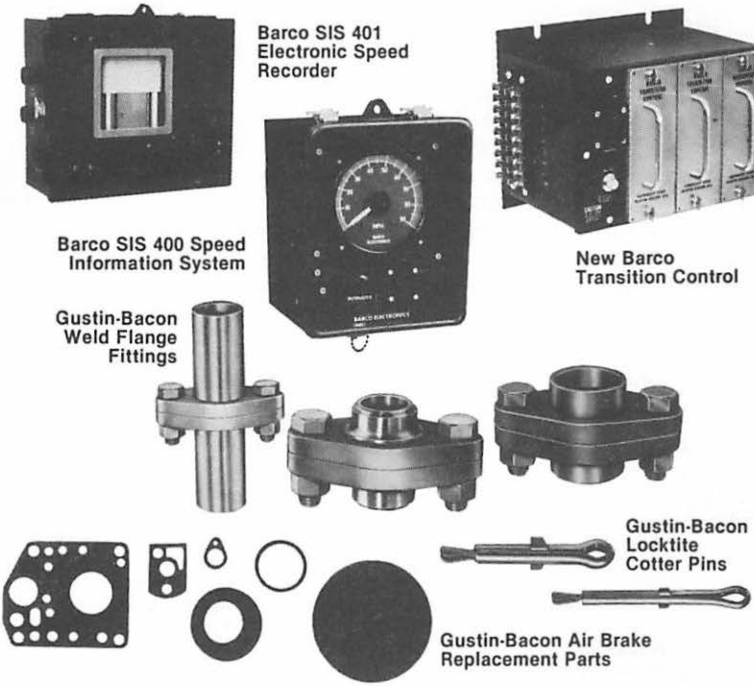

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ducted to screen such incompatibility. The lesson learned, or relearned, concerning the use of residual components in railroad diesel fuel is that simply defining the percentages of No. 2 fuel and No. 6 (or 4 or 5) does not adequately describe the product desired. Specifications can be developed which will allow the inclusion of some residual components and cause only minimum handling difficulties.

If railroads wish to increase the quantity of fuel available in the near term, it is mandatory that fuel specifications be issued which define other acceptable products. It is not possible at this time to state that this specification should be named "No. 4 light" or "railroad residual blend" or "railroad heavy." Until such time as a specification is developed, a continuing supply of acceptable broader specification fuel will not be available.

The technology to produce synthetic distillate fuels from either shale or coal is in hand. Enough is known about fuels from shale and from coal to be certain that U. S. railroad diesel engines can operate satisfactorily on some of them. Table 8 exhibits the diesel properties of a shale derived liquid fuel. Table 9 displays these same properties for two widely different types of coal derived materials. In both Tables 8 and 9, requirements for ASTM No. 2D fuel are listed for comparison.

The Republic of South Africa has been serious about synthetic fuels for a long time. As a consequence, that country is now constructing a third major plant for conversion of coal to synthetic fuels and chemicals. The fuel listed as Type B in Table 9 represents

COMPARISON SHALE DISTILLATE WITH ASTM 2D

Property	ASTM 2D	Shale
Viscosity @ 100°F SUS	40 Max.	35.5
Cetane No. (Calc.)	40 Min.	55
Sulfur, %	0.5 Max.	0.06
10% B.P. °F	470 Typ.	456
90% B.P. °F	640 Max.	562
Distillation Recovery %	98 Typ.	98
High Heat Value BTU/#	19,400 Typ.	19,600

Table 8

COMPARISON COAL DERIVED FUEL WITH ASTM 2D

Property	ASTM 2D	Type A Coal Derived	Type B Coal Derived
Viscosity @ 100°F SSU	40 Max.	37.4	35
Cetane No. (Calc.)	40 Min.	4.2	48
Sulfur %	0.5 Max.	0.04	.001
10% B.D. °F	470 Typ.	396	385
90% B.P. °F	640 Max.	528	581
Distillation Recovery %	98 Typ.	98	98
High Heat Value BTU/#	19,400 Typ.	17,360	Est. 19,800

Table 9

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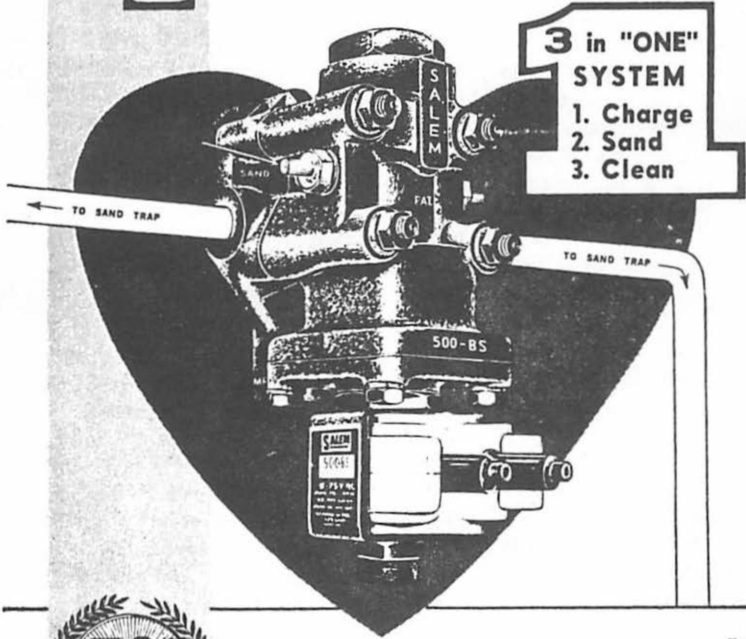

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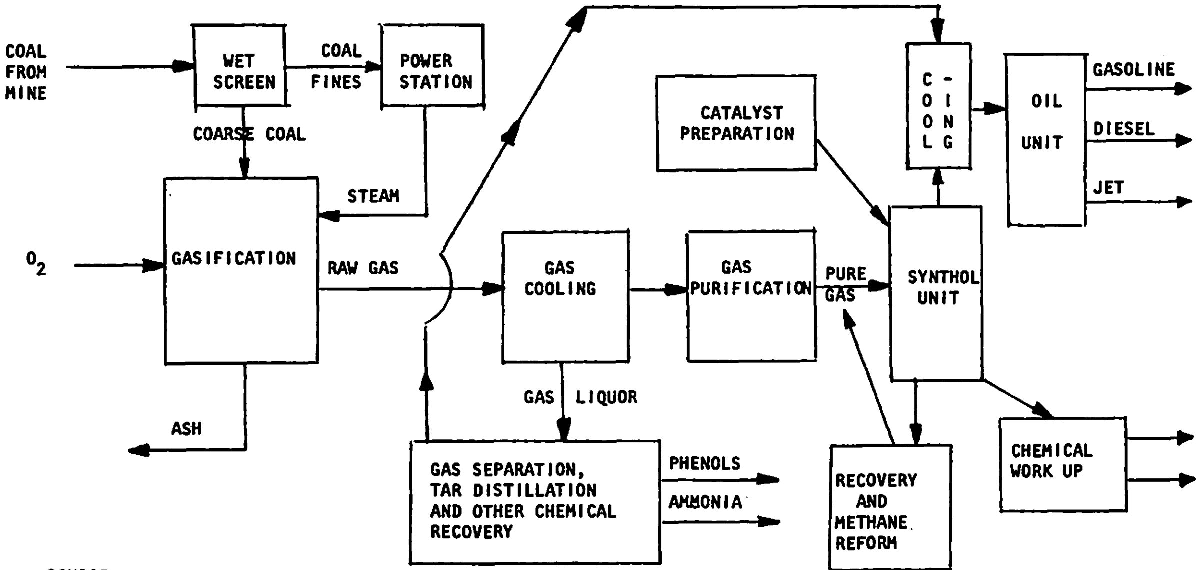
the best type diesel fuel material available from a process such as used in South Africa. Presently, the U. S. believes this process to be non-cost effective. However, it can be done. An advertisement from a Republic of South Africa magazine states, "While South Africa continues its search for oil Sasol is expanding its highly successful oil-from-coal operation. Starting from scratch in 1950, Sasol soon proved it could produce oil from coal economically by declaring a profit only 5 years after commissioning Sasol No. 1." When Sasol No. 3 is operational, the three plants will convert more than 32 million tons of low grade coal per year into liquid fuels, pipeline gas, and chemicals. Figure 1 is a flow diagram of the Sasol process. It should be understood that United States researchers in this field are quite cognizant of the general procedure, but for obvious reasons, technical details of the process are considered secret. The flow diagram used in Figure 1 was reproduced from a publication entitled "Liquid Fuels From Coal — Meeting the Challenge" which was provide by Sasol Ltd.

Fuel defined as "Type A" in Table 9 is a minimally refined product. Research into the use of this material is currently ongoing. It has been investigated by SWRI in the 2-cylinder, 2-cycle engine. The almost non-existent cetane number (like alcohol) was overcome by using diesel pilot injection. Four-cycle railroad engine research with this fuel is using the "blend with diesel fuel" approach. The first criterion for blending is to achieve the minimum cetane number requirements for the engine design. Full load multicylinder engine running has been completed on a blend of 25% of this fuel in diesel fuel. Complete results of this investigation will be available in the technical literature by the end of 1981. Table 10 displays the properties of this 25% mixture compared to the ASTM No. 2D fuel specification. At this point it is only appropriate to say that from a combustion viewpoint the fuel performed quite satisfactorily as would be predicted from the analysis. Some operational difficulties were encountered which are believed to be minimal and easily overcome.

As mentioned earlier, a considerable amount of work is going forward in a number of laboratories with slurries of solid combustible materials in a liquid. This work is considered at the research stage. The November 1980 issue of Marine Engineers Review contains an article by Messrs. T. W. Ryan, W. E. Likos and C. A. Moses of Southwest Research Institute. Table 11 is a portion of Table No. 2 from the SWRI article. Products of this nature are not considered "alternative fuels" in accord with the definition given previously.

It should be clear from the above discussion that the only viable present alternative fuels are those derived from petroleum. In the long term, the raw materials will be coal and/or shale. No alterna-

FLOW DIAGRAM SOUTH AFRICA SASOL SYNTHOL



SOURCE:

"LIQUID FUEL FROM COAL"
PUBLIC RELATIONS DIVISION
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Figure 1

COMPARISON 25% BLEND TYPE "A" COAL WITH ASTM 2D

Property	ASTM 2D	Coal Liquid Blend
Viscosity @ 100°F, SSU	40 Max.	35
Cetane No. (Calc.)	40 Min.	37
Sulfur. %	0.5 Max.	0.3
10% B.P. °F	470 Typ.	382
90% B.P. °F	640 Max.	540
Distillation Recovery %	98 Typ.	97.5
High Heat Value BTU/#	19,400 Typ.	18,860

Table 10

*EXAMPLES OF SLURRY FUELS ATTEMPTED

Formulation	Engine Performance	Problem
20% Coke	Ran	None
20% Wheat Starch With 1% Lecithan	Ran	None
20% Coke and 1% SOA	Ran	None
20% Carbon Black And 1% SOA	Failed	Nozzle Sticking
20% Cornstarch And 1% SOA	Failed	Rapid Settling
40% Coke and 1% Lecithan	Marginal	Nozzle Sticking

*Source: "The Use of Slurry Fuel in a Diesel Engine" — Marine Engineers Review, Nov. 1980

Table 11

tive fuels will be available in quantity unless the users — the railroads — point a direction for the supplier. This must include the degree of inconvenience they are willing to accept in order to lower costs and/or increase supplies.

skip

#1 II.

UPDATE ON COLD WEATHER PROCEDURES FOR FUELS

Most of us know from first-hand experience that when the weather turns cold enough, water or wax crystals can form in fuel systems and partially or completely block fuel flow to the injectors. When this happens, not only does it require considerable time to remove the deposits, but if it happens on line of road it can also interfere with the traffic flow, and cause serious damage to the engine itself.

Down time can be minimized in most cases, by good fuel systems housekeeping and other methods of controlling cold weather problems which we will discuss as this paper progresses.

When the cause of a problem is known and understood, it can best be met and managed. The diesel engine cold flow problem, whether it is partial or complete blockage

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of fuel, is caused by either ice or wax crystals, or both.

In more cases than not, these crystals (which are not very large) plug the fine pores of the fuel filter. These crystals can also plug fuel lines, usually at elbows where flow is restricted.

If the restricted flow is ice crystals (which usually happens between 0° and 32°F.) and if icing is the problem the solution is to get the water out of the fuel and, by good housekeeping, keep it out. The best method of controlling the ice problem is keeping all moisture out of the system; however, this cannot always be accomplished. Many railroads use alcohol (preferable Isopropyl) in quantities of one gallon per thousand gallons of oil. The alcohol works but should not be relied upon to remove large quantities of water.

All so-called middle distillates (diesel fuel) contain waxes, some of which cannot be removed. It is these waxes that drop out of solution and clog fuel systems when the temperature gets low enough.

Cloud point is the most important fuel property affecting the low temperature operation of the diesel engine, and since there is very little (other than blending of fuels, which is next to impossible at this time) that can be done to lower the cloud point, we shall endeavor to update you on the things that have been done to overcome this problem.

Chemical Additives

First we would like to discuss briefly chemical additives to fuels.

Additives most commonly referred to as cold weather improvers, wax crystals modifiers, or fluidity improvers can reduce the pour point but not the cloud point. There are some fuel additives that may improve the cloud point by modifying the size and structure of the wax crystals. However, the extent to which this takes place depends largely on the composition of the fuel, and there is no guarantee that this will be to our benefit. In most cases the additive will lower the pour point but in reality has no effect on the operation of the diesel engine.

Fuel Heaters:

Railroads are equipping locomotives with fuel heaters which use the heat from cooling systems. These heaters have some problems, such as contaminates in the water that act as abrasives and in some cases deteriorate tubes. However, these problems are not insurmountable. The proper selection and installation of the fuel heater is usually based on the engine builder's recommendations. It should also be noted that these heaters can be bypassed in warm weather.

Automatic Drain Valves:

Locomotives can be equipped with automatic drain valves. This feature is useful when engines cannot be drained manually. These devices are controlled by a thermostat that activates the drain valve when descending temperatures reach approximately 45°F (7°C).

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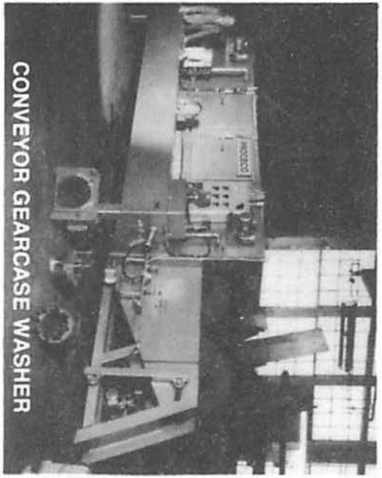

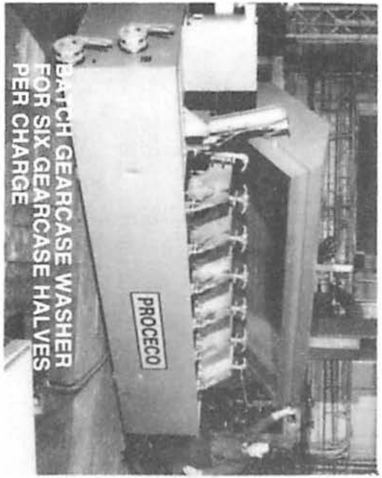

The operation features can be found in M. I. 582 for EMD and Gem data 1-18-80 for GE engines.

Oil Coolers:

Tubes in GE oil coolers have been increased in diameter from 1/4 inch to 5/8 inch. This should prevent the plugging of tubes, which no doubt will prevent cooler failures in cold weather.

Mixer-Divider:

In 1979 the Union Pacific Railroad conducted a full-scale locomotive test to determine the effectiveness of a system designed to eliminate cold weather related fuel flow problems. This system is known as the Mixer-Divider system.

The MD system design, as used in this test, was developed and tested in the laboratory using scale modeling techniques. Dividing ratios were selected to provide a mixture of tank fuel, and warm return fuel is mixed with tank fuel. At idle, approximately 70 percent of the returned warm fuel is mixed with tank fuel. When the throttle is advanced, a higher percentage of the return warm fuel is mixed with the cold. At throttle eight, seven, and probably six, all of the warm returned fuel is being mixed with the cold at the suction pipe. This simple, nonmechanical system provides warm fuel for the engine primary fuel system, maintains warm fuel at the fuel suction pipe in the tank, and effectively proportions warm return fuel with cold tank fuel.

The MD system places the heat exchanger in the fuel return line from the engine to the tank so that all heat added to the fuel will be transferred to the fuel at the tank. In order to prove its theory UP conducted a test as follows:

EMD furnished a reported 54,000 BTU Young heat exchanger and AMOT valve to temporarily replace conventional fuel heating during this test. The AMOT valve, which is a thermal control device, was arranged in the EMD system to mix warm fuel from the Young increased capacity heat exchanger and cold fuel to deliver controlled temperature fuel to the fuel filter and engine.

Test Procedure

At noon one ton of dry ice was added to approximately 700 gallons of alcohol in the fuel tank tub and 330 gallons in the radiator tank. One hour later another ton was added. To attain the fuel temperature of -22°F a total of six tons of dry ice was required over the 12-hour test period.

The locomotive was set up for low idle. The MD and EMD system temperatures were monitored and recorded at low idle and at eighth notch power. Cooling fans were blocked in to maintain engine hot water temperature at 90 to 95°F for heat exchanger "worst case" performance during low idle test. Fans were returned to normal operation during eighth notch load tests. Throttle changes from low idle to eighth load were made with one minute intervals in each throttle notch.

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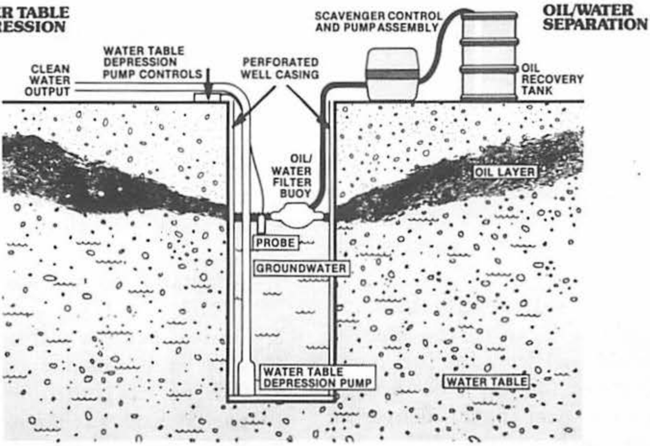

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Conclusions of UP Test

The results of the test indicate that the Mixer-Divider system and the increased capacity heat exchanger/AMOT valve system satisfactorily accomplished their design goals.

The MD device proportionally mixed warm return fuel from the engine with cold tank fuel to furnish warm fuel to the fuel pump, fuel filter, and engine.

By placing the heat exchanger in the fuel return line between the engine and fuel tank, the total heat input is used to heat the fuel suction, as well as mix proportionally as required by engine consumption.

The increased capacity heat exchanger/AMOT valve combination mixed cold fuel from the fuel pump with warmed fuel diverted through the heat exchanger, delivering warmed fuel to the filter and engine.

The EMD system depends on the AMOT valve to proportionally mix cold and heat exchanger warmed fuel. If the AMOT valve fails by "sticking" open or closed, fuel to the filter and engine will range from extremely cold to extremely warm. Use of the AMOT device eliminates the need for a summer/winter valve, but the thermal valve must operate properly or fuel related problems are sure to occur. The EMD system will not protect the fuel suction inlet inside the tank. Heat exchanger heated fuel is returned to the fuel tank in proportion to that consumed by the engine, thus the total capacity of the heat exchanger is not available to warm fuel in the tank.

Advantages and Disadvantages Of the Mixer-Divider

Advantages:

1. Protects suction pipe.
2. Provides warm fuel for strainer and filters.
3. No moving parts (no AMOT valve)
4. Total effectiveness of heat exchanger available to warm and mix with fuel at the suction inlet.
5. Will operate at low idle.
6. No tank modifications necessary.
7. Adaptable to any locomotive (EMD or GE).
8. Device can be fabricated in shop at minimal expense.
9. Can be used with lowest capacity heat exchanger.
10. Will operate with fuel temperatures ranging from -30° to +80°F.
11. Fuel strainer can be left in to protect pump.

Disadvantages:

1. Requires being cut-out in spring and cut-in in early winter.
2. Requires draining tank to install device.

#2 Hudgins

III.

NEW TECHNIQUES IN LUBE OIL ANALYSES

As a preface to this portion of our paper, we would like to briefly touch upon the importance of sampling technique. It should be ob-

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vious to all of us that with all of the sophisticated instrumentation and techniques we now employ, with the most competent personnel staffing our laboratories and with the new gizmos and whatnots the future will bring, that the reliability of our work begins with the submission of a representative sample properly taken.

Training of people for this important task should not be taken lightly. Many of us have seen a locomotive tied up and good oil dumped because laboratory analysis showed free water in the oil only to have it turn out being contamination from a previous sample. We cannot afford to waste good oil and tie up good power because of mistakes like this. The persons responsible for taking samples should be thoroughly instructed in proper sampling techniques and should be shown the effect they can have on the overall program.

Viscosities

Measurement of a lube oil's viscosity is certainly not a new laboratory technique. We have not researched the subject but would scarcely be surprised if it were found to be one of the first if indeed not the first routine test given to lube oils. The viscosity of an oil is probably the most important criterion in its selection as a lubricant in a particular machine, so we can readily see the necessity for its measurement. Viscosities are measured in various ways, probably the most common of which is the time of flow of a fixed volume through a capillary tube at some selected constant temperature. In measuring this time an analyst must carefully watch the oil flowing in the capillary, start a stopwatch when the moving oil front reaches a calibration mark, wait until the volumetric chamber fills or empties depending upon the design of the tube, then stop the stopwatch precisely when the moving oil front reaches another calibration mark. Then he must calculate the viscosity using the time taken during this procedure and the calibration constant for the particular tube used.

A silicon valley instrument manufacturer has developed a viscometer which automatically takes over this time consuming procedure. An innovative southern railroad was the first in the industry to utilize this instrument and others are known to be following its lead. This instrument utilizes fiber optics and solid state circuitry to accomplish its purpose. The Zeitfuchs Crossarm viscosity pipet is incorporated into this instrument. This is a reverse flow viscometer, i.e. the oil flows against a clean dry surface and fills the volumetric chamber from the bottom to the top.

Mounted beside the top of the tube on the flat part of the holder is a small black box less than two cubic inches in size. This is connected by a means of a cable to the timer and power supply. Inside the box, but segregated from

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one another, are two photosensitive transistors and a high intensity lamp (Fig. 2). Light from the lamp is channeled through the holder plate and down alongside the viscosity pipet by a fiber optic tube which splits in two after emerging from the bottom of the holder plate. One of these tubes goes into a L shaped stainless steel block below the volumetric chamber and the other into one above it. Mounted at 90° from these tubes are another pair which channels light bounced off of the capillary tube back up to the two photosensitive transistors. As the oil passes through the capillary area encompassed in the L shaped block below the volumetric chamber, it interrupts the light reaching one of photosensitive transistors. This in turn opens a gate in the timer, allowing 100 Hz clock

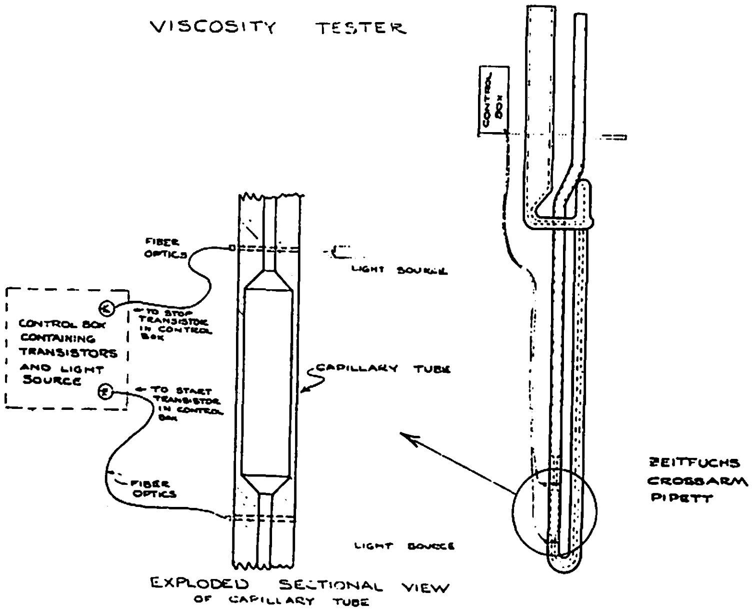

Figure 2

pulses from an oscillator to be fed through a counter circuit and LEDs display the increasing time. When the volumetric chamber is filled and the moving front of oil enters the upper capillary it passes through the upper block breaking the other light beam which closes the gate in the timer and it stops. Since the tubes can easily be calibrated to unity factor by the selective placement of the lower and upper fiber optic blocks, there is no need to calculate the viscosity, and the time displayed on the LEDs is the viscosity in centistokes.

The outstanding feature of this instrument is that it frees the analyst from the time consuming process of clocking the samples, and productivity in the laboratory can be increased as well as the accuracy of the results. In an on-line laboratory operation with a single person on duty, results of analysis can more quickly be obtained and passed on to the responsible mechanical department person so that he may have any pertinent information available to him that might affect his decision to run or shop a particular locomotive.

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Ferrographic Oil Analysis

A new technique recent years have brought to lube oil analysis is called ferrography. It differs from spectral analysis in that it looks only at ferromagnetic particles, generally iron and/or its alloys, whereas spectral analysis looks at many different elements simultaneously. Also, this technique looks at specifically sized ferromagnetic particles while spectral analysis would give a total concentration of the elements of interest, independent of size, although very large wear particles may not show at all in spectral analysis, depending on excitation conditions.

Unfortunately, wear is an inescapable consequence of operating machines. As they operate they will generate particulate material which circulates in the lube oil system. Under normal circumstances these particles would be expected to be 15 micrometers or less — the majority of which would be 2 micrometers or less — and an equilibrium of distribution of particles would be established after a period of time.

Ferrography is a method of monitoring the relative concentration of the small (less than 2 micrometers) and large (5 micrometers or more) ferromagnetic particles and to determine if the equilibrium is shifting. If the equilibrium, having already been established for a specific machine, were to suddenly shift to a greater concentration of larger size particles, excessive wear of a component of that machine would be suspected. Studying the particles under a microscope can even give clues as to the specific areas of excessive wear.

There are three basic types of ferrographic instruments. They are the analytical ferrograph, the direct reading ferrograph and the online ferrograph. The analytical ferrograph is a laboratory instrument that is used to make ferrograms. A ferrogram is an orderly array by particle size of the precipitated ferromagnetic particles on a specially prepared glass slide. The oil sample is channeled down the glass slide which is placed over a strong magnetic field that is perpendicular to the flow. The oil is washed away with a solvent, the slide dried and examined microscopically. With proper lighting and heat treatment of the slide an experienced analyst can differentiate between cast iron, low carbon steels, alloys or non-ferrous metals such as lead, copper or aluminum. The knowledge of where these metals are located in the machine can be useful in pinpointing areas of possible severe wear.

The direct reading ferrograph is the laboratory instrument that is used to determine the relative concentrations of the large and small iron particles in lube oil. A fixed volume of oil is passed thru a small glass tube located over a strong magnetic field. A light beam is passed thru two fixed points in the field by means of fiber optics and the attenuation of

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the light is measured. On this instrument the quantitative measurement of the light attenuation is most accurate at 50% or less, because of the nonlinear response above 50% caused by particles piling one on top of another. Because this is a laboratory instrument the analyst can take an aliquot and calculate back to a fixed volume if the attenuation exceeds 50% for a sample.

The on-line ferrograph is an instrument that can be attached to a machine's lubricating oil system and continuously monitor the concentration of the large and small particles. The data can be recorded automatically or readings taken periodically by an attendant. Because this instrument operates unattended, the time to reach a fixed attenuation point is measured as is the volume of oil, and the relative concentration of large and small particles is calculated by the instrument from these data and the display changed and/or automatically recorded accordingly whenever the attenuation point is reached. As far as is known at the time of this writing, Union Pacific is the only railroad experimenting with this new technique. UP has both a direct reader and an on-line ferrograph.

The remainder of this portion of the paper will focus on the direct the on-line is generating data on a number of selected engines while the on-line is generting data on only one engine.

The data output from the direct reader will be two separate numerical values relating to the attenuation of the light beam due to the large (L) and small (S) particles accumulating in front of the fiber optic light tubes. As previously stated this numerical value is calculated back to a fixed volume of oil if it was necessary to aliquot the sample. Although as previously stated the majority of the particles generated during normal operations are small (S), the attenuation by the large (L) particles is usually greater; presumably because they are larger. As an abnormal wear mode begins the size of the particles generated shifts significantly to larger (greater than 15 micrometer) particles and the quantity L - S would increase. Also, as abnormal wear begins, the total amount of particles S+L would increase too, indicating a quantative expression of excessive wear. A single value used to indicate the beginning of a severe wear event is the product of the sum of L + S, indicating an increased quantity of particles, and the difference L - S indicating a change in the balance of the relative size of the particle. This single value is called the severity index and expressed as $1 = (L - S)(L + S) = L^2 - S^2$.

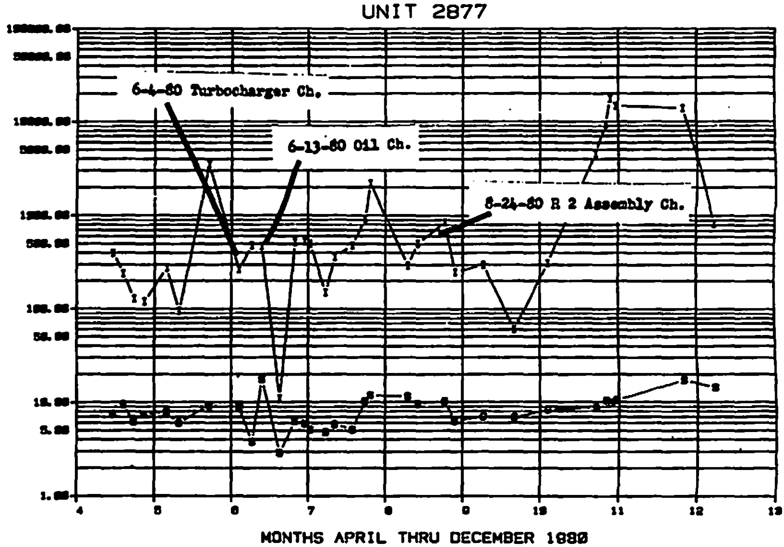
The severity index should, according to the theory of ferrography, be a constant number indicating the equilibrium condition of the machine when no abnormal wear is occurring; however, if we look at the data in Table 12, we can see some rather wild fluctuations in the severity index, particu-

Table 12

	2877			8068	
Sample Date	I	FE By Spec.	Sample Date	I	FE By Spec.
4-14-80	400	7.5	4- 4-80	385	13.7
4-18-80	240	9.5	4-30-80	2695	9.6
4-22-80	128	6.2	5- 5-80	2401	11.1
4-26-80	120	7.5	5- 9-80	2378	14.5
5- 5-80	275	7.8	5-15-80	2295	17.9
5-10-80	95	6.0	5-18-80	6661	19.1
5-22-80	3424	9.2	5-23-80	2356	18.0
6- 3-80	264	9.0	5-31-80	2418	21.1
6- 8-80	479	3.8	6- 5-80	3936	24.9
6-12-80	468	17.6	6-10-80	9661	35.5
6-19-80	11	2.9	6-11-80	6572	33.4
6-25-80	519	6.3	6-18-80	29670	27.5
6-29-80	527	5.9	7- 4-80	867	29.5
7- 1-80	496	5.1	7- 7-80	221	36.9
7- 7-80	150	4.8	7-13-80	224	30.1
7-11-80	360	5.8	7-14-80	101	44.2
7-18-80	479	5.1	7-21-80	92	46.0
7-23-80	920	10.2	7-26-80	189	41.5
7-25-80	2178	11.8	7-30-80	419	33.8
8- 9-80	293	11.5	8- 6-80	206	29.1
8-13-80	504	9.6	8-12-80	371	35.3
8-24-80	850	10.2	8-21-80	289	30.0
8-28-80	250	6.3	8-26-80	1003	29.3
9- 8-80	297	7.0	9- 5-80	243	23.6
9-20-80	60	6.9	9-19-80	2457	30.6
10- 3-80	310	8.3	10- 8-80	186	15.2
10-22-80	4575	8.7	10-13-80	21	13.7
10-26-80	9202	10.4	10-18-80	88	15.0
10-28-80	17620	9.8	10-27-80	231	20.5
10-29-80	15150	10.5	10-31-80	178	18.5
11-25-80	14564	17.2	11- 8-80	675	11.8
12- 7-80	826	14.4	11-21-80	88	10.9
12-18-80	480	12.7	11-26-80	16	12.9
12-26-80	5123	9.0	11-30-80	56	19.6

larly in the case of the Unit 2877. These fluctuations might well be due to the additions of unknown quantities of lube oil and/or to the erratic operating cycle of the railroad diesel engine. These values are plotted (Fig. 3 & 4) along with spectrometric iron values. Any known events are also marked. Looking at Figure 3, it would be difficult to pick any significant event other than the oil change on 6/13/80 where the plotted values dropped dramatically. The assembly changed on 8/24/80, was because of a water leak which was detected 8/24/80, by the routine lube oil analysis.

The data plotted in Figure 4 do show more stability in the severity index and more clearly defined trends preceding the as-



I = SEVERITY INDEX
S = SPECTRAL IRON (PPM)

FIGURE 3

sembly change-outs on 6/29/80 and 10/2/80. Routine analysis of oil samples gave no extraordinary indications of problems in this engine at the time preceding these change-outs; in these two instances ferrography indeed seems to be pointing to an abnormal wear condition. This engine received a major overhaul on 11/10/80 and subsequent data seem to be erratic.

These are two examples of some of the data so far compiled. The data in Figure 4 are representative of the best obtained while those in Figure 3 are somewhat worse than the average.

Work is continuing with this instrument and with the on-line instrument with hopes that the data generated can be used to confidently predict the beginning of an abnormal wear mode and that it can become another useful tool of preventive maintenance.

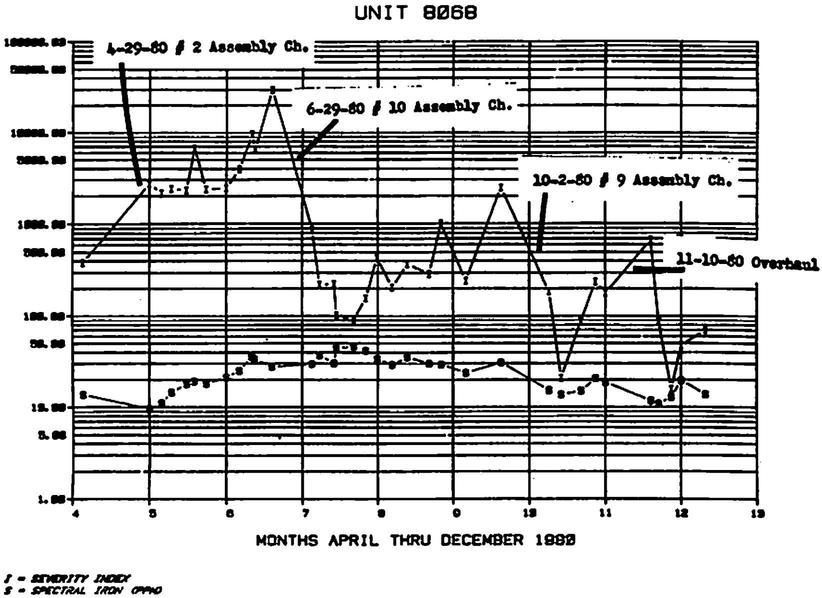


FIGURE 4

#3

IV. TRACTION MOTOR GEAR LUBRICATION

Introduction

Traction motor gear lubrication is a matter of immediate concern under several adverse conditions. These conditions are:

1. Insufficient lubricant in the gear case,
2. Poor low temperature and high temperature flow properties of the grease,
3. Excessive lubricant in the gear case, and
4. Water contamination of the grease.

The presence of these conditions in a traction motor gear case will lead to excessive gear wear or to the failure of the traction motor pinion-end armature bearings. Eventually, the pinion gear slips and the gear set loses its torque transmission ability.

Causes of Traction Motor Gear Set Failures

The causes precipitating these failures can generally be traced to the combined effect of poor maintenance practices and improper gear lubricant qualities for the application.

A recent survey has indicated that maintenance procedures and lubricants very considerably among railroads. Results of this survey which appear in Table 13 suggest that some railroads are not conforming to the procedures or products recommended by the engine builders. The railroads that are involved point to the recent increase in failures following a change of recommendations by one builder from sodium to lithium greases and to the lower viscosity base oil used in lithium-based grease.

Maintenance-Related Causes— Back Shop some

~~Diagrams~~ of the EMD ~~axle seal~~ and traction ~~motor armature~~ seal ~~arrangements~~ appear in ~~Figures 5, 6~~ and 7. ~~Listed below~~ are shop maintenance practices and equipment conditions found to contribute to the failure problems: are as follows:

SURVEY OF RAILROADS INDICATING TYPE OF GEAR LUBRICANT IN CURRENT USE

Type of Lubricant	No. of Users	Method of Use
Crator Compound	3	All-Year
Crator Compound	1	Summer
Sodium Thickened	4	All-Year
Lithium Thickened		
5000-10000 BAV	1	Winter
15000-20000 BAV	3	All-Year
15000-20000 BAV	2	Summer
Greater than 20000 BAV	1	All-Year

Table 13

1. Gear cases are not reapplied as matched pairs. The leakage of lubricant from or dust into the gear case through the parting line is increased by mismatching. Separation of the case halves in the process of rebuilding can result in a mismatch of top and bottom halves and can be responsible for improper seating of seals.
2. Seals are not properly applied. For example, the channels are not thoroughly cleaned, or the gear case may lack seal retainers. The use of a seal of the wrong configuration can cause problems.
3. The gear case gutters are improperly installed or are not installed. The gutters direct the major flow of the grease around the seal and back to the sump. Without gutters, the seals are flooded and gross leakage will occur.
4. Excessive wheel hub runout tends to enlarge the seal inner diameter, offering an open leakage path for grease.
5. When a wear step is formed under the felt seal, the grease can be pumped through the seals as the axle moves latterally with respect to the gear box.

Maintenance-Related Causes — Running Shop

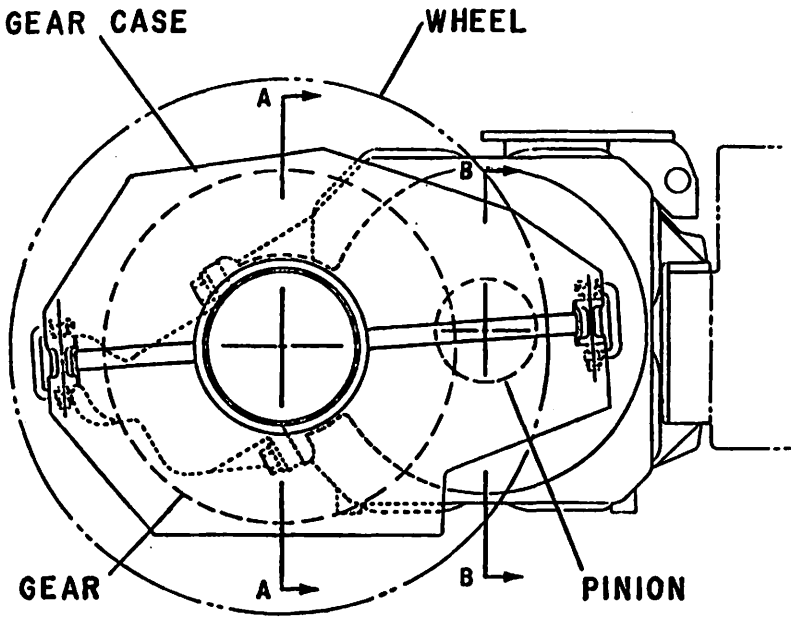
Running maintenance programs must be re-examined:

1. The time interval between scheduled inspections may be too long to replenish the lubri-

cant before a leaking gear case runs dry. The minimum level of lubricant must allow the complete immersion of the gear tooth in grease.

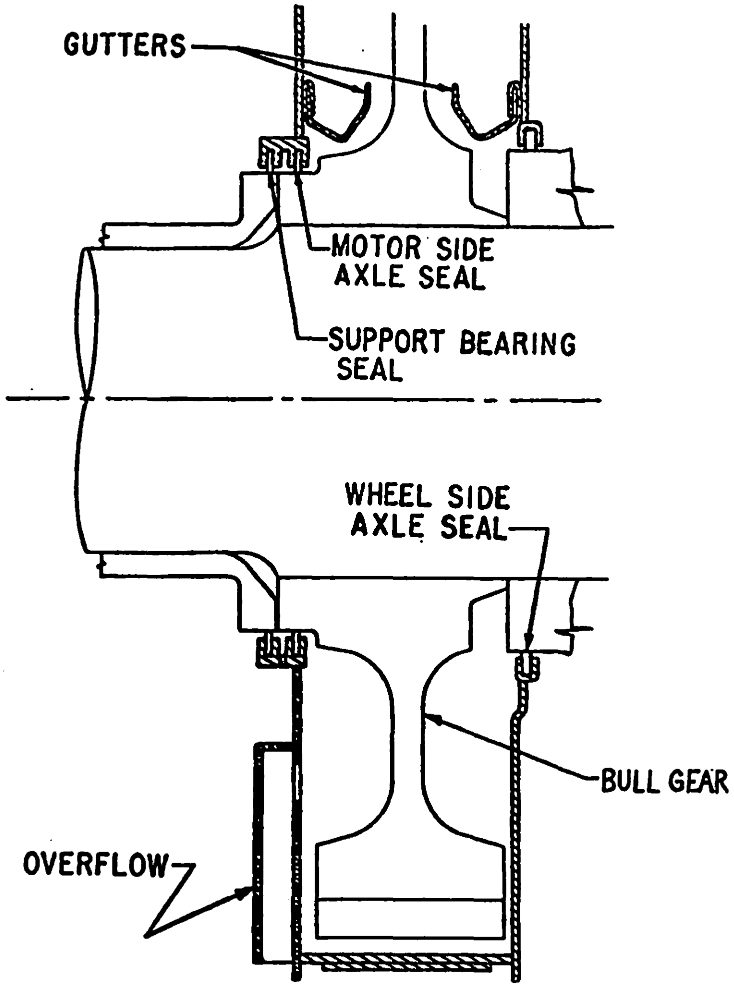
2. Excessive lubrication can be a critical problem, if the overflow becomes plugged or if grease is being added automatically with no check of the level of tooth dip. The lubricant builds up in the gear case and is forced past the seals into the traction motor bearing and into the the support bearing ~~(See Figure 7)~~. Both of these bearings can fail as a result of contamination by the traction motor gear lubricant.

Good lubricant maintenance procedure is only as good as it is enforced. To avoid the over-lubrication and under-lubrication problems, the proper level of lubricant must be known and grease added up to that level on a regular basis. The established procedure must be available to the maintenance personnel and a periodic check made for compliance with these procedures. The responsibility of first-line supervision must be clearly defined and is essential to establish these procedures.



AXLE HUNG TRACTION MOTOR

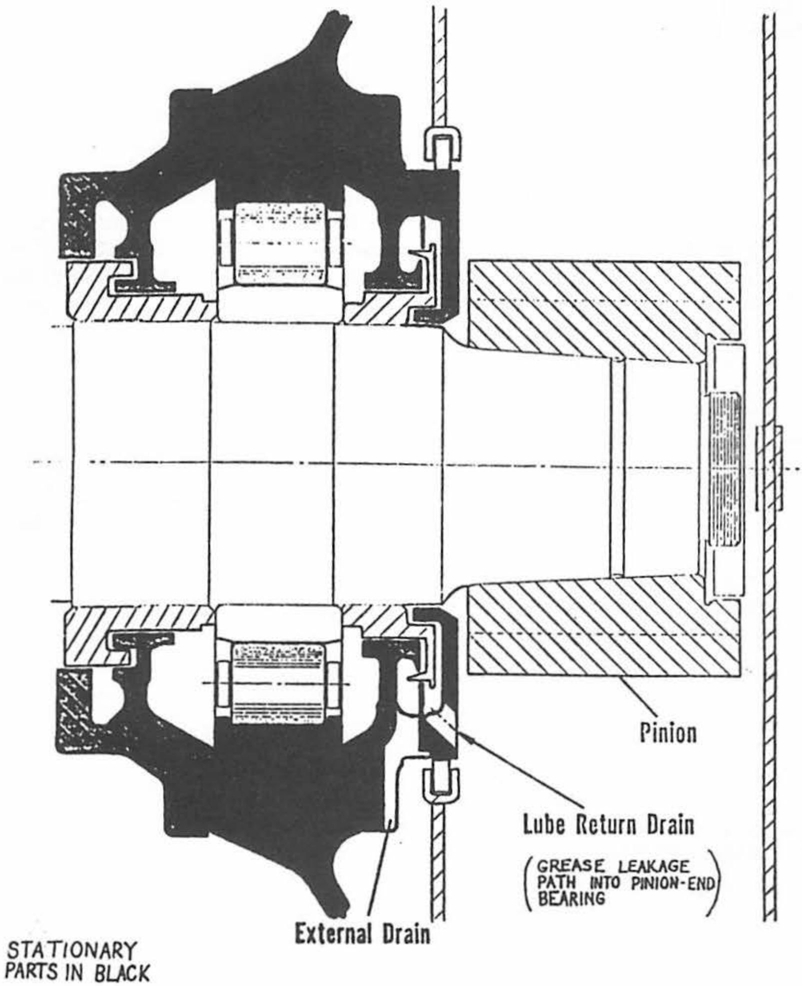
FIGURE 5



AXLE SEAL ARRANGEMENT

SECTION A-A

FIGURE 6



ARMATURE SHAFT SEAL ARRANGEMENT

FIGURE 7

Grease Properties

The lubricant properties required for the traction motor gear lubrication are as follows (a more complete description of grease properties appears in Table 14):

1. Extreme pressure properties protect the gear teeth under adverse conditions which occur often in the starting of a train: gear velocities are low and little lubrication is available for the tooth loadings which can be very high ~~(see Region 1 in diagram of Fig. 8).~~ Extreme pressure properties are essential to reduce gear wear to a reasonable level.
2. Water resistance of the soap thickener avoids emulsification and washing of the grease from the gear teeth. The water accumulates from condensation or from leakage through the seals during water-washing of the locomotive trucks and underframe. Sodium soaps do not have good water resistance and emulsify easily; however, lithium soaps are relatively good in water resistance properties and minimize these problems.
3. Resistance to thickening by oxidation when subjected to lengthy service periods is important in higher temperature operations when minimum lubricant make-up is required.
4. Good grease mobility at low temperature is necessary to eliminate channeling and inadequate lubrication prior to the heating of the gears. This mobility must be a compromise: higher apparent viscosity yields lower grease loss for a given gear case but also yields higher cold viscosity. In general, lithium greases provide better low temperature mobility than sodium greases, primarily because of the lower base oil viscosity of the lithium grease.

The newer specification, lithium soap-thickened grease in the 5,000 to 10,000 BAV range ~~(the traction motor grease specifications of both engine builders has been included in Table 15)~~ has not performed with complete satisfaction in general service. New locomotives do not exhibit problems, but after gear case reconditioning, excessive leakage of grease has been cited as the cause of an increased number of failures. Several lithium greases with a higher apparent viscosity, now under test by several railroads, have been giving satisfactory results thus far, but no specific data regarding cold weather performance are available at this time.

Recommendations

Maintenance

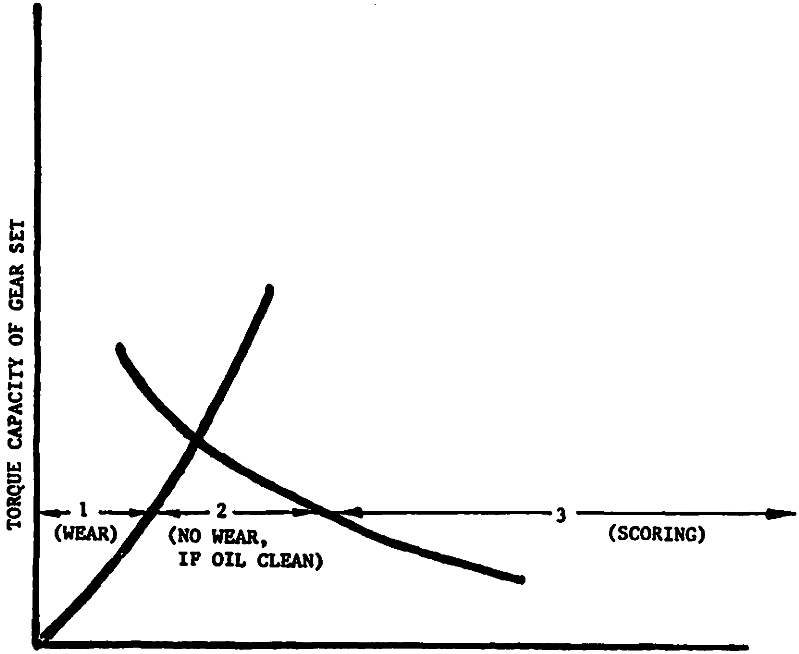
1. Good maintenance practices must be established, including both shop gear case rebuild practices and running maintenance procedures. Failure to observe these will perpetuate the problems encountered. These practices should coincide with the engine builders' recommendations. ~~For details regarding the rebuild procedures see EMD's M.I. 1520 and GE's Maintenance Manual, Vol. II, GE133577G. A~~ cam-

SUMMARY OF THE PROPERTIES OF GREASE

Properties	ASTM Test	Definition and Performance Characteristics Influenced or Controlled
Consistency	D 217	Measure of relative hardness or greases. Varies with use. Controls ability to lubricate, stay in place and seal. Influences method of dispensing and application.
Flow Characteristics	D 1092	Influences flow of grease through pipes and lines and dispensing equipment. Controlled by viscosity of fluid lubricant and type and amount of thickening.
Texture and Structure	None	Appearance and feel of greases. Defined by visual inspection. Influence adhesiveness and ease of handling.
Structural and Mechanical Stability	D 217 D 1831	Both of these tests measure ability of the grease to resist breakdown under low shear such as is encountered in dispensing equipment. Bearings generally operate at much higher shear rates. No standard test is yet available to measure the stability of greases under high shear rates.
Dropping Point	D 566 D 2265	Temperature at which a grease becomes liquid in ASTM test.
Lead Carrying Capacity	D 2596 & D 2509	Ability of a grease to prevent EP wear under high load conditions.
Oxidation Stability	D 942 D 3336	D 942 has little significance in service, either in storage or in use. D3336 is a bearing life test that is a measure of the time the product stays grease-like and lubricates at elevated temperature.
Rust and Corrosion Protection	D 1743	Ability to seal against entrance of water and corrosive materials. Rust protection improved by rust inhibitors.
Bleeding Characteristics	D 1742	Tendency of fluid lubricant to separate from grease during storage. Gross separation unacceptable. Some bleeding desirable to ensure immediate lubrication during startup.

Table 14

THE REGIONS OF GEAR FAILURE



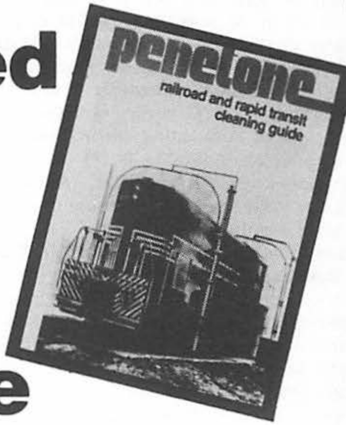
LEGEND: REGION 1 - LACKS OIL FILM DUE TO SLOW SPEED

2 - GOOD OIL FILM

3 - TOO MUCH HEAT DEVELOPED

FIGURE 8

Organized Grime Fighters ...from Penetone



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SPECIFICATION TRACTION MOTOR GEAR LUBRICANT

EMD Specification EMS 1027	
Soap Type	Lithium
Soap, % Maximum (ASTM D 128)	5
Free Alkali, % Maximum (ASTM D 128)	.10
Water Content, % Maximum, (ASTM D 128)	.10
Brookfield Apparent Viscosity at 200°F	
(EMD Standard Laboratory Practice No. 90)	
No. 3 Spindle at 4 rpm (centipoise)	5000 - 10000
Viscosity of Lubricating Oil in Product	
SUS at 210°F (ASTM D 88)	900 - 1100
Extreme Pressure Properties, (ASTM D 2596)	
Load Wear Index, Kg Minimum	40
Weld Point, Kg Minimum	200
Cone Penetration, Unworked at 77°F (ASTM D 217)	
GE Specification D 50E8C	
Worked consistency, 77°F.MM/10	360 to 395
Mineral-oil viscosity at 210°F, SSU. minimum	1500
Mineral-oil viscosity index, approximate	100
Soap base	Sodium
Soap, maximum percent	2.5
Free alkali, maximum percent	0.1
Free acid, maximum percent	0.1
Timken Number, minimum	35

Table 15

paign to determine which units are without gutters and reapply these gutters may expedite the cure, but will be expensive as a short term solution.

2. Maintenance personnel must be instructed in the proper procedures for maintaining gear case lubricant levels. This will avoid overfilling, the loss of grease as waste through the overflow, and traction motor bearing failures.
3. First-line supervision must enforce the established procedures.

Gear Case

The engine builders must reevaluate present gutter design and develop one that is easier to apply or one that is permanently attached.

Gear Lubricant

Cooperative development work is underway by oil companies with the engine builders and several railroads. The objectives are:

1. Adequate anti-wear performance.
2. Reduced tendency to leak.
3. Good low temperature mobility.
4. Resistance to water-washing.

One factor which must be considered in these development programs is the compatibility of the various brands of lubricants. Different brands must have the ability to be intermixed without causing increased leakage or mechanical failures.

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V.

MULTI-VISCOSITY OILS AS AN ENERGY CONSERVATION TECHNIQUE

The subject of energy conservation is of interest to all. It certainly is receiving a lot of attention from railroad management. The cost of fuel represents the largest single contribution to railroad operating costs.

Engine lubrication is one of the many items which are being examined in the search for fuel economy. It is clear that reducing the friction in an engine is a logical way of improving the fuel economy of the unit.

This overview of the subject will provide definitions, explain what may be expected, and identify some of the reservations that must be resolved before new lubricants can be commercialized.

The potential changes in lubricants that will be considered in this review are multi-viscosity and friction modification.

To understand the term multiviscosity, we will go to the SAE system of grading the viscosity of a crankcase lubricant. Table 16 shows the current SAE classification system. You will note that it is a dual system with the lower viscosity oils (w-grades) rated at -18°C and the higher viscosity oils rated at 100°C. It is possible to design lubricants so that the viscosity will fall in the W-grade range at -18°C as well as in the non-W-grade range at 100°C; hence, multigraded oils.

Multigrading is accomplished by providing an oil which has a high viscosity index. The viscosity index (VI) of an oil is an empirical number which indicates the degree of change in viscosity with a change in temperature. A low VI signifies a relatively high change in viscosity with temperature, whereas a high VI indicates a relatively low change in voscosity with temperature. Figure 9 gives a graphic illustration.

Historically, railroad engine crankcase oils have been of "medium" VI (in the range of 60-75 VI) as guided by engine builder specifications. In recent years base oil supply problems and new formulation technology have introduced "high" VI (up to 105 VI) railroad oils.

To provide multigrading, oils of much higher VI must be provided. This is accomplished by the use of VI Improvers which are typically high molecular weight, and high viscosity, polymers. When blended with conventional base oils, the viscosity effect is such as to markedly increase the viscosity index. As shown in Figure 9, an oil can be an SAE 20W/40, a "20-weight" at low temperature and a "40-weight" at high temperature.

As mentioned earlier, friction modification is another approach to be considered in designing an energy saving lubricant. These are materials, usually oil soluble, which change the friction condition in certain critical parts of the engine, usually in those areas where

TYPICAL VISCOSITY-TEMPERATURE RELATIONSHIP FOR AN SAE 20W-40 MOTOR OIL

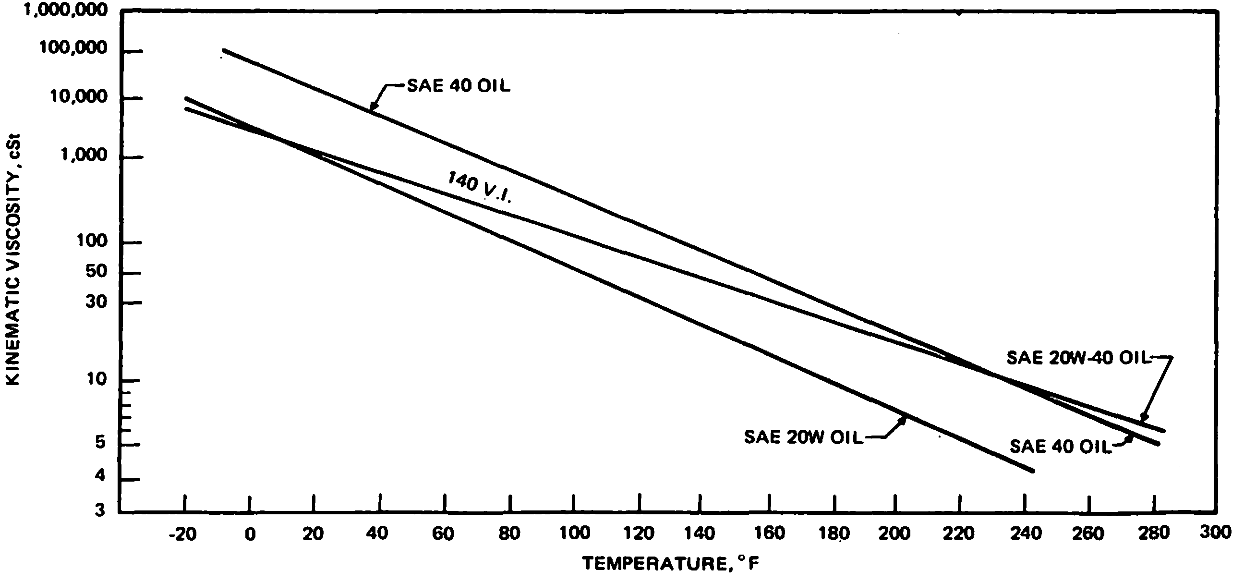

FIGURE 9

borderline lubrication exists. It is generally known that this concept, in addition to multigrading, is used in commercially available lubricants for automobiles and heavy duty trucks. Fuel saving claims of 1 to 3 percent are made for these oils.

The benefits of viscometric changes and friction modifications of lubricants have been well demonstrated in automotive gasoline engine service. To a lesser extent fuel savings benefits have been introduced into the oils for diesel engines used in trucking and other heavy duty services. In general, this has been accomplished with no decrease in lubricant performance as measured by deposit and wear control.

As of now, we can report that only limited information is available as to application of friction modifiers to locomotive crankcase lubricants.

Engine Builders' Position

In the case of application to locomotive engines, two potential benefits are recognized:

1. Fuel Savings
2. Starting capability at lower temperature

The present position of the engine builders in this multi-vis and/or friction modified oil is based on lack of or, at least, limited experi-

TABLE 16

ENGINE OIL VISCOSITY DESIGNATIONS

SAE Viscosity Grade	Viscosity Range		
	cP at -18°C (ASTM D-2602)	cSt at 100°C (ASTM D-445)	
	Maximum	Minimum	Maximum
5W	1,250	3.8	–
10W	2,500	4.1	–
20W*	10,000	5.6	–
20	–	5.6	9.3
30	–	9.3	12.5
40	–	12.5	16.3
50	–	16.3	21.9

*SAE 15W may be used to identify SAE 20W oils which have a maximum viscosity at -18°C of 5000 cP.

Note: 1 cP = 1 mPa·s; 1 cSt = 1 mm^2/s; cP = cSt x Density

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ence rather than solid comprehensive experience. As a result, they have reacted cautiously in their assessment of the "energy saving" oil concept.

EMD estimates, based on limited multicylinder laboratory engine data, that a multigrade SAE 20W/40 oil reduces fuel consumption (relative to an SAE 40 oil) about 0.2% to 0.4% in medium duty cycle road locomotive service. They also estimate that in switcher service savings in the range of 1 to 3 percent may be realized. These estimated percents only represent that a fuel saving potential exists. More testing and statistical analysis of the data will be required to establish the real fuel savings magnitude.

EMD addresses the cold starting benefits of the multi-vis oil by noting that its engines using conventional SAE 40 oils can currently be started down to 50°F (10°C) and, with some engine modification, down to 35°F (1.7°C). Further reduction in the temperature at which the engine can be started will entail significant changes in the engine systems beyond the contribution of a special lubricant. It appears that savings from a starting capability below 35°F (1.7°C) may not be commensurate with the engine and locomotive modification costs.

GE also recognizes the potential benefits of multi-vis oils as being fuel economy and improved cold starting capability. When evidence of significant fuel economy gains is presented or a need for cold engine cranking is established, it will investigate these products.

From its limited engine experience with oils other than SAE 40, GE has serious reservations relative to multi-vis oils with respect to bearing wear or power assembly wear. In its opinion substantial test work will be required before multi-vis oils should be given extensive field trial.

Field Experience

The Committee has been furnished with the results of a one-year test of an SAE 20W/40 oil in two EMD freight units on a western railroad. The test oil was formulated with a conventional Generation 3 additive and a commercially available VI improver. This test was conducted as a no-harm evaluation of an oil with multi-grade viscometrics without the influence of a friction modifier.

The results were encouraging:

A. Oil viscosity decreased in service due to shearing of the VI improver; however, the oil remained within the SAE 40 limits.

B. Oil consumption was typical of a conventional SAE 40 grade oil.

C. Silver bearing condition was excellent.

D. Engine deposit levels were normal with no ring sticking.

E. Liner and ring wear rates (chrome and cast iron liners) were typical of experience with conventional SAE 40 oil.

It is clear from the Committee's review that fuel saving benefits can be expected when these oils are applied to locomotive engines. Extensive stationary locomotive fuel consumption testing will be required to establish the magnitude of this saving.

In view of the reservations on the part of the locomotive engine builders, considerable laboratory and field study will be required before these oils will be generally accepted and applied. The builders' questions as to wear protection and deposit control in their engines as well as the magnitude of fuel saving benefits must be answered.

Your Committee will continue to monitor the development of multi-vis/friction modified oils. We expect to report more fully on this subject next year.

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Monday, September 28, 1981

2:00 P.M.

REPORT OF THE COMMITTEE ON DIESEL ELECTRICAL MAINTENANCE

Pre-Convention Presentation: Southwestern Railway Club

April 23, 1981 Camelot Inn Little Rock, AR

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Senior Electrical Engineer
Chicago & North Western Transp. Co.
500 West Madison St.
Chicago, IL 60606

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1981 TOPIC:

"INNOVATION: PAST AND PRESENT"

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.

INTRODUCTION

The application of technology to maintenance problems is not a new idea. The ideas discussed in this paper range from well known methods carefully applied to innovative applications of well known methods to innovative ideas which have not yet been developed as useable maintenance tools. We recommend careful study of these ideas to best adapt them to your situation.

I
TRACTION MOTORS

It's a never ending nightmare. We have traction motors repaired by various repair shops, or in our own railway shops, and we just can't keep these motors under our locomotives. Some people will blame the locomotive or the environment. Too much horsepower is impressed on the motors because of faulty control systems, in the cut-out mode for example. Too much current is drawn for too long because those fellows up there in the Transportation department always try to add a few more cars to a train that is already too long. As long as the train can make the ruling grade without having to double up, well, that's good enough. Too bad we can't teach a lesson to those power control officers by having them disconnect a few greasy and filthy traction motors under a unit. High voltages stress the insulation beyond limits because the locomotive doesn't make transition, or high centrifugal forces destroy the commutator because that smart engine driver found a way to nullify the overspeed trip circuit.

Motors have it tough. But, before we point the finger at somebody else, before we start making excuses, are we sure our own act is clean?

Evaluation of Improved Test Methods

In last year's paper this Committee recommended better testing methods (simulated load) of overhauled traction motors as one way of reducing the failure rate and extending the miles or months per failure. However, many are reluctant to adopt more demand-

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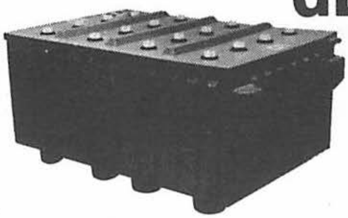

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ing test procedures for fear that too many motors will fail the test and create chaos in the shops. What would really happen? Let's look at a typical case: a railway shop which started to use the simulated load method approximately 15 months ago (at time of writing).

In 1980, this railway had slightly over 6000 traction motors in service. The historical failure rate of the motors repaired in the railway shop was 50%. This means that half the motors repaired in that shop were failing in less than a year. This compared to an approximate failure rate of 10% for new motors under new locomotives.

In an effort to contain the high number of premature failures, the management authorized the purchase of a traction motor test console from the General Electric Co. of Cleveland, Ohio. This machine was installed in November 1979. During the first few days of operation, the reject rate was in the order of 40-50%. Corrective action was quickly initiated on the assembly line and the reject rate was lowered to 20-22%.

From December 1979 to December 1980, 1394 overhauled traction motors were tested using the GE console. Of these, 1086 motors passed the test and were released for service. The remaining 308 motors failed the test and had to be reworked. These results are summarized in Figure 1.

The reject rate of 22% may look high, but considering it was originally over 40%, we must conclude that there was a significant improvement in the quality of the workmanship.

At this stage, it can be very temping to lower the test standards in order to pass more motors. It didn't happen in our example. The railway chose to work towards the elimination of the problems rather than take the easy way out. In the end, the reduction of traction motor failure on the road confirmed that they had made the right decision. However, before analyzing the performance of these motors under locomotives, we must answer another question. What sort of defects were picked up during the test? Figure 2 lists the failures that occurred on the test bench.

Mechanical failures account for 46.7% of the total, electrical failures 42.6% and miscellaneous 10.7%.

Quite a few of the problems picked up at the test would have resulted in premature failures. Consequently, the use of this testing procedure should result in a significant reduction in traction motor road failures.

The graph in Figure 3 was calculated according to the "Survivorship Curve" method which was outlined in last year's paper. It shows that the number of traction motors surviving twelve months in service increased from 50% to 72%. In other words, the number of motors failing in a year or less after they were repaired was lowered from 50% to 28%.

During the same time interval, the performance of the motors subjected to a bearing run only also increased, but not quite in the same proportion. It seems that the improvements in repair practices that resulted from the better test methods, were beneficial to all repaired motors. However, there remained a certain number of hidden defects that could only be detected by the traction motor tester.

Figure 4 lists the principal modes of failures that occurred in service on the motors that passed the simulated load test during the first thirteen months of operation. The bottom line of this table shows the failures as 15.8% of the motors tested. This figure cannot be compared directly with the 28% failure rate quoted previously. The 15.8% is the ratio of the failures that took place during the same 13 calendar months during which our sample of motors were repaired. Some of these motors, those that

SIMULATED LOAD TESTING

OF TRACTION MOTORS

(TWELVE MONTHS OF OPERATION)

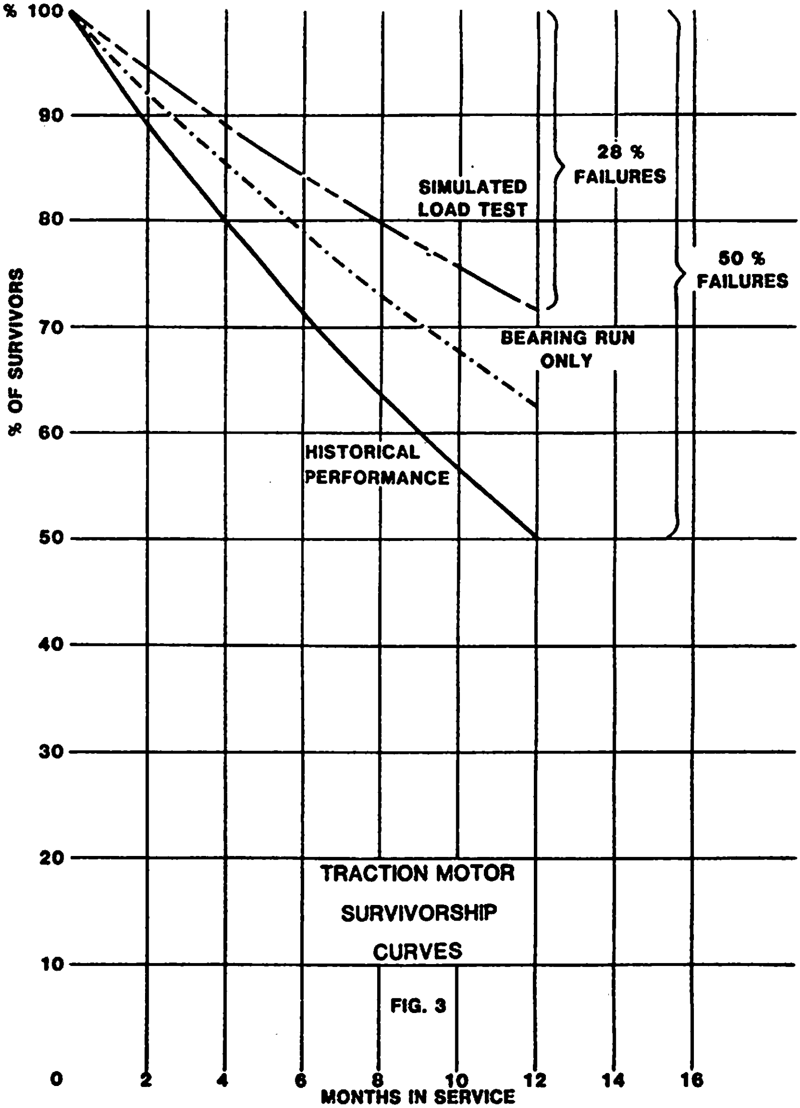
NO. OF MOTORS PASSED	1086	78 %
NO. OF MOTORS FAILED	308	22 %
TOTAL MOTORS TESTED	1394	100 %

Fig. 1

TRACTION MOTOR
FAILURES AT TEST

TYPE OF FAILURES	NO. OF FAILURES	% OF FAILURES
VIBRATION / NOISY	91	29.5
FLASHOVER	47	15.3
OVERHEATED BEARING C. E.	28	9.1
OVERHEATED BEARING P. E.	25	8.1
ARMATURE GROUNDED OR SHORTED	23	7.5
LOW IMPEDANCE	23	7.5
FIELD GROUNDED	17	5.5
INTERPOLE GROUNDED	13	4.2
HIGH IMPEDANCE	8	2.6
MISCELLANEOUS	33	10.7
TOTAL	308	100.0

FIG. 2



TRACTION MOTOR SURVIVORSHIP CURVES

FIG. 3

FIG 3

ROAD FAILURES OF TRACTION MOTORS

AFTER SIMULATED LOAD TESTING

FLASHOVER	17
COMMUTATOR SCORED	7
BRUSH HOLDER BO.	6
ARMATURE GROUNDED	16
ARMATURE OVERHEATED	0
INTERPOLE GROUNDED	11
INTERPOLE (OPEN - SHORTED)	16
MAIN FIELD GROUNDED	14
MAIN FIELD (OPEN - SHORTED)	4
DAMAGED LEADS	7
MISC. ELECTRICAL	10
HOT SUSPENSION BEARING	5
DEFECTIVE PINION	16
OIL SOAKED	19
MISC. MECHANICAL	41
TOTAL FAILURES	189
NO. OF MOTORS TESTED	1194
FAILURES IN %	15.8

FIG. 4

were outshopped in the first month, were in service for 12 months, but the motors repaired in the subsequent months were in service for 11, 10, 9 months all the way down to 0 months in service for the motors repaired in the thirteenth month. By the time all motors have run 12 months, more failures will occur. The 28% failure rate is a projection. It predicts how many motors will fail during their first year under a locomotive.

Looking at the above results, can we conclude that it suffices to buy a traction motor tester to eliminate all your motor problems? This would be a misleading conclusion indeed, as there are many other necessary ingredients in the successful reduction of traction motor failures. These include:

—A commitment on the part of senior management to turn out a repaired motor with reliability approaching that of a new motor.

—An extensive engineering effort to produce a repair procedure that allows the quality of repair at intermediate points within the repair cycle to be verified.

—The expenditure of a considerable amount of money for test equipment which will be used to check the adequacy of repairs during the overhaul cycle.

—The implementation of an ongoing quality control system to audit the conformance to repair procedures and to measure the progress towards achieving the initial objective.

—The correction by the shop personnel of those practices which resulted in test failures.

—The engineering investigation and correction of problems beyond the control of shop personnel.

—The investigation of causes for motor failures under locomotives, and the correction of these causes.

Thus it can be seen that the simulated load tester, although important in improving reliability, is but one element in a comprehensive control cycle. This test can best be looked upon as a "silent policeman." It is not swayed by schedule requirements, costs, expediency or any other such pressures normally imposed on a shop, hence it gives an honest indication of the "goodness" of repaired motors. If it is used to identify deficiencies in the repair operation and these deficiencies are subsequently corrected, reliable motors can be turned out at acceptable costs. If, on the other hand, this test is used only to segregate good motors from bad, cost of repairs will remain exorbitantly high and pressure will increase to "pull the plug" on the test console.

II

TEFLON BANDS

The string band covering the commutator front V-ring is a very important link in the armature defense system against electrical grounds. The traditional epoxy coated string band offers a definite protection to the V-ring but unfortunately it is affected by a severe drawback. After some time in service, it has a tendency to crack. Because of the continuous heat cycles the commutator is subjected to and the different coefficients of expansion of steel and copper, the copper segments move with respect to the steel spider and eventually the epoxy band refuses to follow.

It is not unusual to see a crack develop right at the end of the commutator bars. There could not be a worse place for a crack to develop. Carbon dust generated by the friction of the brushes on the commutator quickly finds its way into the crack and gradually causes a short between adjacent bars. Arcing follows and soon will burn the V-ring. Result—the commutator is grounded. Unless the repair shop has a way of replacing the front V-ring without disturbing the copper segments and the mica insulators between them, the commutator must be rebuilt, which means that the armature must be stripped. The winding is lost. A very expensive failure indeed.

In an effort to alleviate this problem, the major locomotive builders introduced the Teflon band, a strip of Teflon, etched on the back side, which is glued to the string band with epoxy or some other type of adhesive. Two types of bands appeared on the market—the split band and the solid or continuous band.

The split band does not require any complicated tooling to apply. The ends must be trimmed accurately so they will butt against each other without gap or overlapping. At the beginning this band was flat. Later a lip curving upwards against the edge of the copper bars was introduced to provide a better seal against carbon infiltration.

The application of the solid band requires expanding and shrinking it in place. Bands are available from the locomotive builders (EMD and GE) and also from the Halogen Insulator and Seal Corporation, for both the EMD "D" motor and the GE "752" motors.

Is the string band problem gone forever? Well, not quite. One advantage of the Teflon band is that its shiny surface does not easily pick up dirt or contaminants. If it does it can usually be cleaned easily with a dry rag or a rag slightly dampened with solvent. However, it should never be cleaned with sandpaper. If you do (some people do) you end up with a rough surface and you defeat the purpose of the band.

Perhaps the worst problem associated with the Teflon bands is the fact that they don't always stay in place. In the case of the split band, if one end becomes loose, the whole band will quickly unwrap itself. With both the split and the solid band, the lip has a tendency to part from the end of the copper bars. When this

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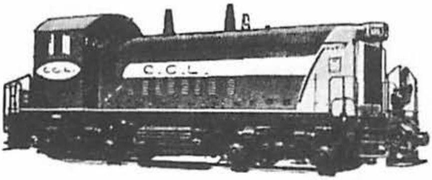
happens we are back to the carbon infiltration problem faced with the epoxy coated string band. At this time EMD is experimenting with the reduction of the height of the lip. There is also a possibly that the lip will be eliminated completely. Is the final solution at hand? Only time will tell.

To summarize, there are many opinions about the Teflon Band; some railways like it and use it, some don't. There are still problems to be ironed out. To conclude this section, let's have a look at one procedure used for the application of the solid (continuous) Teflon band to an armature. The bands are obtained from the Halogen Insulator and Seal Corporation, Elk Grove, Illinois. Initially there was some reservation concerning the quality of these bands. In particular the etching on the back side appeared to be somewhat irregular. A consistent etching is necessary to ensure a bond between the epoxy and the Teflon, because by nature the pure Teflon will not adhere to anything. Also the surface of some of the original bands was on the rough side. However these problems were ironed out and the bands now appear to be quite satisfactory. Here is the application procedure:

1. Machine the end of the commutator copper bars just enough to clean up the end of the bars (approximately .002").
2. Apply Hysol polyester filler in the "V" portion of the end of the commutator bars (EMD only).
3. Wrap glass tape over exposed portion of front V-ring. Distribute glass tape so that the resulting surface is square to the end of the copper bars. It may be necessary to apply more tape near the copper bars.
4. Wipe the end of the copper bars with alcohol or degreaser fluid to remove all traces of oil and grease. Then avoid touching that surface.
5. Cover the outer portion of the commutator brush surface, also top and front face of the steel edge with masking tape to facilitate removal of surplus epoxy from these areas.
6. Put the band on the expander and note the degree of expansion necessary to slide the band in place. Trim as necessary to prevent the Teflon band from riding over the steel edge or pushing into the "V".
7. Mix epoxy with catalyst (recommended kit Electrolok No. U-958-12A). This kit provides enough epoxy to install two bands. Therefore, it is suggested to work on two armatures at one time.
8. Apply epoxy primer to the vertical edge of the commutator. (EMD Part No. 8430367).
9. Apply epoxy evenly over glass tape and against the end of the copper bars. Use brush



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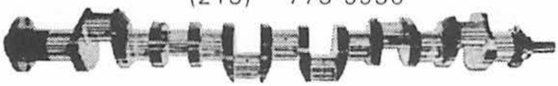


The Chrome Crankshaft Locomotive Sales © 1981

and/or spatula. Standing the armature upright on a rotating stand will facilitate the job.

10. Expand the Teflon band on the expander. Wipe the back of the band (etched side) with alcohol or degreaser fluid. Slide the band in place and push it until the lip of the band sits tight against the copper bars.
11. CAUTION: If an inward "V" is present at end of the commutator bars do not force the corner of the Teflon band too far into it. This would cause the lip of the band to part from the copper and open a path for carbon penetration.
12. Remove excess epoxy and apply shrinkable Mylar tape over the Teflon band 3 or 4 turns evenly distributed. Secure it in place with masking tape.
13. With the armature standing in an upright position (commutator up) apply preheated ring (220°F) over Teflon band and leave it there until it cools to room temperature.
14. Remove ring and Mylar tape. Inspect carefully to make sure that there is no void between the vertical section of the Teflon band and the end of the copper bars. If there is, the application is not satisfactory. Remove the band and apply a new one.

This committee will be glad to hear of any improvements adopted by a railway or a repair shop which would lead to an even longer lasting application of the Teflon band. Significant betterments will be included in future paper(s).

III
NEW GENERATION LOCOMOTIVES

This year a number of railroads have taken delivery of "new generation" locomotives. These units are characterized by various improvements in adhesion control. A brief summary of the operation of these systems follows, including maintenance experience to date.

Shown in Figure 5 is the EMD Super-Series excitation control system. Current feedback from each traction motor is combined with main generator voltage to develop a signal proportional to motor rpm. This is compared with ground speed measured by a doppler radar to develop a signal proportional to wheel creep. The main generator excitation is controlled to maintain wheel creep within acceptable limits. Sand is not used unless a full blown wheel slip develops. A "coast" signal is used to compensate for variations in wheel sizes.

Railroads which have received these locomotives report poor quality in construction generally. This extremely disturbing situation has primarily been seen in the mechanical area, but may also be responsible for what has seemed an unusually high module failure rate.

These failures seem concentrated in the PS, FM modules and

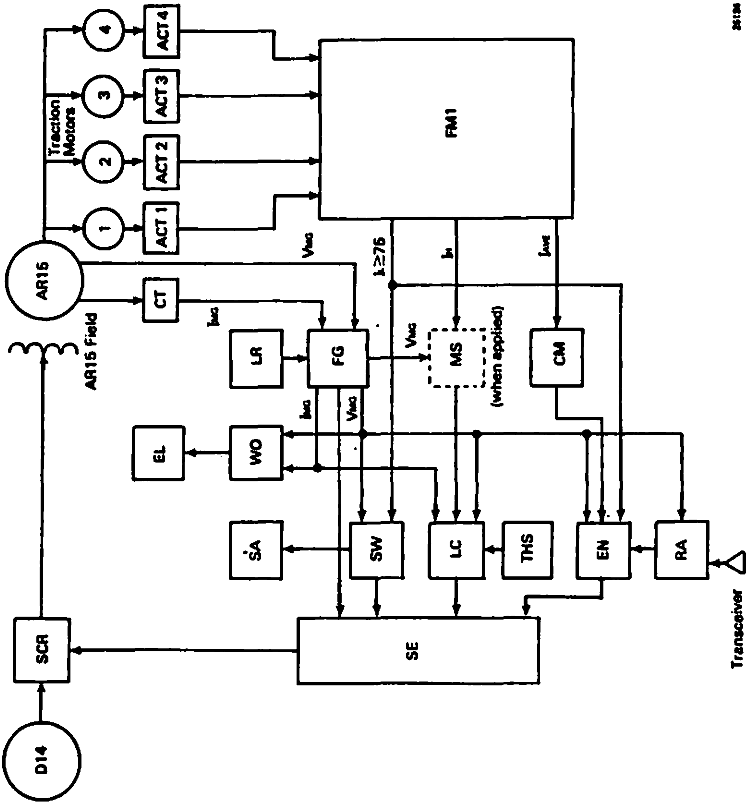


Fig 5 – Basic Electrical Control And Excitation System radar transceivers. We urgently hope that General Motors can overcome this situation and restore the quality we have come to expect.

Some roads have experienced difficulty with parts availability. This may require railroads to increase inventory levels if the builder is not able to make timely delivery. One maintenance problem which has arisen is the lack of any method of testing operation of the radar transceiver other than milepost and stopwatch. Test equipment is being designed by several vendors and prototypes should be available soon.

Figure 6 shows the GE Sentry adhesion control system. The system will seem familiar to those with experience on older GE systems, representing an evolution of previous equipment. The speed sensors are located on the traction motor rather than end-of-axle to better protect the pickup and cable. A "coast signal" provides compensation for wheel wear. The system responds to wheel creep by applying sand. If creep increases, power is reduced as needed to maintain creep within desirable limits. Wheel slips or overspeed are controlled by larger power reductions.

Experience with the Sentry system is limited at this time, although one railroad with B36-7 locomotives reports difficulty with the alternator mounted transition contactors. Further information will be reported as it becomes available.

IV
ELECTRICAL TROUBLE-SHOOTING

On today's modern locomotives, electrical advancements have progressed to the point that actual repair time is generally minimal when compared to the time needed to diagnose the specific problem component. In plain words, it now takes us longer to find the problem than it does to fix it. With this situation, electrical trouble-shooting is becoming a critical step to quick and efficient locomotive repair.

Trouble-shooting, or fault diagnosis, describes the act and procedures used to identify a malfunction and isolate the problem component. To be effective, the trouble-shooting procedure used must be simple and straight forward while providing ample coverage to the various suspected problem areas.

With this thought in mind, this committee has put together two trouble-shooting guides covering wheel slip systems found on late model EMD and GE power. The two guides presented are different in format and procedure and are meant to provide working samples to aid railroads in developing in-house trouble-shooting guides.

Trouble-Shooting Guide #1

The first guide illustrated, Example 1, is for EMD GP40-2 units. This guide is set up in chart form allowing the mechanic to determine the purpose of the specific

SENTRY ADHESION SYSTEM

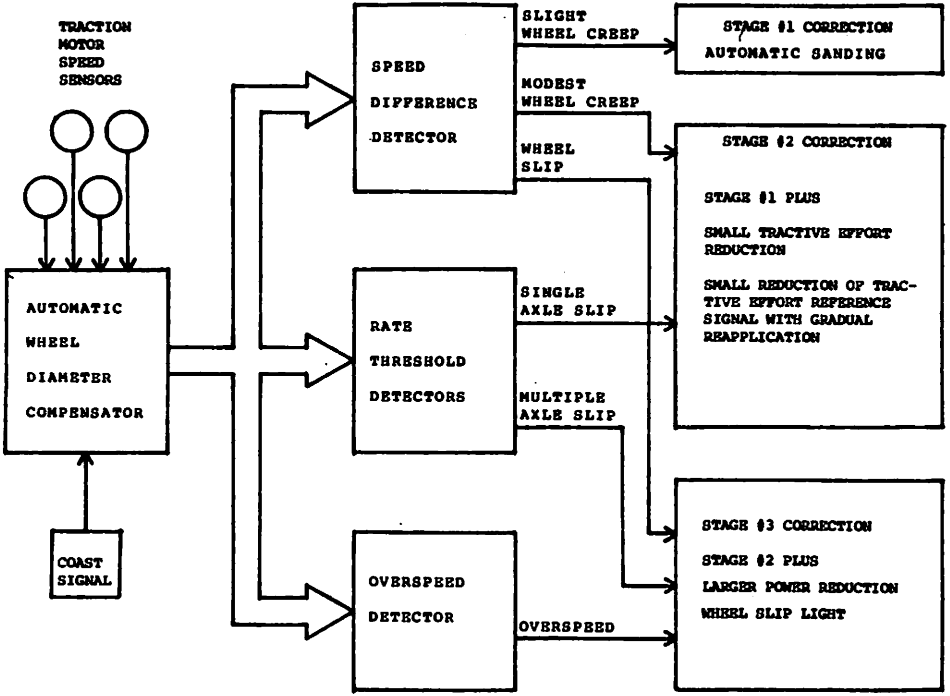


FIG 6

test, the set-up procedures required, the action and expected response, and corrections required for undesired responses. The actual trouble-shooting procedure shown has been taken from the GP40-2 Locomotive Service Manual.

Trouble-Shooting Guide #2

The second guide, Example 2, is for New Series GE locomotives with the CMR wheel slip system. This procedure was taken from the GE Locomotive Service Manual. It utilizes the block form with various paths to follow, dependent on results obtained. In addition, specific procedures are provided to isolate the problem component. In using this system, a mechanic can be led directly to the problem.

Conclusion

With today's complex and rapidly advancing locomotive systems, a guide to aid the mechanic is a necessity. The two examples shown here are meant to provide samples of various methods available; to be of full benefit, they should be modified to cover the specific systems on individual railroads. This committee is hopeful that the samples shown will provide a starting point, and the stimulus needed to help the rail industry in developing better trouble-shooting methods and in turn quicker and more efficient maintenance and repair.

PROCEDURES

Procedure A

1. The problem is with transistor Ql. On a six-axle locomotive, replace the FD1154 Card located in the FL80 CMR Wheelslip Panel. On a four-axle locomotive, replace the FD1155 Card located in the FL84 CMR Wheelslip Panel.
2. Proceed to Step 2.

Procedure B

WSX relay is not picking-up. Look for grounds or short circuits. If none are found, replace WSX relay located on CMR wheelslip panel.

Proceed to step 3.

Procedure C

At this point, several possible things could be the cause of the trouble. Therefore, it is necessary for further testing to determine where the fault is located.

1. Return the Throttle handle to IDLE, center the Reverse handle and place the Alternator (Generator) Field (GF) circuit breaker to OFF.
2. Equalize the wheelslip panel inputs from the CMR's by jumpering the following terminals together.
   a. On the FL80 Panel (six-axle locomotive), jumper terminals C-D-E-F-G-H.
   b. On the FL84 Panel (four-axle locomotive), jumper terminals C-D-E-F.
3. Pump up the air brake system and set the locomotive brakes.
4. Place GF breaker to ON, move Reverse handle to FOR-

EXAMPLE 1-1

PURPOSE OF CHECK	GENERAL QUALIFICATION TEST SETUP	ACTION	RESPONSE	CORRECTION REQUIRED
CHECKING WS MODULE AND WHEEL SLIP CORRECTION	POWER SETUP, ENGINE RUNNING, REVERSER FOR-WARD, AIR BRAKES SET. THROTTLE IN IDLE.	MOVE WS MODULE TEST SWITCH TO TEST POSITION-HCLD	GREEN TEST LAMP LIGHTS AND REMAINS LIT	NONE
			RED TEST LAMP LIGHTS CONTINUOUSLY	REPLACE WS MODULE
			W/S LIGHT COMES ON AND REMAINS LIT	IF NOT-CHECK W/S LIGHT
			SA MODULE TEST LAMP COMES ON	IF NOT-REPLACE SA MODULE
			SA MODULE TEST LITE GOES OUT IN 3-5 SECONDS AND SAND IS APPLIED TO RAILS	IF NOT-REPLACE SA MODULE
			LOAD REGULATOR MOVES TOWARD MINIMUM FIELD	IF NOT-REPLACE WS MODULE
		RELEASE WS TEST SWITCH	WHEEL SLIP LIGHT GOES OUT W/S MODULE TEST LAMP GOES OUT	IF NOT-REPLACE WS MODULE

EXAMPLE 1-2

PURPOSE OF CHECK	GENERAL QUALIFICATION TEST SETUP	ACTION	RESPONSE	CORRECTION REQUIRED
CHECKING POWER RESPONSE TO WS TEST		CONNECT JUMPER FROM WS-TP1 TO WS-TP22. MOVE THROTTLE TO RUN 1 OPERATE WS MODULE TEST SWITCH	LOAD METER NEEDLE DIPS SLIGHTLY	IF <u>NOT</u>-REPLACE WS MODULE
CHECKING MOTOR CIRCUITS FOR FAULTS	ENGINE RUNNING, CONTROLS SET FOR POWER OPERATION SET AIR BRAKES (COUPLE TO ADDITIONAL UNITS FOR ADDED BRAKING)	ADVANCE THROTTLE TO POSITION 3	NO WHEEL SLIP ACTION	NONE
			WHEEL SLIP ACTION NOTED	PROCEED WITH PROCEDURE TO ISOLATE PROBLEM
ISOLATE W/S TROUBLE TO SPECIFIC MOTOR CIRCUIT	ENGINE RUNNING, CONTROLS SET FOR POWER OPERATION, SET AIR BRAKES	1. (a) OPEN AC CONTROL CIRCUIT BREAKER (b) REMOVE AXD1 FROM TB48B1, AXD2 FROM TB48B2, AXD4(AXE1) FROM TB48B3		

PURPOSE OF CHECK	GENERAL QUALIFICATION TEST SETUP	ACTION	RESPONSE	CORRECTION REQUIRED
		(c) CLOSE AC CONTROL CIRCUIT BREAKER		
		(d) ADVANCE THROTTLE TO POSITION 3	WHEEL SLIP ACTION NOTED	INSPECT #4 TM, CONTACTORS, AND CABLES
			NO WHEEL SLIP ACTION NOTED	PROCEED WITH ACTIOI STEP 2
		(e) RETURN THROTTLE TO IDLE		
		2.(a) OPEN AC CONTROL CIRCUIT BREAKER		
		(b) REMOVE WIRE AXD5 (AXE2) FROM TB48B4		
		(c) RE-APPLY WIRE AXD4 (AXE1) TO TB48B3		
		(d) CLOSE AC CONTROL CIRCUIT BREAKER		
		(e) ADVANCE THROTTLE	WHEEL SLIP NOTED	INSPECT #3 TM, CONTACTORS, AND CABLES
			NO WHEEL SLIP ACTION NOTED	PROCEED WITH ACTION STEP 3
		(f) RETURN THROTTLE TO IDLE		

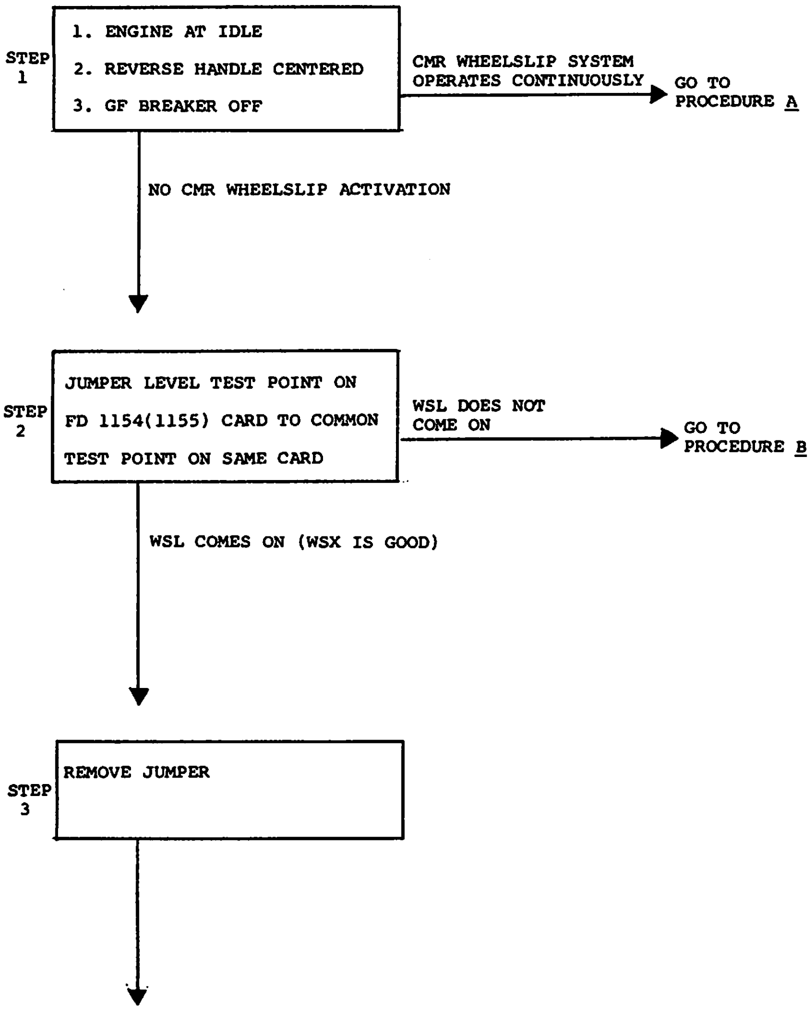
EXAMPLE 1-4

PURPOSE OF CHECK	GENERAL QUALIFICATION TEST SETUP	ACTION	RESPONSE	CORRECTION REQUIRED
		3.(a) OPEN AC CONTROL CIRCUIT BREAKER		
		(b) REMOVE WIRE AXD4 (AXE1) FROM TB48B3		
		(c) RE-APPLY WIRE AXD2 TO TB48B2		
		(d) CLOSE AC CONTROL CIRCUIT BREAKER		
		(e) ADVANCE THROTTLE TO POSITION 3	WHEEL SLIP NOTED	INSPECT #2 TM, CONTACTORS AND CABLES
			NO WHEEL SLIP ACTION NOTED	PROCEED WITH ACTION STEP 4
		(f) RETURN THROTTLE TO IDLE		
		4.(a) OPEN AC CONTROL CIRCUIT BREAKER		
		(b) REMOVE WIRE AXD2 FROM TB48B2		
		(c) RE-APPLY WIRE AXD1 TO TB48B1		

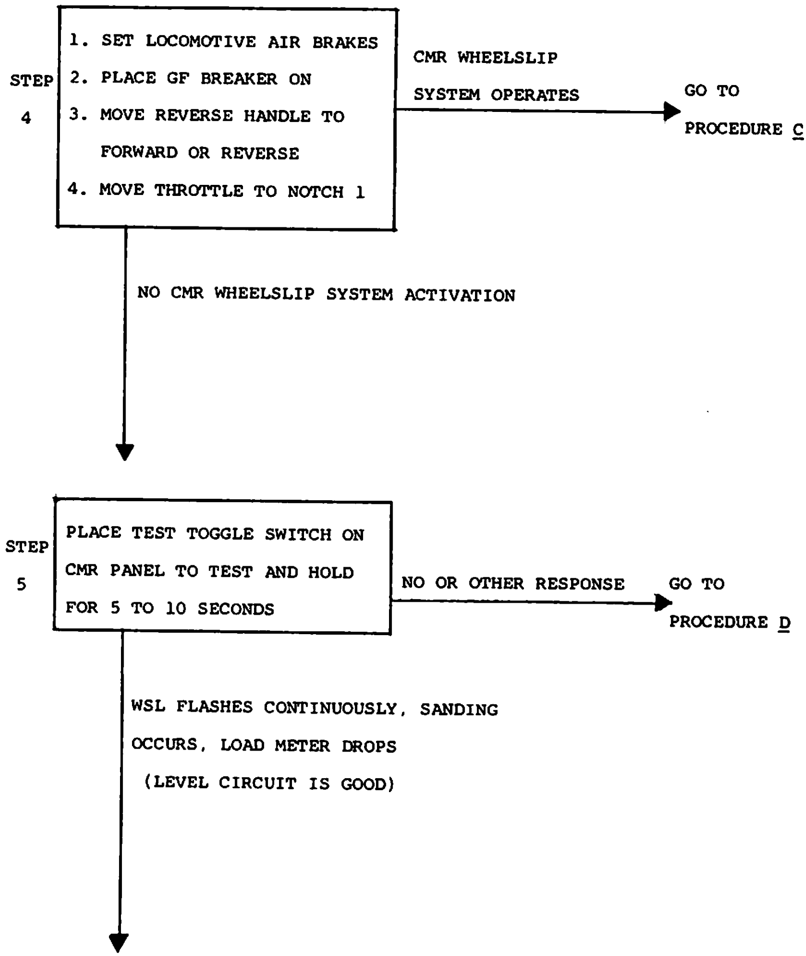
EXAMPLE 1-5

PURPOSE OF CHECK	GENERAL QUALIFICATION TEST SETUP	ACTION	RESPONSE	CORRECTION REQUIRED
		(d) CLOSE AC CONTROL CIRCUIT BREAKER		
		(e) ADVANCE THROTTLE TO POSITION 3	WHEEL SLIP NOTED	INSPECT #1 TM, CONTACTORS AND CABLES
			NO WHEEL SLIP ACTION NOTED	NONE
		(f) RETURN THROTTLE TO IDLE		

EXAMPLE 2 - 1


STEP 1
1. ENGINE AT IDLE
2. REVERSE HANDLE CENTERED
3. GF BREAKER OFF
CMR WHEELSLIP SYSTEM OPERATES CONTINUOUSLY
GO TO PROCEDURE A
NO CMR WHEELSLIP ACTIVATION
STEP 2
JUMPER LEVEL TEST POINT ON FD 1154(1155) CARD TO COMMON TEST POINT ON SAME CARD
WSL DOES NOT COME ON
GO TO PROCEDURE B
WSL COMES ON (WSX IS GOOD)
STEP 3
REMOVE JUMPER

EXAMPLE 2-2


STEP 4
1. SET LOCOMOTIVE AIR BRAKES
2. PLACE GF BREAKER ON
3. MOVE REVERSE HANDLE TO FORWARD OR REVERSE
4. MOVE THROTTLE TO NOTCH 1
CMR WHEELSLIP SYSTEM OPERATES
GO TO PROCEDURE C
NO CMR WHEELSLIP SYSTEM ACTIVATION
STEP 5
PLACE TEST TOGGLE SWITCH ON CMR PANEL TO TEST AND HOLD FOR 5 TO 10 SECONDS
NO OR OTHER RESPONSE
GO TO PROCEDURE D
WSL FLASHES CONTINUOUSLY, SANDING OCCURS, LOAD METER DROPS
(LEVEL CIRCUIT IS GOOD)

EXAMPLE 2-3

STEP 6

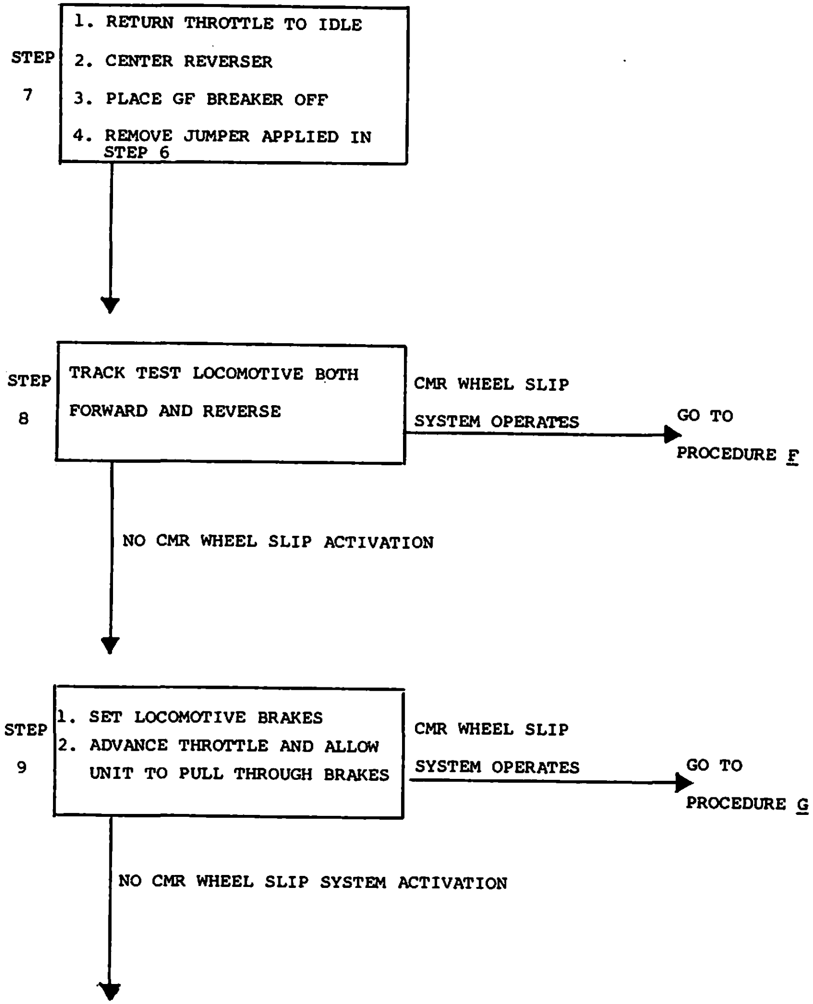
1. RETURN THROTTLE TO IDLE
2. CENTER REVERSER
3. PLACE GF BREAKER OFF
4. PLACE TEMPORARY JUMPER ON WS TERMINAL BOARD
   AP TO AR ON 6 AXLE
   AC TO AD ON 4 AXLE
5. SET LOCOMOTIVE AIR BRAKES
6. PLACE GF BREAKER ON
7. MOVE REVERSER HANDLE TO FORWARD
8. MOVE THROTTLE TO NOTCH 1
9. WAIT FOR LOADMETER TO BECOME STEADY
   NOTE: DO NOT HOLD LONGER THAN 1 MINUTE
10. PLACE TOGGLE SWITCH TO TEST AND HOLD FOR 5 TO 10 SECONDS

NO RESPONSE OR RESPONSE SAME AS STEP 5 → GO TO PROCEDURE E

WSL FLASHES CONTINUOUSLY, SANDING OCCURS, LOADMETER DROPS TO LOWER LEVEL (Q3 AND RATE CIRCUIT GOOD)

↓

EXAMPLE 2-4


STEP 7
1. RETURN THROTTLE TO IDLE
2. CENTER REVERSER
3. PLACE GF BREAKER OFF
4. REMOVE JUMPER APPLIED IN STEP 6
STEP 8
TRACK TEST LOCOMOTIVE BOTH FORWARD AND REVERSE
CMR WHEEL SLIP SYSTEM OPERATES
GO TO PROCEDURE F
NO CMR WHEEL SLIP ACTIVATION
STEP 9
1. SET LOCOMOTIVE BRAKES
2. ADVANCE THROTTLE AND ALLOW UNIT TO PULL THROUGH BRAKES
CMR WHEEL SLIP SYSTEM OPERATES
GO TO PROCEDURE G
NO CMR WHEEL SLIP SYSTEM ACTIVATION

EXAMPLE 2-5

STEP 10

1. LOCOMOTIVE AT IDLE AND STANDSTILL
2. PLACE UNIT IN DYNAMIC BRAKING

CMR WHEEL SLIP SYSTEM OPERATES → GO TO PROCEDURE H

NO CMR WHEEL SLIP ACTIVATION

STEP 11

1. LOCOMOTIVE AT IDLE
2. DISCONNECT AXLE ALTERNATOR LEADS
   L AND M ON 6 AXLE
   N AND P ON 4 AXLE
3. CONNECT FREQUENCY GENERATOR TO AXLE ALTERNATOR LEADS
4. OBTAIN NECESSARY FREQUENCY FOR OVERSPEED PROTECTION FROM GRAPH IN FIGURE 7

CMR WHEELSLIP SYSTEM FAILS TO OPERATE OR OPERATES AT DIFFERENT SPEED → GO TO PROCEDURE I

CMR WHEEL SLIP SYSTEM OPERATES AT PROPER SPEED

STEP 12

1. REMOVE FREQUENCY GENERATOR
2. RECONNECT AXLE ALTERNATOR

New

For locomotives with D14* alternators.

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5. Reasonable initial cost.

6. Low maintenance.

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WARD or REVERSE and advance Throttle handle to Notch 1.

5. The FD406 Card located on the FL80 Panel (six-axle locomotive) and on the FL84 Panel (four-axle locomotive) has five test points numbered 1, 2, 3, 4 and Common. The FD408 Card located on the FL80 Panel (six-axle locomotive) has three test points numbered 5, 6 and Common.

   Check voltage between test points 1, 2, 3, 4 and Common on the FD406 Card (and 5, 6 and Common on the FD408 Card, if applicable) with a voltmeter. The meter scale should be selected to read d-c volts between 24 and 30 volts (4 volts for every 100 amperes on the loadmeter in the cab). The maximum difference should not exceed 3 volts, or 7 percent variation from highest to lowest.

6. Proceed with Case No. 1. NOTE: Several possible things could be the cause of the trouble. To simplify trouble-shooting, the fault situation has been presented in three "Cases": Case No. 1, Case No. 2 and Case No. 3.

Case No. 1

If the CMR wheelslip system activates (WSL light is lit, sanding occurs and there is a reduction of excitation), then proceed to Case No. 2. If the CMR wheelslip system does not activate, the problem is localized to the external portion of the CMR system. Proceed with the following:

1. Return Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.
2. Remove the jumpers from the panel terminals and then repeat Steps 4 and 5 of Procedure C, noting which test point gives the abnormal reading.
3. Return Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.
4. Using the locomotive schematic and the applicable CMR Wheelslip Panel schematic, trace the circuit containing the test point in question. Determine which wires on the panel terminal strip are in the same circuit as the test point.
5. Check the wiring to the CMR's by removing the wires from Terminal C, D. E, F, G and H on the CMR Wheelslip Panel (six-axle locomotive) or Terminals C, D, E and F (four-axle locomotive).
6. Using a Simpson 260 meter (or equivalent), measure the resistance between the wire and its corresponding terminal stud. If a different resistance is noted (as compared with the others), the problem is in that circuit. Replace the wires when finished.

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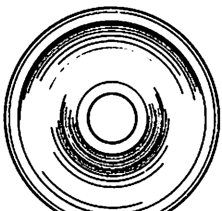

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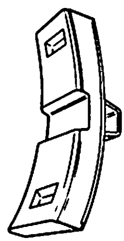

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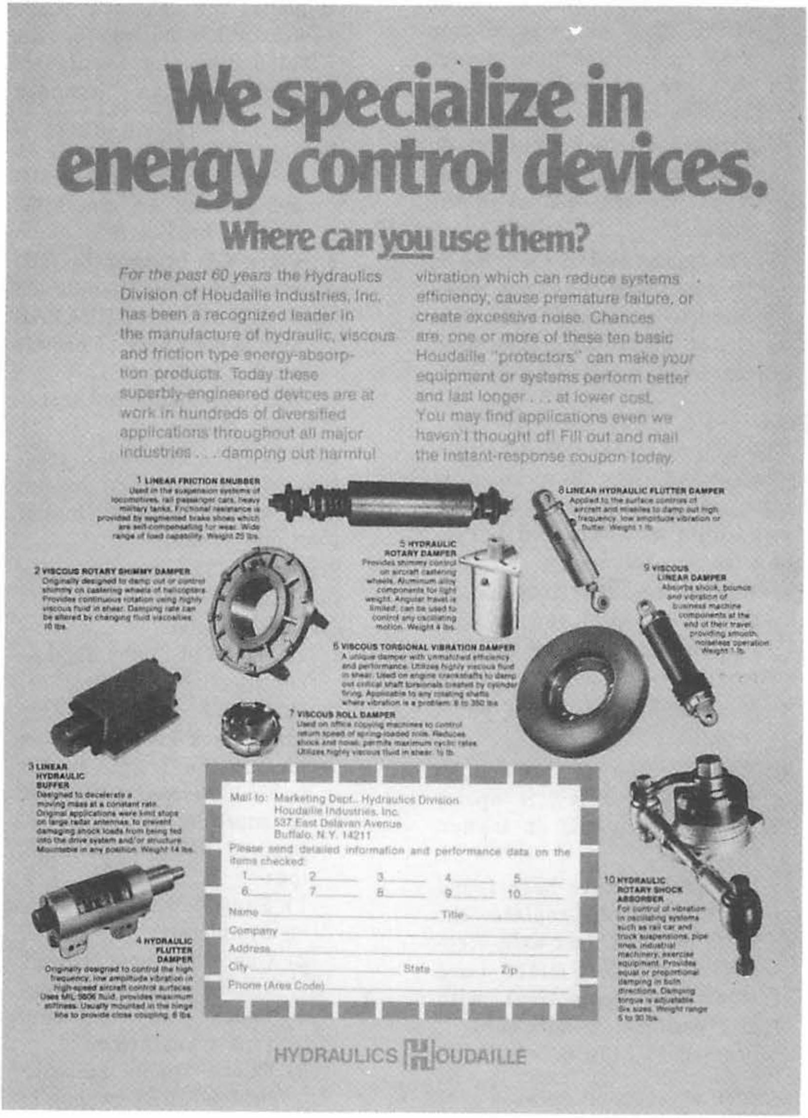
7. Check for an open or shorted CMR. Compare resistance measurements with a CMR known to be good. Check the CMR terminals for dirt or conducting material. Clean terminals if necessary.
8. Check for loose bolted joints either in the traction motor connections within the motor itself, or in the accompanying busbars and cables. Look for signs of heat and/or smoke.
9. Check the motor contactor sequence operation. Assure all tips are operating and are in good condition. Also, carefully check the traction motor shunt connections.
10. Check for an open circuit within the traction motor. Check to see if a pinion has come off of a traction motor.
11. Check traction motor connections to assure motors will rotate in proper direction and that there are no locked axles.
12. Carefully inspect wheel sizes. If there is a difference of greater than one inch diameter between the largest and smallest wheels, the CMR wheelslip system will detect it. Change wheels, if necessary, to satisfy the tolerance.
13. Check to assure all traction motors have the same gearing. Also, check the nose mountings of the traction motors to assure they are firmly seated in the rubber mounts.
14. Check the CMR's are effectively shielded from nearby cables.

    This is the end of Case No. 1. If the fault has not been corrected, proceed to Case No. 2. If the fault has been corrected, proceed to Step 5.

Case No. 2

If the CMR wheelslip system activates and there is no significant voltage difference between the test points on the card(s), proceed to Case No. 3. If there is a significant voltage difference, the problem is most likely in the current measuring circuit (transformer(s) on the panel) or the voltage comparison circuit (FD409 or FD410 Card). Note the test point(s) giving the abnormal reading and then proceed with the following.

1. Return the Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.
2. Remove jumpers from panel terminals.
3. Assure all wires on the panel terminal strip are firmly fastened.
4. Using a Simpson 260 meter (or equivalent), check the winding continuity of the panel transformers. Espepecially check the transformer in the circuit with the abnormal reading.
5. Remove all the cards from the panel and visually check for burned or damaged components. Especially check the filter capacitors on the



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FD409 Card (six-axle locomotive) or the FD410 Card (four-axle locomotive). Also, check the plug connection pins on each card to assure they are not bent or broken. Replace any defective card.

6. Replace all the circuit cards in their proper slots and assure they are secured in the panel.

   This is the end of Case No. 2. If the fault has not been corrected, proceed to Case No. 3. If the fault has been corrected, proceed to Step 5.

Case No. 3

The lack of a significant voltage difference indicates the problem is in one of the detection circuits (Level, Rate or Overspeed). Proceed with the following:

1. Return the Throttle handle to IDLE, center the Reverse handle and place GF breaker to OFF.
2. Remove jumpers from panel terminal.
3. Repeat Step 2 to double-check WSX relay is operating properly. If it is not, replace it.
4. If no faults have been found to this point, replace the FD1154 Card (six-axle locomotive or the FD1155 Card (four-axle locomotive) with an "assumed good" card. Proceed to Step 5.

Procedure D

1. Return the Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.
2. Replace the FD1154 Card (six-axle locomotive) or the FD1155 Card (four-axle locomotive) with an "assumed good" card.
3. Perform the following:
   a. Pump up the air brake system and set the locomotive brakes.
   b. Place GF breaker to ON, move Reverse handle to FORWARD or REVERSE and advance Throttle handle to Notch 1.
   c. Wait for loadmeter to become steady.

   CAUTION: To avoid traction motor damage, do not hold motor current longer than one minute.
4. Place test Toggle switch on the panel to TEST and hold for 5-10 seconds.
   a. If the WSL light flashes continuously, sanding occurs and the loadmeter drops to a lower level as long as the Toggle switch is held, proceed to Step 6.
   b. If there is no response, proceed with the following:
      1) Shut down locomotive completely.
      2) Check for open circuit condition in wiring between panel and current transformer.
      3) Check diode rectifier bridge 5BR1 which is located on the side of the panel.

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4) Restart the engine; observe standard railroad procedure and precautions.
5) Perform the initial conditions of Step 1 and then return to Step 4.

Procedure E

1. Return the Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.
2. Replace the FD1154 Card (six-axle locomotive) or the FD1155 Card (four-axle locomotive with an "assumed good" card.
3. Repeat Steps 4, 5 and 6.

Procedure F

1. Return the Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.
2. Carefully check the cabling to the reverser. Look for shorts, grounds or loose connections between the cables and busbars.
3. Check the contacts of the reverser. Assure all contacts are picking-up properly when the reverser operates. Leave the reverser in the position it was found initially.
4. Repeat Step 7. If the problems still exist, return to Step 4 to locate the trouble. If there is no CMR system action after repeating Step 7, proceed to Step 8.

Procedure G

1. Return the Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.
2. Carefully check the CMR's. Either one or more of them are not giving the proper signals at higher traction motor currents.
3. Repeat Step 8. If the probstill exists, return to Step 4 to locate the trouble. If there is no CMR system action after repeating Step 8, proceed to Step 9.

Procedure H

1. Return the Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.
2. Carefully check the cabling and busbars of the dynamic braking circuits to the traction motors. Look for grounds and loose bolted connections.
3. Check that the extended range braking contactors are operating properly.
4. Check for an open circuit in the braking grids; either a grid is burned open or a cable is burned off.
   Proceed to Step 10

Procedure I

1. Return the Throttle handle to IDLE, center the Reverse handle and place the GF breaker to OFF.
2. Use a 44-pin card extender and extend the FD406 Card from the panel.

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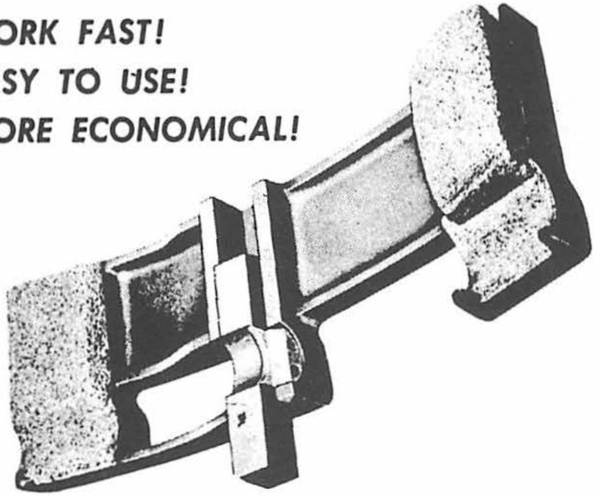

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3. With the frequency generator Test Kit still connected, set the frequency to the proper value as indicated on Fig. 7.
4. Adjust the card potentiometer until the CMR wheelslip system activates with a small increase in frequency above the proper value.
5. If the wheelslip system is not responsive to any setting of the potentiometer, replace the FD406 Card with an "assumed good" card. Set the potentiometer on the replacement card as specified in Steps 3 and 4 above.
6. Disconnect the card extender, replace the FD406 Card in the panel.

   Proceed to Step 12.

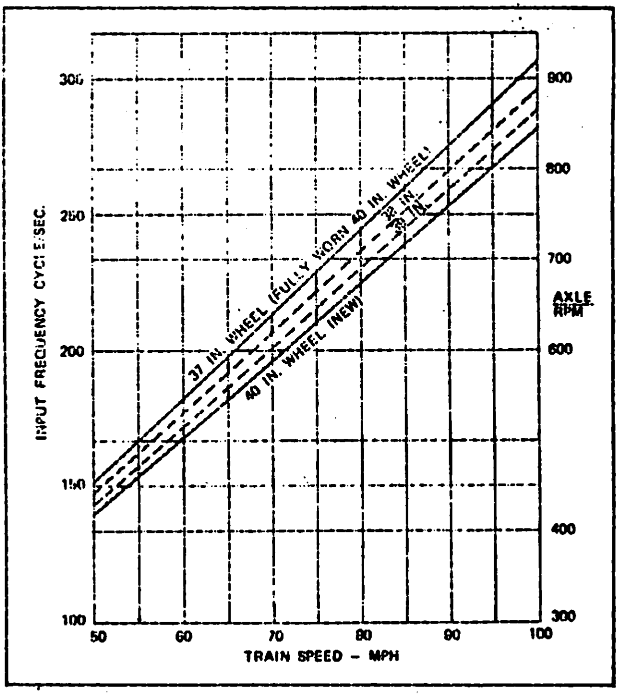

FIG. 7 AXLE ALTERNATOR OUTPUT FREQUENCY OR AXLE RPM VS. TRAIN SPEED.

V
BATTERIES & CHARGING SYSTEMS

A previous year's paper discussed batteries and charging systems. One problem being encountered at that time was low voltage output from a-c auxiliary generators during low idle operation of EMD locomotives. EMD has designed a new voltage regulator module, VR 13, which will maintain adequate battery charging voltage down to an idle of 255 r.p.m. Begining January 1, 1981, a new a-c auxiliary generator design which permits operation down to 235 r.p.m. has been standard.

The a-c auxiliary generator, like any new equipment, requires training for maintenance forces in new techniques and procedures. The following tips from EMD have been tested during the last year on one railroad.

TROUBLE-SHOOTING

Symptom:
Excessive use of battery water.

Check voltage between VR module TP1 and TP14. At idle this voltage should be between 68 and 72 volts for VR11 and 71 to 74.5 volts for VR 13. At engine full speed this voltage should be between 73.5 and 74.5 volts.

1. If voltage is higher than allowed range, adjust the potentiometer on the face of the VR module to bring the voltage within tolerance.
2. If the voltage cannot be brought within tolerance, replace the VR module with a qualified module and retest. Reset the new regulator to the proper voltage.
3. If the voltage is low or within tolerance at idle and excessively high at full speed, the full-wave three-phase rectifier is probably at fault. Refer to the section on testing this assembly.

   CAUTION: Do not remove or install the VR module unless the diesel engine is completely stopped.

Symptom: Battery charge low.

Check specific gravity (see battery manufacturer's manual).

Check voltage between VR module TP1 and TP14. At idle this voltage should be between 68 and 72 volts for VR11 and 71 to 74.5 volts for VR13. At engine full speed, this voltage should be between 73.5 and 74.5 volts.

1. If voltage is lower than allowed range, adjust the potentiometer on the face of the VR module to bring the voltage within tolerance.
2. If the voltage cannot be brought within tolerance, replace the VR module with a qualified module and retest. Reset the new regulator to the proper setting.
3. If the voltage is low at idle and excessively high at full speed, the full-wave three-phase rectifier is probably at fault. Refer to the section on testing this assembly.

CAUTION: Do not remove or install the VR module unless the diesel engine is completely stopped.

Symptom: Auxiliary generator breaker tripped.

Check voltage between VR module TP1 and TP14 with the engine at idle speed.

1. Voltage at or near 64VDC indicates a shorted battery charging rectifier. Refer to the section on testing this assembly.
2. If the voltage is zero or nearly zero, disconnect the VR module.

   CAUTION: Engine must be completely stopped whenever removing or installing the VR module.

Open the main battery switch and check the three-phase rectifier as outlined in the section for testing this assembly. If the circuit is satisfactory, the VR module is probably defective. Replace the VR module with a qualified module and close the auxiliary generator CB. Start the engine and check for proper operation.

Symptom: Auxiliary generator breaker tripped.

Shut down the engine and isolate. Pull out the VR module and open the auxiliary generator CB.

1. Test the auxiliary generator as outlined in section for testing this machine.
2. Check the auxiliary generator CB.
3. If the auxiliary generator tests good, replace the VR module with a qualified module and retest.

   CAUTION: Engine must be completely stopped when removing or installing the VR module

Symptom:
No auxiliary generator output.

Perform the functional test of the auxiliary generator as outlined in that section of this memorandum.

1. If the auxiliary generator tests good, replace the VR module with a qualified module and retest.

   CAUTION: Engine must be completely stopped when removing or installing the VR module.

Battery Charging/Three-Phase Rectifier Testing

CAUTION: Engine must be shut down during these tests.

Open the main battery switch, auxiliary generator circuit breaker and auxiliary generator field circuit breaker.

Remove the VR Module.

Full-Wave Three-Phase Rectifier Qualification

1. Remove the ALN, AFN3 and AFN7 wires from the negative bus of the assembly.
2. Connect a continuity tester from the assembly positive bus to terminal AC1 (AE13 and AE 18 wires). Then reverse the tester leads.
3. Repeat step 4 with the meter from the positive bus to ter-

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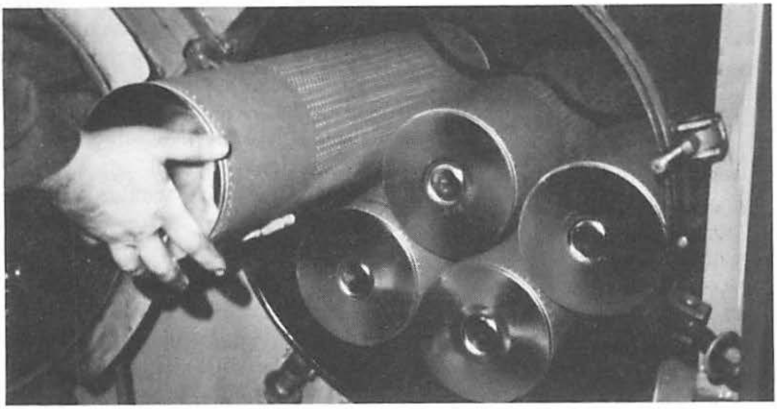

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minal AC2 (AG2 and AG23 wires), then to terminal AC3 (AE38 wire).

4. Connect a continuity tester from the assembly negative bus to terminal AC1, then reverse the tester leads.
5. Repeat step 6 with the meter from the negative bus to terminal AC2, then to terminal AC3.
6. Replace any diodes found defective.
7. Replace the wires removed in step 1.

Battery Charging Rectifier Qualification

1. Open all control circuit breakers.
2. Connect a continuity tester across the battery charging rectifier (from the positive bus to the BP7 connection), then reverse the testing leads.
   If diodes are good, the meter registers 10 to 20 ohms in one direction and above 30,000 ohms when leads reversed.
3. Replace any diodes found defective.
4. Close control circuit breakers opened in step 1.

Auxiliary Generator Functional Test

The following is a functional test for A. C. Auxiliary Generators which will not assume bus voltage after start up. The test should be used after all other components in the circuit have been found to be in working condition and the problem has been isolated to the machine.

Prior to the test the unit must be set up with the VR module pulled, no electrical load on the machine and the engine at idle (315 RPM).

1. Measure the output of the machine. Voltage should be 2 volts RMS phase to phase. This checks the magnetic residual.
2. With 6 VDC applied to the field (make sure the polarity is correct) the output should be 74 volts RMS phase to phase, ± 7 volts. This checks the electrical integrity of the machine.

New developments continue in the area of batteries. One railroad has begun a test of 50 locomotive sets of so-called maintenance free batteries. Another road has 50 locomotives equipped with electrically heated batteries. Results of these tests will be reported as experience develops. An innovation which all railroads could appreciate would be a corrosion resistant battery enclosure. We challenge the supply industry to develop ideas in this area.

Several railroads have attempted to develop battery specifications along the lines suggested in a previous year's paper. Two items of interest have developed from this effort:

1. No battery small enough to fit on the locomotive can start a cold (4°C, 40°F) engine when the electrolyte temperature is below -20°C (0°F).
2. There is a need for a simple standard of comparison such as the automotive industry's

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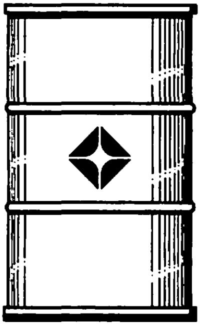

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cold cranking amps (CCA) rating. Input from both suppliers and railroads is needed to prepare such a standard.

In view of item 1, interest in alternative starting systems has been expressed. This also adds importance to the tests of heated battery systems.

VI
SELECTION OF LOCOMOTIVES FOR MAJOR LOCOMOTIVE OVERHAULS

Locomotives considered for major overhaul are usually selected for two main reasons:

1. Deterioration of performance resulting in low reliability.
2. Expensive repairs caused by serious electrical fires or other damage.

Candidates for overhaul must be examined to assure that the basic locomotive structure is sound and able to provide a minimum of ten additional years of service. Such candidates are usually 10-15 years old for freight locomotives and up to 20 years old for switchers. Another factor to be considered when selecting a unit for overhaul is the requirement for the service that is basically needed. Is the locomotive to be overhauled suitable to meet the requirement selected?

Three categories of overhaul should be considered at this point. The selection of any of these categories largely depends on the funds available, the performance expected after overhaul, and the locomotive industry.

The three types of overhauls are:

I Basic Overhaul in Kind
II Overhaul with Upgrade in Problem Area and Technology Improvement
III Overhaul with Major Redesign and New Technology

To determine which category applies to a locomotive class, the railroad must examine the original design of the locomotive, its history of failures, and the service to which the overhauled locomotive will be assigned. If the locomotive will be assigned to switcher service, the basic overhaul will most likely be sufficient. On the other hand, if the locomotive will be assigned in high priority, high speed trains, category II or III will be more appropriate. In analyzing the original design of the locomotive, one has to be familiar with its history of performance and details of failures. For instance, if the locomotive has a long history of generator failures, consideration should be given to upgrading the generator or reducing its operating horsepower. This is done after the normal failure rate due to age has been discounted. By reducing horsepower shunting steps can be reduced and circuits simplified.

A similar process is used in analyzing failures of major components such as traction motors or power contactors, reversers and transition systems. Those systems showing consistently poor performance should be replaced with more reliable ones. Finally, all components should be examined for obsolescence. Obsolete components should not be overhauled, but they should be replaced with up-to-date replacements. Keep in mind each locomotive class has its own characteristic and it is rare that one improvement applies to all.

In summary, a locomotive class considered for overhaul that has rendered good performance for at least 10 years and suddenly starts failing is a good candidate for Category I basic overhaul. A locomotive class that has a history of failures in one particular area should be considered for overhaul under Category II with upgrade in the problem area. A locomotive class that has not performed well and whose design has been obsoleted because of its performance is a good candidate for overhaul under category III with major upgrade in design.

Following is a breakdown of work to be done in each category. Each railroad must evaluate its own needs to set its own parameters. You will also see a summary of electrical modification options that are available for application.

It is obvious that the decision for major overhauls involves the cooperation of the Transportation, Mechanical and Purchasing Departments and requires planning well in advance of the schedule of work.

A planned and programmed approach to major locomotive overhauls will pay for itself in terms of locomotive performance and lower maintenance costs.

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I. BASIC REBUILD IN KIND

1. INSPECT UNIT, UNTRUCK
   DISASSEMBLE
2. BASIC TRUCK OVERHAUL
3. ENGINE OVERHAUL — RESTORE TO OEM SPECIFICATION
4. TRACTION MOTORS — BASIC RENEW BEARINGS, REIMPREGNATE
5. MAIN GENERATOR — BASIC
6. MISC. ROTATING RENEW BEARINGS & REIMPREGNATE
7. REPLACE U/F, CAB & SHORT HOOD
   WIRE & CABLE REPLACE POWER CABLE AS NEEDED
8. A. QUALIFY & REPAIR SWITCH GEAR. UPGRADE TO LATEST STANDARD
   B. REWIRE HIGH VOLTAGE CABINET
   C. PRESSURIZE HIGH VOLTAGE CABINET (EMD'S ONLY)
9. QUALIFY AIR EQUIPMENT
10. LOWER SHORT HOOD
11. CLEANING
12. ASSEMBLY & PAINT
13. TEST & CALIBRATE
14. INSTALL ELECTRIC EMERGENCY SHUTDOWN

II. REBUILD WITH "PROBLEM AREA"

1. INSPECT UNIT, UNTRUCK
   DISASSEMBLE
2. BASIC TRUCK OVERHAUL
3. A. ENGINE OVERHAUL — UPGRADE TO LATEST STANDARD
   B. APPLY LOW IDLE
4. TRACTION MOTORS — UPGRADE TO LATEST STANDARD
5. MAIN GENERATOR — BASIC OR UPGRADE TO LATEST STANDARD
6. MISC. ROTATING — UPGRADE TO LATEST STANDARD
7. REPLACE U/F, CAB & SHORT HOOD
   WIRE & CABLE
8. REPLACE SWITCH GEAR — UPGRADE TO ELECTROMAGNETIC OPERATION, REWIRE HIGH VOLTAGE CABINET & PRESSURIZE WHEN APPLICABLE
9. APPLY 26L AIR BRAKE EQUIPMENT
10. LOWER SHORT HOOD
11. CLEAN CAB MODIFICATION
12. INSTALL AAR CONTROLLER
13. INERTIAL FILTERS — OVERHAUL & PROVIDE PROTECTION
14. APPLY ELECTRIC CAB HEAT
    REWIND AUX. GEN. TO 14 KW (EMD'S)

15. REPLACE RADIATORS
16. CLEANING
17. ASSEMBLY & PAINT
18. TEST & CALIBRATE
19. REPLACE BATTERIES
20. APPLY ELECTRIC EMERGENCY FUEL SHUTDOWN
21. APPLY ELECTRIC SANDING

III. REBUILD WITH MAJOR UPGRADE

1. INSPECT UNIT, UNTRUCK
   DISASSEMBLE
2. BASIC TRUCK OVERHAUL
3. ENGINE OVERHAUL — UPGRADE TO LATEST STANDARD
4. TRACTION MOTOR UPGRADE TO D77 OR E8
5. MAIN GENERATOR UPGRADE TO SINGLE FIELD
   IF APPLICABLE
6. MODERNIZE SMALL ELECTRICAL ROTATING EQUIPMENT
7. REPLACE U/F, CAB & SHORT HOOD WIRE & CABLE
8. NEW TYPE ELECTRICAL CABINET WITH PRESSURIZATION
9. APPLY 26L AIR BRAKE EQUIPMENT
10. LOWER SHORT HOOD WHEN APPLICABLE
11. CLEAN CAB MODIFICATION
12. INSTALL AAR CONTROLLER
13. INERTIAL FILTERS
14. APPLY ELECTRIC CAB HEAT
    REWIND AUX. GEN. TO 14 KW
15. REPLACE RADIATORS
16. APPLY "NEW" TYPE MANIFOLD FOR TEMPERATURE
    SWITCHERS
17. CLEANING
18. ASSEMBLY & PAINT
19. TEST & CALIBRATE
20. REPLACE BATTERIES
21. APPLY ELECTRIC EMERGENCY FUEL SHUTDOWN
22. APPLY ELECTRIC SANDING

Modification Options — Electrical
GP9, GP18, GP20
Electromagnetic reversers (Motorized not recommended, too slow)
Electromagnetic contactors in place of pneumatic
Barco 3-step transition
Upgraded transductor wheel slip system
New style relays
Low idle 235 RPM

New adjustable temperature switches
2-Pole ground cut-out
Fused a-c fan circuits 48" 200A 36" 110A
Modernized static charging and regulating system
Upgraded generator
Upgraded motors
Upgraded 14 KW auxiliary generator
Electric heat
Electric drain valve system for cooling water

GP40, SD40, SD45
Removal of field shunting
Pressurization of electrical cabinet
Applicaion of GV and GX modules for voltage and current control
1200 amp power contactors
Relocation of SCR to cabinet lower left
Sealing back of electrical cabinet #1
Application of automatic ground relay reset
Application of self loading feature
Modularized dynamic brake circuit protection
Fusing a-c fan circuits
Application of low idle
Upgrading of AR10 to A3
TR Module for transition
Electric drain valve system for cooling water
Replacement of fuses with 100A breaker

GP 35
Reduction of horsepower to 2250
Simplification of transition to 1Q-step EI
or speed actuated
Replacement of TR and FSA relays
Conversion of main generator to single field
with IDAC wheel slip control
Overhaul of main generator with SCR control
2-pole ground cut-out switch
Replace excitation fuses with breaker (50A)
Fusing of a-c fan circuits
Replacement of temperature control switches
with non-adjustable and waterproof plug
Electric drain valve system for cooling water

VII
CONCLUSIONS

Two particular points are evident from the foregoing discussions. First, the increasing complexity of locomotive controls requires more sophisticated trouble-shooting tools. Particularly urgent is the need for some sort of "rider" system which could bring to bear some of the same intelligence which a skilled electrician applied to simpler controls:

a. The ability to distinguish between normal and abnormal conditions
b. The ability to return to the shop a detailed description of the abnormal conditions and the events which preceeded them

Such a system could function with as few inputs as:

a. Train speed
b. Traction motor or main generator current
c. Signals in the 27 wire train-line system:
   1. Thottle notch
   2. Generator field
   3. Directional control
   4. Dynamic braking
   5. Alarm bell
   6. Wheel slip

The second point, as demonstrated by the experience in traction motor testing, is that any tool, be it a torque wrench or a computer, will produce quality results only when applied by a management committed to effective maintenance, a management that wants true answers, not easy solutions.

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Tuesday, September 29, 1981

9:00 A.M.

REPORT OF THE COMMITTEE ON SHOP EQUIPMENT

Pre-Convention Presentation: Southern and Southwestern Railway Club

April 23, 1981 Holiday Inn (Gateway) Huntington, WV

T. A. KESSENGER, Chairman
Senior Engineer-Facility Planning
The Family Lines Rail System
Jacksonville, FL 32202

VICE CHAIRMAN

P. F. Hoerath, Superintendent Plant Engineering, Conrail, Altoona, PA

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M. S. Anderson	Shop Engineer	D. M. & I. R.	Proctor, MN
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J. J. Wheelihan	Supvr. Prod. Install	EMD	LaGrange, IL
T. E. Whitten		Precision Nat'l	Mt. Vernon, IL

1981 TOPIC:

"TOOLS AND TRAINING FOR PRODUCTIVITY"

PERSONAL HISTORY

THOMAS A. KESSENGER

Thomas A. Kessenger was born in Louisville, Kentucky, May 24, 1945. He attended grade school and high school in Louisville, graduating high school in 1964. Tom was employed by the Louisville and Nashville Railroad the same year as a machinist apprentice and within two years was placed in a special mechanical management training program.

Tom attended the University of Louisville and studied mechanical engineering through I. C. S. School of Scranton, Pennsylvania.

In 1969, he was promoted at the L&N to Engineer Methods and Procedures at South Louisville Shop and in 1977 was promoted to General Engineer Methods and Procedures. In 1977, Tom was promoted to his present position as Senior Engineer — Facility Planning. In January of 1981 he was transferred to Jacksonville, Florida due to the consolidation of the SCL and L&N Mechanical Departments into one department of the Family Lines Rail System. All of Tom's job assignments have been shop related.

From 1965 to 1971, Tom also served as a member of the U. S. Army Reserve. He has been a member of the LMOA since 1972 and first served on the Shop Equipment Committtee in October 1974. Tom has also been a member of the American Society of Mechanical Engineers since 1976.

His hobbies include woodworking, skiing and horses.

Tom has been married to the former Kathy Pfaff of St. Paul, Minnesota since August 10, 1970. She is a teacher of special education.

INTRODUCTION

Today, more than ever, railroad employees and facilities must be utilized to their maximum production capabilities. Also, for employees to perform to their full potential, they must be properly trained. They should be provided with the latest time saving tools.

Owing to the high cost of energy, our companies need to be kept abreast of energy saving methods. Those should be implemented as soon as possible to achieve operating cost savings.

Federal agencies adopt new standards that affect our operations. We must implement standards if we are to continue operating.

The Shop Equipment Committee covers all of those areas in "Tools and Training for Productivity," as follows:

I. Training Aids
II. Testing Devices Brought About by the New FRA Laws
III. Small Tools
IV. Changes to Shop Facilities Required by Newly Adopted EPA and OSHA Regulations
V. Tour Through Conrail's Altoona Shop
VI. Supply and Service Facilities
VII. G. E. Power Assembly Shop

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- MS Load Tester
- AK Brazing Machine
- Balancing Machine
- TFR Motor Frame Stand
- MG Armature Extractors
- DGL Generator Upender
- BM Armature Upender

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I

TRAINING AIDS

Railroads are challenged by the pressures of change from within. Those pressures are brought on by introduction of sophisticated electronic technology, government regulation, increased competition and extreme change in the labor force. Nowhere are those pressures more apparent than in Mechanical operations.

Computer systems now assist in the scheduling of car and locomotive maintenance activities and shop production control. Technology advances appear almost daily in new locomotive designs and the devolopment of 'specialized maintenance equipment. They are a necessary part of providing a marketable service and in remaining competitive.

With those changes comes an increasing pressure to update the knowledge and skill of workers on the job. Employees are more dependent than ever on information to do their jobs properly and make efficient use of the systems and technology provided. In order to give maintenance personnel a good understanding of the technical information necessary to the job, employee training and improved communication have become vital.

Various approaches have been developed. Among them are the use of shop training aids. They provide training and information within the actual working environment. This enables the employee to gain a clearer understanding of the subject matter, within the context of varying work methods, machinery and local management policies. Through the use of onsite training, information can be readily adapted to fit particular needs.

Here are two innovative methods of providing on-site training: specialized training workshops at the location, and a video based information system.

The specialized workshop approach often is used when training is required at a particular location to correct specific maintenance problems. An example is the GENERAL ELECTRIC LOCOMOTIVE MAINTENANCE SCHOOL recently begun by the Union Pacific at its North Platte facility. Its goal is to improve the availability ratio of G. E. locomotives by improving the knowledge and capabilities of employees at a main repair location. The intensive training involves all machinists, electricians and pipefitters. The school is one week long and includes two sessions per day, one first shift and one second. Each week-long session is divided equally between classroom instruction and hands-on training in the shop.

This hands-on training is done by using a specially designed G. E. locomotive with the outer carbody removed for instruction purposes. The parts have been cleaned of all grease and oil and painted. Two cylinders have been cut away to illustrate the various operating functions and common defect con-

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ditions. Trainees learn about a specific area, such as power assemblies, early in the day in class and work on power assemblies in the diesel shop later the same day. Students are required to remove and replace cylinders, pistons and rods according to the procedures explained. Participants also have daily homework assignments and tests to assess how much they've learned.

When completed at North Platte, the training program will move to Salt Lake City, which is heavily involved in G. E. maintenance.

A unique feature of the training program is the use of video playback equipment to enhance the learning process. Instructional programs produced by G. E. and U. P. are integrated closely with the actual hands-on work. This allows the student to view a particular procedure before actually performing it.

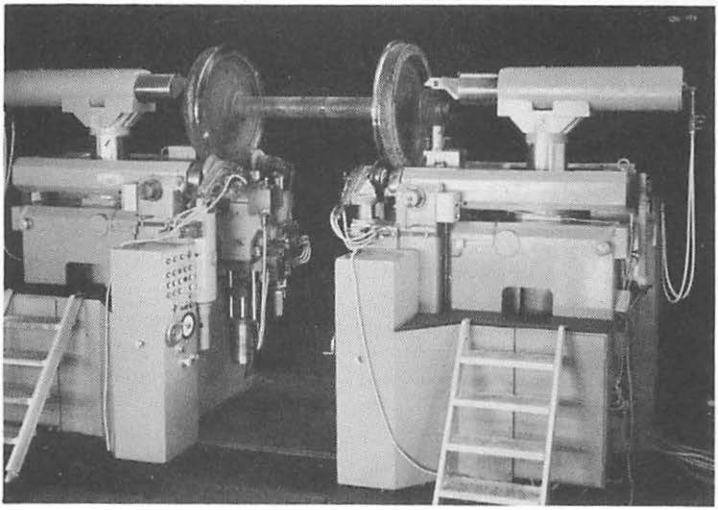
The use of videotape playback equipment and pre-recorded tape programs have several advantages for the training instructor and the on-line supervisor alike. Through this medium, information can be presented quickly, clearly and uniformly to a single employee or an entire group. This flexibility has made it a valuable shop training aid.

There are several considerations that must be taken when establishing a video based information system. Basically, there are two main areas of concern: the method by which programs are produced, and the system for distributing and using the programs.

There are various ways of obtaining training programs. They vary from simply purchasing a commercially produced program to producing the program yourself. In either case, attention should be focused on the intrinsic value of the program as it relates to specific training objectives. A safety program, for instance, may not portray the actual operation found in a shop or trainyard. However, it may contain basic safety themes applicable to any situation.

If a program must be developed to meet specific needs, its success depends largely on how effectively you convey the basic message to the audience. Thus, emphasis should be placed on developing that infomation to meet clearly defined program objectives. Often, more attention is paid to the hardware, i.e. cameras, recorders, lights, etc., than the basic intent and purpose of the program.

The system by which videotapes are distributed and used by online personnel also is important. Consideration must be given to creation of a viable playback system. First, you need to identify locations for playback equipment. On the Union Pacific, this was determined by the number of employees based at each location, with special attention to equipment accessibility. A minimum of ten employees justifies an installation; on this basis a network of playback units was established at 42 locations. The BN has a total of 64 such lo-



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cations, with an additonal 6 portable systems for use at smaller remote facilities.

A typical network location has four elements:

1. Television set
2. Videotape playback unit
3. Storage Cabinet
4. Program library

The following discussion will deal with each element of the system and identify some of the basic considerations that should be taken to develop a system that fits your needs.

The Television

In choosing a television set, the first decision is whether to purchase black and white or color. The black and white units are less expensive and will provide a somewhat better picture than color. However, if plans for in-house production include color capability, a black and white network would not be a wise investment. Further, almost all programs purchased from outside sources are produced in color, and many make use of color graphics for explanation purposes.

What size and type of TV must be decided next. That depends on the number of people in the audience and other viewing requirements. TVs are available either as receivers or monitors, with the latter providing a somewhat higher picture quality. However, the cost differential between the two is significant, and repairs to the monitor could be a problem for the local service center.

Size can vary from 9" to 21". A portable system intended for a limited viewing audience might utilize a 9" or 12" receiver with or without the capability of battery power. A 19" or 21" unit could adequately service groups of 25 to 30 people. For larger audiences, several TVs could be wired together, or a large screen projection system could be installed. The BN reports the major drawbacks of the large screen to be in its setup time and portability. It is rather heavy, bulky and requires color correction each time it is moved. While color adjustment does not require a technician, it does require an individual who is familiar with the unit.

When purchasing TVs, one consideration is the availability of service at a network location. Often, substantial savings can be realized in purchasing several sets from a single supplier. However there can be problems if service becomes necessary and the units are placed at on-line locations. If the model is not sold locally or service is limited, repairs may take some time. If the unit must be shipped back to the original supplier for repair, the purchase cost savings will be lost in transporation expenses. In that case, it might be best to purchase the TV at a higher price from a local supplier to provide adequate services when required.

The Videotape Playback Unit

There are several brands and types of videotape playback equipment on the market. Before purchasing, the first decision is to determine which tape format is to be used for program distribution. The most practical formats now in use ar the 3/4" and 1/2" varieties. Each offers specific viewing advantages.

It cannot be overstated that a decision regarding format is probably the most important aspect of the overall distribution system. Not only will there be a sizable investment in the playback units, but, in time; a sizable investment in videotape itself. It is important, therefore, to carefully weigh the advantages of each format before purchasing playback equipment.

The most significant selling point of the 3/4" system is that it will provide better picture quality than the 1/2" system. This depends largely on the type of production and duplication equipment used. However, the 1/2" tapes are less expensive and capable of providing more available programming on each cartridge (up to 2 hours normal speed playing time). This can provide important savings when stocking numerous tape libraries or at locations where storage space is limited. One drawback of the 1/2" tape is that it can be used in the home video player and there is always the possibility of theft if usage is not properly controlled.

All 3/4" equipment is compatible, which is not the case with the 1/2" units. These come in either VHS or Betamax versions requiring different style cartridges for use in each machine. This means that a decision to purchase 1/2" equipment also requires a decision on whether VHS or Beta is best. Both provide comparable picture quality. The decision will usually be based on the availability of local service or on reliability statistics.

At Union Pacific, the field distribution system is the 1/2" VHS format. During the past three years, maintenance has been minimal. BN's distribution system is the 3/4" format. With equipment in service for the past seven years, maintenance has been minimal.

After determining the distribution format, it is important to be aware of several other considerations. One is the special features available on various types of equipment. Those include record/audio dub features, search speeds, slow motion, or freeze frame capabilities. It must be decided what is actually needed at the location to accomplish overall program objectives. A 7-day programming feature is nice for recording the daily soap operas but an unnecessary expense.

A unit capable of recording both sound and video can be useful for documenting problems or procedures at a location. This information can be easily transmitted to headquarters for management evaluation. A freeze frame or slow motion capability is useful when evaluating work methods or when a supervisor is answering questions. The point here is to first determine your present or future needs, then purchase equipment that will meet, not exceed them.

Finally, what brand? This may be one of the hardest decisions to make because there are many opinions as to the best buy. Basically, there are three items to consider before the purchase: check the cost of the equipment, the reliability of the equipment and the availability of service. And don't check with the dealer — check with the other users in the area.

The Storage Cabinet

A storage cabinet is necessary to provide security for the television and playback unit. The cabinet should be lockable and located for accessibility. Cabinets may be constructed as either a fixed unit or with a mobile base for easy movement.

There are several types of cabinets designed for video equipment storage. These are available through audio-visual suppliers or video equipment dealers. Since the primary purpose of the cabinet is to secure equipment, make sure your purchase will afford an adequate degree of protection. This may necessitate some minor modifications to the cabinet doors and the addition of secondary locking devices.

The Library

Establishing a program library at a network location requires the assignment of an individual responsible for maintaining a system of usage. This includes the ordering of programs, organizing the library, and checking out tapes to supervisory personnel.

This individual may also be responsible for maintaining a utilization log to document program usage. On the BN, the utilization log is sent monthly to the manager of technical training to assess the number of people watching specific programs. It is also a good method of assuring that programs are being used at a particular location.

Tapes should be placed in a secure location to prevent theft; inventories should be made periodically for accurate accounting.

Depending on the distribution format used, tape storage may be accomplished in a number of ways. The 3/4" tapes may require only simple shelving or specially designed cabinets. Storage of 1/2" tapes can be done the same way. However, since those cartridges are relatively small, a standard file cabinet for 8"x 5" index cards can be used. Those cabinets are lockable and hold from 175 to 450 programs.

II

TESTING DEVICES INSPIRED BY NEW FRA LAWS

When laws change governing the testing of locomotive equipment, and when new locomotive equipment appears, new test equipment often is needed. With modern electronics, more reliable and more portable test equipment has become available.

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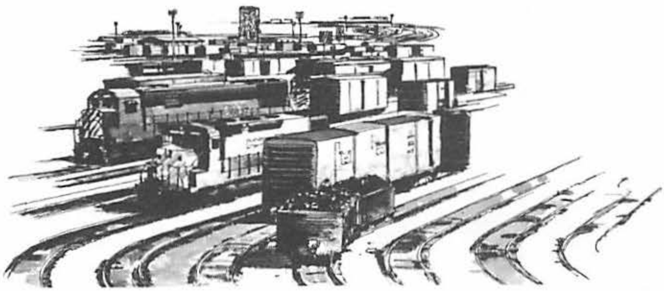

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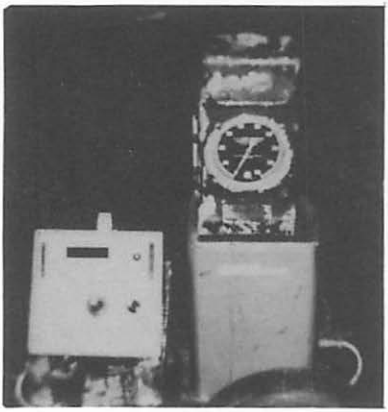
Speed Indicator—P-1

The Dynapar Corporation has developed a universal speed indicator calibration system featuring solid -state circuitry and digital readout. The system consists of a motor drive unit and an instrumentation unit. The system can be mounted on a roller cart for portable trackside use or permanently installed for indoor bench testing.

For bench testing, a speed indicator is mounted on the motor drive unit. The speed indicator input shaft is coupled to a variable speed motor within the motor drive unit. Using the instrumentation unit, an operator can control the motor's speed and direction of rotation. As the motor rotates, it causes the speed indicator to operate in the same manner as it would if it were installed in a locomotive. A tachometer detects the RPM of the motor which in turn causes the instrumentation unit to display the speed in MPH



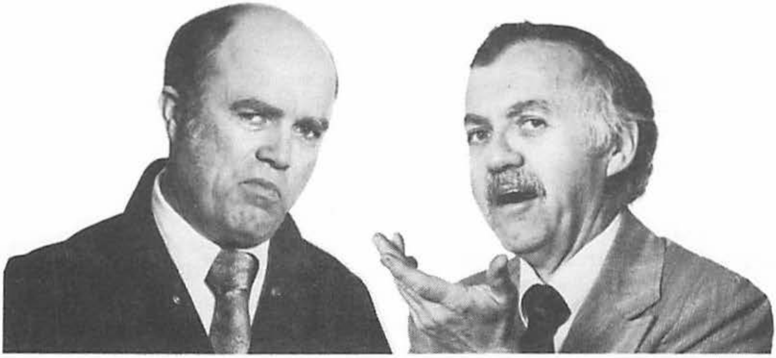
P-1

or KPH. The system's digital readout and the indicated reading on the speed indicator should agree; if they do not, the testing repairman can adjust or repair the speed indicator and repeat the test.

For trackside testing, the motor drive unit is placed near the locomotive wheel. The locomotive's speed indicator drive cable is disconnected from the axle drive and connected to the calibration systems' axle drive. The instrumentation unit can be taken to the cab so that the operator can observe the locomotive speed indicator as he remotely controls the operation of the motor drive unit.

The instrumentation unit contains a power switch, a digital readout, a direction control knob, a speed control knob, and a ratio preset control knob. Internal acceleration and deceleration circuitry prevent abnormal stress on the speed indicator, preventing possible damage to the indicator under test. An automatic shutdown circuit will disable the motor drive unit if excessive torque is required to operate the speed indicator. That feature prevents the motor drive unit from trying to operate a jammed or defective speed indicator, which might cause the motor to overheat. If automatic shut-down does occur, the system can be reset by turning the power switch "off," then "on."

Bohr Electronics offers a portable calibrator for electric speed indicators. This calibrator weighs about five pounds and has about



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the same measurements as a Simpson 260 volt-ohm meter. It operates from eight self-contained ordinary "D" size flashlight batteries. Over-load protection prevents damage to the unit in the event it is connected to a "hot" circuit rather than a speed indicator circuit.

One railroad has mounted a speed indicator circuit receptacle on the throttle stand of each of its locomotives that has an electric speed indicator. The Bohr calibrator has a cord with a plug to match this receptacle.

The calibrator contains a power switch, a power light, a battery-o. k. light, a five-position frequency knob, and a variable frequency knob.

The calibrator is plugged into the receptacle, the frequency knob is set at 50 CPS, and the power switch is turned on. The power light and the battery-o. k. light should burn. The frequency knob is then turned to three positions: at 173 CPS, the speed indicator should read 60 MPH; at 125 CPS, 42.5 MPH; at 50 CPS, 15.5 MPH. Next, the variable frequency knob is turned all the way counterclockwise, and the frequency knob is set at "variable." The variable frequency knob is then rotated clockwise until the overspeed picks up. Speed indication is adjusted by turning the resistor box rheostat.

The Bohr calibrator is also used to check the operation of magnetic tape speed recorders. When the calibrator is plugged into the receptacle, the recorder runs.

Pulse Electronics has introduced an electric speed indicator that requires no calibrator. Calibration is checked by opening the indicator door and observing the indicator hand. When the door is opened, the indicator will automatically go into calibration mode and indicate 40 MPH for a 40-inch diameter locomotive wheel, 38 MPH for a 38 inch wheel, etc. Speed indication is adjusted by turning the MPH knob on the indicator. The switch on the indicator is then held in the "1/2" position; the indicator should read half the speed read with the switch in the normal position. When the switch is held in the "overspeed" position, the indicator hand will move up slowly, and the overspeed will trip. Also, while the indicator door is opened, the magnetic tape speed recorder runs.

Cab Signal Equipment

The coded cab signal-safety control equipment (CCS-SC) on locomotives, regulated by the "Rules, Standards, and Instructions for Railroad Signal Systems (49CFR-236)," is subjected to two types of tests. A periodic inspection, done monthly, is a comprehensive evaluation of all components and functions of the CCS-SC. A departure test must be performed on each locomotive from which the brakes of the train are controlled at the initiating terminal. This test must determine that the equipment is capable of performing its functions and that performance is within the specified limits.

One railroad has built a lightweight, portable tester to perform the departure test. The tester is powered by locomotive batteries.

At initiating terminals, a permanent loop is installed on the rail to carry the varying codes that are necessary to activate the CCS-SC. One railroad built a small, inexpensive, solid-state generator to generate those codes.

A typical test procedure would begin with a mechanic activating the code generator with an on-off switch. This exposes all locomotives within the confines of the loop to the code rates. The mechanic controls the equipment by placement of the reverser handle. In neutral or reverse, the receiver bar circuit is open; in the forward position, the receiver bar circuit has continuity, and aspect changes occur. The code generator automatically cycles the aspects from green thru red over yellow. The acknowledge handle is moved after each of these more restrictive aspects to determine that acknowledgement will silence the audible indicator and forestall a penalty brake application. When the aspect again turns green, the reverser is centered. The resulting more-restrictive change is not acknowledged, and observation determines that the equipment makes a full service penalty brake application. To complete the test, the automatic brake handle is placed in "emergency." This determines that the brake application can be increased, as required by law.

Sound Level Testing—P-2

A battery-operated sound-level meter sold by General Radio Company can be used to measure sounds produced by locomotives and shop equipment. The meter measures 3.63 x 6.50 x 2.09 inches; it weighs 13 ounces; it has a range of 40 to 140 decibles; and it comes in a carrying pouch. Measurement of sounds is accomplished by changing a noise into an electrical signal and displaying it on an indicator in terms of decibels (dB). Sound pitches as well as sound pressures are taken into account.

Operation is as follows: remove and retain cap on microphone; set level-range control to the 110-120 dB range; slide power switch to "on"; depress and hold battery check button (meter should indicate in "battery" portion of scale); depress the appropriate weighing and meter-speed buttons; point the microphone at right angles to the direction of the noise path; adjust the level range control for a reading.

General Radio Company also offers the following publications on sound: A Primer of Noise Measurement; Handbook of Noise Measurement; and Primer of Plant-Noise Measurement and Hearing Testing.

III
TOOLS AND TRAINING FOR PRODUCTIVITY

Small Tools

Hydro-Set Precision Load Positioner—P-3

On many occasions shafts are bent or housings cracked when attempting to align and mate heavy parts where critical alignment is necessary.

The Hydro-Set load positioner is capable of lifting or lowering the load with control at the rate of .001 inch at a rate of 0 to 8 feet per minute.

This picture shows the positioner being used to install a turbocharger.

The load positioner is connected to the overhead crane and the load.

The load positioned to within 12 inches of its final position. The positioner is then operated with the up and down pump levers until proper alignment is accomplished.

The positioner has a dial that indicates the weight of the load it is lifting and may be used to determine the weight of any load.

It can also be used to test lifting slings, etc. There are ten models of the positioner available with the capacity ratings of 1 ton to 250 tons with manual, pneumatic, electro-hydraulic, and remote control optional.

Electronic Connecting Rod Precision Gauge—P-4

The Tobin ARP Model RI 9000E electronic connecting road gauge can be used to indicate twist, bend, or variation of center to center dimension of connecting rods for locomotive air compressors, or engines with rod 22 inches center to center and maximum size of 3 inch wrist pin and 4⅛" crank pin.

Photo shows a Gardner Denver locomotive air compressor rod being tested.

The features of the tester are: electronically operated indicators graduated to indicate a .001" twist in 8 inch spread, a .001" bend in 8 inch spread, and any variation to .001 inch in length compared to another rod of the same set.

Easy to read dials and a master gauge for calibrating bend and twist indicators are also features.

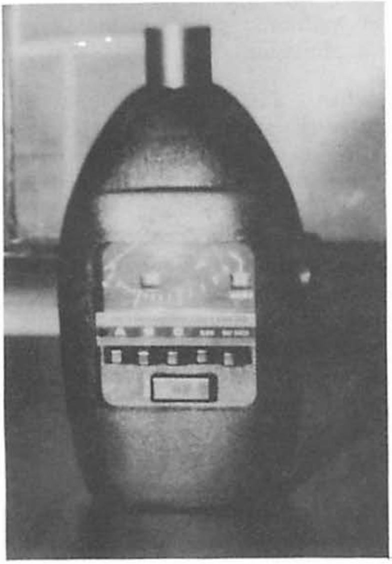
Myron L DS Meter

The Myron L. Meter is used to check the concentration of the water treatment to ensure the protection of the locomotive cooling water systems.

The instrument measures total dissolved solids by conductance and displays the parts per million value on the meter located on the face of the instrument. It should be noted that this instrument must be calibrated for each particular type of water treatment being used. This instrument is recommended by G. E. and its use is covered by a newly revised M. I. on water treatment.

TAME Model 70 Hydraulic Ratchet Wrench—P-5

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. Note that the socket may be



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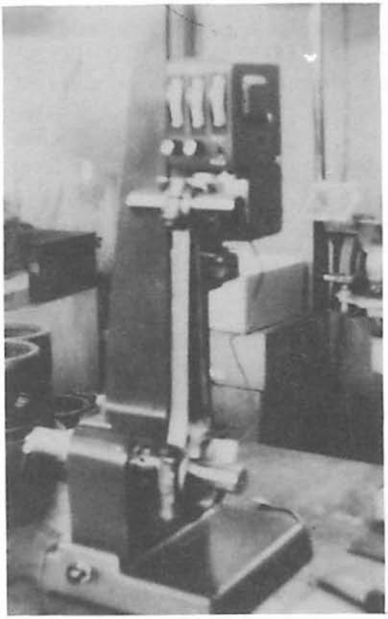

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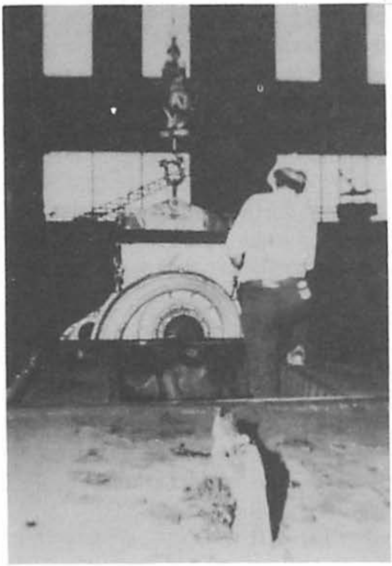

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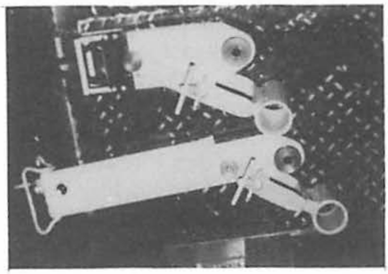

P-5

inserted into the ratchet gear opening from either side, and the words "LOOSEN" and "TIGHTEN" are stenciled on opposite sides of wrench body control box. To reverse the wrench rotation, remove the socket and knurled handle from the drive gear and re-install from the opposite side of wrench. Also remove lock pin and torque arm handle; reinstall on opposite side of wrench.

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.

Operation of wrench is controlled by two pushbuttons located in wrench body control box. The words "TIGHTEN" and "LOOSEN" are stenciled on the wrench main frames adjacent to the pushbuttons. Either pushbutton will start pump motor and wrench operation. When "LOOSEN" button is pressed, motor will start and wrench will ratchet continuously until pushbutton is released. Wrench torque output will be limited only by an adjustable mechanical pressure regulator located in the top of the hydraulic pump oil reservoir. The regulator is pre-set at 5500 PSI, which should be sufficient pressure to remove capscrews torqued up to approximately 1500 foot lbs. 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.

When "TIGHTEN" pushbutton 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 pressure switch calibration point, the pressure switch opens, de-energizes motor start relay and stops pump. If pushbutton is held closed, pump motor will cycle on and off until pushbutton is released. The pressure switch has been pre-set to open at 4200 PSI, or 1100 ft. lbs. This pressure may be adjusted as required up to 5500 PSI by a set screw located in the side of switch body. Due to slight variations in pressure gauge calibrations, wrench torque output should be confirmed by tightening a contraction motor support cap bclt with this tool and checking torque obtained with a reliable torque wrench. Readjust pressure switch if necessary to obtain the desired torque output.

Model 70-DP wrenches are equipped with two pressure control switches and a 2-position toggle switch to select desired torque range. A toggle switch is located on top of the motor starter relay box and is labeled "HI-TORQUE" and "LO-TORQUE." When the wrench is operated with toggle switch in "HI-TORQUE" position,

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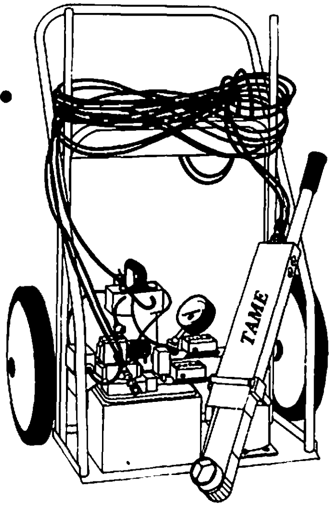

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sequence of operation is as described in Paragraph 4 and the top-mounted pressure switch (set at 4200 PSI) is in series with the motor starter relay coil. When wrench is operated with toggle switch in "LO-TORQUE" position, the sequence is the same with the exception that the motor starter relay coil is in series with the bottom mounted pressure switch, which has been preset to open at 2250 PSI, or approximately 600 ft. lbs. Pressure adjustment is made with a set screw located in the side of the switch body. (Those switches may be readjusted and re-labeled "EMD" motors and GE motors if desired.)

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 receptacle should be used.

IV

CHANGES TO SHOP FACILITIES REQUIRED BY NEWLY ADOPTED EPA & OSHA REGULATIONS

Existing and newly adopted EPA and OSHA regulations have prompted many changes to railroad shop facilities. Railroads are required to control the environment workers are exposed to. Regulations cover air contamination, water contamination, sound levels, etc. Railroads also must be concerned with the effect they have on the environment in which they operate.

Changes in shop operations are exemplified in the many new controlled exhaust systems, filter systems, controls for water discharge into streams and rivers, pollution abatement ponds, fume and smoke collectors, sound level controls, etc. Shops with coal-fired boilers have a unique change, a requirement to control stack emissions.

One railroad with three coal-burning, traveling grate, stocker-fired boilers controls emissions with a five compartment "baghouse." Four of the compartments are "on line" (under normal operating conditions), while one section is being cleaned. The baghouses can remove 99.9% of the particulate; tests performed after the unit was installed showed stack emissions well within the limit set by the state EPA.

This is one example of the many changes to shop facilities brought about by EPA and OSHA regulation. There also are many test instruments to aid in regulation compliance. Following is a brief description of some of them:

Ozone Analyzer

The Model 560 Ozone Analyzer is a fully portable self-contained instrument using the EPA-approved method of measuring the light produced from a vapor phase chemilluminescent reaction of ozone and ethylene. The instrument is used to measure the ozone concentration in welding shops or any high-voltage area.

Save on filter maintenance costs

with AMER-kleen replaceable filters

AMER-kleen nonflammable filters are ideal for engine intakes. They cost less to use and throw away than washing and reoiling metal filters. With AMER-kleen filters, you don't need filter cleaning equipment at all.

Air cleaning efficiency is greater than that delivered by any panel-type filters available for locomotive service. AMER-kleen filters are progressively packed for greater dust-holding capacity.

And because AAF glass-fiber filaments are spun continuously, and bonded with a heavy-duty adhesive, fiber particles cannot be dislodged despite air volume and dirt buildup. For additonal information on the most practical filter for engine intakes, write Manager, Railroad Products, American Air Filter Company, Inc., P. O. Box 1100, Louisville, Kentucky 40201.

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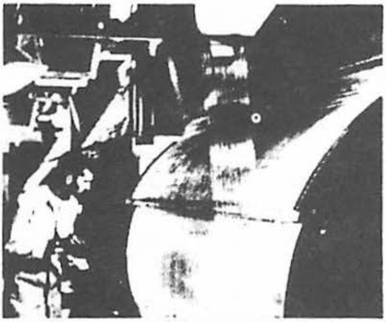
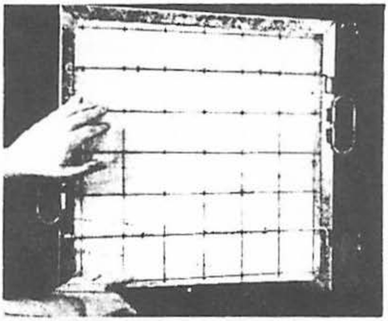


Unique spinning process guarantees continuous filament fibers throughout the pad.



Fast, easy installation. Throw away old filter, tuck new one in, close grid . . . in seconds.

The instrument is manufactured by Analytical Instrument Development Company and costs $3,000.

Ecolyzer—P-6

The Ecolyzer is used to monitor the carbon monixide concentration of shop air. The instrument analyzes the ambient air for carbon monixide by passing a stream of air over an electrochemical sensor. The sensor, by oxidizing the carbon monoxide, produces a current output whose magnitude represents the level of the carbon monoxide in the air. The current causes a meter indication showing the level of carbon monoxide in parts per million.

The instrument is manufactured by Energetics Sciences and costs $700.

Sound Meter—P-7

The General Radio Sound Meter is used to analyze noise in shops for overall sound level, as well as single source peak sound levels. The meter is capable of monitoring noise on the A, B & C Weighting scale, as well as performing octave band analysis to determine the frequency of a specific noise source. The A Weighting scale is normally used in shop tests because the decibels of noise detected on this scale is most representative of the effect of noise on the human ear.

The meter sells for $4,000.

Combustible Gas Meter—P-8

The Model 40 Combustible Gas Meter is used to determine if an atmosphere is explosive. The instrument operates by the catalytic action of a heated platinum filament in contact with combustible gases. The filament is heated to operating temperature with an electric current. When an air sample contacts the filament, combustion on its surface raises the temperature in proportion to the quantity of combustibles in the air. A Wheatstone bridge circuit measures the change in electrical resistance due to the temperature increase. This change indicates the percentage of combustibles present in the air. This instrument can be used to detect gas leaks and is used to monitor the air when relining storage tanks.

The gas meter is manufactured by Mine Safety Appliances and costs $300.

Miran 1-A Gas Analyzer—P-9

The Miran 1-A is a portable infra-red spectrophotometer used to identify and quantify air contaminants.

Identifying an unknown material with infra-red is a process that is similar to fingerprinting. The identification of a material is determined by scanning the infra-red spectrum and noting the absorption peaks. The absorption noted at various wavenumbers, when plotted, will form a spectrum which varies with each material.

This instrument was used to identify the odor in several covered hopper cars that were rejected by a shipper for sugar service. It was determined that the lining in the cars had not ade-

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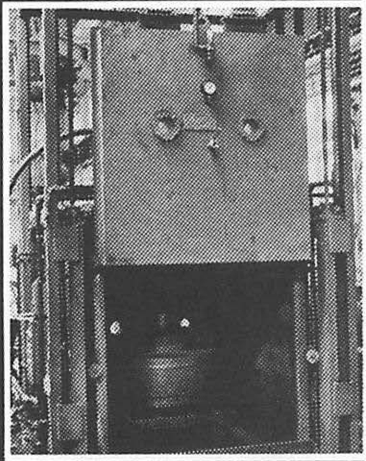

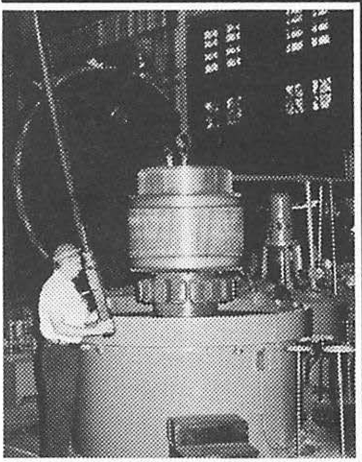

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quately cured and therefore was emitting solvent fumes.

The Miran 1-A is manufactured by Foxboro Instruments and costs $7,700.

Organic Vapor Monitor—P-10

The Century Organic Vapor Monitor is a portable gas chromatograph that can be used to monitor shop atmospheres that are contaminated with paint or cleaner solvents. The instrument utilizes a flame ionization detector that is fueled by a built-in hydrogen cylinder.

A volume of air is injected into a gas stream where the organic material is combusted in the flame ionization chamber. The electrons formed during the combustion process are quantified by a detector and then are related to a concentration of a known organic substance. This value is then shown in a parts per million relationship on the sampling head meter.

The instrument is manufactured by Foxboro Instruments and sells for $3,500.

Air Sampling Train—P-11

Gravimetric samples for particulate matter such as airborne lead from painting operations or welding fumes are taken with an air sampling train. The sampling train consists of an air pump, neoprene hose and filtering cassettes.

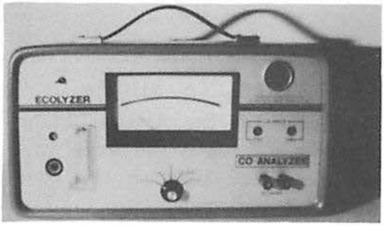
The DuPont Model P-4000 air pump is used to power the train. This pump is capable of producing a flow rate of 0-4000 cc/minute and will automatically compensate for an increasing pressure drop across the filter system. The pump also has a built-in timing system to monitor the total time it has operated. The Model P-4000 sells for $850.

The Millipore filtering cassette is used to collect the particulate matter. The cassette is constructed with two or three interlocking sections and marked inlet and outlet ports. The filtering medium is normally 0.8 micron cellulose acetate. The cassettes sell for $1.00.

To collect a sample, the pump is attached to the worker's belt and the cassette is clipped to the lapel. After a pre-determined air volume has passed through the cassette, the filter is analyzed using laboratory procedures

Audio Dosimeter—P-12

The DuPont Audio Dosimeter is designed to measure and record personal exposure to noise in compliance with the current OSHA Occupational Noise Standard. The dosimeter incorporates a microphone which is clipped to the worker's collar and the case fits in the shirt pocket or is fastened to the belt. The memory cell stores and calculates the worker's actual noise exposure. After exposure, the memory cell is placed in a remote readout, which displays total exposure as a percentage of the standard.



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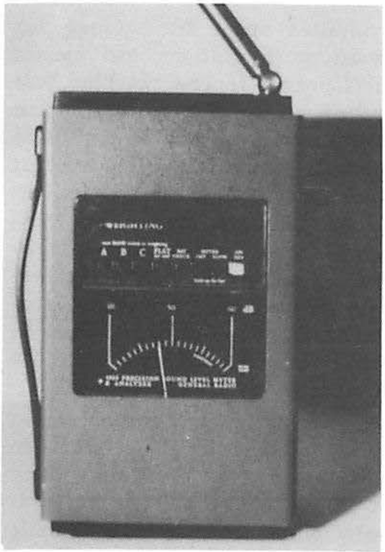

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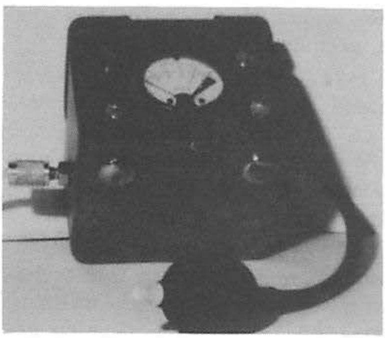

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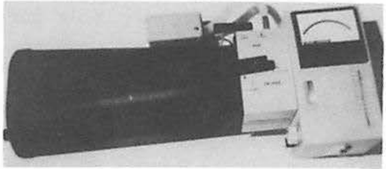

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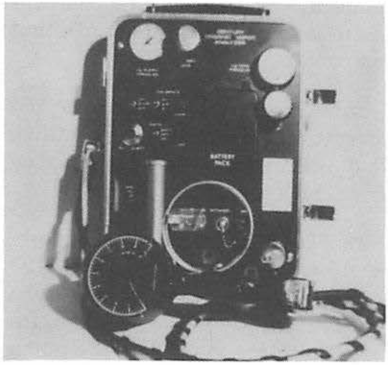

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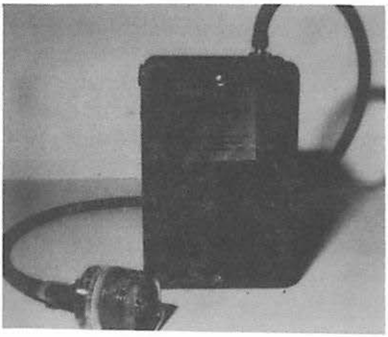


P-11

P-12

The Audio Dosimeter sells for $750 each.

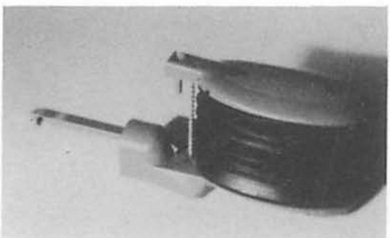
Detector Tubes—P-13

The Draeger pump and detector tubes are used as a quick and easy method of identifying a chemical compound and measuring the approximate concentration of that compound.

Tubes are available for over 100 different compounds. They utilize the colorimetry of established chemical reactions.

The Draeger pump is a bellows hand-held device that draws 100 cc/stroke. The ends of the tube are broken, the tube is then inserted into the pump and the pump is then operated for a pre-determined amount of strokes that are printed on each individual tube type. After the appropriate amount of air has been drawn through the tube, the concentration of the compound that is present is determined by the length of color change in the reaction layer.

The Draeger pump costs $110 each and a typical detector tube costs $2.00 each.



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V

TOUR THROUGH CONRAIL ALTOONA SHOP

In order for the Altoona Shops to handle efficiently the large work load generated through the combining of railroads into Conrail, the facility had to be expanded and modernized.

Limited space for storage between work stations had caused inefficiency. If one machine was out of service for repairs or an operator was absent, it tended to limit the output of the line for that work trick. Machines themselves were a problem area. They suffered from breakdowns, obsolescence resulting in hard-to-get repair parts, and deviation from standards. The latter resulted in rework because machines were not dependable to hold tolerance.

Some machines required excess labor to operate in relation to parts cleaned or produced. Many of those old fashioned methods were eliminated. New automatic or semi-automatic machinery has been installed. A slide presentation shows many of the changes. A sampling of these follows:

P-14 — View of new "E" Bay added in the Modernization Project. This bay is 691 ft. long and 110 ft. wide and houses the new locomotive steel shop and radiator repair area.

P-15 — Injector parts are disassembled and cleaned in this turbulator cleaning machine, utilizing ultrasonics for better cleaning action for the small parts.

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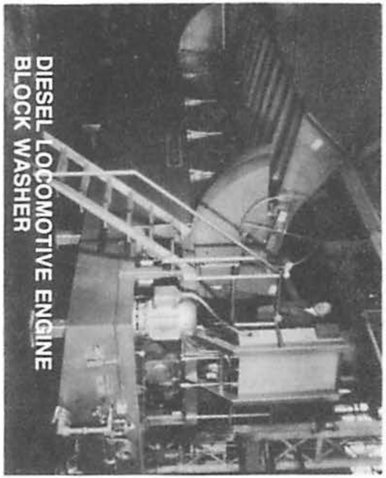


P-16 — the first operation is cleaning in one of two wheel washers. Note that a common dirt separator system serves both wheel washers. The cleaning solution is used for three months with just make up water and cleaning compounds added. Prior to installation of the fluid cleaning equipment, solution had to be changed weekly. This new wheel washer is capable of cleaning five wheel sets per hour.

P-17 — This double headed boring mill is used for machining the traction motor frames.

P-18 — Heads are machined on this tape controlled Vertical Turret unit.

P-19 — Electrical control panel inbound for rebuilding.

P-20 — Paint booth showing air motor powered man carriers. These carriers propel painters the length of the unit, raising or lowering the painters as needed to properly paint the locomotives.

P-21 — Storehouse showing stacker equipment. This equipment makes use of cubic capacity available in this former shop building.

P-22 — Storehouse material bins in this 36,000 sq. ft. area in which are stored some 18,000 spare parts. Order pickers are guided through aisles between bins by a wire in the floor eliminating necessity of person to steer.

VI
SUPPLY/SERVICE FACILITIES

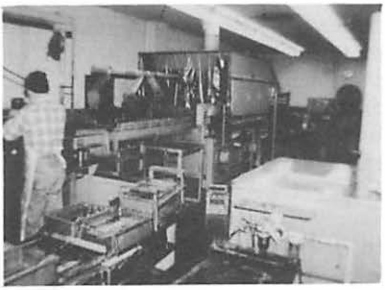
To enhance locomotive utilization, railroads are increasing their efforts to minimize downtime or turnaround time through their mechanical facilities. The efficiency of the supply/service facility can have tremendous impact on turnaround time and, therefore, the design of those facilities warrants careful consideration.

It is important to note that what is efficient in one context may not be efficient in another, i.e., a system that functions well with minimal traffic volume may become more inefficient as volume increases. Therefore, in discussing different systems for supplying and servicing locomotives, it is important to address the basic components of such systems and the factors that affect their operation.

Any supply/service facility consists of a tie-up or inbound track, a supply track, service track and make-up or outbound track. The inbound track enables the consist to enter the area for supplying and servicing locomotives. The fueling and sanding operation is conducted on the supply track, outbound consists are assembled on the outbound track or system of tracks.

The efficiency of any supply/service facility layout may be affected by the blue flag law. This law requires that the restricted area, which includes the supply, service and outbound tracks, be protected from unauthorized entries. A straight line layout may ease compliance with this law, but it may not optimize efficiency in a low-volume facility.

P-14



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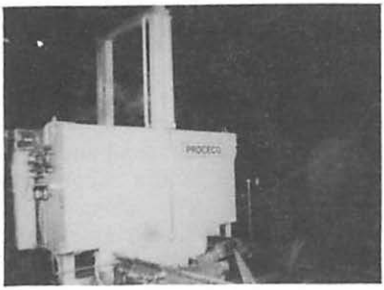

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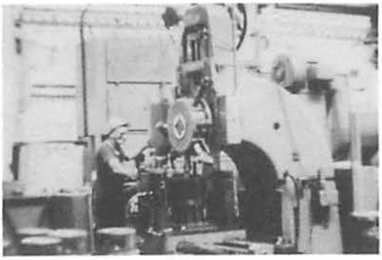

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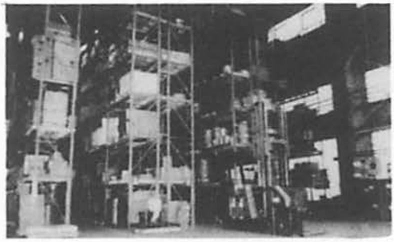

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The rate at which locomotives are fueled also affects efficiency. Variables that are independent of the supply/service facility design, such as proper maintenance of the fuel station filter system and the type of fueling adaptor used, will increase or diminish the fueling rate. However, pressure available at the nozzles is the major determinant of fueling efficiency that is affected by the supply/service facility design. A reduction of pressures from an insufficient supply system could double the fueling time when several units are fueled simultaneously.

The sanding process can also significantly lengthen the supply process, depending on the system used. Unless gravity flow systems are properly arranged, sand flow may be severely restricted. If a gantry crane is used, the hopper must be of sufficient size to reduce the number of refills required. However, the design of the supply/service facility will dictate the type of sanding system to be used.

Traffic volume is important in considering the efficiency of the facility's layout. A heavy flow of power requiring a quick turnaround time may become hopelessly bottlenecked in a compact facility. On the other hand, a straight line layout may significantly lengthen turnaround time in a facility that accommodates light to medium traffic. Such traffic would be served more effectively by a compact facility where the entire operation is within close reach.

Heavy switching requirements of a given layout may also affect the facility's efficiency. A compact layout may have a combination inbound-outbound track located adjacent to the service and supply tracks, or the service and supply tracks may be combined. In those cases, heavy switching may be required and efficiency may be reduced. However, this inefficiency may be offset by the need for a compact facility in a low traffic yard.

Missouri Pacific's Kansas City facility is an example of a compact system of inbound-outbound tracks adjacent to the supply and service tracks. The inbound consist is delivered to a single track adjacent to the outbound tracks. The consist is hostled to one of the two fuel tracks capable of fueling six units simultaneously. The consist is moved next to the gravity flow sanding system and finally to the inspection track. After being inspected, the consists are moved to the outbound tracks for make-up.

Missouri Pacific's North Little Rock facility is another example of a compact system, but one

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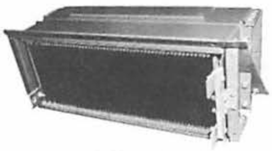

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Los Angeles, California 90009

capable of handling a higher volume of traffic with a faster turnaround time than the Kansas City facility. The inbound and outbound tracks are separate but adjacent with the supply and inspection tracks that are combined in a single location. The inbound consist is brought on one of the two service tracks where it is fueled. Sanding is performed through the use of an overhead gantry crane. The consist is inspected during the supply process, which reduces the turnaround time significantly. The consist is then assembled for outbound trains in the outbound tracks.

Union Pacific's North Platte facility has a four-track service/supply facility over 500 feet long. Sanding is performed with the use of two overhead gantry cranes, each capable of supplying two of the four tracks. The cranes have a 240 cubic foot hopper and travel at a rate of 200 feet per minute. Servicing is performed simultaneously. This system is capable of handling a high volume of traffic with fast turnaround.

The Burlington Northern's facility at Alliance, Nebraska, also uses a combination supply/inspection service track with gravity flow sanding from overhead storage tanks

VII

G. E. ASSEMBLY SHOP

Although previously covered, the subject of rebuilding G. E. cylinder assemblies merits updating in view of the newly established facility on the Santa Fe Railroad at Topeka, Kansas.

This shop is presently rebuilding five cylinder assemblies daily and is capable of producing about 12 daily if needed. The rebuild cost is approximately $750. The real advantage lies in the close working relationship with Topeka and Argentine Shops, which is the running maintenance shop for Santa Fe's G. E. locomotive fleet. Should a problem develop in a certain area, the rebuild process, seals, etc., can be changed to counteract the problem. The shop has been in production several months and though it is somewhat early the success rate looks very good at this point.

The cylinder assemblies are received on a special metal pallet or container that holds four units in an upright position. This pallet is easily moved with forklift or crane.

The assemblies are placed on individual wheeled carts, permitting easy removal of the miscellaneous small parts or "jewelry." After removal of the jewelry, the assembly is placed on a revolving rack, which rolls on a track.

The assembly first is turned to a horizontal position to allow any excess water or oil to drain out. Then it is set upright and moved under the first hydraulic press to compress the valves and release the valve keepers. The assembly is then inverted to allow a hydraulic jack, which is sunken in

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the floor, to press out the head and liner. Once they have been pressed loose, the liner is lifted out with the use of a special lifting device on a hoist. Then the head is lifted out by use of an electric magnet attached to the hoist.

The valves and miscellaneous small parts are discarded as new valves are used in the rebuild process as well as various bolts, etc. The valve springs are checked for proper length and are reused if they qualify. The reuseable parts are placed in cleaning baskets to be cleaned in the adjalift cleaning vat, which is charged with a caustic-type cleaner.

The heads are all returned to General Electric Company for remanufacturing. The jackets are first placed in a large cleaning container and run through an initial cleaning process in a large outdoor cleaning vat. They are returned to the adjalift vats and cleaned with a caustic solution, along with the liners and other small parts.

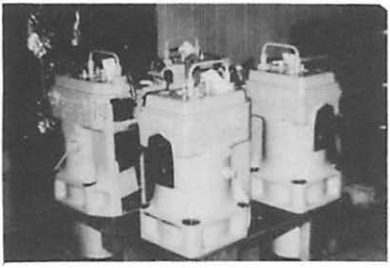
After washing in the caustic solution at a temperature of 175-185 degrees F for a period of time, they are rinsed in a vat with an antirust solution and then washed down with a high-pressure mixture of air and cleaner. The jackets then are moved down a conveyor toward the assembly area.

The liners are moved down another conveyor to a high-speed brushing machine. That machine uses rotary wire brushes to remove all excess carbon and debris from the outer perimeter of the liner.

The liners are checked to see if they qualify for reuse or must be sent in for rechroming or rehoning.

If the liner is reusable, it is placed in a lathe and the tang is recut to allow for a proper fit in the head to liner seal area. The depth of the tang is measured, as well as the inside and outside diameters. The tang machining must result in a 125 R. M. S. finish. Those areas are critical to insure proper fit at reassembly. Next, the heads are reassembled with the valve springs, etc. A lubri-plate coating is applied to the valve stems and then the new valves are placed in the remanufactured heads. The heads have been double checked for proper dimensions. The valve springs, keepers, etc., are assembled by use of this hydraulic press. The assembled heads are progressed down the conveyor toward the assembly area. Prior to assembly into the jacket the head and liner are lapped together. This is to insure a positive metal to metal finish where they come in contact at assembly. All lapping compound must be completely removed prior to assembly.

The jackets, after being cleaned in the adjalifts, are thoroughly checked, all threads are chased with taps and assembly hold-down bolt surfaces are reground to insure a good surface for proper torquing. After going through a final rust preventative solution and



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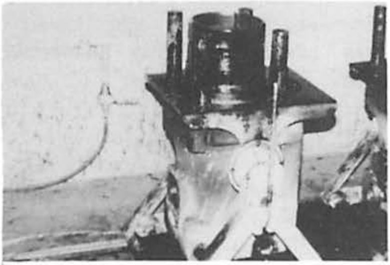

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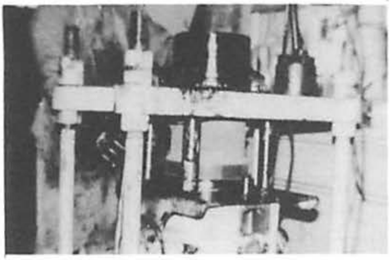

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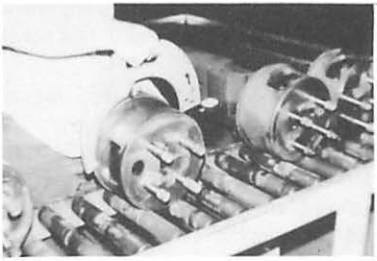

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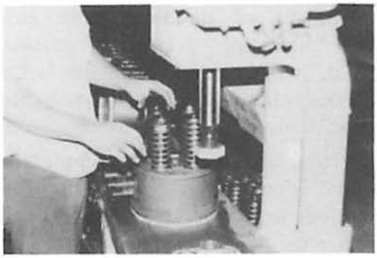

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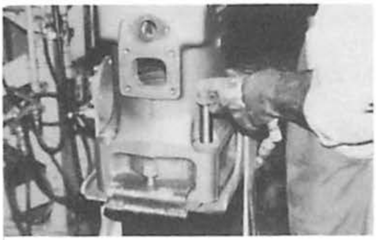

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cleaning, jackets are blown dry and prepared for the heating furnace. Before going into the furnace, the water discharge, nozzle and asbestos seals are placed in the jacket.

The jacket is heated to about 375 degrees F for at least 6 hours to allow sufficient expansion for the head and liner to be placed in it. The furnace is electrically heated and thermostatically controlled to maintain a constant temperature.

After removal of the jacket from the furnace, the head is lowered into place by use of an electro-magnet. Then the liner is lowered into place in the jacket, and the cylinder relief port is properly lined up. A clamp ring then is secured to the "hot" jacket by means of double torque gun with attached Allen wrenches, which will torque opposite bolts of the clamp ring at the same time.

After the jacket is completely cooled down the clamp ring is gauged to determine the proper "O" ring and proper number of retainer spacers. The clamp ring is removed and reapplied using the seals and spacers and new bolts, which are properly torqued.

The assemblies are moved down the conveyor to the testing area. They are water tested for 5 minutes under 35-45 pounds of air pressure. No leaks or air bubbles should be seen at all during this test.

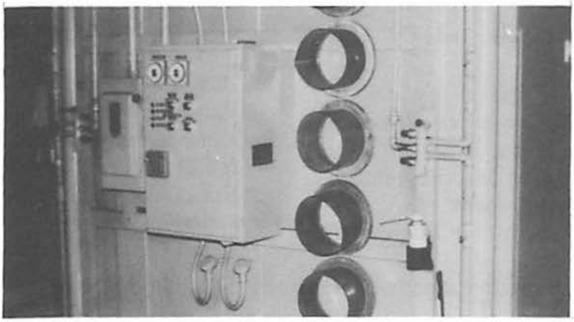
The assembly is hydraulic tested for 6 minutes at 5,000 p. s. i. and must not leak off over 500 pounds during this 6 minute test. Only a small percentage of the assemblies fail either of those tests and have to go through the assembly process again.

After passing the pressure testing, the assemblies again have the "jewelry" applied to them. All the miscellaneous parts and jewelry have been thoroughly inspected prior to reapplication. If new pieces or parts are required to replace damaged or worn parts, they are used to insure that a quality assembly is made that will be capable of producing a service life of 500,000 miles or more.

After complete assembly of all pumps, nozzles and jewelry, the assemblies are painted their original gray color. They are placed again on the shipping containers to be returned to the maintenance shop which will complete the cycle.

Record keeping is being placed in the computer system so that it will be easy to locate a particular assembly or get information concerning service life. Computers are fast becoming an invaluable tool for record keeping in the railroad industry.

This cylinder assembly rebuild shop is just another example of the railroad's ability to remanufacture various components and obtain a quality product at a very cost effective figure.



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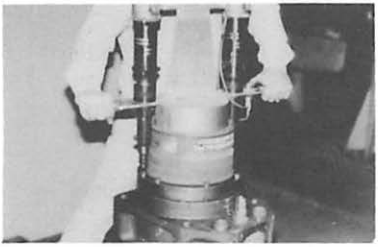

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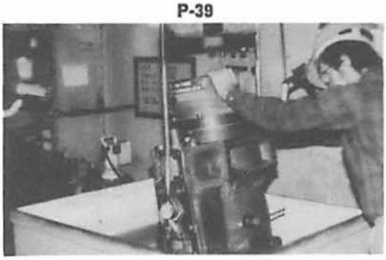

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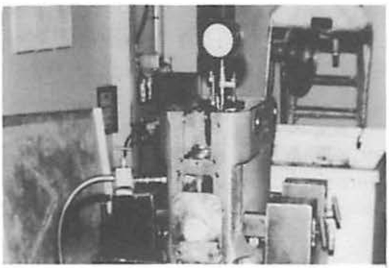

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SHOP EQUIPMENT
Five-Year Index

1980

New Tools for a New Decade

1. Traction Motor Lines
   a. Update on traction motor shop equipment
   b. Traction Motor Basics — Southern
2. Fuel Saving thru Security and Reclamation
3. Wheel Machinery, Automated for Diesel Wheels
4. Governor and Injector Room Fuel Savings
5. New Developments in Tooling
6. Locomotive Running Repair Shop
7. Sulzer Diesel Engine — New Tools

1979

It Ain't Just the Same Old Tools

1. New Facets in Locomotive Journal Box Repairs
2. Update & Revaluation of Power Assembly Repair Lines
3. New Concepts in Tools
4. Update on Wheel Truing
5. Concepts in Streamlining Ready Tracks for Locomotives
6. Update Locomotive Cleaning and Washing Equipment
7. Micro Processor — Application for Tooling (Machines)

1978

New Facets and New Concepts — Problem Solvers in Shop Equipment

1. Updating
   a. Fuel Facilities
   b. Fastner Systems
   c. Gear Grinding
   d. Rerailing Equipment for Locomotives
2. New Facets in Locomotive Painting Facilities
3. More Managed Maintenance for Machinery
4. New Concepts in Cleaning Traction Motors
5. Radio-Control Cranes
6. Tool Control

1977

A Better Way — Work Smarter Not Harder

1. Power Assembly Changeout
2. Power Wrenches in Use
3. Wheel Truing Machines
4. Metrics and the Effect on Machinery
5. More New Developments in Shop Equipment
   a. Engine Barring-Over Devices
   b. Magnetic Base Drill Press
   c. Bolt on Stub Shaft
   d. Hydraulic Draft Gear Carriage
6. Managed Maintenance for Machinery

1976

New Tools and Shop Equipment Concepts to Improve Diesel Maintenance

1. Specialty Tools for Running Maintenance
2. Guides or Gauges for Preventive Maintenance
3. Progression System for Maintenance
4. Pollution Control in Diesel Maintenance
5. Profitable Reclamation Practices

NEW WATER COOLER

MODEL 200

Holds ice in 130° F. temperature for 24 hours

Ajax Consolidated, a leader in the manufacture of electro-mechanical water coolers for the railroad industry, has developed a rugged new unit.

Tested in 130° temperatures, the Ajax 200 water cooler still had ice after 24 hours.

Developed for major railroad

The new model was developed specifically for a major railroad. Several hundred of the units have either been purchased or specified by railroads.

Ice capacity is 12 lbs. The water tank holds two quarts and the water bottle two gallons of water.

The unit has an aluminum exterior and a stainless steel interior. It is bolted to a 13 gauge steel base. It comes complete with drain and overflow. The 17" high stand is optional.

SPECIFICATIONS:

Height of cooler and stand $46\frac{7}{16}$"
Height of cooler $16\frac{1}{2}$"
Width of cooler 12"
Depth of cooler $19\frac{5}{8}$"
Height of optional stand 17"
Width of stand $12\frac{3}{4}$"
Cooler interior stainless steel
Cooler exterior aluminum
Insulation urethane foam
Water tank capacity 2 quarts
Water bottle capacity 2 gallons. (1 gallon bottle available)
Ice capacity 12 lbs.

AJAX

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4615 W. 20th St. Chicago, IL 60650 (312) 242-0940

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COMMITTEE ON DIESEL MATERIAL CONTROL

PRE-CONVENTION PRESENTATION, KANSAS CITY

GOLD BUFFET RESTAURANT APRIL 21, 1981

Railroaders and supplymen were pleased to be hosts to the Locomotive Maintenance Officers Association Committee on Diesel Material Control for their Pre-convention presentation at Kansas City on April 21, 1981.

A large turnout was had, which was made possible through the efforts of Mr. J. G. Carr, Supt. of. Shops, Santa Fe Railway, Kansas City, Kansas, and his associates.

Anyone interested in forming a diesel club in the Kansas City area and possibly the Omaha area should write to Mr. Carr expressing their comments.

Tuesday, September 29, 1981

10:30 A.M.

REPORT OF THE COMMITTEE ON DIESEL MATERIAL CONTROL

Pre-Convention Presentation: Santa Fe Railway Kansas City, MO

April 21, 1981 Gold Buffet Kansas City

D. L. WARD, Chairman
Coordinator Shop Methods
Burlington Northern, Inc.
Springfield, MO 65802

VICE CHAIRMAN

M. L. Wall, Superintendent Motive Power, Missouri Pacific, St. Louis, MO

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R. B. Hall	Mgr.-Maint. Engrg.	GE	Erie, PA
M. B. Negus	Mgr.-Loco. Matrl. Procur.	D&H	Watervliet, NY
W. R. Powell	Material Supvr.	Santa Fe	Topeka, KS
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R. M. Stobo	Mgr. Matrl. Planning	SP	San Francisco, CA
M. L. Tataroff	Elect. Engineer-Loco.	ICG	Chicago, IL
G. M. White	Reg. Sales Mgr.	Alco	N. Bergen, NJ

1981 TOPIC:

"DIESEL MATERIAL CONTROL — NEW INNOVATIONS IN MATERIAL HANDLING AND CONTROL"

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 his Bachelor of Science degree in Engineering Management from the University of Missouri-Rolla in 1969 and received a Master's Degree in Business Administration from Drury College, Springfield, Missouri, in 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. With the merger of the Frisco and the Burlington Northern Railroad, Mr. Ward became coordinator Shop Methods at the Diesel Shop in Springfield, Missouri.

In his spare time, Mr. Ward teaches night school at Drury College in Springfield.

Mr. Ward is married to the former Jean Duggan, and they have two daughters.

He has been a member of LMOA since 1972.

The LMOA Diesel Material Control Committee's 1981 paper is entitled Diesel Material Control: Innovations in Material Handling and Control. This paper is divided into the following four subtopics:

- I Disposal of unserviceable component parts: What is the most profitable method?
- II Innovations in stores material handling, via computer technology.
- III Locomotives held for material: An update for the 80's.
- IV The best approach to procuring material: New UTEX repair and return or shop repair.

Probably one of the greatest hurdles to the locomotive maintenance officer in carrying out his job effectively is not having the required material at the locomotive when it is needed. "Stock-outs" have a devastating effect on the maintenance officer's ability to plan his locomotive maintenance programs. Add to this the ever spiraling cost of repair material, and it is no wonder that today's maintenance officer is faced with a dilemma of staggering proportions. It is with this in mind that the committee, in this year's paper, will look at some innovations in material handling and control, and present to the maintenance officer what are hoped to be some new suggestions that could possibly help him to overcome his dilemma.

In Part I, the committee explores the numerous approaches to disposing of unserviceable component parts. Through a survey of numerous railroads, the committee will attempt to offer railroads suggestions that will allow them

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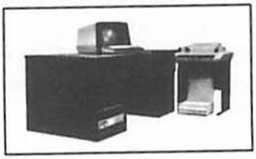

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to receive "top dollar" for those component parts which no longer qualify for use.

In Part II, the committee presents one railroad's computerized material handling system, and shows some innovations incorporated in the system, which in the long run could significantly aid the maintenance officer. Also, this computerized system represents significant cost savings for the Material Department in its material handling operations.

In Part III, the committee updates a survey which it conducted in 1977 and 1978. This is a survey of units, held out-of-service, waiting material, and covers a one month period. Through this survey the committee hopes to show the impact of not having necessary repair material on the maintenance effort, while at the same time pinpointing some specific material items that are causing the maintenance officer problems.

Finally, in Part IV, the committee looks at the many approaches to procuring material, and tries to establish a formula or decision criteria for making a decision as to the most economical method: buy new, UTEX, repair and return, or shop repair. Although every maintenance officer has a method for making such a decision, in this section the committee gives a step-by-step approach which can be used by all officers.

As in the past, the committee hopes that the matter covered in this year's paper will be of significant value to the locomotive maintenance officer in making the necessary decisions regarding material needs. The uniqueness of our committee, in that material and mechanical department people along with vendors are represented, allows all sides of significant repair material issues to be presented in a way that the committee feels will be most valuable to the maintenance officer.

I.

Disposal of Unserviceable Components: What Is The Most Profitable Method?

The disposal of unserviceable components can be profitable. Some of the metals used in components are readily recycleable and will bring a good price in the scrap market. Unsorted or mixed scrap is sold at a much lower price than many specific items. In order to realize the largest return, the more valuable items must be identified and segreated so they can be offered for sale to the highest bidder.

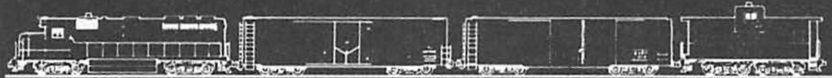
Some components can be sold to various companies who are in the remanufacturing business. The prices offered by these companies are usually much better than scrap prices. Here again, it is necessary to identify and segregate the desirable items for sale to the highest bidder.

Many railroads have developed procedures for handling and disposing of the unserviceable components for the highest prices obtainable. This committee polled

ITEM	KIND OF DEALER	EXAMPLE OF PRICE
EMD 645 E Cylinder Heads	Reconditioner	$ 50.00 Ea.
EMD 567 B Cylinder Heads	"	25.00 Ea.
EMD 8157990 & 8305512 Liners	"	50.00 Ea.
EMD 645 E 8415993 Liners	"	171.00 Ea.
8361565 Insert	"	10.00 Ea.
8068624 Bushing	"	35.00 Ea.
5227853/5228236 Plunger/Bushing	"	2.05 Ea.
Diesel Traction Motor Coils	"	97.00 CWT.
Steel Inserts from Traction Motor Coils	"	40.00 CWT.
Mixed Ferrous Scrap, Item 77	Scrap Dealer	4.16 CWT.
Diesel Engine Castings Aluminum and Steel	"	27.00 CWT.
Diesel Engine Electrical Castings — Brass	"	22.25 CWT.
Radiators	"	53.00 CWT.
Carbon Brushes	"	2.75 CWT.
Diesel Engine Parts — Red Brass	"	72.25 CWT.
Batteries	"	11.20 CWT.
Silver from Pins, Bushings and Miscellaneous	"	19.50 Troy Oz.
Diesel Engine Parts — Ins. Copper	"	48.50 CWT.
Scrap Axles, Item 3A	"	128.81 NT
Locomotive Axle Gears	"	85.00 NT
Steel Wheels, Item 42	"	114.70 NT

New Air Compressor Concepts:

- Full Flow Oil Filtration
- Positive Oil Control
- Balanced Lube Oil System



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numerous railroads in an effort to learn how disposal is being handled. This information was consolidated and we hope the following will help you to find new ways to more profitably dispose of unserviceable components.

This list includes a brief description of the item, the kind of dealer to whom sold and an example of the price received during 1980.

In conclusion, the committee suggests a critical look at scrap containers. You may be selling some valuable items for the relatively low mixed or unsorted scrap price.

II
INNOVATIONS IN STORES MATERIAL HANDLING VIA COMPUTER TECHNOLOGY

It is recognized that the purpose of the Purchasing and Materials department is the most economical and efficient procurement of material and making this material available to the various using departments of the railroad, when and where it is needed.

To keep abreast of changing economic conditions and computer technology, the railroads' Purchasing and Materials departments are constantly looking for new and better ways to perform this service.

One Midwest railroad, after much study, found that by building a central warehouse and distribution center, and through extensive use of computer technology, the desired results of more efficient material management could be achieved.

As a result, this railroad built a warehouse and distribution center consisting of a two-story office with 19,000 sq. ft., basement with 8,000 sq. ft., and a warehouse with 89,000 sq. ft.

The warehouse is divided into a receiving area which averages 300 items per day, a shipping area which ships 1,000 items per day, and a storage area capable of hold-12,000 different items.

To best utilize the storage space, material is stocked by cube size in four areas:

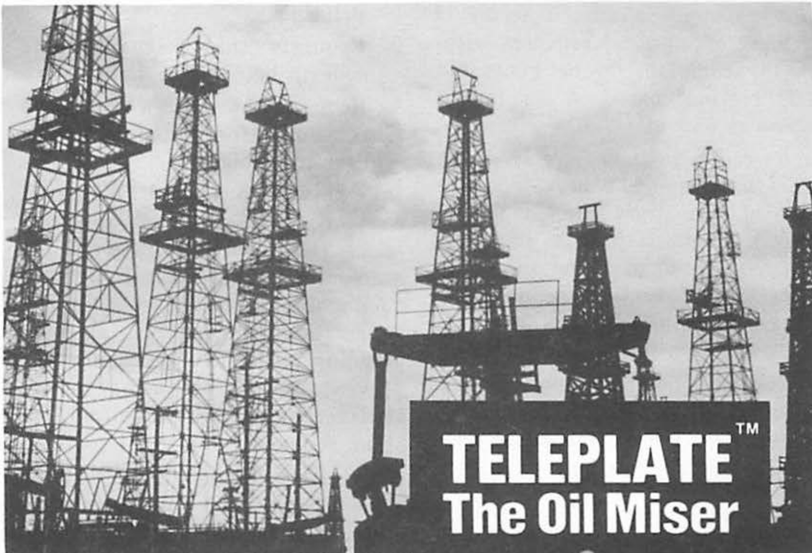
Carrousels (2 Units, 50-ft long)	5,000 Items
Shelving (5,500 sq. ft.)	4,000 Items
Pallet Racks (21,000 sq. ft.)	1,700 Items
Outside	1,300 Items

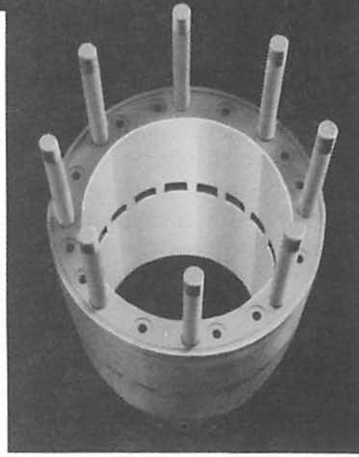
To stock these areas and pick material for shipment, two Drexel narrow-aisle fork lifts (4,000 lbs.), and five Yale order pickers (3,000 lbs.) were purchased.

This warehouse inventory is computer controlled. All material, immediately upon receipt, is implemented into the computer; and the computer controls when and how every item is to be shipped. To achieve these results, the following procedures and documents were implemented.

Material Requisitions (Exhibit "A")

Material requisitions are data entered into the computer so that they can be processed under the





Teledyne Metal Finishers has scored a major energy breakthrough. To meet the demand for a cylinder liner that can significantly reduce lube oil consumption, a new hard chrome plating process has been developed . . . Teleplate. The first major improvement in liner plating technology since Mecrome, Teleplate cuts lube oil consumption drastically. Other important advantages include faster break-in time. Engines reach peak efficiency more rapidly than ever before. Contact our nearest plant for more details on this exciting new energy-saving process! Put Teledyne liners to work in your engines now!

TELEDYNE METAL FINISHERS

Plants and Sales Office at:

1725 E. 27th St., Cleveland, OH 44114 • Ph: 216-696-0511
TWX: 810-421-8318

3125 Brinkerhoff Rd., Kansas City, KA 66115 • Ph: 913-371-8501 "pick slip" system. The "pick slip" system in simple terms is holding of material requests within the computer to be generated for "picking" based on a shipping schedule and material availability.

As requisitions are received, the item number and route code are applied. The item number identifies the specific stock item requested by the user and the route code identifies the scheduled car or truck in which the Materials Department will ship the material.

Requisitions for non-standard material and material for which there is no item number are forwarded to Purchasing.

Pick Slips — Form 1110-A Std. (Exhibit "B")

Pick slips are printed daily for those requests that require picking to be loaded the subsequent day. Picks that are made on a Monday are loaded on Tuesday, except for local delivery.

Picks are printed in store, bin location and route code sequence. This sequence reduces travel time required to make the picks in the warehouse as pickers will not travel by an item to be picked today without making the pick. When at an item, pickers will make all the picks required of the item for the day.

The computer will look at requests held for possible printing on a given day based on the following:

1. Requests flagged for priority handling regardless of the route code. Priority requests are looked at daily for possible printing.
2. Requests that have a route code to be shipped daily.
3. Requests that have a route code scheduled for shipping on the current date.

Picks will be printed as long as the "available on-hand" quantity is greater than zero. "Available on-hand" is determined by reducing the current on-hand by the "quantities required" on all outstanding picks. This procedure will prevent picks from being generated for quantities committed for other requests.

Transfer shipments to other store locations are internally generated by the computer as they reach order point. These requests have a predetermined route code assigned by the computer and are printed based on the scheduled ship day for that route. Transfer picks are printed in the same sequence as requisition picks.

There are conditions which may dictate that the Materials Department not fill the pick the day it is printed. Requests may be put back into the computer for holding until the next scheduled ship day by writing the proper code in the new shipped block. This procedure is used effectively for carload type items by letting the system accumulate requests for a given location.

Recap Report (Exhibit "C")

The first two digits of the bin location denote specific storage areas within the warehouse or

DOC CODE 1 REV. (2-79) MATERIAL REQUISITION EXHIBIT "A" ROUTE CODE: 106 4557

REQ'N. DATE August 30 1979

STORE NO. AND DATE: 8750

FOR MAT'LS. DEPT. USE ONLY

SHIP TO L. D. Bailey - District Supervisor
Mechanical Dept,

STREET ADDRESS: East 2nd Street

TOWN-STATE-ZIP Winslow, Arizona 86047

PURPOSE: Repairs to freight ~~xxxxx~~ cars
(DESCRIBE UNIT OF PROPERTY AND FUNCTION OF WORK FOR WHICH MATERIAL IS INTENDED)

MAKE SEPARATE REQUISITION FOR EACH UNIT OF PROPERTY AND EACH FUNCTION OF WORK

AREA CODE P.R.	AREA CODE LOC.	FUNCTION CODE ACCT.	FUNCTION CODE ACTIVITY	Ch.	State	AUTHORITY TYPE	AUTHORITY NO.	AUTHORITY YR.	SPECIAL DATA	TAX CODE	511 CLASS	PURCHASE ORDER NUMBER
304	0302	314	002	1	00					47		

DO NOT WRITE MORE THAN ONE ITEM TO A LINE — THIS AREA FOR MAT'LS. DEPT. USE ONLY

REQUIRED QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	S H	PROGRAM	ITEM NUMBER	ISSUED QUANTITY	U/M
2	EA	Trainline Tee, 90-deg. 1-1/4"						
6	EA	Key, Draft Key, Item No. 2044600032						
10	EA	Bracket, 96074 Pipe, Complete Item No. 2200960745						
20	EA	Coupling, Dresser 1-1/4" Item No. 4220300124						
20	EA	3/4" Flange Unions EH Dresser Item No. 2205635702						
~~2~~ 10	EA	Valve, Retaining, 3 Position 574944 Item No. 2205749449						
8	EA	Adapter, No. E-6005, 6" x 11" Item No. 1600400068						

FOLLOWING INFORMATION MUST BE SHOWN OR REQ'N. WILL BE RETURNED.
1 FULL ACCOUNTING - AREA AND FUNCTION CODES, INCLUDING STATE AND TAX CODES.
2 FULL STREET AND U.S. MAIL ADDRESSES, INCLUDING ROOM NO. AND ZIP CODE.

ITEMS NOT SHIPPED ARE BACK ORDERED AND WILL FOLLOW.

SHIPPING INFORMATION FOR BILL DESK.

NO.	CONTAINER	MATERIAL	WEIGHT

DATE REQUIRED SAP

SIGNED

APPROVED General Car Foreman TITLE

APPROVED District Supervisor TITLE

MATERIAL REQUEST EXHIBIT "B"

FORM 1110-A STD PICK SLIP

STORE	CONTROL NO.	ITEM NUMBER
8750	7908191568	4735200025

REQUISITION	
1	991631

SHIP TO SPOT

DJ MATZEKY
C/O ROBINSON
TOPEKA KS

BIN LOCATION				
AREA	AISLE	BIN	SHLF	LOC
34	00	00	00	00

AUTHORITY	
3	000192

ROUTING 030

UNIT WGHT
.8166

QUANTITY REQUIRED	U/M
1180	CFT

QUANTITY SHIPPED	
NEW	SH
DATE	COMPLETE

LOCAL DELIVERY
HAZARDOUS MATERIAL

FLAMMABLE GAS

QUANTITY RECEIVED					
NEW			'SH		
					DATE
AREA	AISLE	BIN	SHLF	LOC	
BIN LOCATION					

DESCRIPTION

GAS, ACETYLENE, WK CYLINDER.
295 CU. FT. PER CYLINDER.

CONDENSING FOR BILL DESK	
DESCRIPTION OF ARTICLES	WEIGHT

PROCESSING COPY

MATERIAL REQUEST

FORM 1110-A STD

PICK SLIP

8750	7909047091	3669700147	
STORE	CONTROL NO.	ITEM NUMBER	REQUISITION

SHIP TO

SPOT

8587 ALBUQUERQUE

BIN LOCATION				
AREA	AISLE	BIN	SHLF	LOC
03	03	18	08	01

AUTHORITY

ROUTING 185
ALBUQUERQUE

HAZARDOUS MATERIAL

UNIT WGHT	QUANTITY REQUIRED	U/M
.0100	2500	EA

QUANTITY SHIPPED	
NEW	SH
DATE	COMPLETE

QUANTITY RECEIVED					
NEW			SH		
					DATE
AREA	AISLE	BIN	SHLF	LOC	
BIN LOCATION					

DESCRIPTION

SEAL, 1/2-IN. STEELBINDER, EAR TAB STYLE,
FOR 1/2-IN. X .020 STEEL STRAPPING.

CONDENSING FOR BILL DESK

DESCRIPTION OF ARTICLES	WEIGHT

PROCESSING COPY

outside buildings. This provides the Materials department with a way to distribute the daily picks to each work area. When printing the pick slips as the Materials department starts a new storage area, a recap is printed for that area, showing the number of picks by route code. This report is helpful to the supervisor of the area in determining the picks for the day and to the storehelpers in determining the number of tubs, containers, etc. required for each destination.

Requests Not Processed Listing (Exhibit "D")

The system assumes that the pick slips printed each day will be processed back to the computer the same day.

This listing is printed daily and contains requests that have been printed but not yet processed. The purpose of the listing is to monitor the handling of requests by storage area and to insure that the computer is updated for all shipments of material.

Packing Bench Manifest (Exhibit "E")

Material is picked in bin location sequence, causing items for a given consignee to flow to the packing area throughout the picking cycle. The manifest is printed daily and groups "pick slip" data for each consignee by storage area. This gives the packing bench an opportunity to review the listing for material to be picked for each consignee. For those picks that have a truck routing, the listing can be used to determine those shipments that may be sent Parcel Post or UPS, based on the total weight of the material.

Count Document (Exhibit "F")

A basic assumption of the "pick slip" system is that the computer record of on-hand is a true representation of the physical inventory on hand. Requests for material are printed as long as there is a quantity on hand for an item. So that the system will operate as defined, an operational policy of filling all requests to the point of out-of-stock is being followed. Therefore, the system can further assume that if a request is partially filled, not checked complete, then the physical inventory is at zero. After processing a partially filled request, the system will check the computer balance on-hand and, if it is greater than zero, then there is a discrepancy between the computer and physical on-hand.

When a discrepancy of this nature occurs, the system will perform one of the following:

1. If the value of the computer on-hand is less than $10.00, an internal adjustment, reducing on-hand to zero, will be made by the system.
2. If the value is $10.00 or more, and no receipts have been processed the same day, no picks will be printed the next day, but a "count" document will be printed for physical inventory verification and possible inventory adjustment.

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

You don't have to accept an HVI oil.

MVI oils have been proven in almost half a century of operation in medium-speed diesels. Shell's MVI Caprinus* R Oil maintains that reputation of MVI oil and uses a modern additive package to meet the latest engine service requirements.

Since Shell 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.

Area Offices

Atlanta	404-955-4715
Baltimore	301-667-0410
Chicago	312-887-5500
Cleveland	216-842-4000
Detroit	313-855-9000
Houston	713-526-4631
Los Angeles (Anaheim)	714-991-9200
San Francisco (San Ramon)	415-820-7000
St. Louis	314-291-5700
Seattle	206-453-3000

Come to Shell for answers

*Caprinus is a trademark and is used as such in this writing

Stock Material Receipt — Form 1120-Std. (Exhibit "G")

This form is printed for each item on a stock purchase or shop order. It contains data required to check in material received and the bin location to properly store the material. If "as required" is printed in the bin location block the material will not be stored, as there is a Material Request document on file in the receiving office to cover the quantity received. Requests for "as required" items will be filled at the time of receipt.

Non-Stock Material Receipt — Form 1121-Std. (Exhibit "H")

This form is printed for each item on a non-stock purchase or shop order. It contains data required to check in material received and to ship the material to the individual that requisitioned the material.

The storehelper will write the quantity received, date and initials in the blocks provided, making distribution of the three-part form as follows:

Packing Slip Copy —
To be used as the shipping label or placed in the container with the material.

Bill Desk Copy —
To be used as the billing copy for other than local delivery.

Processing Copy —
To be data entered to create a receipt record for invoice matching and to charge the value of the material to the user account.

Material Request Inquiry (Exhibit "I")

A Material Request Inquiry will list, by item or requisition, requests that are open to the document masters. This listing is used to determine open stock items on a requisition or when the Materials department needs to establish priority on requests being held for an item. Transfers to other store locations will also be printed on this report.

Priority Handling

Normal procedures are for material requests to be printed based on the shipping schedule and material availabiliy. Due to emergency conditions, critical shortage of material or the increase in demand of an item, certain requests may take priority over others. In some cases, the Materials department may want to distribute the material received so that each user gets a portion of his request.

Requests may be altered as follows:

1. **Route Code —**
   The route code may be changed to any other route code. This type change will normally occur due to a rush request by the consignee and the Materials department wants to make shipment immediately, not in scheduled car or truck. The program will flag the request with priority and it will be checked daily for printing as a pick.
2. **Priority —**
   If the request is to be shipped in its normal scheduled car or truck, flagging it with priority

MATERIAL REQUEST

EXHIBIT "C"

FORM 1110–A STD

STORE	CONTROL NO.	ITEM NUMBER	REQUISITION

SHIP TO

SPOT

BIN LOCATION				
AREA	AISLE	BIN	SHLF	LOC

AUTHORITY

ROUTING

UNIT WGHT	QUANTITY REQUIRED	U/M

QUANTITY SHIPPED	
NEW	SH
DATE	COMPLETE

HAZARDOUS MATERIAL

QUANTITY RECEIVED					
NEW			SH		
					DATE
AREA	AISLE	BIN	SHLF	LOC	
BIN LOCATION					

DESCRIPTION

ROUTE	DOCS	ROUTE	DOCS	ROUTE	DOCS	ROUTE	DOCS
010 -	2	030 -	5	108 -	1	120 -	3
121 -	10	124 -	15	129 -	4	133 -	5
205 -	7	300 -	2				

AREA 01 TOTAL DOCS 54

CONDENSING FOR BILL DESK

DESCRIPTION OF ARTICLES	WEIGHT

PROCESSING COPY

EXHIBIT "D"

REQUESTS NOT PROCESSED   LOCATION 8715   09/05/79

BIN LOC	ITEM NO	CONTROL NO	REQUISITION	QUANTITY	U/M	SHIP TO	AGE
6000000000	2519000230	7906190304	1 186399	30	FT	FO COLLINS NEWTON KS	1
6000000000	6134100212	7906190321	1 186399	2	EA	FO COLLINS NEWTON KS	1
6000000000	6134100239	7906190322	1 186399	4	EA	FO COLLINS NEWTON KS	1
6000000000	6138920036	7906190324	1 186399	2	EA	FO COLLINS NEWTON KS	1
6000000000	6142000081	7906190325	1 186399	1	EA	FO COLLINS NEWTON KS	1
6000000000	6158200536	7906190329	1 186399	2	EA	FO COLLINS NEWTON KS	1
6000000000	6166200189	7906190347	1 186399	3	EA	FO COLLINS NEWTON KS	1

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EXHIBIT "E"

PACKING BENCH MANIFEST

SHIP TO	REQN	BIN LOC	ITEM	REQD	U/M	WGHT	DESCRIPTION
GW FRANKLIN NORTH BROAD STR GALESBURG, IL 61401	1 880776	0700000000	2504800167	11	EA	15	BATTERY, ELECTRIC
	1 880776	0708050301	2504800051	84	EA	153	BATTERY, NO. 6 DRY
	1 880776	0710240101	2513980011	8	EA	1	CELL, HEAVY DUTY TYPE
GW FRANKLIN NO BROAD ST GALESBURG, IL 61401	1 880779	0709260301	6107000133	100	EA	125	BLOCK, NO. 023390-
	1 880779	0710260101	3616700021	5	QT	10	CLEANER, WATERLESS
GW FRANKLIN NORTH BROAD ST GALESBURG, IL 61401	1 880780	0708170102	6186100083	8	EA	368	TRANSFORMER, NO. 9
GW FRANKLIN NORTH BROAD STREET GALESBURG, IL 61401	1 880782	0709030101	4717600040	50	LB	50	COATING, COLD ROOF
GW FRANKLIN NORTH BROAD STR GALESBURG, IL 61401	1 880791	0708100301	6146000400	4	EA	16	LAMP, NO. 11312-AX
GW FRANKLIN NORTH BROAD STREET GALESBURG, IL 61401	1 880799	0711090101	3619600010	1	EA	5	COOLER, 3-GAL. WATER
GW FRANKLIN NORTH BROAD STREET GALESBURG, IL 61401	1 880800	0709010401	4782000069	2	ROL	1	TAPE, MASKING 1-1
GW FRANKLIN NORTH BROAD STREET GALESBURG, IL 61401	1 821426	0708240101	6143400024	200	EA	150	INSULATOR, NO. CC-
GW FRANKLIN NORTH BROAD STREET GALESBURG, IL 61401	1 880781	0709010101	6107760065	24	EA	6	BOND, 33-IN. LONG,

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will cause it to be looked at daily for picking and held in an accumulation area pending the scheduled shipping day.

3. Cancel —
The Materials department has the ability to cancel a request held in the computer.
4. Part Quantity —
If only a portion of the quantity due on a request is to receive priority handling, the Materials department may specify the quantity to be handled as such. The request will be "split" into two records, one flagged with priority, and the other to be handled in the normal manner.

This procedure is useful when the quantity on hand is less than the total quantities due on the requests being held and the Materials department wants to give each request a portion of its requirements.

Job Callout —
Requisitions for program type work such as signal jobs, bridge jobs, etc. are entered in such a way that they will be held by the computer until requested to be printed. A form is submitted referencing a specific "authority" number or job which causes the picks for that job to be printed the next day. A listing may also be printed the next day for those requests not printed due to on-hand being zero. This list is used to expedite material on order and to advise the using department of those items that are shipped short.

An additional computer aid given the Purchasing and Materials department supervisors is the C.R.T. (Cathode Ray Tube) for making inquiries.

This inquiry is the ability to extract information from the files resident in the central computer complex. The purpose is to improve the overall operation of the material function on the railroad. With inquiry, a vast amount of information is at the inquirer's fingertips to help solve daily problems, enhance document turnaround, improve data integrity, and to make better decisions. The data available will be as current as the last batch processing run.

Some examples of the data items available are:

1. Quantities on hand, by location, and price for entire railroad, or for a specific location.
2. Surplus quantities on hand by location.
3. All open items on a specified requisition.
4. All open requisitions and/or transfers for the items specified.
5. All open purchasing orders for the specified item and/or location.
6. Vendors pertaining to a specific bid list number.
7. System prices, quantities on hand by location, current month receipts and issues, past 12 months by location, description, etc.

With the computer monitoring all transactions, more effective inventory management and control

MATERIAL REQUEST EXHIBIT "F"

FORM 1110-A STD

8750	08/30/79	2008501370	BUR 1
STORE	CONTROL NO.	ITEM NUMBER	REQUISITION

SHIP TO SPOT

NEW OH SH OH N-IT SH-IT ON ORD RECEIPTS

BIN LOCATION				
AREA	AISLE	BIN	SHLF	LOC
03	03	17	09	01

AUTHORITY

ROUTING

HAZARDOUS MATERIAL

UNIT WGHT

QUANTITY REQUIRED	U/M
	EA

QUANTITY SHIPPED	
NEW	SH
DATE	COMPLETE

QUANTITY RECEIVED					
NEW			SH		
					DATE
AREA	AISLE	BIN	SHLF	LOC	
BIN LOCATION					

DESCRIPTION

BRACKET, NO. E-6773, SEAL PIN, REVERSE
ENTERPRISE DWG. NO. 10887-B

CONDENSING FOR BILL DESK

DESCRIPTION OF ARTICLES	WEIGHT

PROCESSING COPY

EXHIBIT "G"

4549100061	01	50	04	02	01
ITEM NUMBER	AREA	AISLE	BIN	SHLF.	LOC.
	BIN LOCATION				

LOCK, NO. 193-C PAD, KEY
ED ALIKE TO NO. 2A97530

4549100061	01	50	04	02	01
ITEM NUMBER	AREA	AISLE	BIN	SHLF.	LOC
	BIN LOCATION				

LOCK, NO. 193-C PAD, KEY
ED ALIKE TO NO. 2A97530

STOCK MATERIAL RECEIPT

Form 1120 STD.

8750	4549100061	12	EA	07 02 79	175660
STORE	ITEM NUMBER	QUANTITY ON ORDER	U/M	ORDER DATE	ORDER NUMBER

DESCRIPTION:

LOCK, NO. 193-C PAD, KEYED ALIKE TO NO. 2A97530

QUANTITY RECEIVED		ORDER COMPLETE
		I HEREBY CERTIFY RECEIPT OF MATERIAL IN QUANTITY SHOWN
DATE		

7244770716	AS	RE	QU	IR	ED
ITEM NUMBER	AREA	AISLE	BIN	SHLF.	LOC.
	BIN LOCATION				

KIT, GASKET, NO. KIT-202

7244770716	AS	RE	QU	IR	ED
ITEM NUMBER	AREA	AISLE	BIN	SHLF.	LOC
	BIN LOCATION				

KIT, GASKET, NO. KIT-202

STOCK MATERIAL RECEIPT

Form 1120 STD

8750	7244770716	8	EA	07 16 79	271661
STORE	ITEM NUMBER	QUANTITY ON ORDER	U/M	ORDER DATE	ORDER NUMBER

DESCRIPTION

KIT, GASKET, NO. KIT-202.
FOR MODEL 51F863LYN, 6-CYL. HERMETIE
COM-862 COMPRESSOR.

QUANTITY RECEIVED	ORDER COMPLETE
	I HEREBY CERTIFY RECEIPT OF MATERIAL IN QUANTITY SHOWN:
DATE	

Form
1121 STD.

NON-STOCK MATERIAL RECEIPT

EXHIBIT "H"

SHIP TO
DO GOODWIN
DEL SPOT 8
1001 NE ATCHISON
TOPEKA KS 66616

SPOT

STORE	ORDER DATE	ORDER NUMBER
8750	07 24 79	230663

REQUISITION	
1	170046

ROUTING

ITEM NUMBER	QUANTITY ON ORDER	U/M
2306632201	12	EA

AUTHORITY	

DESCRIPTION

CUT OUT COCKS WESTINGHOUSE #96878.

HAZARDOUS MATERIAL

CONDENSING FOR OTHER THAN RAIL ROUTING

DESCRIPTION OF ARTICLES	WEIGHT

QUANTITY RECEIVED/SHIPPED	ORDER COMPLETE

I HEREBY CERTIFY RECEIPT OF MATERIAL IN QUANTITY SHOWN:

DATE

PROCESSING COPY

EXHIBIT "I"

LOCATION 8750 BUREAU 2 07/18/79

REQUESTS FOR ITEM 4554200120 NOZZLE, NO. 15-Z-19 CUTTING, NO. 8, ONE PIECE

		REQN NO	DATE	RTE	CONTROL	BRIDGE	AFE NO	ORD	DUE	PRIOR	OUT
8615 BARSTOW HUMP STORE			0717	160	7907177182			24	24		
8511 ARGENTINE			0717	300	7907177387			9	9		***
WR FLEMING C/O DIST SUPVR	SOUTH AVE AEROGLIDE EMPORIA KS 66801	1 200887	061379	135	7906170268			12	12		
PW MCCLUER ATSF RY CO WAY YDS	3231 E AVE C HUTCHINSON KS	1 332411	052479	130	7905290021			8	4		
PL BARNES 1ST & COLORADO	LA JUNTA CO 81050	1 637101	1212	114	7812140279			2	2		
WR FLEMING C/O DIST SUPVR	SOUTH AVE & AEROGLIDE EMPORIA KS 66801	1 852461	042779	135	7905010297			12	12		

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result from availability of current and timely information. Purchasing procedures will be enhanced through maintenance of a purchasing data base, eliminating repetitive efforts in preparation of purchase orders. The computer will generate and submit orders to the vendors automatically and result in earlier delivery of the material, which enables the Purchasing and Materials department to achieve the goal of more efficient service to the using departments.

III.
LOCOMOTIVES HELD FOR MATERIAL:
AN UPDATE FOR THE 80'S

The original intent of this section of the committee's 1981 paper was to conduct a survey of units held out of service awaiting material for a one month period, and then compare this survey to similar ones which the committee conducted in 1977 and 1978. However, due to the overwhelming response of this year's survey (sixteen railroads responded), the committee is unable to make a valid comparison because of such a large discrepancy in sample size over the 1977 survey, in which six railroads responded, and the 1978 survey, in which seven railroads responded. Therefore, it has become necessary to allow this year's survey to stand on its own. The committee would like to express its thanks to all those railroads who responded to this year's survey. It is through such cooperation that the LMOA remains a strong and viable organization.

This year's survey was conducted during the month of December, 1980. As a part of the survey, the committee asked responding railroads to report those locomotives held out of service awaiting material each day, and to list the specific material item or items each unit was awaiting. In order to achieve consistency, each responding railroad was asked to use the following definition for determining whether or not a locomotive was being held out of service, awaiting material:

> "A locomotive is out of service awaiting material when all other work on the locomotive is completed, and no further work can proceed until a required piece of material becomes available."

The committee also asked respondents to indicate on each unit held, what type of locomotive it was by manufacturer, whether the malfunction was electrical or mechanical, the reason the locomotive was shopped, whether the item needed was a stock or non-stock item, the material source, the responsibility for the out-of-stock condition, and any other contributing factors for the required part being out-of-stock.

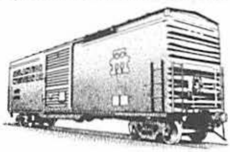
As can be seen in Exhibit J, for the month of December, 1980, a total of 1952 locomotives were held out of service awaiting material on the sixteen responding railroads. Of that 1,952 locomotives, 51 or 2.6% were Alco locomotives,

We Meet Our Commitments.

We never let a customer down.

Southeastern Specialties is a unique railroad car service organization with capabilities to do much more than rebuild and repair cars.

Our facility comprises 65 acres of shops and specialized work stations



A high-demand XL boxcar converted from obsolete RB.

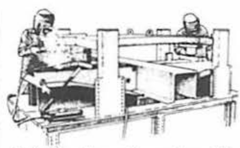
requiring 10 miles of track with a 300 car capacity. We are equipped and experienced for repairing, rebuilding, modification, FRA inspections, painting, and lining. Construction of prototype cars is one of our specialties. We can handle all kinds of service including the converting of obsolete cars to modern efficient high-demand designs. We are leaders in the industry for building energy-saving locomotive booster units (commonly called "slugs").

Installing EOCC unit utilizing pit and lift table method.

Our business is owned and operated by the original founders who are personally involved in meeting both quality and production commitments.

State of the art booster unit, constructed on recycled locomotive underframes.

This management team received its training on one of our country's most progressive railroads from specialists who were noted for excellence in the business. Since 1967 the firm has enjoyed steady growth every year based on solid customer satisfaction,



Fabrication of center sill and bolster complete with EOCC unit for application to rebuilt car.

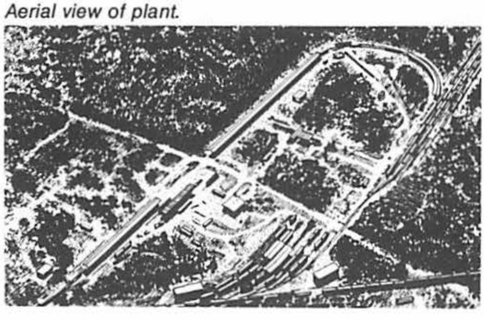
high ethical standards and subscribing to AAR approved specifications. We are members of Southern Southwestern

Prototype single trailer flatcar capable of handling trailer of any length or configuration.

Railway Club, Chicago Railway Diesel Club, Railway Supply Association, and charter members of Rail Car Repair Association.

We welcome any opportunity to quote modifications, upgrading, programmed maintenance or special custom designed work.

Aerial view of plant.



Southeastern Specialties, Inc.

7305 Kings Road
Jacksonville, FL 32219
(904) 786-1700

EXHIBIT "J"

RESULTS OF
LMOA COMMITTEE SURVEY
OF UNITS HELD FOR MATERIAL

DECEMBER 1980

BUILDER TYPE	UNITS	PERCENT
ALCO	51	2.6
GE	303	15.5
EMD	1,598	81.9
	1,952	100.0
CAUSE OF MALFUNCTION		
MECHANICAL	1,320	67.6
ELECTRICAL	632	32.4
	1,952	100.0
REASON FOR SHOPPING		
SCHEDULED	265	13.6
UNSCHEDULED	1,619	82.9
WRECK DAMAGE	62	3.2
MODIFICATION	6	0.3
	1,952	100.0
INVENTORY		
STOCK ITEM	1,330	68.1
NON-STOCK ITEM	622	31.9
	1,952	100.0
MATERIAL SOURCE		
PURCHASE	664	36.1
VENDOR UTEX	162	8.8
VENDOR R&R	103	5.6
SHOP R&R	910	49.5
	1,839	100.0
RESPONSIBILITY		
LOCAL STORE	1,383	71.0
DISTRICT STORE	303	15.6
MECHANICAL DEPARTMENT	262	13.4
	1,948	100.0
CONTRIBUTING FACTORS		
UNUSUAL DEMAND	771	42.4
SEASONAL FLUCTUATION	49	2.7
POOR PROJECTION	483	26.5
BUDGETARY REASONS	23	1.3
LIMITED SUPPLIES	343	18.8
LAXITY OF INSPECTIONS	1	0.1
ORDER DELAYED	37	2.0
SHIPMENT DELAYED	112	6.1
MECH. DEPT. PLAYING STOREKEEPER	1	0.1
	1,820	100.0

303 or 51.5% were GE locomotives, and 1,598 or 81.9% were EMD locomotives. Also, of those 1,952 locomotives held, 1,320 or 67.6% were shown out of service because the malfunction was mechanical in nature, and 632 or 32.4% were shown out of service because the malfunction was electrical in nature. With regard to the reason for shopping the locomotives, 265 or 13.0% of those locomotives shopped, were done so on a scheduled basis, 1,619 or 82.9% were unscheduled, 62 or 3.2% were for wreck repair, and 6 or 0.3% of the locomotives were for modifications. Finally, the remainder of Exhibit J shows whether the needed items were stock or non-stock items, with the majority being stock items, the source of those needed items, who is responsible for the stock-out, and finally any contributing factors which might also be responsible for the stock-out situation.

Exhibit K shows a graphic representation of the data contained in Exhibit J.

It is worth noting that if material department personnel were completing this survey, the results in both the area of responsibility for a stock-out situation, and those contributing factors to the stock-out situation, might have been considerably different. In other words, it's quite easy to blame the other guy for a situation which possibly could have been avoided.

Of all the data presented in Exhibit J, several items are quite significant and could possibly warrant further study by the railroads.

1. The majority of the malfunctions, in fact twice as many malfunctions, on the railroads responding were mechanical in nature.
2. Almost 83% of all the locomotives held for material was a result of unscheduled maintenance inspections.
3. Surprisingly, 71% of the material items involved were items normally stocked at the local store.
4. The material required was not only a stock item, but the majority of the items were repaired or rehabilitated by the railroad.

Exhibit L is a graph showing the ratio of units held for material versus total diesel power for each railroad which responded to the committee's one month survey. This graph was done in order to show the representative impact that being out of service awaiting material has on each railroad's availability picture. Interestingly, of the sixteen railroads which responded to the survey, fifteen of the railroads' units out of service awaiting material represent less than one percent for the month of December, 1980. Only one railroad (not shown on the graph), had more than one percent of its fleet out of service awaiting material and that railroad had 3.23% for December.

EXHIBIT "K"—Page 1

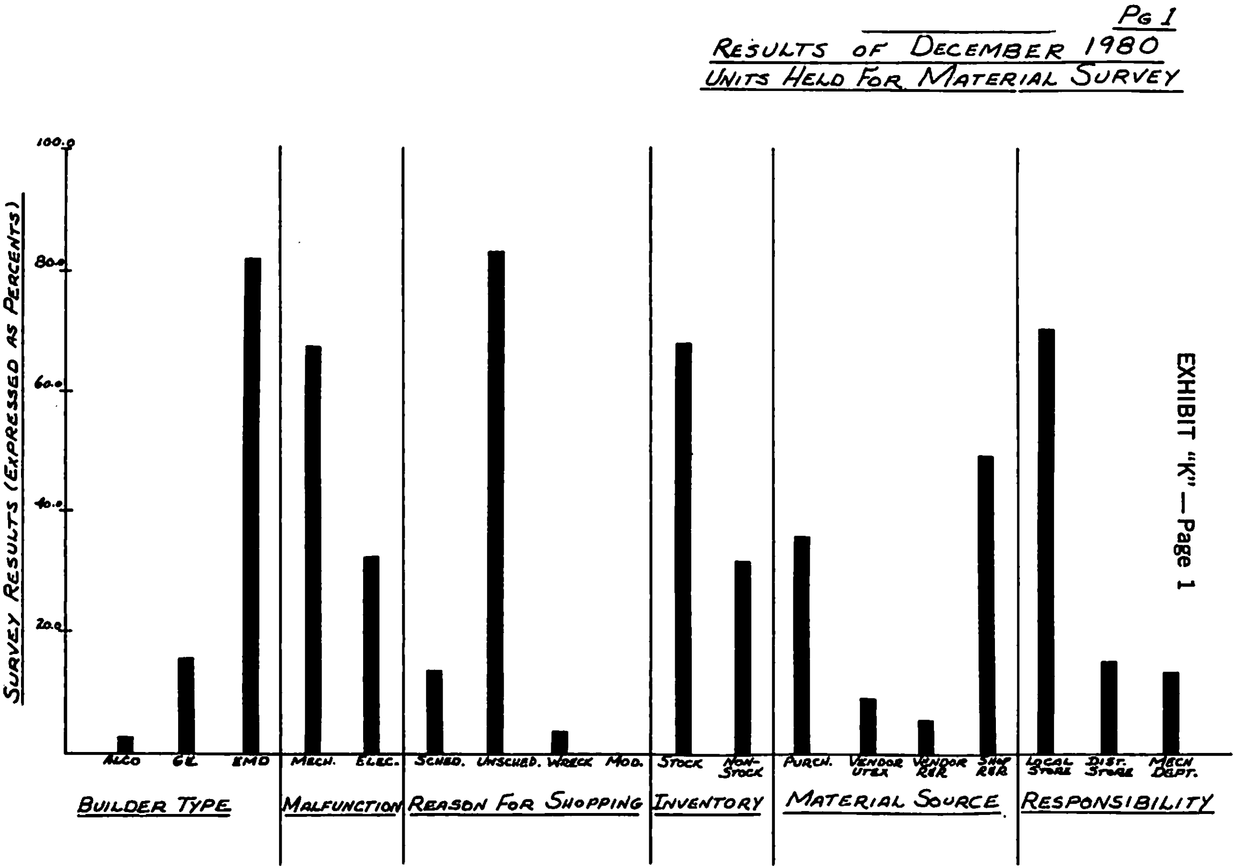


EXHIBIT "K" — Page 2

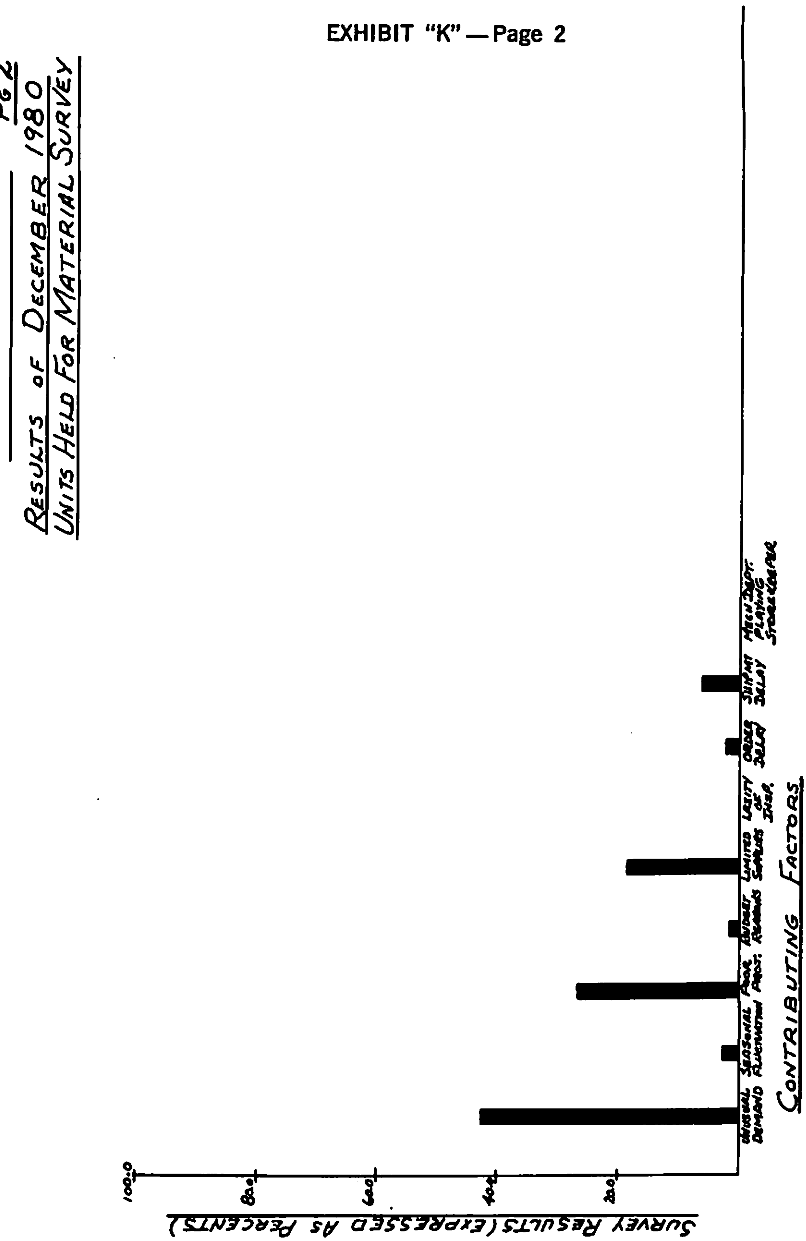


EXHIBIT "L"

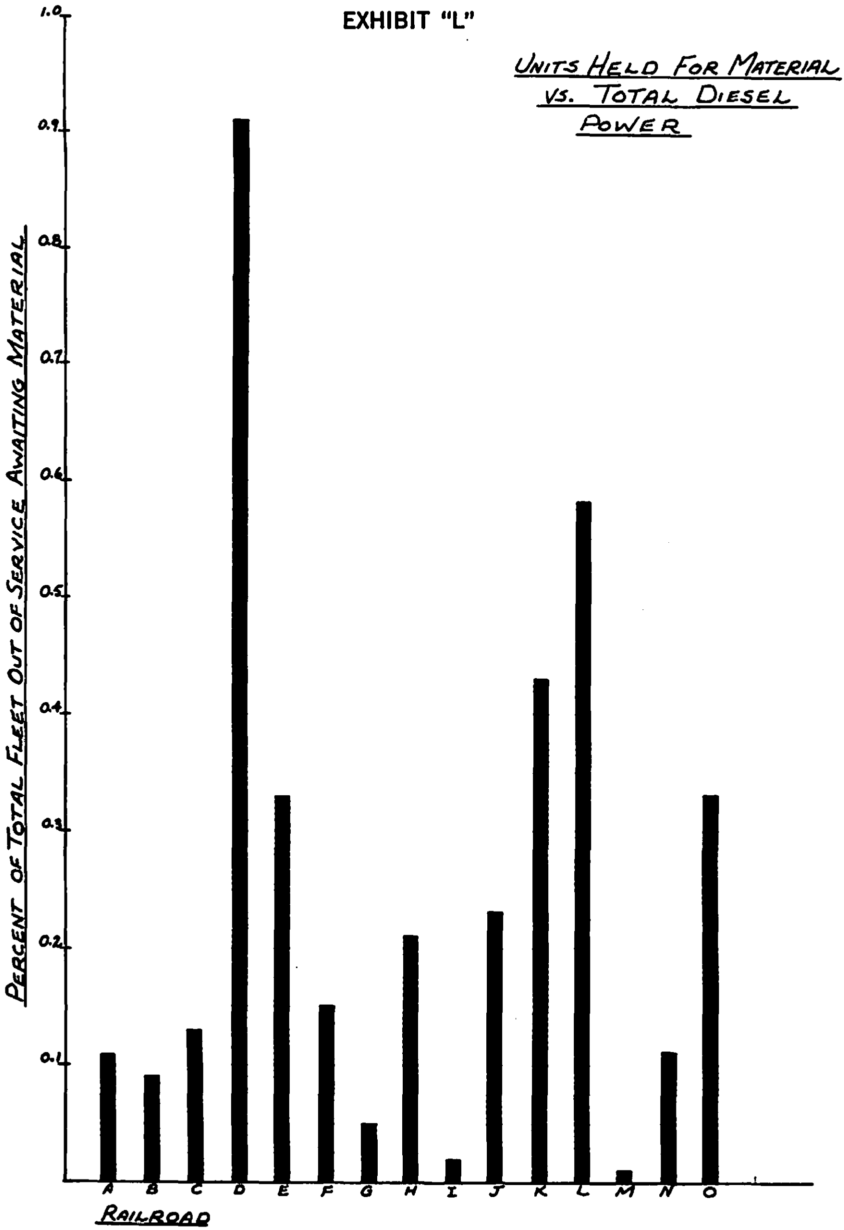

UNITS HELD FOR MATERIAL VS. TOTAL DIESEL POWER
PERCENT OF TOTAL FLEET OUT OF SERVICE AWAITING MATERIAL
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
A B C D E F G H I J K L M N O
RAILROAD

EXHIBIT "M"—Page 1

SELECTED MATERIAL ITEMS
LMOA COMMITTEE SURVEY
OF UNITS HELD FOR MATERIAL
DECEMBER 1980

DESCRIPTION	QUANTITIES REPORTED
AIR BRAKE MATERIAL	70
AIR COMPRESSOR COMPONENTS	22
AIR COMPRESSOR - COMPLETE	38
ELECTRICAL	
AUXILIARY GENERATORS	67
MAIN GENERATORS	28
STARTING MOTORS	21
CAB HEATER MOTOR	1
CONTACTORS	53
RESISTORS	16
FUEL PUMP MOTORS	4
COOLING FANS	17
RECTIFIER PANELS	15
EXCITATION PANEL	1
RELAYS	19
MODULES	22
ELECTRICAL WIRING	11
ALTERNATORS	52
SWITCHES	24
VOLTAGE REGULATORS	8
BRUSH HOLDERS	5
RECTIFIERS	1
DYNAMIC BRAKE GRIDS	21
LOAD AMMETER	6
LOAD REGULATOR	26
W/S PANEL	20
TRANSITION PANEL	8
EXCITER GENERATOR	4
BLOWER MOTOR	6
CONTROLLER	9
T. M. BLOWER ASSY.	44
REVERSER	6
DYNAMIC BRAKE BLOWER MOTOR	3
MECHANICAL	
FAN DRIVES	2
MANIFOLDS	4
ENGINE BLOWERS	12
ENGINE GOVERNORS	72

EXHIBIT "M"—Page 2

SELECTED MATERIAL ITEMS
LMOA COMMITTEE SURVEY
OF UNITS HELD FOR MATERIAL
DECEMBER 1980

- PAGE 2

DESCRIPTION	QUANTITIES REPORTED
MECHANICAL (CONT'D)	
WATER PUMPS	33
ENGINES - COMPLETE	67
INJECTORS	15
POWER ASSEMBLIES	45
LINERS & PISTONS	8
CYLINDER HEADS	12
LUBE OIL PUMPS	1
MAIN BEARINGS	1
FILTERS	3
GOVERNOR DRIVES	1
CRANKCASE PRESSURE SWITCH	4
CAMSHAFT SECTION	6
FUEL INJECTION PUMP	6
IDLER DRIVE GEAR	14
COUPLINGS	26
GASKETS & GASKET KITS	31
VALVE BRIDGE	2
BEARINGS	18
"P" PIPES	14
CARRIERS	4
STUBSHAFT	12
DAMPER ASSEMBLY	8
CONNECTING RODS	7
GEAR TRAIN	4
RADIATORS	76
RADIATOR GASKETS	6
RADIATOR HEADERS	4
OIL COOLERS	53
OIL COOLER CORES	1
CAB HEATER CORES	52
AFTERCOOLERS	4
TURBOCHARGERS	52
CRAB STUDS	9
TRACTION MOTORS	
TRACTION MOTORS	23
TRACTION MOTOR SUPPORT BEARINGS	1
PINION GEARS	23
TRACTION MOTOR LUGS	3
TRACTION MOTOR BRUSHES	3
GEAR CASES	5
TRACTION MOTOR AIR DUCTS	13
TRACTION MOTOR WICKS	6

EXHIBIT "M"—Page 3

SELECTED MATERIAL ITEMS
LMOA COMMITTEE SURVEY
OF UNITS HELD FOR MATERIAL
DECEMBER 1980 - PAGE 3

DESCRIPTION	QUANTITIES REPORTED
TRUCKS	
TRUCKS	5
BOLSTERS	1
BRAKE CYLINDERS	24
JOURNAL BOXES	1
COIL SPRINGS	23
WHEELS	52
BRAKE HANGERS	4
LEAF SPRINGS	1
PEDESTAL LINERS	4
BRAKE RIGGING	3
CENTER CASTING LINERS	3
SHOCK ABSORBER KITS	8
SPRING SEATS	10
MISCELLANEOUS	
HANDRAILS	3
STEP TREADS	9
DOORS	2
TOILETS	5
COUPLERS	25
COUPLER CARRIER	4
COUPLER CARRIER SPRING	5
DRAFT GEAR & YOKES	32
PILOT PLATES	2
FUEL TANKS	2
AXLE DRIVES	3
HAND BRAKES	13
FUEL OIL PREHEATERS	2
CAB GLASS	9
WATER COOLERS	2
SPEED RECORDERS	3
CROSSING BELL	1

Finally, Exhibit M is a listing of selected material items which were reported in this year's survey. Along with the listing of material items is the number of locomotives which were held out of service awaiting each of the items. This listing is by no means complete and merely reflects either the more commonly used material items or those items which had significantly enough reports to merit their listing.

In general, the major conclusion which can be drawn from this year's survey is that the primary reason locomotives are held out of service awaiting material is the railroads' inability to plan material requirements for unscheduled failures. This was the same conclusion that was drawn in the committee's previous two surveys of this type. For every railroad which responded, the majority of units that were out of service were for unscheduled repairs.

How do railroads solve this problem? Logic tells each of us that it is economically not feasible for railroads to stock every repair item and in sufficient quantities to cover all unscheduled locomotive failure. With the tremendous dollar investment required to stock locomotive repair material today, the only alternative is for railroads to develop planning systems which will more effectively forecast unscheduled locomotive failures and thus material needs.

In past years, this committee has presented various material planning systems that will better aid the maintenance officer in planning his material needs and, in turn, better cope with unscheduled failures. This year's survey seems to suggest that the maintenance officer should look at, and consider using some of these planning systems, in order to more effectively plan for his material needs, and thus keep the number of locomotive units held out of service awaiting material to a minimum.

IV.

ACQUIRING REPAIR MATERIAL — A CRUCIAL DECISION

Well over fifty different models of locomotives are operating on American railroads today. Each model has many hundreds of unique components and sub-components which range from small bolts to diesel engine crankcases. When a new locomotive rolls off the assembly line, it is easy to forget the many years of maintenance which lie ahead. As maintenance officers, we cannot afford to forget.

One of the major policy decisions which must be made by a railroad is determining the best method of obtaining replacement material. Although the diesel engine crankcase is, in most cases, thoroughly analyzed, what about the bolts and the numerous other smaller components? Although a bolt may be an exaggeration of the practical level of concern, many once expendable items have become worthy of attention.

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Repair and Return, Unit Exchange or Outright Sale of all products.

What are the available choices in acquiring replacement material? The following is a list of common alternatives:

1. Shop repair by the railroad.
2. Repair and return with the vendor.
3. Trade or purchase second hand.
4. Unit exchange.
5. Purchase new from the OEM or other vendor.

When you analyze the choices and the many different components, the decision process certainly becomes more difficult. The responsibility for making the correct decision cannot be taken lightly.

The Committee recently surveyed various railroads requesting the factors they consider in making their decision. Some of the responses were:

—Availability of material
—Cost—including the cost ratio between alternatives
—Quality/reliability of the component
—Facilities available
—Tools and machinery available
—Manpower—availability and training requirements
—Labor agreements.

No attempt is made to list these factors in priority order or to claim that these are the only factors involved. In reality, different components which are being considered may require different priorities. With the possible exception of labor agreement restrictions, there is a common denominator for all the listed factors — they all affect maintenance expense either through the component cost, capital investment, or locomotive availability.

As the problem is more deeply analyzed, the solution becomes more complex. It is with this in mind that the Committee offers the logic chart shown in Exhibit N.

Although any of the alternatives may be explored first, it is most common for a railroad to begin with its own repair capability.

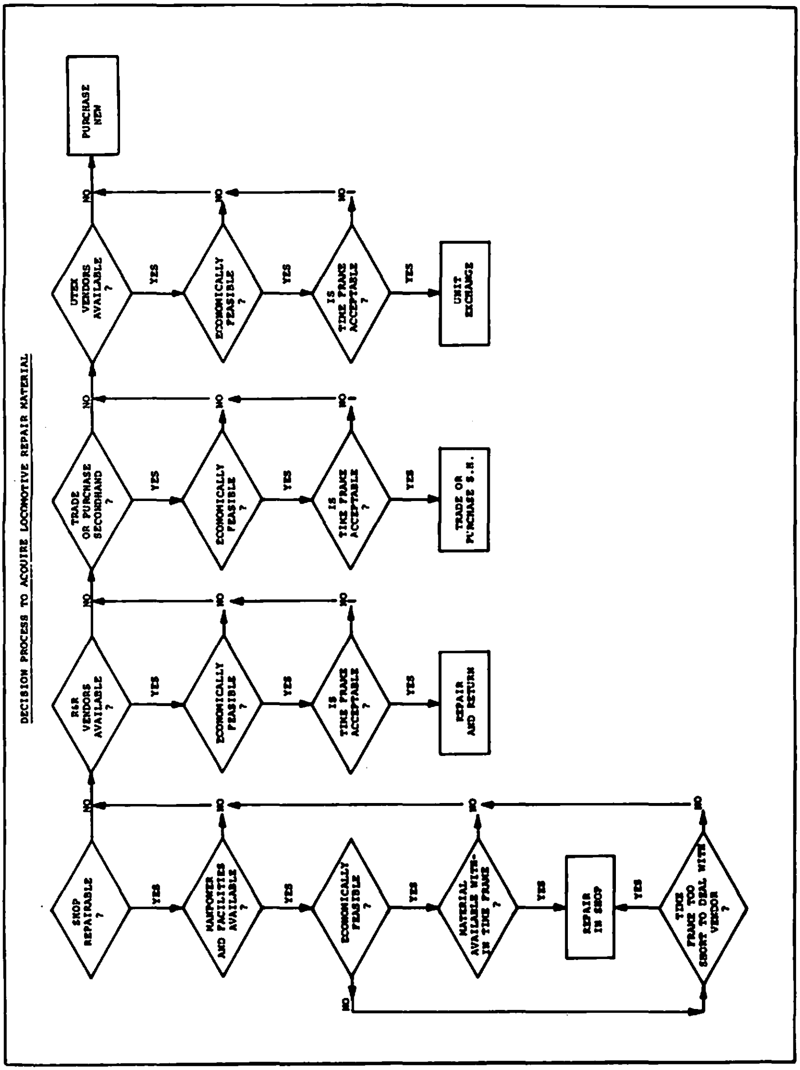
Shop Repair

The obvious first question is whether or not the component can be repaired.

If the answer is yes, the next step is to determine available manpower and facilities. In some cases, the additional work load can be absorbed by existing forces without affecting quality. More often, the decision must be made either to divert manpower from other duties or to hire new employees to perform the additional component repair. The learning curve associated with training new employees must be considered. Also, if employees must be diverted from other duties, is the repair of the item more important than the original work they were performing? If the component repair does not require full-time manpower assignment, what other duties can he perform and what time is lost in moving from one job to another?

Facilities include more than just having a shop or a space in a shop to accomplish the work. Changes

EXHIBIT "N"


DECISION PROCESS TO ACQUIRE LOCOMOTIVE REPAIR MATERIAL
SHOP REPAIRABLE ?
MANPOWER AND FACILITIES AVAILABLE ?
ECONOMICALLY FEASIBLE ?
MATERIAL AVAILABLE WITH-IN TIME FRAME ?
REPAIR IN SHOP
TIME FRAME TOO SHORT TO DEAL WITH VENDOR ?
R&R VENDORS AVAILABLE ?
ECONOMICALLY FEASIBLE ?
IS TIME FRAME ACCEPTABLE ?
REPAIR AND RETURN
TRADE OR PURCHASE SECONDHAND ?
ECONOMICALLY FEASIBLE ?
IS TIME FRAME ACCEPTABLE ?
TRADE OR PURCHASE S.H.
UTEX VENDORS AVAILABLE ?
ECONOMICALLY FEASIBLE ?
IS TIME FRAME ACCEPTABLE ?
UNIT EXCHANGE
PURCHASE NEW
YES
NO

in a shop layout and production flow must be explored to determine impact on other operations. What machinery must be purchased to accomplish the repairs? If existing machinery can be utilized, must it be shared with another operation? Can the two operations co-exist with one machine without reducing productivity and efficiency? If the component is not being presently repaired, what test machinery is required to qualify the component?

Manpower and facilities are the practical aspects of the shop repair consideration which strongly influence the economic feasibility. The labor cost to repair any component depends on the man hours required. If the component has not previously been repaired in the shop, it is based solely on estimated repair man hours which becomes more difficult. It is important to establish a time standard and then verify later that the standard is being achieved. If your shop has productivity levels established for similar type repairs, this percentage must be applied to the actual time required to repair the component. In making a realistic labor cost estimate which will ultimately be compared with other alternatives, not only direct labor, but all appropriate fringe benefits must be applied to the labor cost.

The facility cost also contains many factors which must be considered. If an existing facility is used, a proportion of the shop overhead expense should be applied to this repair operation. If a new facility must be provided, the cost of the facility must be amortized in the economic analysis. This is also required for any machinery purchased for the repair or testing of the component.

Transportation and store expenses must be included in the economic feasibility study also. To the best of the railroad's ability, the true cost of gathering repairable material, transporting to the repair location, and returning to the using shop must be included. If store expense is involved, it is normally a percentage of the component cost.

Although it is a cost which is not easily quantified, any difference between a shop repaired component failure rate and an alternative method failure rate should be considered. The use of new or qualified parts in the repair operation may account for some differences in service life. This is also where the value of warranty is factored into the equation.

After totaling all the individual costs, the economic comparison can be made. Obviously, if the shop repair cost exceeds the alternative costs, the decision will not be made to shop repair the component. But if the cost is 99% of the alternative, what then? Again, our survey indicated that 50% - 75% of new cost is a common guideline used, but it is also important to establish percentages

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for unit exchange and repair and return alternatives.

Even after justifying the economic feasibility, several other questions must be answered. Can the material be made available within the required time frame? Time must be allowed to set up the repair operation and must include lead times on material, machinery and facility construction. Also the training of personnel should be considered. It will defer full productive output.

If the answers to all the above questions are "yes," then the obvious decision is to shop repair the component. There is, however, one exception to this statement. If the need for the material is critical and the alternate methods cannot supply the need, it may be necessary to shop repair the component which cannot otherwise be justified.

Repair and Return

Repair and return of a component is another alternative which should be investigated. The obvious first question is whether or not repair and return vendors are available.

The next step in the logic sequence is to determine economic feasibility. The cost of the component may vary depending on the repairs required or the degree of upgrading you stipulate. The advantage is that you can specifiy or limit the amount of work performed by the vander. A cost which must be taken into account is the size of the component pool which is required to support this alternative. A larger inventory is required to compensate for the transportation and repair time involved. Again, transportation and store expenses must be applied to the repair and return cost to make an accurate comparison. Transportation must include the expense to ship to the using point if this method is used for other alternatives.

A positive response to the above consideration next leads to the time frame involved. As mentioned, normally the turnaround time is slower since the specific item must be transported to the vendor, repaired and returned. If local repair and return vendors are used, this problem is minimized. In any case, increasing the pool will offset the disadvantage.

Trade or Purchase Secondhand

This is an alternative which is not widely used but should not be overlooked. The most difficult problem is to keep abreast of material which is available and to determine if it is suitable for your needs.

The economic feasibility of this method is more difficult to ascertain. The cost of secondhand components fluctuates depending on the market. Also the availability of needed components is uncertain. Transportation and store expense must be considered. One peculiar expense in puchasing or trading for secondhand material is that the components should be

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inspected and qualified by the railroad before acquiring. Another important consideration is whether or not you want to use secondhand material in a locomotive. The accumulated mileage on the component will reduce service life and possibly detract from the economic benefits. If the secondhand component must be repaired or rebuilt, then these costs become a factor.

The question of an acceptable time frame is difficult to predict or generalize. Availability is solely dependent on the market source.

It is hard to conceive of this method as a viable alternative to obtain locomotive repair material which is used on a continuous basis. It can be beneficial to supplement material pools or to obtain material which can no longer be purchased. It may also offer an attractive means to dispose of material which is no longer needed and can be traded at a value higher than scrap value.

Unit Exchange

Again, the first question to ask is whether or not unit exchange vendors are available.

The economic feasibility decision is similar to that of repair and return components. The unit exchange cost is normally fixed, based on an average cost to repair the component. Usually upgrading to latest standards is included and a value should be applied to the resultant benefits. Transportation to the using point and store expense should be calculated for the comparison. Leadtime is not as critical since a pool of unit exchange components is available.

The time frame is normally more stable due to the unit exchange pool. There is often a penalty for failure to return unit exchange components within a predetermined time which may result in payment of new component cost. If items are not returned, it can also deplete the unit exchange pool which can result in lack of availability.

Purchase New

The final alternative to be explored, although it could be the first, is the purchase of new components. This includes purchases from both the OEM as well as from other vendors.

The cost of a new component is normally known which makes the comparison simpler. With all new components, service life is expected to be maximized although infant mortality is a factor in some components. In most cases, this is the most expensive of the alternatives. Offsetting the premium cost are warranty, reliability and service life. Transportation and store expense are costs which must be added for the comparison.

The time frame for delivery can be predicted, although we have all had some difficulty in acquiring new material in the past.

Conclusion

The above five methods are the common alternatives which are available to acquire locomotive re-

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pair material. Other variations may exist but these are the ones in common use.

Ideally, specific percentages and factors would be supplied to allow a clear determination of the best method to use. It is difficult enough to apply these factors to one railroad without adopting "standards" for the industry. As illustrated earlier, there is a wide variance in the percent of new cost which makes repair attractive. This decision cannot be reduced to an equation which eliminates all other tangible and intangible considerations.

The purpose of this Committee report is to present an approach which logically analyzes as many variables as possible. If it is not already apparent, the logic chart does lend itself to programming for computer analysis. Actual labor, material, facility and transportation costs would have to be input for the different alternatives. Other factors such as percent of new cost, percent of unit exchange cost, relative service life and warranty influence could be input as constants. This would allow the computer to rank the alternatives in order of preference. It is emphasized that this does not replace a "common sense" review before the decision is made, but it would eliminate arbitrary weighting factors.

This Committee is not aware of any railroad which uses computer analysis, but it is offered as an alternative to manual calculations. It must be remembered that the initial decision to repair or purchase is not the only time this process must be used. Each component must be reviewed periodically to determine if the original method is still cost effective or if an alternative method should be used. At least one railroad has a review committee consisting of mechanical and material members, which analyzes all shop repaired components annually.

DIESEL MATERIAL CONTROL
Five-Year Index

1980

Locomotive Material Management: What Lies Ahead in the 80's?

1. Robbing Material — Its Consequences to the Railroad
2. Cyclical and Seasonal Demand for Material — Some Counteractive Methods
3. Improved Mechanical Department and Material Department Communications — One Step to More Efficient Locomotive Maintenance
4. Uses and Service Life of Reclaimed Power Assembly Components

1979

Material Management: Dollars Saved Through Efficiency"

1. Investment and Cost of Carrying Inventory — 1979 (A Comparison with the Committee's 1973 Study)
2. Dollars Saved Through Advanced Inventory Control

Systems, Via Increased Availaility

1978

Problem Solving Through Analysis and Projection

1. Warranty Labels and Their Use
2. Economics of Rebuilt Components
3. What Have We Learned From the 1975 Material Crisis?
4. Locomotives Held for Material
5. Computerized Information Systems

1977

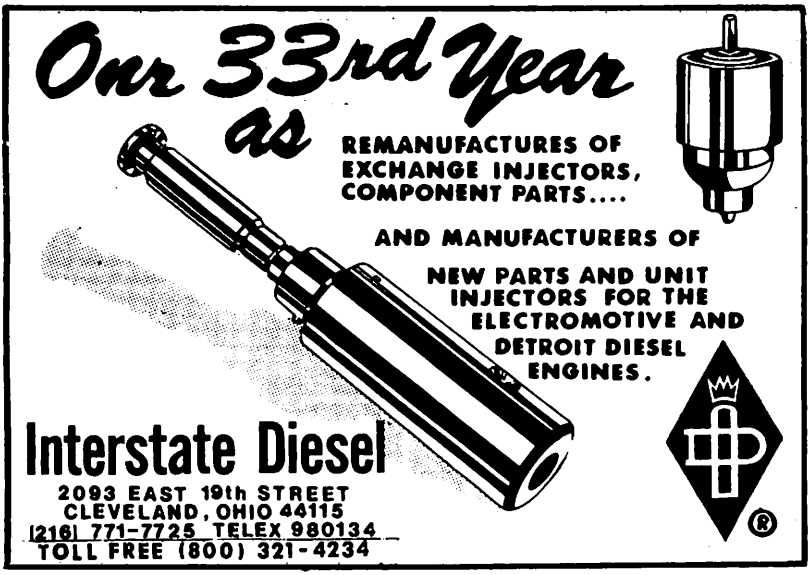
Production Stops — Causes and Cures

1. Units Held for Material
   a. Causes: Mechanical? Stores? Etc.?
   b. Methods for Correction: Scheduling? Computer? Etc.?
2. Changing Warranty Procedures
3. Progress Made in Using Pressure Sensitive Labels

1976

Profitability in Warranty

1. Warranty
   a. Define what warranty is
   b. How it is approached
   c. Who handles the warranty items
   d. Guidelines on how to handle warranty
2. Damage in Material Handling
   a. Specialized containers
   b. Containerization
3. Material Distribution Systems — New Conrail System
4. Warranty — A Further Look



J. F. McDONOUGH
Chief Mechanical Officer
Union Pacific Railroad Co.
Omaha, Nebraska

R. P. NEELEY
General Mech. Supt.-Locomotive
Union Pacific Railroad Co.
Omaha, Nebraska

LMOA wishes to express its thanks to Union Pacific Railroad for again hosting Pre-convention Presentation in Omaha.

Our Diesel Mechanical Maintenance Committee's presentation was well received in what we trust was a mutually beneficial experience.

Our thanks again to Messrs. J. F. McDonough and R. P.Neeley and others responsible for and participating in this activity.

Tuesday, September 29, 1981

2:15 P.M.

REPORT OF THE COMMITTEE ON DIESEL MECHANICAL MAINTENANCE

Pre-Convention Presentation: Union Pacific Railroad

April 14, 1981
Red Lion Hotel
Omaha, NE

J. L. KUHNS, Chairman
Manager Planning & Maintenance
The Family Lines Rail System
Jacksonville, FL 32202

VICE CHAIRMAN

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1981 TOPIC:

"INCREASED SERVICE LIFE THROUGH IMPROVED TECHNOLOGY"

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, Superintendent - Motive Power Maintenance, and presently has position of Manager, Planning and Maintenance with the Family Lines Rail System in Jacksonville, Florida.

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
RUNNING GEAR

A. Traction Motor Gearing
B. Gear Cases
C. Suspension Bearings

Traction Motor Gearing

For many years, the emphasis in diesel electric locomotive design and maintenance has been on improving availability and reliability. That effort was directed at the diesel engine, lubricating oils, turbocharger and electrical systems.

Little emphasis was placed on components below the main frame of the locomotive. Doubtless, those components—so vulnerable to the severe environment of weather, shock and vibration—were responsible for a high percentage of the locomotive maintenance dollar.

During the early 1970s, a study was conducted by a major western railroad to identify causes and cures for the problem of short life of traction motors. The study found the major problem to be ground relay caused by insulation breakdown. It also found that worn gearing was causing abnormal vibration within the traction motor. Gearing having excessive departure from correct involute profile is responsile for a high percentage of traction motor removals. As a 1978 Shop Equipment Committee report noted, the cost of traction motor removals is a key factor in the evaluation of costs of preventive maintenance vs. failure costs.

In 1974, Electro-Motive Division and Union Pacific conducted extensive testing to determine the source and magnitude of traction motor component vibrations. Electro-Motive has seen a significant percentage of motor failures which appear to be caused by vibration. These failures can be categorized as:

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1) Electrical grounds and shorts that occur as a result of chafing and wear between layers of insulation.

2) Fatigue fractures of gear cases, support arms, electrical connections, etc., caused by high frequency cyclical loading.

As a result of this testing, Electro-Motive's Service Department published a paper in 1975 detailing the test. (Slides on this test Figs. 1-10)

General Electric's publication GEK-35824A details gear tooth profile deviation and will be covered later in this report because numbers do vary somewhat.

Figure 1 shows the normal wear pattern, also known as the involute wear. The recommended maximum wear limit measured with a profile gauge, which is shaped to the original new tooth contour, is .010" on the axle gear or pinion. Pinions not meeting the limit should be replaced while the axle gears can be refurbished.

The two known accepable methods of reclamation are by physical grinding at TRW or electrochemical grinding using the Arrowsmith design.

Figure 2 illustrates armature shaft torque versus locomotive speed for several combinations of axle gears and pinions.

Figure 3 shows that as armature speed increases, the overhung end turns of the armature winding act as a large flywheel. And as speed increases with worn gearing, the circumferential movement increases causing insulation chafing and wear leading to grounds and shorts in the winding.

Figure 4 shows the vibration forces resulting from worn gearing will produce other fatigue failures, such as this fatigue crack in the gear case.

Figure 5 shows fatigue failure that occurred at a brazed interconnection between two stator main field coils.

Figures 6 and 7 show the difference in vibration severity between new and excessively worn gearing. Figure 6 shows the vibrations measured vertically over the motor nose, and Figure 7 was measured vertically over the axle. Note that the frame acceleration increases directly with train speed.

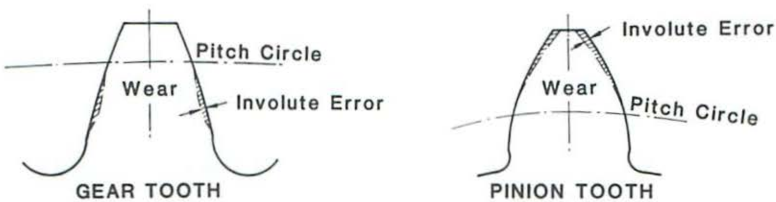
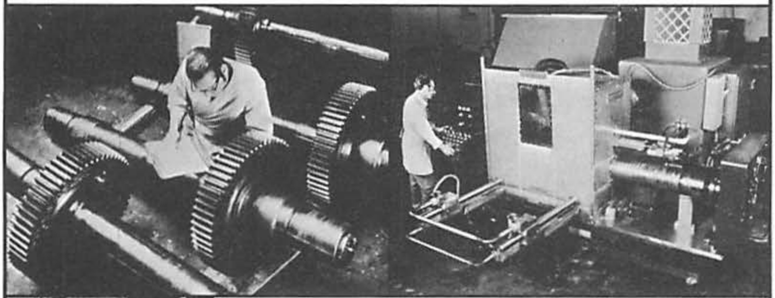


Fig. 1

LOCOMOTIVE AXLE GEARS
Reprofiled for 1/4 the Cost of New
(on or off the axle)




It is genuine economy to reprofile locomotive axle gears that have a tooth involute profile variation in excess of .008" provided the tooth wear does not exceed a total of .050" per side.

Electrochemical reprofiling of axle gears provides like-new performance. As a result, shock and vibrations are eliminated, thereby reducing traction motor injuries and maintenance expense. After reprofiling, gears are thoroughly inspected, including tooth spacing (the distance from groove center to groove center), and tooth width (at different points along the contour). Precision equipment is used for inspecting tooth size, shape, and spacing.

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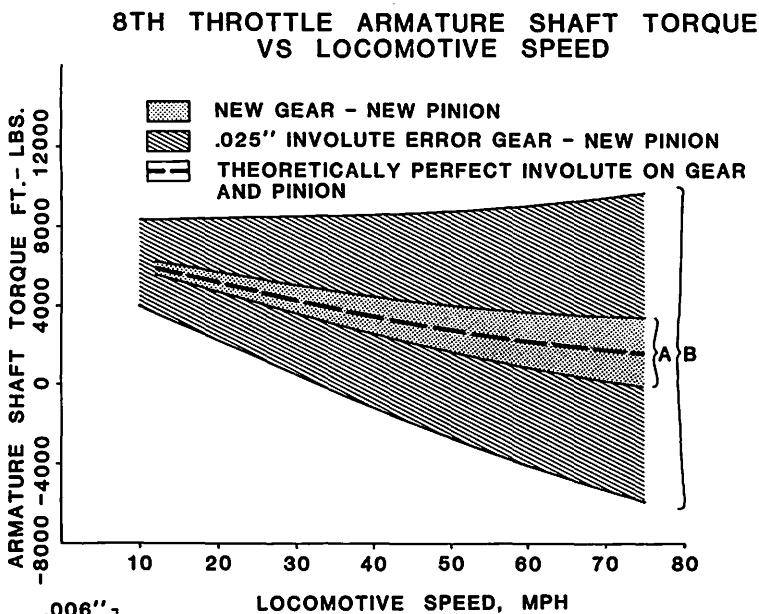

8TH THROTTLE ARMATURE SHAFT TORQUE VS LOCOMOTIVE SPEED
NEW GEAR - NEW PINION
.025" INVOLUTE ERROR GEAR - NEW PINION
THEORETICALLY PERFECT INVOLUTE ON GEAR AND PINION
ARMATURE SHAFT TORQUE FT.- LBS.
-8000 -4000 0 4000 8000 12000
A
B
10 20 30 40 50 60 70 80
LOCOMOTIVE SPEED, MPH

Fig. 2

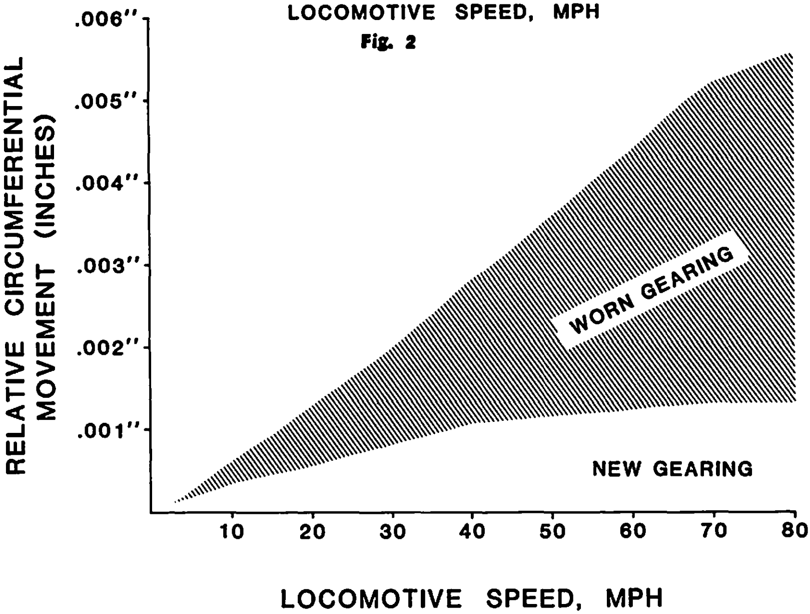

RELATIVE CIRCUMFERENTIAL MOVEMENT (INCHES)
.006"
.005"
.004"
.003"
.002"
.001"
WORN GEARING
NEW GEARING
10 20 30 40 50 60 70 80
LOCOMOTIVE SPEED, MPH

Fig. 3

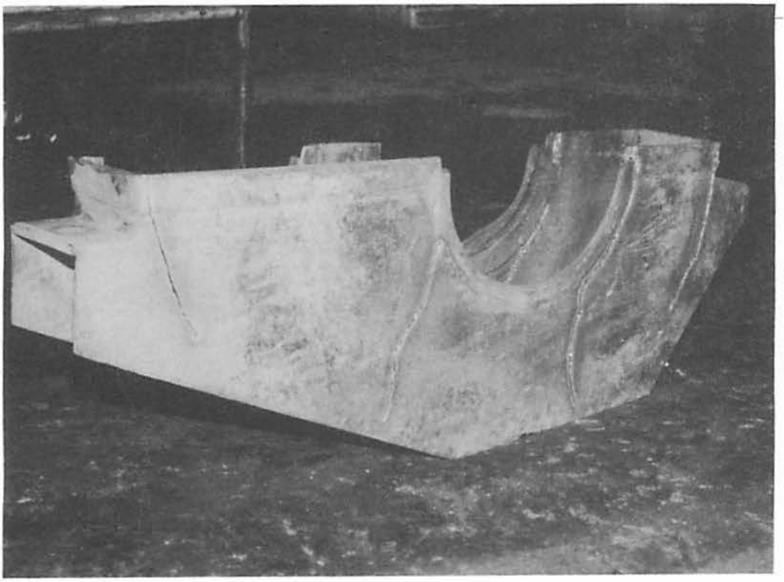


Fig. 4

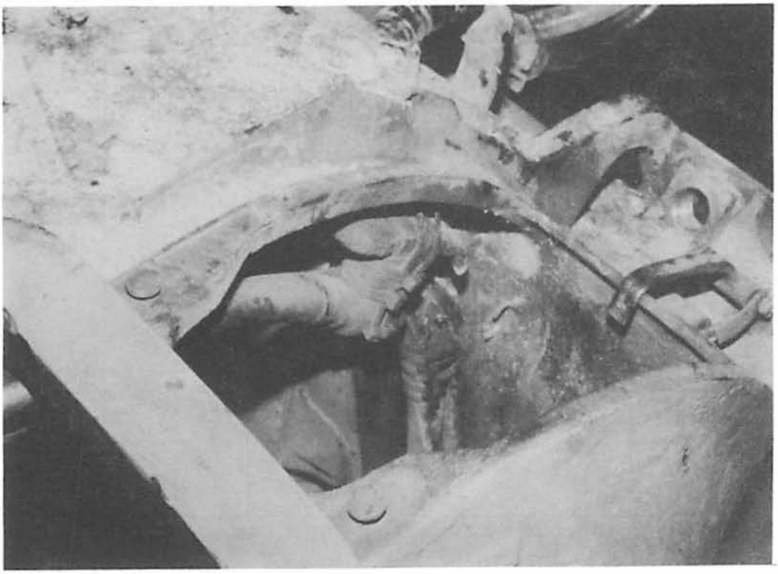


Fig. 5

TRACTION MOTOR STATOR ACCELLERATION
MEASURED VERTICALLY OVER MOTOR NOSE

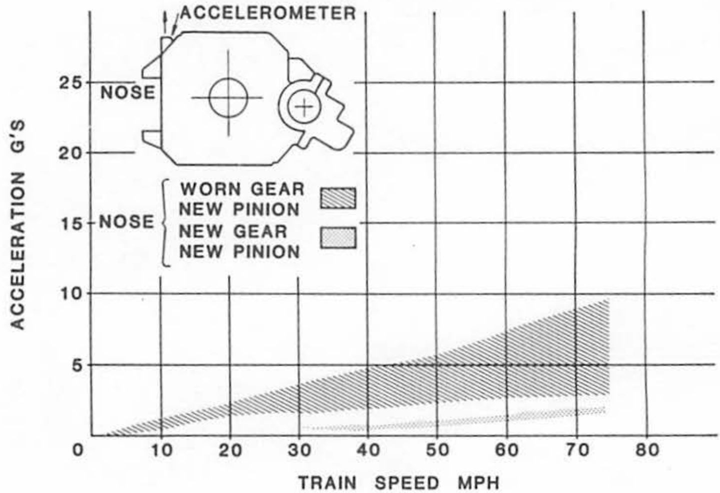


Fig. 6

TRACTION MOTOR STATOR ACCELERATION
MEASURED VERTICALLY OVER AXLE

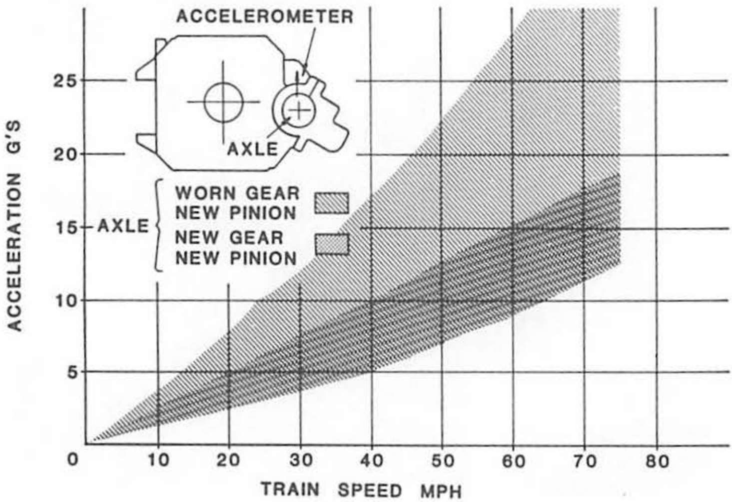


Fig. 7

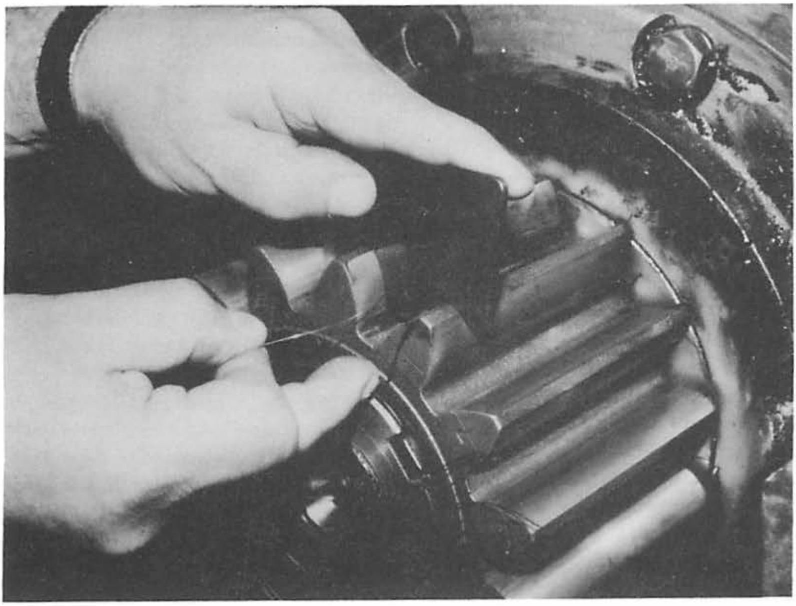


Fig. 8

Figure 8 shows the method used to check for involute wear.

The basic reason for any change in gear tooth profile is wear. And the limiting factor on reclamation of axle gears and pinion gears varies between manufacturers.

As previously stated, EMD recommends maximum limit for reinstallation of used axle gears or pinions at .010". The establishment of a maximum limit or involute wear is the singlemost important factor in controlling traction motor failure caused by vibrations.

General Electric recommends that an axle gear or pinion gear having a profile deviation of .008" or less be reused. If the deviation is more than .015", the gear or pinion should not be used. EMD and GE, as well as other companies in reclamation, do not at this time recognize the economic value of regrinding the pinion. New EMD and GE pinions have a taper from front to back.

Whenever a wheel set is removed from a truck, the gears should be thoroughly inspected for tooth contour and tip wear. It must be pointed out that a worn gear does not always change the profile of the tooth beyond usable tolerances. For example, a gear tooth may show severe wear yet be in fair profile.

Tooth tip width at the present time will be governing factor in determining if the gear should be scrapped. This statement only points out that to our knowledge gears have not been run in a controlled test to identify if these numbers are valid. EMD recommends axle gear tooth tip at 1/4". However, some railroads go to 7/32" with no ill effects. GE recommends axle gear tooth tip at 1/8", and we have not heard of any tooth breakage.

With introduction of electro-chemical grinding, came a drastic change in the method of reprofiling gears in the 1970s. Not only was it possible to remove metal and re-establish profile of the axle gear, but that could be done with the gear still mounted to the axle. With the scrapping of large numbers of gears and axles because of gauling, damage that had resulted in gear removal for profiling was of grave concern.

The Arrowsmith Company designed the electro-chemical grinder so that the gear can be left mated to the axle. The pros and cons of this procedure involve shipping cost where transit distance makes axle gear comination uneconomical.

Gear Cases

With the introduction of the lithium base greases, the integrity of the gear case and seals has become a must. The Committee polled several railroads concerning practices and policy on gear case reclamation and found that generally the gear cases do not receive the attention that is required to contain the gear lubricant.

Proper repair of the gear cases is essential to good performance and extended gear case life.

Welding of gear cases should be kept to a minimum. Jigs and fixtures should be used to eliminate distortion during the welding repair. If gear cases are maintained to a standard dimension, they should be interchangeable from one to the other.

To facilitate proper alignment, a tapered bar should be used to align the top and bottom gear case holes to the support arms prior to bolting or use of Huck bolt fasteners.

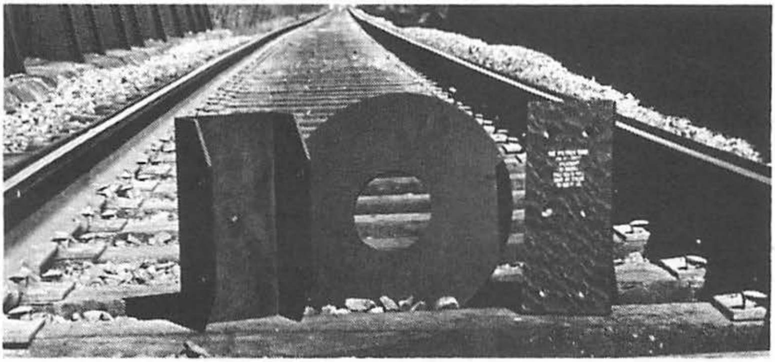
Owing to migration of grease into the pinion and armature bearing when the gear case is overfilled, most railroads buy gear cases with the overflow design. They also are modifying their present design on both the EMD and GE gear cases.

This survey also indicates that most railroads are going to the increased capacity design with the top and bottom fill arrangements.

EMD and GE have an improved gear case sealing arrangement. This new arrangement incorporates molded plastic side sheet-to-axle seals with 360° integral gutters. The new seals are utilized in conjunction with a modified standard type EMD or GE gear case.

This new sealing arrangement is presently undergoing field tests on four major railroads. Field inspections to date have confirmed excellent results.

Each railroad must evaluate its own operating conditions to determine what type of gear lubricant meets its requirements. Some will use the lighter viscosity in winter



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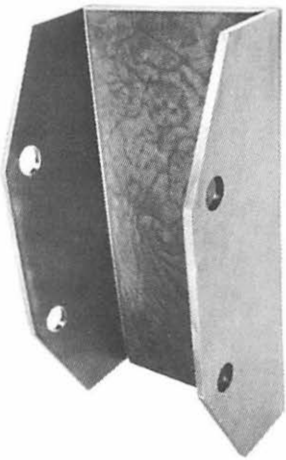

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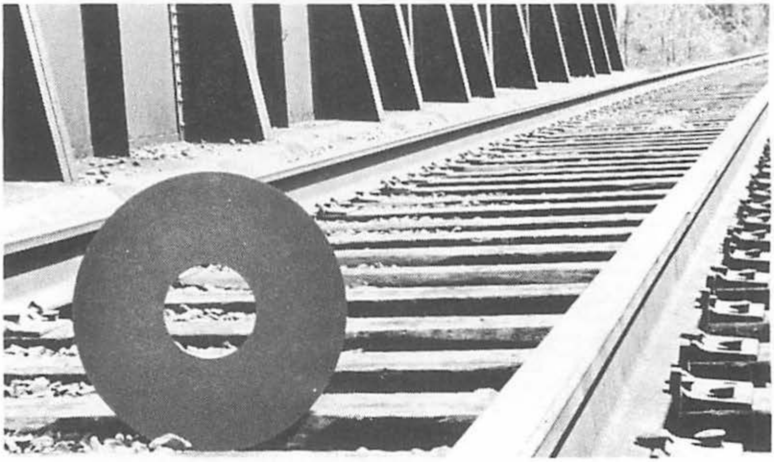

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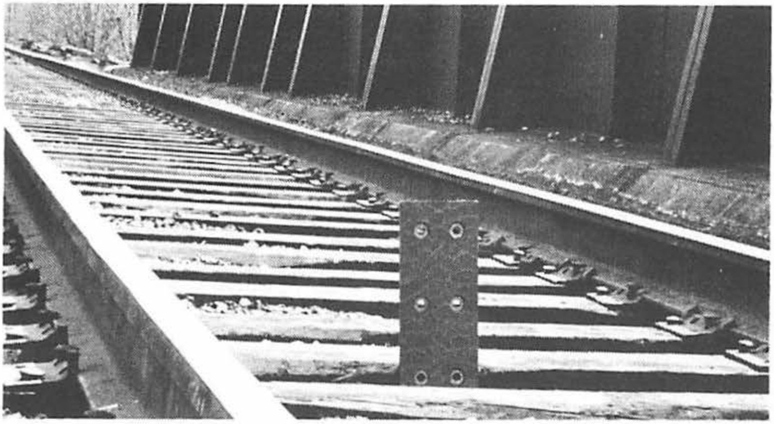

Bolster Wear Plates

- Nylatron® nylon wear plates are made of the same self-lubricating and wear-resistant material as the Nylatron pedestal liners which outperform steel. They also incorporate a witness groove or wear line across the narrow ends ¼″ from the face, which aids in the evaluation of wear.
- Nylatron nylon bolster wear plates are approved by EMD.
- Nylatron wear plates feature a unique proprietary insert which permits maximum bolting torque for installation, provides high resistance to pullout, and resists loosening of bolts under vibration. The wear plates are installed using the same procedures as for laminated phenolic wear plates.
- Nylatron wear plates cost less than the laminated phenolic you probably now use on your locomitive.
- Nylatron wear plates weigh less than bonded phenolic, which affords savings in shipping, handling and installation. The lighter weight of the Nylatron wear plate also makes it easier to handle and install.

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and the heavier in summer; others will stay with the same lubricant the year round. Whichever one they choose, they must have good matching gear cases good seals and maintain proper levels of the lubricant.

Suspension Bearings

The double seal or twin seal support bearing is the most commonly used bearing in the industry today, both on EMD and GE locomotives.

Due to the twin seal, oil consumption is greatly reduced. Dirt, water and gear lubricant are better excluded, thus extending oil, lubricator and bearing life. No changes are required to the traction motor or axle to convert or utilize this style bearing.

Many advantages were realized when this bearing was introduced. Those include reduced oil consumption, lower labor costs (for adding oil), better oil film in load zone, less chance of running out of oil, lower operating temperature and longer wick life.

A chronic problem we all face is keeping the support bearing bolts tight. Most railroads use an impact tool and not a specified torque. If a motor support bolt has been properly stretched, the bolt should not lose this torque.

Torque value for the GE drilled bolt should be 720-800 ft. lbs. EMD uses a standard bolt at 1100-1200 ft. lbs. When using the longer bolt and spacer (used with locking wire), the torque value also should be 1100-1200 ft. lbs.

Depending on each railroad's operating conditions, maintenance procedures will vary as to when to check oil level, drain condensate, remove and inspect wicks. A poll of major railroads showed variations ranging over a broad spectrum: daily, weekly, every time over a pit, monthly, 45 days and 92-day inspection.

When failures occur in this area, they can be very costly. Every effort should be made to insure that your own railroad policy is cost effective.

At the present time, EMD has a project going that will change the present journal bearing to the Timken grease type bearing.

Summary

This Committee recommends that the following maintenance reference material of running gears be implemented:

Axle gears and pinion gears be maintained in a condition that will reduce costly traction motor and gear case fatigue due to vibrations.

1. EMD WS 13924 "Reground Axle Gears" 1/30/78.
2. EMD "Traction Motor Life Vs. Vibrations" 9/75.
3. GE "Inspection of Traction Motor Gearing" GEK 35824A.
4. Arrowsmith "Measurement Ranges to Determine Grind" 2/29/80.
5. EMD Maintenance Instruction MI 1518 Rev. C, 10/75.
6. Arrowsmith brochure "Electrochemical Grinding and Gear Reprofiling."

Gear cases must be in such con-

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dition as to match to insure fit. That will prevent the stresses that encourage fractures.

Establish a reclamation procedure to insure the same gear cases do not keep coming back for repairs.

Use jigs and fixtures for gear case repair.

Manufacturers of gear cases give the railroad a better, sturdier gear case.

Apply overflow to gear cases not equipped.

Maintain gutters and seals in good condition.

Use torque wrenches on GE and new EMD gear cases and motor support bolts.

On EMD support bolts, use the longer bolt with spacer to achieve maximum stretch.

Investigate the use of the Tame Model #70 hydraulic torque wrench.

II
FILTRATION

A. Fuel Filters
B. Lubricating Oil Filters
C. Air Compressor Filters
D. Engine Air Filters

Fuel Filters

With few exceptions, the present fuel systems available from both major builders provide adequate protection of fuel injection equipment while permitting satisfactory engine performance under normal operating conditions. The committtee members concur in the belief that filters provided by OEM and alternate vendors also perform satisfactorily under normal operating conditions when coupled with an adequate maintenance program.

Unfortunately, maintenance managers are not always faced with normal operating conditions. It is in areas of abnormal operating conditions that we must concentrate our endeavors.

Initially, we must recognize both builders' recommendations covering filter specifications and maintenance practices. Many railroads represented on this committee have used this information as a guideline, and then adjusted their maintenance program to best suit their own operational requirements. A similar situation exists concerning specifications for filters used. This committee does not, however, recommend using any filter that has not been subjected to both laboratory and controlled field evaluations, as well as meeting or exceeding OEM specifications.

Once manageable maintenance and equipment standards have been established, we must then consider the unusual or intermittent conditions that directly affect locomotive operations.

A timely problem we all face is that the quality, as well as quantity, of diesel fuel oil available to the United States railroads will continue to deteriorate rather than improve. A related problem is locomotive operation during periods of severe cold weather.

Cold weather and poor grade fuel have caused severe problems and great expense to railroads with

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locomotives improperly equipped for this type of operation.

Railroads must evaluate their environment or geographical location and operational requirements. For those railroads needing improved fuel system performance during weather extremes, or having difficulty obtaining an acceptable grade of fuel oil, the Committee recommends consideration of the following:

1. Installation of high-capacity fuel oil preheaters.
2. Apply a thermostatic control valve with the fuel heater.
3. Retrofit to high-capacity fuel transfer pump on units equipped with new fuel heaters.
4. Install the "hot well" or UP developed mixer divider concept in locomotive fuel tanks.
5. Remove primary screens from the suction side of fuel system.
6. Install filter indicator gauges on units not so equipped.

Several railroads represented on this committtee have adopted many of the preceding modifications and report a significant improvement in locomotive performance during a wide range of operating ambients.

In addition to the self-help modifications, the committee has found a need for basic changes in the present General Electric fuel system. Unauthorized removal of the General Electric fuel filter has caused damage to injection equipment. Therefore, the Committee believes a secondary fuel filter and visual fuel flow indicator system is needed to improve injection equipment operating reliability and to extend component changeout intervals.

As improvements or design changes are implemented by both builders in the future, the Committee suggests that standardization of filter elements be given foremost consideration to promote inventory reduction.

Lube Oil Filters

Lube oil filter performance has been a long-standing concern of all personnel involved in locomotive maintenance. We find a variety of filter change intervals, as well as a variety of media, being used throughout the railroad industry. Operational requirements, recent changes in FRA inspection intervals and differences between locomotive manufacturers have contributed toward this lack of standardization.

Some railroads have developed the pressure test method to determine when filters require replacement. Pressure is measured by means of a quick disconnect fitting on the filter tank, and readings exceeding 20 pounds at throttle position 8 disqualify the filters. Readings are taken at 30-day intervals, and filters replaced at 90 days regardless of pressure readings obtained.

Other railroads replace lube oil filters at scheduled intervals ranging from 30 to 120 days.

There is also significant difference in specifications between both locomotive builders. The latest filter offered by EMD has a suggested change interval of 60 days.

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General Electric has three filters available with the long life type expected to operate for a period of up to 180 days.

There is also a significant difference in the micron size between both builders' recommended filters. EMD requires removal of particles of 13 micron size and over with General Electric rated nominally at 23 microns. Both builders do not recommend interchange of their filters.

One member railroad has standardized on the 23 micron filter for all units. Changeout intervals have been established at 90 days for EMD and 30 days for GE locomotives.

Engine tear down inspections have revealed no adverse effects on components as a result of this policy.

The preceding presents a fairly clouded picture with respect to development of a recommended policy toward lube oil filters. Mergers, increased locomotive interchange between railroads, new generation lube oils, etc., all have contributed toward the need for improved filtration. The committee does see a definite need for an exchange of data and close cooperation between all concerned in order to control costs and improve locomotive performance.

Air Compressor Filters

Few comments or issues have been raised by the committee members relative to compressor air filters. Members polled have indicated satisfactory performance of compressor components between overhauls, with no abnormal wear or other defects attributed to air filters reported.

Also, a minimum of information concerning air filter maintenance is published in both builders' maintenance manuals. We do find mention of maintaining filter housings, etc., and recommended schedule of filter replacements. We find there is little to add to these publications.

Member railroads have reported air filter replacement intervals ranging from 60 days to a period of one year. We can assume the railroads changing air filters at the more frequent intervals are operating in an extremely *harsh* environment or are utilizing filters with relatively short service life. EMD recommends replacement of paper cartridge type filters at one year intervals and other filters at six months. Owing to the extended service life and decreased labor costs, the committee suggests, for those railroads that have not already completed a retrofit program, that consideration be given to cartridge compressor air filters.

One railroad has modified its GE locomotives to take the air compressor air intake supply directly from the filtered engine air plenum chamber.

The General Electric Company offers a lube oil filter as standard on units equipped with Gardner-Denver machines; this system is also offered by EMD as an option. The lube oil filter is used with the gear-driven oil pump-designed compressor.

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Nalco Diesel Fuel Oil Treatments	Improve engine performance and minimize maintenance costs. Nalco's exclusive formulations protect against fuel gelling, control microbial and sludge formation for improved combustion.
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A member railroad that uses all types of designs has reported little, if any, difference in components of compressors torn down for heavy overhaul. This railroad uses a strict oil analysis program, as well as a scheduled interval of oil changes. This may contribute to the lack of noticeable component wear between the two lube system designs.

The gear-driven pump with oil filter does offer improved lubrication; however, retrofit to this system is costly owing to the necessity of replacing the crankshaft.

Many railroads are testing operation of compressor crankcases directly connected to the diesel-engine lube system. Additional compressor oil filtration is not needed with this arrangement. This system was used by some railroads in the past, with valve and ring problems reported. The advent of new lubricating oils has prompted additional tests. However, insufficient data have been reported to the committee at this time to develop recommendations.

Engine Air Filters

Over the past several years, there have been a variety of types of filters used to clean the combustion air of the diesel engine. Those filters went through several stages of evolution, ranging from the early reusable metal mesh impingement, oil bath, mechanical self-cleaning, and throw-away impingement types to the present paper or fiberglass filters.

The early filters did provide adequate filtration, but presented a challenge to mechanical maintenance forces in the form of excessive locomotive down time and labor expenditures. Many of those early filters required excessive labor during removal, cleaning, assembly and reapplication to the locomotive. The advent of the throw-away impingement or mechanical self-cleaning filter was welcomed by the railroads for their improved reliability and reduced labor costs.

During the 1960s the locomotive horsepower race began. Diesel engines developing up to 3600 horsepower and requiring over 10,000 cubic feet per *minute* of combustion air were becoming commonplace throughout the United States. This increase in horsepower placed additional demands on all diesel engine support systems, including the engine air filters. As a result of the increased demands, EMD for example, implemented major changes in its primary filter system. It was during this period that filter manufacturers introduced the paper engine air filter to the railroad industry. Shortly thereafter the fiberglass filter, commonly known as a "baggie," became available.

The paper and fiberglass filters have operated successfully for several years and have met or exceeded both AAR and builders' specifications with respect to efficiency, dust holding capacity, flammability, mechanical stability, temperature, etc.

Following the eruption of Mt. St. Helens in May 1980, there was great concern over the possibility of severe engine damage on locomotives operating in the Northwest. After the eruptions, one major railroad in this area implemented a policy of replacing filters on all locomotives arriving at maintenance points from their tours of duty. As dust conditions began to subside, this policy was amended to include inspections by both visual and manometer means and a strict oil analysis program. None of the locomotives operating in this area exhibited adverse effects as a result of inadequate filter performance.

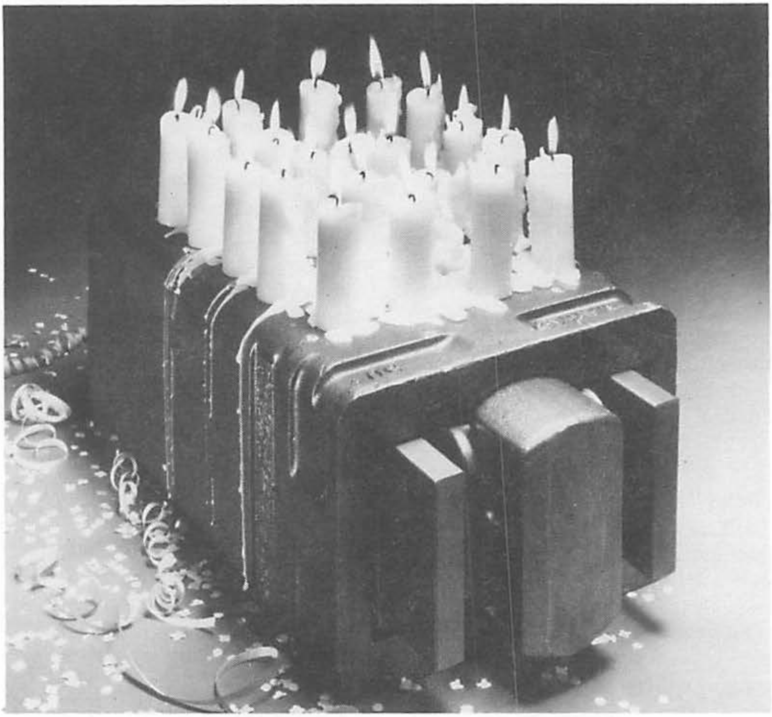
The preceding amplifies the need for a diligent filter maintenance program. The U. S. locomotive fleet now exceeds 28,000 units, an increase of just over 1,000 units since 1969. During this period the aggregate horsepower of the fleet increased from 51.1 million to about 62 million horsepower, indicating a large influx of the high-horsepower locomotive. Assuming one-half of this fleet is equipped with paper or fiberglass filters and based on the manufacturers or vendors recommended changeout interval, total annual filter costs would average approximately $550 per unit or over $7.7 million on a nationwide basis. Those figures are based on latest manufacturer's price lists and the assumption that the filter applications are divided evenly between fiberglass and paper types.

Those figures emphasize the need for strict management of filter maintenance programs. Infrequent filter changes can result in poor engine performance with respect to fuel consumption and the possibility of costly premature wear or total failure of engine components. Too frequent filter changes will unnecessarily increase total expenditures for replacement filters.

That problem causes great difficulty for Maintenance Managers in development of a filter maintenance policy to control costs without sacrificing diesel engine performance. Initially, any locomotive maintenance facility must insure that the entire locomotive air system is properly maintained in order to obtain maximum secondary filter life.

Inspection of such items as doors, partitions, gaskets, dampers, primary cleaners, blowers, etc., must be performed on a regularly scheduled basis. That should be relatively simple to accomplish by incorporating those items into a scheduled maintenance program. However, the question remains, at what point do we replace the engine air filters?

Both major locomotive builders recommend periodic measurement of pressure drop across the filters by means of a manometer. Although a fairly simple task to accomplish, the four-cycle engine on the GE locomotive requires operation at full load to obtain



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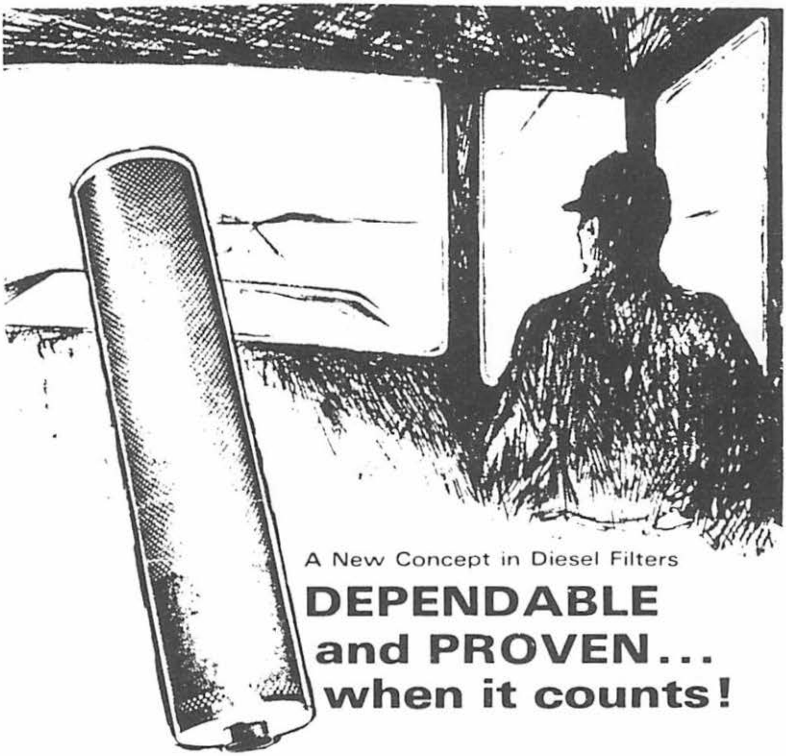

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proper manometer readings. The question is, are there always load boxes available, or can we afford to incur fuel, labor and locomotive down time costs to complete a load test at thirty-day intervals?

Another issue is that more than one railroad represented on this committee complete scheduled maintenance at more than one maintenance facility. How is it possible to maintain a log of initial and subsequent manometer depression readings throughout the life of the filter? An accurate log of observed manometer readings is mandatory in order to notice any abrupt change in filter depression. Without this log, filter maintenance is haphazard at best.

Railroads with any sizeable fleet of locomotives find load testing or record keeping virtually impossible to accomplish on a consistent 100 percent basis. The answer to these questions is fairly obvious. Replace filters on a regularly scheduled basis and discontinue using manometer readings.

The next step managers must take is to determine how long to permit filters to operate, what safety margin to require and, based on this data, establish the scheduled interval of replacement.

This committee is well aware of the controversy that this recommended policy may cause with filter vendors. For example, filters with additional service life would be needlessly discarded, and protective devices mounted on the locomotives will prevent serious engine damage in event filter replacement is deferred.

We find, however, that while many filters will perform satisfactorily over advertised service life, many will not. Protective devices have and, unfortunately probably always will be subject to tampering by unauthorized personnel.

Based on the fact that manometer readings and protective devices can be unreliable or improperly used, this committee recommends that engine air filter replacement be performed at regularly scheduled intervals, and recognizes the need for further devopment of filters to economically favor such a program.

III

FRA RULES

A. Speed Indicators
B. Periodic Inspection Vs. Maintenance Periods
C. Load Meter Testing
D. Air Brake Records
E. Window Glazing

A. Speed Indicators

FRA rule part 229.117 requires that all controlling locomotives which exceed 20 MPH in operation must be equipped with a speed indicator. Accuracy of the indicator must be ± 3 MPH in the range of 10 to 30 MPH and ± 5 MPH at speeds over 30 MPH.

Generally speaking, all of the speed indicators in common usage will meet the FRA requirements for accuracy. While the indicators are capable of meeting this FRA accuracy, proper testing and main-

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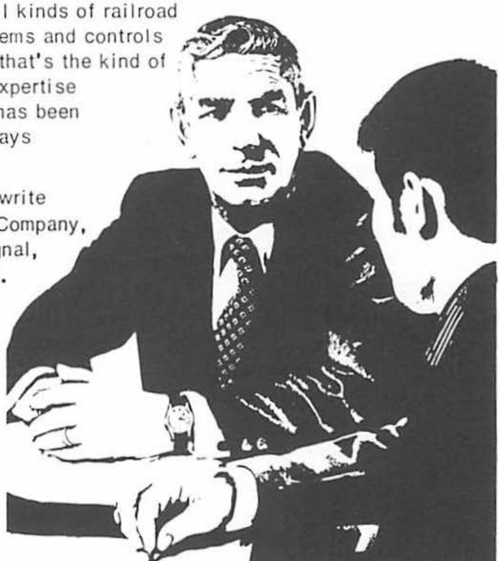

MEMBER RPI RAILWAY PROGRESS INSTITUTE

tenance procedures also are required. Other requirements of FRA Rule 229.117 are: speed indicator must be located so that it can be clearly read by the engineer from his normal cab position and under all light conditions; speed indicators must be tested as soon as possible after departure by use of speed test sections or equivalent procedures. Measured milepost spacing at various locations should comply with this rule.

A variety of speed indicators and recorders are presently in use including:

- GE dual range speed indicators
- Barco mechanical indicator/recorder
- Barco electronic indicator/recorder
- Chicago Pneumatic mechanical indicator/recorder
- EMD radar type indicator; used on 50 Series units
- Pulse electronic indicator/recorder
- Vapor electronic indicator/recorder

Some of the deficiencies or problems encountered with speed indicators are:

1. Totally inoperative
2. Inaccurate
3. Stuck at a fixed point
4. Does not operate above, or below a specific mph
5. Does not have a consistent error throughout the operating range.

Many of the electric (electronic) type indicators can be checked on the unit and can be fixed and recalibrated in a minimum of time if nothing is seriously wrong. While the mechanical type also can be checked on the unit, in some cases they will have to be removed for repair and calibration. An outline of a good inspection and calibration for mechanical speed recorders follows:

1. Inspection of:

Axle angle drive unit for flexible axle-driven shaft and drive spade. Gear-change-type for proper wheel size compensating gear ratio.

Mechanical drive system for wear, damage, supporting braces and drive cable routing. Minimum bend of drive cable to be 36-inch radius, at all directional changes of flexible drive cable.

Speed indicator/recorder for general mechanical condition. Particular attention to be given to: stylus, recording tape guides and retaining devices, hinges, fasteners, speed limit decal and provision for wire seal.

2. Calibration Verification

All inspection and repair(s) of speed system to be performed prior to calibration verification.

Apply axle angle drive assembly to calibrating machine, should type of calibrating machine used be incapable of driving at axle drive shaft. Speed signal input to be applied at available location furthest from the speedrecorder. Mechanical drive system NOT verified by use of test machine, MUST be thoroughly inspected and manually tested for functional operation.

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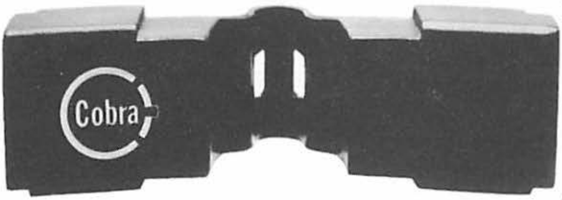

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Measurement of speedrecorder driving wheel must correspond to wheel size compensation device.

Chicago-Pneumatic speed system must be equipped with wheel size compensating gear(s) for wheel size of driving wheel of locomotive.

Barco speed system using model DPC-85 and DPC-FL-85 recorders to be equipped with 40 inch wheel compensating unit.

Speedrecorder verification of calibration to be performed with speed signal inputs for 10, 20, 40 and 60 miles per hour. Speed indicator and recorder readings must coincide within ± 3 mph.

Locomotive overspeed protection device must be checked for speed setting and functional operation at maximum permissible speed plus 5 mph for locomotive being tested.

3. **Calibration of Mechanical Speedrecorders**

Calibration of speedrecorder to be performed by supplying known speed signal inputs at axle-driven shaft of angle drive unit.

Various types of speedrecorder calibrating machines are in use that supply speed signals for recorder verification.

Speedrecorder calibration requirements must verify:

a. Condition of mechanical drive system.
b. Proper gear ratio of the wheel size compensating device to locomotive wheel being sensed for speed.
c. Calibration of speed indicator and recording device. Verification must be performed with speed signal input applied in BOTH rotational directions.

When calibration machine used is unable to test the above requirements, manual testing and inspection must be performed to verify requirements of both directions of rotations.

B. **Periodic Inspection vs. Maintenance Periods**

Rule 229.23 covers the general requirements for periodic inspections. It states that inspections must be made where adequate facilities are available and complete underneath inspection can be safely made. The time interval between periodic inspections is 92 days, which cannot be exceeded except when out-of-use credit may be used to extend next inspection per Rule 229.33.

Another requirement of Rule 229.25 is that information covering each periodic inspection must be recorded on Form FRA F6180-49A and that the form must be signed by the person making the inspection and his supervisor.

One railroad specifies that on 7-day and 30-day inspections, the FRA inspection requirements are checked on Form F6180-49A and air brake record Form to make sure that all inspections are current. Computer printouts indicate when FRA inspections and scheduled maintenance are due, although they may not be performed at the same time. These computer records are made available whenver a unit arrives at a maintenance terminal. The inspection period chosen by the FRA of 92 days fits well

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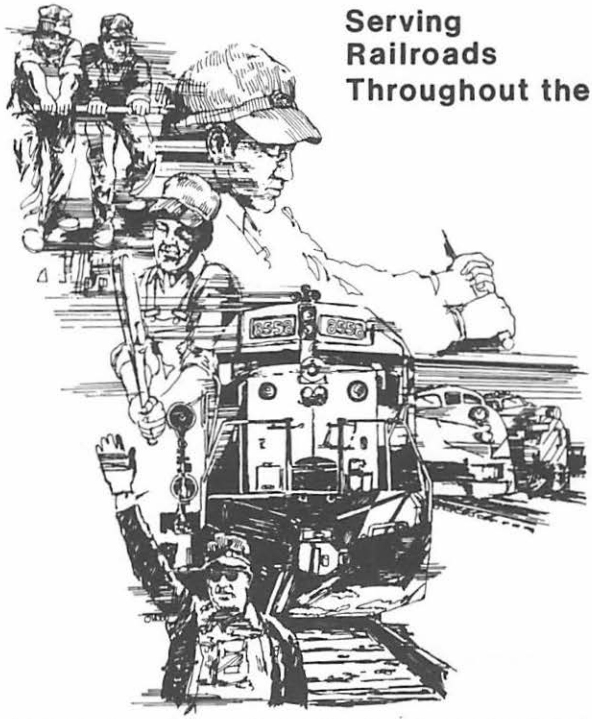

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with maintenance intervals which are in multiples of 90 days. Although the primary part of scheduled maintenance is preventative in nature, this is also the time for inspection of the entire locomotive and correction of any defects found.

The goal of most railroads is to be able to get a locomotive to run 90 days between tie-ups for maintenance attention. This will require considerable time and effort on the part of railroads and suppliers. Everyone must work together if satisfactory solutions are to be found to the problems in the way of this goal.

Some of the tasks that limit locomotive maintenance intervals are:

1. Traction motor gear cases
2. Traction motor support bearings
3. Exhaust manifold carbon traps
4. Journal boxes (oil)
5. Fuel filters
6. Lube oil filters
7. Fiberglass air compressor filters
8. Carbody fiberglass filters
9. Eductor tubes

The above list does not contain any items that could not be done on most service tracks, providing units are over pits. However, the amount of labor required could slow down servicing operations too much.

Item 6, lube oil filters, can be extended to 90 days or longer by use of the "long-life" filters. A number of the other items have been extended to longer time periods by some railroads depending on operating conditions and mileages run by the locomotives.

C. **Load Meter Testing**

In accordance with FRA Part 229.27(b), load meters must be tested annually and cannot have more than 5 percent error. Methods of testing load meters generally is by comparison with a meter tester which must have an accuracy of 1 percent or less. This committee recommends that the meter tester be checked against a master meter calibrated weekly in order to assure dependable accuracy. A record of the tests, including date tested, location, signature of the person doing tests and his supervisor must be made on Form FRA F6180-49A.

The newer type of load meter is dual range, showing dynamic brake amperage as well as current in power. There is no need for special meter testers for each portion, as the one tester will work for both ranges.

All types of load meters are highly damped in order to perform properly when exposed to the various vibrations of locomotive operation. During testing, as the load meter pointer nears its set position, the meter should be tapped lightly so as to simulate locomotive operation and vibration and improve accuracy of readings. Tests should be made several times to see if they repeat the same readings and verify errors.

In order to save time and labor, load meters can be tested in place on locomotive whenever possible

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rather than removing and taking to the shop for bench testing. Load meters found with more than 5 percent error must be corrected by rework or replaced with a qualified meter.

D. Air Brake Record

Brake equipment must be inspected and maintained in accordance with current FRA Locomotive Safety Standards, Part 229.27 covering annual tests and Part 229.29 covering biennial tests. A record of date tested, cleaned and repaired and person doing work is made on Form FRA F6180-49A and report certified to be correct.

A separate card record may also be maintained in the cab showing all the individual components and the date and place each were cleaned and tested. This enables maintenance personnel to identify the specific requirements for each item showing when last serviced. Air gages and handbrakes are also included on record card along with all Annual and Biennial FRA requirements.

A separate record is required if a railroad chooses to fragment the work and do portions at intervals, such as 3 months, 6 months or others, rather than the complete air schedule at the annual or biennial times specified by Rules 229.27 and 229.29. This option is covered by part (4) of Rules 229.27(a) and 229.29(b). Railroads with maintenance tasks scheduled to provide equal labor requirements at each normal maintenance period may consider handling the air brake equipment in the same manner.

The intervals specified for air brake equipment testing can line up with preventive maintenance program scheduling in most cases.

E. Window Glazing-FRA Part 223, Safety Glazing Standards — Locomotives

Programs should be designed to retrofit approved glazing material on all non-equipped units by the deadline of June 30, 1983.

Locomotives being completely rehabilitated or undergoing heavy repairs are most likely candidates to be completely outfitted with FRA approved glazing. Locomotives that will not go through this program can be retrofitted in scheduled phases at running maintenance plants. The FRA regulations covering handling of broken windows are quite complex owing to the many variables involved. Instructions to maintenance personnel should be complete and clear so that action taken will not violate FRA rules.

Care is necessary in handling and applying the new certified glazing materials. Although those certified safety glazings are designed to withstand heavy impacts, the edges chip very easily and render the material unsuitable for use. Therefore, glazing should be handled with care and should be installed with plastic tools. Do not use metal tools. Prior to the installation of sliding side window glazing, inspect tracks and sash for excessive wear, distortion, mis-

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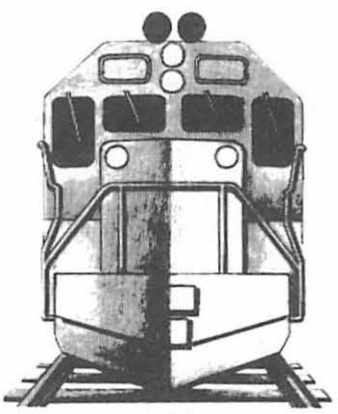

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P. O. Box 40555, Fort Worth, Texas 76140 alignment or conditions that could cause leakage and difficulty in opening and closing windows. Replace excessively worn or damaged hardware with new sliding window assembly.

Certain of the glazing materials, other than glass, are readily susceptible to scratching owing to careless handling and cleaning with abrasive cleaners. Windows made of material, such as Lexan, should be cleaned with lukewarm water and a mild soap or detergent applied with a clean sponge or soft cloth. **Do not use cleaning agents containing abrasive materials.** After cleaning, wash thoroughly with clean water and wipe with soft sponge or cloth to remove water spots. There are other precautions to take depending on the type of material used, and those should be obtained from the glazing supplier.

Kits of glazing materials and hardware are available from a number of sources. This may be a convenient way to purchase.

IV
FOLLOW-UP ON PREVIOUS TOPICS

A. Air Cooled Vs. Water Cooled Air Compressors
B. GE Fuel Fires
C. Crankshaft Welding Specifications

A follow-up on previous subjects begins with air compressors:

Air Cooled versus Water Cooled

Air versus water is like a pendulum swinging back and forth. Several railroads are again reconsidering the air cooled air compressor. One railroad on this committee has standardized on air cooled compressors and has both Westinghouse and Gardner-Denver compressors. Those have been applied by the railroad as well as both locomotive manufacturers on new equipment.

The gear pump system can be applied to both water cooled and air cooled Gardner-Denver compressors. The Wabco machine uses a piston type oil pump. To the best of our knowledge the Wabco compressor does not have full flow oil filtration available.

The primary advantage cited in favor of the air cooled compressor concerns the freeze damage potential of the water cooled compressor. This mode of failure can be due either to failure to drain the cooling system of the locomotive or to failure of the compressor itself to drain when the entire cooling system is drained.

The automatic drain valve has improved technology to protect the entire cooling system against freezing and, in turn, protect the air compressor.

Where compressors have frozen after the cooling system has been drained, sludge in the compressor system has been the primary cause. Anti-sludge water systems were released for compressors in 1973 (EMD reference M. I. 144, Rev. A).

In general, air discharge temperatures from air cooled compressors are higher and that is the primary reason for shorter valve life. In addition, higher discharge

Electro-Motive has five WXO 8100 air cooled air compressors on test on Clinchfiled GP38-2's. These units were delivered in June 1978 and were inspected after two years' operation in July of 1980. The machines were found to be in good operating condition, and it was estimated that a three-year valve maintenance period might be achieved. This is a longer service period than had been anticipated. However, the compressor duty cycle is said to be light on this particular railroad.

General Electric has furnished both Family Lines and UP locomotives with air cooled air compressors and are experiencing good reliability since the cooling fan problems were resolved. These machines are all Wabco.

General Electric is experimenting with the Gardner-Denver air cooled machine. It is claimed to be as cool running as a similar water cooled machine under normal operating conditions. This we believe explains the good valve life reported by EMD. The air cooled unit offers advantages of less complexity in cooling with elimination of the water tubing, even though a cooling fan has to be added.

In addition, the following Family Lines locomotives have been shipped with Gardner-Denver air cooled machines:

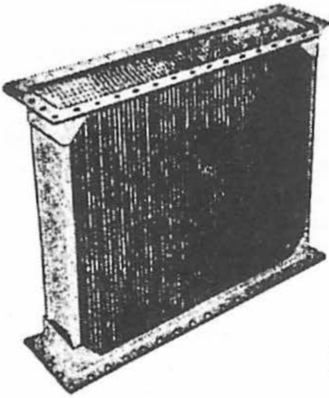
Three SD40-2, Clinchfield, delivered August 1980

Continued cooperation of the railroads involved in the testing will make possible further assessment of the comparative performance of air compressors.

All are aware that air compressors have always been a problem on locomotives and continue to be so. Air compressors on the first locomotives built and on the most recent have reciprocating machines. Other industries requiring large amounts of compressed air have gone to rotary type compressors with far fewer parts. The rotary air compressor is still under development. Although simple, it requires more sophisticated auxiliary equipment. GE has experienced extensive bearing failures and problems with air-oil separation. The maintenance requirements for this type of machine are more stringent than for a reciprocating machine. We would expect that the bearing problems can be overcome, but do not forsee a reduction in maintenance requirements.

Separately motor driven air compressors present a number of opportunities for both fuel savings and greater reliability. Various configurations are under consideration by both builders.

This committee feels revision of our compressor is long overdue and urges both locomotive manufacturers to take a long look at



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rotary or electric driven air compressors.

GE Fuel Fires

The General Electric engine has been prone to fire damage as a result of fuel line ruptures. Those lines are normally the low-pressure lines connecting the manifold with the fuel injection pumps. The lines are a convenient handhold when climbing on the engine ramps to inspect the upper areas of the cylinder or exhaust manifold. After the hoses have been abused in this manner, they are prone to having leaks in either the hose or fittings. Anytime a leak occurs, it often is directed toward the hot exhaust manifold.

General Electric Company has been trying for some time to develop an alternate low-pressure fuel line arrangement. This has included an improved low-pressure hose with stronger fittings as well as a steel line arrangement. GE also has an alternate arrangement under consideration for testing some time during 1981. This design has a flow through fuel injection pump with separate supply and return fuel lines.

One other part of the low-pressure system that has contributed to fire damage is the crossover line from the right bank to the left bank that crosses under the exhaust manifold at the turbocharger. Hopefully at the time this paper is presented in Chicago, more positive information will be known on this fuel system arrangement.

Crankshaft Welding Specifications

During our convention last year, we chided the locomotive manufacturers to become more heavily involved with the railroads concerning crankshaft repair.

EMD still does not consider welding a method of crankshaft repair. EMD still is for chrome plating with a maximum of .030 for 645 engines and .070 on 567 engines. EMD states that all crankshafts coming to its reclamation program can be salvaged by plating with only 1½ shafts per month requiring weld. Therefore, it does not believe the expense for the necessary equipment is justified. However, this does not reflect the total number of EMD scored shafts from the industry that could be repaired by welding.

General Electric, on the other hand, is quite involved with this process and has been working with two crankshaft repair facilities (Precision National and Chrome Crankshaft) over the past two years.

A crankshaft repair specification covering the welding of shafts for 7FDL engines is being prepared for distribution on request.

DIESEL MECHANICAL MAINTENANCE
Six-Year Index

1980

Fuel Economy through Improved Maintenance in the Coming Decade

1. Fuel conservation
2. Winterization
3. Utilization of on-board load test
4. New FRA Rules
5. Welded crankshafts

1979

Maintenance for High Reliability

1. Welded crankshafts
2. G. E. power assemblies
3. Assigned maintenance terminals
4. Radiators
5. Dye and cooling system
6. Air compressors
7. Viscous and gear dampers
8. Hard bore liners
9. Progress toward elimination of oil leaks

1978

Problems, Causes, Prevention and Repairs

1. Power assembly water leaks —E. M. D.
2. Turbos—Diagnosis of failures to replacement
3. Winterization
4. Update
   a. Viscous dampers
   b. Grooveless connecting rod and main bearings — G. E.
   c. Solid low pressure fuel lines — G. E.
   d. Air compressor

1977

Better Management of Mechanical Maintenance

1. Air compressor
2. Crankshaft failures
3. Vibration dampers
4. Fires — mechanical
5. Road failures

1976

Improved Locomotive Availability by Judicious Maintenance

1. Recommended maintenance schedule
2. Definition of availability
3. Quality control
4. Update on truck maintenance
5. Progress report
   a. Piston reclamation — G. E.
   b. Exhaust silencers
   c. Scored liners — G. E.
   d. Scored liners — E. M. D.
   e. Engine air filters
   f. Engine fluid temperatures
6. Storage of Diesel Engines — short term

1975

Progressive Action on Maintenance and Ecology

1. Engine protective devices
2. Cleaning G. E. oil coolers
3. G. E. cooling system improvements
4. G. E. Turbo labyrinth seal
5. Reclaiming diesel pistons
6. Crankshaft failures
7. Scored liners EMD 645
8. Exhaust mufflers
9. Economics of 3 cylinder vs. 6 cylinder air compressors
10. Rotary air compressor, G. E.

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

EXCERPTS FROM SPEECH OF J. J. BUTLER TO LMOA
April 1, 1980 — Sheraton Motor Inn, Altoona, PA

Good evening ladies and gentlemen, it is indeed a privilege and a pleasure to receive this honorary life membership in LMOA from my fellow locomotive maintenance officers.

I have been a member of the LMOA for 25 years, ever since I was a foreman at the old Erie Avenue, Philadelphia Enginehouse on the former Reading Railroad. This Association has been invaluable to me as I continued my career in the mechanical department. Obviously I have gained a great deal of technical know-how from the LMOA papers, convention meetings and pre-convention presentations such as this. But just as important, in my eyes, are the personal relationships that have come about through this organization. Through LMOA, I have become friends with some very fine people and it is always a personal pleasure for me to attend these functions and meet these friends again.

As you can see by the agenda, one of the presentations at this meeting concerns locomotive utilization. That topic as well as the others on the agenda, will provide you with ideas and innovations which will enable you to do a better job for your company. It is this opportunity for free exchange of ideas that perhaps is the most important reason to support the LMOA and to attend its functions. I urge each of you to participate enthusiastically in this endeavor and to encourage your colleagues on your home roads to join the LMOA.

I am grateful for this honor and thank you for this opportunity to speak. I will look forward to seeing you at our convention in Chicago.

Wednesday, September 30, 1981

8:30 A.M.

REPORT OF THE COMMITTEE ON NEW DEVELOPMENTS

Pre-Convention Presentation: Consolidated Rail Corporation

April 8, 1981
Sheraton Motor Inn
Altoona, PA

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

VICE CHAIRMAN

M. E. Kane, Manager, Locomotive Information System, Conrail, Philadelphia, PA

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T. L. Scott	Asst. Manager	Southern	Chattanooga, TN
T. C. Whittle	Mgr. Product Planning	GE	Erie, PA

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 Developments Committee herewith provides LMOA with an explanation of the new **AAR Standard Rating For Fuel Consumption.** We agree with the AAR that it is time to stop trying to decide the fuel consumption of a given locomotive based on an individual builder's standard or a railroad's test procedure. Now locomotive fuel consumption will be expressed in terms of pounds of fuel required to produce a net traction horsepower hour with variables such as atmospheric pressure, ambient temperature, specific gravity and higher heating value of fuel all brought to an AAR standard condition.

This paper also provides procedures for testing locomotives in the Dynamic and Static modes. Once a railroad has these data for various locomotives in its fleet, it will have a valuable tool for selecting a locomotive by its cost to do work in a particular assignment and the sizing of a consist. Through periodic retesting, plans for locomotive overhaul or replacement can be developed.

The second part of the paper reports on new products offered to the railroad industry over the past year. Thse include an EMD traction motor gear case seal, a Farr

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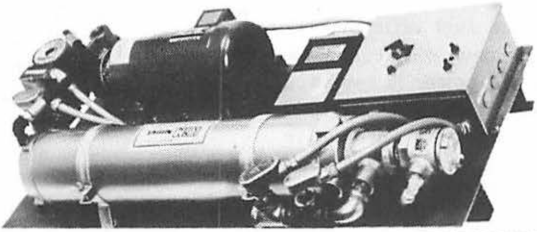

*PATENT APPLIED FOR.

FEATURES	BENEFITS
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2. Over 100% return on investment at end of first year.	Annual fuel savings of 12,000 gallons per locomotive.
3. Complete pre-lubing of bearings and oil gallery while engine is shutdown.	Eliminates wear caused by cold weather starts that result in costly damage to hard-to-get internal parts.
4. Electrical-mechanical flow type heating system.	Absolute minimum maintenance.
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6. Self-contained components are pre-wired and palletized in compact industrial package.	Assures simple and short time installation requiring less than 12 cubic feet of space (24" x 48" x 18")
7. Solid state remote control built-in alarm system.	Eliminates locomotive freeze-up on electrical power failures, element failures and/or coolant flow failures.
8. Fused 115 volt junction box control voltage regardless of applied voltage.	Eliminates hazardous working conditions in high voltage area.
9. Flow control detection valves, and motor relay lockouts.	Additional safety features to shut system down in case of insufficient flow.

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"slammer," new locomotive models from EMD and General Electric, and an update on the Pulse Speed indicators and recorders.

AAR STANDARD RATING FOR SPECIFIC FUEL CONSUMPTION

With the escalating cost of diesel fuel, all railroads are more concerned with the fuel efficiency of both old and new diesel electric locomotives. Old power is reviewed from the standpoint of overhaul or replacement. New locomotive fuel efficiency is a key factor in locomotive purchases.

To assure a uniform method of comparison of specific fuel consumption of diesel electric locomotives, the AAR is developing a standard rating for specific fuel consumption. With the specific fuel consumption for all makes and models specified to a common base, all data — published or test — will be directly comparable. The proposed AAR standard will be reviewed by commenting where appropriate on the specific sections which are in bold type.

STANDARD RATING FOR SPECIFIC FUEL CONSUMPTION OF DIESEL ELECTRIC LOCOMOTIVES SCOPE: To assure uniform method of rating the specific fuel consumption of diesel electric locomotives.

When required by the purchaser, the manufacturer must provide the data on fuel consumption expressed in pounds per hour and provide net traction horsepower under the AAR standard reference conditions at 40 MPH for all throttle positions, including idle, low idle and dynamic brake with full field excitation. The manufacturer must furnish similar type data for additional speed or speeds specified by the purchaser.

Note that the fuel performance will be based on net traction horsepower, which is the output of the main generator. The objective is to determine the useful work performed by the locomotive per unit of fuel. While drawbar horsepower-hour would be the ideal comparison, methods for accurately making this measurement are not currently available. Main generator output is measurable for either static or over-the-road testing. A typical locomotive operating speed is specified to establish the operating point for main generator efficiency.

DEFINITIONS:

(a) **Traction Horsepower**

The traction horsepower rating of a locomotive diesel power plant is the manufacturer's published input horsepower to the main generator for traction purposes, at AAR reference conditions, when all locomotive auxiliaries are operating as necessary to maintain builder's locomotive design specifications except, (1) the air compressor is unloaded, (2) no other power to be provided for other than that required for engine operation, (3) fuel heater to be cut out.

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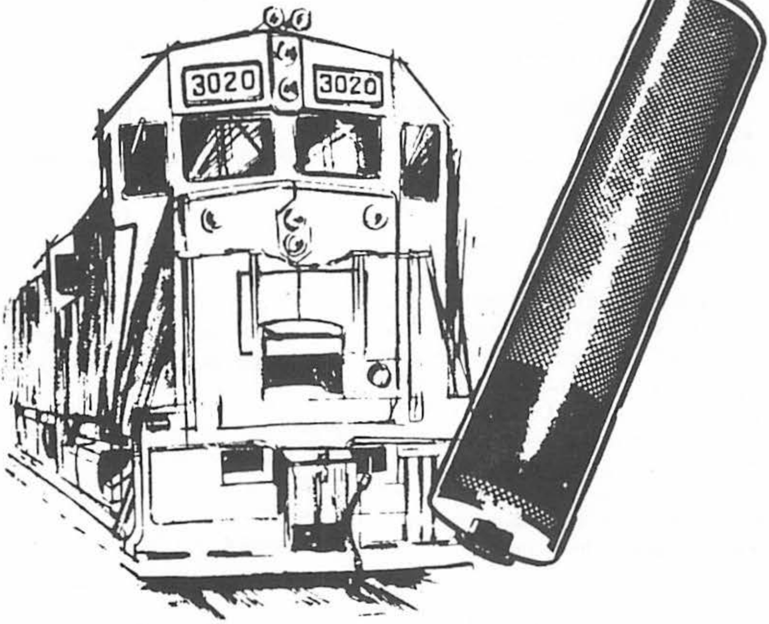

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(1) Traction Horsepower
Using the generator efficiency curve, horsepower input into the main generator can be found thus:

$$\text{Traction Horsepower} = \frac{\text{Main Generator Horsepower}}{\text{Generator Efficiency}}$$

The objective in specifying AAR reference conditions and locomotive accessories operated to maintain builder's design specifications is to take into account that the maximum auxiliary load is not required at AAR conditions. Radiator fans are sized to provide full cooling at 100°F plus. At the AAR 60°F ambient, proper water temperature is maintained with partial fan load. On EMD units, a reduced number of cooling fans will be operated. With GE's recently introduced variable-speed fan drive, the fan operates at a lower average horsepower.

As blowers are direct drive and vary only with engine speed, this auxiliary load can be adjusted only for air density at 60°F.

(b) Brake Horsepower
The brake horsepower of the locomotive diesel engine is the published traction horsepower plus the actual accessory horsepower required at the AAR reference conditions.

Again the raditor fan horsepower should be that required for AAR conditions provided the fan drive horsepower is variable.

(c) Net Traction Horsepower
The net traction horsepower* is the DC electrical horsepower output of the main generator.

(1) Horsepower at the output of the main generator can be determined as follows:

$$\text{Net Traction Horsepower} = \frac{\text{Gen. Volts X Gen. Amps}}{746}$$

or where output is read in watts:

$$\text{Net Traction Horsepower} = \frac{\text{Watts}}{746}$$

*Note: This is observed data that must be corrected to AAR standard conditions.

As mentioned previously, main generator horsepower output or net traction horsepower can be readily and accurately measured. Procedures developed for normal load boxing can be utilized.

(d) Auxiliary Horsepower
The auxiliary horsepower is the actual power required to operate locomotive accessories required to maintain locomotive design specifications at AAR reference conditions. These accessories will include but are not limited to cooling fans, traction motor blowers, unloaded air compressors, etc. Each accessory is to be rated in accordance with AAR reference ambient conditions.

The definition of auxiliary load further reinforces the intent to

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credit fuel efficient auxiliaries such as variable speed fans for the resulting economy.

(e) AAR Standard Reference Conditions are:
  (1) Barometer=28.86" mercury
  (This corresponds to approximately 1000' altitude above sea level.)
  (2) Air Temperature=60°F (15.6°C)
  (3) Fuel Temperature=60°F (15.6°C)
  (4) Specific gravity of fuel=.845
  (The weight or density of fuel=7.043 pounds/gallon
  (5) Fuel high heat value=19,350 BTU/pound
  (Measured by Baum calorimeter)

As the three builders consulted on the fuel specification utilize different standard conditions, the resulting AAR standard conditions are a compromise. Only fuel and air temperature values were common for the builders.

The selection of the standards was based on present day condition. A barometric pressure of 28.86 inches of mercury corresponding to approximately 1000 feet above sea level was accepted as typical of average railroad operation.

The fuel specific gravity and higher heating value selection were based on the results of fuel sampling on four major railroads. As two were Eastern railroads and two were Western railroads, it was felt that the results should represent the total railroad industry.

The fuel sampling also indicated a lack of correlation between fuel higher heating value as determined by a calorimeter and the HHV determined by specific gravity. The use of specific gravity and API tables produced an average error of 1.2%. As fuel testing requires a high degree of accuracy, the standard for fuel HHV specifies that it will be determined with a Baum calorimeter.

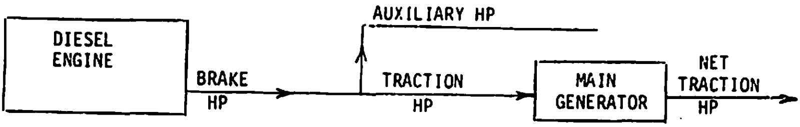
With the annual fuel bill for U.S. railroads already measured in billions of dollars and individual railroads spending as much as $400 million, all railroads should have the capability of establishing the heating value quality of their fuel supply. Although fuel is purchased in gallons, it is the BTU content that makes the wheels go round. The equipment required to perform the test can be purchased for under $10,000. With training, the test can be performed by competent lab personnel. For railroads that do not want to develop this capability, commercial labs throughout the country can provide this service.

Summary

The following diagram visually portrays the new AAR definitions.

SPECIFIC FUEL CONSUMPTION — STATIC TEST

Two major questions arise when determining specific fuel consumption. One, the amount of fuel burned over a specific period of



All horsepowers are to conform to AAR standard reference conditions.

time and, two, the amount of useful work being performed by the locomotive under test. The measurement of both fuel consumption and work performed (generator output) are required for an accurate test. Both measurements are necessary because some locomotives operate with a constant fuel rate while others operate at constant horsepower. Fuel rate alone does not reflect actual locomotive efficiency.

The Static or Load Box test will provide the basic measurements of fuel consumed and work performed for each unit on a notch by notch basis. Static testing offers the following advantages:

1) A reasonable correlation with over-the-road testing.
2) The test unit will be out of service for a minimum amount of time.
3) A minimum investment in manpower is required.
4) Most railroad shops will find the instrumentation and hardware required to be readily available.
5) The test has a high potential accuracy (± 0.25% to 0.50%).

Reliability and Service

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Before testing can proceed, the various systems on the locomotive should be known to be in good condition. This action will enhance the potential accuracy and repeatability of the test results. The Committee strongly recommends checking the following items:

1) Cooling System including fans, radiators and temperature control devices.
2) Air Filtration System — engine air filters.
3) Fuel Systems, including fuel filters, injection equipment and fuel lines. Injection timing, rack length and governor settings (engine speeds) should be verified.
   Note: If the unit is equipped with a fuel preheater, it should be cut out.
4) Engine air exhaust including valve timing, condition of turbochargers, after coolers, air leaks from turbo to cylinders, exhaust leaks from cylinders to turbo, any restrictions of air flow (carbon build-up, etc.). Note: G. E. recommends preturbine temperatures be verified to within prescribed limits.
5) Electrical System — all nonessential accessories should be turned off, including lights, electric heaters or air conditioners, radios, etc.
6) Air Compressor — should be in the unloaded state during test.

The following equipment is required for the test:

1) A calibrated platform scale with either a 500 or 1000-lb. capacity. Would suggest a large dial and pointer-type scale as preferable to a balance beam-type scale.
2) A clean 55 gallon drum with one end cut out.
3) A calibrated 5000 amp shunt, meter and leads for generator current.
4) Calibrated meter and leads for generator voltage.
5) Two accurate thermometers or thermocouples and thermocouple readouts.
6) An accurate barometer.
7) An accurate stop watch.
8) One or two extra fuel transfer pumps.
9) Assorted hoses, fittings and valves.

After the locomotive is on the load box, proceed to re-sequence the fuel piping so that all fuel lines that normally run to the fuel tank are run to the clean 55 gallon drum. The platform scale with the drum on it should be placed on level ground along the locomotive near the fuel booster pump. The suction line from the locomotive fuel tank should be disconnected and replaced with a hose of equal size to the 55 gallon drum (to within 6 inches of the bottom of the drum). All hoses should run either level or downward toward the 55 gallon drum. Care should be taken when laying the hoses in place to prevent kinks or sags in them. The hoses should not touch the sides or bottom of the drum as they run into it.

During the testing, the drum can be filled between test runs by using a spare fuel pump so that fuel is drawn from the locomotive fuel tank. A second spare fuel pump may be used in order to reduce the time required for this task.

Again we point out that the air compressor should be run in the unloaded state. All unnecessary auxiliary loads such as electric cab heat, lights, etc., should be turned off. With EMD units, it is required to manually control cooling fan operation to prevent unintentional fan cycling during the test. Engine water temperature should be maintained in the range of 170 to 190°F.

On some G. E. units equipped with an eddy current clutch in the cooling system, the clutch must be electrically jumpered at either full speed or at intermediate speed, in order to prevent cycling.

With the fuel piping completed and the drum filled, the engine should be brought up to temperature. Run the engine in throttle 8 for approximately one hour to insure that all engine temperatures and pressures have reached a steady state. This also will allow sufficient time to stabilize generator efficiency. For best accuracy and repeatability, start testing at throttle 8 and then proceed through the lower throttle positions in their normal downward sequence. After each subsequent throttle change, allow approximately 10 minutes in order to again reach a steady state.

The fuel return hose(s) should be suspended over the 55 gallon drum in such a manner that their ends are above the level of the fuel. It will then be possible to observe the amount of fuel being returned. After the warm-up period, a steady flow of fuel should be observed from the fuel return hose(s). During the measurements, care should be taken not to disturb the hoses.

During each run, the length of time required to burn a weighed amount of fuel should be timed with the stop watch. It is recommended that no less than 100 lb. of fuel be burned at run 8 and no less than 15 lb. of fuel be burned at idle. To insure repeatability and insure a stabilized engine/generator system, obtain at least three complete readings of all required data at each throttle position. The throttle 8 readings should easily repeat within 0.25%.

At the same time the fuel is being timed, the following additional measurements should be taken:

A. Generator Current
B. Generator Voltage
C. Barometric Pressure
D. Ambient Air Temperature (Inlet air temperature)
E. Fuel Temperature (fuel in 55 gallon drum)

At sometime during the test, a fuel sample should be taken from the drum. This sample should later be analyzed to determine its fuel higher heating value in BTU's/lb. and specific gravity.

With the data taken, the calculations should be done as follows:

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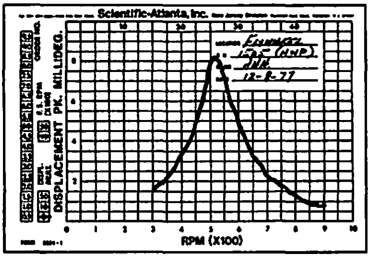
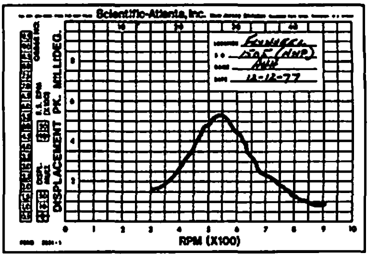


By comparing test results of the same diesel...



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involves electronically measuring shaft angular velocity to determine normal levels of torsional vibration, from which by visual comparison you can subsequently spot abnormal levels — the first signs your diesels need help.

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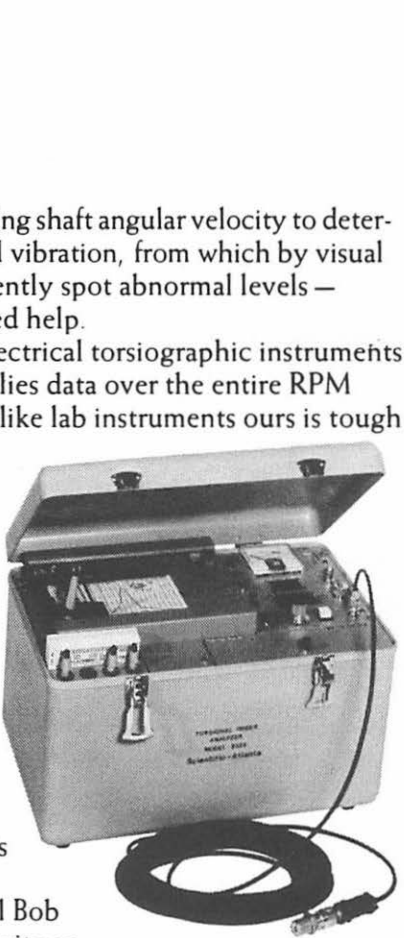

Do your dampers, drive shafts, gears or couplings need help? Should a defective part be repaired or replaced? Or has a new engine component been installed properly? Find out with the Scientific-Atlanta 2524 Torsional Order Analyzer. It costs too much to guess.

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Scientific Atlanta

EMD

1) The observed fuel rate varies with fuel temperature and fuel specific gravity.

2) The observed brake horsepower varies with fuel temperature, ambient air temperature, barometric pressure and fuel higher heating value

3) The observed traction horsepower varies with engine brake horsepower and locomotive auxiliary horsepower.

4) Locomotive auxiliary horsepower varies with engine speed and ambient air density (temperature and barometric pressure).

For a proper evaluation and comparison of load box test results, it is considered necessary to correct the fuel burned and work done to standard AAR reference conditions.

A. Obtain the auxiliary horsepower (provided by EMD for throttle 8).

CHP=Compressor Horsepower----unloaded
AGHP=Auxiliary Horsepower (all accessories off)
TMBHP=Traction Motor Blower Horsepower
CFHP=Cooling Fan Horsepower
ISBHP=Inertial Separator Blower Horsepower (if applied).

Note: The auxiliary horsepowers provided by EMD are for throttle eight rated engine speed and 0.070 LBM/FT^3 ambient air density. Actual speed and site or observed conditions require the following adjustments:

$$CHP_A = CHP \times \left(\frac{RPM}{T8RPM}\right) \quad \text{(EMD Data Sheet, Line 23)}$$

AGHP = Constant, no adjustment required (EMD Data Sheet, Line 14A)

$$TMBHP_A = TMBHP \times \left(\frac{RPM}{T8RPM}\right)^3 \times \frac{B.P.}{29.03} \times \frac{550}{460+A.T.} \quad \text{(EMD Data Sheet, Line 24)}$$

$$CFHP_A = CFHP \times \left(\frac{RPM}{T8RPM}\right)^3 \times \frac{B.P.}{29.03} \times \frac{550}{460+A.T.} \times \text{No. Fans Running}$$
(EMD Data Sheet, Line 21)

$$ISBHP_A = ISBHP \times \left(\frac{RPM}{T8RPM}\right)^3 \times \frac{B.P.}{29.03} \times \frac{550}{460+A.T.} \quad \text{(EMD Data Sheet, Line 22)}$$

B.P. = Test Site Barometric Pressure
A.T. = Test Site Ambient Air Temperature

B. Total Corrected Auxiliary Horsepower Observed ($TCAHP_O$) as follows:

$$TCAHP_O = CHP_A + AGHP + TMBHP_A + CFHP_A + ISBHP_A \quad \text{(EMD Data Sheet, Line 25)}$$

C. The Observed Traction Horsepower (THP_O) as follows:

$$THP_O = \frac{\text{Volts X Amps}}{\text{746 X Generator Efficiency}}$$
(EMD Data Sheet, Line 26)

Note: The appropriate generator efficiency is provided by EMD.

D. The Observed Brake Horsepower (BHP_O) at site conditions as follows:

$$BHP_O = TCAHP_O + THP_O \quad \text{(EMD Data Sheet, Line 27)}$$

E. The Observed Brake Horsepower must now be corrected to AAR standard conditions (BHP_{SC})

$$BHP_{SC} = \frac{BHP_O}{AxBxCxDxE} \quad \text{(EMD Data Sheet, Line 33)}$$

A. Correction Factor for ambient air temperature

1.033612 - (.0005602 X A.T.) (EMD Data Sheet, Line 16A)

B. Correction Factor for altitude

$0.875899 \times 10^{-5} (B.P.)^4 + 0.983816 \times 10^{-3} (B.P.)^3$
$-0.417117 \times 10^{-1} (B.P.)^3 + 0.795486 (B.P.)$
-4.7882103

(EMD Data Sheet, Line 16B)

C. Correction Factor for fuel specific gravity

$$\frac{\text{Actual Specific Gravity}}{.845} \quad \text{(EMD Data Sheet, Line 30)}$$

D. Correction Factor for fuel temperature

1.03 - (.0005 X Inlet Fuel Temperature) (EMD Data Sheet, Line 31)

E. Correction Factor for fuel Higher Heating Value

$$\frac{\text{Measured HHV of Fuel}}{19350} \quad \text{(EMD Data Sheet, Line 32)}$$

F. Corrected Fuel Rate (FR_{SC}), lbs/hr, at standard conditions:

$$FR_{SC} = \frac{\left(\frac{\text{Weight of Fuel}}{\text{Time to Burn}}\right) \times 60}{\left(\frac{\text{Specific Gravity}}{.845}\right) \times 1.03 - (.005 \times \text{Inlet Fuel Temp.})}$$

(EMD Data Sheet, Line 39)

G. The Brake Specific Fuel Consumption ($BSFC_{SC}$) at standard conditions:

$$BSFC_{SC} = \frac{FR_{SC}}{BHP_{SC}} \quad \text{(EMD Data Sheet, Line 40)}$$

H. The Net Traction Specific Fuel Consumption ($NTSFC_{SC}$) at standard conditions:

$$NTSFC_{SC} = \frac{FR_{SC}}{(BHP_{SC} - TCAHP_{SC}) \times \text{Gen. Efficiency}} \quad \text{(EMD Data Sheet, Line 42)}$$

Note: $TCAHP_{SC}$ calculations are required as EMD published auxiliary horsepowers have not previously been rated at new AAR standards. (EMD Data Sheet, Line 35)

G.E.

The observed test data is taken for site conditions of:

1. Ambient Temperature
2. Barometric Pressure
3. Fuel Higher Heating Value (H.H.V.)

For comparison with published data, these readings must be corrected to AAR standard conditions.

A. Obtain the auxiliary horsepowers at throttle 8 (provided by GE)

CHP = Compressor Horsepower---unloaded
AGHP = Auxiliary Generator Horsepower (all accessories off)
FBHP = Radiator Fan + Equipment Blower Horsepower
HPCF = Horsepower Correction Factor

$$HPCF = \frac{520}{460 + \text{Air Temp. }^{\circ}F} \times \frac{\text{Barometric Pressure}}{28.86}$$

Note: G.E. specifies the various auxiliary loads for each notch for standard AAR conditions. Fan and blower loads must be corrected for observed or site conditions. Throttle 8 loads should be used and corrected for lower speeds. Aux. Gen. and unloaded Compressor are not affected by variations in Temperature and Barometric Pressure.

B. Total Corrected Auxiliary Horsepower Observed ($TCAHP_O$)

$TCAHP_O$ = (FBHP X HPCF) + CHP + AGHP (GE Data Sheet, Line 22)

C. The observed Traction Horsepower (THP_O) as follows:

$$THP_O = \frac{\text{Volts X Amps}}{746 \text{ X Alternator Efficiency}}$$ (GE Data Sheet, Line 23)

Alternator efficiency varies with rpm, horsepower and load resistance. The appropriate alternator efficiency is provided by G.E.

D. The observed Brake Horsepower (BHP_O) at site conditions as follows:

$BHP_O = TCAHP_O + THP_O$ (GE Data Sheet, Line 24)

Note: The observed Brake Horsepower (BHP_O) must now be corrected to standard AAR conditions for inlet air temperature (A) and barometric pressure (B).

Inlet Air Temp. correction factor (A)
A = curves for specific models are provided in the maintenance instructions by GE or see GE Data Sheet, Line 25

Barometric Pressure correction factor (B)
$$B = 1.0 + \left(\frac{28.86 - \text{B.P.}}{192.3}\right)$$ (GE Data Sheet, Line 26)

E. The Brake Horsepower at standard conditions (BHP_{SC}) as follows:

$BHP_{SC} = BHP_O$ X A X B (GE Data Sheet, Line 28)

F. The Fuel Rate at standard conditions as follows:

$$FR_{SC} = \frac{60}{\text{Time in Minutes to Burn Fuel}} \times \frac{\text{Fuel H.H.V.}}{19350} \times \text{Weight of Fuel}$$
(GE Data Sheet, Line 30)

G. The Brake Specific Fuel Consumption at standard conditions ($BSFC_{SC}$)

$$BSFC_{SC} = \frac{FR_{SC}}{BHP_{SC}}$$ (GE Data Sheet Line 31)

H. The Net Traction Specific Fuel Consumption at standard conditions ($NTSFC_{SC}$)

$$NTSFC_{SC} = \frac{FR_{SC}}{(BHP_{SC} - TCAHP_{SC}) \text{ X Alt. Efficiency}}$$

(GE Data Sheet, Line 33)

Note: Total Corrected Auxiliary H.P. at standard conditions ($TCAHP_{SC}$) are required. See GE Data Sheet, Line 33.

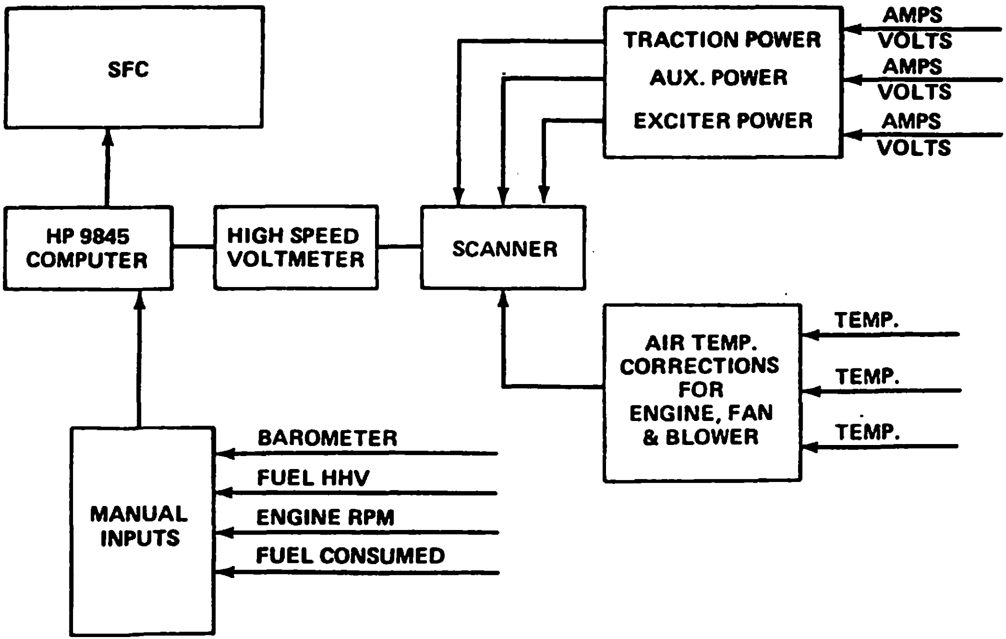
The resulting figure, $NTSFC_{SC}$, is the pounds of fuel consumed per net traction horsepower hour. The lower this number, the more efficient the locomotive is. Once the net traction specific fuel consumption has been determined in each throttle position and mode of operation, this fuel consumption profile can be plugged into the actual duty cycle for the specific locomotive to evaluate its fuel consumption for a given type of service. The duty cycle can be determined with the use of throttle clocks.

The Committee notes that there have been computerized systems developed for fuel consumption testing. Those systems do improve on the accuracy and repeatability and can further reduce the test time and manpower required. (See Diagram I).

In closing, we also point out that Static or Load Box Specific Fuel Consumption testing cannot evaluate locomotive transients and does exclude generator efficiency effects, two subjects dealt with next in over-the-road or dynamic testing.

DIAGRAM I

FLOW DIAGRAM OF GE STATIC MEASUREMENT SYSTEM



FUEL CONSUMPTION - EMD LOCOMOTIVE
TEST DATA SHEET

Run # 2 Throttle # 7

1) Locomotive Road # 3526 Test Date 1-26-81 Test Location ENG'R.
Locomotive Model # GP50
Engine Model # 16-645F3 Engine Serial # ________

2)	Actual RPM	842	RPM
3)	Barometric Pressure	29.10	IN. HG
4)	Fuel Inlet Temperature	90.6	°F
5)	Ambient Temperature	59.0	°F
6)	Generator Voltage	870	VOLTS
7)	Generator Current	2460	AMPS
8)	Pounds of Fuel Burned	70	POUNDS
9)	Test Time	3.74	MINUTES
10)	Number of Radiator Fans Running	3	
11)	Fuel Specific Gravity (measured by laboratory)	0.8560	
12)	Fuel Higher Heating Value (measured by laboratory)	19362	BTU/LBM
13)	Other Pertinent Test Information (not required for calculations)		
	a) Load Regulator Position	9:00 o'clock	
	b) Governor Rack Position	0.83	IN.
	c) Engine Inlet Water Temperature	175.1	°F

COMMENTS: ________

\- 2 -

FUEL CONSUMPTION - EMD LOCOMOTIVE

MANUFACTURER'S INFORMATION SHEET

LOCOMOTIVE MODEL GP50

14) Accessory Horsepower Values

a) Auxiliary Generator . . . . 4.0 HP

b) Unloaded Air Compressor . . . . 17.0 HP

c) Inertial Separator Blower . . . . 14.0 HP

d) Traction Motor Blower . . . . 87.0 HP

e) Cooling Fan, ea. . . . . 47.6 HP

15) Accessory Horsepower Rating Conditions

a) Rated Engine Speed . . . . 950 RPM

b) Air Temperature . . . . 90 °F

c) Barometer . . . . 29.03 IN.HG
(equivalent to 0.070 lbm/ft^3 air density)

16) Engine Correction Factors

EMD Engine Model # 16-645F3

a) Ambient Air Temperature Correction Factor
60°F ambient air temperature standard reference condition

$$FACTOR = 1.033612 - 0.0005602\,(AT)$$

b) Ambient Barometric Pressure Correction Factor
28.86 in. HG barometer standard reference condition

$$FACTOR = 0.875899 \times 10^{-5}(BP)^4 + 0.983816 \times 10^{-3}(BP)^3 - 0.417117 \times 10^{-1}(BP)^2 + 0.795486\,(BP) - 4.7882103$$

- 3 -

FUEL CONSUMPTION - EMD LOCOMOTIVE

CALCULATION SHEET

	17)	Line 2 ÷ Line 15a	0.8863
	18)	$(\text{Line } 17)^3$	0.69625
	19)	Line 3 ÷ Line 15c	1.0024
	20)	(460 + Line 15b) ÷ (460 + line 5)	1.05973
($CFHP_A$)	21)	Adjusted Radiator Fan Horsepower: Line 10 x Line 14e x Line 18 x Line 19 x Line 20	105.62 HP
($ISBHP_A$)	22)	Adjusted Inertial Blower HP: Line 14c x Line 18 x Line 19 x Line 20	10.35 HP
(CHP_A)	23)	Adjusted Air Compressor HP: Line 14b x Line 17 . .	15.07 HP
($TMBHP_A$)	24)	Adjusted Traction Motor Blower HP: Line 14d x Line 18 x Line 19 x Line 20	64.35 HP
($TCAHP_O$)	25)	Total Corrected Auxiliary Horsepower Observed: Line 14a + Line 21 + Line 22 - Line 23 + Line 24 . .	199.38 HP
(THP_O)	26)	Observed Traction Horsepower: Line 7 x Line 6 ÷ 700 .	3057.4 HP
(BHP_O)	27)	Observed Brake Horsepower: Line 25 + Line 26 . . .	3256.8 HP
	28)	Ambient Air Temperature Correction: Line 16a x Line 5	1.00056
	29)	Barometric Pressure Correction: Line 16b x Line 3	1.00098
	30)	Fuel Gravity Correction: Line 11 ÷ .845	1.0130
	31)	Fuel Inlet Temperature Correction: 1.03 - (.0005 x Line 4)	0.9847
	32)	Fuel HHV Correction: Line 12 ÷ 19350	1.00062
(BHP_{SC})	33)	Brake Horsepower Corrected to Standard Conditions: Line 27 ÷ (Line 28 x Line 29 x Line 30 x Line 31 x Line 32)	3257.9 HP

- 4 -

FUEL CONSUMPTION - EMD LOCOMOTIVE

CALCULATION SHEET

	34)	Number of Cooling Fans Required at Standard Conditions (furnished by manufacturer)	2
($TCAHP_{SC}$)	35)	Total Corrected Auxiliary Horsepower at Standard Conditions: Line 14a + [(Line 34 x Line 14e) + Line 14d + Line 14c] x [Line 18 x (28.86 ÷ 29.03) x (550 ÷ 520)] + Line 23	158.43 HP
(THP_{SC})	36)	Corrected Traction Horsepower at Standard Conditions: Line 33 - Line 35	3099.5 HP
($NTHP_{SC}$)	37)	Corrected Net Traction Horsepower at Standard Conditions: Line 36 x (700 ÷ 746)	2908.4 HP
(FRo)	38)	Observed Fuel Rate: (Line 8 ÷ Line 9) x 60	1123.0 #/HR
(FR_{SC})	39)	Fuel Rate Corrected to Standard Conditions: Line 38 ÷ (Line 30 x Line 31)	1125.8 #/HR
($BSFC_{SC}$)	40)	Brake Specific Fuel Consumption: Line 39 ÷ Line 33)	.3455 #/Brake HP HR
($TSFC_{SC}$)	41)	Traction Specific Fuel Consumption: Line 39 ÷ Line 36	.3632 #/Traction HP-HR
($NTSFC_{SC}$)	42)	Net Traction Specific Fuel Consumption: Line 39 ÷ Line 37	.3871 #/Net Traction HP-HR

FINAL COMMENTS: ______________________________

____

____

FUEL CONSUMPTION - GE LOCOMOTIVE

TEST DATA SHEET

Run # 4 Throttle # 8

1) Locomotive Road # 505 Test Date 1/15/81 Test Location Erie, Pa.

Locomotive Model C30-7

Engine Model # FDL16 Engine Serial # -

2)	Actual RPM	1049	RPM
3)	Barometric Pressure	29.40	In Hg.
4)	Fuel Inlet Temperature	Not Recorded	°F
5)	Ambient Temperature	20.0	°F
6)	Generator Voltage	733.4	Volts
7)	Generator Current	2985	Amps
8)	Pounds of Fuel Burned	100	Pounds
9)	Test Time	5.52	Minutes
10)	Radiator Fan Horsepower	12.0	HP*
11)	Fuel Higher Heating Value (Baum Calorimeter)	19,219	BTU/Lb.

COMMENTS: * Eddy current clutch energized on low speed

FUEL CONSUMPTION - GE LOCOMOTIVE MANUFACTURER'S

INFORMATION SHEET

LOCOMOTIVE MODEL C30-7

12) Accessory Horsepower Values

a) Auxiliary Generator . . . . 4.0 HP

b) Unloaded Compressor . . . . 12.0 HP

c) Equipment Blower . . . . 117 HP

d) Radiator Fan (Line 10 Operating Mode) . . . . 12.0 HP

e) Radiator Fan (AAR Standard Conditions - Furnished by Notch) . . . . 45.0 HP

13) Accessory Horsepower Rating Conditions

a) Rated Engine Speed . . . . 1050 RPM

b) Air Temperature . . . . 60 °F

c) Barometer . . . . 28.86 In Hg

14) Generator Efficiency - Conditions of Lines 2, 6 & 7 . . . . . . 94.7 %

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FUEL CONSUMPTION - GE LOCOMOTIVE

CALCULATION SHEET

LOCOMOTIVE MODEL C30-7

	15)	Line 2 ÷ Line 13a	.9990	
	16)	(Line 15)^3	.9971	
	17)	Line 3 ÷ 13c	1.0187	
	18)	(460 + Line 5) ÷ 520	.9231	
	19)	Adjusted Radiator Fan Horsepower: Line 10 X Line 16 X Line 17 ÷ Line 18	13.2	HP
(CHP)	20)	Adjusted Air Compressor Horsepower: Line 12b X Line 15	12.0	HP
	21)	Adjusted Equipment Blower Horsepower: Line 12c X Line 16 X Line 17 ÷ Line 18	128.7	HP
($TCAHP_o$)	22)	Total Corrected Auxiliary Horsepower Observed: Line 12a + Line 19 + Line 20 + Line 21	157.9	HP
(THP_o)	23)	Observed Traction Horsepower: Line 6 X Line 7 ÷ (746 X Line 14)	3098.8	HP
(BHP_o)	24)	Observed Brake Horsepower: Line 22 + Line 23	3256.7	HP
	25)	Ambient Air Temperature Correction Factor: (Line 18)$^{.197}$ (Line 18)^3	.9877	
	26)	Barometric Pressure Correction Factor: 1 + [(28.86 - Line 3) ÷ 192.3]	.9972	
	27)	Fuel HHV Correction Factor 19350 ÷ Line 11	1.0068	
(BHP_{sc})	28)	Brake Horsepower Corrected to Standard Conditions: Line 24 X Line 25 X Line 26	3207.6	
	29)	Observed Fuel Rate (Line 8 ÷ Line 9) X 60	1087.0	#/Hr
(FR_{sc})	30)	Fuel Rate Corrected to Standard Conditions: Line 29 ÷ Line 27	1079.6	#/Hr
($BSFC_{sc}$)	31)	Brake Specific Fuel Consumption: Line 30 ÷ Line 28	.3366	#/BHP-H
($NTHP_{sc}$)	32)	Net Traction Horsepower Corrected to Standard Conditions: [Line 28 - Line 12a - (Line 12b X Line 15) - Line 12c X Line 16) - (Line 12e)] X Line 14	2869.3	N.T.HP
($NTSFC_{sc}$)	33)	Net Traction Specific Fuel Consumption: Line 30 ÷ Line 32	.3762	#/NTHP

SPECIFIC FUEL CONSUMPTION DYNAMIC TEST

The accuracy of over-the-road fuel consumption testing became important in recent years when such tests were conducted to determine the effectiveness of fuel-saver devices at reducing fuel consumption. The original fuel saver test gave results that varied from 10% more fuel consumed to 25% fuel savings. It quickly became apparent that the many variables involved in over-the-road testing, made it almost impossible to get repeatable results without using sophisticated equipment. It also became apparent that gallons per thousand gross ton miles was not a good measure of locomotive performance because this figure varies with too many variables.

Since those first tests, sophisticated systems have been developed to accurately measure fuel consumption and traction horsepower during over-the-road tests. Tests conducted using those sophisticated systems have shown that over-the-road test results can be reasonably predicted using accurately measured static load box fuel consumption test results and the correct duty cycle.

One method of conducting an over-the-road fuel test is to: run the test locomotives in the same consist, measure all power produced, and correct the data to standard conditions. By correcting the data to standard conditions, results of over-the-road tests can be compared to other tests that have been corrected to standard conditions, regardless of what the conditions were when the tests were conducted. Those tests also can be compared to manufacturer's published data, which is corrected to standard conditions.

A second test method is to operate the test locomotives in the same consist, but make no corrections to the data. The results are based on total kilowatt hours produced and total gallons of fuel consumed. The total gallons fuel consumption is corrected to standard reference conditions or constant BTU because of unit to unit differences in fuel temperature and energy content. The results of head to head testing conducted in this manner can be used to compare the performance of a test locomotive, but cannot be used to compare with other test results not conducted at the same operating conditions and cannot be compared to manufacturer's published data that have been corrected to standard conditions.

A controversy now exists as to which test method gives the true results. One locomotive builder argues that the head to head test with no correction factors is the true test. That builder contends that correction factors do not pull box cars. Another locomotive builder argues that the head to head test, corrected to standard conditions and accounting for all work produced will give repeatable results regardless of what the conditions are when the test is conducted. It contends that not correcting the data will give a

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different result every time the test is run. Based on previous test results, the committee recommends that the tests should be run to record enough data so that the data can be corrected to standard conditions, the results can be calculated using both methods.

Figure 1 is a measurement flow diagram for a computerized system used to measure and calculate fuel consumption. As shown in the diagram, both manual and automatic input are used because it is necessary to account for all power produced and corrected to non-standard conditions.

Useful Work

In accounting for all work produced the air compressor horsepower and cab heat energy must be added to traction horsepower when calculating net traction specific fuel consumption. The cab heat energy is a manual input at the end of the run from data obtained using standard kilowatt hour meters. This is important because cab heat during cold weather can be as much as 3% of the total duty cycle traction horsepower. To account for air compressor work, it is necessary to determine the throttle duty cycle and the air compressor duty cycle. When unloaded, the air compressor is not doing useful work and becomes a parasitic load.

Since the alternator efficiency changes with volts, amps and alternator speed, it is necessary to input these conditions so that the computer can calculate the efficiency continually for the varying operating conditions.

Non-Useful Work

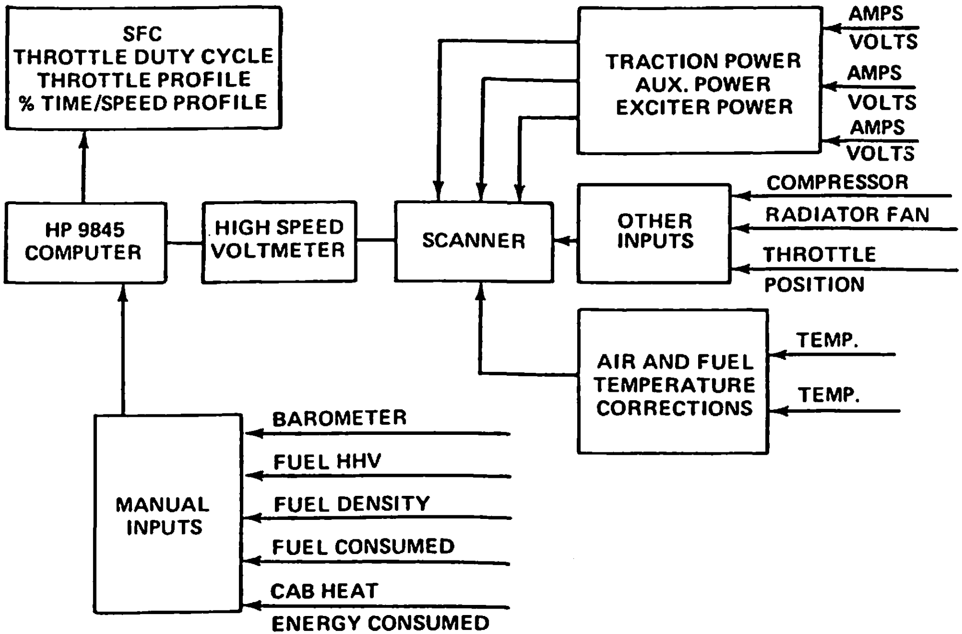
Auxiliary generator horsepower, exciter horsepower, radiator cooling fan horsepower, and equipment blower horsepower are all considered parasitic loads and are used to calculate brake horsepower. Fan horsepowers are corrected to standard conditions using corrections for barometric pressure and air temperature.

Fuel Measurements

The major difference between static and dynamic fuel consumption testing is in the measurement of fuel consumed. Fuel weight is the ideal measure in establishing specific fuel consumption, but it is not considered practical for over-the-road tests. Instead, it is recommended that fuel consumption be measured using a positive displacement flow meter. Figure 2 shows the recommended scheme to measure fuel consumption on an EMD locomotive. The fuel to fuel heat exchanges help to reduce the return fuel temperature. Without this heat exchanger, the fuel temperature at idle could become excessive causing injector damage, as most of the return fuel remains in the closed loop. The fuel meter is a positive displacement type and is used to measure only the fuel that is burned by the engine. The return fuel from the engine is returned ahead of the flow meter.

Figure 3 shows the recommended scheme to measure fuel consumption on a G. E. locomotive.

FLOW DIAGRAM OF GE DYNAMIC MEASUREMENT SYSTEM



FLOW DIAGRAM OF FUEL MEASUREMENT SYSTEM FOR EMD LOCOMOTIVES

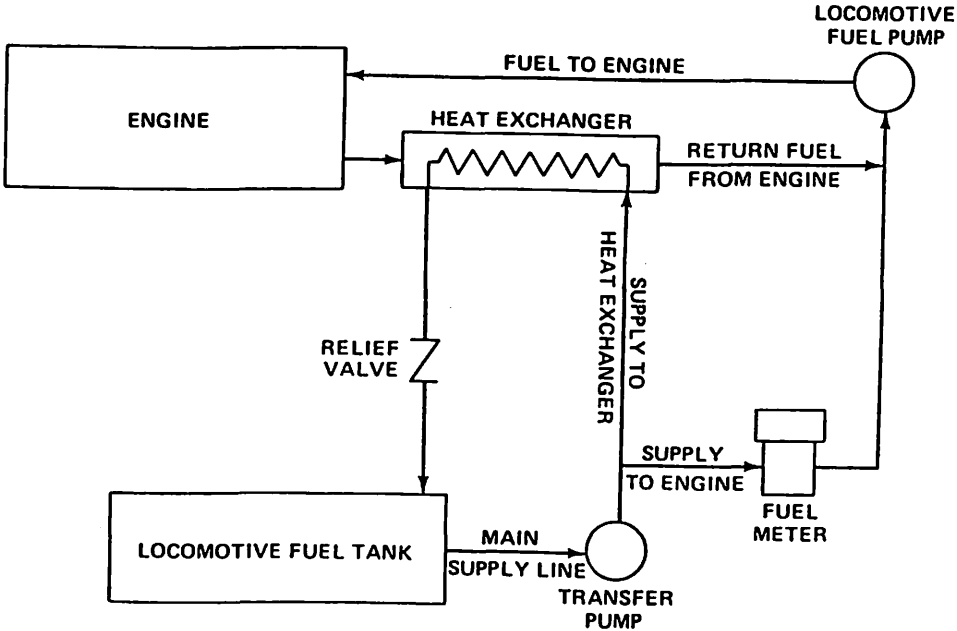
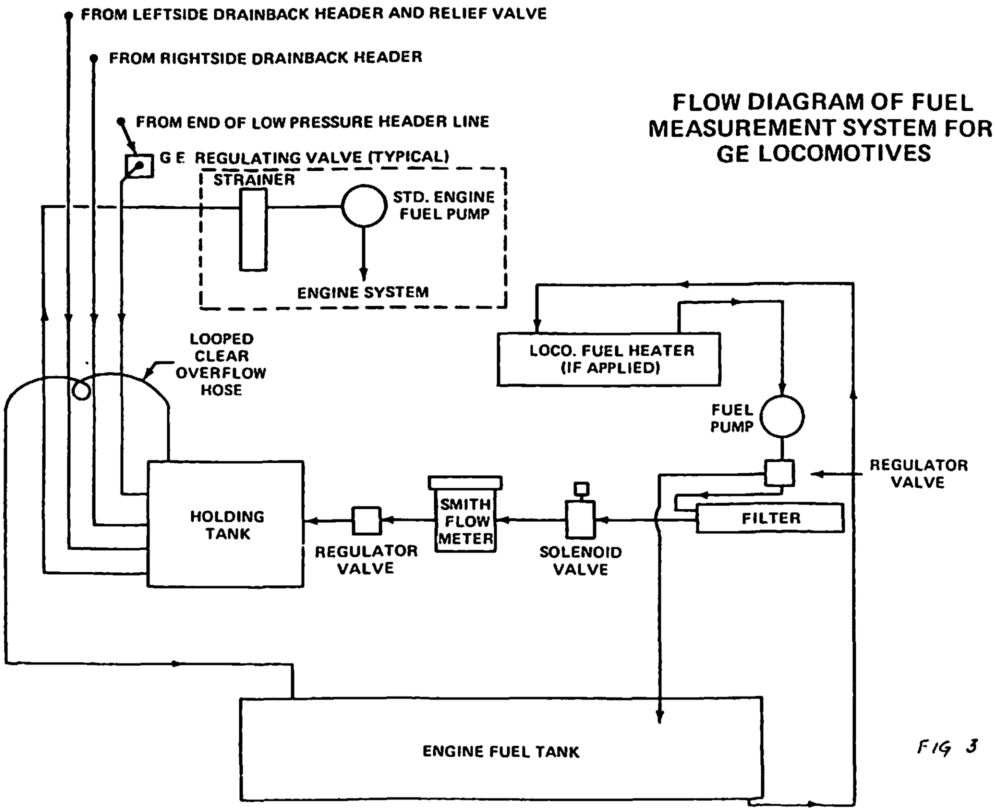


FIG 2



FLOW DIAGRAM OF FUEL MEASUREMENT SYSTEM FOR GE LOCOMOTIVES

FIG 3

The high-pressure pump and nozzle arrangement on the G. E. locomotive causes high-pressure pulsation that prevents using the same method as on the EMD system. The recommended method isolates the flow meters from the high-pressure pulsation by using a holding tank. The holding tank is equipped with a high and low-level detector that controls the solenoid valve regulating the addition of fuel to the holding tank. The holding tank also serves as an easy means of collecting fuel from the drain back headers.

Several major railroads have conducted both static and dynamic fuel consumption tests. They have concluded that the results correlate reasonably well when the dynamic tests are run so as to account for all work produced and the data are corrected back to standard conditions. Locomotive builders are not in agreement on this point, so are working in conjunction with a major western railroad to run accurately controlled dynamic tests to resolve this controversy.

NEW EMD TRACTION MOTOR GEAR CASE SEALS

Gear case sealing performance has not kept pace with advances in other areas of locomotive design. One major railroad had an average of four dry gear failures per day during a past summer with annual estimated cost above two million dollars.

Recent LMOA meetings have produced much discussion of the problems resulting from loss of lubricant from gear cases. EMD now has readdressed this problem by the development of an improved traction motor gear case seal arrangement. This new arrangement incorporates gear case side sheet to axle seals of molded plastic with 360° integral gutters. The new seals are utilized in conjunction with a modified standard-type gear case, which should permit eventual retrofit at more reasonable cost.

The new sealing arrangement is presently undergoing field tests on four major railroads. Field inspections to date have confirmed the excellent results anticipated based on laboratory tests.

The new seals will be adopted for EMD production locomotives pending continued satisfactory results and final inspection evaluations of test seals. This is expected to occur before mid-1981.

NEW FARR "SLAMMER" ENGINE SHUTDOWN DEVICE

A new Farr "Slammer" Engine Shutdown device was developed to quickly and safely cut off combustion air to the diesel engine when an engine abnormality is detected, in order to minimize consequential damage. For example, the device is intended to protect the turbocharger against damage from overspeed and overheat in the event of an air box fire.

The device consists of an air cylinder powering a guillotine-type air valve incorporated into the Farr paper engine air filter housing just before the turbocharger air inlet. This air valve closes in approximately 1/4 second, shut-

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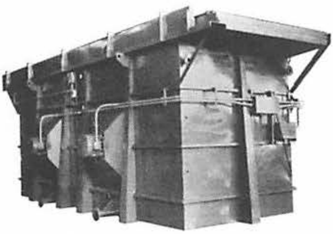

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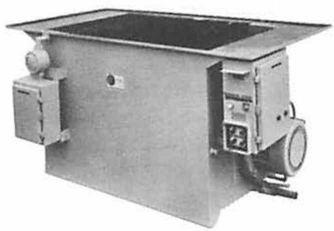

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ting off combustion air to the engine when temperatures or pressures exceed the threshold of special sensors in the engine air box. It can bring the engine to a stop from full load in approximately 10-12 seconds.

Limited field experience (on SD-45 locomotives only) indicates that the device functions as designed. In actual service, the device has been triggered by excessive blow-by, fuel dilution, broken valve guides, broken piston rings and an overheated assembly caused by a plugged piston cooling oil pipe. It has extinguished air box fires in time to prevent turbocharger damage.

Experience so far seems to indicate that the device can frequently prevent expensive consequential damage that can result from many types of primary failure. Experience also has emphasized the very hostile environment to which the sensors and wiring are exposed.

Any decision for applying this device must necessarily take into account (1) the present incidence and cost of fleet failure which this device addresses, (2) the requirement that equipped units must use paper filters only and (3) the possible extra cost for maintenance of the sensing devices and wiring to avoid false shutdowns and insure maximum protection. Current estimated material costs are $2500 per locomotive unit.

As additional test experience accumulates, the long-term evaluation of this item for a given fleet will become much easier.

EMD AND GE's NEW OFFERINGS FOR THE 80's

EMD

EMD has been actively developing improved fuel consumption features for all of its locomotive models. In 1979 EMD introduced the EB model in its 645 engine series which, associated with low idle and 2-speed regulated dynamic brake, has provided a 3.3% improvement in duty cycle fuel efficiency for the 40 Series locomotives.

In 1981 Electro-Motive is making further engine and locomotive accessory changes for improved fuel economy. Using the SD40-2 as an example, the 1981 package includes the fire ring piston, hardened upper bore liner, larger radiator area, 6-bladed cooling fans, 235 rpm full time idle, and idle-throttle 4 regulated dynamic brake. On the SD40-2 those features comprising the 1981 EMD fuel economy package provide an additional 3.6 improvement over the 1979 EB package.

Overall, the 1981 fuel economy package as applied to the SD40-2 will provide a 6.9% improvement in duty cycle fuel efficiency over the equivalent 1978 model. As a further advantage, many of these improvements can be applied to earlier 40 - 2 Series locomotive models to improve overall fleet fuel consumption. The payback period for those added fuel saving features is generally one to two years.

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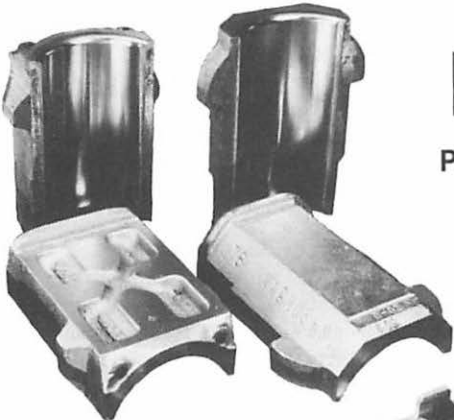

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Between December 1977 and December 1978, EMD constructed 23 locomotives designated GP40-X. Those locomotives were part of a test program to prove the reliability and durability of systems and components that would become part of EMD's planned 50 series locomotives.

Design of those systems started in 1973 with the ultimate goal to develop a locomotive series that would, simply pull more cars per unit. There are three parameters that limit the pulling power or tractive effort of a locomotive. They are: horsepower, traction motor capacity and adhesion.

In the case of adhesion, the normal average adhesion limit of pre-50 series units is around 18%. Testing showed that by allowing a certain percentage of wheel creep, or wheel slippage, within limits, there was a significant increase in average usable adhesion of up to 24%, a 33% increase.

Present wheel slip systems are designed to prevent wheel slip. EMD's superseries wheel slip control system is designed to allow a specific amount of wheel creep to allow the locomotive to operate at the peak adhesion limits under any operating conditions.

The heart of the system is the "EN" module. It compares wheel speed signals of each axle to a base line locomotive ground speed signal. When the "EN" module senses that any one of the axles has exceeded a maximum wheel creep value, exitation to the main generator is reduced until the desired wheel creep and maximum adhesion is again achieved. If this is not achieved before power is reduced to 90%, sand is automatically applied.

The base line locomotive ground speed signal is provided through the radar module that uses the input from a doppler radar unit mounted under the front of the locomotive. This also is used to provide speed indication for the engineer.

In order to effectively use the increased adhesion capability of this system, EMD increased engine horsepower and traction motor capacity.

To provide the increased horsepower requirement, EMD developed the 16-645F3 engine, which develops 3800 brake horsepower at 950 rpm with 3500 horsepower avaliable for traction. The increased horsepower is derived from new turbocharger and fuel injector designs.

Other design changes in the 16-645F3 engine include the rocking piston pin, crowned rocker arm rollers, increased hardness camshafts, a one piece crab plate combined with new-design crab bolts and a higher bolt torque, laser hardened cylinder liners, strengthened exhaust valves, strengthened crankcase and a new gear-type vibration damper.

To increase traction motor capacity, EMD developed the D87 motor. This motor has a continuous rating of 1170 amps compared to the D77 rating of 1050. The new D87 motor incorporates transposed

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armature conductors designed to cut eddy current losses in the motor and decrease motor heating. The field coils of the D87 motor contain 16% more copper than the D77 and the interpoles have had the number of windings increased from 14 to 17 to improve commutation at the higher current levels at which the D87 motor will operate.

Components in the D87 motor have been strengthened to handle the increased horsepower and torque, and a new diametral pitch pinion and gear with increased surface hardness have been specified for the D87 motor with a standard ratio of 70:17, compared to 62:15 for the D77 motor.

In the GP50 locomotive, the four D87 motors are permanently parallel connected. To supply increased continuous operating current, the locomotive is equipped with a new AR 15 main generator with a 4600 amp continuous rating. The increased rating was accomplished by increasing the amount of copper in the stator windings and stator coils. Increased cooling demands are satisfied by fan blades added to the rotor.

Several standard features have been incorporated into the the 50 series locomotives that are designed for improved fuel economy, in addition to those designed into the 16-645F3 engine. These include:

1. Low idle.
2. Dynamic brake operation in throttle notch two.
3. Improved efficiency cooling fans that operate at lower noise levels.

Optional features include:

1. Two speed regulated dynamic brake.
2. An optional engine purge system that allows slow engine cranking for six seconds to prevent engine damage from hydraulic lock without manual purging. This provides for easier starting of engines that are shut down for fuel savings when ambient temperatures permit.

The new cooling fans, together with a new exhaust silencer also help the 50 series locomotives meet new federal noise regulations.

The SD 50 Locomotives

The SD 50 locomotive incorporates many of the same components and systems as the GP 50, including the superseries wheel slip system, the 16-645F3 engine, and the D87 motor. Unlike previous SD models, the SD 50 has all six D87 motors connected in permanent parallel with no transition. To supply the resultant increased current demand, the SD 50 is equipped with an AR 16 main generator which has a 7020 amp continuous rating.

New radial design dynamic brake grids are located in a separate compartment freeing up space above the diesel engine and providing easier engine maintenance. The radial design also uses only one 36 horsepower cooling fan as opposed to two 18 horsepower fans used on previous SD models. The space below the brake compart-

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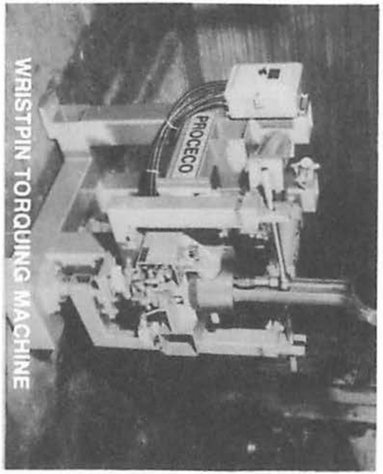

ment can be used to locate optional control or radio equipment.

Production 50 series locomotives are presently being operated on several major railroads. Their increased traction horsepower, adhesion and fuel efficiency is a significant step forward in railroad applied technology.

General Electric

General Electric's offerings for the 80's also embraces high adhesion, high tractive effort locomotives, with work done in the specific areas of wheel rail adhesion, traction motor capacity, and high-horsepower fuel efficient engines.

In the area of adhesion control, GE released production units equipped with the Sentry Adhesion Control System in 1980. This system is six times more sensitive than wheel slip systems used on earlier locomotives. It is designed to detect any tendency of a wheel to slip during a heavy pull. The Sentry system provides three successive stages of wheel slip correction that are selectively applied depending on the wheel slip severity. Full power is gradually reapplied as the slip is controlled.

Owing to the sensitivity of the system, normal wheel diameter differences would tend to cause slip detection problems. To compensate for wheel diameter differences, a logic unit is used to calibrate the system automatically by sensing wheel diameter differences whenever the locomotive is in a coasting condition.

Extensive testing on locomotives equipped with the Sentry system shows that adhesion gains of up to 30% over earlier locomotives can be obtained under almost any conditions.

In the area of traction motor capacity, GE has upgraded its Model 752 traction motor and has developed the Model 752 AF motor. The 752 AF motor uses a parallel conductor arrangement for the armature coils that reduces eddy current losses with resultant decrease in motor heating. The motor also incorporates a reaction-type brushholder for better commutation, allowing longer brush life at higher operating currents. Additional copper in the armature is made possible by the use of Class H insulation that provides improved dielectric properties with thinner insulation.

In the areas of horsepower, GE has for a number of years offered a 16 cylinder 3600 tractive horsepower engine. By combining this engine with the 1980 fuel package, GE has created a high reliability, fuel efficient engine of sufficient power to meet tractive effort requirements.

The 1980 fuel package consists of five basic items:

1. The GE-designed 1616 B2 turbocharger is improved in both reliability and fuel efficiency. It also permits operation without power deration at high altitudes.
2. GE has developed a reduced horsepower cooling fan and gearbox that reduces fan horsepower requirements in the

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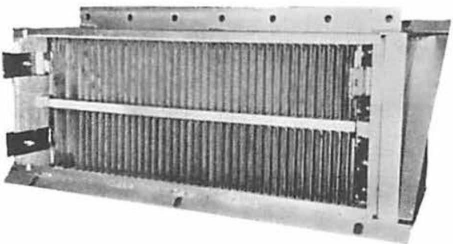

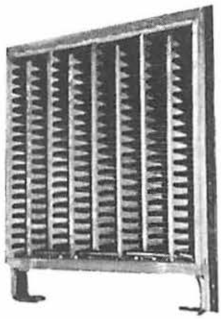

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range of 45%. GE also offers eddy current clutches for use in cycling the cooling fan off when not required.

3. A revised engine speed schedule. This schedule skips the No. 3 engine speed and uses the No. 6 speed in throttle notches 5 and 6. In addition to fuel economy, this also improves exhaust emissions.
4. GE has incorporated low idle into new model locomotives with an automatic system that returns to normal idle should engine temperature drop below a specified level.
5. For engines equipped with dynamic brakes, engine speed during dynamic braking has been tapered to match cooling requirements of the braking resistors, resulting in fuel savings.

The 1980 fuel package has yielded fuel savings of 7% over prior models. Tests were verified with GE 6 axle 3000 HP locomotives on several railroads. The 1980 fuel package can be applied to earlier locomotive models to provide improved fuel economy. The resultant fuel savings over a normal duty cycle can yield a payback period of as little as two and one-half years with today's fuel prices.

The B36-7 locomotive equipped with the Sentry Adhesion Control System, the new 752 AF traction motor and the 1980 fuel package coupled with all of the improved reliability features of the dash 7 series is GE's contribution to improved motive power.

CALIBRATION AND MAINTENANCE PROBLEMS OF PULSE SPEED INDICATORS AND RECORDERS

Increased emphasis on rules compliance, safety, accident investigation, train handling dynamics, and other operating considerations have created a demand for a durable, accurate, easily maintained system of speed indication and/or recording. The Pulse system has proven relatively easy to maintain and accurate and simple to calibrate.

The basic Pulse speed indicator head is compatible with most electrical axle drives (generators) in current use. This feature facilitates retrofit application and eliminates the need for stocking a variety of spare heads. Pulse can also furnish an axle drive (generator) of its own design. One road with more than two hundred of these drives in service reports no major problems with them.

Calibration of the basic Pulse speed indicator can be accomplished in a matter of minutes and requires no external test equipment. The Pulse indicator uses a built-in calibrator in order to make adjustment for wheel size. Calibration is accomplished by first determining the diameter of the wheels mounted on the axle that drives the axle generator. Then, the face of the indicator box is opened to reveal a wheel size calibration chart. That puts the indicator into the calibration mode.

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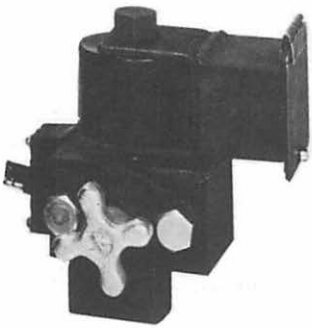

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The MPH (miles per hour) knob then can be adjusted so that the indicator reads the correct speed for the wheel diameter measured (as determined by referring to the calibration chart). For instance, for a 40 inch wheel diameter, the indicator should be adjusted to read 40MPH. Linearity of the meter may be checked by moving a toggle switch adjacent to the calibration chart to the "1/2" position. The indicator should then display half of the original reading. For the 40 inch wheel mentioned above, 20 MPH. To check overspeed circuit (on indicators so equipped) the same switch is moved to the "overspeed" position and the calibration signal is increased past the overspeed threshold causing the relay to close.

With the introduction of the EMD's Super Series Wheel creep control system, a need arose for a speed indicator system not dependent on an axle drive (generator) for a speed signal to the speed indicator. This is because the Super Series system allows controlled wheel creep to maximize tractive effort. With a conventional axle generator drive assembly, a percentage of error would be allowed into the locomotive speed indicator and recorder due to the allowed wheel creep. Pulse responded to this need with its radar-type speed indicator, which is compatible with the EMD furnished radar transceiver and module. These are used to generate an accurate traction motor speed (RPM) signal that is used as a reference for the wheel creep control system.

The system operates in the following manner. The radar system transceiver (a small low-power microwave transmitter) is mounted under the draft gear pocket on the front end of the locomotive at a precise angle to the roadbed. When the locomotive is stationary, the transmitted microwave signal and the signal reflected from the roadbed have the same frequency. When the locomotive is in motion, the frequency of the returned (reflected) signal is slightly higher or lower in frequency than the original signal. This difference in frequency is always the same for a given transmitter frequency, angle to the roadbed, and (locomotive) speed. If the transceiver under the locomotive is moving in the direction of the reflectional signal, the return frequency is higher. If the locomotive transceiver faces away from the direction of movement, the reflected signal is lower in frequency. In each instance the differences in frequency are equal and consequently, direction of movement is of no importance. From this description it is known that when the return signals are different from the original signal there will be a measurement of actual locomotive movement. It is this characteristic that enables the radar speed indicator system to be calibrated.

The prototype calibrator available from Pulse is a treadmill arrangement marketed under the name of Speedbelt. This is a table sized device with an electric motor that drives a continuous loop belt at the rate of 10 MPH. The locomotive is positioned over the belt, and movement of this belt simulates movement of the locomotive over the roadbed.

One disadvantage of the Speedbelt is its size. It requires installation in a pit so that the radar transceiver on the locomotive can be positioned over it, eliminating the flexibility of a portable test. Also, the failure of the belt to exactly simulate movement of the locomotive over the roadbed resulted in variations of two to three miles per hour on the speed indicator and recorder. Pulse is developing a more reliable calibration device for use with the radar indicators.

Bohr Electronics has developed a portable device for calibration of radar speed indicators. It also uses the principle that a return signal different from the original will simulate movement of the locomotive. The test set consists of two function blocks, a passive antenna (or responder) and a combination precise fixed-frequency generator and a variable-frequency generator. The antenna is passive, meaning that it generates no signal of its own, but processes and returns the signal from the radar transceiver. The second function block (a fixed frequency/variable-

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frequency generator) supplies frequencies to the responder antenna through a small two-wire cable. These frequencies modulate or change the strength of the signal reflected from the antenna in order to produce a return signal with a different frequency which will correspond to a given locomotive speed. Fixed frequency positions provide precise calibration at 10, 20, 40 and 60 MPH. A variable-frequency position provides continuous testing over the entire speed range of the indicator to check for pointer hang or sticking. The variable position also can be used to test operation of the overspeed relay.

CMI, Inc., one of the producers of the radar transceivers used by EMD, also provides a device similar to that produced by Bohr Electronics.

The above calibration devices with the exception of the Pulse speed belt require the use of an inclinometer to determine that the radar transceiver is mounted at the proper angle to the roadbed, within specified tolerances.

Pulse recorders do not require periodic adjustment or calibration due to wheel size variations. The recorder records frequency rather than an analog voltage. This type of digital recording eliminates calibration and maintenance inaccuracies. The playback machine takes signals from the recorder's clock (a precise 50 HZ frequency) and speed data (a digitably recorded frequency derived from the locomotive's axle generator) tracks and converts them into a usable speed tape. Variations in wheel size are compensated for by feeding wheel circumference into the playback machine.

Experience to date indicates that Pulse indicators and recorders are accurate and reliable devices. One road with more than 1,000 recorders and several hundred indicators reports few operational and maintenance problems. Some early problems were reported with sticking pointers on speed indicators owing to a switch from a brass to a nylon bushing in the meter movement, but this now appears to be overcome.

There have also been occasional problems with recorders resulting from failures of integrated circuits, recording heads, drive sprocket bearings and motors. However, the general performance of this equipment has been very good.

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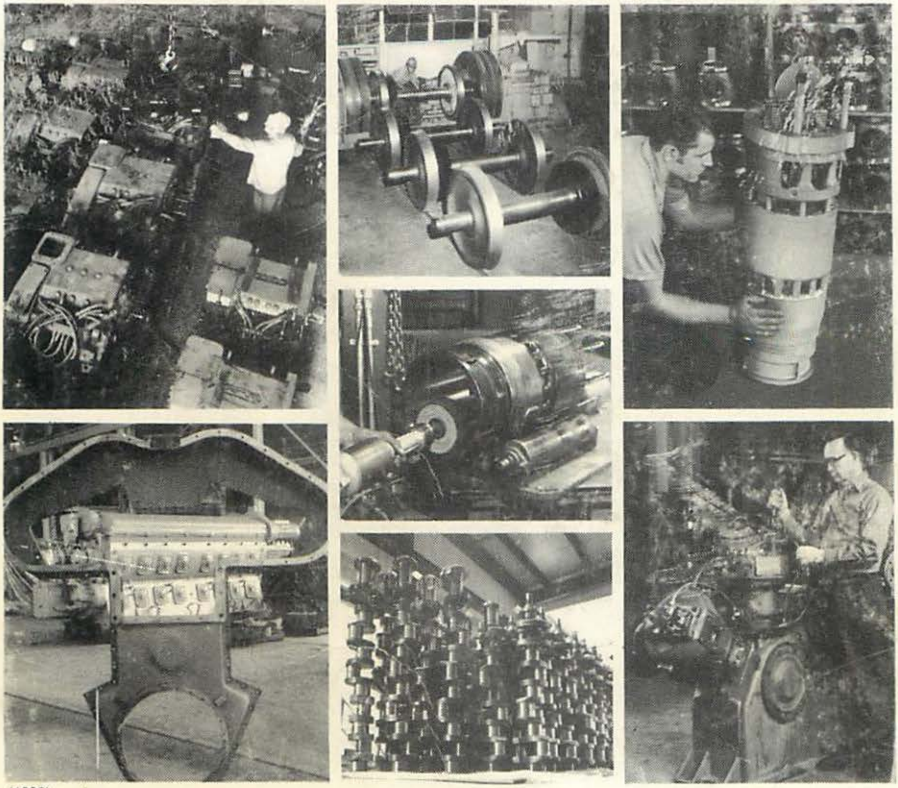

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