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Official Discussion Record of 37th Annual Meeting

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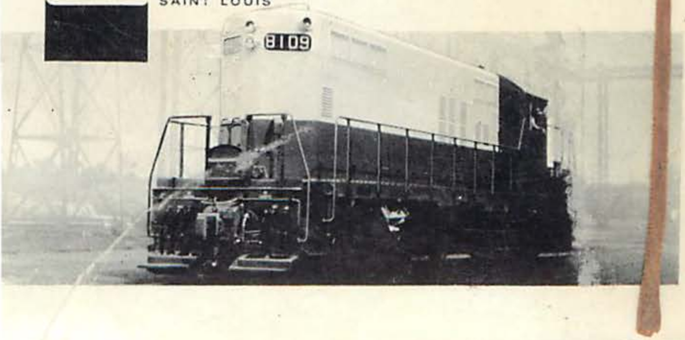

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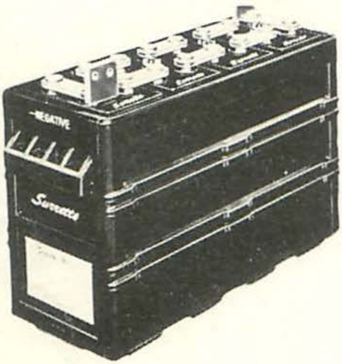

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PRESIDENT'S PROLOGUE

Just as this year 1976 is a milestone in the history of our great country, it is hoped to be a very significant year in the brief 38 year history of your Locomotive Maintenance Officers Association.

Throughout this year the officers of the Association have rededicated their attempts to provide the forum for exchange of information that will be truly beneficial to the membership and the industry they serve. It is hoped that these efforts will prove to be fruitful and that the functions of the Association will become more valuable to you in the future.

In this, your personal copy of our annual publication, you will find the report of the proceedings of the annual meeting of 1975 and the reports of your technical committees for 1976. It is hoped that you will use this information to constructively improve the vital function of effectively and efficiently maintaining the locomotives with which you are involved.

We want to stress the fact that this is YOUR Association, therefore your participation, criticism and suggestions are welcome and needed.

Sincerely,

John D. Schroeder
President

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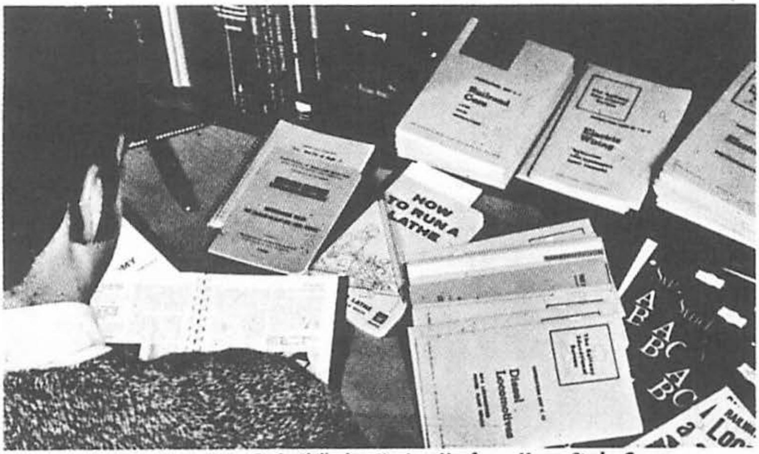

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MONDAY MORNING SESSION
September 15, 1975

L. H. BOOTH
PRESIDENT
Asst. C.M.O.-Loco.
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The 1975 Annual Meeting of the Locomotive Maintenance Officers Association, held on September 15-17, 1975 at the Conrad Hilton Hotel, Chicago, Illinois, convened at 9:30 a.m., Mr. L. H. Booth, President, presiding.

PRESIDENT BOOTH: Gentlemen, it is now 9:30 and we must get moving.

Some 22 or 23 years ago I was located at Peru, Indiana as a Master Mechanic, and the pastor of our Free Methodist Church was Dr. Ernest E. Lawshe. When I contacted Dr. Lawshe earlier this spring and asked him if he would come to Chicago to give the invocation at this meeting, he very graciously accepted.

I would like to ask you now to please stand while Dr. Lawshe pronounces the invocation. After the invocation will you please remain standing in silent prayer for those who have departed in the past year.

DR. ERNEST E. LAWSHE: Let us pray. Our Father and Our God, we have come together this morning from many far-flung places across this continent. We come from many different backgrounds and different life situations, and with a wide diversity of interests. Help us now as we come together to approach our tasks with unity of purpose to achieve the ends we seek.

We have felt Your presence beside us in the exalted experiences of worship in church or synagogue. Let us feel Your nearness now in the business of this day. Be the Unseen Delegate present and voting. Vote through these men, O God, that what they say and do may be in accordance with Your will for this organization and its members.

Turn their thoughts to You and open their hearts to Your Spirit, that they may have wisdom in their decisions, understanding in their thinking, love in their attitudes, and mercy in their judgments. Grant them the ability throughout all their deliberations to understand the point of view of one another and to yield the minor interests for the greater cause.

So, help us all this day and throughout this annual convention, for the glory of Your Name. Amen.

[Silent standing tribute to departed members.]

PRESIDENT BOOTH: Thank you, Dr. Lawshe, and thank you, gentlemen.

Gentlemen, it is an extreme honor for the Locomotive Maintenance Officers Association to have a man as experienced and knowledgeable on diesel locomotives as Mr. S. Graham Hamilton to address us this morning.

Mr. Hamilton was born in Boston, Massachusetts on April 2, 1928, and after attending and graduating from high school and a short stint in the Navy he attended George Washington University, graduating in 1950 with a degree in Electrical Engineering.

Mr. Hamilton began his career with General Electric in 1950 in Erie, Pennsylvania, where he held assignments in locomotive engineering and sales and was then transferred to Philadelphia, where he became a Transportation Specialist, being involved with locomotive sales and railway car manufacture. He later diversified by transferring to Steel Mill System Sales in General Electric's Atlantic Region for several years before returning to Transportation in Erie in 1969.

Prior to his appointment as General Manager of the Locomotive Products Department in April, 1974, Mr. Hamilton managed General Electric's international and electric locomotive businesses from Erie. The Locomotive Products Department is the largest in the Transportation Systems Division, and one of the largest in the General Electric Company. This Department is responsible for the design and assembly of diesel engines and all domestic and overseas locomotives, both electric and diesel electric.

Mr. Hamilton was married to the former Gene Cheney and they are the parents of two sons.

Gentlemen, it is an extreme honor and pleasure for me to present to you Mr. S. Graham Hamilton, General Manager, Locomotive Products Department, General Electric Company, Erie, Pennsylvania. Mr. Hamilton. [Applause]

MR. S. GRAHAM HAMILTON: Thank you, Larry.

When I first started to put this presentation together I thought it might be appropriate to have an opening joke, but you have assigned me the subject of Motive Power, and I bring a manufacturer's point of view. With the number of orders we have had lately I didn't think it was a joking matter.

Fortunately, last night a CMO very appropriately helped solve my problem. We were talking and inevitably got into the subject of non-orders of locomotives domestically this year, and the low level of operations that all the manufacturers will have in the next eight months or so. He said, "You are general manager of a business that manufactures locomotives, aren't you?" I said, "Yes." He said, "Then I have one question. Have you ever had appendicitis?" I said, "No." And he replied, "Gee, this would be a very good time to have it." [Laughter]

S. GRAHAM HAMILTON
GENERAL MANAGER
Locomotive Products Dept.
General Electric Company
Erie, Pennsylvania

As I look around this morning at the problems of our industry, it is great that you can really have a meeting at all, and I think it attests to the interest the industry has in the progress and strength of the LMOA.

[Applause]

First, I'd like to thank your Program Committee for inviting me to join with you this morning and the opportunity to discuss motive power development, the progress and the opportunities that we see in this important area of railroad operations.

The subject is, I think, most timely—not only from the standpoint of the historical progress that's been made, but also because the subject has taken on new and special significance in the current environment — the Nation's economy, environmental pressures and the energy situation have added new burdens for all of you and the railroad industry and these elements will have just as great an impact *as* our engineers' evolutionary developments will have on trends in motive power development.

Motive power development is no longer the private province of railroad management and manufacturers working together. The development process has become *far* more complicated as our industry becomes responsive to new government guidelines. The environmentalists, conservationists and others concerned with the broad well-being of our nation impact heavily and these factors must be considered as we go about our basic task of improving locomotive designs to achieve the highest reliability, availability and maintainability possible.

Since there can be little doubt that these influences outside of our industry have impacted and will continue to impact on operating costs and help *define future locomotive designs,* it has therefore become imperative that we as business managers and, as companies, monitor the trends as they surface.

But first, where are we right now—the current business climate in itself is certainly not encouraging—car loadings for the year are down some 13.5% and locomotives in storage are declining slowly from a peak of over 2000 as we wait for the economic recovery to reach our industry—and operating budgets have been slashed.

There *is* gloom and doom about us—yet I doubt that it can be justified for long.

I have an abiding belief in the vitality and strength of the railroad industry.

It's unquestionably painful to experience these short-term economic adjustments, but it's important to remember that nothing, at least nothing that *I* have seen or experienced, has affected the basic and inherent cost advantage of the steel wheel on the steel rail—and unless someone comes along and demonstrates a more efficient means for moving this nation's freight—the need for efficient transport and especially efficient use of energy for transport simply means our industry's future is undeniably secure. And incidentally, let's all get out and sell these advantages everywhere—civic groups, even the schools.

Now, as for motive power *today,* it's certain that the diesel locomotive has contributed much and has served our industry well for over 30 years, and I venture that its inherent economic advantages will assure its presence on the scene for very many years to come.

The economics of the diesel *will,* of course, be challenged to some degree as fuel costs rise and as additional controls of exhaust stacks, emission and noise are enacted into law by the various agencies of government. Along with you, we have worked hard to bring realism to these new influences – legislators, environmental agencies, and even Congressional hearings.

We are all familiar with the early OSHA standards for locomotive cabs shown here. Fortunately, most locomotives of recent design meet or exceed these requirements.

Now the Environmental Protection Agency seems about to put into effect laws establishing permissible limits for sound external to the locomotive both at idle and full load. The major noise sources identified on the locomotive are engine exhaust, fans and blowers, gears, transmission and wheel /rail noise. The noise limit law EPA proposes has only one advantage—it supersedes state laws and does not require the retro-fit of units in service before 1979.

While significant progress has been and is being made in the fuel consumption of the diesel engine, additional new legislation may result in diminishing returns in this important area—for still facing the industry are possible laws affecting the gaseous emissions from the engine. As the specific fuel consumption of the diesel is decreased, the oxides of nitrogen tend to increase. While more than 99 per cent of the exhaust gases from a locomotive are *not* considered to be polluting in nature, that small remaining percentage may present quite a problem to engine manufacturers. If the goal of the California highway vehicle regulations should also apply to locomotives, the oxide of nitrogen and hydrocarbons must be reduced from 16 grams to 5. Many years and millions of dollars haven't disclosed how to reduce hydrocarbons by more than 12 or 15% without affecting fuel consumption. The moment of truth in the United States is fast approaching for such a law, as we now see it, would have a drastic negative effect on fuel economy. But again, the real point is that locomotive-hauled freight is so efficient compared to trucks that it's inconceivable railroads would be criticized in this area. Railroading is on the order of magnitude 4 times better by any measure.

But, fuel alone will not dictate the future shape of American motive power—technical innovations will, and speaking for a moment as a supplier—our current program is aimed at "life-cycle costs" where specific measurable improvements in annual maintenance costs, reliability, and availability, as well as fuel costs are being developed and implemented.

Two years ago, *both* our customers and our field service people were canvassed to identify those improvements which would impact favorably on any one of the measures.

We identified over 60 items—the most recurring and troublesome—and developed an implementation program for each. These items, both large and small, have been incorporated into production locomotives without much fanfare, and range in scope from a new rollout bubble screen in the cooling water system to remove scale and other impurities, a new platform sump and drain, to field tests on the General Electric's own turbocharger design and new air compressor integral with the diesel engine. Benefits of this latter innovation using two of the diesel's 16 cylinders to produce train air includes obvious maintenance and reliability improvements and this will become available in production units when *fully* proven in field service.

General Electric for one will continue its progress in improving "life-cycle cost" to meet specific targeted objectives in 1975 and 1976 production locomotives, and we're measuring ourselves in these three key areas.

In addition to these technical improvements both large and small, it's time to look at other broad areas to find opportunities to not only improve locomotive performance but also control cost without sacrificing any features. We certainly subscribe to the theory proposed by Allen De Moss of the SP and others relative to the savings to be gained by the recycling of used components. This offers a significant opportunity to hold the line in terms of material conservation and costs. Such programs are now in effect to recycle these components rebuilt to like-new standards and incorporated into locomotive designs with the latest features and technical advances that in turn have an impact on improved reliability, availability and reduced maintenance.

In addition, *standardization* offers another significant opportunity to hold the line on costs.

The U. S. locomotive industry will provide you with a darn good product incorporating the features we've been talking about, but no way has been found to halt the inflationary spiral. Costs will increase as inflation continues to take its toll. Yet, looking to the future, a degree of more standardization may be one way to reduce the cost of new motive power.

Now I'm not suggesting that every railroad buy identical locomotives—all painted the same color—not by any means. And great progress has already been made by your run-through agreements—what I am suggesting now is that your New Developments Committee, working with locomotive manufacturers' representatives can develop a list of items similar to this, that could be standardized. It would result in fewer options, fewer modifications and fewer renewal parts and could be a major contribution toward holding down or at least slowing down the increasing cost of locomotives by 1977.

As you've probably become aware, by the amount of time I've devoted to the future development of diesel locomotives, I see nothing down the road that is destined to replace the diesel engine on board a locomotive as its prime mover.

There will be evolutionary changes but that's all. First cost and operating expense rule out the return of turbine powered locomotives even though great progress has been made in turbine efficiency.

Nuclear power, carried on the back of a locomotive, has more negatives than time today permits us to consider.

So what does that leave—the answer of course is turbines and nuclear but in another configuration. There is little question that coal power and nuclear, two fuels which the diesel can't handle, will be dominant sources in America's transportation future over the long term simply because petroleum will be *first* expensive, and *later* in short supply.

Railroading is the *only* transportation system that can effectively utilize *alternative* sources of abundant energy —and with great economic benefit for the railroads.

So, in my opinion railroad electrification in America is inevitable. Coal reserves in our country are enormous and because of the fundamental maintenance advantages of the electric there is a discounted rate of return that makes the very large initial investment entirely viable.

The technology is fully developed for heavy duty U. S. freight service. It's been proven at the Ohio Power Company's 25 KV operation near Zanesville where the locomotives have operated for over 17 years without a single power component failure, at the Black Mesa and Lake Powell facility in Page, Arizona—the world's first 50 KV with a product that's been so successful, two more additional locomotives have just been purchased, —and on the Penn Central where tests are currently underway with two new locomotives.

In addition, our experience base is growing fast with U. S. electrification technology now being supplied by GE for the lighter duty service found on most offshore railroads. It will be applied in Taiwan where 74 GE locomotives will be shipped starting next year. These were won in competition with the entire world—Europeans, English—all the long entrenched suppliers, beaten by modern U. S. technology.

The motivation for railroads all over the world in adding to their electrified system at a record rate stems from operational benefits of the electric locomotive as well as the chance to use the lowest cost, most abundant fuel for power.

But, if railroad electrification is all that it seems to be—when is it going to happen here?

By now you probably know that many studies show that the high density, 22,000 miles, or about 10% of the nation's rail system economically justify electrification—diesels belong on the other 90%. Many studies are complete. The major obstacle is, of course, the initial investment. This hurdle—the necessity for railroads to keep their debt/equity ratios in balance—means that railroad electrification in America will require some form of special financing, i.e., government action or third party financing which will permit railroads to buy electric power at the point of use as do all other industries.

LMOA President Larry Booth presenting S. Graham Hamilton traditional engine desk set emblematic of Honorary Life Membership in LMOA.

When the economy recovers from its current slump—and I think it will soon—when the federal government takes a hard objective look at projected freight movement forecast for just five years away and fully understands the value of our nation's railroads—and this awareness is coming fast—then electrification will become a reality.

So, to briefly summarize—motive power development in America will see improvements in "life cycle costs" and fuel efficiency. Railroad electrification is coming within the decade at both 25 and 50 KV, along with more standard locomotives, easier to maintain, with higher availability—and in spite of the present economic problems, you'll see our industry recover with a *new vitality* and *greater strength* than ever before. We're making progress in every direction. If nothing else was gained from the recession—railroads and suppliers found new ways to operate more efficiently. In my opinion, the current traffic problems *will* soon be behind us. The industry's future has *never* been brighter and I for one am privileged to serve it.

Thank you.

PRESIDENT BOOTH: Thank you, Mr. Hamilton, for those very enlightening remarks. If you will stand, please, the LMOA on behalf of your interest in their organization would like to present to you this desk set which is emblematic of Honorary Life Membership in our Association. [Applause]

MR. HAMILTON: Thank you very much. I meant what I said in the beginning: I am very proud to be here. [Applause]

PRESIDENT BOOTH: Before we move on, I am sure those of you who have not met the officers of the Association would like to do so. At my extreme right is Jim Long, the 7th Vice President. Next to him is Jim Taggart, from the Canadian National, our 6th Vice President. Jim Butler, from ConRail, our 5th Vice President. Eldon E. Dent, from the Missouri Pacific, our 3rd Vice President. Tom Tennyson, from the Southern Pacific, our 2nd Vice President, John Schroeder, our 1st Vice President, from the Burlington Northern and heir-apparent to this position. [Applause]

On my left we have two former Presidents of the LMOA, Mr. George Niemeyer and Mr. Ky Pruchnicki. [Applause]

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MONDAY MORNING SESSION
September 15, 1975

REPORT OF THE COMMITTEE ON DIESEL ELECTRICAL MAINTENANCE

W. R. JAMES, Chairman
Supt. M.P., Chessie System
Huntington, W. Va. 25718

E. E. DENT
3rd VICE PRESIDENT
Supt. M.P., Missouri Pacific-Texas Pacific RR Company,
St. Louis, Mo. 63103

Bill James, will you bring your Committee to the head table, please?

I would like to call upon Mr. Eldon Dent to act as officer of the session.

MR. ELDON E. DENT [Superintendent Motive Power, Missouri Pacific-Texas Pacific Railroad Company, St. Louis, Missouri]: Thank you. Good morning, gentlemen.

There may be those of you who are not acquainted with Mr. W. R. James, Chairman of the Committee on Diesel Electrical Maintenance and the events leading up to his present position as Superintendent Locomotive Department, Chessie System. Please refer to page 144 of the Annual Proceedings where his story is told in full.

Mr. James has been active in the LMOA for many years, contributing greatly to the development and presentation of many fine programs. Most outstanding is Mr. James' ability to eliminate the thicket of technicalities in the many complex areas of his Committee's subject matter so as to make it more interesting and more easily understood by even the laymen in our industry.

I am honored to have the opportunity to thank Mr. James personally and on behalf of the LMOA for the excellent work he has done with his Committee. With that, may I present Mr. James.

[Mr. James introduced the members of his Committee and summarized his report.]

MR. JAMES [Superintendent Locomotive Department – Staff, Chessie System, Huntington, West Virginia]: Gentlemen, we have now concluded our paper and will have a question and answer session. We will try to supply answers to your questions. If we can't answer a question we promise to get in touch with the gentleman who asked it and give him the answer.

Is Mr. Oscar Summers, Chief Mechanical Officer Motive Power, St. Louis - San Francisco Railway, and President of the Southwestern Railway Club, in the room? Evidently he is not with us. I wanted to acknowledge him because our preconvention paper this year was presented at their very fine meeting in Little Rock. If you are ever in that territory and have an opportunity to attend the Southwestern Railway Club meeting, I would urge you to do so, because it was certainly inspiring to see the enthusiasm and turnout that the members of the supply industry and members of the Club accord that organization. I wish to publicly express our thanks and appreciation.

Gentlemen, if there are any questions we will attempt to answer them.

MR. J. D. SCHROEDER [Assistant Chief Mechanical Officer – Locomotive, Burlington Northern, Inc., St. Paul, Minnesota]: Bill, first of all, I would like to say that I think you gave a very interesting and informative presentation. Perhaps it would be a little difficult to develop the discussion we would like. You covered things quite well, I thought, but the AR-10 slide, on longevity of the machine, indicated something like 40 or 42 months.

Talking about unit exchanges, I think you said it was considered reasonable. I am wondering, first, if it is reasonable to expect that type of machine to be subject to repair and return or replacement on that sort of schedule.

The second question I have concerns the third line. It didn't come through to me as fully explained. Maybe the question on that third line should be this: How would one make a determination of the breaking point, which was the long, more sweeping curve? Could we have a little more discussion of that? I think it was in the summary of the performance of the AR-10 machine.

MR. JAMES: I intended to convey to all of you that certainly we have not been satisfied with the performance of the AR-10 on those two particular purchase orders of new power. Forty months is a very short time to expect from a machine such as that. In the past, other than the maintenance of the DC commutator, we received ten years of service from the old D-12 generator. We expect to see a service life in excess of ten years, and hope we are there today with the present machine.

Concerning the three lines that were shown on the graph during the talk, the flat line to which you refer represented our first purchase of GP-40s. While any failure is of concern, it was rather flat as compared to the other two, and we were not particularly alarmed except with those that were premature failures. The other two were the next purchase order of our GP-40-2 locomotives with the AR-10.

In plotting AR-10 performance, as we do in our Engineering Maintenance group, we noticed that when we reached the 40- to 42-month period the next two failures thereafter took a serious uptrend which caused us alarm.

We established a unit exchange program to minimize a catastrophic type of failure which would have been considerably more expensive.

The third line on the graph was watched critically, having had prior knowledge and experience, we were in hopes of seeing a longer life machine; but the failure trend clearly indicated to us that the 40- to 45-month period was the critical time.

Knowing the costs and the down time from previous catastrophic type failures, we convinced our management that it was more profitable to remove these machines and, in conjunction with the builder, arrange a unit exchange program for reworking the stator windings. By doing that, and projecting the costs of the earlier failures, we anticipated a very minimum cost avoidance of $156,000.

Before I conclude on that (and I hope I have answered your question), I would like to ask Dennis Chirikos, of EMD, if he would care to add anything to these comments.

MR. D. W. CHIRIKOS [Assistant Manager, Technical Section, Electro-Motive Division, LaGrange, Illinois]: I have no comments, unless someone from our Chief Engineering Department would like to speak to it.

MR. MAX EPHRAIM [Chief Engineer, Electro-Motive Division, La-Grange, Illinois]: One point should be made clear here, and that is the failure rate that Bill James has cited relates to the GP-40. The major problem there related to high currents in the generator. This same problem does not occur on the SD models where the motors are in series at low speeds. In very heavy-duty drag service the motors can withstand the high overloads better than the generator, and under some of these conditions the high heating conditions of the generator resulted in the type of failures that Bill has mentioned here.

Fortunately they tend to be related only to railroads that operate GP-40s in very heavy drag service, or railroads that have other than a 62:15 gear ratio and have operated at low speeds in drag service.

MR. JAMES: Thank you, Mr. Ephraim. Yes, our SD-40 performance was very good, and in no way has this been seen in our Dash 2 locomotive.

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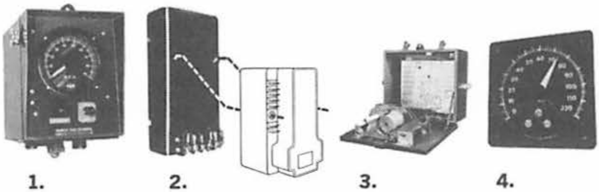

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Are there any further questions?

MR. FRED I. BURCHETT [Mechanical Assistant—Locomotives, Atchison, Topeka & Santa Fe Company, Chicago, Illinois]: Bill, in your paper you cited the new bearing. I think you are speaking about phase 3 bearing for the AR-10 generator, with the hardened nickel sleeve. Has anyone had experience with that bearing or been able to look at it to give us a life expectancy for that bearing?

MR. JAMES: We have not had enough experience to offer comment. To date, the larger bearing has performed very well on the Chessie System. Does any panel member care to offer a comment in regard to Mr. Burchett's question. Will Mr. Chirikos of EMD comment?

MR. CHIRIKOS: Since May, 1973, on the large bearing, when we have had the large bearing with the nickel-plated bore with increased clearances, there has not been any failure to date of that bearing design. We would anticipate you look at this bearing in an inspection procedure at a 6-year point in life, and from that point on we would still anticipate the bearing would have a 12-year life in the AR-10 machine.

But at the 6-year point we would recommend that the bearing be inspected, and obviously the cover should be taken off and inspected thoroughly, re-greased, and then placed back into service judging from what you see at that point in time. This is what we are anticipating.

Does that answer your question?

MR. BURCHETT: At a 6-year period we would expect to have locomotives approaching 1,200,000 miles. Are you going to or can you relate that to mileage?

MR. CHIRIKOS: I don't have a good feeling on that as far as mileage is concerned. I am just going by the time basis. Different railroads will accumulate different mileages at that point.

MR. BURCHETT: At the outset of the AR-10 bearing problem we began to experience difficulty in our heavily loaded drag fleet at about 900,000 miles. We examined some locomotives of similar class with similar bearings in lighter loaded fleet that had approached one million miles, and we did see significant differences. We feel if there is a heavy load on a locomotive, 900,000 miles is a pretty good inspection. We hope this new bearing will be the answer to this, but we would appreciate the manufacturer continuing efforts to examine that bearing before we get into the same trouble we had the last time.

MR. JAMES: May I add to those comments that many of the records and data that are kept on various railroads are in terms of miles. I believe the controlling factor will be the average engine speeds or the time span in given kilowatt hours. That is what the bearing would most likely recognize.

Are there any further questions?

MR. FRANK D. BRUNER [Assistant Chief Mechanical Officer, Union Pacific Railroad, Omaha, Nebraska]: I have a question for Mr. Morrison in regard to training. When you select an individual and train him, how do you handle it with the unions? Say you give an individual who has had training a little preference job over someone who has more seniority. How do you propose to handle this?

MR. D. J. MORRISON [Electrical Engineer–Locomotive, Illinois Central Gulf Railroad Company, Chicago, Illinois]: I am glad you asked that question, Frank. Of course in any training efforts described this morning it is going to be handled locally. I think you already know the first part of the answer.

First, I think you will agree you must know your agreement. I learned through experience, in applying a system like this, that you are going to get your best cooperation and best results by working hand-in-hand with the local organization people.

We set up a system like this to operate. We tried getting it off the ground at one of our smaller locations, and at the outset we enlisted the aid of the various local chairmen involved. We had to make it very clear that we were not out to try to change any agreements to start with, but we were mainly interested in looking at efficiencies and proficiencies at that given time.

By making those people a part of the plan and religiously observing agreements, we were able to resolve such matters as whose time, your time versus ours; and by doing this I think we gained effective results. I do not propose that this be used as a means of, say, juggling people around in various jobs. You can get into a lot of trouble on that score, and you are going to lose the support of your local organization people. If you lose their support, gentlemen, you will have lost the battle.

MR. T. A. TENNYSON [Assistant Manager – Engineering – Technical, Southern Pacific Transportation Company, San Francisco, California]: Along that same line, Bill, I would like to mention that in your paper you do emphasize the fact that we should utilize all the training we can. After you have trained a man you should give him a chance to fully utilize that training. But in a union shop where there is a lot of bidding on jobs, and job changes, how much time do you allow for training this individual after he bids in on a new job?

MR. MORRISON: That is a question more easily answered by taking a look at a specific facility. You put a lot of time and effort into bringing some individual's skill up to the standards you need, and the first thing you know he is either bumped or bids off the job. By utilizing some system such as I outlined this morning I think you have half the battle won right there, because you know from your own survey exactly what the skills requirement is for that particular job. This is why all during my talk I tried to underscore the fact that these things apply to a specific skill or job at a specific location.

By assessing the skills of the man coming onto the job I think you are going to save an awful lot of time by referring back to your task analysis, as I said this morning. This is one of the ways it pays off. It is very difficult and time consuming to make up, but it is going to save you a lot of time later when you have a turnover of this type.

MR. R. N. PIERCE [Quality Control Inspector–Locomotives, Illinois Central Gulf Railroad, Chicago, Illinois]: In reference to your organized training, would you say the company should take care of the expenses of the training program?

MR. MORRISON: This is a question that is always asked whenever there is a training effort: Who pays the tab? I am not in a position to say, because this varies according to the philosophy of the railroad. It will vary in terms of the economic climate today. Who has money right now, for example.

I am going to answer that question with a question: What is it worth to have the skills of these men improved to an acceptable level in order to gain some control over the cost effectiveness of labor? What is it worth to us?

MR. JAMES: May I add a personal comment. We studied this problem quite seriously on the Chessie System, and decided it was definitely in the best interests of our company to establish in-house training system and pay the people to attend. The knowledge and understanding of the work force has a direct bearing on unit availability, product reliability, and so on.

So, speaking for the Chessie System, we feel that training must receive the attention it is most deserving of. We have in-house training systems for all crafts, apprentices and supervision, and they are paid while attending classes.

MR. W. E. BUELL, JR. [General Locomotive Foreman, Illinois Central Gulf Railroad Company, Memphis, Tennessee]: Mr. Edson, you referred to a new type of temperature switch. Where do you get these switches? How many are in supply right now and actually being used, and how many can you account for as being failures?

MR. L. D. EDSON [Supervisor Electrical Design and Maintenance, Union Pacific Railroad Company, Omaha, Nebraska]: EMD has a part number covering the switches. Our failures have been fairly low—I would say less than 1 per cent. They have been doing a very good job. I can't tell you offhand what the part numbers are, but I can get the information for you. Also, if you are interested in price, they are very comparable to the standard temperature switches.

MR. KJELL AXELSON [General Manager, Work Equipment and Machinery, Burlington Northern, Inc., St. Paul, Minnesota]: On your section on vibration analysis in rotating electrical, is there any source where we can get some good, reliable figures on baseline signatures that would average out for various types of motors to use for guidelines, either from the bearing manufacturer, locomotive manufacturer, or from the vibration equipment people? This is a fairly new procedure, and possibly you might name a few railroads that have gone into depth on this

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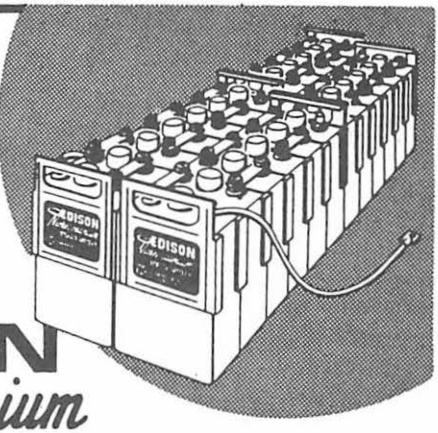

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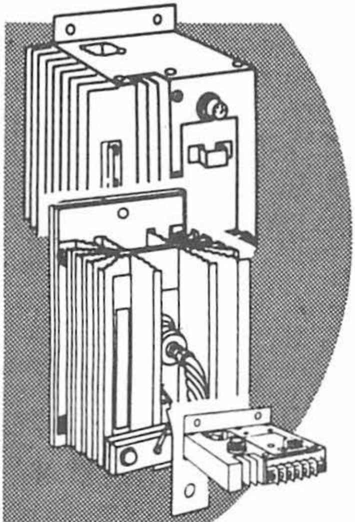

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program to give us a little better insight as to what to shoot for in the way of baseline signatures for criticals.

MR. JAMES: The Missouri Pacific uses vibration analysis extensively in their traction motor shop at Little Rock, which we had the privilege of visiting while there for our pre-convention presentation, and a nice facility it is. I will ask Mr. Ed Heaton to make a few comments.

I spotted a friend in the audience from IRD who spent some time with us on the Chessie System. While I can't add much to your comments, Kjell, we are endeavoring to establish such data, and further improve our over-all traction motor performance record.

MR. E. F. HEATON [Supervisor Locomotive Equipment, Missouri Pacific Railroad Company, St. Louis, Missouri]: We started our traction motor analysis around 1967. When you do start such a program of IRD motor analysis, usually you will find about 20 per cent reject rate. In four or five years of such analysis the rejection rate will drop to 2 to 3 per cent.

As far as a criterion for measuring an EMD or GE traction motor, we have graphs of both types. Some even fall into the same qualification ranges. However, one must compare by using same motor speeds, frequency cycles, running time, and so on. To give a random figure on a reject limit would be impossible.

We have at Missouri Pacific a traction motor maintenance plan. By working the motor, regreasing the bearings every 350,000 miles and then running it over the IRD analysis to qualify again, one can soon realize a million-mile traction motor.

MR. JAMES: Would the gentleman from Stanray care to comment?

MR. E. J. MALEK [Stanray Corporation, Chicago, Illinois]: IRD Mechanalysis is a procedure using vibration and noise analysis as an indicator of machinery condition. This program is based on three simple steps: detection, analysis, and correction. We found that with the help of the Missouri Pacific and other progressive railroads we have been able to establish baseline signatures for qualification of traction motor assemblies. Stanray has collected historical data on many types of railroad equipment, and we would be happy to assist you in starting a Mechanalysis program on your equipment. Thank you.

MR. PAUL R. BIEN [Electrical Rotating Supervisor, Electro-Motive Division, LaGrange, Illinois]: I would like to say that we found the best use of this type of vibration monitoring equipment is as a diagnostic tool when a particular problem develops on a locomotive or component of a locomotive.

In particular, we have not used it to qualify traction motors as they pass through the electrical test floor. In a recent check using the equipment on an experimental basis, we found that the limits proposed by the Committee would reject approximately one-third of our new motors and newly rebuilt motors.

This is at a time when we are enjoying a very, very low warranty bearing failure rate. Moreover, we believe using this type of equipment will likely pass high mileage motors which should be overhauled, because it cannot detect the condition and quality of the grease. For this reason we recommend that motors be overhauled on a mileage basis, and the mileage we recommend is 540,000 miles. Thank you.

VOICE: Mr. James, in the course of your discussion you spoke of specific problem areas relating to rotating equipment and traction motors in particular, also specific maintenance policies you recommend. In regard to traction motor failures, what are the two most prevalent reasons for traction motor failure, and also what is the average motor mileage at time of failure?

MR. JAMES: A sampling of our Committee members reveals the primary area of failure within the traction motor is the armature. Second is the stator, and that specifically is the interpole windings. The average time of failure is approximately 300,000 miles.

MR. ELDON E. DENT [Superintendent Motive Power, Missouri Pacific-Texas Pacific Railroad Company, St. Louis, Missouri]: I wanted to respond to the remark by the gentleman from EMD about the fact that you might overlook the lubrication of the armature bearings. Our position utilizing the IRD is that at the time of wheel change, which can occur between 285,000 and 385,000 miles, we do remove the motor, remove the pinion, give the bearings an IRD check to verify their being within an acceptable range. We remove the caps, flush, clean and repack the bearings. We do this maintenance in all mileage instances.

Following this, we again check the motor with the IRD unit. If it is still within the acceptable range we replace the pinion and put the motor with the matched set to go in the trucks for the next unit application. We don't mix-and-match our motors. We keep the builder's motors together. We keep together the motors we rebuild, and in all instances the IRD motors are kept matched.

We had some 66 armature bearing failures a year when we started, and today we run between 8 and 12. Considering the high cost of rebuilding traction motors, where the armature is dropped on the pole pieces, this rebuild cost will run $6,200 and up. I think it behooves you to take a look at the use of the IRD in monitoring your motors.

MR. JAMES: Thank you, Mr. Dent. I am certain that vibration sensing equipment has a definite place in our industry for qualifying our rotating equipment. Likewise, there is much to be learned in developing specific data or signatures for proper interpretation of the data. It is appalling to go through a motor shop and see the means for qualifying bearings is by one of the men listening with a metal rod. I don't believe that is the way to do it in this day and age.

One thing for sure, it will eliminate or at least minimize human failures, and we will have good baseline data from which to establish references for the future.

MR. FRANK H. ZUERNER [Mobil Oil Corporation, Oakland, California]: I noticed in the talks today you mentioned measurement of vibration, but this was without the pinion gear and bull gear engagement. Has there been any study to show what the engagement of gears does to increase or decrease the vibration reading?

MR. JAMES: Yes. Those two graphs to which I referred during our discussion of rotating equipment depicted the problems encountered when deviation of gear profile occurs. However, to the best of my knowledge there is no railroad running vibration checks with the total motor wheel assembly.

It certainly is a very important one, and perhaps one day we will perform vibration checks on the assembly. Today we assume that if we maintain the pinion and bull gear as specified by the builder, and follow the prescribed lubrication and other aspects referred to earlier, that we will indeed obtain the motor wheel performance we expect from that assembly.

Mr. Bien, can you offer any further comment in this regard?

MR. BIEN: As many of you know, we completed a rather extensive test on the Union Pacific last fall to investigate this very question of the effect of worn gearing on the vibration experienced by many traction motor components. The test has been summarized in a recent publication of *Railway Age,* and there will be a further publication.

We tested gearing with involute error measuring up to .025". In our experience it is very typical to find gears in that condition running on the railroads. We found that gear tooth error is the biggest source of vibration that the motor components see. This includes armature coils, field coil connections, gearcases, support arms, and so on. The establishment of a condemning limit on allowable involute error we think is the biggest step that could be taken toward reducing these types of failures.

MR. JAMES: May I add further that EMD, in conjunction with the U.P., recently updated this information. I would refer you to an ASME paper presented in 1960 by E. E. Green, Project Engineer with the General Electric Company, and M. A. Pinney, Engineer of Tests for the Pennsylvania Railroad, where they ran dynamic over-the-road vibration analysis, and it was very similar to the current information EMD has obtained.

Are there any further questions, gentlemen?

MR. CHARLES M. SMITH [Manager Mechanical Engineering — Passenger and Locomotive, Penn Central Transportation Company, Philadelphia, Pennsylvania]: I have a three-part question relating to the use of permanent jumpers.

1—What is the initial cost of the installation that you showed?

2—What is the economic justification?

3—Would you make that same installation on a new locomotive? The one you showed looked as if it was particularly designed with retrofit in mind.

MR. JAMES: As to the cost of such a system as depicted here, which the L&N has developed in conjunction with the Power Parts Company, I believe it is approximately $350 per end.

Secondly, the cost benefit would have to be a result of an in-house study on your particular road to determine what your present or past costs have been in regard to jumper cables.

I would further comment that on our particular road, in 1974 we incurred an expense of approximately $35,000 for repairing jumper cables. Ninety per cent of all cables repaired were a direct result of physical abuse by various people when changing consists in yards, which of course is directly associated with removable type cables. You will have to make a cost benefit study within your own company in order to figure savings.

MR. PETER SASGEN [Power Parts Company, Chicago, Illinois]: As to the cost of the jumper cable complete, each end of the locomotive is $373. However, you can reduce that cost by using up your own spare jumper cables. We will supply you the box, the equipment without the jumper cable in it, and you can supply your own. You will save yourself about $100 per application.

I must agree with you that the savings are there, because generally when you take a jumper cable off a locomotive you throw it on the ground and change the consist and the jumper cable becomes damaged, dirty, it gets wet, dirt is embedded in the contact area, and it gets a lot of abuse.

If your railroad is like most of those we have dealt with, you are buying from 200 to 300 jumper cables a year new, in addition to what you are repairing. When you look at today's prices of $106 for a 9-foot jumper cable, you can compare that with a permanent cable that will stay on the locomotive and give you the service you are looking for.

MR. JAMES: Gentlemen, if there are no further questions I will call on Mr. Bob Clevenger, of the Santa Fe, Regional Officer of the LMOA, to summarize our paper. While Bob is coming up I would like to extend our sincere thanks to each of you for your courtesy and attention during this discussion. Thank you.

MR. R. G. CLEVENGER [Supervisor of Locomotive Maintenance, Atchison, Topeka & Santa Fe Railway System, Topeka, Kansas]: Thank you, Bill.

Gentlemen, I am sure we are all appreciative of Bill James and his Committee's fine efforts in preparing this year's paper. You will note that it covers a large field. The first section covers a subject not considered by most maintenance officers as a part of maintenance, namely, the schooling and training necessary to provide competent maintenance personnel. All of you should completely digest this section of the paper and develop a program that is best suited to your

R. G. CLEVENGER
REGIONAL EXECUTIVE
Supvr. of Locomotive Maint.
Santa Fe Rwy. System
Topeka, Kansas

particular mode of operation. The continued use of schools offered by the railroad suppliers cannot be overemphasized, but a careful screening of who will attend these schools is necessary.

The remaining parts of this year's paper stress the procedures necessary and make recommendations for the so-called running maintenance aspect. The point was made that this is the type of repairs that account for the major portion of today's mechanical department budget. Through the use of effective managing, plant productivity can be improved, available power requirements can be utilized more efficiently, and effective utilization of skilled labor can be increased.

Finally, I would like to quote a paragraph from this year's paper that could be made a part of every paper presented during these meetings: "It is a recommendation of this Committee that each of you, upon returning to your home assignments, give these items your most serious cost benefit review if indeed you are endeavoring to improve locomotive reliability and reduce maintenance cost through technological process."

Again, Bill, I would like to congratulate you and your Committee on a job well done. [Applause]

MR. DENT: Thank you, Bob. That was a very fine paper and splendid summarization, and best of all a most excellent response from you, the members.

At this time I would like to turn the microphone back to Larry for some closing remarks.

PRESIDENT BOOTH: I was just given some information this morning that I had not had before. I think everyone in the room is familiar with Pete Sasgen, of Power Parts, who certainly has been a friend to the LMOA during the years, and worked with committees as they travel around the country presenting their preconvention papers.

Effective the first of the year, Pete is going on one of the most unusual retirement programs I have ever heard of. He is being relieved of all his actual duties with Power Parts, but he will still be on full salary, and all he will do will be to ride around the country in a motor home visiting all the shops and shaking hands with people. Pete, for goodness' sake don't forget the LMOA. Come and visit us, too. We wish you all success and the best of luck in your travels.

MR. SASGEN: It is not a real retirement. I will still be ex officio Chief Engineer of Power Parts Company, but it is a matter of taking up the slack. As Marty would say, I am turning myself into a yard switcher instead of a mainline freight locomotive. [Laughter] I will be around to see you, and I will still be active in the LMOA.

PRESIDENT BOOTH: Gentlemen, we will ask that all of you stay out of the hospitality rooms while the program is in session and papers are being given, because we do need your attendance. We rely on you to be here.

Mr. James, we thank you and your Committee for a wonderful paper, well presented. We ask that the audience stand and give you its vote of thanks.

[The audience arose and applauded.]

[The meeting then recessed at noon.]

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MONDAY AFTERNOON SESSION
September 15, 1975

The meeting reconvened at 2 p.m., Mr. L. H. Booth, President, presiding.

PRESIDENT BOOTH: Gentlemen, it is two o'clock and time to begin the program.
Gentlemen:

During this era of soaring prices, escalated wage earnings, a recession, and reduced income, the mechanical departments of all railroads have an immeasurable and unenviable assignment ahead.

Not only must locomotive officers keep the locomotive fleet in condition to handle current levels of business, but must be in position to accept and move the expected rise in business with a minimum of delay and on-line troubles. In most cases this must be done with less manpower for reasons previously stated, but using more efficient methods and maintenance practices, better utilization of the manpower available to them and by strong management and control of factors involving maintenance operations.

We have discussed this in past papers, seminars and conferences but we feel it would today be timely to again for a few moments review this situation.

You will recognize that I used the statement "Strong Management." In these days of short maintenance dollars and less employees every effort must be exerted to know that our manpower is being utilized to the fullest. This connotes that scheduling of locomotives into maintenance stations for maintenance must be on a basis to eliminate peaks and valleys formerly existing that represented over-manning to offset the peak shop load. With most roads having power bureaus responsible for movement and assignment of power, the balancing of scheduled work can be programmed and controlled to the point that effective utilization of manpower can be realized.

In some geographic areas of the country, skilled experienced mechanics are simply not available to the railroads. On many railroads apprentice training has been curtailed due to the economic situation and in order to qualify and expect normal and

L. H. BOOTH
PRESIDENT
Asst. C.M.O.-Loco.
Chessie System
Huntington, W. Va. 25718

proper repairs from our available work force, and supervisors, training schools have been established. These training schools use visual aids, moving pictures of many of the operations, cutaway models and even simulators to teach and train our people the proper procedures and techniques necessary to enable them to be of real value to us.

All this is necessary and when our supervisors have become familiar and are schooled in proper techniques of maintenance they can then do an effective job of managing. Thus the Locomotive Maintenance Officers with their technical committee papers designed and prepared to convey the latest maintenance practices, procedures, new equipment and innovations can be of vast importance in this endeavor and it is our hope that our members will recognize and employ this valuable organization to this end. As our keynote speaker has pointed out in his opening address, the resources we have available must be used in the most efficient manner possible.

Innovative maintenance practices pointing to efficiency with our available resources should be considered such as the "Q" system as developed and employed on one large railroad. By this method all quarterly, semiannual, annual and 2-year work requirements were analyzed and divided with respect to craft division and time consumption into eight quarterly inspections. By doing this all "Q" forms require the same approximate man-hours regarding craft and time so that minimum in-shop time is required and maximum utilization of manpower available is realized.

There are many practices different railroads are using, all pointing to the same result and the purpose of the Locomotive Maintenance Officers Association is to publicize these innovations through our committee papers to everyone so that they, if so desired, can take advantage of the tried and tested methods that have been developed. Also by this procedure many design changes have been recommended to our builders eliminating in some instances redundant maintenance or improving in other areas operating results. All the above points to our intended goal.

In the years ahead, I suspect there will be many progressive changes in motive power. With the ever present fuel shortage in the background, it could well be electrification, developed in power plants at the mine sources or coal-burning-turbine-electrics using coal, pulverized to a talcum-powder consistency, being used as the fuel agent. Whatever the future holds in store for us, I am sure our locomotive builders through research and development will be able to provide movers that will keep our railroad industry viable and healthy. I have every confidence in them.

At one of our preconvention presentations, I had the pleasure of viewing a study made by one of the air brake manufacturers on the effect of train braking in the year 1995, 20 short years from now. This, I thought, is the kind of research we need and it would be my recommendation that all railroad officials should see. What I am trying to say is that we cannot sit back in a complacent attitude and let things assume a status-quo position and progress.

As I look back over my railroad career, I have seen many changes which if many of the old-time-railroad officers could now see would not believe, and just the same would occur if we could come back 30-40 years from now and observe the changes. All has been good for the railroads, and as I close my career this January, I am happy to have been a part of it.

My association with the Locomotive Maintenance Officers Association has been a very, very interesting and eventful part of my career. As I, therefore, bid you adieu, I am also challenging the younger group of Maintenance Officers to pick up the torch and maintain the great tradition of the railroads, which has been part of the heritage of this great country.

Gentlemen, I thank you.

[Applause]

PRESIDENT BOOTH [continuing]: I would now like to call on Mr. Jim Butler to act as officer of this session.

MR. J. J. BUTLER [Chief Mechanical Officer, United States Railway Association, Washington, D. C.]: Thanks, Larry, and thanks for all you have done for the LMOA.

I would like to start by correcting one thing. Several times yesterday and today I was introduced as being a member of ConRail. I do not work for ConRail. I work for the United States Railway Association, which is the planning arm of ConRail. As of now, ConRail has three employees. Maybe six months from now I might be working for ConRail, but not now.

I would like to introduce Tom Harley to give the report of the Membership Committee.

MR. E. T. HARLEY [General Mechanical Superintendent, Engineering & Research, Penn Central Transportation Company, Philadelphia, Pennsylvania]: In six months I might be working for ConRail, too. [Laughter]

Basically, what we had going into this session was a rather sizable deficit in members as compared to the total in 1974. Active membership in 1974 totaled 1,735. As of 2 p.m. today we have 1,524 members, or a deficit of 211. In the category of Associate Membership for 1974 we had 384, and as of 2 p.m. today we have 334, or a deficit of 50. Advertiser Members: We had 124 in 1974 and we have 103 today, or a deficit of 21. All of this adds up to a grand total of membership, Active, Associate and Advertisers, of 1,961 as compared to 2,243 in 1974, or a deficit of 282.

E. T. HARLEY
4th VICE PRESIDENT
(Gen. Membership Chmn.)
Gen. Mech. Supt.-
Engineering & Research
Penn Central Trans. Co.
Philadelphia, Pa. 19104

This is not an insurmountable deficiency. As of this morning the deficiency was 524, so there have been well over 200 members in the Active and Associate categories signed up just since this morning.

What I ask you to do as you see people come into the meeting, and as you talk to both potential and active members, is to take them to the place where you registered and see if we can close up the remainder of this deficit. We are half-way there, and we need only 284 more new members.

MR. BUTLER: I am Membership Chairman for 1976. I have already had a pep talk from John about what he expects from me. Nobody can do this job alone, and we need help from the CMOs. I am sure if the CMOs get behind the membership drive we will get more members.

At this time I would like to call on Past President George Niemeyer for the report of the Nominating Committee.

G. W. NIEMEYER
PAST PRESIDENT
Mechanical Superintendent
Texas & Pacific Rwy.
Fort Worth, Texas 76102

MR. GEORGE NIEMEYER: Thank you, Jim. Gentlemen, it is always a pleasure to come to the LMOA meetings. It is a treat to see all of you and renew acquaintances and see the people who are going to keep the LMOA in operation.

The Nominating Committee met and has selected the following members as nominees for office in our Association for the year 1976:

President: J. D. Schroeder, Assistant Chief Mechanical Officer-Locomotive, Burlington Northern, Inc., St. Paul, Minn.

1st Vice President: T. A. Tennyson, Assistant Manager Engineering-Technical, Southern Pacific Transportation Co., San Francisco, California.

2nd Vice President: E. E. Dent, Superintendent of Motive Power, Missouri Pacific Railroad, St. Louis, Missouri.

3rd Vice President: E. T. Harley, General Mechanical Superintendent-Engineering & Research, Penn Central Transportation Co., Philadelphia, Pa.

4th Vice President: J. J. Butler, Chief Mechanical Officer, United States Railway Association, Washington, D. C.

5th Vice President: J. Taggart, System Mechanical Officer, Canadian National Railways, 935 Lagauchetiere St., West, Montreal H3C 3N4, Quebec, Canada.

6th Vice President: J. H. Long, Regional Locomotive Superintendent, Chessie System, Cincinnati, Ohio.

7th Vice President: R. G. Clevenger, Supervisor Locomotive Maintenance, Atchison, Topeka & Santa Fe Railroad, Topeka, Kansas.

EXECUTIVE COMMITTEE

C. N. Cawlfield, Engineer Motive Power, St. Louis-San Francisco Railway Co., Springfield, Missouri.

N. A. Buskey, Assistant Manager-Mechanical, Chessie System, Pittsburgh, Pa.

F. D. Bruner, Assistant Chief Mechanical Officer-Operations, Union Pacific Railroad Co., Omaha, Nebr.

C. M. Smith, Manager Mechanical Engineering-Passenger & Locomotive, Penn Central Transportation Co., Philadelphia, Pa.

R. R. Holmes, Chief Chemist, Union Pacific Railroad, Omaha, Nebraska.

L. O. Townley, Assistant Manager, Industrial Engineering, Atchison, Topeka & Santa Fe Railway, San Bernardino, California.

D. M. Walker, Diesel Superintendent, Southern Railway Co., 99 Spring Street, Atlanta, Ga.

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

MR. NIEMEYER [continuing]: This is the slate of officers presented to you for next year. If there are any nominations from the floor we will be glad to accept them at this time. If there are none, I move that these officers be elected by acclamation.

[The motion was severally seconded, was put to a vote, and was carried unanimously.]

MR. NIEMEYER: Mr. President, the slate of officers has been approved.

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MR. BUTLER: Thank you, George.

MR. BOOTH: I would now like to call on our new 7th Vice President, Bob Clevenger, to come to the platform. Bob, the donning of this red coat is emblematic or like a takeoff of winning the Masters, having a green coat put on. With this red coat you assume the obligations of 7th Vice President of the LMOA, which we know you will carry through, and we are sure you will perform your work with the greatest expertise. We congratulate you on being elected 7th Vice President. [Applause]

MR. CLEVENGER: You know the old expression "The Redcoats are coming!" I didn't think I would be one of them. Thanks a lot, Larry, and I thank the entire Association for this honor. [Applause]

MR. BUTLER: I am sure you will make a good officer, Bob. You did a fine job as a committee chairman.

I will now call on Past President Ky Pruchnicki to give the financial report for 1975.

MR. KY PRUCHNICKI: The financial report for 1975 is as follows:

LMOA President Larry Booth and incoming President John Schroeder help newly elected 7th Vice President Robert G. Clevenger into his new LMOA officer blazer.

LOCOMOTIVE MAINTENANCE OFFICERS' ASSOCIATION STATEMENT OF REVENUES, DISBURSEMENTS AND CASH BALANCE – CALENDAR YEAR 1974

BALANCES IN FUNDS JANUARY 1, 1974:			
Checking Account–Security Bank		$35,473	
Reserve Account–Security Bank		4,485	
Balance			$39,958
RECEIPTS:			
Interest on Reserve Account	$ 249		
Active Membership Dues	9,606		
Assoc. Membership Dues	4,660		
Registration Fees	2,130		
Advertising Revenues	19,552		
Miscellaneous	– 1		
Total Receipts		$36,196	
DISBURSEMENTS:			
Convention, Publication and Travel Expense	$14,655		
Office Expense, Office Assistance, Supplies, Postage, Stationery Expense & Payroll Taxes	19,200		
Total Disbursements		$33,855	
Excess Receipts Over Disbursements			$ 2,341
BALANCE CARRIED FORWARD TO 1975			$42,299
BALANCES DIVIDED AS FOLLOWS:			
Reserve Account–1973 Balance		$ 4,485	
Deposit Transferred From Checking Account		1,500	
Interest Received on Reserve Account		249	
BALANCE IN RESERVE ACCOUNT			$ 6,234
CHECKING ACCOUNT BALANCE 12/31/74			36,065
TOTAL CASH BALANCE			$42,299

APPROVED:

(Signed) L. H. Booth, President

(Signed) J. D. Schroeder, 1st Vice President

Approved this 7th day of April 1975, Chicago, Illinois.

MR. BUTLER: Thank you, Ky.

I would now like to call on our Secretary, Mr. Joe Koerner, to give his report. You heard our cash balance, and you ought to give this fellow a hand because he has done a heck of a job. [Applause]

KY PRUCHNICKI
PAST PRESIDENT Retired
Genl. Supvr. Loco. Maint.
Southern Pacific Trans. Co.,
San Francisco, Calif. 94105

SECRETARY JOSEPH J. T. KOERNER: Thank you, Jim. I don't have much to say. I just want to say it has been a real pleasure work-

JOSEPH J. T. KOERNER
SECRETARY-TREASURER

ing with Larry Booth as President this year. We had a great relationship.

I am glad to hear that although Pete Sasgen is retiring, he will still be coming to the LMOA meetings. We appreciate his help.

I also want to thank all the committee chairmen and members who have done such fine work this year.

Are there any questions from the floor? If not, that's it. Thank you. [Applause]

MONDAY AFTERNOON SESSION
September 15, 1975

REPORT OF THE COMMITTEE ON DIESEL MECHANICAL MAINTENANCE

R. W. LEEDY, Chairman
Supt. Motive Power,
Illinois Central Gulf Railroad,
233 North Michigan Avenue
Chicago, Illinois 60601

J. J. BUTLER
5th VICE PRESIDENT
Chief Mechanical Officer
U. S. Railway Assn.
Washington, D. C. 20595

MR. BUTLER: I would now like to ask the Diesel Mechanical Maintenance Committee to come to the platform. Bob Leedy has done this job for the last couple of years and has done it excellently again this year. He presented the preliminary paper at the Greater Kansas City Railway Club on April 25.

[Mr. Butler introduced Mr. R. W. Leedy, Superintendent Motive Power, Illinois Central Gulf Railroad, Chicago, Illinois], who in turn introduced the members of his Committee and summarized the report.]

MR. LEEDY [continuing]: Gentlemen, that concludes our paper. We presented our preconvention paper in Kansas City. There are some wonderful people there who were our hosts. Jim Pike, of the Santa Fe, their president, was there. Larry Schroeder is filling in for Jim today. I would like to ask Larry to present the first question.

MR. SCHROEDER: While the Committee has recommended that we evaluate the economics of restoring the EMD piston ring grooves, we are wondering if the Committee has made an evaluation of any one of the processes. Is it more economical to process the piston or to scrap it and buy a new one? I wonder what the feelings of the Committee are.

MR. LEEDY: As you know, a new EMD piston costs around $100 without rings. The more processes you can do in-house economically, the cheaper they are. It will probably run from $10 to $45 depending on which supplier's system you want to use to reclaim the ring grooves. If you do have a whole slug of pistons that have just one thing wrong with them, if it is just a worn ring groove, not cracked, not heavily scuffed, with no chipped areas, then you should seriously think about one of these processes. It can save you money and keep locomotives in service.

MR. J. H. LONG [Manager Locomotive Department, Ohio Division-Western Division, Chessie System, Cincinnati, Ohio]: Your Committee talked about two distinct methods of cleaning filters. Which method does your Committee recommend?

MR. M. GOGOL [Regional Manager—LRM, Southern Pacific Transportation Company, Los Angeles, California]: The cleaning in place is the most economical, and means less out-of-service time for the locomotive, although it has limitations.

We measure the cooling water suction pressure at the water pump inlet with cooling system open to atmospheric pressure. If the suction pressure is between zero and negative 4" of water suction the citric acid wash is used. If water suction at pump is greater than negative 4" of water, the lube oil cooler should be removed and cleaned.

MR. W. O. BROWN [Chief Mechanical Officer—System, Southern Pacific Transportation Company, San Francisco, California]: For the second time today I have seen in connection with liners this reference to environmental conditions. I am a bit confused. I don't know what environment there is for a locomotive except to run back and forth on a 4'8½" track gauge. Our builders and designers certainly must know of the conditions which exist on railroads over many years. Would you restate what you mean by environmental conditions?

MR. L. F. TURNEY [Manager Technical Section, Electro-Motive Division, LaGrange, Illinois]: Mr. Brown, the scoring transparency as showed as part of our presentation indicated status of scoring today. Any changes in design by EMD to the power assembly since the scoring problem developed on your railroad and the other four railroads was done to make the power assembly more compatible with adverse environmental influences.

Looking over last year's paper and the paper of the year before, we spent about three-fourths of our time going into all the details of scoring from the standpoint of EMD Engineering and Service. I don't see that we have anything more to offer.

Things are on the upswing. Your railroad has no scoring problem with our latest power assemblies.

As I have said before, lube oil is one of the environmental influences, temperature is another, operating continually in a dusty desert area is another, and a railroad operating in a clean atmosphere are some of the environmental influences. The conditions can be good or bad. Nothing further can be said on the subject which has been aired thoroughly, both in LMOA and in meetings with the railroads that have had the problem.

MR. BROWN: I wanted it recapped as you have just done. As you know, we still have some scuffing and we still are losing assemblies because of this. I can't change the environment, and I just wanted a capsule explanation of what you call environmental conditions. Thank you, sir.

MR. TURNEY: That is why I covered the question as I did. EMD is continually trying to improve our locomotive so that it can operate under any influences. This is a challenge to the manufacturer and always has been. The ideal situation is to build a locomotive that will perform trouble-free under any operating conditions, and that is EMD's goal. Little by little we may some day reach that goal.

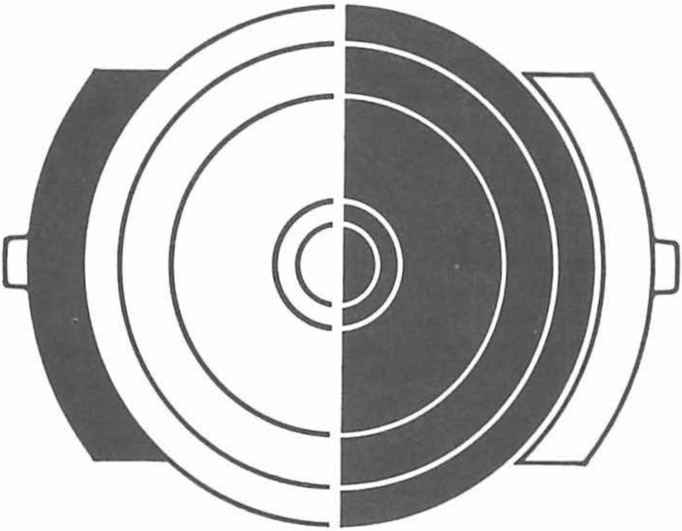
MR. C. W. HANES [District Manager, General Electric Company, Roanoke, Virginia]: You commented on the difference of opinion in the Committee about the EMD hot oil shutdown. Can you elaborate on that a little more—this difference of opinion among the Committee?

MR. LEEDY: I for one disagree with EMD that we have to have this on our railroad. I think we have enough protective devices onboard now, and if we just keep those working properly we won't have any serious problems.

Some of the operations in high altitudes or in tunnels may find this a desirable feature. I just don't think it is, and some of the Committee members feel the same as I do. It is just a personal opinion. Each mechanical officer who has any responsibility or any authority to do this should evaluate it and make his own judgment, and if he feels it will benefit him by all means he should do it. Personally, however, I don't believe it is necessary on all railroads.

MR. E. RISBJERG-THOMSEN [Technical Director, Danish State Railways, Copenhagen, Denmark]: Mr. President and gentlemen, I feel very honored to be present on this occasion when so many outstanding officers of the mechanical departments of United States railroads are discussing important maintenance problems.

In Denmark we have motive power equipment built by EMD that has been in service for more than twenty years, and we have had much assistance from the builder and from colleagues here in the United States in trying to keep up good maintenance. Last but not least, the reading of the Proceedings of the LMOA has been very helpful to us.



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I am asking a question now because in Denmark we have the same problem mentioned by Mr. Brown of the Southern Pacific, that of liners scoring on 20-cylinder engine locomotives of the 45-2 type, delivered in 1972 and 1973. I am also wondering about the environmental influences. We have no deserts in my country, we have no tunnels, we have no high temperatures. We have tried different types of lube oil but we still have a problem. I am also looking for those other mysterious environmental influences and would like to hear even more about them, even though Mr. Turney said the problem is finished. For us it is not quite finished yet. Thank you.

MR. LEEDY: If I might say something before Lou jumps in, this subject of liner scoring has been in the forefront of LMOA meetings for the last three years. As I understand environmental influences, these can include such things as the sulfur content of the fuel oil, perhaps an additive in the lube oil, perhaps some brand of lube oil you are using, airborne dirt, perhaps temperatures, and so on. Lou, can you add anything to that?

MR. TURNEY: Mr. Thomsen, the only thing I can add is that you were involved in quite a lengthy meeting at EMD to discuss this problem; and although I didn't attend the meeting, I understand the subject of scoring was satisfactorily covered in that meeting.

To my knowledge, lube oil has been a factor in Denmark. Fuel oil has been a factor. Another factor that is somewhat different in your operation than it is here, which can be called an environmental influence, is a different exhaust system on your locomotive than on the railroads in this country.

There are very stringent regulations in relation to ecology in Denmark, much more so than we have in the United States. From what I have been told, the Danish Railway has an exhaust system like the Cadillac compared to a Chevrolet. They go all-out to develop an exhaust system that will cut down emissions and also reduce noise levels. This is a factor that we are now investigating to see what effect it can have on the scoring problem.

Further, EMD has made arrangements for you to meet with some of the American railroad people so that you can better understand the scoring problem in the United States. We are trying to do all we can to expose you to the scoring problem we have experienced. I am sure every railroad represented here today will cooperate, but I don't feel we should pursue the subject further at this meeting.

Proceedings of previous LMOA meetings where the subject of scoring was thoroughly discussed are available in published form to provide you with complete details. I will be glad to sit down, aside from this meeting, and discuss scoring with you.

MR. THOMSEN: It is true, we have discussed the matter at EMD. I have talked with one member of your Committee, Mr. Burchett. I am going to meet with other railway people. In this short time I can only meet a few railroad people, and this is an opportunity for me to ask if there would be somebody outside the two major roads who have trouble and who can also give me some information. I am very interested in all the information I can get. When I am this far away from home I want to get as much information as possible.

May I answer what you said about exhaust systems. We have built the same exhaust systems into our locomotives with 16-cylinder engines where we have not had scoring. That is one of the things we wonder about. Will you discuss that later? I will not take more of your time now.

MR. TURNEY: I will be glad to let you know who the other railroads are of the five, and I am sure they will cooperate with you, too. Okay? Thank you.

MR. BROWN: One more question. In one of these piston repair processes, I see you finish up by coating it with a dry film lube. Is this for cosmetic reasons or does this take the place of luberizing? Is it as good as luberizing? Could someone tell me about this, please?

MR. LEEDY: I don't think the representative is here. What is the material you put on your pistons, Lou?

MR. TURNEY: This is something else. I don't know whether it is a good replacement or not. It does not compare to our luberizing. Let's put it that way. It is something that is painted on the piston.

MR. BROWN: Luberizing is a chemical process, and it is going to cost us about $70,000 to set up proper luberizing tanks to follow EMD's recommendations. If there is an easier and less expensive way out, I would like to know about it.

MR. LEEDY: I apologize for not having the answer, but I will get it for you before the end of the day.

MR. D. L. STUBBS [Superintendent Locomotives, Lehigh Valley Railroad Company, Sayre, Pennsylvania]: Mr. Leedy, could you tell us how much time has elapsed on test mufflers, and when will the Committee be able to provide us with a report or recommendation for same?

MR. LEEDY: Some of these systems have been onboard in test as long as a year, and the information I have is that they are all in trouble to some extent. I would suspect it will be at least another 12 to 18 months before we can say for sure that they are even going to work properly and will do what we expect them to do.

MR. W. F. HAMBLY [Atchison, Topeka & Santa Fe Railroad Company, San Bernardino, California]: I would like to direct a three-fold question to Mr. Turney in regard to cylinder liners. We still feel we have problems in our power assemblies on the Santa Fe.

Much has been said about the critical importance of the configuration of the port relief area. Recently your people have instituted tests with hard bore liners as well as chrome liners. I would like to know how these tests are developing in companies other than the Santa Fe.

Also, there has been some talk among people I have been privileged to meet here about the feasibility or practicality of a straight bore cylinder. I would appreciate anything you can tell me about this.

MR. TURNEY: On the testing of the hard bore liner, this is still in the very early stages of testing, and I am in no position at this time to evaluate current status of test. All I can say is that it certainly is not ready today. I can say it will be some time before enough data will be available to evaluate the test.

We are making extensive tests and must make sure our process is right before we introduce a change. The same applies to the straight bore liner test. So far, to my knowledge, the straight bore liner does not look very good.

Would one of the EMD Engineering representatives care to go further into the subject?

MR. JOHN MALINA [Electro-Motive Division, LaGrange, Illinois]: Mr. Hambly, with regard to your questions I would like to say first that we are testing hard bore cast iron liners on four different western properties. We recently completed inspections on yours and another property after approximately six months' service, and I can say at this early date the results are very encouraging.

With regard to the chrome liner, and more specifically the straight bore chrome liner, it has been long known that a straight bore in a cast iron liner will not operate satisfactorily. Presently, several of our western customers are testing straight bore chrome liners. At this time we are not endorsing nor condemning the straight bore in a chrome liner, but we do view the approach as primarily a chrome liner supplier manufacturing simplification.

The fact that the straight bore chrome liners on test have operated scuff-free for 6 to 12 months cannot be considered a qualification of the straight bore. It is going to take 18 to 24 months or perhaps longer to determine the long-term wear characteristics of the straight bore.

MR. DENT: Bob, I would like to ask a question about crankshafts. In the data you furnished in the report, does this encompass the reconditioned shaft and the new shaft? Do we have the same kinds of events happening at the same time, in miles or months or however you determine this? For instance, in breakage, do you have the same number of new shafts breaking as reconditioned shafts?

MR. LEEDY: The survey didn't really point this out. I can only speak for my railroad. Maybe some other members have more specific information. On our road it is about half and half. We will fail the original steel shafts and then we will usually break a chrome-plated shaft. Is that what you had in mind?

MR. DENT: Yes. As you know, the new locomotive has a new shaft. The remanufactured locomotive has a used shaft. Do you have the same number of fault events occurring in the reconditioned, remanufactured locomotives as would occur in new locomotives?

MR. LEEDY: Does anyone have a specific answer?

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La Grange, Illinois 60525 USA

MR. DENT: I have another question about the chrome liner that EMD is developing. I would like to ask if they are designing or engineering into this chrome liner the ability for the railroads to reapply the chrome liner without benefit of the break-in finish on its reuse in case it should happen to be pulled prematurely.

MR. TURNEY: We are evaluating chrome liners and hard end bore liners. A chrome liner is very expensive; I think we can all realize that. That is why EMD is looking for other means of achieving a hard bore liner. As John indicated, so far it looks good, and we are very hopeful this is going to be the answer for a very long-life liner. When we reach that point I think we will then be in a position to decide more about what can be done in the area of reconditioning the liners.

MR. HAMBLY: Mr. Turney, is your hard bore liner just hardened in the port relief area or is it the full length of the cylinder?

MR. TURNEY: I don't have all the details on the process. Mr. Malina, from EMD Engineering, might provide some detail for you.

MR. MALINA: Bill, the liners you are testing on your property are hardened in the entire Mae West or port relief area. We are testing similar liners on two other western properties in which not only is the Mae West hardened but the upper bore as well. With upper bore hardening, we are hopeful for a bore wear reduction of such magnitude to allow the liner to be re-honed after the first power assembly life and reinstalled in the engine. In such a manner, the iron liner could then be used for two complete power assembly life intervals before reclaiming the bore with chrome.

MR. HAMBLY: Would this hardening be deep enough so you can re-hone the liner?

MR. MALINA: Yes, it would. The hardened layer is of sufficient thickness so that when the liner is removed at the end of its first power assembly life period, it can be re-honed and enough hardened material will remain so as to retain the improved anti-scuff and wear benefits throughout the second power assembly life.

MR. R. R. POOLER [Manager Testing, Atchison, Topeka & Santa Fe Railroad, Topeka, Kansas]: I would like to get back to the crankshaft question. Has a study been made relating broken crankshafts to the age of viscous dampers? Secondly, what is the life of a viscous damper in a 20-cylinder engine?

MR. TURNEY: As far as the viscous damper is concerned, if there is no external damage to a viscous damper EMD feels the damper should run six years. If you examine a damper after it has been running four years and see no dents and no indication of loss of oil, we feel the damper should run another two years.

MR. BURCHETT: Earlier Mr. Brown referred to his environmental problem. Mr. Thomsen of the Danish Railway has referred to his problems. We have an environmental problem as well on our railroad. Our environmentalist is not here today, but I feel we would like to more or less change the phraseology from "environmental" to "brinkmanship".

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We had a problem with liners. We are still working with liners. We have recognized here today that liner scoring can be improved by a chrome plated liner or a hard bore liner that will improve the life of the liner. What is going to be the next environmental problem we come up with in this "brinkmanship"?

We have increased horsepower by using the 20-cylinder engine. We still use the same scavenging oil pump that we did on the 16-cylinder engine, and we are getting more horsepower out of it. We are getting closer to that brink. We are going to fall over.

This may be a problem some railroads are not experiencing, as to the high rate of failure we are having on our railroad. The scoring of liners is a serious problem with us. We are a poor railroad and have to watch our money. It is expensive. Mr. Malina has explained that chrome plating of liners is expensive, but power out of service to us is expensive when you have to pull these cast iron liners to replace them.

We all refer back to the good old days when we had the L-1 liner. It might be a step backward, but it might be a step toward improvement. That is at least to the first shopping, and we can chrome plate and live with them by bringing them back to standard size.

Lou, without going any further with your phrase, I would like to change it to "brinkmanship", and we will call it "brinkmanship" on our railroad for the time being at least.

MR. LEEDY: I want to get back to this gentleman's question about the relationship between broken crankshafts and viscous dampers. I don't think we answered it completely. Mark, do you have anything on that?

MR. M. M. EARLY [Mechanical Supervisor-Locomotive, Norfolk & Western Railway, Roanoke, Virginia]: I don't know if we are the only ones who have broken crankshafts on 20-cylinder engines in large numbers in the 10 and 20 and No. 11 main. We have taken out a number of them that were broken and in two pieces. We have taken out two of them that were still intact, with cracks in them, but they had torn out or wiped out the bearing. In quite a number of these cases we have found damaged viscous dampers.

We have a concern on these viscous dampers, that we will not put them back in a 16-cylinder engine if we can open one up and it has one in it. We have gone back to the old 6 pack with the GP40s.

EMD has been working with us in putting dampers of the paddlewheel type or gear type. We have five of those running, and we have big expectations for them because you have a damper you can measure. You can see the life of it. If we pull the damper off of an engine that has been opened up, if it is 2 or 3 years old we are afraid of it, and send it back. We don't trust a damper over 3 years old because there is no way we can qualify it. We send it to the plant and they have passed on it as being good. I am not sure they are thoroughly convinced the damper they send back is in good condition, because the means of qualifying a viscous damper is nebulous.

We feel we have something there that needs to be improved, and we are looking forward to EMD coming up with a better damper. The vibration we run through on a 20-cylinder engine in about the 5th and 6th notch makes us feel we have a vibration problem in a 20-cylinder engine. We have noticed more of a frequency of occurrence in ones with packets on the A frames.

The second order of fifty that we got were more prone to break than the first ones we got. There are various reasons put forth or conclusions drawn by the builders and us, and obviously there is a difference of opinion, but we look forward to EMD coming up with a better damper.

MR. TURNEY: Relative to vibration dampers, I have never heard of a damper causing a crankshaft failure. Can you imagine the force it takes to break a crankshaft? Loss of support on the shaft results in such a force. If a vibration damper is not functioning before you break a crankshaft, your operating crews would refuse to operate the locomotive for fear it would shake them to death.

A viscous damper, alone, will not cause a crankshaft to fail.

Other conditions in the engine along with a bad damper might cause a crankshaft to fail, but bear in mind that operating crews wouldn't tolerate running a locomotive that is excessively vibrating to a point where the crankshaft will break.

MR. BRUNER: Some time ago we tore one of the viscous dampers apart and found that the oil or viscous material was becoming hard and black. Our chemist analyzed that there is a chemical reaction between the fluid in the damper and the brass ring. This has been called to the attention of EMD, but we do not have a report on their findings.

MR. TURNEY: I don't know what the final analysis was. Bob Hart, can you help us on that?

MR. ROBERT HART [Electro-Motive Division, LaGrange, Illinois]: I cannot comment specifically on the chemical reaction between the fluid in the viscous damper and the brass. However, the polymerization of the fluid inside is a natural function of both time and temperature. We are well aware of the fact that you cannot tell for sure the amount of life left in a viscous damper, which is the reason we are proceeding with the gear damper program. Our actual failure rates on viscous dampers themselves have been quite low. Our problem is primarily a requalification problem.

MR. POOLER: Our lab has cut up about eight viscous dampers off of failed crankshafts, 20-cylinder, and in every one that we have cut up the fluid has turned either to jelly or powder. We believe there is a definite relationship between a broken crankshaft and a defective viscous damper. Every one of the viscous dampers we have cut up that had 3 to 4 years' service in a 20-cylinder engine has been defective.

MR. HART: We have looked at a large number of returned dampers from several railroads, and put them through the requalification tests of the manufacturer, and also have cut them up. Unfortunately we are not able to see a 1:1 correspondence between what the requalification tests tell us (whether a damper is good or bad) and what cutting it up and looking at the fluid tells us. You never can have perfection.

We are not satisfied with the requalification process, as I said earlier, and that is why we are looking at the gear damper hoping we can get a damper which will lend itself better to opening it up and telling us the amount of life in it and telling us that it is satisfactory.

Perhaps another word is in order on the questions that are before all of us regarding the inter-relationship between failed viscous dampers and failed crankshafts. As Lou mentioned earlier, it is our feeling that in general the failure of a damper alone does not account for failures of 20-cylinder crankshafts. Perhaps a few words are in order on this logic.

When torsional vibration causes the failure of a crankshaft, if there are no other contributing factors, we expect to find a failure through the No. 10 pin. The failure should be roughly a 45 degree helix. If the failure is in another location, we accept this as evidence that there have been other contributing factors. If the failure is in bending through a web, a classical lack of support, we infer that it is not a damper failure which caused the crankshaft failure.

I think, as in many cases, there will be many gray areas where there may be contributions from more than one cause. There is no question that the bulk of our crankshaft failures have been due to lack of support and due, in short, to main bearing failures or main frame fractures. I think this relates to the earlier questions of new versus used crankshaft failures. We don't see any appreciable difference in the failure rates, because the weakness in the crankshaft is not the primary cause of failure.

Getting back to the question of dampers, we have seen perhaps two, three or four of all the crankshaft failures on 20-cylinder engines where we feel a primary contribution was a failure of the viscous damper. In many instances we see viscous damper failures without crankshaft failures. In many other instances we see viscous damper failures and if there have been crankshaft failures they have either been at the wrong time to be associated with the failure or the wrong failure mode.

This is the story in a nutshell. We are concerned about the viscous damper failure not because of the high failure rate but because of the requalification problems. We are concerned about crankshaft problems, but in general they are not related to the damper failures.

MR. EARLY: In mentioning this lube oil problem that has been brought up by the manufacturer as perhaps contributing to the cause of the bearing support failure, we made an in-depth analysis of all the lube oil samples we have taken on these engines since we bought them, and most unusual was the fact that the engines that had the broken crankshafts had the best lube oil record, far better than the average of the rest of them.

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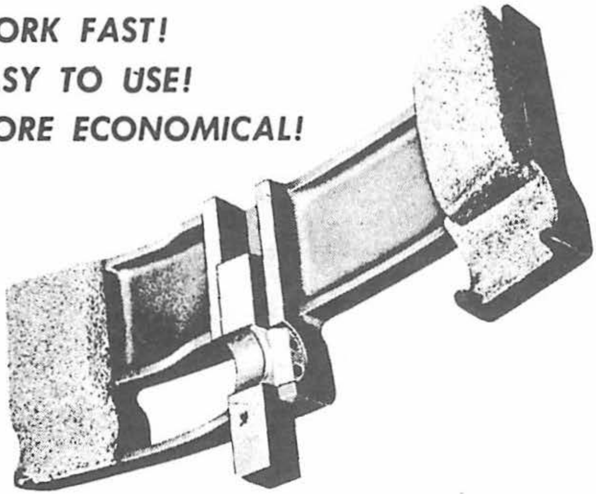

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I recognize it is just a coincidence. We could not establish water leaks as being tied in with a broken crankshaft, but we did establish pretty conclusively to ourselves that the broken crankshafts in many cases had bad dampers on them, and they were either leaking or they turned hard because we had sent numerous ones (maybe fifty or more dampers) in to EMD.

We finally started cutting them apart ourselves and saw this hardening of the silicone material. The vendor himself will tell you that a damper that has worked out will cause heat, and that heat will destroy the silicone, for reasons we don't know.

In this engine it seems to cause more heat in the damper, with subsequent shorter life. We think the 20-cylinder engine has a problem as far as vibration is concerned.

MR. TENNYSON: In connection with reconditioning of crankshafts, very often some straightening must be done, and then the shaft is plated and finished up without any heat treatment.

There has been a suggestion from time to time that heat treatment might give longer expected life from a reconditioned shaft, particularly one that has been straightened. I would like to know how the Committee feels about heat treatment of reworked shafts. When should it be done, and should we or should we not expect increased life from this process?

MR. L. K. ADAMS [Manager Product Service, General Electric Company, Erie, Pennsylvania]: I am not sure I can answer your question, Tom. Perhaps Jack Hoffman can reply.

MR. HOFFMAN: I have nothing to add to it.

MR. TENNYSON: Does any railroad that you know of, or any reconditioner, at the present time heat treat a shaft that is large? I know some small shafts are heat treated, but do they heat treat a shaft this large?

MR. ADAMS: I am not aware of any.

MR. TURNEY: Heat treating of the shaft after plating the worn areas will relieve stresses and throw the shaft out of tolerance beyond reclaiming. I can't envision the shaft staying stable dimensionally after heat treat even without the plating. There are certain stresses in the shaft just from normal operation that will be relieved through heat treat. I doubt that crankshafts can be successfully reclaimed through plating and heat treating.

MR. TENNYSON: This is part of the reclamation procedure. In other words, if a shaft has been straightened should it be stress relieved?

MR. HARRY WILLIAMSON [Chrome Crankshaft Company, Bell Gardens, California]: We have found that a crankshaft scored on the No. 2 or No. 11 main can be repaired. We have found probably three out of five are scored on the No. 11, another 20 per cent are scored on the No. 8, and another 20 per cent on the No. 2. The crankshaft that is scored on the No. 8, we feel, is automatically a candidate to be scrapped because of the fact that there seems to be stress that you cannot properly relieve.

On the No. 11 we have run tests and we have been baking them for the Southern Pacific, with their permission and on a test basis, at 850° for 12 hours. After this we have used glass beads on them to remove the scale caused by the heat treating. Then we pre-grind the shaft and finish straightening it. The runout has not been materially affected by the heat treating. If you have .030 runout before you heat treat it, you have .0295 after you heat treat it. Then we pre-grind it to remove the score marks. Most of the time this will go approximately .030 to .040 in depth on the diameter. At this time we chrome plate it and then bake it at 450° for approximately 8 to 10 hours after chrome plating.

We have two shafts that have had this done that are running on the Southern Pacific and, as far as I know, according to their records and ours, they are still all performing satisfactorily. The No. 2 main does not seem to have that particular problem.

On the GE crankshafts, we found that any crankshaft that is scored on the intermediate rods is a candidate for scrapping. The 1 and 2 rods and 7 and 8 rods seem to be successfully repaired, but we are having very bad luck with the nitrided shafts. I feel probably four out of five of the nitrided shafts that are scored are candidates for scrapping.

As far as heat treating is concerned, we have done this for only about 9 months. On the 20-cylinder shafts we repaired earlier, before the beefing up of the frame, we found that the shot peening seemed to relieve any stress that wasn't burned too badly. But since then we found that if a shaft is burned, most of them are candidates for scrapping, and I don't believe the heat treating will help that much. We don't have conclusive proof, but it seems to be working toward that.

MR. LEEDY: Then, as I understand it, if railroads send a crankshaft back to you for chrome plating you normally now do not heat treat it?

MR. WILLIAMSON: We do on the Southern Pacific on their 20-cylinders on the rear halves. We do heat treat any that are scored badly enough to have discoloration and are not scrapped. We are working with their lab on this.

MR. HART: With regard to the reprocessing of crankshafts, I want to draw a distinction between the journal treatment which involves the preparation for chrome plating, and the chrome plating and straightening of the shaft—that is, the fillet and web treatment.

There seems to be a fundamental lack of understanding of the problems associated with straightening. It is well established in the literature that cold-press straightening is harmful to the fatigue life of crankshafts. For a number of years at EMD we have not cold-press straightened our repaired crankshafts. Instead, we use a blunt chisel and hammer. Supporting the crankshaft on rollers, we hammer peen as need arises (in the fillets) for straightening the shaft. This has the advantage of introducing a favorable condition of residual stress.

In addition to this, on crankshafts that are going into turbocharged engines we shot peen for residual stress relief in the fillets. This has a double benefit. One is that it induces a favorable condition of compressive residual stress, and the other is that it gives an armor, if you will, of work-hardened material.

Cold-press straightening should not be done on the crankshaft. As far as location in the crankshaft is concerned, the crankshaft may be adequately straightened by peening with a blunt chisel regardless of where a bend may have occurred in service where there has been a failed shaft.

MR. HARLEY: The subject of locomotive mufflers has come up several times this afternoon, and I believe a comment is in order concerning one of the more recent tests involving locomotive mufflers.

This test was done on a large western railroad in conjunction with appropriate federal agencies, the AAR, and one of the other large muffler manufacturers who had had extremely good success in attenuating noise in trucks, and thus has an excellent reputation with the federal agencies involved.

Basically, the test consisted of taking standard locomotives, normally aspirated and turbocharged, placing them on a siding, with a loadbox located some distance away. The loadbox was screened so that its noise would not be a part of the additive noise. A flatcar was placed beside the locomotive to be tested, and a gigantic muffler supported by a forklift truck was held up in the air at right angles to the locomotive. In other words, the manufacturer was given no limit as to size, as to whether it would fit in a locomotive body or not. Without those limitations the device he came up with was cylindrical in shape, at least 4 feet in diameter and 15 feet long. [Laughter].

The sound attenuation with this absolute muffler was quite noticeable with the exhaust noise by itself. Its attenuation was in excess of 20 dba. However, when they got to the distance of 30 meters or 100 feet, which is the standard distance called for in the EPA rulemaking, the attenuation was very modest, in the neighborhood of 4 or 5 dba, which is little more than experimental differences that occur from locomotive to locomotive or that occur in instrumentation.

As a result of this test and other work done, including the EMD cost analysis which was made available to the EPA, the posture that EPA has taken is apparently to go slow on pushing for any retrofit of mufflers with present technology on existing locomotives, and looking more toward sound attenuation on new locomotive models where more techniques can be used other than just trying to fit a muffler into an existing carbody.

MR. TENNYSON: In connection with muffler development for roots blown engines, where your report mentioned the combination spark arrester-muffler device, I wonder if the devices that have been tested or are being tested right now incorporate the carbon retention trap that we are required by law to use in the West, and if so, what is the back pressure?

MR. RUDY PRIBRAMSKY [EMD, LaGrange, Illinois]: The system EMD designed for the roots blown locomotive, the 38-2 series, indeed does incorporate a carbon retention manifolding system. This design takes into consideration all that is required to meet 5100-1a, which is the U. S. Forest Service specification that EMD's present spark arrester complies with.

In addition, EMD now has the muffler in series with the spark arrester manifolding. At the present time we have three test units running on the Illinois Central Gulf Railroad. The back pressure of this new system, based on tests conducted to date, shows no adverse penalty being paid as far as engine performance is concerned.

MR. LEEDY: Gentlemen, I think you can see that the manufacturers are doing their homework. You may not agree with all their explanations, but hopefully you did get an answer to your questions. As Lou pointed out to our good friend from Denmark, some of these things are better settled on a one-to-one basis. Or, contact your neighbor. All this is very helpful.

I appreciate your attention and participation, and will now turn the program over to Nelson Buskey to summarize the report.

MR. NELSON A. BUSKEY [Assistant Manager-Mechanical, Chessie System, Pittsburgh, Pennsylvania]: Thank you, Bob. I wish to congratulate Bob Leedy and his fine Committee on a very well prepared paper. It is obvious from the questions

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generated by the report that considerable work remains for the locomotive builders to improve reliability in our locomotive fleet.

In summarizing this Committee's report I find many topics of great interest. First, the engine protective systems have proven invaluable and have saved our railroads many thousands of dollars, although the value of hot oil shutdown is not unanimously accepted by the Committee.

GE lube oil cooler cores continue to be a problem. Cleaning thoroughly is essential. The citric acid cleaning method is very interesting.

Piston reclamation is very important to many of us. The methods described are of great interest, and I am sure a conclusive report is in order for next year's Committee report.

Broken crankshafts and EMD cylinder liner scoring still appear to be problematical.

Exhaust mufflers or silencer tests are being conducted, and the results on exhaust valves and other related components affected by back pressure are of interest, and again we will look forward to a conclusive report next year.

Gentlemen, I am confident you will agree that Bob Leedy's report on Progressive Action on Maintenance and Ecology is both timely and appropriate, and will be of assistance to each and every one of us who maintains locomotives.

Again, Bob, congratulations to you and your fine Committee. [Applause]

MR. BUTLER: I want to thank the Committee for the fine job they did.

I will now turn the meeting back to Larry Booth to conclude the program.

PRESIDENT BOOTH: First of all, Joe Koerner informs me that those of you who have paid your 1976 dues can pick up your card at the registration desk in the lobby.

I am sure you don't need any reminder, but we would suggest now that you do visit all the hospitality rooms, but not to the extent that you won't be able to attend the session tomorrow. We want all of you back here.

With that, Bob, you and your Committee are thanked for the job you have done and the energy you have expended in putting this paper together. I would like to suggest the audience give you a rising vote of thanks for your effort.

[The audience arose and applauded.]

[The meeting then adjourned at 4:10 p.m.]

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TUESDAY MORNING SESSION
September 16, 1975

REPORT OF THE COMMITTEE ON FUEL AND LUBE OIL

D. H. PROPP, Chairman
Engineer of Tests
Burlington Northern Inc.
St. Paul, Minn. 55101

T. A. TENNYSON
1st VICE PRESIDENT
Asst. Mgr.-Engrg.,-Tech.
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The meeting reconvened at 9 a.m., Mr. T. A. Tennyson presiding.

CHAIRMAN TENNYSON: Good morning, everyone. We will start with the Fuel and Lube Oil Committee presentation. It is certainly nice to welcome you here to this session. I hope everyone had a chance to visit the suppliers last night and thank them for their advertising and their support. We appreciate these people very much. If you will visit them in the evening and come to the sessions during the daytime everything will work out fine.

This morning it is my pleasure to introduce to you the Committee on Fuel and Lube Oil, one of our most active and largest committees. This year we not only introduce the Chairman who will present the paper, but I would like to mention Mr. Newt Brightwell, who started the year in a noble fashion. Mr. Brightwell did a lot of work with this Committee and then retired from the Rock Island before he had a chance to finish his term of office on the Committee.

Newt was a very familiar face in all the organizations. He worked with the Chicago, Rock Island & Pacific. He was born in Arkansas a few miles from my birthplace. We have known each other for a long time. He was in the chemical warfare business and joined the Rock Island in 1947. We all wish Newt a very happy retirement, and we would like to see him in future years if he has a chance to get around here.

When Newt had to retire in the middle of the year it became the duty of Dale H. Propp, Engineer of Tests for the Burlington Northern, to take over the Committee, which he did without a hitch.

[Mr. Tennyson introduced Mr. Dale H. Propp, who in turn introduced the members of the Committee. Mr. J. L. Wilkison summarized Part 1 of the report; Mr. S. P. Spargo summarized Part 2, Mr. Propp summarized Part 3, Mr. K. D. Reed summarized Part 4, and Mr. Jack G. Hoffman summarized Part 5.]

MR. PROPP [Engineer of Tests, Burlington Northern, Inc., St. Paul, Minnesota]: Gentlemen, we have time for a question and answer period. I would like to call on Mr. G. E. Warfel, President of the St. Louis Railway Club, who was our host at our preconvention presentation. Is Mr. Warfel here? Did he designate a representative? If not, we will proceed with questions from the floor. I have a series of questions that have been presented to us, but we will start with questions from the floor.

MR. AXELSON: Mr. Propp, in your section on recycling and reclaiming of oils and fuel, has there been any more research or development for onboard type equipment that will literally re-refine the oil in place, for the benefit of extended service life of the engine as well as to extend the life of the oil itself?

MR. PROPP: Do you mean on the locomotive?

MR. AXELSON: Yes. I am thinking that years ago in the Navy, aboard ships they used centrifuge type oil cleaning equipment as opposed to the conventional filtration used today. I wonder if there are any other mechanical devices that could be used or are being developed.

MR. PROPP: Presently, many centrifuges are available which could be mounted on a locomotive. In my opinion, the centrifuge is superior to a filter. There are also combinations of centrifuges and filters. As mentioned in the paper, neither filters nor centrifuges return the finished product to a new state. If there is any depletion of additives, this would have to be monitored and very carefully adjusted in the event the product began to deteriorate. However, centrifuges may help to eliminate some of the insolubles.

It is questionable whether filters can efficiently remove the small micron size particles suspended in highly dispersant oils.

MR. HARLEY: Mr. Propp, about ten years ago we tried a centrifugal separator on an E type passenger locomotive. This was just about the same time the second-generation oils were coming in. We found with the dispersant qualities of the second-generation oils that they "fought" the centrifuge, and the net result was that it was not successful at least on the particular design we tried out.

MR. PROPP: I generally would agree. The ASTM centrifuge method for determining insolubles is somewhat undesirable with high dispersant oils. Does anyone on the Committee wish to respond to that question? Does that answer your question, Mr. Axelson?

MR. AXELSON: Yes. It tells me that there are no such devices available. I was thinking that the automotive industry has done a lot of research and development in this area. The paper mentioned synthetic oils used by police departments. I was thinking if we had onboard equipment it would eliminate the need to change the oil so often and put up with the attendant handling costs, spillage, and so on. Maybe it would be timely to look at this proposition again because of our energy position today.

MR. PROPP: That probably will be discussed in the future.

MR. TENNYSON: Dale, I would like to get into this discussion a bit. If you look at the reasons for changing oil, predominantly they are water and fuel contamination resulting from leaks, and nothing you can do onboard the locomotive will help you at all in this regard.

MR. AXELSON: Just one more remark. I am thinking in terms of maybe different types of filtration. I mentioned centrifuge as an old method of doing this. Today, with diatomaceous earth, and so on, involved, I thought a new concept might be looked at that would take care of suspended particulates in oil. Maybe you have an additive package that would automatically inject the additives required. I still believe it is worth thinking about.

MR. PROPP: It certainly is. We agree that all new concepts should be investigated. At the Burlington Northern we have been studying centrifuges, filters and their combinations, not necessarily onboard the locomotive but at our wayside spillage stations and water treatment plants. We have subjected the recovered oil phase to centrifuges. As previously mentioned, centrifuges improve the product up to a point, but do not return it to a new condition. However, it may extend the oil life.

MR. K. D. REED [Director Research Laboratory, Penn Central Transportation Company, Cleveland, Ohio]: I would like to comment on the last question. There is a device that came to my attention the other day, the name of which I forget. This is a combination filter and distillation outfit that comes in various sizes, some big enough for a railroad diesel engine. The seller proposes that it would filter and distill the volatile contaminants.

One of the problems is that the crankcase is probably a better distillation device than the electrically heated device in this element. Secondly, it is questionable how much fuel and water would really be removed from the oil. It would do nothing, of course, to remove oxidation products, acidity that wasn't taken care of by the TBM, and that sort of

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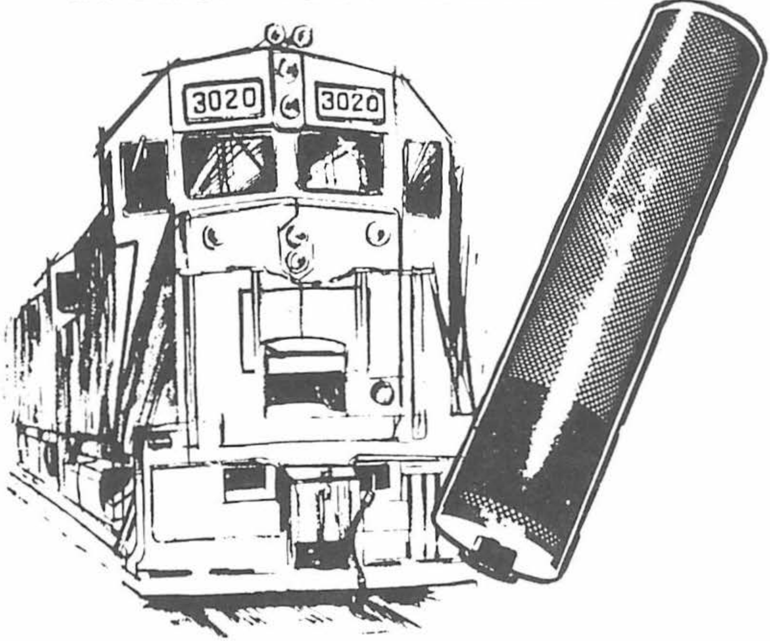

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thing. So, even at best it would appear that the cost, which was very high, would do very little for the engine that the current crankcase distillation and filtration wouldn't do. I would suspect many of you will be called upon to consider this device.

MR. PROPP: Any other questions from the floor? If not, there was a question submitted regarding the matter of synthetic oils. Many of you might be interested in what is the cost related to diesel lube oil change-outs in the event we were using synthetics. I will call on Mr. Wilkison to answer that.

MR. J. L. WILKISON [Products Application Engineer, Shell Oil Company, Houston, Texas]: Let's assume an average freight locomotive holds 400 gallons of oil, and the price of the blend of synthetic and petroleum base oil mentioned in my part of the paper is $6 per gallon. $6 for 400 gallons is $2,400 per change of oil. If you want to project this to include a fleet of 400 locomotives, it would cost $960,000 for one oil change.

MR. PROPP: As Jim just mentioned, this is not necessarily an expensive synthetic, but a medium priced one. Besides that, synthetics can still become contaminated with water and you would have to drain them for that reason.

MR. P. M. STETLER [Assistant Plant Manager, Southern Pacific Transportation Company, Sacramento, California]: If you are using spectrographic analysis to pinpoint engine problems, and your railroad mixes chrome and cast iron liners in an engine, how can you develop a good baseline to know when you have a problem, without knowing the specific proportion of cast iron to chrome in a given engine?

MR. PROPP: What kind of water inhibitor do you use—borate or chromate?

MR. STETLER: Borate.

MR. PROPP: Does anyone on the Committee wish to answer that question?

MR. R. L. TEN EYCK [Engineering Department, EMD, LaGrange, Illinois]: I think in general we have observed that chrome rings in themselves are probably not the major contributing factor when you see high chromium content in the spectrograph. Of course if you are using boron containing water treatment, the water leak is quite apparent from the presence of boron in the spectrograph. I think the railroads that are using chromates generally will find spectrograph readings that will show a considerable jump due to a water leak.

You have to bear in mind, really, that the value of the spectrographic analysis as a diagnostic tool is based on the rate of change of any particular element that is read on the spectrograph. So, it should not be difficult by observation to determine that you have had a considerable jump in chrome indicating a water leak is present when chromate is being used as an inhibitor.

MR. STETLER: What I was referring to was not so much a water leak in the engine but rather scuffing and scoring of a chrome liner versus the scoring of a cast iron liner, where you are comparing the amount of chrome versus the amount of iron in the engine. You may have anywhere from one to twenty chrome liners in an engine, with the rest being cast iron.

MR. PROPP: If a chromate inhibitor is used, you have more of a problem. If you are using borates, then all chromium would be associated with the chrome parts in the locomotive. Normally, it is advisable to observe both chromium and iron levels from the spectrograph, and associate increased trends of both elements. Those persons using chromate inhibitors must determine chrome liner wear only with similar increase in iron levels. An experienced spectroscopist can normally identify liner scoring.

MR. J. G. HOFFMAN [Fuel & Lubes Engineer, General Electric Corporation, Erie, Pennsylvania]: I think one point Bob mentioned I have to agree with, and it is important to emphasize. I understood Bob to say that very little chromium from chrome rings ends up in the oil that you can find spectrographically. That is our experience, too. So, if you find an elevated chromium level the choices are you have chromium liners or you have a water leak if you are using chromate. In our experience iron increases should be the guideline unless you know the engine is equipped with chromium plated liners.

MR. AXELSON: It was interesting to note that you are interchanging data on spectrographic analysis results, but there was a variation in interpretation and possibly attributed to instrumentation. I wonder if you are working up a standard for the railroad industry and recommending an internal standard such as lead, possibly, which is quite common, that might resolve some of the differences in the readings you get. Were all the internal standards the same in your instrumentation?

MR. PROPP: No. Unfortunately, as mentioned in the paper, some of the problems of interchangeability on spectrographs are proportional to the type of instrument. Most of the railroads now are using the new emission type rotating disk electrodes spectrographs. Therefore, repeatability of results between laboratories has improved.

The NARET program has been in progress about four years. I believe within the last six months we have observed a 65 to 70 per cent improvement in the repeatability of results between any two laboratories. This is proof the NARET program is providing an excellent improvement in standardization of instrumentation and resultant data.

With many varying parameters, there will always be deviations; but this program, which biannually provides standards to all participating laboratories, will continually improve.

If your railroad or oil company has a spectrograph and you are not participating, please join us. You may contact me or any member of NARET to become a participant.

MR. HARLEY: One of the questioners mentioned the possibility of injecting additive concentrates into lube oil on a locomotive to cut down on the additive depletion problem as a result of low specific lube oil consumption. The Penn Central has tried adding concentrated additives at monthly inspections. Possibly Mr. Reed might want to comment on the results obtained on some U 23-B locomotives.

MR. REED: The program Mr. Harley refers to was devised because we had approximately fifty locomotives at one time at one location, which were of the low consumption type, and we found that in less than 30 days we had to change all the oil in all of the engines. When the problem first arose we didn't have enough oil in stock to do it because we were caught unawares (this happened to be right at the time when it was hard to get oil), so we thought there may be some other way to overcome this problem rather than continually changing oil. Of course there were some oils recommended that would give us longer life, but for logistic reasons some of them weren't available to us.

We started an experiment wherein we would add one-third of the amount of additive that would be in a new charge of oil at each monthly inspection period so that at the end of 90 days we would have in effect replaced the entire additive package.

This was frowned on by the engine builders and some of the oil companies. Generally it was claimed that this sort of thing should be done in a refinery and not in an engine. Of course, as a general practice we do not disagree with them. We were conducting an experiment to see whether it was the additive package that was failing or just what was happening, and possibly it would lead to new additive development.

The oil company that supplied the additives has taken samples from the crankcases of the locomotives and is currently studying what happened to them, to see whether it was the entire package that failed or whether it was just the alkaline reserve portion. Hopefully a new additive generation may be developed to cope with the GE engine with the tuftrided liner-ring combination that has been pretty hard on oil especially when the engines are new.

We feel this was a success, in that we could actually postpone oil changes indefinitely by this approach. There are some problems arising in some diesel engines as the ash values get up to 1.0 or 1.5 per cent, so we watched this and this didn't happen. We didn't get ash values to the danger level, but we started to find pentane insolubles were up to around 4 or 5 per cent. We had to change the oil for this reason. We could go 6 or 9 months by merely adding additive rather than a whole charge of oil.

Again I say, we weren't trying to beat the oil company at its own business. We were merely experimenting to see what was happening with the oil in these engines, and if it would be possible through oil formulation to provide the 6 to 12 month or indefinite changeout period that we had been used to in EMD and GE engines.

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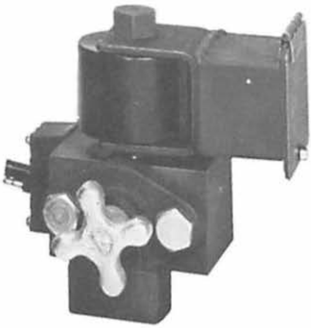

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MR. PROPP: Another question concerned the problem related to high viscosity oils. What is the present position of engine builders, specifically EMD, regarding the possible use of higher viscosity oils, relative to supply of paraffinic versus naphthenic stocks? I will ask Mr. Ten Eyck to respond to this question.

MR. TEN EYCK: I would have to say, first of all, that we are well aware of the potential for shortages of medium viscosity index lube oils and the necessity in the next 3 to 5 years, perhaps, of qualifying or being in a position to operate on high VI oils, and to that extent we have participated in a field test which has now run about 2 years in Canada.

The results look acceptable on a particular high VI oil. We have run lab engine tests on another high VI oil for approximately 2,000 hours each on a turbo engine and on a normally aspirated engine, and in neither case did we see anything that was detrimental to the engine. We expect there will be further railroad oil tests that will be conducted on high VI oils, so we are in a position where we are making progress toward, you might say, full usage of that type of oil in the EMD engines.

It is a matter of the necessity of changing position on our part, where eventually we must relax the 75 VI limit that we have. It is just a matter of time and experience with those oils in our engines.

MR. PROPP: Would you be thinking in terms of 100 VI or less than 100 VI?

MR. TEN EYCK: When that is changed I think it would probably have to go to 100 VI. You hardly see any petroleum product in excess of that. Only the synthetics tend to run above that.

MR. HOFFMAN: Historically we haven't had a prohibition on high VI oils and have not had an upper limit. Obviously, the bulk of our experience, at least in the United States over the years, has been with mid-VI products.

In the export field we have had some experience over many years with high VIs. Generally, however, the high VIs in the export field have been formulated with additives that are different from those used in the typical railroad oil. So, a question which we have been looking at in the past year or two, as we have requalified or examined new lubricating oil additives, is: How about the additives that are normally used in railroad engine formulations? Are these the type that would be adequate and satisfactory in paraffinic type base stocks?

Our answer so far has been yes. Modern railroad lubricating oil additives are the proper type to be used in high VI base oils. We have one listed in our current list that is fully approved as a high VI material.

I do want to acknowledge something. While GE and others in the 4-cycle business have said for a long time that high VI oils are satisfactory, and some of our 2-cycle friends have said "We don't want them," many of us, even 4-cycle people, years ago thought we saw harder carbon deposits resulting from their use. I would like to reaffirm that those things do show up even in 4-cycle engines with at least some high VI paraffinic base stocks mixed with the same additive used in conventional mid-VI product. However, they have not caused problems or rejection. Academically (a) the carbon is harder, and (b) there is more of it. So, our eyes weren't playing tricks on us in the past. It is true today, too.

MR. PROPP: Thank you, Jack.

I have been informed our time is up. With all the experience and technical ability of the crew on both sides of me we could probably talk all day, but it is time for us to stop.

At this point I would like to call on Mr. Dick Holmes, our Regional Executive, to summarize our paper.

MR. HOLMES: Dale Propp and his able Committee deserve our commendation for their excellent report, which I am sure is the result of many hours and days of hard work.

The merits of lube oil re-refining and fuel oil recovery cannot be overemphasized or repeated too often. The Committee reported on new developments for this subject in view of the problems we face in energy conservation, and discussed the opportunity for railroads to realize appreciable savings.

R. R. HOLMES
REGIONAL EXECUTIVE
Chief Chemist
Union Pacific Railroad Company
Omaha, Nebraska 68102

The Committee reported on interesting applications of synthetic oil that now are in a highly specialized category, but have the potential for development and expanded application for railroad use other than locomotive.

They reported on progress in standardizing test procedures among railroads in order to implement the exchange and interpretation of test data to reduce repetitive evaluation and increase test control on foreign railroads.

Effects on lube oil condition brought about by reduced consumption resulting from improved engine design was presented. The Committee also reports that improvement in oil quality can be expected, as the results of several oils designed to meet increasing engine demands are now in field test stage.

I am confident the message we received this morning on many of the subjects will be put into early practice throughout the industry.

May I suggest we give Mr. Propp and his Committee a hearty vote of thanks for their efforts this morning. [Applause]

Also, I want to put in a plug for What's Your Problem tomorrow morning, so any incomplete or unsatisfactory answers given during the session today can be brought up at that time tomorrow morning.

MR. TENNYSON: Thank you, Dick.

TUESDAY MORNING SESSION
September 16, 1975

REPORT OF THE COMMITTEE ON NEW DEVELOPMENTS

J. R. RYDER, Chairman
Committee on New Developments
Director Industrial Engineering
Rock Island Lines
Chicago, Illinois 60605

J. TAGGART
5th VICE PRESIDENT
System Mechanical Officer—
Canadian National Rwys.
Montreal, Canada

MR. TENNYSON: I would like Mr. Ryder and his Committee on New Developments to come to the platform, please. I will call on Mr. Jim Taggart to act as officer during the next committee presentation.

MR. J. TAGGART [System Mechanical Officer, Canadian National Railways, Montreal]: Thank you, Mr. Tennyson.

The New Developments Committee has an enviable task. They don't have the same sort of continuity in their subjects that the other committees have, so each year they have to sort of take what is left over, put it together, and sell it.

Today they have four topics, of which two are of particular interest. One is on Management Information Systems and the other is on Training. As you will recall, yesterday morning Bill James' Committee had a brief discussion on training as it affects electrical workers. Today Jim Ryder's Committee will expand on the field of training mechanical department personnel.

[Mr. Taggart introduced Mr. J. R. Ryder, who in turn introduced the members of his Committee. Mr. B. A. Cumbea summarized Part 1 of the report, Mr. V. L. Smith summarized Part 2, Mr. R. T. Thetford summarized Part 3, and Mr. Ryder summarized Part 4.]

MR. RYDER: We would like to thank J. C. Foster, President of the Southern and Southwestern Railway Club, who allowed us to present our paper on April 17 in Birmingham. Their Club showed us excellent hospitality, and we really enjoyed our trip down there.

At this time I would like to throw the floor open to questions, please.

MR. LEEDY: I noticed in the paper there were a number of good slides on fuel pans for areas around tracks, to collect fuel spillage. This is costing the railroads millions of dollars collectively. Has your Committee made any investigation into the possibility of improving the automatic fuel shutoff systems? Is there anything new that we can hope for to stop a lot of spillage, rather than spending enormous amounts of money for exotic drain pans?

MR. RYDER: There are a couple of problems, not only spillage but also drainage that comes out of locomotives. We might ask one of the builders to answer the question.

MR. WALTER WECK [Assistant General Service Manager, EMD, LaGrange, Illinois]: I have nothing to add to what has already been said, except that the systems that are required to be put on the locomotive are your choice. The brands of automatic fuel systems and shutoffs are not indicated by us but by you, our customers. From observations we have found that the automatic fueling devices used today are quite adequate, but they are most often found to be abused and poorly maintained.

We were a little ashamed of some of the photographs you saw here when we started talking about collection pans. You noticed the first slide showed somebody had taken one of these rather expensive devices and had it lying on the deck where it could be kicked or run over or be filled with dirt, or some such thing. Therein we think lies the problem. The devices are good, but they are a maintenance item and they require care in handling.

MR. THOMAS C. WHITTLE [Manager, Product Planning, General Electric Company, Erie, Pennsylvania]: The only experience we have had in regard to new systems is with Moore Products, who supply the fluid amplifier system used in our locomotive cooling system. They approached us to find a railroad that might be interested in a more positive shut-off fuel system. They were directed to the Seaboard Coast Line. Their system is much more positive than anything that is currently available. However, they have run into the problem that there are so many systems used that you get into compatibility problems. If there were fewer systems being used by the railroads, and therefore more standardization, I think we could come up with a more foolproof system.

MR. RYDER: Walter indicated it is the railroads that are dictating some of the systems. Unfortunately, the Environmental Protection Agency is dictating some of these systems. These are very expensive systems. We indicated in the paper that we think there is a lot of innovation that should go on in this area to reduce some of these costs.

In line with that, the Rock Island specifically and others, we had some problems, and we looked into fiberglass. A few years ago the Penn Central had an article in one of the railroad magazines (I believe it was *Modern Railroads* discussing some of the fiberglass systems they put in at some of their lower fueling systems, and we mentioned it in our paper.

We investigated and found that over the last few years fiberglass costs have gone up comparable to some of the steel collection pans. Originally the Penn Central stated the fiberglass costs were 60 per cent less than steel. That is no longer true, from the experience we had. Something along that line is certainly needed to reduce some of these costs.

MR. DENT: Is there any attempt being made to standardize mechanical and electrical component coding for compatibility among the various railroads?

MR. B. A. CUMBEA [Supervisor Product & Stat. Control, Chessie System, Huntington, West Virginia]: Some seven or eight years ago there was a special study group that was assigned the task of attempting to develop a system for interchanging of data compatible with either manual or computerized systems. I think the problem is that this group became a little overambitious. They developed something which was too sophisticated and too complex to be accepted. However, they did write a specification and submitted it to the AAR for consideration. This was some five years ago, and apparently it died within the AAR. This might be a good thing for the Committee to look at as a future subject.

MR. BRUNER: I think one of the problems we have today on some railroads is trying to cut too short on fueling time to save on terminal delay. We are trying to get 100 to 300 or even 500 gallons a minute through too small a hose.

If we were still operating steam engines and we had to put on 20,000 gallons of water, would we try to do it through a pipe the size of the fuel hoses we are using? Why don't we look at a possible solution to increase the hose size and add fuel through a larger opening, possibly at the top of the locomotive? Some research along this line might develop that we should redesign for larger capacity at lower pressure, and that might be the answer. This is a toss-up you might want to consider.

MR. RYDER: On the Rock Island we had some problems with fuel capacities in terms of the volume going in, and we had to make some changes.

VOICE: What is the status of the mobile training center? I think the Chessie is looking into it or working on it now.

MR. CUMBEA: This first portion of the paper which dealt with general training for supervisory personnel currently is being offered at major facilities where we have classroom area

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available. We did have delivered earlier this month a van which has been set up and equipped to take this particular training program to smaller locations. It hasn't moved out of the property yet but it is ready to go; and as soon as we finish the larger locations, the instructor will start taking the mobile unit into smaller places and provide the supervisory personnel at those locations with the same type of training.

MR. AXELSON: I am glad to see that your Committee took on a tough job, talking about training, because it seems that training, similar to safety, costs money and it is pretty hard to show an outward appearance of ROI. Not only the railroad companies but manufacturers invest a lot of money in training.

In view of the present economic slowdown, I am wondering how this has affected railroad training programs. In a mutual or joint effort should locomotive or equipment builders bring more schools to railroad sites during the low economic periods?

MR. RYDER: We as a Committee discussed this. Unfortunately, during low economic times most of the training programs in the railroad industry are cut out. It is really unfortunate, because it is probably during those times when we are losing forces of both management and labor that training programs become most critical.

I would like to ask Mr. Weck to answer it in terms of the builders' viewpoint.

MR. WECK: We have noticed a slight down-trend in the number of students coming to our training facilities at EMD in LaGrange. In the recent past we have gone to several large railroads at their request and put on specific type training programs. With the facilities we have at LaGrange we would like very much to continue to have students come to us, rather than we go to them.

At our LaGrange Service School we have a large amount of capital invested in training equipment. To produce a cutaway engine involves an expense equal to a production engine. The electrical cabinets and lockers, the simulators we have in the classroom, are equally expensive and necessary for good training. It is difficult for us to take to the field the caliber of instruction and training that people could get if they came to us.

In recognition of the thing you have referred to, we are creating small traveling shows to go onto the customer's property in an attempt to help him in his training efforts.

I think there is a secondary portion to this problem of training away from our own facility. One of the things that becomes difficult is that many of the railroads that ask us for this kind of assistance will ask for an instructor or a group of instructors to instruct at different times. They would like to have this take place from 1 to 4 p.m. and from 6 to 9 or 10 p.m. They ask the people on the third shift to come in from 12 to 4 p.m., and then they ask the people on the second shift to come in in the evening, many times on their own time. Therein lies a problem. A great many railroad employees find it difficult to do anything on their own time. There has to be some sort of uniform policy that would say to the employee, "You are going to be trained and you are going to go on company time, or it will be a split." If we go into the field as we have, we certainly would like to have the kind of attendance that would make this kind of venture worthwhile.

MR. WHITTLE: Our experience has been very similar to what Walt has described. We do find there is some advantage in taking the schools into the field. It is true that we do get away from all the facilities that we have at Erie. However, we find that at Erie the students who normally come are supervisors. When we take the schools to the field we find it is actually the man who gets his hands dirty and uses the wrench who benefits directly from the instruction.

Within the budget constraints we are suffering in common with the railroad, we will endeavor to make field schools available. This fall, for example, we are starting a tour of the western part of the United States with a special tool demonstration that will provide on-site demonstration of the tools that are available for the maintenance of the GE locomotive.

MR. AXELSON: I would like to say that the railroads of course are using improved techniques and training films, for example. Some are furnished by equipment or locomotive manufacturers; some are furnished by the railroads themselves.

I agree with you entirely that the man should get his hands dirty and get the feel of what he is trying to work on. One of the problems with a training film is that it is hard to ask the film a question when you want an explanation or more detail, or even, for the sake of argument, to bring out a point. Don't get me wrong—training films are a big improvement.

MR. HAMBLY: The training center at Cumberland is very beautiful and impressive. I wonder if you have any idea of the cost of such a center.

MR. CUMBEA: If you should ever have the opportunity of going to Cumberland to see this facility, and if you talk to the people there, you will probably be told that it costs nothing. This obviously can't be true. However, in setting up the Cumberland school all the equipment we showed on the slides was salvaged either from locomotives which were damaged beyond economic repair through accident, or some allowable salvage from trade-in locomotives.

The work of putting the components together and simulating the operation was done by the personnel at Cumberland. In planning a similar center for Huntington we looked at some of the sources for equipment—cutaway engines and things of that kind—and found the cost to be totally prohibitive. So, I think the same approach will be used in setting up the Huntington school. I can't give you any actual cost figures, though.

MR. GOGOL: I would like to address my question to EMD. We recently received a new SDT-2 locomotive. The integral holding tank, when we went to drain it, had nothing but pure fuel. We suspect it has a fuel leak. Looking at it, it is quite a job to repair or even locate the leak. How would EMD recommend it be repaired?

MR. WECK: Mr. Gogol, I am familiar with what you are talking about. I believe we did dispatch a welder to effect the repair. This was the second instance of this particular failure mode.

It is an internal welding sheet problem, and one that is rather difficult. Fortunately we do have some hand plates, some cleanout traps and plates that we can get into and look at, but the technique of locating the leak and repairing it is rather difficult.

MR. RYDER: Mr. Schroeder has handed me a note saying that it is agreed sophisticated information systems are an asset, but he asks if our Committee has looked into how much this asset costs the railroads, and have we evaluated all the costs of gathering the information, and have we compared these costs with some other method. We haven't, and maybe that is a good topic for next year, because I think it will probably take the whole hour to discuss some of these problems.

At this time I would like to call on Mr. Townley, of the Santa Fe, who is one of the Regional Executives. He is a Past Chairman of this Committee and has given us very strong support this year.

MR. L. O. TOWNLEY [Assistant Manager Industrial Engineering, Atchison, Topeka & Santa Fe Railway, San Bernardino, California]: Jim, you and your Committee are certainly to be commended for your real contribution and positive approach to solving some of the problems we railroad people have.

L. O. TOWNLEY
REGIONAL EXECUTIVE
Asst. Mgr. Industrial Engineering,
Atchison, Topeka & Santa Fe Rwy.,
San Bernardino, California 92410

The importance of the training system as a positive way of making our people more productive and better able to handle their jobs is attested to by the number of times the subject has come up on the floor yesterday and today. I think the contribution the Committee has made in a positive way in suggesting how to handle these matters is very important.

The part on computers is likewise a positive approach to a problem. We can no longer afford to have a very complex computer system unless it can give us something. It has got to save us money. It has got to make a better product as a result of using the computer, rather than feeding stuff into the computer for the sake of the computer. I think continued research by this Committee and future reports will make it even more positive and more possible to use the computer in a beneficial way.

Again I would like to congratulate Jim and his Committee on the work they have done. We owe them a real debt of gratitude. [Applause]

MR. SCHROEDER: Thank you, Jim.

Speaking on behalf of President Booth, I know he would want me to direct your attention to the Honor Roll on my right, showing the advertisers who support our organization, and would ask you to express your appreciation to them, as I certainly do from this podium. We need them. Tell them how much we appreciate them.

We will reconvene at two o'clock. Please be on time. The benefits from this Association come from your attendance and participation in the sessions.

With a rising vote of thanks to this Committee for their fine efforts, we will recess until 2 p.m.

[The audience arose and applauded.]

[The meeting recessed at noon.]

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TUESDAY AFTERNOON SESSION
September 16, 1975

REPORT OF THE COMMITTEE ON SHOP EQUIPMENT

KJELL AXELSON, Chairman
Genl. Mgr. Work Equip. & Mach.
Burlington Northern
St. Paul, Minn. 55101

E. T. HARLEY
3rd VICE PRESIDENT
Gen. Mech. Supt.—
Engineering & Research
Penn Central Trans. Co.
Philadelphia, Pa. 19104

The meeting reconvened at 2 p.m., Mr. L. H. Booth, President, presiding.

PRESIDENT BOOTH: Gentlemen, it is two o'clock and we will begin the session.

The afternoon session will deal with the report of the Committee on Shop Equipment, of which Mr. Kjell Axelson is Chairman. I will introduce Mr. E. T. Harley, Third Vice President, who will be chairman of this session.

MR. HARLEY: As of 2 p.m. the Active membership of the LMOA is 1,546 as compared to 1,735 last year, or a decline of 189. The Associate members total 360 compared to 384 last year, or 24 short. Advertisers stand at 103, or 21 short of last year's 124. The grand total of all three classes last year stood at 2,243. As of right now the figure is 2,009.

People are still out in the registration area. If you haven't signed up, there are several people out there waiting to receive your membership and your money. It is never too late to sign up.

The report this afternoon will be given by the Committee on Shop Equipment. Mr. Axelson is Chairman. Mr. Axelson.

[Mr. Axelson introduced the members of his Committee. The report was summarized by Mr. Kessinger, Mr. Whitten, Mr. Anderson, Mr. Nielsen and Mr. Axelson.]

MR. AXELSON: On May 15 of this year we had the pleasure of giving our preconvention report at the Great Lakes Railway Club in Cleveland. This active Club responded with a gratifying turnout of railroad and supply members to support our LMOA endeavors for improvement. At this time I would like to call on the President of the Great Lakes Railway Club to again help our Committee activities by opening our discussion period. Mr. J. W. Boughton.

MR. J. W. BOUGHTON [General Superintendent Shop, Penn Central Transportation Company, Collinwood, Ohio]: The Great Lakes Railway Club was honored to have Mr. Axelson and his Committee present their preconvention paper at our meeting. It was very evident then, as it is now, that considerable effort went into the preparation of the paper, and it was thoroughly enjoyed by all those present.

The Great Lakes Railway Club is located in Cleveland, Ohio, and we meet every other month, September through May. We normally have an interesting railway-oriented speaker, and I would like to invite any of you ladies and gentlemen who happen to be in town on a meeting date to accept our invitation to attend the meeting.

I would like to ask a question: Are there any substantial economic- and energy-related savings to be realized from the turbolator cleaning equipment utilized in the ICG engine rebuild line?

MR. T. E. WHITTEN [Coordinator, Research and Planning, Illinois Central Gulf Railroad Company, Paducah, Kentucky]: There are a number of economic benefits from the turbolator. We received it in just the last month or so, and we are in the process of installing it in the shop right now.

Some of the economic benefits we reaped in our shop were that the manhours were reduced in cleaning time due to the turbolator, also a direct reduction in cleaning time as opposed to the arrangement we had before. The crane time was reduced tremendously because it gave us easier access of the crane to move parts in and out. Another saving we hope to realize is in chemical. The turbolator gives us a process of closing the top up and we don't lose as much chemical through evaporation.

With respect to the energy-saving aspect of the turbolator, Mr. Bob Erlenbaugh, of Turco Products, is in the audience and might enlighten us a bit on that subject.

MR. R. J. ERLENBAUGH [Area Supervisor, Railway Sales, Turco Products, Joliet, Illinois]: Thank you very much. I am pleased that you brought up that subject, because fundamentally that is one of the best sales tools we have, on the amount of savings you have over and above the old-fashioned method of fueling and heating up with oil and steam, and so on, because fundamentally the machine itself is a mechanical liquid blast cleaning system. The heat involved is not really relative like it would be in the rolling boil where you get up to 180° or so.

The best part of all is the longevity of the materials that you spoke of, and that is relative to the automatic desludging program we have. We have had tanks run in the area of 18 to 24 months without cleaning out a tank, as opposed to the build-up you get in most tanks. It has worked out very well for us, and I am glad you asked me to say something about it. Thank you.

MR. WHITTEN: We have another representative on the Committee who has had a turbolator in operation for approximately three years, Mr. Kessenger from the L&N. He might comment on the use of his turbolator.

MR. T. A. KESSENGER [General Engineer, Methods and Procedures, Louisville & Nashville Railroad, Louisville, Kentucky]: Everything Tom said is absolutely true. (Of course it is not just because of his size that I am saying this.)

We have had a turbolator for about three years. We find the filtering system very effective. We have drained the tank only a couple of times, and even then did not renew the chemical. The chemical was put in a holding tank and then pumped back in. We have just added make-up chemical. That is hard to believe, but it has been in there for three years. We don't know when it is actually going to be condemned.

It seems that the filtering system can actually separate all of the particles out of suspension. It has a scum gutter on the rear of the machine, and you can float all of the oils and greases at the top right off, and that is why we are able to add only the make-up chemical.

The turbolator can be purchased with a positioner which really minimizes the time for the work piece to be in the washer. Before we had the Turco we used to put our engine blocks into a lye vat for a day or two, and then we would spend almost four hours with a laborer steaming the block off. Then we would spend another four hours with two mechanics cleaning up the critical areas. Now, in two hours the block is clean.

The biggest problem we had with the Turco is that the workpiece is so clean it will rust immediately after being taken out of the washer. We have to rinse the workpiece off and apply a rust preventative as soon as we take it out of the washer.

MR. DENT: Can a reduction be made in crab stud bolt failures through the use of the hydraulic torque wrench in the application of the upper deck crabs, and if so, why?

MR. AXELSON: The Southern Pacific has been doing some developmental work with this new hydraulic wrench. Pete, can you shed some light on that, as to how we are able to reduce stud cracking?

MR. STETLER: With a tool of this type, where you can quickly and

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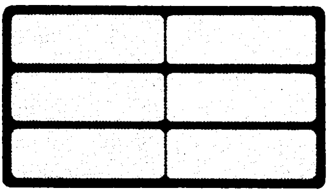
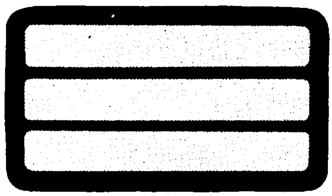


Cross section of armature coil with insulation of KAPTON



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accurately re-torque and verify the torque on crab stud nuts, you can reduce the number of failures simply by assuring yourself that your top deck is torqued properly. I think this is something that should be done on a periodic basis, particularly if you are looking at a locomotive that is relatively new or a new engine in an older locomotive, or an engine that has recently had the assemblies changed.

As you know, periodic re-torquing is important because as an engine breaks in we may experience slight stretch of the crab studs or wear on the crab pedestals on the ends and center of the engine. I think the answer is yes, you can expect a reduction in crab stud failures if you periodically accurately re-torque the top deck.

MR. AXELSON: Mr. Browning, would you say a few words on this process?

MR. JACK BROWNING [N-S-W Corporation, Houston, Texas]: The N-S-W SLECT-A-TORQ hydraulic torquing wrench is relatively new, considering we have been in business for three years. The SLECT-A-TORQ was primarily introduced for torquing nuts and bolts on flanges in the refinery industry. N-S-W then branched off into the chemical plants and pipeline construction, as far as installing flanged valves and doing station work. Our next involvement was in exploration drilling onshore and offshore with some sub-sea work.

We then proceeded to the shipbuilding industry, and are presently working on aircraft carriers, submarines, and other ships. We have applications in steel mills, such as overhauling blooming machines. We then expanded into the manufacturing industry of large valves, vessels, and fabrication shops. N-S-W is now working with many divisions of General Electric and Westinghouse Electric regarding power generation. Now we are involved with railroad locomotives.

The SLECT-A-TORQ 3000A will be used for locomotive work, which will produce up to 14,700 ft./lbs. of controlled torque. This unit operates at 3000 PSI, using 90 to 100 lbs. of air. The most important factor we have to offer is accuracy, also uniformity in torquing nuts and bolts. We know the yield of a bolt, and under normal conditions we would torque at 50 per cent of yield.

As you saw in the film today, N-S-W has designed this locomotive wrench with tooling, which offers you lightweight and available clearance among the other parts of your engines. The SLECT-A-TORQ system has a safety factor in this type of application because we have eliminated many other hazardous ways of tightening nuts and bolts.

Lastly, and very important, we do offer economies, in that we eliminate many manhours.

N-S-W has an 8-minute film on our SLECT-A-TORQ hydraulic system which would give you an idea of many areas of application.

MR. AXELSON: All I can do at this point is wish you a lot of luck. We appreciate your entry into this field. I don't think there is anything wrong in saying that our old friend TAME, INC., provided the initial

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breakthrough for us. I understand they are trying to improve their product even more. I think there is plenty of room for several suppliers.

Are there any other questions?

MR. STEVE BAKER [Test Department, Chicago & Northwestern Transportation Company, Chicago, Illinois]: For how long does the urethane paint emit a gas before a second color or reflective stripping can be applied?

MR. R. E. CLAWSON (General Foreman—Locomotives, Missouri Pacific Railroad, North Little Rock, Arkansas]: It takes at least 24 hours for urethane to set properly, in contrast to what we have been used to. Any masking could lead to paint peeling when it is removed, or any reflective stripping that is put on would not adhere as it should because of this setting condition, which continues for at least 24 hours.

MR. BAKER: Does heating urethane speed up the process, or would that destroy the final finish?

MR. CLAWSON: I can't answer that. We have not had any experience with the heating process in setting up urethane. Maybe Frank can tell us.

MR. F. P. BOATWRIGHT [Manager, Product Installation, EMD, LaGrange, Illinois]: I assume you are referring to a heating room of some sort to speed up drying. There is some improvement in drying time with temperature. However, waiting 24 hours before applying Scotchlite is recommended.

MR. T. L. WESTERFIELD [Electrical Engineer, Chicago, and North Western Transportation Company, Chicago, Illinois]: I have two questions. The first is for Mr. Nielsen. In setting up the blower reclaim operation, what sort of assistance did you get from the factory in determining the specifications and dimensions involved?

MR. N. J. NIELSEN [Shop Superintendent, Chicago, Milwaukee, St. Paul & Pacific Railroad, Milwaukee, Wisconsin]: At the beginning General Motors sent one of their representatives, and we worked in stages on this particular line, one item at a time, to make sure it would work correctly and that the men could work with it. As each process was completed we moved to another area. General Motors was very cooperative in all areas in this particular setup.

MR. WESTERFIELD: My second question is for Mr. Whitten. Regarding the automatic equipment for welding and boring the traction motor frames, what sort of production volume does it take to justify that sort of setup?

MR. T. E. WHITTEN [Coordinator, Research & Planning, Illinois Central Gulf Railroad, Paducah, Kentucky]: For the past three or four years we have justified every project on our in-house production needs. The equipment for boring the traction motor frame was justified on our production, say, of two or three years ago.

On the automatic welding machine it is a different matter altogether. This machine is in its infant design stage. We cooperated with the Canadian National, going in on the engineering costs of this machine, and at the last meeting we had the machine was going to run in the range of $250,000. This is very expensive, and it is doubtful if we can justify that on our needs at the ICG. We are looking at some other equipment at this time, and it is hoped that maybe Standard Modern will drop their cost on that machine.

To put down a figure and say how many traction motors you would have to machine to justify that expense, I can't honestly say, because I don't know what your operation is. The amount you will pay for the shuttle machine will be higher than what we paid for it, because ours was the first one built and we got a little reduction that way. You would have to look at it through your own company.

MR. HAMBLY: I would like to ask Mr. Nielsen a question. In the sleeving of the air compressor cylinders, what material are you using and where are you obtaining the sleeves?

MR. AXELSON: Mr. Kelly, can you answer that? The gentleman wants to know what material is used for the sleeving on compressors.

MR. T. F. KELLY [Superintendent Locomotive Shops, Chicago, Rock Island & Pacific Railroad, Silvis, Illinois]: It is a centrifugal spun casting and it is bought outside the United States. Years ago Hunt-Spiller furnished a casting and it had to be machined both internally and externally, but since they have gone out of the business of castings we have had to depend on an outside source.

MR. J. H. LEHMAN [Facility Analyst, Illinois Central Gulf Railroad Company, Chicago, Illinois]: Mr. Nielsen, on your blower line: You got the dimensions from the manufacturer, I understand, which I imagine some other railroads also have. When you go through your break-in test do you run through any particular test procedures to check either for pressure delivery or volume delivery from the blower to make sure that you are not getting too much bypass even though the dimensions are still right?

MR. NIELSEN: No, we don't check to see what is the volume of air that would be delivered. We run it strictly to make sure the lobes are correct as far as clearance is concerned, and that there are no oil leaks, and we check out oil pressures on the thing itself, but we do not check the volume of air.

MR. LEHMAN: A question for Mr. Boatwright: Is this a good idea, or should some procedure be set up to check to make sure we are getting enough air through these blowers?

MR. BOATWRIGHT: It is easy enough to make an airbox pressure check once the blower is put on the engine. Most railroads that do rebuild blowers have found that if they come within the dimensional checks, they have the pressure.

MR. R. G. CLEVENGER [Supervisor Locomotive Maintenance, Atchison, Topeka & Santa Fe Railway System, Topeka, Kansas]: In the process of working up your material on sleeving of air compressor cylinders, did you make any comparison with the chrome plating of cylinders? Which is the best method? Always before we have talked about chrome plating cylinders.

MR. AXELSON: We didn't make any comparisons between materials. We were trying to bring out component reclamation procedures. However, some railroads, including the Burlington Northern, do spray-metalize air compressor cylinders for reclamation purposes. I can't give you the mix of the spray-metal being used, but I can find out and let you know. I am sorry we are not in a position to give you an evaluation between this and similar types of material used in this process.

MR. T. A. KESSENGER [General Engineer, Methods and Procedures, Louisville & Nashville Railroad, Louisville, Kentucky]: In regard to chrome plating of the liners, we tried that on the L&N and had very high oil consumption. When we were originally writing this paper we looked into it because I was going to write that section. I found we did have very high oil consumption, and we are strictly sleeving cylinders now.

MR. AXELSON: Have other member roads had that experience, and if so could they help us out?

PRESIDENT BOOTH: In regard to chrome plating the air compressor cylinders, that has been tried. Of course a big problem there is in the oil carryover into the air system, into the trainline system and brake equipment. For that reason the Chessie System does not chrome plate cylinders. They are re-sleeved. It is a castiron or ductile iron sleeve that goes into the cylinder, and most of ours are done at Triangle.

MR. HAMBLY: Is anyone here re-sleeving their own air compressor cylinders?

MR. AXELSON: Yes, the Rock Island. That is where we got this procedure for our presentation. Tom Kelly is Mr. Rock Island to us.

Are there any other questions from the floor? This is your last chance to get back at us. If there are no further questions, we will close our part of the session and I will turn the meeting back to Mr. Harley.

MR. HARLEY: I would like to call on Regional Executive C. M. Smith to summarize the report of this Committee.

C. M. SMITH
REGIONAL EXECUTIVE
Mgr. Mech. Engr.-Pass. & Loco.
Penn Central Co.
Philadelphia, Pa. 19104

MR. C. M. SMITH: Thank you, Tom. Mr. Axelson and his Committee are to be congratulated for the very informative paper they have presented. The subject of "Progressive Approaches to Painting, Cleaning and Reclamation" was a challenging one, which took much time and work to review and reduce to the final form just presented.

The subjects of painting, cleaning and reclamation are not entirely new to the Shop Equipment Committee, having been touched upon several times in the past. However, new developments in these fields make a continuing review of our practices necessary. Thanks to the Committee's good work, we now have the latest information at our fingertips.

I urge all of you to keep the LMOA Proceedings on hand and to review the Shop Equipment Committee report from time to time through the coming year. The report contains much detail not brought out in the oral presentation, and which will be of value to you in your regular duties.

Our thanks to the Shop Equipment Committee for a job well done. I will now turn the meeting back to Tom Harley for his closing remarks.

MR. HARLEY: Thank you, Charlie, and thank you, Mr. Axelson, for your fine report. We will now go back to Mr. Booth, who will make some announcements.

PRESIDENT BOOTH: Thank you. I would like to remind you that tomorrow's session begins at 8:30 a.m. This is necessary because we must clear the room at 11:30 for the luncheon.

I think Swede Axelson and his Committee have done a tremendous job in the preparation of their paper. It indicates a lot of time and effort has been put into it. I would like to ask for a rising vote of thanks to Swede and his Committee for the work they have done.

[The audience arose and applauded.]

[The meeting recessed at 3:45 p.m.]

BRENCO

WEDNESDAY MORNING SESSION
September 17, 1975

The meeting reconvened at 8:35 a.m., Mr. L. H. Booth, President, presiding.

PRESIDENT BOOTH: Gentlemen, we will move on with the program.

Before relinquishing the Presidency and the gavel, I want to express my thanks and gratitude to the committee chairmen, the people I have had the privilege of working with in the past year, all those who have given me support to make this job easier for me, and to them I give my heartfelt thanks. My association with the LMOA has been extremely gratifying to me, and I will always look back on this part of my career with feelings of pleasure because of the enjoyment I have had in meeting and working with the various men in the organization.

John, if you will step up here I would like to extend to you my heartfelt congratulations on assuming the Presidency of the LMOA, and wish for you the success I have had during my tenure of office.

[Mr. Schroeder assumed the Presidency.] [Applause]

Retiring President Larry Booth presenting gavel to President John Schroeder with LMOA Vice Presidents Eldon Dent, Tommy Tennyson and Jim Taggart observing the change of command.

PRESIDENT SCHROEDER: Thank you, Mr. Booth. Ladies and gentlemen, I consider it an honor to succeed to this office in our Association. I also recognize it as a distinct challenge. First, to speak to such a large group is a difficult thing for a fellow like me, and I am not being facetious when I say "large group." I feel duty-bound to talk to each and every one of the members of our Association, whether they be here today or not. I hope anything I have to say that may be a little bit constructive will be taken to all of our membership by you gentlemen and perhaps through our printed publication. I also feel I am speaking to railroad management, who I think should come to believe in us, and we must prove to them that we are a valuable supplement to the locomotive maintenance officers' efforts on America's railroads.

It is a wonderful opportunity to have this position with the LMOA in the year 1976. On our membership cards for 1976 you will note there is the statement, "We Salute The Past." That's great. It is beautifully done. We salute a great country and its 200 years, but what has contributed a great deal to making this a great country has been the railroads of America. Without the locomotives and maintenance of same, perhaps the railroads would not have done so well. So, I feel we do have a very, very important job to do.

Throughout my 1976 term of office it will be my hope that we can have all our members become more active.

Past President George Niemeyer presenting outgoing president Larry Booth Life Membership in LMOA and the locomotive desk set as a memento of the occasion. LMOA Vice Presidents Jim Taggart, Jim Long and Jim Butler looking on.

I hope all 2,000 and perhaps even 2,500 members will feel this is their Association, not an Association of some eighty or ninety people who do the footwork that we see and hear about at these meetings on an annual basis.

I have been allowed ten minutes for these remarks. It is like the admonition given a guest speaker at a convention of the Underwear Manufacturers Association. The only stipulation given him was that he make it brief. [Laughter]

So, with that we will get on with the business of the day. Again, I say I hope I can make some contributions to the Association, as President Booth has done and the Presidents who went before him. I make a plea for the support of each and every member and the management team of the American railroads. I thank you for the honor. [Applause]

At this time I would like to call on Past President Ky Pruchnicki who has a little chore to handle for us at this time.

MR. PRUCHNICKI: Mr. Booth, it gives me great pleasure to thank you for the wonderful work you have done for the LMOA. Starting at the bottom of the ladder and advancing to the top, burning midnight oil in connection with your railroad work, you have done your job well. This Life Membership and President's Pin will help you remember the people you have worked with for many, many years. [Applause]

Past President Ky Pruchnicki and retiring President Larry Booth exchange smiles as Ky presents Larry with his gold past president's pin. Tommy Tennyson and Tom Harley add their approval.

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WEDNESDAY MORNING SESSION
September 17, 1975

REPORT OF THE COMMITTEE ON DIESEL MATERIAL CONTROL

D. M. WALKER, Chairman
Diesel Superintendent
Southern Railway
Atlanta, Ga. 30303

J. D. SCHROEDER
PRESIDENT
Asst. C.M.O.-Loco.
Burlington Northern, Inc.
St. Paul, Minn. 55101

PRESIDENT SCHROEDER: Now we will get down to the business of the day. It is time to introduce the Chairman of the Committee on Diesel Material Control, Mr. D. M. Walker. His report appears on page 342, and you will also see his biography. Mr. Walker holds the position of Diesel Superintendent of the Southern Railway Company, Atlanta.

[Mr. D. M. Walker introduced the members of his Committee, and Mr. Dusack, Mr. Ward and Mr. Gregory summarized the report.]

MR. WALKER: At this time I would like to express again our thanks to the Chicago Railroad Diesel Club, our gracious hosts, for allowing us to make our preconvention presentation at their meeting. Is there someone here from the Chicago Railroad Diesel Club to open the discussion? If not, the floor is now open for questions.

MR. W. O. ALBRITTON [Quality Control Inspector–Electrical, Illinois Central Gulf Railroad Company, Chicago, Illinois]: I would like to ask the EMD representative if their material places in St. Louis and New Orleans are set up to handle the module cards for their Dash 2 locomotives. We recently had a Dash 2 locomotive out of service for several days and we could not locate one of our cards except at the LaGrange plant.

MR. R. J. HONDLIK [Parts Sales Manager, EMD, LaGrange, Illinois]: Would you please restate your question?

MR. ALBRITTON: Is your place in St. Louis and in New Orleans set up to handle unit exchange for the Dash 2 locomotives? Do they have them? Or is your LaGrange plant the only place that is going to handle the warranty exchange for the module cards?

MR. HONDLIK: No. St. Louis, New Orleans and LaGrange should all have units available for exchange for module cards. Maybe at the time you wanted them they didn't have them, but under normal circumstances all exchange items except a few are carried in all parts centers.

MR. BOOTH: I would like to direct a question to Bob Hondlik. Piston rings still seem to be on the critical list, Bob. What is the outlook for improvement in that area in producing rings, particularly high horsepower 645 units?

MR. HONDLIK: The backorder situation generally, Larry, since January 1, 1975 to the present time, overall, has had a reduction of some 75 per cent and is trending downward, meaning we are eating up the backlog we had. In the case of piston rings, ring sets in particular have been rather difficult in recent months, but our schedule now on piston ring sets, depending on what it is, the 645 application is running presently in about 5,000 sets a month and increasing. I would say that by the end of this year the difficulty on piston rings will probably be over.

MR. CLEVENGER: If we eliminate the economy picture from the procurement of supplies and material, what does the Committee think the future delivery of material will be as compared with 1974?

MR. D. M. WALKER: I think this could best be answered by the builders, but before I call on them for an answer I would like to make one comment.

Right now we are getting in general the parts we want; but these builders and other suppliers, more than ever before in history, need a forecast as to what the railroads are going to do. It is only good business for them to also reduce inventories and unnecessary employees at a time when business is off. If we expect them to gear up and be able to produce, it takes a prediction from us to let them know what we are going to do, as far in advance as possible.

MR. F. L. BAUMGARDNER [Manager, Locomotive Parts Marketing, General Electric Company, Erie, Pennsylvania]: As far as the production capability this year as compared to last year is concerned, we have more capability to produce parts.

MR. HONDLIK: EMD in the past year, and even sometime prior to that, and in a program continuing at the present time, has added considerably to their new tooling. We have more automation now than ever before. We have better scheduling than we had a year ago. There has been some relocation in our plant of machinery and things to allow us to produce faster.

Our inventory levels at this time are the highest in our history. We are not too happy about that, except we know that we have had these depressions or recessions in the industry several times in past years, and typically if the railroads didn't buy something we didn't stock it. Then when the economy got good again the railroads started ordering and we would be caught short.

Our management has allowed us to continue our forward schedules on the fast-moving items—heads, liners, pistons, rods, rings. They have allowed us to continue our forward schedule as though the economy was good. This embraces probably upwards of 500 fast-moving items. So, right now our inventory is extremely high, and when the door opens we should be in a good position to fill demand.

In the case of heads, liners, pistons, and so on, our casting situation has improved tremendously. We have quite a stockpile of castings on hand. Forgings the same. With the additional machinery coming in I am confident we will be in good shape.

MR. AXELSON: I would like to direct a question to the purchasing segment of your Committee. We all read and hear that a purchase order costs from $25 to $50. Of course one of the prime functions of an organization such as this is to reduce the cost of maintaining locomotives, and this purchasing cost is chargeable to locomotive maintenance. I am not sure what is involved in the $25 to $50, but I am certain it is an added expense. I wonder, in the state of computerized handling of orders, if there has been any research into the reduction of cost of issuing purchase orders, to help our commitment to reduce over-all expenses.

MR. E. H. FOLLWEILER [Purchasing Agent, Reading Company, Philadelphia, Pennsylvania]: First of all, the cost of the purchase order entails more factors in the formula other than just the cost to produce a purchase order. There is the cost of carrying inventory involved, which is insurance, handling, storage, investment. Those are all the factors I can think of at the moment. There probably are several more. So, the $25 to $50 cost is not necessarily the preparation of the documentation.

MR. AXELSON: I am sorry I misunderstood that portion of the paper. We have the burden of storage expense, which I was under the impression covered insurance, inventory, warehousing, and so on, and I took it at face value that the issue of the purchase order itself would cost this amount, in addition to the overhead we incur other than in the purchase order. If that is the logic behind the formula, that explains my problem. Thank you.

MR. W. J. DUSACK [Assistant Purchasing Agent, Chessie System,

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Baltimore, Maryland]: I might comment about the computer application of placing a purchase order.

Like anything else in the world, there are systems and there are systems. It depends on what system your company has purchased. You can go from the simplest to the most complex. As Mr. Gregory mentioned, what you get out of the system depends on what you put into it.

Our own company has investigated automatic ordering to eliminate the human element, but it was asking a little too much of our old system. We have hopes of starting again soon with more sophisticated equipment to remove the human element, and this includes triggering an order, processing the invoice, initiating the check—all the manual tasks involved that are handled by people in the clerical union who work on a pretty good pay scale.

We threw out this $25 to $50 per order figure. In my opinion it is a lot higher than that. We find that the efficiency of the clerical help decreases with increases in pay, and I am sure you all agree with that.

The computer itself can present problems. If you make an error it is an unbelievable mess to correct. This all has a bearing on the cost of the order placement.

There is another problem involved with a computer application of orders. You have to have a stock system of some sort. A lot of the things we talked about today—repair and return, warranty, unit exchange, and so on—cannot be handled on a computer-generated order. These require manual handling and a manual follow-through. This contributes to the cost of an order. A simple stock replacement order has the lowest cost. If you have a problem with warranty, the costs are higher. We average out the cost of placing an order to $25 to $50. It is not really a scientific estimate.

MR. RYDER: In your report you had a section in which it was stated that some of your Committee members felt it would be advantageous to have a committee of locomotive maintenance officers pass on all new components from the manufacturers. I don't quite understand this concept, and I wonder if someone on your Committee who thinks that way would list some of the advantages and disadvantages of such a system.

MR. WALKER: The portion of the paper dealing with this came from a question directed to the Committee, and I think you will find the Committee did not find it had merit. As a Committee we feel that adequate testing is done by the builders.

At last year's meeting someone brought up the question, and I am sure he had in mind the bearing problems of the AR10 and some others. We really, as a Committee, do not feel that the board of officers of the railroad could help in this situation. We do know the procedures that EMD, GE and other suppliers go through. In most cases as much as a year of tests in laboratories and then field tests for as long as two years are done. We realize problems sometimes do develop, but as a Committee we have looked at this and discussed it and do not think such a board would be necessary.

MR. HAMBLY: I have something I would like to say to Mr. Hondlik that he might take back to his people. I would like to see EMD review their packaging of some of the diesel engine components, principally overspeed trip shafts, fuel manifolds. By the time they are received by the railroads in some cases they have been damaged through inadequate packaging.

A second message I would appreciate his taking back to EMD is that they tighten up their quality control on their Utex 20-cylinder block and pans.

MR. HONDLIK: I will do that, sir.

MR. LEEDY: Darryl, has your Committee considered the possibility of all the railroads, in cooperation with EMD and GE, setting up a central warehouse where surplus material or material that is not obsolete but is sitting on the shelf, not moving, could be sent, and everybody jointly share the expense? I think by sharing either our surplus or obsolete warranty we can help each other out. Have you any thoughts on that?

MR. WALKER: Yes, Bob. Several years ago a member of this Committee, who had urged for years that the railroads do such a thing, started his own company to do it because his belief in such an activity was strong enough that he was willing to put some money into it and try it himself, because it seemed he couldn't get anyone else interested in it at the time.

When you come right down to it, it seems there is not too much material that is either junk or obsolete. The last report I had was that he was giving up the enterprise.

I don't think we have that much material that is surplus. Most of the parts you would be listing would be for locomotives you would be disposing of. Maybe some foreign roads would be interested, but the majority of United States railroads I don't think are interested.

MR. LEEDY: Someone said yesterday that because of past practices or bad habits we have a tendency to buy stuff by the barrel. My thought was that when business gets better we may slip back into this habit and buy everything we can get our hands on. I am sure that in spite of the economic situation now, there are some surpluses in inventory that could be used by other railroads. I think it would be helpful.

MR. TENNYSON: Darryl, a question came to mind in connection with shipping containers for components. As I understand it, these items do not now have a part number so they can be bought regularly from the engine builders. It would be very handy to have good containers always available to ship components, and if there are no part numbers already established would the locomotive builders consider establishing part numbers when proved containers are developed so they can be purchased?

MR. HONDLIK: EMD in the past has furnished certain cartons, boxes, to the railroad when they had a special need for them, but normally EMD would prefer not to be involved in selling packaging materials, cartons, boxes, and so on.

So, we would suggest that if you need a particular carton you contact us and give us the part number or assembly number of what you want to package, and we will be happy to give you our specifications. Also, we will give you the source where we get them, and the part number we use, and you can go directly to the source, thereby handling it directly, and EMD would not be involved. We will give you the specification of what we put in it, what kind of preventive materials could be used, bubble airfoam, or whatever it might be, and the pound limits on the cartons, the kind of lumber used, and so on. We have done this in the past and it has worked out quite well.

MR. RYDER: In some of the papers in the past you suggested that railroads get together and centralize some of their storage facilities—that is, where one railroad may have a small storage facility at one location and another railroad has a large storage facility that they could consolidate. To your knowledge has there been any cooperation between the railroads to do this sort of thing?

MR. WALKER: To my knowledge some railroads are still doing it, but the participants have not responded in the last two years, so I can't give you a current status report. I understood it was on a small-scale arrangement with a road having a larger facility and another road having a small facility. At the time of the last report I had, it was acceptable to two roads. As I said, the two roads involved did not participate in the Committee's activities in the last couple of years, so I haven't had any real input from them lately.

MR. TENNYSON: Has this Committee given consideration to the study of protection of parts in storage, parts in transit from one shop to another, protection from rust, weather, or other damage that could occur? This might make a good topic for a future report if you haven't already covered it thoroughly.

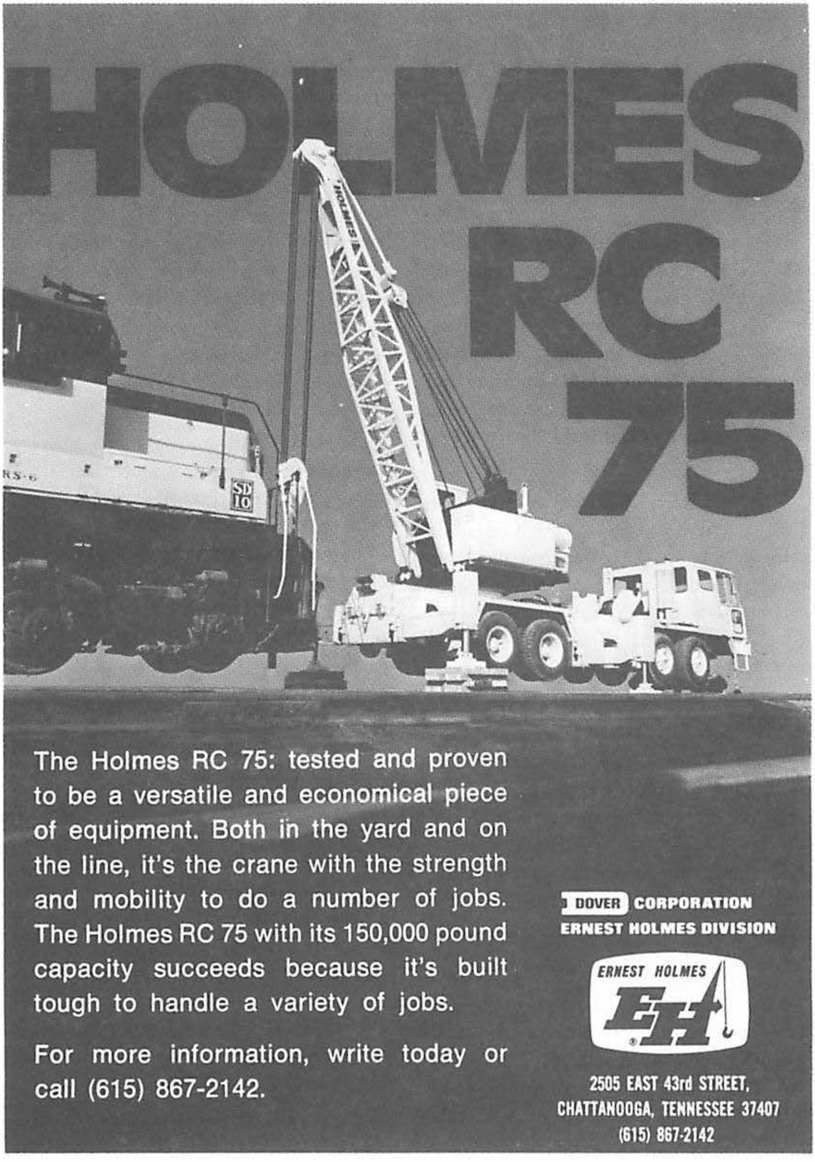
MR. WALKER: You are right. Of course we did mention in the first portion of the paper that in many cases (and in fact in far too many cases) damage inflicted by transportation from one shop to another facility for repair or to an outside point for repair is a lot heavier than what the original failure was.

Our builders were quite outspoken in our Committee meetings as to the way the material received for repair and return and unit exchange (diesel engines and large components) came in to them without proper protection. We are facing a huge cost as far as our own railroad is concerned, without giving too much thought to it.

MR. TENNYSON: I wonder if this Committee might consider developing some specifications which in a general way will outline how to protect parts from corrosion, rust and other damage. A section of the paper could discuss that subject.

MR. WALKER: We will pass it on to next year's Committee and see what they think of it. I am sure it could be a topic in future years.

MR. BOOTH: I would like to ask anyone on the Committee or in the audience about the matter of perpetual inventory of materials. Two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or three companies have approached us and proposed that they establish a perpetual inventory of material in the storeroom and keep it maintained to that figure. The only thing we would pay for would be the material that was used. This of course would eliminate material ordering, requisitions being issued, and so on, where there were no blanket purchase orders established.

We have even had some discussion with EMD on their supply facility at Bedford and our Cumberland Shop on this basis. Is there any railroad here that is using that sort of material inventory? If so, understanding that there are a lot of ramifications to it, I would like to ask how it has worked out.

MR. CLEVENGER: I think Ollie Dial might be able to give you some information on that, because we have this particular type of consignment inventory with traction motor rewind kits, with National Coils, Motor Coils, and some others. Do you know about that, Ollie?

MR. O. D. DIAL [Assistant Purchasing Agent, Atchison, Topeka & Santa Fe Railroad, Topeka, Kansas]: Yes. We have some items of material we handle that way. However, we still have to have the accounting, and we have to have requisitions.

MR. WALKER: What about in-house inventory consignment?

MR. FOLLWEILER: Mr. Booth, we are trying to interpret the full meaning of your question. There are two areas you can become involved with. One is consignment of materials which are basically forwarded by the vendor or manufacturer to a stores location and so handled by railroad personnel, and there is another area evolving, namely, that the vendor or manufacturer maintains his particular line of material inventory on the shelf and accounts for it and replenishes it at his expense. Is that system what you are referring to?

MR. HONDLIK: About the only form of consignment I feel EMD has would be on the matter of unit exchange, where they send you a rebuilt assembly and you send back the old one, and in the meantime we repair it and you run the new assembly. Eventually you pay the bill and it evens off.

We have had many, many discussions about consigning material to the railroads. Being in the replacement parts phase of our business, I would be happy to have consignment authorized, because it makes it very easy for the shop man or the store man to issue a nice new part and let's not monkey with the old one but throw it out, don't bother repairing it, or don't do anything with it. As a parts salesman I think consignment would be quite helpful.

On the other hand, it would cost a lot of money. We have gone into the subject with several large railroads, and they have quite a list of fast-moving items they like to have on hand. They like to have a 60-day supply. If you add up the cost of this to EMD, it could amount to millions of dollars. If you multiply that with the other large systems, something will have to go.

All in all, the expense would be so great and the end result such that

I don't think you would care to pay the price for this type of service. To compound this, as Ernie mentioned, if the supplier had to send a representative out to count the material every month, and make a full report probably in quadruplicate, this would be another expense.

I must confess to you the only place we get the majority of our money from is the American railroads. At the risk of sounding facetious, you can get anything you want if you want to pay for it. It has proven out that the economics would be quite adverse to the user.

MR. LEEDY: I would like to make a comment on high-consumption items. We have contacted four or five suppliers and they have indicated a willingness to do this, that is, consignment stock. If you are not going to approve my warehouse plan, let's do this.

VOICE: Has the Committee considered the best way for a local organization to eliminate double and triple orders, or is it strictly up to the man in the storehouse to screen this? Is there a better way to do it?

MR. J. J. GREGORY [Production Control Manager, Penn Central Transportation Company, Altoona, Pennsylvania]: I think your question was, is there a way of eliminating double and triple orders? Here again, you must have cooperation between your stores and your Mechanical Department. More importantly, if you have sufficient data available you can determine what your requirements are, whether to determine your needs for 3 or 6 months or whatever it is. When you put in order after order, I think it just compounds the problem. If you have some back data, as most railroads do whether they realize it or not, you can pretty well forecast or, let's say, have a good ball park forecast of what your needs are.

I think I would be remiss if we didn't get Mr. Hondlik on the ropes a little bit. The question came up, maybe justifiably or not, but why is it possible to get a locomotive and you can't get parts? The Committee brought out this point, and I was satisfied with it until Mr. Hondlik mentioned that they have a very high inventory, and for once they can get us all the power assemblies we need. But who wants to buy power assemblies and end up with rods and other longer wearing parts? How is it we can get E power assemblies but no E-3 pistons until after September 22? We have been waiting for these for some time. I don't mean to embarrass you, sir. [Laughter]

MR. HONDLIK: Gregory is not getting a Christmas card this year. [Laughter]

Here you have to be very specific. There are several kinds of pistons, several kinds of Power Packs. We have manufacturing schedules so that when they set up to make a B piston hopefully our inventories will be heavy enough to carry us through this period of time with the E piston, the D, and so on.

To change our line from a C to a D piston takes a lot of time and production lost time, and it could be that he might be fortunate enough to get the Power Pack one design but can't get a piston that would fit in a different Power Pack. So, you have to be very specific, Mr. Gregory, as to the part numbers you are talking about. Then I can go back and find out what happened.

Power Packs have been hard to come by in the last year and a half. By the end of the year we think we will have them available in all varieties. Does that answer your question, Mr. Gregory? Just shake your head "No." [Laughter]

MR. GREGORY: If I can tell Mr. Fadale when I get back that you will give us E3 pistons, I will be satisfied.

MR. HONDLIK: I will get you E3 pistons.

MR. WALKER: Right at this time, when railroads have other priorities, it is hard to talk about a material crisis; but where do we stand today? Really, things are not different than they were a year ago. Unless we work together as suppliers and as railroads, we are going to be headed into a situation far worse than that in 1974. These people have told us they would be able to supply our needs, and we can stay out of this situation if we will just give them a little lead time or a little advance notice so they can gear up ahead of our demand. There is no need for railroads not giving these builders and other suppliers this input as far in advance as possible.

I am now going to call on Mr. Nelson Buskey to summarize our paper.

N. A. BUSKEY
REGIONAL EXECUTIVE
Asst. Mgr.-Mech.
Chessie System
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MR. NELSON A. BUSKEY [Assistant Manager–Mechanical, Chessie System, Pittsburgh, Pennsylvania]: Gentlemen, I wish to congratulate Mr. Walker and his fine Committee on a very well prepared paper. Darryl and his Committee represent a cross-section of the nation's railroads and locomotive builders. As most of us have experienced shortages of materials during the past several years, I feel this report is timely and appropriate.

To you gentlemen who have been here all three days, this paper may appear to overlap with others; but I think you will agree with me this report has realistic approaches and solutions.

Repairable material was a very interesting subject. The section on care of removed components is of great value to all of us. We all recognize the additional damage to components results only in added cost to our railroads, and a little education in handling can save us many dollars.

New sources of new materials could benefit us a great deal. Interchange of inventory listing between railroads also could benefit us. The section of the paper devoted to lead time was revealing, and it is well to know there has been some relief. The questions and answers on section 3 of the report were good and sounded logical, and are of interest to all of us.

Again, Darryl, congratulations to you and your fine Committee for a splendid report on material controls and for a job well done. [Applause]

PRESIDENT SCHROEDER: Thank you, Darryl and your Committee, for a splendid presentation.

President John Schroeder presenting Past President and Chairman of the Board Carl Stendahl with leather bound volume of LMOA proceedings.

WEDNESDAY MORNING SESSION
September 17, 1975

PANEL ON WHAT'S YOUR PROBLEM

R. R. HOLMES, Chairman
Chief Chemist, Union Pacific Railroad
Omaha, Nebraska 68102

J. H. LONG
6th VICE PRESIDENT
Regional Locomotive Supt.
Chessie System
Cincinnati, Ohio 45202

Now we come to another dynamic portion of our meeting, the What's Your Problem Committee. I will ask 6th Vice President Jim Long to preside at this time.

MR. J. H. LONG [Regional Locomotive Superintendent, Chessie System, Cincinnati, Ohio]: Gentlemen, as I was sitting in the hall listening to Larry Booth's swan song I thought of the many benefits each of us has acquired through this Association. By associating with the various supply people we have found out about product development; we have had a better understanding of their problems; we have been able to communicate to them our problems and our future requirements; we have made a lot of wonderful friends, and we have brought together a lot of closeness through association with our tremendous properties. It has had a tremendous effect on mergers, consolidations, affiliations, and our everyday operations.

We are striving now for a better supply membership growth. There is a charge to every member here to endeavor to visit the various supply rooms, talk to the supply people, find out about their products, find out what they are working on, tell them what you need, and see if you can get them to work with us for the future development of the industry. In general we have much to gain in the future. This Association can give a lot to each of us, but we only get out of it what we put into it.

The next part of our program has always been a highlight of the meeting. Jack Dwyer was like a firehouse. When this part of the program was announced he would be right up here. We would be very remiss if we didn't acknowledge Jack's work. [Applause] Jack passed the gavel on to other very capable hands, to Mr. Richard R. Holmes.

[Mr. Long introduced Mr. Richard R. Holmes.]

[Mr. Holmes then introduced the members of his Committee.]

MR. HOLMES: The LMOA wants to acknowledge the long and able service of three technical committee chairmen who have completed their terms. They are R.W. Leedy, Darryl Walker and Kjell Axelson. On behalf of the LMOA I want to extend to them personal congratulations as well as those of the LMOA membership for an excellent job. [Applause]

I will now ask if Ken Ellsworth is in the audience. He has been of great assistance in publishing our articles in *Railway Age*, of which he is the Mechanical Editor. [Applause]

I don't know if Tom Shedd or any other editorial people are here. We will acknowledge them, too. [Applause]

Now let's get right into the program. We have the Mail Bag. One important question should be taken up. During this year of energy conservation it behooves us all to take advantage of any available potential energy saving. Although this particular question has not been brought out, the inquiry has been made about claims that have been made that one type of engine air filter used provides somewhat less fuel consumption when compared to a different type filter made from different media, such as the comparison between fiberglass and paper.

What our questioner wants to know is this: Has any data been developed from railroad service that substantiates that there is a measurable reduction in fuel consumption when one type of filter is used in comparison to another? Would anyone on the Committee or in the audience have a contribution to make on this question? Has any actual work been done?

MR. L. M. BUFFINGTON [Assistant Superintendent Locomotive Shops, St. Louis-San Francisco Railway Company, Springfield, Missouri]: As a sideline, it is not a comparison between filters but with a filter. I was running a test and as an afterthought I changed filters. The fuel consumption goes down with clean filters. Any time you restrict air you increase fuel consumption.

MR. HOLMES: You haven't noticed any difference between two different types of filters?

MR. BUFFINGTON: No, not between filters, just the restriction.

MR. LUD KOCI [Assistant Chief Engineer, EMD, LaGrange, Illinois]: What has been said here is certainly true. Any filter restriction (or any restriction of air flow to the engine) will affect fuel consumption, and in closely controlled lab tests you can develop what the relationship is between fuel consumption and that restriction.

I don't happen to have the figures here, but certainly we have them. Based on my memory only, which may not be entirely reliable, I think on a very heavy kind of duty cycle you would expect to save in the course of a year perhaps 400 gallons per inch difference in pressure drop. Obviously that is far too small a kind of thing to measure with normal fuel monitoring methods out on the road.

MR. HOLMES: I thought some filter manufacturer might have developed some data along with some railroad in this regard, since statements have been made that such a thing does exist.

MR. SPARROW [Manager Railroad Sales, American Air Filter Company, P. O. Box 1100, Louisville, Kentucky 40201]: We have made an effort with our fiberglass bag filter to lower pressure drop to the engine. We have reviewed all our housing designs recently, and where possible revised them by making a larger clean air plenum behind the elements to reduce the pressure drop that the engine intake sees.

We have been encouraged by locomotive builders to do this because an engine definitely prefers to see as low pressure drop as possible. In doing it, of course, we compared a pitot tube traverse of our original housing, our new-style housing, and the paper filter current style housing. We have then compared fuel information that has been developed comparing the bag filter initial pressure drop, and its pressure drop at the end of a 90-day cycle, which is our maintenance recommendation and practice, with the pressure drop of paper air filters at the time they are installed and at the condemning limit of 14 inches which is read in the locomotive cab, correlating this information with the pitot tube traverse results. We then compared the average pressure drop of paper filters from the time they are installed until they reach their 14 inches resistance versus the average pressure drop of the bag filter.

The pitot tube traverse information (and it has been confirmed on locomotives) shows that the engine will see an average of 5.1 inches lower pressure drop with bag filters than with paper air filters.

We have used the AAR approved duty cycle which is based on 90% availability of the locomotive and 30% operation in 8th throttle during the 90% time. Based on that, it comes out to 472 gallons per year, per inch of restriction based on the locomotive builder's test information on what an inch of restriction does in 8th throttle operation. Whether it is 400 or 472, it does over the course of a year mount up to a fair amount of fuel, and it is one of the things a railroad can do, in our opinion, to conserve fuel.

It is going to take a lot of little things to accomplish a fuel savings as far as locomotive operation goes. We feel this is one thing that can be done to help conserve fuel. Of course at 30 cents a gallon it is more significant than it was back when it was originally reviewed, comparing paper versus our oil bath filter, when fuel was only 10 cents a gallon.

Thank you.

MR. F. A. DOODY [National Sales Manager — Railroad Products, Farr Company, Oak Brook, Illinois]: I am just asking for equal time.

I believe you all remember the work done some five or six years ago at the Southwest Research Institute. We supported a program down there to evaluate filters, to evaluate the effect of filtration on the engine wear rates, whether the dirt was in the fuel, lube or air.

What has been said by Joe Sparrow and Lud Koci is very true. The engine wants the least amount of pressure drop it can see on the intake system. I might take exception to one of the numbers Joe brought out, but I don't think this is the time or place to do it.

To tell you what we have done beyond the Southwest Research Institute, I imagine a number of you are well aware that during the past year we have had a number of locomotives on test with a new paper filter which we have worked for about two years to develop. We ran the test in cooperation with Electro-Motive and the results have been quite gratifying to date. What it has brought about for us is a better filter to supply to the industry. It is a filter that is substantially better in performance than prior designs of ours. We go along with the whole group, though, that the lower the pressure drop, the less fuel consumed, the better off we all are.

MR. R. A. POLLMANN [Manager—Railroad Market, Donaldson Company, Inc., Minneapolis, Minnesota]: In the interest of equal time I thought maybe Donaldson should make a statement at this point.

In our attempt to determine the effect of intake restriction on fuel consumption, we ran a test using an Illinois Central Gulf SD40 locomotive on a SEARCH machine at the Woodcrest Shop. Horsepower was measured accurately along with other parameters to maintain controlled conditions; then fuel consumption versus intake restriction was measured. Fuel consumption was measured by weight using a balance scale and a 55-gallon drum with fuel pump and return lines running from the drum. The fuel consumed was then plotted against the intake restriction. We increased restriction up to 15 inches of water at the engine intake. Within the range of experimental errors that we could measure, we actually found no difference. Some of the data even indicated slightly decreased fuel consumption at higher restriction, which we all agree is not possible, but this does point out how even with the accuracy of the SEARCH machine the experimental error can reverse predicted results.

We are looking for a needle in a haystack here. The longer life you get, the lower the over-all pressure drop, which is a definite advantage.

Some of the fuel savings claims that have been made are a little overplayed because of the popularity of fuel savings. The data we have collected to date is available for your inspection. Thank you.

MR. PROPP: Does the gentleman from American Air Filter have any data that would document or substantiate his remarks regarding actual fuel saved?

MR. SPARROW: I don't know. We have no information that says a fleet of locomotives was equipped with bag filters versus a fleet of locomotives equipped with paper air filters to monitor the fuel. I don't know how any railroad could possibly keep track accurately of how much fuel goes into one class of locomotive versus another class of locomotive.

The information comparing what an inch of pressure drop does as far as fuel consumption is concerned was originally in a report in 1968 comparing a cycoil versus a paper air filter. It was based on fan engineering, except EMD took their own lab information based on their experience with their engine and their test equipment to determine what an inch of restriction does to fuel consumption. We have accepted that information.

Other railroads have told us that they have conducted tests in which they have restricted air flow, compared horsepower and measured fuel, and found basically the same results that EMD found.

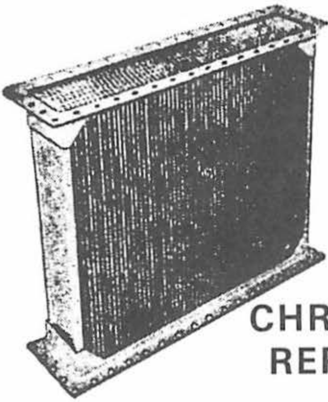
MR. GOGOL: In this day of rising repair costs, one of the large components that is very costly and is going up higher than the inflation rate is the turbo, both EMD and GE. Two of the highest causes of failure of this component are the oil seal and foreign material damage.

I would like opinions on foreign objects or foreign material damage to turbos. We have had turbos reported with this type of damage, with no history of valve failure or other components in the combustion chamber. Where does the material come from that causes this damage? What size of a foreign object would damage a turbo?

MR. L. K. ADAMS: Mike, I wondered when you might get to that. It is a two-part question, as I understand it.

As to the control of turbo costs, I think most of you know, GE has a vertical integration program under way as far as the turbo is concerned, to bring more manufacturing of this turbo in-house. We believe this will be a step forward in the control of turbo costs. I think you gentlemen will see some side benefits of this in terms of turbo efficiency.

The second part of the question sort of spills over into the area of integrity of inspection on turbos. One thing we are trying to institute is that when our inspection people report foreign object damage, we try to obtain whenever possible a sample of that foreign object so we can tell what it is. I agree with Mike, we have had several reports where in the history of the locomotive we couldn't find any upstream failure on



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the turbo. So, we are asking ourselves that question.

We have made progress in eliminating the type of failures that occur upstream—valves, pistons, and so on. We are introducing on turbos other than the BC080, which is a U36 turbo, the sealed air piping that was covered in our report. This is a modification and modernization that is retrofittable on existing turbos. It takes locomotive air, and during the low throttle notch operation of the engine it applies external air to the seal until the turbo can get up to enough rpm to provide its own internal air seal. It has been quite effective on the BC080, and now we are going into the BC065 and the U23 turbo.

I don't know what would be the minimum size foreign object, Mike, that would damage a turbo. It might depend on what shape the object was, and how it approached the nozzle ring.

Jack, do you have any idea of what would be the minimum size debris that the turbo could eat and not be damaged?

MR. HOFFMAN: I can't answer the question like Mike would like to have it answered, with a specific number, but it really must be very small. To give you a general feeling, something the size of your little fingernail, if it is hard enough, and if it is wedged through the nozzle ring opening, will ultimately damage the rotor. How badly it is damaged, and how much the rotor is thrown out of balance, will determine whether you have immediate problems or whether you have long-term repair problems.

One other item I would like to add to Les's comment, which I think is appropriate, is that while the ultimate goal is to reduce the upstream failures that can cause turbocharger damage, there has been a long need in locomotives for an object catcher ahead of the turbocharger. We have worked on this for quite a number of years. I have been involved on and off, and I would like to report here that for the first time we are making what I think is extremely good progress. I think we will have one developed shortly. This still doesn't change the fact that upstream failures have got to be eliminated, but we are all going to have these at one time or another.

MR. JAMES: The G.E. engine does not have a system to collect failed parts as they progress downstream to the input of the turbo. EMD does, as we all know.

We have had a few turbo failures whereby we could not attribute the foreign object to a current failure within the engine. However, in tracing back, we have found that we did *not* do the job properly in cleaning up prior failures. EMD, as you know, has a collector that stops debris and by gravity collects the pieces below the level of the main gas stream.

One other comment: We have had two strut failures within the exhaust system proper that have gone downstream and caused some damage.

MR. GOGOL: Let me expand on my question. Would water treatment deposits from engine water leaks, carbon deposits, or small particles of material that break away from exhaust manifold welds or from the expansion joints be large enough to cause damage to the turbo diffuser ring or impeller?

We put the question to the builders' representatives and even the people who rebuild turbos, and nobody seems to have any information on harshness, size, or quantity of particles to cause this damage. Yet the damage is there. Inspection of the turbo will not find any object in the turbo when it is torn down. In order for us to correct the problem we should know the type of foreign objects that can cause this damage.

MR. LEEDY: I would like to make a comment and then hear from EMD. I can only relate this to one instance, and this had to do with chromate treatment in the cooling system that got in the exhaust manifold and just about plugged up the turbo screen. How much of this went through the screen first, I don't know, but it didn't fail the turbo although it pretty well plugged up the screen. I am not sure how much chromate material can go through that without causing some damage.

Lou, could you fill us in on EMD's turbo?

MR. TURNEY: Taking the first part of the question concerning leaks: One of the major leak areas in our turbo was the lower scroll area. EMD has made an improvement in this area. We have an improved seal now, and we are looking forward to less problems in this area.

Relative to the size of the material, I feel size is irrelevant. It depends on whether the material passes through the system or contacts with the rotating members of the system. There are many materials that will pass through the system and cause no damage to the turbocharger.

I feel Mr. James answered the question of foreign material quite thoroughly. EMD feels the trap screen is a decided improvement. It removes a lot of material before it has a chance to get through the screen.

Another item worth mentioning is EMD's dedication toward educating customers over the past three years to a better understanding of the turbo through classes to train your people. Many of you have participated in this program, which is oriented toward making your people aware of what to look for when you experience a turbo failure. These classes have been very helpful, and in our surveys as a result of these classes every one of the railroads that had experienced many failures due to foreign material have reduced their failure rate.

To some of you who were involved in the program in the very beginning, three years ago, it is possible some of your people need a refresher. We are going to continue the training programs in an effort to make it possible for you to minimize turbo failures, especially due to foreign material.

The foreign material generally comes from previous failures in the engine as the result of not cleaning out the debris after a failure. There have been some instances where as many as seven turbochargers have failed on an engine because the foreign material from the previous failure was not removed.

In summation, our lower scroll seal has been improved. We are involved with fewer leaks today than in the past. We are still looking further at the seal area and hope to improve it even more. The trap screen is reducing turbo failures. EMD turbo training classes can educate your people in preventing failures through a better understanding of the turbo and how to cope with related problems.

MR. LEEDY: I get the impression from both EMD and GE, in answer to Mike's problem, that water leaks or hard carbon particles won't cause this damage, that it has to be something metallic. Is that right?

MR. TURNEY: Yes, that's right.

MR. LEEDY: Would you agree with that, Les, that water leaks and hard carbon particles won't do the damage, and it has to be something metallic?

MR. ADAMS: Yes.

MR. V. L. SMITH [Chief of Motive Power and Purchasing Agent, Belt Railway Company of Chicago, Chicago, Illinois]: I would like to direct perhaps an unfair question to Mr. Leedy. Do you believe if the oil pressure on engines were increased to a higher figure, say 80 or 90 pounds, improved life could be secured on the crankshaft and bearings due to floating them through the bearing?

MR. LEEDY: Will you repeat that, please?

MR. SMITH: There is a reason for asking this question. We operate some Alco locomotives, 2400 HP. At the time we converted and went to the steel cap pistons we increased oil pressure. We were required to do so by recommendation of the manufacturer, to improve piston cooling, and so on. We see some advantages and also some disadvantages. An oil leak, of course, becomes more serious at high pressure. I would like to hear what the manufacturers may have to say about using higher oil pressures on engines and floating the crankshaft through the bearings.

MR. LEEDY: I am not an expert on that. Is Don Coulter in the room?

MR. D. E. COULTER [White Motor Corporation, St. Louis, Missouri]: If my memory serves me correctly, the reason we went to the higher pressure on the system Mr. Smith is referring to is that we went to the steel cap pistons. The higher pressure was to help increase the oil flow to the underside of the piston to increase cooling. We also increased the lube oil pressure so that we could supply this oil externally through the free end of the engine to the vibration dampener. Of course this also increased lube oil pressure to the bearings. The effect this would give on longevity of the bearing life in floating, I am not able to answer. I would imagine it would, but to what degree it would I don't know.

MR. KOCI: Concerning crankshaft bearings, like most friction bearings, you depend on the pressure which actually does the separation to be built up by the hydrodynamic film. Unless you had a completely different type of design it is unlikely that you would increase the pressure sufficiently to make any difference com-

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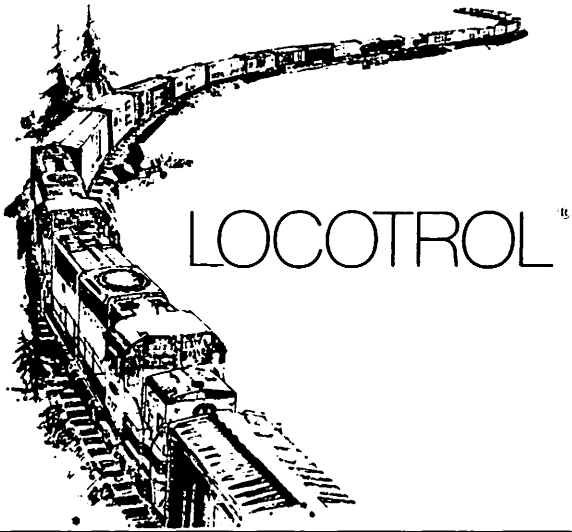

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pared to the hydrodynamic film pressures that are developed from operation.

MR. LEEDY: The increase in oil pressure would probably help piston cooling, but for crankshaft bearings if you have a good film there it is all you need.

MR. SMITH: I would like to make a brief observation from our experience. We have had nearly three years' experience with an EMD 12-cylinder engine that is running with minimal support on the center main bearing.

MR. HOFFMAN: Just a general thought. Remember that the oil flow goes in the 4-cycle design from the bearings on up into the piston for cooling. If a modification were made at the top side which would change or in some way affect oil flow to the bearings, then the bearing and shaft system could not develop the hydrodynamic pressure that Lud mentioned. So, a design around the piston or connecting rod could very well necessitate an oil pressure change and affect bearing performance. But unless there is some change and the whole thing is designed as an integral unit, I would not expect any difference in bearings.

MR. HOLMES: Getting back to conditions that cause turbo failure, Tom, do you have any further remarks?

MR. TENNYSON: Yes. While we are discussing carbon and the influence of water treatment on turbo damage, I think we tend to think of very small particles or almost amorphous carbon as going through the turbos. Such particles certainly should not do any damage. But somewhere in the system it might be possible under proper conditions to collect a chunk of carbon or dried water treatment that is almost like a rock and that can weigh up to 40 or 50 grams. If such particles go through the turbos there would be quite an impact, even though the particles are not metallic. I think there is a possibility of some damage from this kind of particle.

MR. LEEDY: While we are still discussing this subject, I would like to complete an answer to a question that was asked Monday afternoon. It had to do with the coating of pistons reclaimed by Metal Services, Inc. of California. Bob Cyphers, of DEMCO, Atlanta, is here and has some firsthand information. Bob, would you complete that answer for us?

MR. ROBERT CYPHERS [Diesel Electric Magneto Company, Atlanta, Georgia]: We are remanufacturers of EMD engines and components, and along with this work we are continually researching better materials. In the remanufacturing of an engine, of course, after it has been remanufactured the first stroke is the most critical of all the strokes of that engine as far as lubrication is concerned. We had been coating pistons with another product which we found had a tendency to wash off either with oil or if it accidentally had some water spilled on it.

Now we have come up with a product that we have been using for about two years and have found to be highly successful. We coat the pistons before we put them in the power assemblies. This product does not wash off and will not wipe off on your hand. It is basically a dry molybdenum disulfide. It is produced by National Chemsearch Corporation and is known as Aerolex. It comes in one-pound aerosol type cans. It is available through Irving, Texas; Monmouth, New Jersey; Sunnyvale, California; St. Louis, Missouri, and two or three other places that I can't recall offhand. It is relatively inexpensive. A one-pound can will do ten or twelve pistons and costs about $2.50, and we think it is well worth it.

We are small as far as remanufacturing is concerned, thus we do not have facilities for lubrizing, so we are forced to take some other approach to it, and it has been highly satisfactory.

MR. HOLMES: Do you have any idea how long that film lasts?

MR. CYPHERS: The molybdenum disulfide, I am told, tends to penetrate the cast iron and coats it. We are primarily interested in that first stroke or two to avoid any scuffing. After the engine is lubricated I don't think it makes too much difference.

MR. HOLMES: I would like to have an opinion on whether it is the recommendation of the Mechanical Maintenance Committee that luberizing is the first preference in such preparation of pistons, or is the dry film lubricant considered equally as good for the same purpose? Maybe the engine builders have something on that.

MR. LEEDY: I think there is a definite need for this. As I understand it, it is not required on GE pistons, but we do need it on EMD.

MR. WECK: Our standard procedure is luberizing. It is the one we are familiar with. It is the procedure that we would very strongly recommend.

MR. HOLMES: Is it your conclusion, then, that the primary objective is for the first stroke, for break-in, and that is all it is intended for, and that you don't expect it to provide any service after that, or be effective?

MR. WECK: I would say that is extremely important. The well lubricated power assembly, starting out its life, should have good oily surfaces after you have gone through prelubrication. I would say beyond that, the oil retention ability of luberized pistons after an engine has been shut down for a considerably long period of time is also most important. Now I am talking about an engine that has been in service for a period of time. You have a better chance of leaving oil on film on the piston when it is luberized.

I am sure a lot of you gentlemen have had the experience of taking pistons out of engines that are several years old and finding the phosphated treatment is still on the piston. So, it has a long life and it is put there for a purpose, and it is the way we think you should go.

MR. HOLMES: It seems that EMD is putting emphasis on this job of luberizing again. Is that part of your continuing campaign of good maintenance procedure? Does it have anything to do with button-up liner scoring, and so on? Does it have anything to do with whether you luberize it or not?

MR. WECK: This is good maintenance procedure. When a problem exists it has been our experience that you go back to the basics of good maintenance practices and do everything by the book. So, the answer is it is good maintenance procedure, and one we strongly recommend.

MR. HOLMES: I would like to ask Bob Leedy a question from our Mail Bag: Since scuffing and scoring are still with us, even though it has been talked about a lot and some progress has been made in this area, is it the intention of the Committee to keep abreast of this situation and try to arrive at a final solution to the problem or to assist in arriving at a solution?

MR. LEEDY: Yes. In our paper for next year I am not sure we are going to have all the answers, but we are going to update the reclamation of pistons, and we are going into more depth on the scoring of liners. There was quite a bit of discussion on this Monday concerning the scoring of EMD liners. We fully intend to follow through on that.

MR. AXELSON: I would like to address my remarks to Mr. Smith's question about increased oil pressures. I would like to say that several years ago at this convention there was considerable concern about controlling operating temperatures of oil. I think Mr. Smith's inquiry should go a little farther and get into oil cooling and the effects of increased oil pressures.

Also, as I recall, part of the research and control for improved operating temperatures was to do things such as put agitators in the oil cooler tubes and increase the capacity of the oil cooler radiators themselves.

I wonder if the manufacturers could expound a little further to complete the question asked about increased oil pressures and the benefits for the rotating parts, and what effect it would have in the long run by having detrimental effects from operating temperatures. Can today's locomotives handle the increased cooling capacity from increased oil flow pressures?

MR. TOWNLEY: I think I would be remiss if I didn't mention the fact that the Santa Fe has a 20-cylinder locomotive running with an auxiliary oil cooler. We feel the oil temperature going into the 20-cylinder engine is excessive, not only the oil temperature but the resulting water temperature.

The water is heated by the oil cooler just before it goes into the engine, and we have installed an air-cooled auxiliary oil cooler on one locomotive and have equipped it with liner ring assembly combinations that we know won't live in a standard 20-cylinder engine. It does do fairly well in a 16. As far as I know, we have not had any failures on that locomotive. It has been run this summer with much cooler oil.

MR. AXELSON: Thank you. The point I am trying to make is that if we zero in on one problem we have to consider all the problems. Thank you for your remarks.

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MR. KOCI: The oil cooler in our system is in the scavenging system, not in the main bearing system, so going to higher pressure in the main bearing system won't affect the heat transfer in the oil cooler at all. Our water temperatures for all practical purposes are the same in our 16-cylinder road locomotives as in the 20s. The oil temperatures for all practical purposes are approximately the same.

You are all given copies in the maintenance manuals of the water-oil temperature relationship. If you find them running significantly different and think they are running significantly hotter, that is something we all would benefit from knowing and doing something about.

Last year at this meeting a gentleman from one of the railroads said they ran 40 degrees hotter. We tried to follow up with the railroad involved and were given the impression that the information was not accurate. If anyone has any data on oil temperatures running hotter in that engine, it ought to be confirmed and ought to be supported by data. We would like to follow up on it.

MR. TOWNLEY: We can certainly back that up. We have data from our load test and from running tests that the oil temperature is in fact (to be on the conservative side) some 20 degrees hotter on the 20-cylinder engine than it is on the 16.

MR. KOCI: We ought to follow up on it, and we ought to cooperatively report on it at next year's meeting.

MR. BURCHETT: While we are talking about oil and oil coolers. I would like to go back to Mr. Smith's original comment on the Alco locomotive. When they increased the oil pressure I believe they increased the capacity of the oil pump. When we increased the 16-cylinder EMD engine to a 20-cylinder engine we still maintain the same scavenging pump and the same oil cooler. EMD will tell us that this cooler and pump is designed to supply and to cool, and again we feel we may be in a "brinkmanship" area.

If you calculate from EMD's manual the capacity of their scavenging pump and the capacity of the pressure pump on a 20-cylinder engine, you will see you will have a maximum overflow of cooled oil back to the crankcase of 54 gallons per minute. If you look at that on a 16-cylinder engine you have considerably more oil that has been cooled returning to the crankcase, and it will give you hopefully a little cooler oil to start to cool with in the first place.

We have not been successful in increasing the size of the scavenging pump to date. We look forward to that, and would lay down a challenge to EMD to run some tests to see if we can reduce that oil temperature.

MR. ADAMS: I think Mr. Axelson has touched on a very important and critical area to both you operators and the General Electric Company, because he is broaching the subject of real system understanding and the impact of a component some place on the locomotive on engine environment (if you don't mind my bringing the word "environment" back into the discussion).

We know that when oil temperatures get up to 240 or 250 degrees in our engine, you are down to approximately 50 per cent of design oil film thickness in the main bearing, and I don't think you want to operate there. The reason these temperatures are getting up to 240 or 250 degrees is that somewhere in the supporting system some component has gotten into trouble—a plugged radiator, plugged lube oil cooler, that type of thing.

It was touched on in our Committee Report this year—a package called the Engine Systems Monitor. You might ask (and I think Ken Reed did ask), how does it work? We hope it never works, because if it doesn't then it means your radiators are in good shape, your lube oil cooler is able to transfer the heat out of the oil into the water, and so on. However, it does ride onboard the locomotive and monitors temperatures and pressures.

Over the last year and a half General Electric has done quite a bit of special testing in cooperation with several railroads, and we have learned a few things about our system. I would like to pass one or two along to you.

Our current cooling system is in effect self-protecting. Even if the pellet which controls the water switch-up into the radiators is defective, we still get a switch-up. It is approximately 10 degrees higher than normal, but you still do get switch-up in cooling.

We have a much better feel now for the effect on bearing environment if you have, for example, a 50 per cent plugged radiator. What is that doing to you? We do have this data that is certainly available to you people.

I think it is extremely important that all people involved with the GE locomotive understand the supporting systems and their characteristics, and what the evidence is of one of these components getting into a state of degradation. A lot of times you look at wiped-out main bearings and say, "Yes, we have a big bearing problem." You can trot around in the stall and take a lot of time looking at those main bearings and really not solve the problem, because you are looking at the effect and not the real cause.

MR. GOGOL: Another area that is troublesome involves the oldest locomotives and some relatively new locomotives, and that concerns the electrical contactors. This is a high cause of failures, delays, loading problems, and so on. I wonder if anyone has any suggestion or recommendation on a quick method of determining a contactor that should be changed out.

MR. JAMES: Mike, I didn't quite understand your question. Are you referring to the power contactors?

MR. GOGOL: Yes.

MR. JAMES: EMD?

MR. GOGOL: I didn't want to mention EMD, but predominantly EMD, yes. I would say a majority of the problem is in the EMD contactors.

MR. JAMES: And the question was, how do you quickly determine whether it is in a state that it can continue its function or when should it be removed?

MR. GOGOL: When should it be removed prior to failure, leading to more catastrophic failure.

MR. JAMES: If you are having a problem in this area, and apparently you are, I would suggest that you take some of the locomotives in question and, prior to failure, get a good sampling of visual indications. Run some current tests on the particular circuits and their components, and measure voltage drop across it to read what the eye can't reveal, that is, its conductivity. We know the 12R losses increase as the resistance goes up, which will generate sufficient heat to create the conditions that cause failure.

We have done quite a bit in that area, and on the 40 Dash 2 and/or power contactors that have been rebuilt we have not had any trouble. Mr. Chirikos, would you like to comment for EMD?

MR. CHIRIKOS: Bill, I agree with what you said. There has never been any formal publication on what values we would condemn the contactor on on voltage drop test, but this is one way of determining whether or not the contactor is in trouble. The other is the visual examination of the pivot area.

If there was an implementation of a program to update these contactors on perhaps a unit basis for a total locomotive number of contactors, including the reversers and brake transfer switch gear, I believe you would get out of this problem very quickly, because the flexible leaf spring design that we have updated the previous 1000 AMP contactors with has completely eliminated this type of problem.

MR. JAMES: One further comment, Mike. I wish I could give you an answer that you could take home and implement to get relief. Unfortunately I can't. When we were involved extensively with our SEARCH system of evaluating performance of electrical equipment—this goes back again to the GP-30 and GP-35 era when many roads were arbitrarily pulling the switch gear and cycling it through their repair shops and updating it per EMD suggestions—we ran higher current tests on this particular switch gear, and measured the voltage drop.

In working with people at EMD we established some arbitrary values of what we thought would be a good point at which time to pull the switch gear and prevent the oncoming failure. Sorry to say, the switch gear we pulled based on the values established certainly increased our maintenance cost and did not significantly improve performance. It was a step in the right direction for properly defining the problem more clearly, however locomotive performance over the road did not improve very much.

MR. HOLMES: Are there any other questions from the floor?

MR. HAMBLY: Since 1966 we have been working with EMD in an effort to upgrade our 20-cylinder engines. When we had a 3/8 fillet weld engine fail we would send it in on a warranty discussion basis and have it upgraded to a 1/2 inch weld.

It was proven that the 1/2 inch weld was not the answer to a maiden's prayer, so since that time EMD has strengthened the A frame. If we have a block 3/8 inch or 1/2 inch frame cracked and it is determined by our people that we should send it to EMD, are they going to allow us some type of additional adjustment to bring us up to date with a block and pan that they now feel will live in the 20-cylinder locomotive?

MR. WECK: First of all, the statement that EMD doesn't think the 1/2 inch weld is the answer to a maiden's prayer is incorrect. We have statistics to show it is the fix for apex weld failures. We have had 1/2 inch weld failures, but for causes other than that which the original 3/8 inch apex weld was in trouble for.

Your second question asks if we are going to do something for you. The answer is that we have done something for you, and we continue to do it. Your crankcases that have been found to have problems because of the 3/8 inch weld have been handled on a pro-rated basis. The proration continues. That particular program continues on into 1980. The crankcase that you receive today will have the 1/2 inch apex weld and will be the crankcase that will perform in the manner you expect it to, and it will be pro-rated.

MR. LEEDY: Walter, is this true for any 645 engine that was delivered in 1965 and 1966, that is, the 16-cylinder engines?

MR. WECK: Yes, this is true of the 16-cylinder as well as the 20.

MR. LEEDY: And you say this proration is going on through 1980?

MR. WECK: The date is December 30, 1980.

MR. CUMBEA: In the Electrical Committee paper the other morning there was mention of the crew kits. I wonder if any railroad has had these in service sufficient time to get good feedback from their engine crews, and how well they have been accepted.

MR. HOLMES: Bill, did you get feedback on that from other railroads?

MR. JAMES: The L&N has gone to the prepackaged crew kit as a means of dispensing and supplying head-end crews with personnel supplies, and in talking with their member on our Committee he stated it has been well received to date. The crews are appreciative of it because it supplies them with a sanitary packaging system for their drinking water and other personal need. I believe he also told me that, based on prior systems and consumptions, they were hopeful of obtaining a cost reduction in the neighborhood of $250,000 annually. That seems very realistic to me.

At our Cumberland, Md., maintenance facility we had 856 locomotives assigned for maintenance, and in one year spent in excess of $18,000 for paper towel dispensers, paper cup dispensers and toilet tissue dispensers that were either broken or stolen.

So, I think there is a lot of merit in this, and I hope next year the L&N will have a very favorable report.

MR. HOLMES: A question was brought up on the floor the other day in regard to lube oil and spectrographic analysis. Someone asked, when you have both chrome and iron liners present, how do you determine whether any malfunctioning is going on in the engine?

I would like to ask Mr. Propp if he will give an explanation of this again and go into it in a little more detail.

Along with spectrographic analysis, many people ask time and again why do engines with broken crankshafts and often failed journals and bearings show no indication whatsoever on spectrographic analysis.

MR. PROPP: On the second part of the question, I think everybody agrees that the spectrograph is not a complete cure-all. It is an additional maintenance tool for the railroad and other industries to detect trends of wear in the engine. It is very obvious that we have not solved all the crankshaft problems with spectrographs. Some of the engine wear is undoubtedly too rapid. Quick breaks in crankshafts, unrelated to oil condition, are not easily detected by a spectrograph.

From our experience it is necessary to associate increased trends of elemental wear. Through years of experience and large volumes of samples each year, we can detect the development of adverse engine wear and provide substantial savings to the industry.

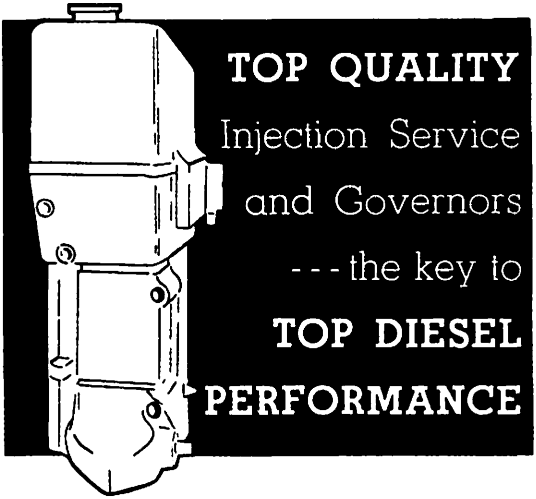
As previously mentioned, regarding the question of chrome and iron, chromium must be associated with increase in iron and type of water inhibitor. If it is a borate treatment which contains some silicates, you must associate the silicates with boron to determine their origin from the water inhibitor or air-borne dust. There is a lot of interpretation on the part of the spectroscopist to analyze the data carefully. Therefore, most of the spectrograph-condemning limits are based on trends with certain maximum levels.

Several years ago EMD set up many condemning limits for spectrographs. These have been changed from railroad to railroad. Not all railroads to date are using the same kinds of limits. We have a set of limits on BN that control our operation. Coordinating programs will standardize these limits more closely. For example, our condemning limits on silver are much lower than EMD's. You do have to develop these limits from trends and experience.

I hope that answers your question. Would one of the engine builders wish to comment on this question?

MR. REED: I want to make a comment that might demonstrate a problem I haven't heard mentioned before, in regard to broken crankshafts. We are going to speculate here. Let's say the shaft break comes from a single bad bearing; this may be unlikely, but let's speculate.

We are asked, "Why didn't you catch this shaft before it was too late?" For anybody who likes to do a little mathematical calculation and speculation, you might take a bearing which you feel is definitely condemnable, and measure the amount of lead and copper that has been removed from the bearing surface. This is a



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bearing you say should be taken out. You can calculate the weight of lead and copper that was dissolved or taken off.

Let's assume this dissolves 100 per cent in the 300 or 350 gallons of oil in the crankcase charge. This calculation shows you how much lead and copper could have been in the oil from the bearing in question. If you follow this calculation through you will come up with perhaps 2 ppm.

The background level for lead and copper on the spectrograph normally runs at least as high. It has always been a mystery to me how sometimes we do find a bad bearing when the contribution from the bearing could have been no greater than the background level for the elements involved. This shows, at least to me, the difficulty in trying to find crankshaft damage due to a single bad bearing.

I would challenge anybody who disbelieves this to make these calculations.

MR. TENNYSON: In order to detect metals in the oil, such metals have to be well dispersed in the oil, as you have heard. A chunk of anything lying in the bottom of the container would not be picked up and carried in the oil stream. Catastrophic failures that occur produce particles that are much too large to even get into the oil sample that we use. The filter picks them up, or they just don't float around, and therefore we can't find them by chemical or spectrographic analysis of the oil.

The ideal situation for a spectrograph was the old copper-lead bearing on the Alco engine in which the lead actually dissolved. When the lead dissolved the particles were well dispersed, and the laboratory could catch the trend and follow it to the point of failure or just before the point of failure. But in too many cases now the large particles that come off just don't get to us in the laboratory; they stay somewhere else.

For this reason I think it is very advisable, when an engine condition like a severe water leak or a severe fuel dilution is discovered, that an examination should be made of the paper oil filter itself. Cut a chunk out of the used oil filter from the engine in question and wash it with some kind of solvent. You may be surprised at what you will find there. Often impending failures can be headed off by this simple examination.

In regard to the first part of that question, about what you are going to do about engines with mixed liners, this gets into the realm of a communication problem. The man in the laboratory sees some increase that he doesn't like, and yet he is not certain that the engine has all iron liners or all chrome-plated liners. He has to get together with somebody and they have to mutually agree to look and see what is happening.

MR. HOLMES: And there would probably be a baseline established for that particular engine, and he was finding something that was 20 or 50 ppm above that, or a sudden rise to incite an investigation.

MR. TENNYSON: I have another question involving a problem. Now and then a slug of water from a storage tank finds its way into the diesel fuel tank on a locomotive. The water can stay in there and set up a perfect breeding ground for slime. Any attempt to clean the tank is very discouraging and practically impossible.

I would like to know if anyone has established any good way to clean a fuel tank on a locomotive and know for sure that the results are as desired.

MR. HOLMES: Does anyone have a solution to Tom's problem, something you have done or can recommend as to how to clean a fuel tank in place on a locomotive?

MR. PROPP: In answer to your question, Tom, we are not cleaning many fuel tanks right on the locomotive, but we have experienced several storage tank situations where excess of water deposits in the bottom of tanks has developed confirmations of microorganisms. This is a potential problem if the microorganisms are transferred to the engine.

We have a program of routinely draining water from the bottom, and treating with various types of biocides that are available on the market. Lab tests are made on the storage tank after cleaning to determine whether or not the problem has been solved. In all cases cleaning has corrected the problem.

On locomotive tanks we have merely treated the fuel tank with the biocide rather than cleaning it. With the large volumes of fuel exchange in locomotive tanks, I believe you can treat with biocide without cleaning.

MR. GOGOL: Some of the contaminant material in the fuel cannot be treated. We have inspected contaminant under a magnifying glass on brand-new locomotives out of the builder's plant, and we have seen rust, debris, rag material, and so on. The unit has not been in service long enough to breed bacteria or microorganisms. It is built in. The contaminate material does not decompose in fuel, and the tank is built so there is no way to easily clean it. I urge the builders who are building fuel tanks to make them more readily cleanable.

MR. PROPP: I agree. I was answering Tommy in regard to insects or microorganisms. If there are solid particles in the tank, I would expect these to be filtered without causing a filter-plugging situation which normally occurs with microorganism contamination.

MR. TENNYSON: You can't even be sure you have all the water out, Dale. You can drain every day for a month and there is still water in the tank, because the locomotive tank is so long. Unless the locomotive is perfectly level, or you jack it up on one side, you can't get the water to run out. If you jack it up on one end the water will lodge behind one of those many baffles in the tank. It is impossible to get the water out.

MR. PROPP: I would imagine the engine builders could certainly look into that design.

MR. HOLMES: We have one more ecology question. In Mr. Ryder's paper on New Developments I am curious to know whether the collection systems on both type locomotives are working equally well. What precautions do you have to take to make sure they are adequately cleaned out, and so on?

MR. RYDER: We discussed this in our Committee meetings. Unfortunately we didn't have anybody who was using them on the EMD or GE locomotives, and we wanted to toss it out as one of the questions to the audience, to see what the experience has been over time with anybody who is using it.

Vern Smith, of the Belt Railway of Chicago, made a comment about GE. Vern, would you like to expand on your comment a bit?

MR. V. L. SMITH: Actually there is very little I can say because we don't have any GE locomotives, although we service three to four daily for another railroad. The new GE locomotives with the side gutters under the hood have been very clean and very effective. The walkways are completely free and dry.

MR. WILLIAM OAKLEY [Engineer, Mechanical Department, Danish State Railways, Copenhagen, Denmark]: Gentlemen, I have a brief question. We still are operating some older EMD-F7 units. The electrical low voltage harness is of course not in the best condition any longer. The wires need replacement.

In order to preclude this replacement, we have been wondering if it would be possible to apply some kind of insulation to the harness, for example using a rubber insulating spray or a rubber moulding procedure. Have any of you gentlemen had any experience with such a procedure, or can you recommend any alternative short of replacement that is available?

MR. HOLMES: I didn't quite hear the question.

MR. GOGOL: Deteriorated insulation on the wiring itself. He wanted to know if he could sleeve it. There is no sleeving to my knowledge that you can use.

BEST WISHES

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MR. HOLMES: Thank you for your comment, Mike. I hope that answers the question.

We must stop now because the hotel has to set up this room for the luncheon. I will now call on Mr. Long to close.

MR. LONG: I am sure you will all agree that an excellent choice was made for the chairman of the What's Your Problem committee this year. There is no doubt that this committee presentation is one of the highlights of the LMOA meeting. This is where your problems can be presented and good, qualified answers received.

On behalf of all the officers and the LMOA I would like to congratulate Mr. Holmes and his able committee chairmen for an excellent handling of the problems presented in the What's Your Problem session this morning. The attendance in this hall today attests to your interest.

I have a brief paragraph I would like to read, entitled "We Think We've Got Problems!" A newly elected traveling minister in a small Tennessee community was visiting some of the small churches in his territory, and in one small town while attending a Sunday School class he decided to question some of the students. His question to one was, "What do you know about the walls of Jericho?" The boy said, "I didn't do it." The teacher said, "Pastor, if Johnny said he didn't do it, he didn't. He's a good boy."

At the next board meeting the pastor was telling the board about the incident. The board chairman said, "I see no reason for further discussion. I make a motion we pay for the necessary repairs to the wall and close the issue." [Laughter]

At this time I will close this part of the program and turn the meeting back to our President, Mr. Schroeder.

PRESIDENT SCHROEDER: Thank you, Dick and Jim. I have one or two final announcements. Jim kindly counted those present this morning, and there are 147 sitting in this session out of a total of 190 registered for our sessions. This is certainly commendable.

Next, did you get some good from these sessions? Assuming that you did, make the fact known when you get back home.

Don't forget to express your appreciation to our advertisers. Help us with our efforts for 1976.

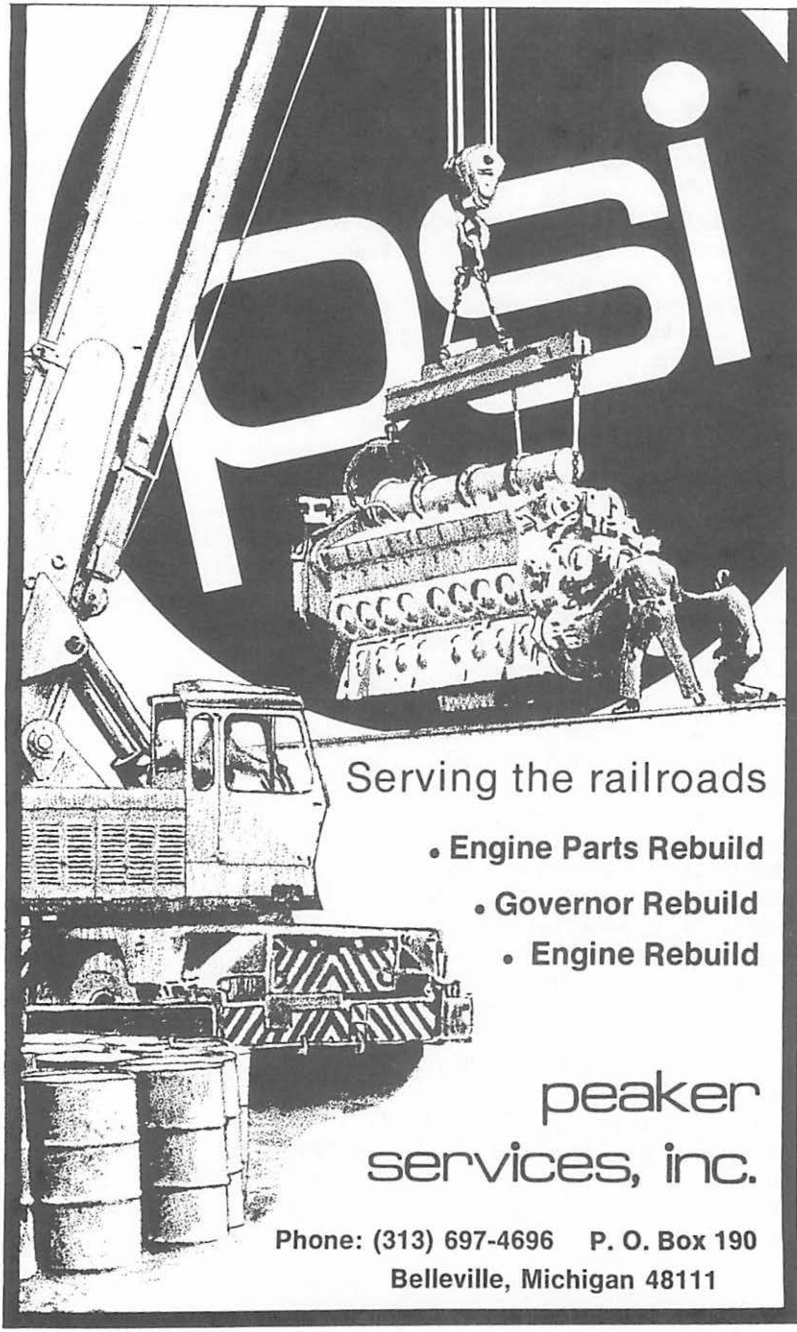
I would like to speak for the LMOA in appreciation of the great job our President, Larry Booth, did for us throughout 1975, and certainly in the many years before that when he worked hard on various committees.

Along with our applause and thanks for the very fine job done by the What's Your Problem committee, I would like to ask Larry Booth to stand and be recognized with a rising vote of thanks. Larry is our new Chairman of the Board. I hope he will keep in touch with us and continue with his fine guidance.

[The audience arose and applauded.]

PRESIDENT SCHROEDER: The meeting is adjourned.

[The meeting adjourned sine die at 11:40 a.m.]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PRE-CONVENTION PRESENTATIONS

INDEX

LOCOMOTIVE MAINTENANCE OFFICERS ASSOCIATION

GRAND BALLROOM, SECOND FLOOR

MONDAY, SEPTEMBER 27, 1976 — Page

9:30 a.m. Special Address: John H. Hertog, Vice President-Operations, Burlington Northern, Inc., St. Paul, Minn.

10:00 a.m. Diesel Mechanical Maintenance: M. Gogol, Regional Manager-LRM Southern Pacific Transportation Co., Los Angeles, Ca. Topic: "Improved Locomotive Availability by Judicious Maintenance" 151

2:00 p.m. President's Address: J. D. Schroeder, Assistant Chief Mechanical Office-Locomotive, Burlington Northern Inc., St. Paul, Minn.

2:15 p.m. New Developments: B. A. Cumbea, Manager Locomotive Data Systems & Procedures, Chessie System, Huntington, W. Va. Topic: "Projections in New Developments; Management and Procedures" 195

3:30 p.m. Shop Equipment: E. R. Hafling, Assistant Mechanical Engineer, Atchison, Topeka & Santa Fe Railway, Topeka, Ks. Topic: "New Tools and Shop Equipment Concepts to Improve Diesel Maintenance" 223

TUESDAY, SEPTEMBER 28, 1976

9:00 a.m. Fuel and Lubricants: D. H. Propp, Engineer of Tests, Burlington Northern, Inc. St. Paul, Minnesota. Topic: "Projected Advances in Locomotive Fuels and Lubricants" 279

10:30 a.m. Diesel Electrical Maintenance: W. R. James, General Manager-Locomotive Maintenance-Engineering, Chessie System, Huntington, W. Va. Topic: "Improving Locomotive Effectiveness Through Modern Management Techniques" 323

WEDNESDAY, SEPTEMBER 29, 1976

9:00 a.m. Diesel Material Control: J. J. Gregory, Production Control Manager, Consolidated Rail Corp., Altoona, Pa. Topic: "Profitability in Warranty" 361

10:15 a.m. What's Your Problem? R. W. Leedy, Superintendent Motive Power, Illinois Central Gulf Railroad, Chicago, Illinois.

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REGISTRATION FEE AT ANNUAL MEETING $5.00 PER MEMBER!

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1. TO SAVE YOUR TIME, WE HAVE A "REGISTER AT THE MEETING SYSTEM." This is described on page 130 of this book. (USE IT **TODAY!**)

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3. **IF YOU LIVE IN THE CHICAGO AREA**: Our registration desk will be open Sunday, beginning at 12 noon. Come in Sunday afternoon, register, and enjoy this special opportunity to visit with our officers and your other friends. THIS WILL SAVE YOU VALUABLE TIME ON MONDAY MORNING. KEEP YOU OUT OF THE REGISTRATION RUSH.

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SPECIAL INSTRUCTIONS: TAKE NOTE

7. **STUDY these reports closely.**
8. **SEND written questions to the Chairmen.**
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Please do not **embarrass** your Supply Company friends by calling at their suites while the meetings are in progress; it will cause them:

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

ALL SUPPLY COMPANY MEMBERS: Your strict observance of the above rule is absolutely necessary, will be greatly appreciated.

You are urged to attend the meetings because:

1. **Your** product might be discussed.
2. You might be in position to answer a question that is asked.
3. You need to know what **our** problems are, in some cases, they are **your** problems also.

★ ★ ★ ★ ★

ATTENTION ALL MEMBERS:

THIS IS A SINCERE WORD OF THANKS TO THE ORGANIZATIONS LISTED BELOW WHO HAVE CONTRIBUTED MUCH TO THE SUCCESS OF OUR PRE-CONVENTION PRESENTATION PROGRAM BY PROVIDING COMPLIMENTARY USE OF ROOMS FOR COMMITTEE MEETINGS AND FOR THE PRE-CONVENTION PRESENTATIONS THEMSELVES:

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There are no obligations for the use of these facilities, but we are quite sure that these establishments would appreciate the opportunity to serve you if and when you are in their vicinity.

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1940	34	48	162	244
1941	38	48	210	296
(Annual Conventions were discontinued during the war after the 1941 meeting)				
1942	31	29	82	142
1943	36	23	57	116
1944	70	58	164	292
1945	76	76	214	366
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
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CP Rail.
Montreal, Quebec H3C 3E4

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C.M.O.—System
Southern Pacific Trans. Co.
San Francisco, Calif. 94105

PAST PRESIDENTS

1939 & 1940—F. B. DOWNEY (Deceased) Asst. to Shop Supt., C. & O. Ry.

1941—J. C. MILLER (Deceased), M. M., N. Y. C. & St. L. R.R.

1942-1946 Inc.—J. E. GOODWIN, Retired Exec. Vice-President, C. & N. W. Ry., 4 River Ridge Road, Little Rock, Ark.

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

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

1949—J. W. HAWTHORNE, Asst. Vice-Pres. - Equipment, Seaboard Coast Line R.R., Jacksonville, Fla.

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

1951—P. H. VERD, Retired Vice-Pres. - Personnel, E. J. & E. Ry., P. O. Box 462, Anacortes, Washington 98221

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

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

1954 & 1955—F. D. SINEATH, Chief of Motive Power, Seaboard Coast Line R.R., Jacksonville, Fla.

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

1957—J. T. DAILEY, Retired Asst. to Pres. - Mech., Alton & Southern R.R., 1211 Simmons Way, Sun City Center, Florida

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.

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

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

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

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

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

1965—J. J. EKIN, Retired Supt. Marine & Pier Maintenance B. & O. R.R., Baltimore, Md.

1966—F. A. UPTON, Chief Mechanical Officer, C. M. St. P. & P. R.R., Milwaukee, Wis.

1967—G. M. BEISCHER, 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, Ill.

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

1970—G. R. WEAVER, Retired Director 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

1972—KY PRUCHNICKI, Retired General Supervisor Locomotive Maintenance, Southern Pacific Transportation Co., San Francisco, Calif.

1973—W. F. DADD, Chief Mechanical Officer, Chessie System, Huntington, W. Va. 25718

1974—C. P. STENDAHL, General Manager M.P. - Electrical, Burlington Northern, Inc., St. Paul, Minn. 55101

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

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H. C. WILCOX (Retired), Editor, Railway Locomotives & Cars

Southwestern Railway Club

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Chief Mechanical Officer
Missouri Pacific Railroad System
St. Louis, Missouri

HAROLD H. VIEHLAND
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Supervisor of Apprentices
Missouri Pacific Railroad
14710 Avocado Lane
Florissant, Missouri 63034

Started in 1946, the Southwestern Railway Club this year is celebrating its 30th anniversary. It is an organization of approximately 350 members dedicated to free and open discussion of problems, solutions, and new developments in the railroad industry. Topics of discussion cover all phases of locomotive as well as freight car maintenance.

Membership is open to all railway personnel and all railway suppliers and builders. Meetings are held three times each year—4th Thursday of October in Fort Worth, Texas; 4th Thursday of January in Houston, Texas; 4th Thursday of April in Little Rock, Arkansas.

Application for membership should be sent to Southwestern Railway Club, 14710 Avocado Lane, Florissant, Missouri 63034.

Monday, September 27, 1976

9:30 A.M.

REPORT OF THE COMMITTEE ON DIESEL MECHANICAL MAINTENANCE

Pre-Convention Presentation: Southwestern Railway Club

April 22, 1976 Camelot Inn Little Rock Arkansas

M. GOGOL, Chairman
Regional Manager—LRM
Southern Pacific Transportation Co.
2850 Kerr St., Griffith Station
Los Angeles, Calif. 90039

VICE CHAIRMAN

J. L. Kuhns, Asst. Manager—Locomotive Quality Control, Louisville & Nashville RR Co., 908 West Broadway, Louisville, Ky. 40201

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L. M. Buffington, Assistant Supt. Locomotive Shops, St. Louis-San Francisco Rwy. Co., Kansas Avenue, Springfield, Mo. 65802
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J. T. Dixon, Gen. Superintendent-Shops, Consolidated Rail Corp., 577 E. 152nd St., Cleveland, Ohio 44110
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M. M. Early, Mechanical Supvr.-Locomotive, Norfolk & Western Rwy., 8 North Jefferson St., Roanoke, Va. 24011
P. W. Larery, Supt. Motive Power, Missouri-Kansas-Texas, 2015 Crawford, Parsons, Ks. 67357
K. R. Manson, Manager Customer Services, MLW-Worthington, 1505 Dickson St., Montreal, Quebec
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Jay Moyer, Master Mechanic, Consolidated Rail Corp., Sixth & Perry Sts., Reading, Pa. 19611
R. T. Thetford, Quality Control Supr., Illinois Central Gulf Railroad, 233 N. Michigan Ave., Chicago, Ill. 60601
B. L. Thomas, Component Rebuild Manager, Chessie System, Huntington, W. Va. 25718
L. F. Turney, Manager, Tech. Section, Electro-Motive Division, LaGrange, Ill. 60525
C. D. Vittur, General Foreman, Southern Railway Co., Chattanooga Diesel Shop, Chattanooga, Tenn. 37401

PERSONAL HISTORY MICHAEL GOGOL

Mike Gogol was born October 25, 1921, at New Cumberland, W. Va. He attended high school at Newell, W. Va., acquired B.S. and M.S. in Mechanical Engineering at the University of Houston, and furthered his education by attending Transportation Management Program and Stanford-Sloan Program at Stanford University.

Mr. Gogol served in World War II as a Navigator.

In 1949 he started his railroad career at Houston, Texas, with the Texas & New Orleans Railroad as Draftsman, progressed through Chief Draftsman in 1955, became Diesel Engineer in 1956, and wound up his service with the T&NO as Mechanical and Test Engineer from 1957 until 1962.

In 1962 Mr. Gogol joined the Southern Pacific Transportation Co. as Assistant to Manager Mechanical Engineering & Research in San Francisco. The following year he advanced to Manager Mechanical Engineering & Research, became Chief Mechanical Engineer in 1966 and Assistant Superintendent Mechanical Department at Houston, Texas, in 1970. From 1972 through 1974 he served as Assistant Regional Manager (LRM) in Los Angeles and moved to his present position as Regional Manager (LRM) in 1975.

In addition to his duties with LMOA, Mr. Gogol is a member of the American Society of Mechanical Engineers and a past president of the Southwest Railway Club. He is married to the former Catherine C. Foyt of Houston.

IMPROVED LOCOMOTIVE AVAILABILITY BY JUDICIOUS MAINTENANCE

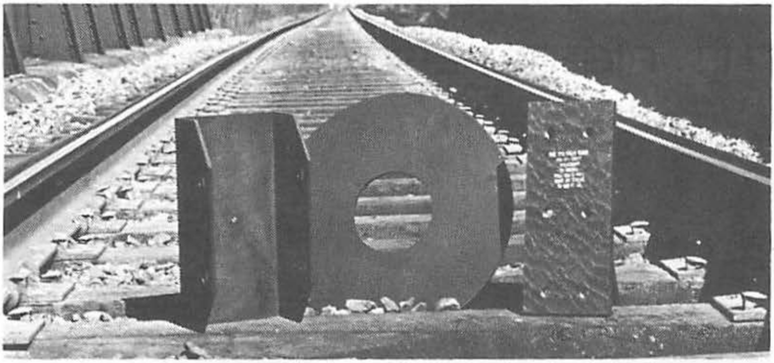
I—RECOMMENDED MAINTENANCE SCHEDULE

Historically, we have performed maintenance on locomotives when they were shopped for Federal Inspections monthly, quarterly, semi-annually and annually as a matter of expediency. The locomotive manufacturers also have scheduled the unit maintenance to coincide with those inspections.

The Federal Inspection Report Form, known as Form 1-A, Blue Form, or cab card, has been changed. Previously the old form was removed from the locomotive, and at least three copies of Form 1-A prepared each 30 days when the locomotive was inspected. One copy had to be notarized and mailed to the Federal Inspector. The new Blue Form remains on the locomotive for six months and has to be notarized and mailed to the FRA only at the end of the six-month period.

As a result of this change in the Blue Form and technological improvements, we can now perform 30-day Federal Inspections and routine maintenance at different times. The maintenance can now be performed when mechanically required which, under present operating conditions, could be 30-, 60- or 90-day periods. However, each time the unit arrives in the shop for a mechanical inspection, a set period of time for the routine work items should be designated.

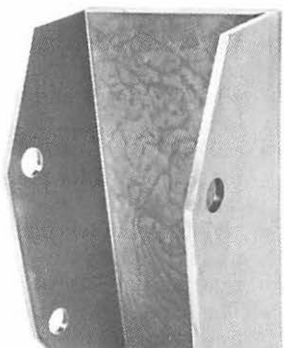
The committee has recommended that the locomotive manufacturers' work items be planned for the maximum number of work periods as de-



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

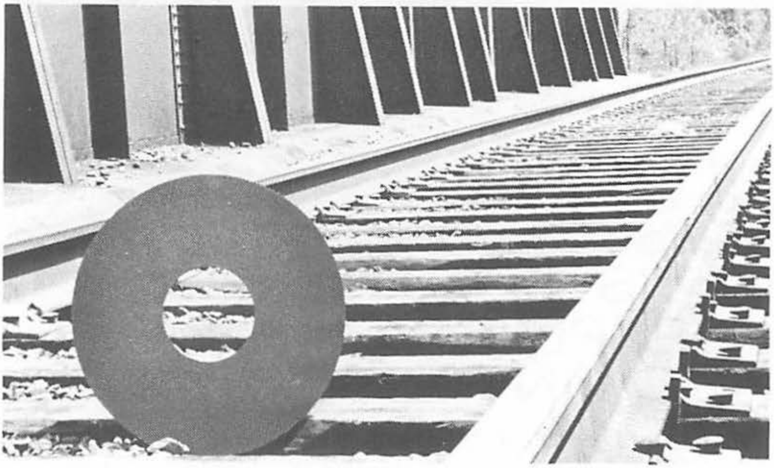
You already know about the premium qualities of Nylatron® nylon pedestal liners. You know they are standard OEM parts on EMD and GE diesel locomotives. You know that they are replacement parts for every major railway in the United States, because

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



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

THE RIGHT PERSPECTIVE IS ON



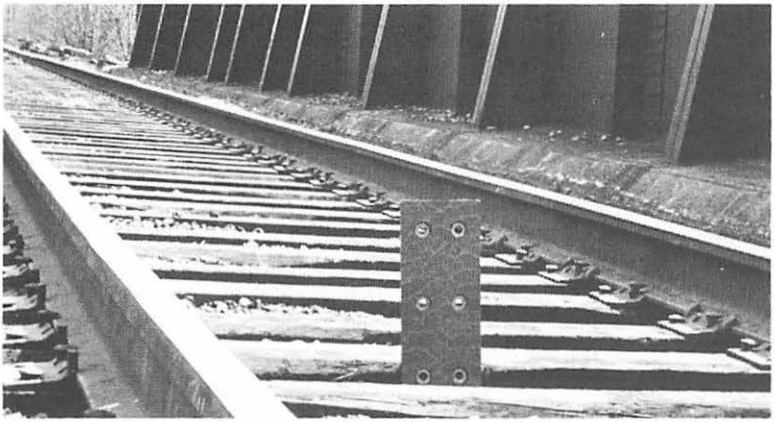
Center Plate Liners

- Nylatron® nylon center plate liners are made of the same self-lubricating and wear-resistant material as Nylatron pedestal liners and are designed for both EMD and GE locomotives.
- Molybdenum disulphide solid lubricant provides Nylatron nylon center plate liners with excellent wear resistance.
- Nylatron center plate liners cost less than the filled phenolic parts you are probably using on your locomotives now.
- The excellent resilience of Nylatron nylon center plate liners enables them to withstand heavy shock loads without cracking.

THE Polymer CORPORATION

READING, PENNSYLVANIA 19603 • (215) 929-5858

NYLATRON® LOCOMOTIVE PARTS...



Bolster Wear Plates

- Nylatron® nylon wear plates are made of the same self-lubricating and wear-resistant material as the Nylatron pedestal liners which outperform steel. They also incorporate a witness groove or wear line across the narrow ends 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.

Join the others who have successfully replaced steel with Nylatron nylon pedestal liners, and ask your Polymer representative for information on our Nylatron center plate liners and bolster wear plates.

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termined on our individual railroads from experience, such as two-year period, four-year period or eight-year period. Those items should then be plotted for the number of routine inspections required to cover all routine work. This will prevent a progressively larger work report from the quarterly up to the 24-month annual inspection as every item on three-, six-, nine- and 12-month inspection would also be due on the 24-month inspection. (Fig. 1) As an example, if we have six work items due every six months and each item required 30 minutes' time it would require three hours each six months. However, if we performed one of those items each month or work period, it would only require 30 minutes at each inspection. All work items on the locomotive manufacturers' recommendation can be treated in this manner to achieve a balanced work load from one major shopping of the locomotive to another.

An interim servicing period should be established for the routine servicing if "Blue Form" work is separated from maintenance. Such an interim period also permits addition of gear lubricant, suspension bearing oil, filters change, etc. at different time periods. One railroad uses 35 days as an interim servicing period to disassociate the 30-day "Blue Form" items.

By utilizing the computers most railroads have, an individual locomotive can be programmed to have its own work report. If one or more items need to be spaced differently, that can easily be done.

If it is necessary to flag an item because of insufficient time to perform, that item will be printed on the next work report and on continuing work reports until performed. (Fig. 2) This will then up-date the program and the item will not be printed again until due.

The computer also permits the use of a simplified work report to keep track of locomotive maintenance and the printing of individual work reports. The committee suggests that the work reports not cover in detail a complete explanation of the work required. (Fig. 3) This detail explanation should be covered in a separate set of instructions. The work item number should coincide with the work explanation number so that at all maintenance points all work report items will be performed exactly alike.

When each unit is shopped, the work report should also contain any information of troubles the unit has experienced in the last 30 days. That information is printed on the bottom of the work report, enabling the mechanics and supervisors to locate or be alerted to any unusual problems; this, of course, would have to be programmed into the computer.

The computer can also be used to print on the work report any modification due to the individual unit. (Fig. 4) Once the modification is signed off, it will no longer show up on the work report. (Fig. 5) The committee suggests that the work report show any information needed for the locomotive wheels. The wheels should be turned periodically to increase wheel life. By turning the wheels prior to the flange becoming dead, less tread metal will be removed to restore the flange contour.

EDM – PROGRESSIVE MAINTENANCE DISTRIBUTION

	1	2	3	4	5	6	7	8	9	10	11	12
Work Items Basic to all EMD Locos.	03 04 05 06 22 23 72 107 114	07 08 09 10 26 27 28 37 73 108	02 14 15 16 17 31 79 81 94 110	03 04 05 06 22 23 83 109 166	07 08 09 10 26 27 28 37 63 64 69	02 14 15 16 17 31 62 66 68 94 111	03 04 05 06 22 23 72 112	07 08 09 10 26 27 28 37 73 133	02 14 15 16 17 31 79 81 94 135	03 04 05 06 22 23 83 136	07 08 09 10 26 27 27 28 37 63 64 162	02 14 15 16 17 31 62 66 68 94
Exception No. 1. Add to basic if it's a GP–18, GP 30-35-38, 38-2 SD38-2, GP-40 SD-35, SDP35, SD40, SD40-2.	11 19 80	25		11 19 82	25 137		11 19 80 167	25		11 19 82	25 134	
Exception No. 2 Add to basic Item 29 to Switchers only	29 29		29	29	29		29 29		29	29	29	
Exception No. 3 Refer to Manual of Motive Power Maintenance on Work Item Listed Below:		51		75 100		153 154		152				

	13	14	15	16	17	18	19	20	21	22	23	24
Work Items Basic to all EMD Locos.	03 04 05 06 22 23 72 107 114	07 08 09 10 26 27 28 37 73 108	02 14 15 16 17 31 79 81 94 110	03 04 05 06 22 23 83 109	07 08 09 10 11 27 27 28 37 63 64	02 14 15 16 17 31 62 66 68 94 111	03 04 05 06 22 23 72 112	07 08 09 10 26 27 28 37 73 133	02 14 19 16 17 31 79 81 94 135	03 04 05 06 22 23 83 136	07 08 09 10 11 27 27 28 37 63 64	02 14 15 16 17 31 62 66 68 94
Exception No. 1. Add to basic if it's a GP–18, GP 30-35-38, 38-2 SD38-2, GP-40 SD-35, SDP35, SD40, SD40-2.	11 19 80	25		11 19 82	25 137		11 19 80	25		11 19 82	25 134	
Exception No. 2 Add to basic Item 29 to Switchers only	29 29		29	29	29		29 29			29 29		
Exception No. 3 Refer to Manual of Motive Power Maintenance on Work Item Listed Below:												

(Item 024 075 152 154)
(051 100 153 165)

PERIODICAL MAINTENANCE SCHEDULE

UNIT 4066 DUE ON 04-19-78 AT RADNOR
••••

SHOP FOREMAN ---------------- DATE DONE --/--/--
MO DA YR

FINAL DISPATCHMENT INSPECTION-FOREMAN ------------

OTHER MAINTENANCE SCHEDULED COL 17 --

CODE DESCRIPTION	SIGN WHEN DONE
000 MONTHLY INSPECTION-BLUE FORM-YELLOW CARD	000-------
001 CK AIR BRAKE EQUIP PER QTRLY AIR CARD	001-------
007 CLEAN WATER SIGHT GLASS	007-------
008 REVERS POLARITY ALTERNATR SLP RING LEADS	008-------
009 INSPECT FUEL PUMP MOTOR	009-------
010 INSPECT OSCILLATING HEADLIGHT MOTOR	010-------
025 CK ENGINE CRANKCASE PROTECTOR	025-------
026 RMV&CLN SUCTION & SCAVAGING OIL STRAINRS	026-------
027 LUBE HANDBRAKE	027-------
037 CHANGE SPIN-ON FUEL OIL FILTER	037-------
063 DRAIN, CLN, REFIL AIR COMPRESS CRANKCASE	063-------
064 CLN AIR COMPRESS CRANKCSE BREATHER	064-------
094 ADD BIO-BAR JF TO FUEL TANK	094-------
137 BLOW OUT HEAT SINK & DIODE COMPARTMENT	137-------

---QUARTERLY DUE

MODIFICATIONS DUE 2507-2 2602-2

THIS UNIT IS INCLUDED IN OUR TRACTION
MOTOR BRUSH CHANGE PROGRAM

RETURN ORIGINAL ALONG WITH FORM 1583 TO
OFFICE OF ASST VICE-PRES MECH IMMEDIATELY

PERIODICAL MAINTENANCE SCHEDULE

UNIT 1327 DUE ON 04-28-78 AT CORBIN
••••

SHOP FOREMAN -------------- DATE DONE --/--/--
MO DA YR

FINAL DISPATCHMENT INSPECTION-FOREMAN -------

OTHER MAINTENANCE SCHEDULED COL 17 --

CODE DESCRIPTION	SIGN WHEN DONE
000 MONTHLY INSPECTION-BLUE FORM-YELLOW CARD	000------
001 CK AIR BRAKE EQUIP PER QTRLY AIR CARD	001------
004 CK FUEL GAGE, FILLER CONN-CLN SIGHT GLASS	004------
007 CLEAN WATER SIGHT CLASS	007------
008 REVERS POLARITY ALTERNATR SLP RING LEADS	008------
009 INSPECT FUEL PUMP MOTOR	009------
010 INSPECT OSCILLATING HEADLIGHT MOTOR	010------
015 INSPECT CAB HEAT & DEFROST MOTORS	015------
020 INSP AIR CLEAN EXH & SHUNTER MOTORS	020------
021 INSP CRKCSE EXHST MOTR & EDDY CURR CLUTCH	021------
065 CLN PANL BATH/CYCOIL AIR FILTR & CHG OIL	065------
093 CHECK VALVE TAPPET ADJUSTMENT	093------
119 CHNG OIL RADIATOR FAN GEAR UNIT	119------
120 CHNG OIL AUX DRIV GEAR HOUSING-MAIN GEN	120------
154 CHANGE TRACTION MOTOR BRUSHES	154------

---QUATERLY DUE

MODIFICATIONS DUE 2602-1 2602-2 3201-2

RETURN ORIGINAL ALONG WITH FORM 1583 TO
OFFICE OF ASST VICE-PRES MECH IMMEDIATELY

PERIODICAL MAINTENANCE SCHEDULE

UNIT 1324 DUE ON 04-30-78 AT CORBIN
****

SHOP FOREMAN --------- DATE DONE --/--/--
MO DA YR

FINAL DISPATCHMENT INSPECTION--FOREMAN ------------
OTHER MAINTENANCE SCHEDULED COL 17 --

CODE DESCRIPTION	SIGN WHEN DONE
000 MONTHLY INSPECTION-BLUE FORM-YELLOW CARD	
000 MONTHLY INSPECTION-BLUE FORM-YELLOW CARD	000-----
001 CK AIR BRAKE EQUIP PER QTRLY AIR CARD	000-----
002 CK AIR COMPRESSOR CONTROLS	002-----
003 BLOW OUT MAIN GEN' TR-MOTR W/COMPRESD AIR	003-----
005 LUBRICATE FLEXIBLE COUPLINGS	005-----
013 CK OPERATION GENERATOR OVERLOAD RELAY	013-----
016 INSP&CLN CONTROL STND & ELEC LOCKR EQUIP	016-----
024 LUBE TRACTION MOTOR BLOWERS	024-----
061 CHNG AIR BRK EQUIP PER 6 MOS AIR CARD	061-----
067 CHNG FUEL INJECTION NOZZLES	067-----
106 ADD GREAS-TOP BEARING RAD. FAN GEAR UNIT	106-----
154 CHANGE TRACTION MOTOR BRUSHES	154-----
---SEMI-ANUAL DUE	

LOCOMOTIVE FAILURES 03-08 TO 04-08		
03-30	MIDDLEBORO	BRAKE RIGGING DEFECT

MODIFICATION DUE 2336-1 2602-1 2602-2
RETURN ORIGINAL ALONG WITH FORM 1583 TO
OFFICE OF ASST VICE-PRES MECH IMMEDIATELY

KELTY RADIATOR COMPANY

NUMBER ONE In The Industry For:
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(319) 366-1849

All of the above requires programming of the computer to furnish the required information. However, we as managers must use every available device to adequately maintain and manage our locomotive fleets at the lowest possible cost. An example of 30-day maintenance versus 60-day maintenance is shown below:

Assuming a railroad has 1000 locomotives that are shopped once each 30 days at an average cost per shopping of $200.00.

$$1000 \text{ locos.} \times \$200 = \$200{,}000$$

$$\frac{1000}{2} = 500 \text{ locos./mo.} \times \$200 = \$100{,}000$$

The availability of locomotives due to routine shoppings doubles and the cost is cut in half.

In addition to the computer work reports, we believe that there is need for a schedule for component part chargeout periods covering cylinder assemblies, main bearings, air compressors, engines, etc. On one railroad, those items are handled separately, and a separate printout is made for engines, main bearings and cylinder assembly replacement. A separate work sheet is made for this type of work and is furnished to the shop that is going to perform the work from Mechanical Department headquarters.

Although suited to computers, everything we have discussed can be done manually and, in fact, is done by one railroad member of this committee. Their system is called the "Q" system. Different items are done on odd and even Q or Quarterly inspections. This system also includes air brake equipment, with individual portions being changed over a 24-month period, rather than changing all equipment at the same time.

II—DEFINITION OF AVAILABILITY

"Improved Locomotive Availability by Judicious Maintenance" can only be measured by means of a bench mark established by clearly defined guidelines.

We believe that it is a responsibility of this Committee to determine those guidelines and how they should be established. We should also try to standardize methods of attaining the information. In this manner we can set up meaningful records at least within one's own railroad that are measurable from one period to the next or from one shop to the next. Most importantly, when a change is made in our maintenance practices, we can then measure the improvement, if any. Because no one wants to admit that his maintenance practices or control of them are unsatisfactory, inability to control "Availability through Judicious Maintenance" may be hidden in an effort to save face.

In order to improve unit availability and reliability at the lowest possible cost, we must first determine what they are. A former railroader used the phrase "motive power capable of being converted into resources," when defining availability. The term "availability" has become more nebulous with each technological advance.

It is self-evident that unreliable power can be very costly. The added expenses arise from extra maintenance to rectify failures or faults as well as from a wide range of intangibles. The final unmeasurable cost is that result-

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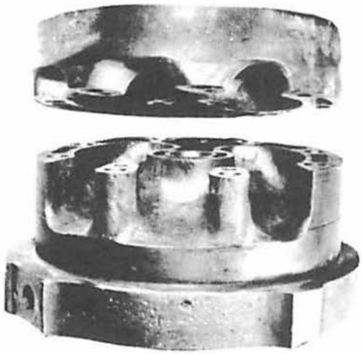

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CYLINDER HEADS

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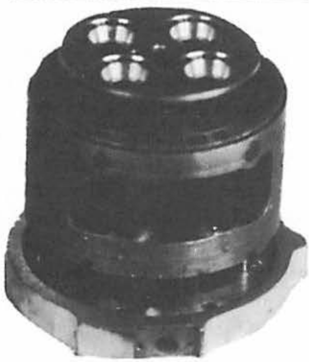

"Jones Process"
Hi-Horse Power CYLINDER HEADS

ing from loss of good will. Comparative statistical data indicating reliability, availability and maintenance costs and their interrelationship must be maintained to measure any railroad motive power fleet, whether it be against steam or an as yet unknown motive power of the future.

Those guidelines reflect how the Mechanical Department is doing in keeping units operating, and how the Operating Department is doing in utilizing the available power. As technical advances were made and communications improved over the years, more statistical data were gathered and more comparisons made between railroads. Publications are available that measure all railroads in maintenance of equipment standards. In establishing guidelines for collecting this information, vague descriptions begin to occur. With computerization, most railroads have, in assembling the statistical data, adjusted their guidelines so as to show themselves in a good light compared with other railroads, rather than being factual and honest with themselves. What we are saying, actually there are lies, damn lies, and statistics in that order.

This type of statistical data is a double-edged sword. When more power is available than needed, in order to improve utilization, the Operating Department tends to use more units on the train than necessary, thus improving utilization. When availability is low, the Mechanical Department tends to defer maintenance in an attempt to increase availability. This causes unscheduled break-down maintenance, further justifying the Operating Department's need for more power than actually needed for the trains to overcome the increased failure rate.

Overpowering of trains is a waste of power but does provide good utilization. It requires a larger ownership and increases maintenance costs. We believe a good preventive maintenance program can improve reliability. In turn, availability increases to justify a smaller fleet.

Good timely statistical data when compared with h.p. miles per gross ton-miles will provide a sound control tool for a good progressive maintenance program. Good statistical information relating fuel consumed to ton-mileage will provide a good tool for proper utilization.

Such data can be used in determining the comparative availability between different types of power, as well as comparing different manufacturers' products. Those data also can be used as a control and a guideline to measure and compare maintenance facilities (when assigned maintenance points are in control) within the same railroad. They can be used to compare new locomotives with older locomotives in the same service so as to justify upgrading or replacement. They can be used as a comparison to reveal the shortcomings of technological advances that in fact were not functionally feasible and reflect additional maintenance or create loss of power resulting from early failures.

It is necessary to collect these data to control preventive maintenance repair programs so that the maximum availability can be obtained at a minimum cost.

In the recent economic recession, many railroads found themselves with excess power, and necessarily stored

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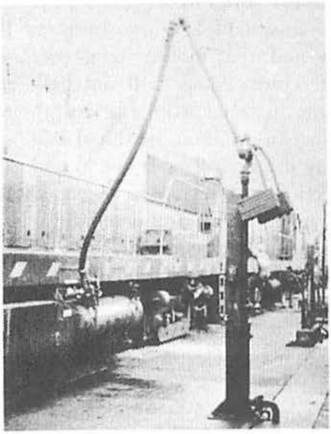
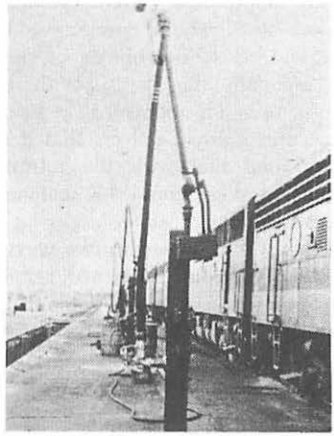
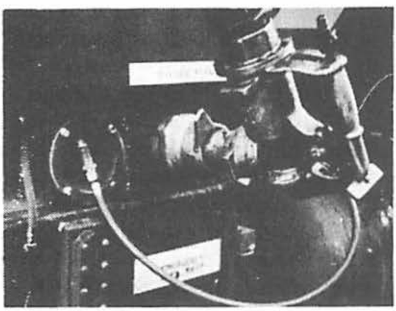


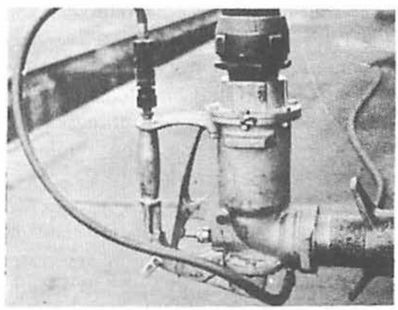
Snyder OPW 1620-DS Automatic Nozzle Fueling on Snyder No. 104-S-2½" Fuel Crane.



Snyder OPW 1620-DS-2½" Automatic Nozzle Secured to Snyder No. 104-S-2½" Fuel Crane.



Close-Up of Snyder OPW 1620-DS Automatic Nozzle in operation, with Snyder No. 565 Quarter Turn Fuel Quick Coupling Adaptor, connected to Standard Protectoseal Diesel Fuel Tank. Fill Adaptor.



Close-Up of Snyder OPW 1620-DS Automatic Nozzle secured, with Snyder No. 565 Quick Coupling Fuel Adaptor to No. 104-S Fuel Crane.

The automatic diesel fueling installation pictured above increases safety and efficiency in fueling diesel locomotives because spillage of diesel fuel is eliminated. fire hazard minimized. and water is not contaminated by fuel spillage.

Efficiency is doubly increased because unattended fueling is possible with automatic shut-off nozzles. Maintenance costs are reduced because the fueling crane pulls the nozzle and hose up and out of the way. (the nozzle is secured to the fueling crane when not in use) which prevents it from swinging freely and being battered about.

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units. When power was stored, certain side effects became apparent. As in any type of business, when times are good, we begin to grow fat. Railroads emphasized purchases of new power and rebuild programs; they employed a large number of people to maintain the fleets. With hard times, railroads reduced fleet size. At least one railroad reflects that it now has found that with the return of traffic, service could be maintained with a smaller fleet.

This was achieved in two ways. A smaller fleet could be turned, serviced, repaired and maintained without overloading the facilities. The facilities were not of sufficient capacity to properly handle the large fleet, but were not overloaded to an extent justifying expansion. A large fleet also proved harder to schedule into shops for routine scheduled repair.

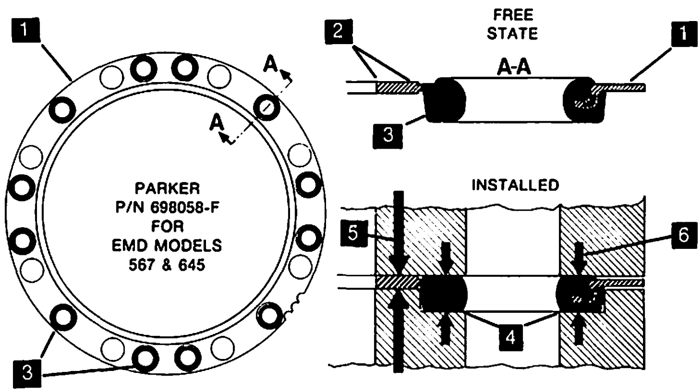
With the reduction in active fleet, railroads were better able to improve the quality of their maintenance. They attributed this to two things: One, with force reductions, the employees left in service were largely those with long service and greater experience; two, with employees recently laid off, those remaining were more interested in doing a good job—not just signing off the work. They perhaps have done this in an effort to show the need for recall of the people laid off, but it does appear to have improved the quality of maintenance. Also, the supervisors with reduced work load have been better able to control their work force and work load.

As a result of the recession, many railroads removed from service units that have had failures. Those were set aside and not repaired. We view this as a very serious condition that continues to worsen due to the power not being needed. Decisions not to repair units might escalate until the number of out-of-service units becomes unmanageable. When business turns up and that power is needed, suppliers very likely will not have sufficient material available for their repair. In addition, qualified manpower may not be available when and where needed to alleviate a severe shortage of power. This could create a loss of business and good will for the railroads. Certainly, locomotive manufacturers that have not received orders for new locomotives have had to reduce manpower and would need considerable time to restore production schedules, should the railroads start ordering new power. It is very necessary that we as managers continue to keep this particular situation foremost in our minds as well as presenting it to our superiors often enough that they will be aware of our dilemma.

We have sent questionnaires to as many railroads as feasible. It is our contention that in comparing one railroad with another, it is essential that the data are gathered in the same manner. Only then can it be used comparably and only then will it be reliable.

The information gathered by the questionnaire indicates that a standard form can be recommended by this committee. It is the decision of the railroad whether to adapt to the standard. This committee recommends that it would be astute to use this standard form when comparing one railroad with another.

Failures once charged and not yet confirmed are very difficult to measure.



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COUNT MADE ONCE EACH DAY AT A SPECIFIC TIME

TOTAL ACTIVE UNITS	=	Total all units on your line. Include: your ownership, run through, leased, switchers — on your line Do not include: stored good order stored bad order retired or pending disposition
AVAILABLE	=	Units in service or ready for call. Units at service pit needing only fuel and sand.
UNSERVICEABLE	=	Failed units moving or on hand at shop Accident repair at shop where can be repaired Units under repair at shops Units for light or heavy schedule or nonschedule Units for Federal inspections Units held waiting material Units held waiting shop room or manpower Units moving or set out on line with mechanical difficulties: May include: hot box, flat wheels, etc. Do not include: accident, wreck
FAILURES	=	Units with reports of mechanical malfunction. Include: producing less than 100% power shut down enroute safety devices functioning low oil pressure G.P.R. or not loading low water or water leaks T.M. or dynamic brake cut out wheel slip relay speed recorder inoperative air brake or compressore failure exhaust leak fuel filter plugged etc.

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The best known method of measure is to adjust the number of failures by a weighted average due to invalid reporting. Failure must be recognized and used as a measure to control maintenance procedures and costs. They must also be used as a quality control measure. Failures must also be used to place responsibility and consideration for retirement or upgrading of fleet.

Delays

This committee does not recommend that delays be considered as chargeable due to their nebulous nature. All delays should be monitored by the Mechanical Department and investigated so that proper and timely adjustments can be made. They may be actually caused by irresponsible crews creating delays en route to better position themselves for their next run. Unfavorable meets by dispatchers, weather conditions, etc. Once delays are charged, continuous disagreement results as to the cause in placing of responsibility and generally creates loss of good will between departments. We do recognize that it is necessary to record delays and in fact make every joint effort to reduce them. All detention should be run down to conclusion, and responsibility placed where it belongs.

Reducing Failure

This committee recommends assigned maintenance points for every locomotive. Serves as a guideline to reduce failures and repeat failures in the following manner:

1. Responsibility for failures can be placed at the maintenance point.
2. Each maintenance point can be evaluated by the percentage of failures of its entire fleet assignment. The types of power should be taken into account.
3. Special types and manufacturers of locomotives can be kept in one particular assignment.
4. Training of people is simplified due to special assignment of power.
5. Material inventory, tooling and facilities can be available due to special assignment of classes of power.
6. Ability to schedule work loads at different facilities.

All of the above takes the complete cooperation of your Centralized Power Bureau.

III—QUALITY CONTROL

Inbound Inspections

This committee recommends:

1. Inbound inspections by a competent employee.
2. Walk-around inspection by a Supervisor or Quality Control Officer on periodic basis as often as feasible.
3. Overpit inspection can vary from 5 to 35 days depending on the mileage and service accumulated on various railroads or territories before mileage inspections are necessary. Mileage inspections are necessary where locomotives are subject to high mileage; however, calendar days are satisfactory where a low mileage is accumulated. In many cases it is necessary to have a combination of both mileage and calendar days to protect locomotives from being abused when changes in service require high mileage and heavy service.

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4. Where self-load test is available it can be helpful on inbound inspections.
5. Cleaning of the locomotive prior to work can be beneficial in locating oil leaks, and physiologically.

Outbound Inspections

1. Outbound inspections are required to comply with FRA rules in many cases.
2. Outbound inspections by Supervisors or Quality Control Officers are necessary on a random basis if for no other reason than the physiological effect.
3. Follow-up communication with outbound inspector on the type of failures being experienced will bring many rewarding dividends.
4. Where available, a self-load test can be helpful.

This committee offers the following devices to measure your judicious maintenance.

Count made once each day will provide:

total active units,
available units,
unserviceable units,
failure of units.

Then using the data gained above and shown on the slide we can now establish:

percent available,
reliability,
utilization,
maintenance cost.

Judiciously comparing those records with historical data we now can compare maintenance practices with past records for our own railroad or with those using different maintenance practices, and make adjustments for corrective action.

IV—UPDATE ON TRUCK MAINTENANCE

Scheduling Wheel Truing

From information furnished by railroads represented in this committee, it is apparent that wheel truing is governed by wheel wear. The condition of the wheel treads, flange thickness and flange height is checked and recorded at each monthly inspection (approximately every 30 days). Wheel treads are turned as they wear or require turning for such other defects as flat spots, shelling, etc. Information obtained at monthly inspection is used to schedule wheel truing or wheel changes depending upon rim thickness of wheel. The type of unit, service, average monthly mileage, terrain, truck type and other conditions affecting wheel wear are taken into consideration in effectively scheduling wheel truing.

Some railroads have made attempts to schedule wheel truing strictly on a time basis. Because of the differences in truck design, mileage variations, terrain, and wheel wear variation between each pair of wheels on a given unit, this method has not proven satisfactory. Some wheels are trued unnecessarily, while others are condemned at inspections. The locomotive availability is lower when scheduling wheel truing by this method.

The committee recommends wheel truing schedules based upon wheel reports made at monthly inspections as the most efficient and economical method. This results in greater locomotive availability.

AVAILABILITY IS THE UNITS AVAILABLE FOR SERVICE WHEN CALLED. DEPENDS ON THE FOLLOWING FACTORS:

$$\frac{\text{UNSERVICEABLE UNITS}}{\text{TOTAL FLEET} - \text{STORED UNITS}} =$$

PERCENT AVAILABLE

$$\frac{\text{FAILED UNITS}}{\text{TOTAL FLEET} - \text{STORED} - \text{UNSERVICEABLE UNITS}} =$$

RELIABILITY IS THE FAILURE–FREE SERVICE OVER A PERIOD OF TIME UNDER GIVEN ENVI–RONMENTAL AND SERVICE CONDITIONS.

$$\frac{\text{HOURS UNIT USED}}{\text{HOURS UNIT AVAILABLE}} =$$

UTILIZATION: AN INDEX OF THE USEFUL WORK IN SERVICE OBTAINED FROM A LOCOMOTIVE. IT IS INFLUENTIAL NOT ONLY BY THE PERFORMANCE OF THE LOCOMOTIVE ITSELF, BUT MORE BY THE MANNER IN WHICH IT IS PLANNED AND HANDLED. IT REQUIRES COOPERATION OF THE CENTRALIZED POWER BUREAU.

$$\text{LABOR} + \text{MATERIAL} - \text{FUEL} - \text{LUBE} - \text{WRECK REPAIR} =$$

MAINTENANCE COSTS, A COMPOSITE OF MATERIAL AND LABOR COSTS (EXCLUDING FUELS AND WRECK REPAIR) INVOLVED IN SERVICING AND MAINTENANCE OF THE LOCOMOTIVE. THIS MUST INCLUDE:

1. ADMINISTRATION
2. REBUILD UPGRADING PROGRAMS
3. THE STEADY INCREASE IN OVERALL COST OF MAINTENANCE IN AGING LOCOMOTIVES.

JUDICIOUS MAINTENANCE INFLUENCES ALL OF THE ABOVE THROUGH:

1. Preventive Progressive Maintenance
2. Control Of Costs
3. Improved Reliability
4. Assigned Maintenance Points
    a. Scheduling Work Loads
    b. Responsibility For Failures Can Be Placed At Assigned Maintenance Points
    c. Material Availability By Inventory Control
    d. Quality Control
    e. Proper Tooling Of Proper Facilities
    f. Training Of Employees
    g. Failure Reduction

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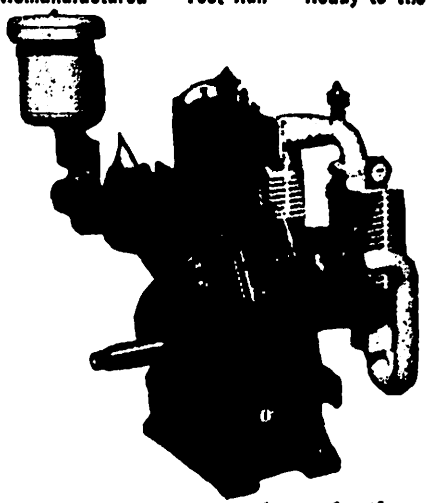

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Scheduling Wheel and Truck Overhaul

In general there are two methods used by railroads in scheduling wheel renewal and truck overhaul. One is to keep the wheel change and truck overhaul on a separate schedule. Each is governed by condition. Wheels are changed when they reach condemning limits. Trucks are overhauled when condition warrants. The second method is to overhaul the trucks in conjunction with wheel changeout when the majority of wheels require changing. Some railroads find it economical to changeout two pairs of wheels for thin rims if the remaining wheels in the trucks are 1-3/8 in. or thicker in order to extend the length of truck overhaul cycle.

In the second method, the matter of scheduling wheel changeout and truck overhaul is guided by the wheel wear and allows maximum life out of the wheels. This means that wheels are run to almost the condemning rim thickness of 1 in. before unit is routed to truck overhaul shop. The flow of units to the truck shop is regulated by monitoring the rim thickness of every unit after it reaches 1-1/4 in. as noted on wheel report form made out at time of monthly inspection. Units with 1 in. thick rims can be used in yard service and shopped for truck change as scheduled by the wheel shop. It is the option of the truck shop to give the unit a wheel change or a spot wheel replacement depending on the need for secondhand replacement wheels.

Monitoring all units with 1-1/4 in. or less rim thickness gives about a 4-month lead time to the wheel shop for scheduling units for wheel changeout and truck overhaul. The long-range wheel forecast can be derived from a master list showing mileage since last wheel change and the average wheel service life (mileage) for each group of locomotives. Based on the average wheel service life (mileage) for each group, a budget for wheel replacements can be projected for a year in advance.

When trucks are overhauled in conjunction with wheel change, the traction motors are inspected and qualified for another period of service and truck components are renewed depending on the service life left in the component. Pins and bushings and pedestal liners will usually go two periods of service. Gear cases must be cleaned, checked, repaired and resealed every wheel change, along with the journal roller bearings. The traction motor support bearing must be cleaned and qualified, and in most cases can be reapplied for several periods of service providing the flange thickness or lining does not condemn the bearing. Traction motor gearing is checked, and gears not meeting builders' profile specifications are reprofiled or scrapped if beyond reclamation limits.

When considering locomotive availability, the best procedure to follow when trucks require overhaul is to have a unit set of overhauled trucks available before scheduling the unit into the truck shop for wheel changeout.

When changing out individual wheel assemblies and trucks, replacement wheels should be matched within specified limits with wheels on locomotive.

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In service, locomotives may give wheel slip indications and experience unloading if operated with wheel diameter variations greater than manufacturers' recommendations.

Mismatched wheel size diameters within a truck, or between trucks of same unit, result in unequal axle loading, poor locomotive performance, and resultant component failure.

When peeling a pair of wheels or replacing less than a full truck set of wheels, it is often inconvenient to limit wheel size variations to 3/4 in. on diameter for a 2-axle truck and 1/2 in. on diameter for 3- and 4-axle trucks, although this is the preferred practice. Some railroads peel wheels to keep wheel diameters within certain limits. This is a waste of wheel service life. An alternate shimming method which allows wheel size variations within a truck, up to the maximum allowable locomotive limits of 1-1/4 in. diameter variation, is permissible.

To maintain safe operation, optimum adhesion and tractive effort levels, it is important to maintain equal loading between axles. Load equalization can be accomplished by shimming between the journal spring seat and the journal box to compensate for wheel size difference. The shimming procedure is useless unless correct and qualified springs are in use. The locomotive builders have available different shims ranging in thickness from 1/8 in. to 1-1/4 in. Refer to builders' instructions for complete shimming procedure.

Premature Wear on Truck Components

A number of railroads have reported premature wear and cracking of Nylatron pedestal liners. Many railroads report obtaining one wheel change service life per set of pedestal liners. There is suspect of possible cold ambient temperature influence on cracking. A number of railroads have changed from round washers to flat plate under Huck bolts for fastening; some railroads have gone back to use of bolts. In order to obtain satisfactory service life from composition or steel pedestal liners, it is very important for the mating pedestal jaw surfaces to be straight, and space between the jaws within original manufacturing tolerance. Pedestal surfaces wear predominantly at top and bottom of the journal box. Worn surfaces should be built up and milled to standard dimensions.

Understand that there are a limited number of units equipped with test floating-type pedestal liners supported on the pedestal tie bar and molded composition-type pedestal liner from a different manufacturer. We do not have any information on performance or service life of either item at this time.

V—PROGRESS REPORT

Piston Reclamation (GE)

Basic reclamation instructions are covered in GEK-18150 for cast iron piston and GEK-29567E for steel crown piston. General Electric has seen no demand for more extensive reclamation procedures (ring grooves for example) for the cast iron piston. There have been several inquiries pertaining to the steel crown piston. The pistons in question showed ring groove wear slightly beyond General Electric's condemning limits. Three alternates are under consideration:

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1. Open up the ring groove to accept oversize rings. This method must be qualified to assure sufficient strength remains in the ring lands to avoid cracking. Laboratory tests are being run to resolve this question. The groove machining must be accomplished with high accuracy and groove finish.
2. Plating to return groove dimensions to original standards. This method is higher in cost and must be equated against replacing the steel crown with a new crown considering the probability of longer life from the new crown. Pistons have been plated and are being field evaluated.
3. Crown replacement. The General Electric steel crown piston was designed to permit salvage by replacing only the crown, if required, thus avoiding complete piston replacement cost. The crown must be separated from the skirt for proper cleaning of cavity after any cleaning, blasting or machining operation.

Recommendations will be made when alternate evaluations are completed.

Experience indicates piston life can be adversely affected by ingestion of unfiltered air or very low cooling system water temperatures. Therefore, by assuring proper engine air filtration and cooling system performance, original piston life will be extended.

Exhaust Silencers (GE)

General Electric has applied exhaust silencers to one group of 35 locomotives. While a welding modification to change from spot to continuous weld in the fabrication was required, no operating problems have developed. Performance is continuing to be tracked.

Exhaust Silencers (EMD)

Turbo Engine Locomotive Exhaust Silencer: EMD is evaluating the performance of an EMD design turbo engine locomotive exhaust silencer on a total of five railroads—Amtrak, Burlington-Northern, Chicago & Northwestern, Denver & Rio Grande Western and NWSTD. The largest number of these silencers are applied to the Amtrak locomotives which were put in field service in June, 1973.

Roots Blown Engine Locomotive Exhaust Silencers: EMD is also evaluating the performance of an EMD design roots blown engine road locomotive exhaust spark arrester and silencer system on the Illinois Central Gulf Railroad. This field performance evaluation was initiated in December, 1974. In addition, development work is nearing completion at EMD on an EMD design roots blown engine road-switcher locomotive exhaust spark arrester and silencer system. Field performance evaluations are expected to be initiated during the latter part of 1976.

Research and development of locomotive engine exhaust silencer hardware has been continuing for many years. Design requirements for suitable exhaust silencer hardware along with spark emission control to meet the needs of current production locomotives are quite extensive. Structural stability, special considerations, effects upon engine performance, and, of course, noise reduction capability requirements, must all be met.

EMD's exhaust silencer development program has been based solely

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Lube Oil Consumption – Slightly higher with wear streaked liner operation but not abnormal.

Pentane Insolubles–Slightly higher rate of increase with wear streaked liner operation. Operation of several streaked liners in a 16-cylinder engine would not result in premature oil change.

Viscosity–Rate of increase with wear streaked liner operation was greater.

Ring Condition–No ring distress was observed.

Alkilinity–There was no effect due to wear streaked liner operation.

Cylinder Compression–No change from start to finish of test.

These tests of very abnormally worn tufftrided liners support the view by General Electric that this liner has exceptional advantages over the chromium-plated liner. Similar operation with chromium-plated liners could well have resulted in a seized piston and possible additional engine damage.

Investigation resulted in the conclusion that this type of wear is caused by abrasive dirt build-up on the piston above the top compression ring. This dirt enters the engine because of improperly applied secondary engine air filters or intake manifold leaks.

Tests are now under way to evaluate operation of an engine with .010 in. oversize liners, and to date no problems have been noted.

Scored Liners (EMD)

The following tabulation submitted by EMD shows the status of original equipment L-2 compared to L-3 power assembly scoring in EMD turbocharged engines through December 31, 1975:

EMD TURBOCHARGED ENGINES
POWER ASSEMBLY SCORING
ORIGINAL EQUIPMENT
DECEMBER 31, 1975

Railroad	1972 L-2 Liners % Scored 24 Months	1974 & 1975 L-3 Liner % Scored 1-24 Months
A	73.7	4.0
B	45.0	2.7
C	30.7	0.5
D	18.7	0.4
E	9.7	0.8
All Others	1.7	0.4
TOTAL	17.4	0.8

Lube Oil Filters (23 Micron) (EMD)

During the past few years much activity has been evident among filter manufacturers to find a lube oil filter comparable or superior to the current pleated paper filter recommended for use with EMD engines. None of the filters thus far submitted to EMD for evaluation meet EMD engineering standards relative to efficiency.

Engine Air Filters (EMD)

Currently EMD has two types of approved engine air filters for road locomotives, the American Air Filter fiberglass baggie filter and the pleated Farr and Donaldson paper filter. The paper filter has been available since 1968, and the fiberglass filter since 1972. Based on EMD evaluations, both types of filters offer comparable protection in terms of engine power assembly wear life and turbocharger performance.

During the past two years, both pleated paper filter manufacturers have developed and released an improved service life paper filter. With the use of these new filters, most railroads should be approaching a twelve-gines load box tested. A summary listing of load box temperatures from 73 engines was provided by one railroad covering the period January 1 to October 2, 1975. The engines were divided as follows:

Locomotive Model	Engine Model	Number of Engines
GP30, 35	16-567D3	35
SD40	16-645E3	6
SD45, F45		
FP45	20-645E3	19
SD45-2	20-645E3	13
	TOTAL	73

The investigation has been completed with the following findings:

The load test data submitted by the railroad do not support the statements that claim the 20-cylinder engine operates with lube oil temperatures 40°F. higher than 16-cylinder engines.

Further, comments to the effect that 20-cylinder engines tested operate routinely with 240°F. oil temperatures cannot be confirmed with the data supplied for analysis. The data do indicate the following:

(1) Not a single engine reached an oil temperature of 240°F. or higher.

(2) Only two of the 32 total 20-cylinder engines exceeded 230° F. oil outlet temperature.

(3) Over 50 percent of the 20-cylinder engines operated at 220°F. or less.

The following Tables I and II of railroad data illustrate the above findings.

The data submitted by the railroad presented an opportunity to evaluate lube oil cooler performance on several locomotive models. The following Performance Curves I and II indicate normal performance indicative of good railroad maintenance practices.

It has been shown, using railroad data, that 240°F. oil temperatures are not routinely observed; furthermore the 20-cylinder engine does not operate with 40°F. hotter oil than 16-cylinder engines. Let us now pursue oil temperature differences between 16- and 20-cylinder engines further.

The tabulated results presented earlier suggest that the 20-cylinder engine runs perhaps 15°F. hotter oil in and out temperatures when compared to a 16-567D3 engine at the same ambient temperature. Specifically let us again review the GP35 to the SD45-2 using the earlier data:

It is very important to recognize that at this range of ambient temperature not all cooling fans are operating on both locomotive models, and therefore relative temperature levels are being controlled by cooling fan temperature switch settings. In this

Locomotive Model	Avg. Ambient Temp. °F.	Avg. Water Inlet Temp.	Avg. Oil Inlet Temp.	Avg. Oil Outlet T[illegible]

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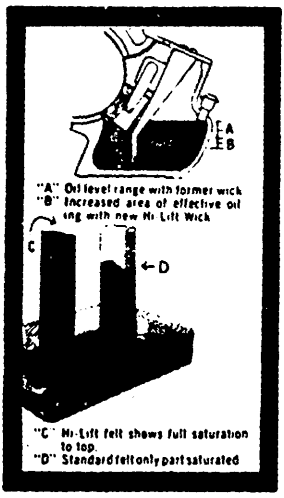

How Miller Hi-Lift Wick Lubricators cut maintenance costs

Here's a locomotive traction motor lubricator that offers 40% greater oil lift and doubled oil capacity. *Upper* picture shows increased oiling efficiency provided by Miller *Hi-Lift* wick lubricator. *Lower* picture illustrates simple test that proves greater oil-lifting ability of *Hi-Lift* felt. *Hi-Lift* felt segment ("C") is completely saturated to top with oil. Standard felt ("D") has unsaturated, white area at top. Both are same size and were placed in tray before oil was added. Details available from your locomotive builder or write direct to:

MILLER FELPAX, CORP.
Winona, Minn., Ph. 507, 452-2461

TABLE I

SUMMARY OF WATER AND OIL TEMPERATURES

JANUARY 1 THROUGH OCTOBER 2, 1975)

LOCOMOTIVE MODEL AND NUMBER OF UNITS	ENGINE MODEL	AVG. AMBIENT TEMP. °F	AVG. WATER INLET TEMP. °F	AVG. OIL INLET TEMP. °F	AVG. OIL OUTLET TEMP. °F
GP30 (11 UNITS)	16-567D3	74.3	169	187	206
GP35 (24 UNITS)	16-567D3	64.5	160	181	202
SD40 (6 UNITS)	16-645E3	62.3	174	190	212
SD45, F45, FP45 (19 UNITS)	20-645E3	68.4	175	197	220
SD45-2 (13 UNITS)	20-645E3	64.7	173	196	218

TABLE II

SUMMARY OF ACTUAL RECORDED OIL OUTLET TEMPERATURES

LOCOMOTIVE TYPE	GP30	GP35	SD40	SD45	SD45-2
ENGINE TYPE	16-567D3	16-567D3A	16-645E3	20-645E3	20-645E3
	OIL OUTLET TEMPERATURE				
HIGHEST TEMP. OBSERVED	232	217	220	235	227
	217	214	220	235	226
	216	214	215	230	225
	210	214	214	228	225
	207	208	207	226	224
	206	206	195	225	220
	204	205		222	220
	202	205		222	219
	193	204		220	218
	192	204		220	210
	190	202		220	208
		202		218	208
		200		214	205
		200		214	
		200		214	
		200		212	
		200		212	
		200		211	
		196		206	
		196			
		195			
		195			
		190			
LOWEST TEMP. OBSERVED		190			
	206°F AVG.	202°F AVG.	212°F AVG.	220°F AVG.	218°F AVG.

...fiberglass and paper filters also are available on most recently released locomotive models, the MP15, MP15AC and GP15-1. Because of the large space requirement for these applications, these filters cannot be retrofitted without carbody modifications to the older SW1500 and SW1001 models. However, a new paper filter application, incorporating a round element, is currently being field tested by EMD on a limited number of railroads, and upon successful completion, will be available for retrofit on these older models. This paper filter application is interchangeable with the panel oil-bath filter system with no change required to the carbody structure.

Engine Fluid Temperatures (EMD)

On several occasions during the past two years, railroad personnel have expressed their belief that the EMD 20-cylinder engine runs hotter than a 16-cylinder engine and consequently is, as a result, more susceptible to power assembly scoring.

Of particular concern to EMD have been the public statements made at the last two LMOA meetings in which the 20-cylinder engine was accused as operating with significantly higher oil temperatures. For example, the following are excerpts of statements taken from the LMOA official proceedings:

"On this lube oil problem, we load test many engines at high ambients. It is very hot. In the 20-cylinder 645E3 engine the lube oil will get around 240°F. On the 16-

"With the SD45-2, a 20-cylinder 645E3 engine, it is not uncommon to have lube oil temperatures at 240°F. We could have damage to the engine at 240° to 250° temperature."

"We have taken no exception to the oil cooler and most of these engines (I will say all of them) run at 240°F. when they are load tested."

"Generally speaking, a 645E3 engine will run at 240°F."

"I believe the water inlet temperature is around 180°F."

Certainly statements of this nature in the presence of the railroading community, EMD's customers, are of concern to all parties. Whereas EMD felt the 20-cylinder engine did not operate with significantly higher oil temperatures compared to a 16, we were anxious to explore the matter to determine if somehow high lube oil temperatures were a result of deterioration of cooling with service life. This situation would demand the immediate cooperative efforts of the railroads to resolve. Of primary concern to EMD is that a level of understanding be reached between the LMOA membership and EMD regarding 16- and 20-cylinder engine oil temperatures.

Accordingly, EMD has promised the LMOA that the subject of 20-cylinder engine oil temperatures be thoroughly investigated. EMD requested that load box data sheets be submitted for analysis covering a representative sample of 16- and 20-cylinder engines load box tested. A summary listing of load box temperatures from 73 engines was provided by one railroad covering the period January 1 to October 2, 1975. The engines were divided as follows:

Locomotive Model	Engine Model	Number of Engines
GP30, 35	16-567D3	35
SD40	16-645E3	6
SD45, F45 FP45	20-645E3	19
SD45-2	20-645E3	13
	TOTAL	73

The investigation has been completed with the following findings:

The load test data submitted by the railroad do not support the statements that claim the 20-cylinder engine operates with lube oil temperatures 40°F. higher than 16-cylinder engines.

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(3) Over 50 percent of the 20-cylinder engines operated at 220°F. or less.

The following Tables I and II of railroad data illustrate the above findings.

The data submitted by the railroad presented an opportunity to evaluate lube oil cooler performance on several locomotive models. The following performance Curves I and II indicate normal performance indicative of good railroad maintenance practices.

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The tabulated results presented earlier suggest that the 20-cylinder engine runs perhaps 15°F. hotter oil in and out temperatures when compared to a 16-567D3 engine at the same ambient temperature. Specifically let us again review the GP35 to the SD45-2 using the earlier data:

It is very important to recognize that at this range of ambient temperature not all cooling fans are operating on both locomotive models, and therefore relative temperature levels are being controlled by cooling fan temperature switch settings. In this

Locomotive Model	Avg. Ambient Temp. °F.	Avg. Water Inlet Temp. °F.	Avg. Oil Inlet Temp. °F.	Avg. Oil Outlet Temp. °F.
GP35 (24 Units)	64.5	160	181	202
SD45-2 (13 Units)	64.7	173	196	218

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LOCOMOTIVE MODEL AND NUMBER OF UNITS	ENGINE MODEL	AVG. AMBIENT TEMP. °F	AVG. WATER INLET TEMP. °F	AVG. OIL INLET TEMP. °F	AVG. OIL OUTLET TEMP. °F
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SD45-2 (13 UNITS)	20-645E3	64.7	173	196	218

TABLE II

SUMMARY OF ACTUAL RECORDED OIL OUTLET TEMPERATURES

LOCOMOTIVE TYPE	GP30	GP35	SD40	SD45	SD45-2
ENGINE TYPE	16-567D3	16-567D3A	16-645E3	20-645E3	20-645E3
		OIL OUTLET TEMPERATURE			
HIGHEST TEMP. OBSERVED	232	217	220	235	227
↑	217	214	220	235	226
	216	214	215	230	225
	210	214	214	228	225
	207	208	207	226	224
	206	206	195	225	220
	204	205		222	220
	202	205		222	219
	193	204		220	218
	192	204		220	210
	190	202		220	208
		202		218	208
		200		214	205
		200		214	
		200		214	
		200		212	
		200		212	
		200		211	
		196		206	
		196			
		195			
↓		195			
LOWEST TEMP. OBSERVED		190			
		190			
	206°F AVG.	202°F AVG.	212°F AVG.	220°F AVG.	218°F AVG.

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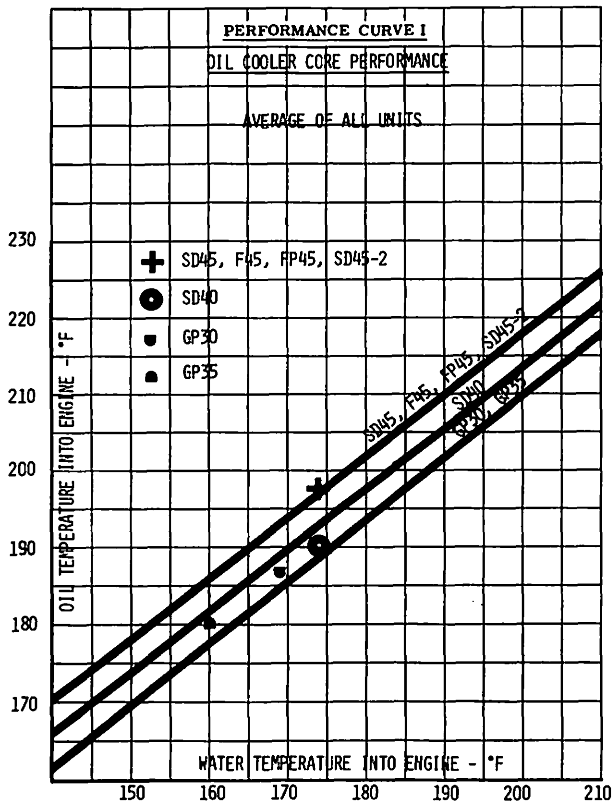
PERFORMANCE CURVE I
OIL COOLER CORE PERFORMANCE
AVERAGE OF ALL UNITS
SD45, F45, FP45, SD45-2
SD40
GP30
GP35
SD45, F45, FP45, SD45-2
SD40
GP30, GP35
OIL TEMPERATURE INTO ENGINE - °F
WATER TEMPERATURE INTO ENGINE - °F
230
220
210
200
190
180
170
150
160
170
180
190
200
210

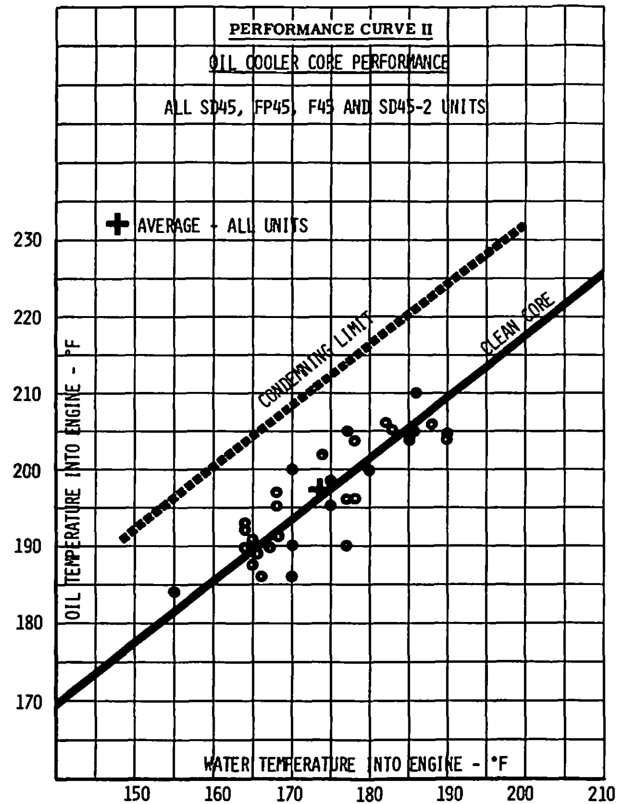
PERFORMANCE CURVE II
OIL COOLER CORE PERFORMANCE
ALL SD45, FP45, F45 AND SD45-2 UNITS
AVERAGE - ALL UNITS
CONDEMNING LIMIT
CLEAN CORE
OIL TEMPERATURE INTO ENGINE - °F
WATER TEMPERATURE INTO ENGINE - °F
230
220
210
200
190
180
170
150
160
170
180
190
200
210

TABLE 3

COMPARISON OF ACTUAL AND PROJECTED
LUBE OIL TEMPERATURES UNDER CONDITIONS OF
MAXIMUM COOLING SYSTEM REQUIREMENTS
(ALL COOLING FANS OPERATING)

LOCOMOTIVE MODEL	UNIT	DATE OF TEST	AMBIENT TEMP. °F	WATER INLET TEMP. °F	OIL INLET TEMP. °F	OIL OUTLET TEMP. °F
SD45	A-1	6/9/75	88	165	188	212
			115	196	215	238
SD45	A-2	9/5/75	95	175	198	218
			115	198	216	239
SD45-2	A-3	8/29/75	74	155	184	205
			115	202	219	242
SD45-2	A-4	8/7/75	85	168	197	219
			115	203	220	243
AVERAGE MAXIMUM CONDITIONS			115	200	218	241

TABLE 3
-continued-

LOCOMOTIVE MODEL	UNIT	DATE OF TEST	AMBIENT TEMP. °F	WATER INLET TEMP. °F	OIL INLET TEMP. °F	OIL OUTLET TEMP. °F
GP30	B-1	8/1/75	104	192	207	232
			115	205	214	236
GP30	B-2	7/22/75	102	175	185	190
	THESE LOCOMOTIVE DATA NOT INCLUDED					
GP30	B-3	8/26/75	89	170	192	206
			115	200	210	232
GP30	B-4	6/6/75	90	168	188	210
			115	197	207	229
GP35	C-1	7/15/75	95	183	201	217
			115	206	215	237
GP35	C-2	8/29/75	84	165	179	205
			115	201	210	232
GP35	C-3	6/20/75	77	155	175	200
			115	199	209	231
GP35	C-4	8/29/75	77	155	175	200
			115	199	209	231
GP35	C-5	2/5/75	61	140	166	190
			115	202	211	233
AVERAGE MAXIMUM CONDITIONS			115	201	211	233

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respect, the GP35 temperature switch settings are lower than later 645 engine model locomotives.

If maximum oil temperatures are of concern, then what is really important is to compare these engine models under the conditions of maximum engine cooling requirements; i.e., all cooling fans operating. To do this, we must examine the railroad data compared to EMD cooling fan performance curves for each locomotive model to determine which units were operating with all fans in operation during load tests.

In the following Table 3, selected 16- and 20-cylinder engines were chosen on the basis of having all cooling fans in operation during load tests. Then, utilizing the actual railroad load box data, maximum engine water and oil temperatures were predicted under a maximum ambient condition of 115°F. A review of these tables illustrates that, under this most demanding engine cooling requirement, the 20-cylinder engine will operate at 218°F. oil inlet temperature compared to 211°F. for the 16-567 engine—only 7°F. higher. Considering oil outlet temperatures, the difference is 8°F.

Summary

EMD has reviewed the operating temperatures of a considerable number of 16- and 20-cylinder engines load-box tested by the railroad. The data have been analyzed by EMD in the most objective manner possible searching for support of railroad personnel beliefs listed earlier in this report regarding 20-cylinder engine oil temperatures. Unless data exist which were not made available to EMD, we were unable to find this support. We can further add that the estimated fluid temperatures under maximum cooling requirements were essentially identical to our design criteria for both 16- and 20-cylinder engines.

VI—STORAGE OF DIESEL LOCOMOTIVES—SHORT TERM

With resultant decreases in traffic resulting from the recession—beginning fourth quarter, 1974, through 1975 and into the first quarter of 1976—railroads found it necessary to place locomotives in storage.

In general, these instructions apply to locomotives to be stored for short term—a period of over three months up to one year. The atmospheric conditions where locomotives are to be stored affect the type of protection needed for stored locomotives. For purposes of this instruction we will assume inclement weather areas.

Placing Units Into Storage

1. The location where units are to be stored should be convenient to plant preparing units for storage. Sufficient track space should be available to handle the total number of units to be stored with adequate switcher service. Choose a location with mild, dry ambient conditions, if possible.
2. It is advisable to complete scheduled maintenance on units that have been in service before storage preparations are made. Units must not be cannibalized during the storage period.
3. Send samples of engine oil and air compressor oil to the laboratory with notation that engine is being prepared for storage. If

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Vortacool* VR770

LOCOMOTIVE CAB REFRIGERATOR

The VR770 offers the following advantages:

- LOW MAINTENANCE—No moving parts, 100% air operated.
- LARGE CAPACITY—Holds 30 half pint cartons or two gallons with enough room remaining for lunch bags.
- TOP LOADING—No door latches required, low thermal loss.
- EASY TO CLEAN—Drain valve provided.
- LOW COST.
- EASY TO INSTALL—Only an air line and exhaust line to install.
- 5 YEAR WARRANTY.

The Vortacool VR770 requires 12" by 18" of floor space and stands 39" high.

Available in custom green. Other colors available at slight additional cost.

VORTACOOL* VR770 IS THE WAY TO KEEP CREWS HAPPY AND COSTS DOWN.

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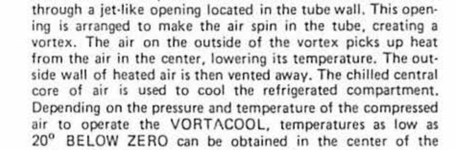
HOW VORTACOOL WORKS

A simple vortex tube does the cooling in VORTACOOL. It has no moving parts. It has no refrigerant to leak. It keeps working long after sophisticated mechanisms have failed.



This diagram shows how temperature is reduced in the VORTACOOL. Air under pressure is admitted into the vortex tube through a jet-like opening located in the tube wall. This opening is arranged to make the air spin in the tube, creating a vortex. The air on the outside of the vortex picks up heat from the air in the center, lowering its temperature. The outside wall of heated air is then vented away. The chilled central core of air is used to cool the refrigerated compartment. Depending on the pressure and temperature of the compressed air to operate the VORTACOOL, temperatures as low as 20° BELOW ZERO can be obtained in the center of the vortex. The temperature of the containerized water in the refrigerator is held to a standard 50° by a snap-action temperature actuated valve. Aside from this thermostat, all that moves in the VORTACOOL is air and water. ABSOLUTELY NO ELECTRICAL POWER IS REQUIRED.

CLEVELAND TECHNICAL CENTER, INC.

Telephone (216) 451-6455 13600 Deise Avenue, Cleveland, Ohio 44110 samples do not show any free water, do not drain the oil regardless of sodium or boron content. If samples show indication of free water, the oil must be drained, filters must be changed and crankcase wiped out. Correct water leak. Fill drained systems with fresh oil.

4. Drain cooling system and recharge with proper concentration film forming inhibitor. This concentration will provide ample protection for the largest cooling systems. Run engine long enough to bring up to operating temperature above 180°F., then idle for at least 30 minutes and drain cooling system. Replace all plugs and pressure caps.
5. Fuel System
   a. Drain water from bottom of fuel tank. Fill fuel tank to capacity adding proper concentration organic fuel soluble biocide before filling tank.
   b. Before draining cooling system, disconnect fuel oil suction line at fuel pump. Apply hose connection to fuel oil suction line and extend open end of hose into a container filled with a mixture of 50 percent high-grade No. 10 lube oil and 50 percent diesel fuel oil.
   c. Start engine and idle for 5 to 10 minutes or until blue smoke appears in the exhaust to assure complete filling of the fuel system with this special storage oil.
   d. On EMD units, during running period, energize and deenergize continuously the ORS magnet in the governor so as to cycle the load regulator, thus flushing the vane motor internally. On Baldwin units, manually lift engine governor pilot valve.
   e. Replace fuel oil suction line.
   f. Coat exposed control racks of fuel injection pumps with vaseline.
6. Clean out all engine and generator sumps. Be sure sump drains are open.
7. Cover all exhaust stacks, cooling fans and air intake openings with Grade A crepe paper and pressure sensitive tape. All cooling fan shutters must be in closed position.
8. Open all circuit breakers and switches, including main battery switch.
9. Insure that batteries are fully charged and free of grounds. Disconnect main positive and negative battery leads and protect terminals with vaseline or equivalent. Battery electrolyte must be at full level and gravity or electrolyte should be 1220, minimum specific gravity.
10. Drain all air reservoirs, dirt collectors, air lines, air filters. Close drain cocks, all MU hose cut-out cocks and brake pipe angle cock. Apply dummy hose couplings.
11. Loosen Vee-belt idler sheave.
12. Open all engine cocks.
13. Drain and clean water cooler, cover well.
14. Drain toilet and water tank. Clean toilet.

15. Remove trainline jumper cables and store.
16. Remove radio unit and store.
17. Pull or raise all brushes.
18. Place tag on battery switch showing date unit prepared for storage.
19. Close all doors, windows and ventilators and lock cab doors. Protect unit from trespassers, pilferage, fire and run-away.
20. Set hand brake and chock wheel on each unit.

Care of Units While in Storage

1. Move locomotive at least once each three months a sufficient distance to lubricate journal box and axle bearings (one rail length).
2. Once each 30 days, test specific gravity of batteries, and recharge if necessary.
3. Once each two weeks, inspect locomotive for vandalism, open doors, windows, etc., and see that all covers are still in place.

Taking Units Out of Storage

1. Remove all covers on exhaust stacks, cooling fans and air intake openings.
2. Fill cooling system, adding water with proper inhibitor.
3. Drain oil and change filters.
4. Pre-lube diesel engine and manually bar engine over one full revolution (EMD), two full revolutions (GE, Alco, Baldwin), with cylinder test cocks loose.
5. Reconnect battery terminals.
6. Reinstall all brushes.
7. Close only breakers and knife switches required for starting, and remove storage tag.
8. Press and release starting button or switch a couple of times before going into full cranking.
9. After the engine is started, close all other breakers.
10. Wait until engine has reached normal operating temperature before moving locomotive on its own power or raising throttle.
11. Perform an intermediate inspection.
12. After engine is running, check for leaks and make necessary repairs.
13. Drain water from bottom of fuel tank.
14. Drain and clean support bearing reservoirs.
15. Adjust all drive belts.
16. Make air test.
17. Make sequence test.
18. Check cab card, make scheduled FRA inspection, be sure to show out-of-service time.
19. Load test unit if inspection reveals deterioration.

Railroads interested in long term storage of diesel locomotives (over one year) should consult builders' procedures for storing locomotives. The builders' instructions for preparing units for storage apply to locomotives to be stored an indefinite period exceeding several months and in inclement weather areas. Consult representative of builder for copy of instructions and answers to any questions on this subject.

ST. LOUIS RAILWAY CLUB

ROBERT J. KEMPER
PRESIDENT
Asst. Chief Engineer
Missouri Pacific Railroad
St. Louis, Missouri 63103

A Pre-Convention Presentation was made to our regular meeting in St. Louis, Missouri on April 8 by Mr. B. A. Cumbea, Manager Locomotive Data Systems & Procedures, Chessie System and his Committee on New Developments.

The members of this club sincerely thank Mr. Cumbea, the members of his committee, and the LMOA for the excellent program and the work that they are doing for advancements within the Railroad Industry.

For full information on membership in the St. Louis Railway Club and schedule of meetings, write to our Secretary.

D. J. FAULKNER
Secretary
P. O. Box 818
St. Louis, Mo. 63188

Monday, September 27, 1976

2:00 P.M.

REPORT OF THE COMMITTEE ON NEW DEVELOPMENTS

Pre-Convention Presentation: St. Louis Railway Club

April 8, 1976 Stouffer's Riverfront Inn St. Louis, Missouri

B. A. CUMBEA, Chairman
Manager Locomotive Data Systems
and Procedures
Chessie System
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1976 TOPIC:

"PROJECTIONS IN NEW DEVELOPMENTS; MANAGEMENT AND PROCEDURES"

PERSONAL HISTORY— B. A. "BUD" CUMBEA

Born in Richmond, Va., on December 27, 1924. He attended public schools in Virginia and West Virginia and graduated from Purdue University in 1948, receiving a Degree of Bachelor of Science in Mechanical Engineering.

Bud started his railroad career when he joined the C&O as a Special Apprentice. He subsequently held positions as Assistant Diesel Engineer, Diesel Maintenance Inspector and Supervisor - Diesels. In 1966 he was made Supervisor Production and Statistical Control for the C&O-B&O and is now Manager Locomotive Data Systems and Procedures for the Chessie System.

Bud married the former Ruth Burkholder and they have two sons, Michael, born April 28, 1960, and John, born August 27, 1962.

He has been an active member of the Administrative Management Association and has authored papers for the ASME/IEEE and the AAR Data Systems Division.

PROJECTIONS IN NEW DEVELOPMENTS, MANAGEMENT & PROCEDURES

I. INTRODUCTION

The New Developments Committee has the unique opportunity of developing very broad and diversified topics. This paper is divided into five major, yet totally different sections.

The first section deals with exchange of information related to locomotive maintenance between railroads. With the growing interchange of power and run-through agreements, there is a recognizable need for an owning road to obtain information relative to work performed on a locomotive while off-line.

The second section deals with computerized locomotive information systems and the potential usefulness of output data by those directly concerned with maintenance of power.

The third section covers management training systems. The need to offer a new and progressive training to all levels of personnel has long been recognized. The approaches currently being used offer real evidence that management is doing more than ever before to cope with the growing need for imparting skills and know-how to both line and staff supervision.

The fourth section deals specifically with some of the new developments in locomotive maintenance practices, materials and designs. For the locomotive maintenance officer to perform effectively, he must keep abreast of improved methods, better materials and design changes developed by the locomotive builders, suppliers and the railroads themselves. The exchange of such information through both formal and informal discussions is the basic foundation of the LMOA and associated railway organizations.

The final section is devoted to the impending change to the metric system. Where the first four sections offer desired improvements in the ability to maintain power at an economic level, the conversion to the metric system, at least initially, appears to have an adverse effect.

II. DATA EXCHANGE SYSTEM

With the ever growing number of run-through and interchange agreements, there is a real need for the various participating roads to have the means to exchange data when work is performed on locomotives belonging to another road. To date, exchange of such information has been handled on an individual and somewhat haphazard basis.

In recommending a system for uniform exchange of data, it was immediately recognized that the reporting format should be simple and basic in nature, yet provide the various computerized and manual data systems in use with material considered essential for the maintenance of such systems. Simplicity is the key for the capture of maintenance both from a physical and economic viewpoint, i.e., line supervision who will be responsible for preparation of data will not have time to prepare a complicated document, nor will management support an expensive, time-consuming system.

To meet the needs for exchange of maintenance data, this committee recommends that a universal reporting system be adopted by the LMOA and submitted to top ranking Mechanical officers to be used as a part of run-through agreements. The primary document for a using road to report data to an owning road is shown in Figures 1 and 2. A general guide for preparing the Universal Locomotive Maintenance Data Document is as follows:

1. PURPOSE: This document is the source of data from foreign railroads to report work performed on a railroad's locomotives. It serves to update and maintain continuity of data on locomotives in computer data bases. While each railroad involved may or may not have a computerized locomotive maintenance system, this document can serve to update both computer and manual systems. Its intent is to provide a universal means of reporting maintenance history in a basic format that can be recognized by high-speed data processing equipment. Since the data captured by this form are generic to most existing locomotive maintenance systems it should be a straightforward matter for most data processing organizations to reformat these data to conform to their own requirements, i.e., file updates.

2. GENERAL: This Universal Reporting Document should be prepared whenever a locomotive of another ownership is placed in shop for any reason – FRA inspection, scheduled maintenance, running repair or accident damage.

3. HANDLING: Two copies of the report should be prepared whenever a foreign locomotive is shopped—an original and one copy. The original document should be mailed to owner road by U. S. Mail as promptly as possible after unit is released to service. The copy should be retained by repairing shop for a minimum of one month in order to allow owner road's data processing people time to process data through their system. Any errors can normally be corrected and resubmitted within this period. By retaining the copy along with other documentation on the shopping most errors in reporting can be rectified. All railroads involved in run-through operation and the resulting maintenance of others' motive power, should arrange among themselves where the data to be exchanged should be sent.

CARD TYPE (1-2)

LMOA-100

UNIVERSAL LOCOMOTIVE MAINTENANCE DATA SYSTEM REPORTING DOCUMENT

OWNING ROAD	LOCOMOTIVE NUMBER	REPAIRING ROAD	SHOP LOCATION	STATE	DATE IN MO. DAY YR.	DATE OUT MO. DAY YR.
(3-6)	(7-11)	(12-15)	(16-30)	(31-32)	(33-38)	(39-44)

HRS. IN SHOP	REASON IN SHOP: FRA	SCH.MTC.	RUN. RPR.	ACC.DAM.
(45-47)	(48)	S (49)	R (50)	A (51)

If FRA inspection performed, indicate type; M, Q, S, A or B. Attach Blue Card and Air Card if applicable.

CODE	POSITIONS ENG.	POSITIONS NO.	POSITIONS R-L	CHANGED/ REPAIRED	NEW S/H	SERIAL NUMBER APPLIED	REMARKS
(52-54)	(55)	(56-57)	(58)	(59)	(60)	(61-70)	

ADDITIONAL COMMENTS:

SEE REVERSE SIDE FOR CODES

SIGNATURE TITLE

COMPONENT CODES

MECHANICAL LOCO. GENL.

001 BELL
002 HORN
003 TOILET
004 WATER COOLER
005 CAB SEATS
006 CAB GLASS
007 CAB FLOOR
008 CAB DOORS
009 CARBODY DOORS
010 MISCL. CAR BODY
011 SPEED RECORDER
012 SANDER SYSTEM
013 COUPLER
014 DRAFT GEAR
015 SHUTTERS
016 HAND BRAKE
017 FUEL TANK
018 LOCO. MISCL.

DIESEL ENGINE

020 ENGINE GENL.
021 ENGINE PROTECTOR
022 LAYSHAFT
023 CYLINDER HEAD
024 CYLINDER ASSEMBLY
025 CRANKSHAFT
026 CAMSHAFT
027 MAIN BEARINGS - LOWER
028 MAIN BEARINGS - UPPER
029 GOVERNOR
030 LOAD REGULATOR
031 ENGINE BLOWER
*032 TURBOCHARGER
033 TURBO AFTERCOOLER
034 STACK GASKETS
035 GEAR TRAIN - ACC. END
036 GEAR TRAIN - FREE END
037 AUXILIARY GEN. DRIVE
038 IMPACT INSPECTION
039 AIR BOX COVER
040 CRANKCASE COVER
041 OVERSPEED TRIP
042 GOVERNOR DRIVE ASBY.

FUEL SYSTEM

050 FUEL PUMP
051 FUEL FILTERS
052 FUEL LINES
053 FUEL INJECTORS
054 INJECTOR FUEL PUMP
055 FUEL SYSTEM MISCL.

LUBE OIL SYSTEM

060 MAIN LUBE PUMP
061 SCAVENGING LUBE PUMP
062 TURBO LUBE PUMP
063 OIL FILTERS
064 OIL LINES
065 PISTON COOLING PIPE
066 LUBE OIL COOLER
067 OIL CHANGE
063 LUBE OIL SYSTEM MISCL.

COOLING WATER SYSTEM

070 WATER PUMP
071 RADIATOR
072 WATER JUMPER LINES
073 CAB HEATER & PIPING
074 COOLING WATER SYS. MISCL.

COMPRESSED AIR SYSTEM

080 AIR BRAKE SYSTEM
081 MAIN RESERVOIR SYSTEM
082 CONTROL AIR SYSTEM
083 AIR COMPRESSOR
084 MISCL.

AIR FILTRATION

090 AIR FILTERS - INERTIAL
091 AIR FILTERS - CAR BODY
092 AIR FILTERS - ENG. INTAKE
093 AIR FILTRATION MISCL.

TRUCK AND WHEELS

100 TRUCK GENL.
101 SPRING RIGGING
102 BRAKE RIGGING
103 WHEELS
104 WHEEL TRUING
105 JOURNAL BEARING
106 SUSPENSION BEARING
107 AXLE
108 PINION & RING GEAR
109 GEAR CASE
110 MISCL.

ELECTRICAL ROTATING EQUIPMENT

*200 MAIN GENERATOR
*201 TRACTION ALTERNATOR
*202 ALTERNATOR
203 AUXILIARY GENERATOR
*204 TRACTION MOTOR
205 TRAC. MO. BLOWER MO.
206 DYN. BRK. BLOWER MO.
207 FUEL PUMP MOTOR
208 COOLING FAN
209 TURBO PUMP MOTOR
210 INERTIAL FILTER MO.
211 STARTING MOTOR
212 EXCITER
213 AXLE ALTERNATOR
214 CAB HEATER MOTOR
215 CRANKCASE EXHAUSTER
216 HEADLIGHT MOTOR

OTHER EQUIPMENT & CIRCUITS

220 VOLTAGE REGULATOR
221 BATTERY
222 REVERSER
223 POWER CONTACTOR
224 GROUND RELAY
225 WHEEL SLIP RELAY
226 TRANSITION RELAY
227 MISCL. RELAYS
228 MISCL. CONTACTORS
229 INTERLOCKS
230 TRAIN CONTROL
231 LIGHTING CIRCUIT
232 POWER CIRCUIT
233 CONTROL CIRCUIT
234 THERMOSTATS
235 AIR COMPR. CONTROL
236 RADIO
237 MISCL. ELECTRICAL

MISCL.

250 STEAM GENERATOR & SYS.
260 NOTHING FOUND WRONG

* REQUIRES SERIAL NUMBER OF APPLIED COMPONENT TO BE RECORDED.

Some roads may require documents to be sent directly to their computer center, while others may require these data to be mailed to the chief mechanical officer. Each road involved should define its requirements to all concerned or responsible for reporting.

The necessary details for preparation of the proposed form are as follows (see Figs. 1 and 2).

GUIDE FOR PREPARING UNIVERSAL LOCOMOTIVE MAINTENANCE DATA SYSTEM REPORTING DOCUMENT

(Form Detail)

1. OWNING ROAD – Reporting initials of locomotive being worked on, e.g., ATSF, SP, ICG. Fill in boxes starting from *left*.

2. LOCOMOTIVE NUMBER – Fill in locomotive's road number starting from *right*-most box leaving boxes to the left blank, e.g., ... 6 0 3.

3. REPAIRING ROAD–Show railroad performing inspection and/or running repair work filling in boxes from *left*, e.g., CR, CNW, NW.

4. SHOP LOCATION–Fill in railroad shop location performing work on foreign locomotive. Begin in *left* box using only the first 15 characters of the shop (location) name.

5. STATE–Use two alpha character abbreviation, e.g., Illinois–IL.

6. DATE IN–Use numeric representation of month, day and year locomotive enters shop, e.g., August 8, 1976–08 08 76. Note: Fill in leading blanks with zeroes.

7. DATE OUT–Use numeric representation of month, day and year locomotive is released from shop and is ready to go back to service (entered as in No. 6).

8. HRS. IN SHOP–Report total number of hours foreign locomotive held in shop. Fill in boxes from right and zero fill boxes on left, e.g., 52 hours in shop–0 5 2.

9. REASON IN SHOP–FRA, Sch. Mtc., Run. Rpr., Acc. Dam. Circle or indicate reason locomotive was shopped. *More than one box may be circled.*

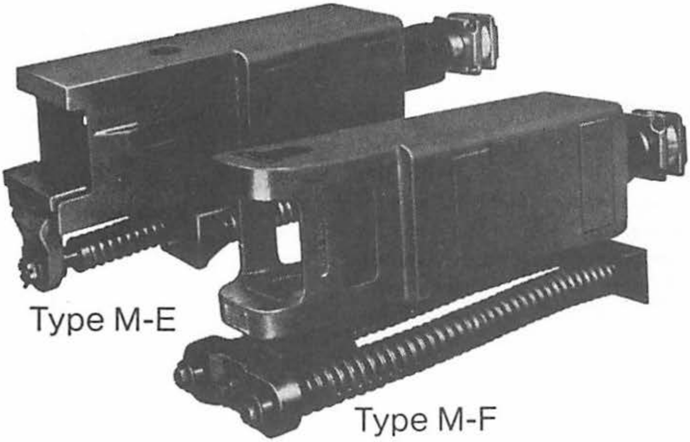
A. FRA–Federal Railroad Administration inspection performed. Fill in type of inspection made, i.e., M–Monthly (30-Day), Q–Quarterly, S–Semi-annual, A–Annual, B–Biennial. Attach FRA Blue Card and railroad Air Card (if applicable) to this document.

B. Sch. Mtc.–Scheduled Maintenance. Circle "S" if some scheduled maintenance work was performed at this shopping, e.g., filter changed, traction motor brushes, etc.

C. **Run Rpr.** – Running Repair. Circle "R" if some running repair work was performed at this shopping, e.g., power assembly change, check for grounds, etc.

D. Acc. Dam.–Accident Damage. Circle "A" if some accident damage repair work was performed at this shopping, e.g., grab irons, pilot, brake rigging, etc.

10. DETAIL SECTION. This area describes the running repair and/or scheduled maintenance work performed on locomotive, showing component by code, which engine (if more than one), position or unit,



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right or left on unit, changed or repaired, applied new or secondhand (reclaimed) component, serial number of component applied (only on certain components) and, under "Remarks" why the component failed and any other relative data.

A. **Code**—Show item that failed by code. All codes used with this document may be found on reverse side of form. Use only one code for each component repaired or changed, e.g., if more than one injector use code 053 on separate lines for as many injectors involved. If code cannot be found leave code field blank and describe component in "Remarks" field.

B. **Positions**

1. **Eng.**—Engine. If locomotive has more than one diesel engine show which engine component relates to, e.g., water pump on No. 2 engine show "2." If unit has only one engine show "1" or leave this field blank.
2. **No.**—Number. If there is more than one component of the same type on locomotive show position number of component worked upon, e.g., number 14 power assembly with broken piston, put *14* in this field. Fill in boxes from *right* and zero fill, e.g., No. 1 cooling fan show *01*. (For purposes of identification, the cab end of locomotive should be considered the front end. In this case, No. 1 cooling fan would be first fan in back of cab.) If there is only one component on locomotive, say, turbocharger, leave this field blank. If *all* positions for this component, say, lower main bearings were changed, show *00* in this field.
3. **R-L**—Right or Left. If there is more than one component on locomotive and it is normally identified as being a right or left component put "R" *or* "L" in this box. Example—water pump on EMD locomotives. If component is identified by both position number and right or left, say, wheels use both fields to identify component, e.g., R-3 wheels; show *03 R*.

C. **Changed/Repaired.** If component was completely changed and replaced with either a new or secondhand (reclaimed) component put a "C" in this box. If component was repaired (although a sub-component may have been completely changed, e.g., brush holder in traction motor), but not changed, show "R" in this box. If component was neither changed or repaired, but merely inspected due to reported trouble, e.g., ground relay action and traction motor was inspected but nothing found wrong, leave this box blank. In a case of nothing being found wrong use both component code of component inspected as well as code 260—Nothing found wrong. Put code 260 immediately under line of inspected component.

D. New S/H—New or Secondhand (reclaimed). If component was completely changed (a "C" in box 59) show class of material applied to replace component changed out. Use "N" for completely new component or "S" for a reclaimed component. If component applied has both new and reclaimed sub-components, e.g., new piston and rings in reclaimed liner with reclaimed head, treat as being entirely secondhand and use "S".

E. Serial Number Applied—Transcribe manufacturer's serial number of component applied. Only major components need to have serial numbers reported. Major components requiring serial numbers are indicated on attached component codes list (Fig. 2).

F. Remarks—Give brief description of why component failed. Example—fuel pump motor grounded; "Fuel pump Mo. grounded." This section can also be used for any other relevant information, e.g., "Unit hit truck on train #61 at Central City, Ky." More than one line may be used if necessary.

11. COMPLETING REPORT. Additional comments regarding the locomotive's shopping or general condition may be entered at bottom of report. Supervisor in charge of work performed on locomotive should sign and document that all work performed was correctly reported on form. This source document and copy of Blue Card and copy of Air Card (if FRA inspection was performed) should be mailed to home road as promptly as possible.

While this reporting recommendation provides a basic and simple means for exchanging minimal data, other areas should be explored and resolved before formulating a final LMOA-approved system. For example:

1. Serial Numbers—The system is designed to pick up serial numbers on any component, but how extensively should serial numbers be reported?

2. Component Type and Manufacturer—As with serial numbers, should the component type and manufacturer be indicated? (Example—D77 traction motor from Chandeysson.)

3. Owning and Reporting Road—Should specific codes be recommended or can it be assumed that existing initials (SP, SSW, BN, ICG) will be acceptable?

4. Procedure for mailing document to home road—This is covered under 3. Handling. Are there other alternatives?

5. Stocking Forms—Will each road be responsible for the reproduction and stocking of forms or should there be centralized printing and stocking?

6. Miles off line—Many roads now have a provision for reporting mileage made by foreign locomotives. Should the methods now used be continued or should a universal document for reporting such mileage be included as part of this proposal?

III. LOCOMOTIVE INFORMATION SYSTEMS

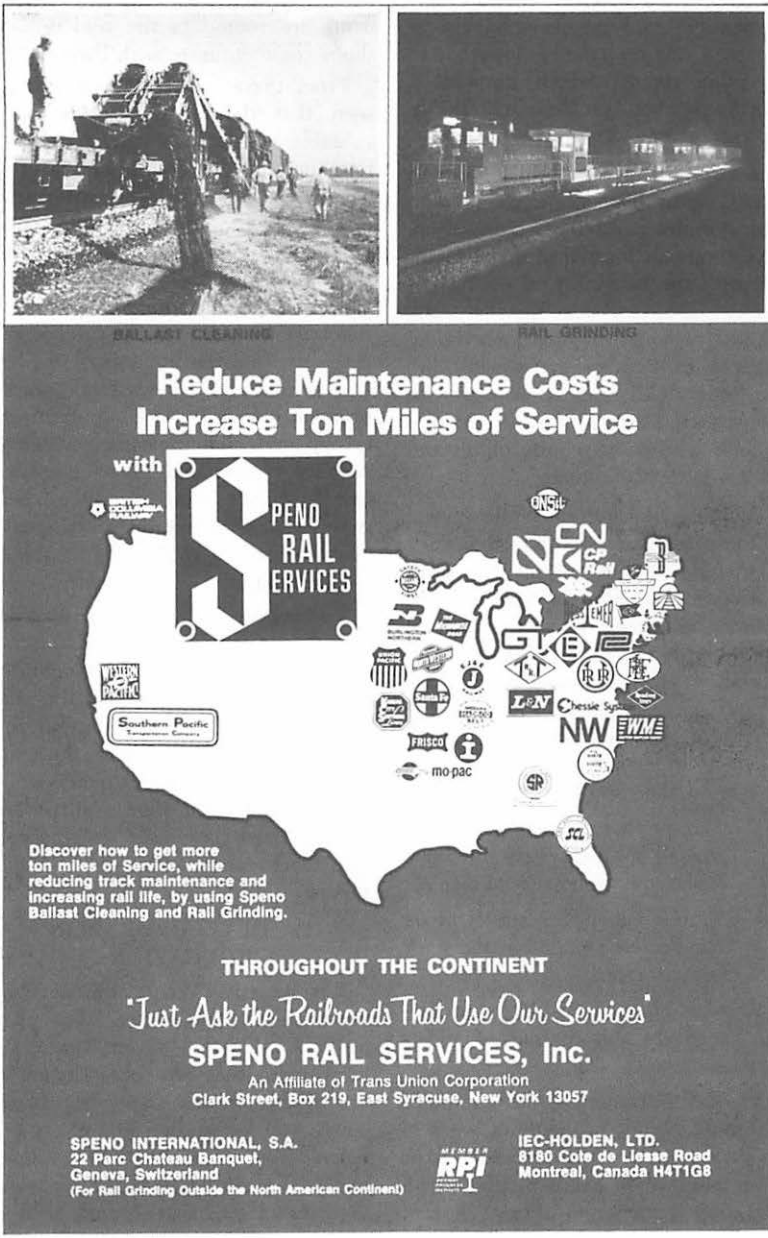
Computerized locomotive information systems have been in use for more than a decade. Most of the earlier systems were developed to provide analytical data for headquarters staff personnel. Revisions to these earlier systems as well as those more recently developed have indicated that the computer can be and is being used as a decisive tool for those directly responsible for maintenance of power. Properly programmed reports can be made available to field line supervision through mailing regularly scheduled output runs directly from the computer center or through providing terminal equipment in the field which can "talk" to the master computer. The terminal equipment obviously offers a means for making information available much closer to real time; however, it adds a great deal of expense to the total systems, expense that may prove difficult to justify.

A number of railroads that have computerized information systems were canvassed to determine what types of output reports are being made available to various shop and line personnel. Rather than illustrate specific reports, these can be grouped into five general categories.

1. **Scheduling**—Virtually every road canvassed uses the computer for scheduling to some degree. Most supply FRA inspection due dates. Others provide scheduled dates for heavier maintenance requirements such as main bearing renewal dates, major component overhaul dates, i.e., engine, air compressor, main generator, etc., and, in some cases, traction motors scheduled for mileage overhaul or attention. So that shop managers can properly plan their daily production activity, such information must be made available on a timely basis.

2. **Projects**—It is frequently necessary to perform modifications on a series or class of locomotives as a result of recommendations from the locomotive builders, legislative action or internal design improvement. Computers are used extensively to monitor progress of such projects. Output reports being made available to line personnel include reports showing the complete status of such projects; reports showing units yet to be modified or already modified, and, on one line, reports listing individual units with modifications assigned but not reported complete. This type of reporting to the field can also be a valuable asset to supervision not only for planning productivity but also for determining in advance the requirements for special materials.

3. **Laboratory Reports**—The second most widely reported use of the computer to supply data to field personnel is in laboratory oil and cooling water control. One road has an automated spectrograph tied into a mini-computer located at one of its major shop facilities. An oil sample is obtained from each unit crossing the servicing facility. The sample is checked for free water, fuel oil and dirt, then burned spectrographically. The results of all tests are automatically fed into the mini-computer where they are compared with the results of the last five samples from that unit and any exceptions are printed out. All this takes place before the locomotive has completed its servicing cycle; thus, any further check indicated as necessary can be made before the locomotive is returned to service. Other reports sent to the field range from a complete history of laboratory results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for each locomotive from which trends in metallic build-up, changing viscosity, etc., can be readily detected, to exception reports which pinpoint a specific potential problem and specify the recommended corrective action.

4. Unit History—Inquiry reports of recent repair history are common in most systems, particularly those which have terminals located at major facilities with the capability of asking the master computer for specific data. Output reports include scheduling dates (FRA and major overhaul) and the last 5 to 15 reported defects with the corrective action taken. Some also include laboratory reports of oil and cooling water conditions.

5. Material Control—While several of the roads canvassed had indicators of material shortages and lost locomotive availability due to material delays, only one reported having a Mechanical department system designed to control inventories. This system was designed to control the supply of repairable components and uses the following basic information to control the supply:

a. The number of each component needed in the system for each replacement shop (pool size).

b. Number of each component on hand to be repaired at the component shop.

c. Man hours available by department in the component repair shop.

With this information, the computer generates a daily schedule of work to be performed at the component repair shop based upon needs of the system and consistent with efficient use of men and materials. Repaired components are routed to the replacement shops commensurate with their needs.

From these generalities, it can be seen that the computer can be a valuable tool for providing timely information to shop personnel. Unfortunately, many of those who were responsible for development of computerized systems (including Mechanical department staff personnel) could not foresee all of the needs of shop supervision. Many existing needs can be met within the framework of present systems with minor design and/or program changes. As computer technology and communication networks advance, more and more emphasis can be placed on supplying field supervision with information that will enable them to fulfill their assigned responsibilities.

To keep the industry abreast of developments and improved techniques, it is recommended that this committee become a clearinghouse for the submission of proposed new output format considered desirable for the management of locomotive maintenance. The committee can then evaluate and massage such proposals and incorporate their recommendations in future reports.

IV. DEVELOPMENT IN EDUCATION

Let us ask — What new developments in education have taken place on your railroad in recent years? We must admit that our first reaction to this question was somewhat blank. Then we remembered the vividly colored cutaways illustrating cross-sectional views of all the components in a diesel engine—the ones seen in manufacturers' classes. We remembered excellent audio-visual productions, with the type of illustrations that excite the eyes and open the mind. Then another reflection on the past brought us face to face with the black and white boldness of an apprentice workbook. Why hadn't this modernization taken place on railroads?

But we were enlightened to find an excellent program well under way. In fact, this program began in 1907 when a master mechanic realized the need for formal training among apprentices. He purchased drawing equipment and hired an instructor with his own money to fill this need. It is this kind of backbone that has made educational programs on railroads some of the finest in industry today.

It is hoped this personal reaction will give an insight into the basis of this committee's recommendations for the development of educational programs which, as an end result, will reduce maintenance costs. The primary ingredient in education, we feel, is communication. Most important is communication between the staff which writes the maintenance procedures and the staff responsible for the education of employees who will enhance and direct maintenance on the "front line."

The rate of change in railroading today establishes the requirement that this communication become clearer and faster than ever. Change is the key word. Changes in personnel and changes in maintenance procedures are taking place continually. Today changes in personnel are taking place at a faster rate due to changes in retirement age limits and the necessary force adjustments resulting from changes in business. Changes in maintenance procedures seem to be controlled by failure modes and purchases of new power. It is most important that an employee be properly educated to accept a new position; and it is most important that changes in maintenance procedures be transferred to the front line staff with minimal time lag.

1. Tools of Education

The method of transferring knowledge can take various forms, ranging from a slap across the wrists with the old rule to floating it in under hypnosis. However, one of the more successful ways is through the use of audio-visual equipment.

Audio-visual equipment has been used for many years. It is by no means a new development in education; however, it can be used to keep education developing.

Video tape, a fairly recent development, is a very effective means for transferring knowledge. Processing the tape can be handled during recording, thus making sequence editing a fast and relatively easy task. This equipment is also known for its excellent sound quality. Video tape equipment is rather expensive and due to its relative lack of portability is usually confined to education centers.

Slide projection equipment is also used quite extensively as an educational tool on railroads. Rear projection cabinet type slide projectors synchronized to a tape cassette which provides sound and an electronic picture change pulse have been quite successful in communicating educational information. This type of equipment is relatively inexpensive. Its compactness and good image quality even in unfavorable lighting make it very effective in field education. Its capability for training small groups or individual study also makes it very useful in an apprentice classroom, where training students at various levels is a basic requirement. This medium is very adaptable to presenting supplemental material which helps students retain important facts.

Both types of audi-visual equipment discussed are effective. The best situation would be to use both types for communication of knowledge; however, it may be necessary to choose between the two, depending on a railroad's particular needs and budget.

Whatever type is used, one must remember that this equipment is only a tool and is no better than what is put into it.

The following photos have been selected from slide shows to illustrate increments of programs possible for education in locomotive maintenance.

2. Management Training Systems

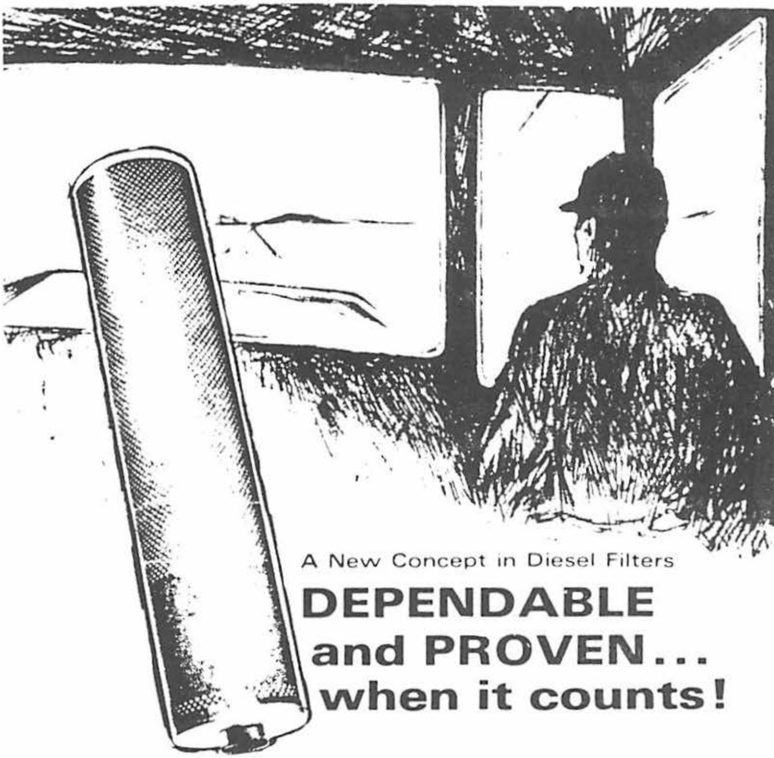
In recent years many railroads have realized the need for constructing formal management training systems within their own organization, systems which would attract new blood, preferably people with graduate mechanical, electrical or industrial engineering degrees. At the same time these systems must be open and meaningful to talented employees who have gained their knowledge through practical experience. It appears these training systems have evolved from the special apprenticeship programs. They are geared to meet the growing demands placed upon management today, demands created by an increasingly competitive transportation environment.

The induction of individuals into management training programs prior to graduation from college is ideal. This allows an individual to take a close look at life on the railroad, to "get his hands dirty," and to let it pass if he so desires. Recruiting individuals into summer work and co-op programs has, in many cases, been effective in selecting candidates for management training programs.

Initially, in the program an individual is based at a central location on the railroad. From this point, he will travel to points all over the system, working short terms in various departments. This allows the person to learn how the railroad works as a system and most important, meet the people who run the system.

He will have the opportunity to express his particular talents and learn where he may best fit, once he is placed in a more permanent position. At the same time, management can view his capabilities to determine where he can do the best job for the railroad. On the average, he will spend approximately a year on this phase of the program, and at the end of this period, formally lose the title of "trainee."

The program is supplemented with various courses dealing with railroad-related subjects, such as: (1) manufacturers' air brake school; (2) locomo-



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tive manufacturers' courses both electrical and mechanical; (3) locomotive simulator class to learn how to operate a locomotive; (4) operating rules class and (5) a supervisor management course covering (a) planning, (b) organization, (c) controlling, (d) standards and appraisals, (e) communication, (f) motivation, and (g) decision making.

During his term as a management trainee, he may spend a great percentage of his time in the Industrial Engineering departments at various shop locations. Some Industrial Engineering departments have been staffed with many trainees and also men who have worked into management from various line positions. This is a good interface point which transmits knowledge in both directions. In fact, the Industrial Engineering department is usually a good step toward educating a man for a more responsible line or staff management position.

The management trainee program actually continues for an individual as he steps up the ladder. His assignments are monitored to fit his particular interests and at the same time to give him a well-rounded ability to accept more responsible positions.

The question has been raised—what new developments in education have taken place on your railroad? In your search for the answer, remember to be proud of the good things you find; but don't forget to face the areas in need of improvement. Face them with the thought in mind that the human being is the best resource we have and there is no end to this resource's capabilities.

V. NEW DEVELOPMENTS

While it is recognized that there are many new materials and techniques being tried, tested and used in the railroad industry there is not sufficient space to discuss them all and this report is therefore addressed to the subjects which have generated more than normal discussion and attention.

1. Vibration Measurement As A Maintenance Tool

Vibration measurements, made periodically on a machine, that show changes in vibration levels can be used with proper analysis as an indication of mechanical deterioration and/or impending problems.

One such example of this is the program which was initiated several years ago to reduce the number of alternator bearing failures on the head end auxiliary diesel engine alternator set used to supply the electrical power for the commuter cars of a suburban fleet.

The instrument used is hand held with a remote pickup magnetically held against the alternator bearing housing. The meter is scaled to indicate average displacement in mils (thousandths of an inch) peak to peak.

To establish a base line vibratory level, it was necessary to first measure all 60 of these machines and the full no-load speed of 1800 RPM was selected as the fixed condition under which all machines could be reasonably measured. Initial readings varied from 1.0 to 7.8 mils displacement with the majority falling in a range of 1.0 to 2.5 mils.

On those machines with readings above 2.5 mils, it was found that misalignment, loose coupling and mounting bolts and worn couplings existed which affected the bearing life. The program is still in effect today with vibration measurements taken every 90 days and any machine with a reading in excess of 4.5 mils is subject to a check of alignment and all mounting and coupling bolts.

Another area where vibration testing is being used with reasonable success is the measurement of vibration levels of traction motor bearings after a shop basic overhaul, as a quality control check.

The motor is mounted on a test stand and operated at a constant speed of 1500 RPM, at which time vertical, horizontal and axial vibration readings are taken at the bearing housing. Readings in excess of 0.8 mils on any scale are cause for rejecting the motor for service and investigating for the cause. Excessive readings can indicate bearing wear, misalignment, misapplication of the bearing, mechanical looseness or unbalance of the armature. This type of vibration measurement program has been a big factor in reducing early bearing failures after a shop overhaul due to misapplication.

Vibration analysis as a maintenance tool for the diesel engine is not recommended by either EMD or GE as a practical shop maintenance tool. The initial studies showed that such a program was feasible but it was quite obvious that a considerable amount of time and money would be required to develop such a system into a practical working tool. Such a system also requires a dedicated facility operated by a select and complete staff under closely controlled conditions.

On locomotives that are manufactured by mass production techniques, the vibratory variations from unit to unit are greater than the vibratory changes expected on a single unit.

Vibration on a given unit can be acutely sensitive to very slight changes in engine speed and the operation of mechanical and electrical equipment. Diagnostic techniques require a baseline vibratory signature of each separate component under fixed operating conditions that will be accurately duplicated at subsequent measurements of vibratory signatures. In general, a relative comparison of several vibration signatures, taken over a period of time, is necessary to detect impending trouble and assist in pinpointing the possible cause. To this end it is necessary to keep a complete record of the vibratory signatures and all component changes that might affect the latest (benchmark) signature of a particular unit.

There is at the present time a vibration testing program for the diesel engine under evaluation and development.

The system used is a vibration spectrum analyzer with recorder. The first phase of the program was to test 75 units and develop initial base line spectral plots for:

A—Accessory drive
B—Main bearings 1-10
C—Turbo gear train
D—Turbo
E—Air compressor
F—Auxiliary generator
C—AR-10

In most cases both a vertical and a horizontal reading are taken.

Of the 75 units tested initially, 18 were shopped because of what was considered excessive readings when compared to other units.

Investigation into these 18 units disclosed one with a bent connecting rod, which would not normally have been detected until the next scheduled lead reading, or if it failed prior to that. Two units had air compressors misaligned and 15 units had auxiliary generators misaligned due primarily to broken mounting bolts and worn or loose coupling bolts.

From the initial data obtained, a preliminary overlay chart has been developed which indicates the component and the frequency level at which it would be operating.

The current phase of this program is:

A. Retest of all 75 units so as to obtain comparative data for evaluation.

B. Re-evaluate the number of test runs required.

C. Make comparative tests with a hand indicator which will greatly reduce the required test time.

D. Develop an overlay with indicated vibration level limits.

This program is aimed at developing vibration testing as a supplemental tool to the usual conventional methods of visual and audio inspection, lube oil analysis, air box inspection, lead readings and oil filter pressure drop.

It is hoped that a system can be developed to detect potential failures between the periods of normal major overhaul work and thus contribute to a more reliable diesel unit with greater availability.

2. **Lexan**

While Lexan has been with the industry for some time, there is as yet no widespread use for total locomotive glass application.

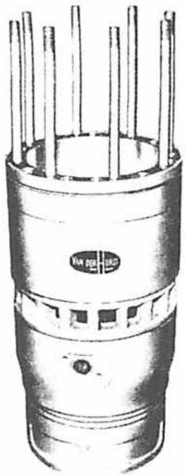
The so-called "halo" effect and the fact that it is easily scratched and clouded by chemical washing have more or less restricted its application to side windows only.

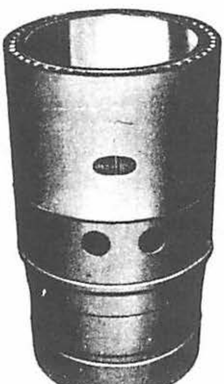
Lexgard, a newer product on the market, offers a possible alternative to the regular safety glass for windshields, particularly in those areas where legislation may require "impact resistant" glass for cab windows. Lexgard consists of a Lexan core and outer plies of strengthened glass bonded together with an interlayer. Because of the nature of this 5-ply composite, soap and water lubricants usually used to install window glass cannot be used. These materials could cause cracking, crazing, or other damage. In order to install Lexgard, General Electric strongly urges the use of its Silglaze construction compound as the most suitable lubricant and sealer.

The cost of Lexgard glass is approximately 3 to 4 times that of safety glass. It does, however, offer a safety factor not available in glass. These two factors must be considered in evaluating its application.

3. **Fuel Economy**

This is a subject that is probably universally thought about in the pres-





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ent times and here are some examples of what is being done to obtain fuel economies.

In the early 1970's, General Electric introduced the 1-5-8 speed schedule as the most economical method of meeting state and local emissions requirements. At the time, fuel was plentiful and relatively inexpensive. Therefore, the 2 percent increase in fuel consumption over the 1-8 speed schedule did not appear excessive as long as the ecology goals were met without requiring the railroads to undertake a major engine rebuild program. Measured by current fuel costs and availability, General Electric considers the 2 percent increase too high a penalty. Revised speed schedules are currently being developed which will do the following:

1. Meet existing state and local emission regulations.
2. Produce a negligible increase in fuel consumption.
3. Perform satisfactorily over the wide range of ambient and altitude conditions found on U. S. Railroads.

The new schedules will be applied to new production. Modification instructions will be provided to customers who wish to modify existing units.

EMD has been working on the performance aspects of the Model 645 engine line as related to ecology and economy for the past several years. A high economy version of the Model 645 turbocharged engine is now undergoing field testing on a few selected customer properties.

There are five basic engine design changes involved in achieving a 4 to 4½ percent increase in fuel economy. These are:

1. New turbocharger.

   The turbine wheel, the turbine blading, the diffuser design, and the nozzle area are different from those now used in the standard turbocharger. The new turbocharger alone contributes approximately 2.5 percent of the economy improvement.

2. A new injector.

   A new injector has been designed which utilizes a one-half inch diameter plunger and barrel assembly as compared to the .421 inch diameter assembly used in the current model injectors. The increased plunger size permits a more rapid fuel injection cycle, which improves combustion characteristics and increases the economy by approximately 0.7 percent.

3. New camshaft.

   A new higher strength camshaft has been designed to withstand the additional injection pressure developed by the larger injector plunger diameter.

4. Rocking piston pin assembly.

   The rocking piston pin assembly which has been under development and test for several years in the high output prototype engines will be installed in the economy engine.

5. Low idle.

   The economy engine will be idled at a lower RPM; this will result in an additional fuel economy varying from 0.5 to 1.6

percent, depending on the duty cycle of the particular engine involved.

6. EMD has recently re-evaluated the need to operate the engine at 5th notch during dynamic braking and is recommending a modification to reduce the engine speed to the 4th notch.

This modification is not recommended for railroads where sustained maximum dynamic braking above 65 mph is required for a period of 1½ hours.

Recently, some midwestern roads have been experimenting with reducing fuel consumption on unit train operations. On the loaded run, the assigned units are all required for acceptable train performance. On the empty run, excess power is available. The railroads are equipping their units with a special control circuit which allows one or more units to be held to notch 1 even though the throttle is advanced further. The units that are loading will therefore work at a higher throttle notch where the efficiency of the engine is greatest. The units that do not advance beyond first notch still are developing sufficient power that locomotive malfunctions can be detected.

This concept is also being extended to regular manifest trains where excess power may be available in one direction or up to a certain point of the run.

4. Positive Traction Control

A. Introduction. In the middle 1960's Canadian National experienced failures in traction motors due to excessive speed of rotation. The motor overspeed problem was traced to wheel slips which occurred at high speed and which were not successfully controlled by the existing wheel slip system. To overcome this problem, an electronic wheel slip system was developed by the Canadian National Technical Research Branch similar in concept to the ALDAC system used by ALCO and GE. While the system proved capable of controlling motor overspeed, the test results indicated that more tractive effort could also be obtained by better wheel slip control.

In line with the foregoing, a wheel slip correction circuit was developed making moderate reductions in the main generator excitation using relays in place of individual armature shunt resistors. The next step was to replace the relays by a solid state control. The third model of solid state control is today's Positive Traction Control system.

B. System Description. The Positive Traction Control consists of axle generators and three electronic panels, two of which form the slip correction system and the third protects the traction motors against a slipped pinion.

(1) The Positive Traction Panel provides the wheel slip detection. The frequencies from the axle generators are converted into wheel velocities and wheel acceleration signals. The logic sections then decide if a wheel slip exists based on absolute wheel acceleration, absolute wheel speed, and relative wheel speed. The slip correction signal generator then develops a slip correction signal tailored to the magnitude of the slip and the number of axles slipping. This slip correction signal is fed to the load control panel where the main alternator excitation is suitably reduced.

(2) **The Load Control Panel** controls the load on the engine based on the demand signal from the throttle and the wheel slip correction signal from the Positive Traction Panel. The Load Control Panel receives a load demand signal from the throttle. This signal passes through several protection interlocks which ensure that no limits, such as overvoltage, have been exceeded. Under non-slipping conditions, the load demand signal is passed to the load regulator at the slow loading rate and thence to the remainder of the excitation circuit.

When slipping occurs, the slip correction signal quickly reduces the effect of the power demand signal. When the slip disappears the power demand returns to the original level but the signal to the load regulator must increase at the slow loading rate.

(3) **The Pinion Slip Panel** uses current unbalance to detect defective motor circuits and slipped pinions. The current unbalance between motors will inherently increase with traction motor current due to slightly different motor speeds and resistance. For this reason, the magnitudes of the unbalance signals are compared to a main alternator current signal giving a more uniform detection sensitivity. At higher locomotive speeds, the sensitivity is changed to ensure good detection capability at these speeds.

When a current unbalance is detected, the excitation is reduced to zero by opening the main alternator field contactor and, at the same time, ringing the trainline alarm bell and lighting the wheel slip light. After the contactor recloses, the current builds up slightly (100 amps/motor) before the alarm cycle repeats.

(4) **Axle Generators** provide a frequency proportional to wheel velocity. They were chosen in preference to electrical signals since no non-linear relationships exist between frequency and speed. Good sensitivity is easily achieved at all normal speeds. A large number of cycles per revolution is required to enable the correction of a slip at its inception.

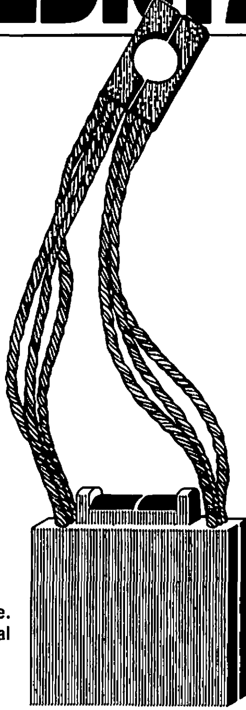
Backlash cannot be tolerated in the axle generator drive, hence a spring loaded connection is used on the drive.

The reliability of the PTC system is dependent on good axle generator signals. When a motor is cut out, the signal from that axle generator is ignored; this feature enables a unit with a defective axle generator to return home. Axle generator reliability has been good. Initially, axle generator drive shafts were lost when water penetrated and froze in the axle generator. A drain plug modification has ended that problem.

C. System Advantages. The main advantage of this wheel slip system is that it provides increased tractive effort compared to that provided by other systems; however, advantages also occur in maintenance using the PTC system. The main advantages are:

(1) Excellent synchronous slip protection preventing overspeed of traction motors.

PREDICTABILITY.



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(2) A reduced number of flashed motors since slip correction is effective at all speeds.

(3) Anticipated reduction in pinion tooth fatigue since PTC does not have to make such severe corrections as other systems.

(4) Less critical matching of wheel diameters as compared with other systems.

(5) Self-test panel for functional checking of the system while the locomotive is stationary.

(6) Reduced requirement for sand as indicated from field experience to date.

The approximate cost to equip a unit with Positive Traction Control is $10,000.00.

5. **Builders Improvements**

The locomotive builders continue in their efforts to improve locomotive maintainability and reliability.

General Electric has prepared a bulletin entitled "1975 Product Improvements." This bulletin lists some 60 items which were approved for production locomotives and indicated the anticipated improvement in locomotive availability and reliability as well as reduction in maintenance expense for each of the items. Space will not permit enumeration of these but needless to say, they do indicate a step in the right direction insofar as locomotive maintenance officers are concerned.

Likewise, EMD has many new development features which have been or will be incorporated in new production locomotives or which may be offered for retrofit. These too offer improved locomotive availability, reliability and reduced maintenance.

6. **Future**

What about future locomotive design? The following remarks have been offered by a former member of this committee and certainly merit inclusion in any discussion related to new developments.

There is a growing feeling that the use of caboose or cabin cars may disappear and that accommodations for the conductor may be provided on the locomotive. This potentially could add items requiring maintenance to the locomotive.

The future locomotive will have larger wheels, say 50 inches in diameter; this will provide better brake rigging clearances, permit larger, more powerful traction motors, increased wheel life, and improved riding qualities.

Draft gear pockets will be provided with hardened wear plates, easily replaceable, which will avoid the loss of time in welding up worn pockets as occurs at present.

Battery boxes will be relocated and redesigned so that the corrosive effects of battery fumes will not deteriorate framing and panels as at present. The completely sealed battery for locomotive work should soon be available.

By strengthening the collision posts in the front nose, opportunity exists to provide lifting eyes for wrecking derrick purposes.

The builders have made substantial improvements in recent designs on the location of radiators and cooling fans;

but, it is believed that a more resilient mounting of the radiators would add to their life. Some forward progress has been made also in the adoption of bi-metallic temperature control switches requiring no adjustment.

The main generator or alternator of one of the leading builders should be flange mounted and indexed to the engine, with a single coupling suitable for the harmonics involved, to avoid the time-consuming task in the shop of aligning the separate generator to the engine.

The locomotive diesel engine has reached a high state of efficiency, but it is hoped that it can be improved with respect to oil leaks in order to reduce cleaning costs.

It is well known that components that can be observed easily are generally well maintained. It appears that the electrical compartment could be arranged in a square "U" shape in plan, the open end toward the generator. This would permit the mounting of contactors and components on the outside faces and bring cabling and connections up on the inside faces for easy inspection, cleaning and repair.

The suggested improvements may increase the first cost of the locomotive slightly, but this expenditure would be quickly returned to the railroad in reduced maintenance and downtime and would help produce a "locomotive man's locomotive."

VI. METRIC SYSTEM EFFECT

The adoption of the metric system and its effect on U. S. industries have been studied and re-studied for years. The subject takes on new emphasis with President Ford's signing of Public Law 94-168. This law creates a broad representative U. S. Metric Board to coordinate, promote, and facilitate a voluntary conversion to the metric system.

The purpose of this discussion is to review some of the problems that will occur in the railroad industry with the conversion to the metric system. While they are not identical, the problems experienced by the suppliers and railroads have a great deal in common. Both are faced with conversion of drawings, re-education of personnel, conversion of tools and maintenance of inventory.

As an indication of how rapidly the metric system may appear on railroad equipment, it is worthwhile to review the current practices of the two principal locomotive suppliers.

EMD's position is to metricate when it is necessary or convenient. There will be no change to metric for the sake of change.

At this time few, if any, EMD drawings, end products, or components are produced with metric measurement. Consequently, technical service to the customer remains in the realm of conventional measurement.

The following practice has been instituted by EMD Service Publications:

1. Measurements in Service Publications translated into other languages are converted to metric by the translator.
2. Beginning with the 645E3A Engine Maintenance Manual dated September 1974, measurements in engine maintenance

manuals are double stated, with metric first, followed by conventional measurement enclosed by parentheses. This practice has since been followed in all new or revised engine maintenance manuals.

Note: Measurements involving a standard such as bolt size are not converted.

3. During the past year, measurements in maintenance instructions also have been double stated. This practice will continue in all new or newly revised maintenance instructions.
4. Double statement has not been initiated in operator's manuals, service manuals, or pointers.

General Electric's policy on conversion to metric units is quite similar to that followed by EMD. Conversion to the metric system is on a need and convenience basis. Drawings and publications that are common to domestic and export locomotives or used on export locomotives exclusively have values for both systems added at the time of modification or when new drawings and publications are prepared. This program started approximately three years ago and has resulted in a gradual conversion.

One thing that is definitely required with the introduction of the metric system is a world standard for units. This requirement is especially true where torque and pressure valves are involved. Some countries that are on the metric system use the metric equivalent of the English unit approach. In this case, pressure is expressed in a unit of weight per area. Others use a system where pressure is expressed as a unit of force per area. Similarly, torques are expressed in newton-meters or kilogram-meters. The newton-meter is a force X distance and the kilogram-meter is a unit of weight X distance.

As mentioned previously, the railroad and supplier problems are quite similar. The railroads will be faced with the conversion of metering devices, scales, and tools to the metric system. It is apparent that all tooling, including thread-cutting equipment and fixtures will eventually have to be replaced. The cost of these items suggests that most of the change will come as an existing item wears out and is replaced by metric. As an example, a set of dies ranging from ½" thru 4" for a pipe-threading machine costs about $425 in ordinary carbon steel. Considerable labor expense will also occur in shops changing over machines to produce a run of English parts or metric parts during the transitional period.

The mere changing of pressure gages to indicate metric units will not provide the complete solution. The dead weight testing equipment will also have to be reworked with regard to weight and marking.

Considerable work will be necessary in drawing offices in revising currently used drawings of equipment and roadway. This will lead to the complete replacement of gradient markers and mileposts along the line of road. Re-education of Mechanical department employees will be required on the limitless application of measurement to railroad work.

The railroads have one special problem which will not be shared, at least in magnitude, by the suppliers. As the railroads interface with a number of utilities and municipalities, they will have a coordination problem of considerable magnitude during the transition period. For example, the Chicago City Fire Department uses 7½ threads per inch on its fire apparatus and hydrants. The railroads conform to this standard in their yards and facilities. This means that a conversion program possibly using adapters will have to be made available in order that fire protection will be maintained during the changeover.

Once equipment is received to metric standards, the railroads will be required for a period of time to double stock their parts inventory. This naturally will add to the expense of storing and handling material.

From the short-range viewpoint, there will be considerable expense in converting to metric components while the benefits derived from the conversion to the metric system for railroads will be few. As long as industry is guided by the short-range view, the voluntary program will probably produce little more than dual marking of weights and measures. The conversion of tooling and other things that will require heavy capital investment will be deferred till such time as a mandatory cutover date is established.

Greater Kansas City Railway Club

A Pre-Convention Presentation was made at our regular meeting in Kansas City, Missouri on April 23 by Mr. E. R. Hafling, Assistant Mechanical Engineer, Atchison, Topeka & Santa Fe Railway, Topeka, Kansas and his committee on Shop Equipment. Their paper was entitled: "New Tools and Shop Equipment Concepts to Improve Diesel Maintenance."

The members of this club sincerely thank Mr. Hafling, the members of his committee, and LMOA for the excellent program.

For full information as to membership in the Greater Kansas City Railway Club, and schedule of meetings, write to our Secretary-Treasurer.

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Monday, September 27, 1976

3:30 P. M.

REPORT OF THE COMMITTEE ON SHOP EQUIPMENT

Pre-Convention Presentation: Greater Kansas City Railway Club

April 23, 1976 Arena Club Kansas City Missouri

E. R. HAFLING, Chairman
Assistant Mechanical Engineer
Atchison, Topeka & Santa Fe Railway
920 Jackson Street
Topeka, Kansas 66616

VICE CHAIRMAN

R. E. Clawson, General Foreman-Locomotive, Missouri Pacific Railroad, North Little Rock, Ark. 72114

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T. E. Whitten, Coordinator Research & Planning, Illinois Central Gulf Railroad, 1500 Kentucky Ave., Paducah, Ky. 42001

1976 TOPIC:
"NEW TOOLS AND SHOP EQUIPMENT CONCEPTS TO IMPROVE DIESEL MAINTENANCE"

PERSONAL HISTORY
Elmer R. Hafling

Elmer Hafling was born in Greeley, Colorado on November 2, 1921. He attended the Denver Public Schools and graduated from West Denver High School in 1940. He entered the University of Colorado, but his education was delayed by W. W. II.

Mr. Hafling served four years in the U. S. Navy and then returned to the University of Colorado and was graduated in 1949 with B. S. in Mechanical Engineering.

In June 1949, he indentured with the Santa Fe Railroad at Cleburne, Texas as a special apprentice; was promoted to an electrician at the Diesel Shops in Argentine, Kansas in 1952; was progressively promoted to Assistant to Diesel Supervisor at Chicago; Assistant Supervisor Diesel Engines at Fort Madison, Iowa and Winslow, Arizona; Fuel Rack Foreman, Electrical Foreman, Passenger Locomotive Foreman, and Truck Foreman at Argentine; Night Diesel Foreman, Emporia, Kansas; Assistant Engineer Shop Extension, Topeka, prior to his present position as Assistant Mechanical Engineer.

Mr. Hafling has been a member of LMOA since 1953; is a member of The American Society of Mechanical Engineers and the Kansas Engineering Society. He is active in his local church and local area resident home association.

He was married to Lona May Erich of Wichita, Kansas on March 18, 1947. They have two sons.

INTRODUCTION

It has been said that economic factors are the motivating force for progressive improvement. Improvements can be directed toward greater operating reliability and improved equipment service life, which are only accomplished by the use of better tools and machinery.

This committee is presenting some ideas and developments on Diesel maintenance and reclamation in the following areas:

I. Specialty Tools For Running Maintenance.

II. Guides or Gauges For Preventative Maintenance.

III. Progression System For Maintenance.

IV. Pollution Control in Diesel Maintenance.

V. Profitable Reclamation Practices.

I. SPECIALTY TOOLS FOR RUNNING MAINTENANCE

There are a number of specialty tools now available for maintaining component parts of locomotives. The use of these tools has become essential if proper maintenance schedules are to be kept and cost held to a minimum.

Both locomotive manufacturers maintain service catalogs that contain their approved mechanical and electrical special service tools. They, like the railroads, are always looking for new concepts and adaptations from the tool manufacturers.

A. Mechanical

The specialty tools that seem to advance most rapidly are new concepts in mechanical advantage wrenches, because they help to decrease down time, increase equipment reliability and service life.

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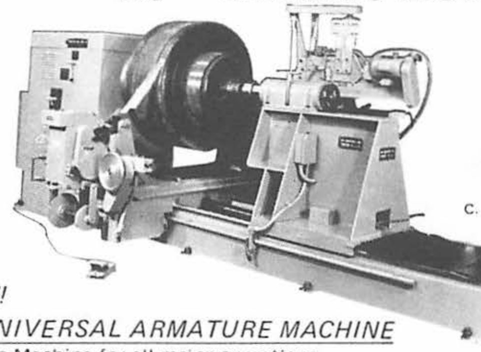

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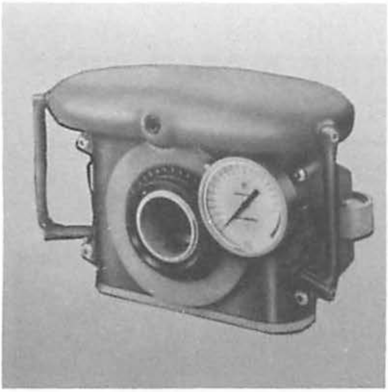
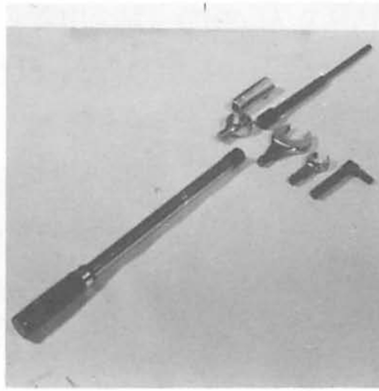
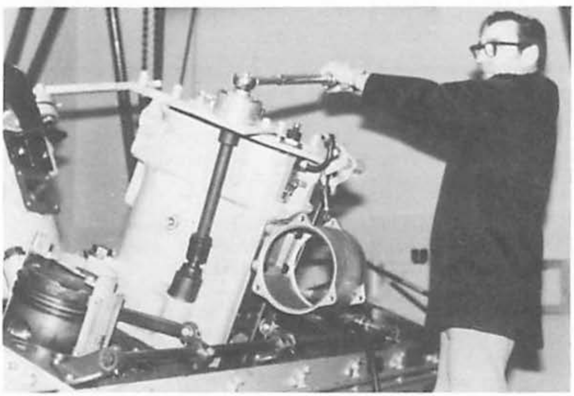
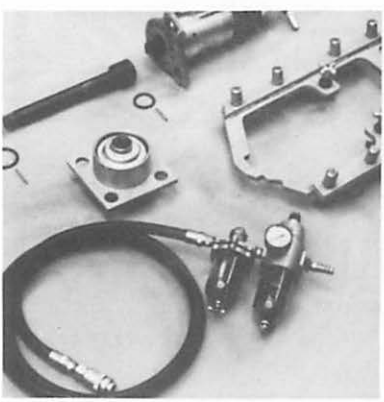








The newest example is a worm gear torque wrench made by Power-Dyne Torque Products.

This wrench is smaller and lighter than comparable torque multipliers and thus is easier to handle. This wrench applies a new concept in torque application and its principal operation may be explained as follows:

When a conventional wrench is applied to a nut-bolt combination, it not only applies torque, but it also produces side loads or reaction forces on the bolt such as bending moments, which create bending stresses in the bolt that add to the tensile stresses. This brings the bolt closer to the yield point without adding to the clamping force. This new wrench incorporates two worm gear drives that provide a better torque couple on the nut.

On the 0–2500 ft-lb torque wrench, the worm gear ratio is 1000 to 1. A man can generate 2500 ft-lbs of torque while applying only 11 lbs. of force to the input crank.

With a bar wrench, a man can only pull on the wrench if he is pushing against the machine or ground. If the wrench slips the man will fall down. This can be dangerous. With this new system, an adapter plate is used to couple the wrench loosely to the body of the machine on which the nut and bolt are being tightened. All necessary reaction forces are generated between the adapter and the body of the machine. The only force required of the operator is to generate the small torque required to turn the handle.

The heavy-duty multi-tooth ratchet mechanism located in the output spindle of the wrench allows the operator to reverse the output motion. The wrench can therefore be used either to tighten or loosen a nut or bolt.

The wrench contains a torque readout dial whose indications are obtained from a sealed hydraulic transducer. It also contains a protractor to measure degree of turn. The square bars used to couple the wrench to the bolt being tightened will twist or fail at torque levels below those required to damage the wrench, thus providing overload protection.

This torque multiplier is being tested for accuracy and repeatability by EMD. It has also been adapted by one railroad to torque crab nuts on the EMD 645 engine with the hope that it will reduce stripped threads and broken bolts.

In new tooling available for use in maintaining General Electric Locomotives, several important modifications have been made.

(1) Fuel Injection Equipment Tool Kit

All the wrenches necessary to change out fuel nozzles, high pressure lines or fuel injector pumps on GE engines are included in an improved tool kit. This new version features three major modifications. (1) The straight fuel-pump hold-down bolt wrench has the tip extended and the shank shortened; this overcomes the possible interface problem caused by occasional cylinder jacket casting variations. (2) A new right angle adapter which tightens the front mounting bolts for the fuel pump. This is used with the torque wrench handle. (3) A redesigned heavy duty open-end adapter head. This is used with the torque wrench handle to tighten large fuel line flare nuts.

(2) Impact Wrench Kit

An impact wrench with ultimate torque of 2600 ft-lb uses a No. 5 spline to connect to a 15 inch spline extension which in turn is connected to a 2 inch spline tapered socket. This is used in removing cylinder hold-down bolts. The tapered socket eliminates the need for a universal joint or ball joint. The use of this kit has greatly reduced the cylinder and head removal time down to 20 seconds per bolt.

(3) Torque Verifier

The torque kit for cylinder hold-down bolts is widely used by railroads with GE engines. This kit includes a highly accurate air operated wrench as the main component.

Verifying the accuracy of this wrench from time to time is recommended. This 5 to 1 multiplier is installed on the cylinder cradle in place of the air wrench, using the same socket and extension. With an accurately calibrated torque wrench, the tightness of the bolts can be verified.

(4) Engine Speed Measuring Kit

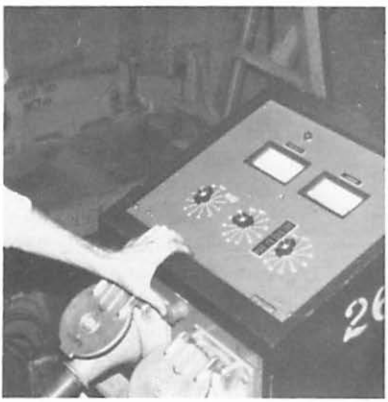
During load testing, while setting a governor on the locomotive, and at other times, accurate measurement of the engine speed is desired.

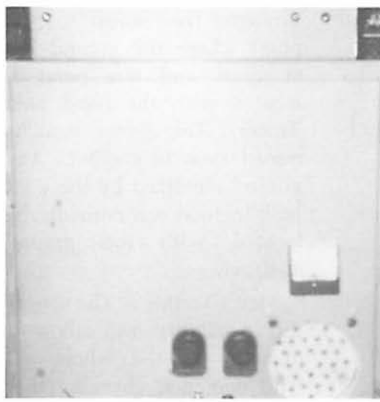
This engine speed measuring kit consists of a digital multimeter, frequency adapter and a pulse generator. This arrangement permits reading the engine speed digitally, with hands-off setup. The tachometer (pulse generator) is secured onto the tachometer drive fitting on the governor drive gear box. It is connected by a pair of wires to the frequency adapter which plugs directly into the digital meter. The latter pair can be set on the running board or any convenient spot.

B. Electrical

The members of the Shop committee have inaugurated the further investigation that involves the tools used in the electrical field of high potential testing – ground analysis-leakage testers, trainline jumper cable testers and voltage testers.

Most of these tools and instruments are in common usage in our shops and diesel houses. This will be an informative review of the products that are available today.






Simpson
260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DIGITAL MULTIMETER
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Test Equipment Available

1. Oregon Technical Products

   A. Ground Analyzer, Model 334 (Meg Tester and Ground Locator): A light, carry-aboard tester for locating grounds in locomotive wiring. In use, it is not necessary to disconnect wiring. When tracing a ground, the signal output leads are connected, one lead to the circuit that is grounded; the other lead to ground. The signal from the Ground Analyzer flows through the wires to the point where the ground has occurred and this point is located with the hand held Tracer. The signal can be traced even in conduit. Any ground identified by the light bulb method can normally be located with the ground analyzer.

      Meg Testing – The meg-test capability will allow a man to do the whole job with one tool, checking that a circuit is free from ground, as well as locating a ground if one is present. To check that a circuit is free of grounds, the test leads are connected as in tracing, one to the circuit, and one to the ground.

      Designed for either 115 v a-c or 74 v d-c, the Analyzer weighs approximately 25 lbs. Lower power, low current tracing minimizes operator hazard in ground locating.

   B. Leakage Tester, Model 329: A carry-aboard tester for evaluating the condition of insulation of locomotive wiring. Operating from the 74 volt battery, it provides up to 2200 v a-c for the high voltage system and up to 300 v d-c for the low voltage section. High voltage short circuit current is 5 ma and low voltage short circuit current is 100 ma. The tester is packaged in an aluminum case approximately 9" x 11" x 12" and weighs 20 lbs. The power cord and test leads are stored in a cover compartment.

   C. Trainline Jumper Cable Tester, Model 370: A shop tool for testing the electrical integrity of 27-pin jumper cables. This tester checks each wire for continuity and measures the leakage current from each wire to all other wires and to the connector shells. The operator manually rotates a 32-position switch and observes leakage and continuity currents at each step. Total time to test a jumper cable is approximately 5 minutes.

      Leakage is measured at 500 v d-c and continuity is 20 a. The readout consists of two easy-to-read numbers, one for continuity and one for leakage. A "short" indicator light is also provided.

      This bench-top tester is approximately 24 x 24 x 24 in. and weighs 150 lbs. Input

Non-stop engine protection

Soot, dust and moisture ruin locomotive engines. That's why you've got to make sure your engines get nothing but clean air. So *you're* protected from the risk of losing an engine.

And that's why Donaldson, the air filtration innovator, has introduced Slim Vee Pac®-2 locomotive engine air filters. This exclusive new paper filter delivers high-efficiency cleaning that outperforms all other types of filters.

Slim Vee Pac®-2 lasts up to 74% longer than any competitor's filter. Lasts up to a full year or more in most railroad environments, cutting maintenance costs nearly in half. Cutting costs even more in really severe environments.

Most important, Slim Vee Pac®-2 works non-stop. It won't fail even if servicing is past due. A unique feature that could save you an engine.

Why take chances on some other filter?

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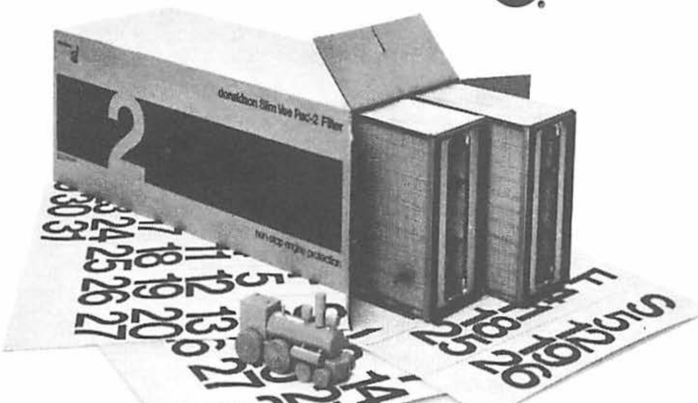

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Company

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power is 115 v a-c 60 Hz, and power consumption is approximately 300 watts.

2. **Power Parts Company**
   A. **Jumper Cable Tester:** This is an automatic jumper cable tester which completely tests a cable in 45 seconds. The operator only has to push one button to start the automatic cycle. The tester simultaneously checks the following:
      1. Proper wiring of cable
      2. Continuity of wires
      3. Shorted wires
      4. Grounds
      5. The above functions are performed while each wire is loaded to 15 amps.

      In order to check the tester for proper operation, a separate circuit is provided, which tests all functions. If there is a problem with the cable, the tester indicates the problem.

3. **Simpson Electric Company**
   A. **Analog Meters Compared With Digital Meters:** Analog meters, such as the Simpson 260 series are rugged, accurate, compact and easy-to-use instruments. They can be used to make accurate measurements of d-c and a-c voltage, direct current, resistance and decibels. In addition, an "Output" voltage function is provided for measuring the a-c component of mixed a-c and d-c voltages in amplifier and similar circuits. This meter contains an overload protection circuit to prevent the meter from being burned out. The batteries and fuse can be changed quickly by loosening the single screw of the compartment cover on the back of the case.

      These instruments are safe to use, but are capable of measuring voltages which are dangerous. Therefore, care must be exercised when measuring high voltage or current in high voltage circuits. For personal protection when making such measurements, turn off the power to the circuit under test, connect the test leads to the circuit and then apply power. After taking the reading, remove power from the test circuit before disconnecting the test leads. Be sure the voltage capability of the meter is not exceeded.

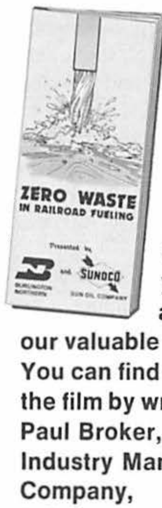
      The digital meters, such as the Simpson Model 464 Multimeter, eliminate human error on reading and interpolation of the scales. They are also more sensitive and more costly.

II. GUIDES OR GAUGES FOR PREVENTATIVE MAINTENANCE

There is an abundant supply of gauges, indicating lights, pressure switches, vacuum switches, telltale devices, etc., available as guides to indicate when maintenance personnel should change filters and devices or check out the locomotive systems needing attention.

WE WANT TO SHOW YOU HOW TO ELIMINATE WASTE IN FUELING

Ten million gallons! That's how much diesel fuel is used every day in this country to refuel locomotives. A significant percentage of that fuel is wasted due to improper fueling techniques. We can't afford to keep losing that valuable fuel, and that's why Sunoco is doing something about it. With the cooperation of Burlington Northern Railroad, Sunoco has produced a 27 minute color film designed to make fuel handlers and supervisors aware of what is being done to prevent the industry-wide loss of fuel, and what they can do to improve their own refueling techniques.



The name of the film is *Zero Waste In Railroad Fueling*. It is designed to help you cut costs and conserve our valuable fuel supplies. You can find out more about the film by writing or calling Paul Broker, Transportation Industry Manager, Sun Oil Company, P.O. Box 7438, Phila., PA 19101. (215) 688-8200.

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However, the real need or necessity for the installation and/or use of the many units available should be determined on a value analysis basis. The "nice to have" concept must not be the criterion for the purchase and installation.

Guidelines and complete instructions must be formulated to assist maintenance personnel in their use, and must be circulated to all concerned. Individual instruction by qualified instructors is essential if the use of instrumentation is to be successful and economical.

Good, reliable communication, documentation and follow-up is essential to determine the value of instrumentation, its reliability and savings realized through its use.

Locomotives manufactured today have, as standard equipment, systems monitoring equipment designed to:

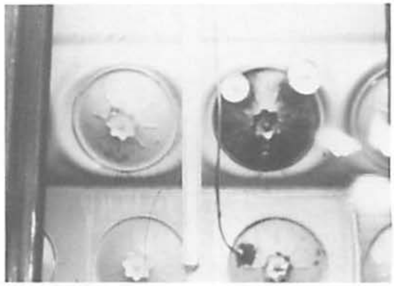
1. Provide maximum over-the-road reliability
2. Avoid unnecessary shutdowns
3. Reduce secondary failures.

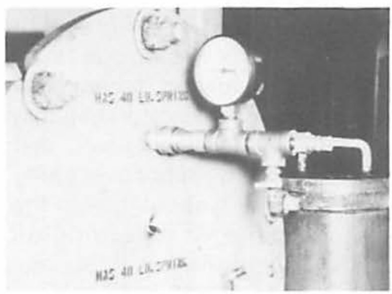
Locomotives can also be equipped with other signaling or protective devices as an option.

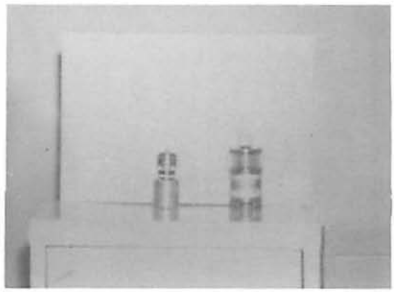
The objective of the use of this type of equipment is to indicate when and what kind of maintenance work is required to correct a condition that would cause a shutdown road failure, or more extensive and expensive repair.

Pressure Gauges

Pressure gauges must be chosen to meet the requirements of the service intended and percentage of accuracy required. Liquid filled gauges are recommended for longer service life where pulsation and vibration conditions exist.







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Two powerhouse cleaners and degreasers from Fine Organics that will solve your toughest cleaning problem as easily as friend racoon washes his supper in a stream. And they're formulated not to pollute the stream.

1. **FO 452 Multi-purpose Heavy Duty Degreaser,** concentrated, low-phosphated liquid, completely biodegradable, containing no synthetic detergents, designed to remove heavy build up of road film, grease, oil, tar from vertical surfaces where scrubbing is either impossible or too costly.

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Temperatures of the media to be measured are also to be considered when selecting pressure gauges.

It is recommended that gauges with a maximum pressure range of twice the required working pressure required be used in all applications where practicable.

Proper wrenches must always be used when installing gauges. Never use the gauge case as a lever when tightening.

Typical example of the uses of pressure gauges are as follows:

1. Air box pressure check (Turbocharged)
2. Turbocharger air pressure check
3. Lube oil filter bowl pressure check
4. Load test set up, monitoring pressure at various test points to determine condition of components in the system
5. Water pressure test check to determine if correct or cavitation condition exists due to various causes such as cracked heads, cracked liners, leaking head seals, etc.

Vacuum Gauges

Vacuum gauges should be of the liquid filled type to ensure long service life and provide more accurate determination of condition of the system being monitored.

Typical examples of the use of vacuum gauges are:

1. Air filter check
2. Crankcase vacuum check
3. Water pump and oil cooler condition check
4. Crankcase overpressure switch check.

Manometers

Manometers can be used to read static pressure, vacuum or differential pressure.

The most versatile and highly accurate manometer is the slack tube type. It is not recommended for use with red gauge oil. Use only water or mercury.

Flex tube manometers are also a versatile and accurate instrument and can be purchased for use with water, mercury, green dye concentrate or red gauge oil. Care must be exercised to determine that proper fluid is used in the manometer. The specific gravity of the fluid determines the accuracy of the manometer reading.

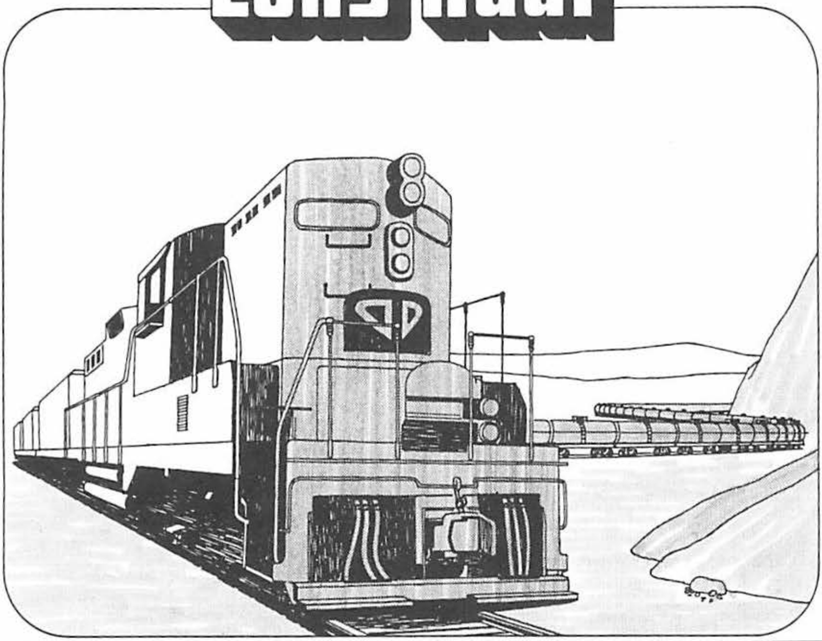
Typical uses of manometers are:

1. Air box pressure, blower charged engines.
2. Engine air filter condition check
3. Back pressure check of exhaust manifolds
4. Crankcase pressure/vacuum check
5. Crankcase overpressure switch check
6. Cooling air pressure check in electrical cabinet, generator, traction motor, etc.
7. Air compressor air filter condition check
8. Air compressor crankcase pressure/vacuum.

Temperature Gauges/Thermometers

Temperature gauges and thermometers are versatile instruments for measuring temperatures of fluids in the various systems and for determining difference in temperatures, where required.

FOR THE
Long Haul



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The range of the instrument used must meet the requirements of the system being monitored. The length of the sensing element is also very important and must be carefully selected to obtain an accurate reading.

Typical uses of temperature switches/thermometers are as follows:

1. Air box temperature under loaded condition of engine
2. Lube oil temperature at various check points to determine condition of components in the system
3. Cooling water system at various check points to determine condition of components in the system
4. Air compressor lube oil temperature check
5. Exhaust gas temperature check at manifold or exhaust stack.

Vacuum, Temperature, Pressure Switches

Switches of various types and design are used to monitor the pressures in various systems, pressure drops, vacuum, heat of fluids, etc.

These switches function in different ways to either indicate there is a need for attention or maintenance in the system, reduce power of output of the system by limiting excitation or by other means, shutting the engine down, etc.

Typical examples of the use of these devices are:

1. EMD crankcase/low water pressure detector
2. EMD hot oil switch
3. EMD low oil pressure protection indicating system engine governor
4. EMD engine air filter condition switch system, late model locomotives
5. Engine air filter conditions indicator
6. Temperature switches in lube oil system GE locomotives
7. Hot water temperature switch to isolate engine in GE locomotives
8. Crankcase overpressure protection device GE locomotives
9. Low water, low oil pressure protective devices, GE locomotives engine governor mounted.

Indicators

Indicators, pressure switches, vacuum switches, limiting devices, etc. can be installed on most locomotives and retrofit kits can be made or are already available.

The economy of installation on part or all of a locomotive fleet must be determined by the actual savings that can be realized through their use.

It remains the responsibility and judgment of each fleet owner to determine the real need for any or all of the devices available. Maintenance practices, operating conditions, materials such as lube oil, lube oil filters, fuel oil, fuel oil filters and other variables on each system make it impracticable for this committee to commit itself to specific recommendations.

All devices discussed are, when properly installed and to an economical advantage, an asset in reducing maintenance costs and road failure of motive power.

III. PROGRESSION SYSTEMS FOR MAINTENANCE

A specially designed dump cart can greatly reduce the housekeeping

MAGNUS Internal Engine Bearings for Locomotives

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Keep Magnus in mind to get long-life durability in replacement engine bearings.

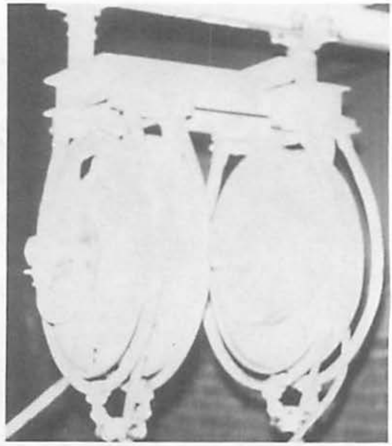
Magnus Bearings have a track record of high performance — achieved by N L's interrelated capabilities in materials research, manufacturing development and precision metal-working.

These bearings are steel-backed copper lead lined with barrier and plated babbitt overlays — constructed to accommodate the high unit loadings encountered.

Magnus main and rod bearings meet all requirements for both turbocharged and non-turbocharged engines... Backed by over 90 years experience serving the railroads. Write or phone for brochure. BEARINGS DIVISION, N L INDUSTRIES, 5461 Southwyck Blvd., Toledo, OH 43614. 419/385-9911.

NL Bearings

problem usually associated with removing engine oil filters. The cart can be rolled up to the running board of the locomotive by the mechanic changing the filters. After the cart is filled up with filters, the mechanic can then push the cart directly to the compactor and dump it. A valve is located at the bottom of the cart so the oil can be drained into a container and reclaimed. In this location of the progression system, there is a hydraulic crossover bridge. The cart can easily be pushed over the bridge to the compactor by the mechanic, even if the filters are removed from the opposite side of the location of the compactor.



Water Treatment System

Water treatment chemical can be bought in bulk and stored in a large heat tank. A saving in unit cost of the chemical and handling will result by being able to receive loads of water treatment either in tank cars or trailer trucks instead of in 55 gallon drums. The chemical is then pumped by an air operated pump which pressurizes the discharge line, pumping only when the discharge valve is opened. A small hand-held totalizing meter is attached directly to the two hose reels which allows the operator to meter the proper amount of chemical directly. The hose reels are attached to a trolley operating on a monorail. In this way one meter and hose reel can cover a two-track operation. A hand chain pull is also provided so the operator can move the reel over the top of the locomotives while standing at ground level. Two hoses are used. One is the main pressure line and the other is a return line so the chemical can continuously be recirculated during cold weather to prevent freezing. A small orifice is used in the return line so there is only a limited volume of chemical being recirculated.

Automatic Locomotive Truck Washer

The automatic truck washer which is described below is a prototype unit designed and built by the L&N rail-

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road at the South Louisville Shops. The washer is designed to wash locomotive trucks using high pressure, 160 deg. F water with or without chemical assistance. One end of the locomotive must be positioned at the home station of the two washers. Two complete washers are required, one on each side of the track. These washers are entirely independent of each other.

A stepping switch controls the overall cycle of each washer. This switch can be easily changed to suit local requirements.

The **electrical control panel** consists of a two position selector switch, manual or automatic. The manual mode is made up of three switches:

(Air)—This switch provides air to move the washer carriage longitudinally, reciprocates the nozzles, rotates left or right nozzle mast and powers the onboard carriage air logic system.

(Rinse)—Rinse selector switch starts the high pressure water pump and selects the upper or lower nozzle.

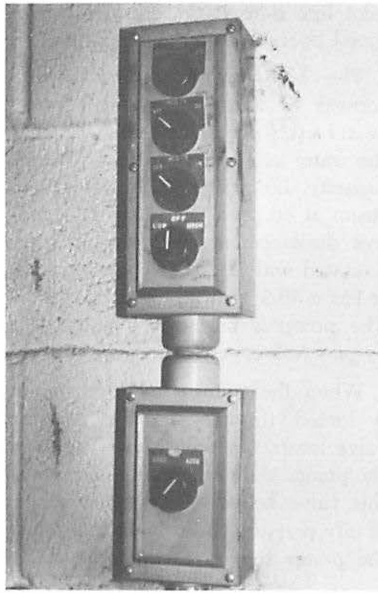
(Chemical)—This switch energizes the chemical foam system. With the auto-manual switch in the auto position, it is only required to push the start button and the washer will automatically run through the complete auto cycle and stop. The washer can be stopped at any time during its auto cycle and be restarted. It will then finish its normal cycle. All motions on the carriage are controlled with an onboard air logic system. The only electrical equipment located in the wash area are the push button control panel and a proximity switch to energize a stepping switch. The pumps, heat exchanger and electric controls are located in a different area.

The **washer carriage** is self-propelled and directly driven by an air motor with an integral gear box. This motor provides a two-speed operation with an approximate 4 to 1 speed difference. The motor can also be adjusted over a wide speed range.

The water and chemical nozzles are positioned 45 deg. left to right by rotating the mast assembly using an air cylinder. The nozzles are positioned at a 45 deg. angle during the wash cycle so that water or chemical will cover the sides and front of trucks, pilot and fuel tank. The nozzles are reciprocated by a cable air cylinder which is cushioned by hydraulic shock absorbers. The reciprocating speed is adjustable. The air, water, and chemical are supplied to the washer carriage by a festoon hose system.

The washer carriage travels in a tubular steel track. The wheels are double-flanged, two are powered and two are idlers. A 100-lb weight is positioned over the drive wheels for traction and the high pressure nozzle is directed away from the direction of travel which aids in propelling the carriage. An air limit switch returns the carriage to its home position and changes the direction of the nozzle.

An air pilot line is used to signal an air operated water valve which switches the water from the upper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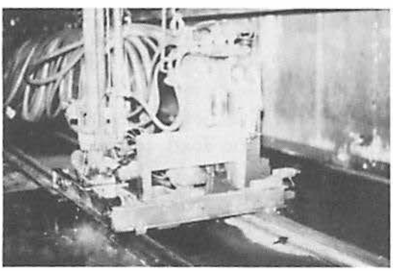

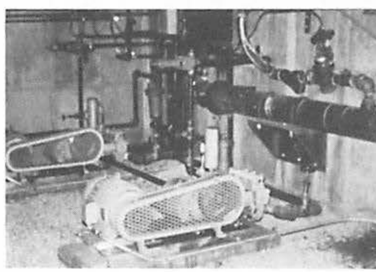

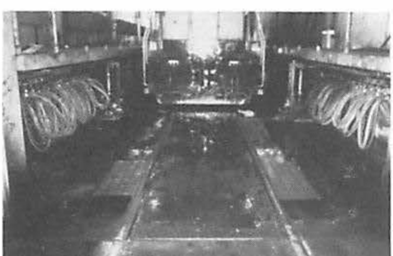

to the lower nozzle. Another air pilot line is used to control the two-speed operation of the air motor.

The high pressure pump system consists of a steam operated water heater exchange. This unit heats only the water as needed. It has a 70 gpm capacity, 60 - 170 deg. F water with steam at 50 psi. The pump is a positive displacement reciprocating type, mounted with a 20 hp electric motor. It has a 36.3 gpm at 750 psi capacity. The pump is belt driven and has a by-pass valve.

When the pump is started, water is forced through a back pressure valve located in the discharge side of the pump. When the pump is stopped, this valve keeps the water, which is at city pressure, from flowing through the pump and on to the nozzles.

The piping is Sch. 40 with AAR fittings and 1-1/8 in. I.D., high pressure, high temperature hose. Two air operated ball valves divert the water from the upper to the lower nozzle. The nozzles are a solid stream type, 1/4 in. orifice diameter, mounted in a stamped flange adjustable joint.

The chemical system has a 10,000 gal. capacity bulk liquid storage tank. Chemical flows by gravity to the automatic mixing pumps where chemical and water are proportioned by two separate piston pumps which are mechanically connected, maintaining a preset ratio.

A 1400 gal. tank for storage of mixed chemical is kept pressurized at 35 psi with shop air. This forces the chemical through the distribution piping and on to the foam guns, a short distance away.

An electrically operated valve allows chemical to flow to the foam gun. An electric stepping switch energizes both the chemical valve and the air valve, which sends a pilot signal to the washer carriage. This pilot signal operates an air valve which aerates the chemical in a special foam gun. The foam reciprocates and is angled at 45 deg.

The cost of washing locomotive trucks with high pressure hot water is about $5.04 per unit. This figure does not include the capital cost of the equipment.

The cost in 1975 to build and install a washer such as the one described above would be about $30,000. This does not include the cost of a bulk chemical mixing system which automatically feeds the washers.

IV. POLLUTION CONTROL IN DIESEL MAINTENANCE

1. Noise

A. Locomotive Load Testing

Sound proofing of the load testing operation: The noise generally associated with the load testing can be reduced to such a low level that the engine exhaust, cooling fan, or blower and load box noise can no longer be heard even within several yards of the testing area.

This extreme measure may be necessary due to the close proximity of residential properties. A situation such as this was the case on one railroad. It had been receiving complaints for a number of years, both from the adjacent residential areas and some nearby industrial operations. It was decided to install two load test cells within an existing coach

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shop which is adjacent to both a progressive running repair line and a back shop operation.

Radiator Cooling System: Putting a test cell in a low head-room building can cause some unique problems. The major difficulty is thermodynamic. A high horsepower engine can discharge approximately 130,000 CFM from the radiator cooling fans at about 40 deg. F above ambient temperature. This is about 0.5 million BTU/hr. of heat energy. The generator blower adds another 0.4 million BTU/hr. to the total heat energy dissipated. Some locomotives have three radiator fans while others have one large fan.

The inside dimensions of the cells were about 18 ft. high, 20 ft. wide and 80 ft. long. This small area will absorb very little heat before the temperature within the test booth becomes too high, resulting in a hot engine alarm. The only way to keep the heat that must be dissipated from the radiator under control is with a local exhaust system. Provision should be made to allow the locomotive to enter the stub-end booth in either direction.

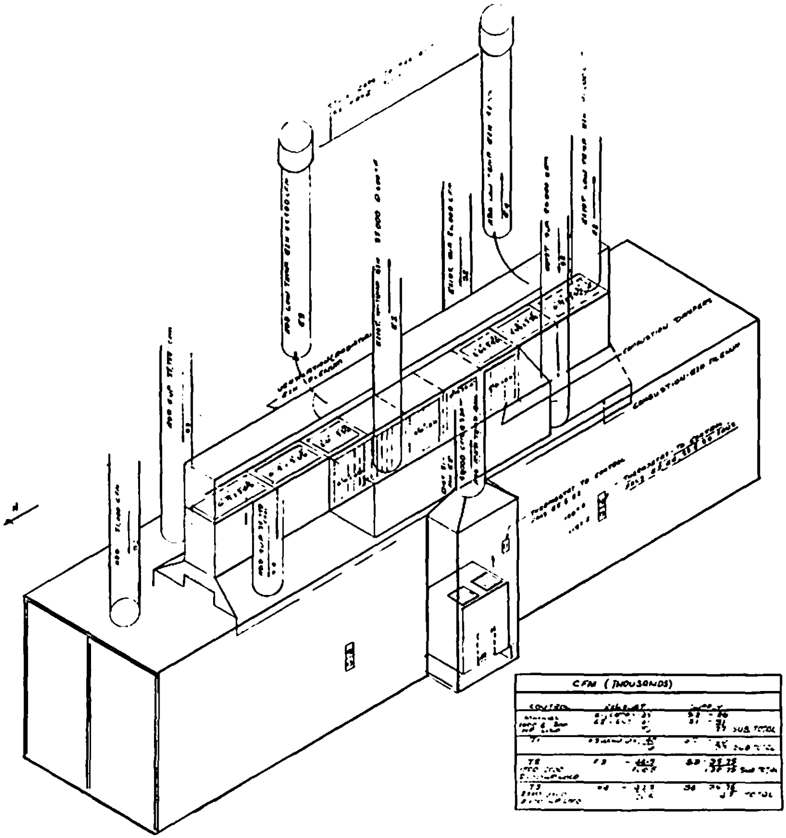
Building a hood with internal partitions will provide a local type exhaust system flexible enough to accommodate any type of locomotive in either direction. A damper is located between each section of the hood and a common exhaust plenum. The plenum connects the hood sections to several fans which are electrically staged with thermostats located in the booth. As the temperature raises in the booth, additional fans are turned on. Staged a-c motor driven fans were used instead of the higher cost d-c motors which have long delivery times when ordered. Stack caps should be provided on the discharges of the staged exhaust fans to prevent reversed air flow through the fans when not operating.

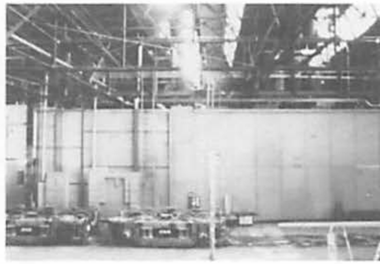
Each exhaust fan should be matched to a supply fan. If supply fans are not used a negative pressure will result in the booth, thus creating a poor environment for testing, the pressure in the booth will be kept very close to atmospheric pressure. One must consider, when matching the staged fans, the difference in temperature of the air entering and leaving the booth. The air weight entering and leaving the booth must be considered, not the CFM, when matching the staged fans. This is due to the fact that air being drawn into the booth is expanded by absorbing the heat extracted from the engine radiators. Since a fan is a constant volume device, each exhaust fan must be sized to move proportionately more CFM than the supply fan in order to maintain a balanced condition within the booth when the inlet and outlet air temperatures differ.

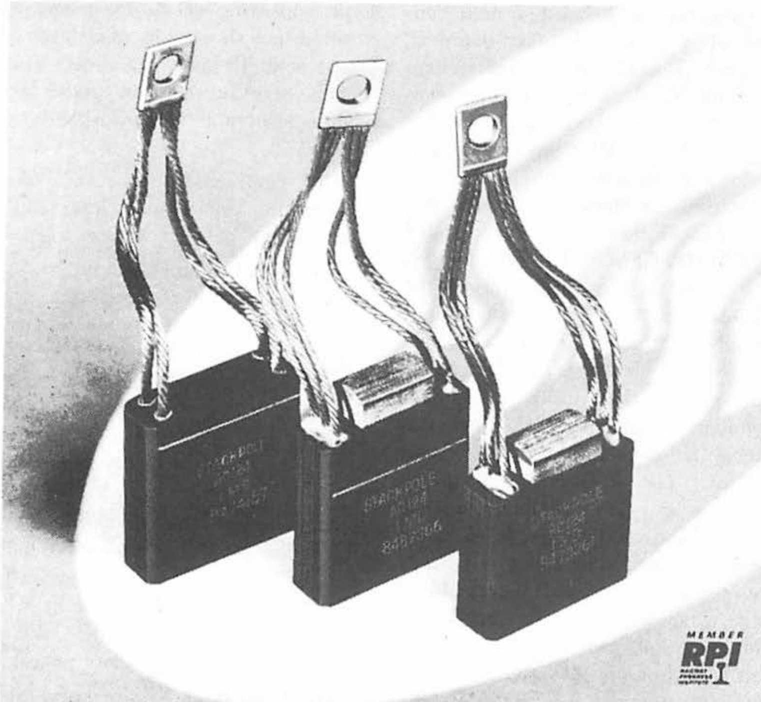
In most cases, fan silencers will not be needed on the radiator supply and exhaust fans of the booth. Due to the high elevation of the discharge of the stack on these fans and their vertical discharge direction, the noise at ground level is greatly reduced.

Noise Control System: The noise control system consists of the following major components listed and described below:

1. Combustion air exhaust system
2. Wall and roof treatment
3. Door and window treatment
4. Load box air exhaust system.


COMBUSTION DAMPERS
COMBUSTION AIR PLENUM
CFM (THOUSANDS)





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Combustion air exhaust system: The combustion exhaust system consists of a hood, plenum, dampers, fan and silencer. This system utilizes the same hood as the radiator cooling system. The dampers are located horizontally at the top of several sections of the hood. A plenum connects each of these sections to one high temperature exhaust fan rated at 35,000 CFM. The silencer is located on the discharge side of the exhaust fan and is mounted horizontally on the roof of the building. The exhaust silencer is a fully reactive type device that utilizes resonator chambers to attenuate the low frequency noise produced by the diesel exhaust. The silencer is 72 in. in diameter and 289 in. long and the shell is fabricated from 1/4 in. thick hot rolled steel. The tubes and heads are of 3/16 in. material manufactured from a silica base refractory fiber. This material provides about a 13 dbA reduction and has a thermal conductivity of about 0.32 BTU/sq. ft./hr./deg./in.

Wall and roof treatment: External wall and roof panels are IAC "Noise-Foil" type consisting of 18 gauge perforated face sheets, 4 in. of acoustic fill, and a screen to retain the fill on the existing wall face. These panels may be held in place by bolting to the existing wall or roof trusses.

Intermediate wall panels are IAC "Septum" type consisting of 18 gauge perforated face sheets on both outer surfaces, 4 in. of acoustic fill, and a 16 gauge solid septum sheet in the middle to insure a good transmission loss. These panels may be held in place by a simple structural framework of 5 in. beams.

Internal wall panels are "Noishield" type consisting of an 18 gauge perforated face sheet, 4 in. of acoustic fill, and a solid 18 gauge up sheet. These panels may be held in place by a simple structural framework of 5 in. beams.

This combination of panels offers absorption, transmission loss, and a combination of both where required.

Door and Window Treatment: Two double leaf acoustic doors are used. Each door is 14 ft. wide x 16 ft. high and 8 in. thick. The outer plate is 1/4 in. hot rolled steel; the fill is 4 lb./cu. ft. fiberglass; the inner sheet is 16 gauge solid. The door is designed to be acoustically compatible with the concrete wall.

All windows offered are 1/4 in. glass, double glazed, designed to be acoustically compatible with the Noishield panels. Desiccant bags are provided to prevent condensation of moisture between the glass panes.

The Load Box: Noise can be greatly reduced by placing the load box within the test cell. An enclosure can be formed with an offset in the wall of the cell. A hood located directly over the fan discharge of the load box picks up the hot air before it can mix with the air inside the booth. A 40,000 CFM exhaust fan is used to convey the 350 deg. F air out of the booth to the atmosphere. A supply fan sized to introduce the required air weight to balance the expanded air being discharged must also be provided to keep the pressure at the desired level. The exhaust fan is equipped with an IAC tubular silencer. The outside shell is 3/16 in. thick hot

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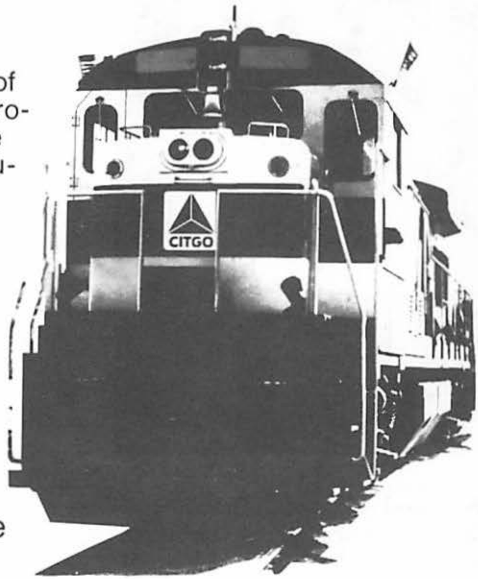

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rolled steel material. The internal bullet is constructed of 18 gauge galvanized perforated steel formed with 18 gauge galvanized steel and packed with 2-1/2 lbs./cu. ft. mineral wool wrapped in fiberglass cloth. The exhaust duct is insulated and has a stack cap at its discharge.

Sound Levels: The sound level inside the test booth with the engine at idle is about 90 dbA. The sound level is about 102 dbA with the locomotive at full load inside the booth. Sound readings were taken to establish the ambient or background noise level outside the test cell. This level was about 75 to 80 dbA. Readings taken outside the cell during full load conditions were not high enough above the ambient level to discern any difference in the readings.

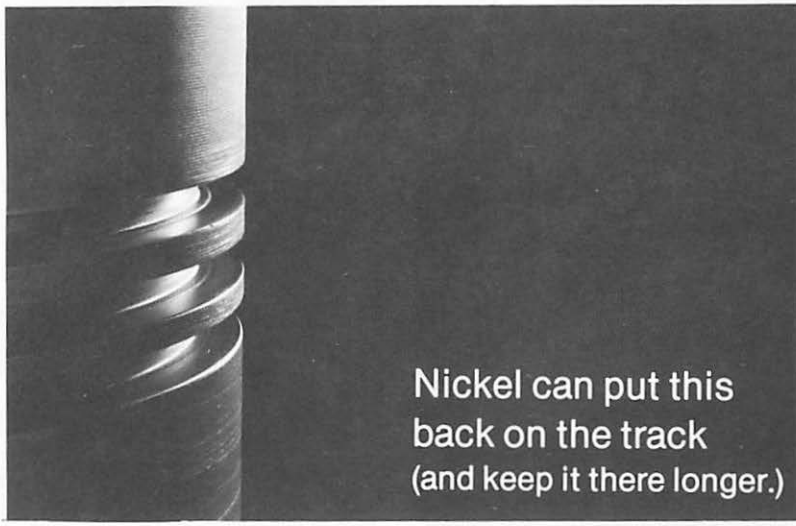
B. Diesel Engine Load Testing:

Another aspect of engine load testing is when the test is accomplished before the diesel engine is placed in a locomotive. The advantage is the ability to have diesel engines tested and ready for installation at any location even at enginehouses located where individual testing would not be practical from an environmental standpoint. GE uses such an arrangement at its Grove City, Pa., engine rebuild facility.

General Electric uses a fully instrumented test cell for final quality assurance of operation under load with all remanufactured engines at the Grove City plant. The test-cycle operation is closely similar to that for a new engine.

A fully assembled engine is coupled to a standard alternator, then both are mounted on a special air-float skid for the testing. This skid is "floated" into the test cell. An air-powered motor assists in the movement, but all guidance or steering is done by men pushing. When the skid is in place, steel tie-down bars are applied to prevent any movement during the test.

The test cell itself is constructed of 10-in. concrete block; internal voids also filled with concrete. The engine goes in and out, on the skid, through heavy steel doors, insulated for both sound-deadening and fireproofing. A small door gives access to the adjacent console room. A heavy plate glass window is also in the wall be-



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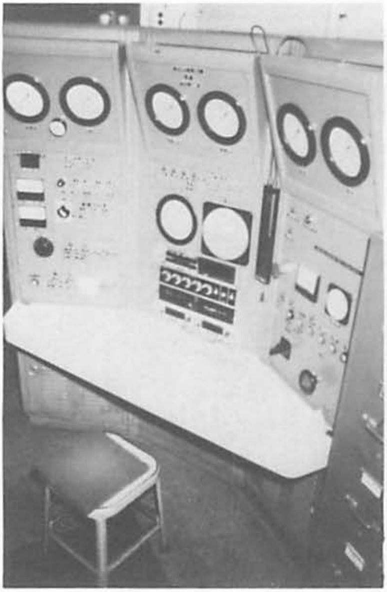

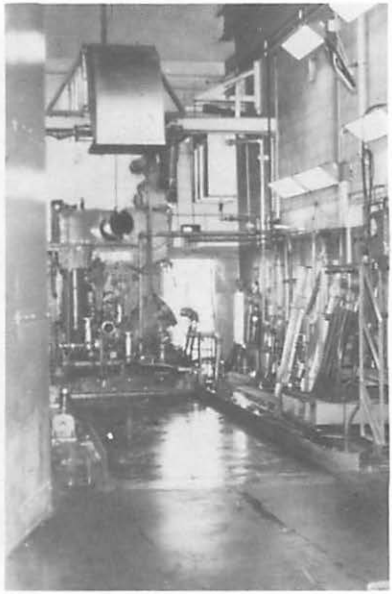

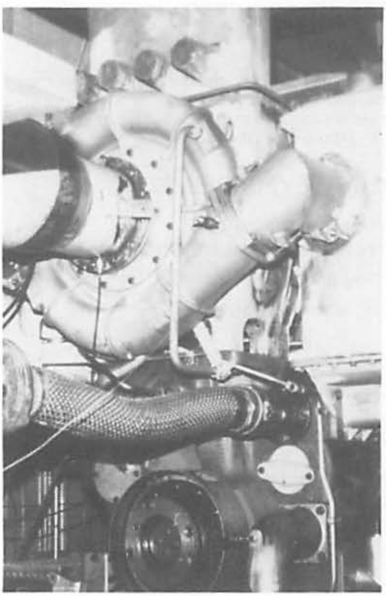

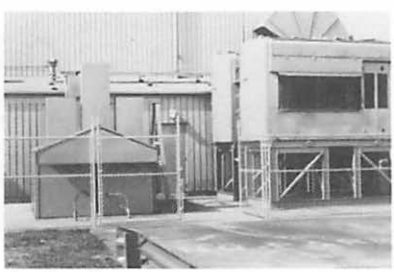

tween the test cell and the control room.

As far as possible, standard locomotive components have been utilized in the support systems, including the lube oil filter, cooler, and dry radiator system. The first two are in the test cell. The radiators are mounted outside. Storage tanks have been added, with transfer pumps, to hold lube oil and cooling water when engines are being transferred. The radiator is driven by an electric motor taking its power from the resistance loader connected to the alternator on the engine under test. The same scheme is used to power the 15,000 CFM blower which supplies ventilating air to the alternator and auxiliaries.

Combustion air for the engine is drawn in through a set of standard locomotive paper air filters, mounted outside the building. Exhaust is through a 30 in. square stack, going straight up about 40 ft. In this stack is a 40,000 CFM "sucker" fan. The engine exhaust stack is a very loose fit into the building stack, so the exhaust back pressure is essentially atmospheric.

At the top of the test cell is a cupola with permanently open louvers. Outside air is drawn in through these louvers whenever the "sucker" fan is operating.

When an engine is operating at full load, sound level at the ground 500 ft. from the stack is about 70 dbA. In the adjacent control room, it is 85 dbA. In the adjacent shop space one is conscious that an engine is running, but noise is in no way objectionable.

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Since all large pipe connections for lube oil and water have quick disconnect fittings, with mating sections mounted on the engine before it is put into the cell, an engine can be operated relatively quickly after it is moved in. After the test is completed, the skid is moved out, the alternator removed, and the engine still on the skid is moved into the adjacent booth for painting.

More than one skid is available. One engine can be prepared for test while another is undergoing test and still another is being painted.

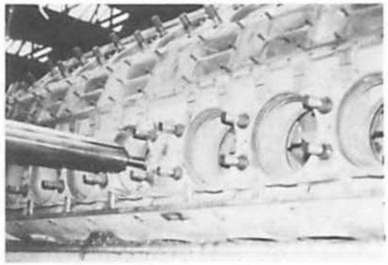
V. PROFITABLE RECLAMATION PRACTICES

1. Conversion From B to BC Engine Configuration (EMD Engines)

EMD has essentially produced the same engine for thirty years, starting in 1936 with the A series through to the present E series. The majority of the components are interchangeable with the exception of the A & B series power assemblies (the piston, liner, and cylinder head). The C engine has a better water seal for the cylinder liners, and to cut down the amount of water leaks a number of B engines have been converted to a BC configuration. Another reason for BC conversion is the difficulty of obtaining B part components.

These factors force a consideration of three alternatives:

1. Scrap the existing B engines and purchase new E cases and pans
2. Send engines to EMD for conversion to a BC configuration
3. Convert engines to BC configuration yourself.



One railroad decided upon the third alternative. A process for converting EMD 567 A or B engine blocks to accept EMD 567 BC power assemblies was initiated. The conversion is made by utilizing a horizontal boring mill. The machine is an N/C controlled horizontal boring, drilling, and milling machine with both positioning and contouring capabilities. It is a table type machine designed for high performance and precision machining.

The second piece of equipment utilized is a trunion fixture for holding EMD 567 engine blocks of 8, 12, or 16 cylinder size. The base and sub-base of the fixture are fabricated from heavy steel weldments arranged with a central air bearing to facilitate indexing the fixture and the part 90 deg. to complete work on one end of the engine block. Indexing and clamping operations are manually performed through a worm and worm gear arrangement. The fixture includes clamps and positive stops for accurately indexing at the 90 deg. locations.

A heavy duty trunion bearing is provided at each end of the fixture base with longitudinal adjustment providing for the various lengths of the blocks. Adjustment and clamp-

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ing are manual. The fixture trunion bearing is arranged for 360 deg. of indexing ability to position work pieces for cylinder boring and other work. This is accomplished by an electric motor driven worm and gear drive, for coarse positioning, and a hand crank to accurately position. The angular location will be indicated by a 360 deg. vernier arrangement. A vernier arrangement is also provided for repeatability of the index position.

Two fixture plates are included, one to be attached to each end of the engine block before loading into the fixture and to be bolted in place using existing tapped holes in the ends of the engine block. Each plate is located in the half round main bearing and equalizing is accomplished with the bracket keyways (allowance is made for two keyway sizes). Clamping is performed on the pan rail surface. Repeatability is ± .002.

The fixture is loaded utilizing standard lifting plates which are not removed during machining. The fixture is also designed to facilitate easy removal and relocation on the machine.

Procedure for machining engine block: The engine block is loaded into the fixture after applying the end plates to each end of the block. The block is now rotated to positions 1 through 8 facing the spindle of the boring mill. The engine block is squared to the boring mill by indicating the top deck cover pads. Side clamps are now applied to hold the fixture and engine block square.

The boring mill is centered on the # 1 bore and activated into cycle. The first operation is to bore the lower water jacket. The top seal is machined to 11.875 in. and the lower seal to 10.875 in. This machining is accomplished by utilizing one cutter equipped with two sets of inserts.

The boring mill is to advance, feed cut, and return to starting position then return to position on the # 2 bore and repeat the cycle. After # 1 through # 8 cylinder openings are bored, the engine block is rotated so that the second bank of cylinder openings is in position facing the boring mill spindle head. The set up is repeated and cylinder openings 9 through 16 are rough bored.

The engine block is now removed from the horizontal boring mill and new spacer inserts welded into place on the bottom water jacket plate. All old water pipes are removed and the top deck drains moved to allow clearance for the new water pipes. With all welding and cutting complete, the engine block is reloaded into the fixture for final machining.

The block is positioned with # 1 through # 8 air box inspection holes facing the boring mill. With the engine block in this position the clearance for the "C" liner water pipe elbows is cut to the proper proportions. The block is rotated so that # 1 through # 8 cylinders face the mill and the lower deck is bored to 11.030 in. and faced to the correct height. A finish tool is now placed in the boring mill and the engine cylinder is bored to 11.062 in., the correct size for the pressing in of the "O" ring seal required for the "C" liner.

The engine is now rotated to where # 9 through # 16 air box inspection holes are in position for boring; also

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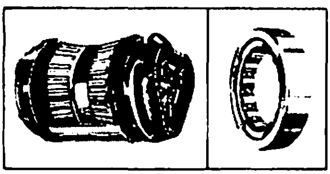

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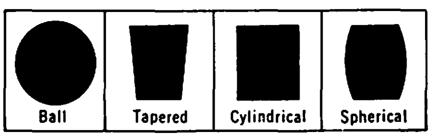

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9 through # 16 cylinder bores are rotated to position, and the process is repeated to facilitate opening the cylinder bores to the correct dimensions.

The final operation is to rotate the engine block horizontally 90 deg. and position. The clearance is cut for the new water pipe arrangement. Two holes are also drilled and tapped to allow for attaching the water manifold to the engine block.

With this work completed the engine block is now ready for rebuild.

2. Component Cleaning: Techniques Now Under Development

Efficient and thorough cleaning of locomotive components is a frequently overlooked subject. The concept of cleaning itself is a simple one; however the configuration and composition of many parts of a locomotive can make cleaning a difficult problem. The constraints now being placed on railroad shops by federal, state and local environmental protection and industrial safety groups adds complexity to the task.

A large Western railroad is now looking at several areas where cleaning has been unsatisfactory due to the fact it has either been incomplete, expensive or has drawn the unfavorable attention of government agencies. It is in the process of developing a number of new approaches to some difficult cleaning jobs. Given below are briefings of progress to date on two of these projects.

Cleaning and servicing GE lube oil coolers: The locomotive lube oil cooler is very difficult to clean. Failure to properly clean and maintain this device will often result in hot oil and low lube oil pressure shut downs, particularly in the summer months. This road has developed a standard procedure for servicing the GE lube oil cooler on a scheduled maintenance basis.

Prior to teardown, sulfamic acid is pumped through the water side of the cooler for approximately two hours. This serves to dissolve and dislodge the calcium carbonate scale built up in the tubes. Following the acid circulation, a soda solution is pumped through the cooler to neutralize the acid.

At this point the oil cooler is disassembled and the housing and tube bundle are inspected. If necessary, tubes are rodded to remove calcium carbonate scale which was softened but not removed by the acid wash.

The tube bundle is cleaned of oil by repeated immersion in a bath of solvent-type cold tank cleaner in an agitating tank. An average of 16 hrs. in the tank is required to remove all traces of lube oil from the tubes. At the same time the housing is cleaned for one hour in a bath of hot alkaline cleaner.

When all components have been inspected and cleaned, the cooler is reassembled with new rubber rings, gaskets and, as required, a new steel gland ring.

The completed cooler is tested by submerging it in water (with oil connections open) and applying air at 90 lbs. pressure to the water side of the cooler. If after four hours, no leaks have been detected, the cooler is drained, painted and prepared for shipment. (If a defect is found during this test, the cooler is

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disassembled and the leaking tube is either repaired or plugged, depending upon location of fault. Experience indicates that approximately 25 percent of all coolers serviced require this additional step.)

Cleaning traction motor gear cases: The cleaning of traction motor gear cases has always presented a problem to most railroads, but here are three methods developed by two railroads that have value.

One railroad cleans its traction motor gear cases in a spray tunnel. The gear cases are brought to the tunnel entrance on a pallet. At this point the halves are placed on a small dolly with the cavity down to allow maximum drainage. The cases enter the tunnel and are sprayed with a 25 percent concentration of alkaline cleaner at 180 deg. Spray pressure of 350 psi is directed at the cases from top and bottom spray manifolds. An average of six hours of this spraying is required to fully remove all crater compound and road dirt.

The crater removed from the cases and cleaner solution are pumped to a collection tank from which the crater and soap are periodically removed by a commercial waste disposal firm.

Now being studied is the possibility of using electrical resistive heating to replace the spray tunnel operation. In cleaning a gear case the primary task, of course, is removing the crater compound. It is felt that if the temperature of the gear case could be raised sufficiently, the crater would flow off and could thus be removed much more quickly and disposed of in a much simpler manner.

In this design, gear case halves will be, one at a time, hydraulically clamped in the cleaning device, and in effect, placed in a short circuit in the secondary winding of a 150 KVA transformer. Specifically, the case half is positioned on the cleaning machine with the open side down and is clamped in place by hydraulically operated pads which pin the lugs on either end of the gear case to the contact busses of the machine. (It may be necessary to quickly clean the case lug area with solvent and an air motor wire brush to provide a minimum resistance contact area prior to clamping the case into the machine.) The two busses are fed by a 150 kva transformer via water cooled cables. The transformer primary is supplied with 440v service and is regulated and pulsed by a spot welder control network and timer.

In a test of this concept, crater compound fell off the gear case into the drip pan rapidly as the case approached 400 deg. Road dirt and grease on the exterior of the case became dry and crumbly. Following the resistive heating removal of the crater, it will be necessary to clean the exterior of the case of this dried dirt and grease with a steam gun or with a short soak in a cleaning tank.

To raise the temperature of a 97 lb. gear case half to 400 deg. with the heating machine will require approximately one kwh. At the machine's design output of 600 kw into the gear case, it will require about six seconds to raise the gear case to the desired temperature. However, because the resistance at the

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contact point where the gear case lugs are clamped to the machine's busses is much higher than that of the rest of the circuit, complete heating and cleaning time is estimated to take about one minute. Energy consumed in this time would then be about 12 kwh and the energy cost of operation at $0.01/kwh will be $0.12 per gear case half. This cost is considerably lower than the average $1.42 required to provide sufficient alkaline cleaner and $0.73 for natural gas to heat the cleaner. In addition a great time saving will be realized over the six hours now required to spray clean the cases.

The method of cleaning traction motor gear cases at the second railroad is by hanging the dismantled cases on a traveling cable which in turn carries items automatically through the various steps of the cleaning process. The first step is passing between four gas-fired infrared heaters which quickly bring the gear case and crater compound up to temperature, thus melting the solidified compound permitting some to drain into a trough and on into barrels for disposition. The second stage is a steam heated solution which is sprayed onto the gear pan through a series of strategically placed jets. The third stage is a steam heated solution, again sprayed onto the gear pan through jets. The last cleaning stage is a hot water rinse. The gear cases leave the cleaning machine and are automatically switched to a "siding" where they are grouped and placed in a carrying cart, eight at a time.

Cleaning electrical components: An area of cleaning which has been neglected until very recently is that of the locomotive's electrical circuit components. Traction alternator diode banks, SCR panels, battery charging rectifiers, field shunting resistors, GE circuit cards and now EMD modules are components which, by their composition and configuration are most difficult to clean efficiently. Here proper cleaning is most critical as, unlike many mechanical components of a locomotive, these electrical components can fail merely due to the presence of dirt. All are subject to dirt related grounds and shorts which can be difficult to troubleshoot. Thorough periodic cleaning of such components is a necessity in a complete maintenance program.

3. Portable Axle End Grinder

The Stanray Corporation is offering a portable axle end grinder. This piece of equipment will refinish railroad axle ends (in Hyatt journal boxes) in place, in the shop, or on the road. This portable axle end grinder detachably connects to the journal bearing box that surrounds the axle end to be refinished. A shaft supported by a frame apparatus and concentrically aligned with the axle, carries a powered grinding tool that rotates about the axis of the axle center while abrasively refinishing the axle end surface. A skirt section and seal ring fit over the axle end at a point inwardly from the grinding area to prevent any abrasive particles from reaching the bearing assembly of the journal box. The grinding tool is air driven. The air motor can be driven by compressed air source in the locomotive enabling the axle ends to be refinished in the field.

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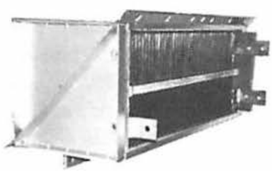

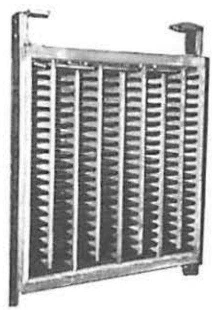

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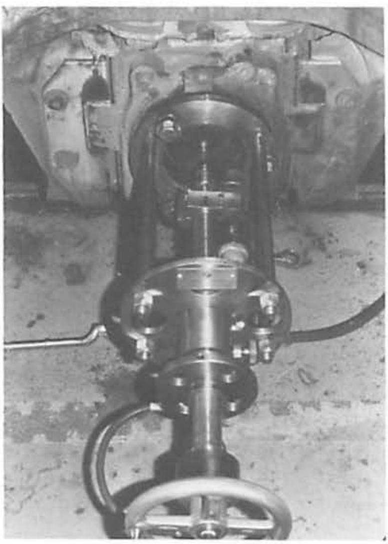
Advantages stated by manufacturer are:

1. Restores axle end surface to original, smooth operating condition
2. Reduces wear on thrust blocks caused by scored planar end surfaces
3. Saves labor required to remove axles or wheel sets from locomotives to refinish axle ends
4. Minimizes equipment down time substantially, due to inplace operating features
5. Does not require special repair shop machinery or facilities
6. Easy to operate in the shop or on the road.

This piece of equipment would be of greatest benefit in a run-through situation. The benefits of the equipment are realized when one does not have to remove axles to refinish the ends. The equipment has definite advantages for on-the-road, field use where complete removal of axles and wheel sets would be difficult and expensive. The axle end grinder has very little application in bigger rebuild shops. Locations where complete wheel-set tear down is standard maintenance procedure would have minimum need for such equipment since its main benefit is in-place refinishing of the axle ends.



4. Honing of Diesel Engine Cylinders, Liners and Air Compressor Cylinders

Proper honing is more important today than ever before, due to the modern high horsepower diesel engines used on American railroads. The high horsepower engine design incorporates higher pressures and heavier loads than used on the earlier engines.

Because of these extreme pressures and loads, the functional characteristics of the sealing and load-carrying surfaces of a cylinder liner are of vital importance. Honing must generate surfaces that are geometrically accurate and are free of burned, smeared or distorted material that might break down under load. Properly performed honing duplicates on every part a surface character that has the functional qualities required to carry a load with minimum wear, support a lubricating film or hold a seal. The efficiency of the engine depends on maintaining a seal between the cylinder liners and the piston rings. These sealing surfaces must become compatible as quickly as possible and then slide, one on the other, with a minimum of friction

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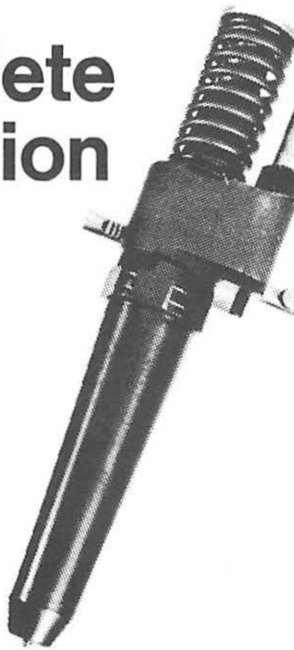

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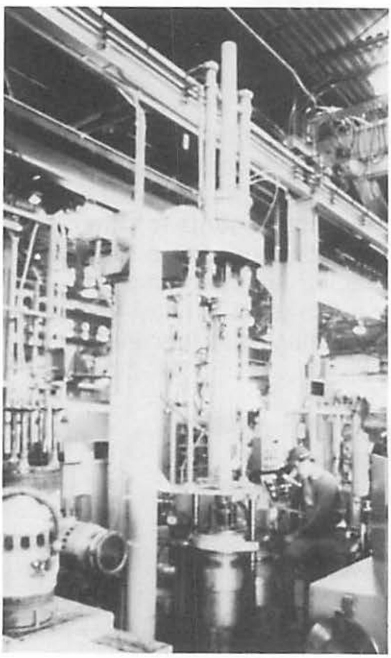
and wear. The liner must be round and straight and have a surface finish that will retain lubricant and yet will not scuff or pick up.

Another factor which has recently come into the picture is the raised position of the upper ring groove in the "E" type EMD piston. The latest "E" type pistons that EMD is manufacturing have the ring groove 3/4 in. higher than the original "E" type produced. Caution should be taken not to install the fire ring piston into a liner that has the long chamfer (L1) production prior to February, 1972.

The two most important features of a cylinder liner which must be held during reconditioning are geometry and surface finish.



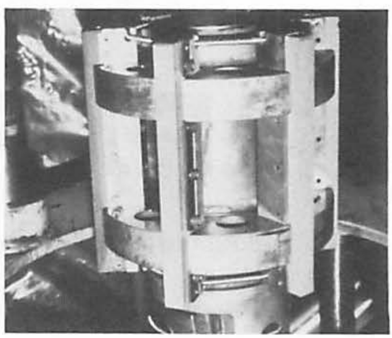
Geometry

1. Quality
2. Waviness
3. Taper
4. Removal of wear step
5. Removal of thrust hollow.

Surface Finish

1. Maintain **30-45** micro-inches RMS, EMD or 25 to 35 RMS, GE on cast iron liners
2. Maintain **50-90** micro-inches RMS on chrome plated liners
3. Controlled crosshatch pattern on cast iron liners
4. Maintain about 15 percent to 35 percent porosity on chrome plated liners.

Quite a few railroads are still using lightweight portable honing sets consisting of a honehead and hand held motor. This type of equipment does not usually have the power or rigidity to drive the type of tooling necessary to hold the geometric dimension and surface finish needed. Even with an experienced operator, it would be quite hard to maintain a high production output while holding a reasonably good quality.



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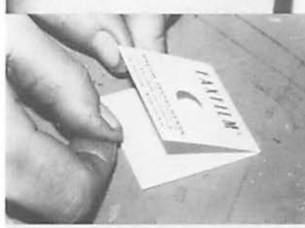
Procedure For Honing Chrome or Cast Iron Liners:

1. The liner should be thoroughly cleaned.
2. Water test the liner if it is an EMD type.
3. Visually check the liner for defects such as cracks, deep score marks at the ports, gasket seat cuts or badly corroded grommet seats.
4. Measure the liner and estimated clean-up size after honing. If this dimension does not exceed specifications, the liner is OK to hone. The measuring operation can be speeded up with the use of a dial bore gauge. A master ring should be used to set and check the dial bore gauge. This gauge should be able to display in the .0001 in. range and have a revolution counter.
5. Hone with appropriate 100 grit diamond stone (chrome liner) or 100 to 120 grit silicon carbide stones (cast iron liner), removing as little stock as possible to clean up visible ring step or score marks. To be considered good, the liner must be completely cleaned up. Liners that have no wear step or very little wear should still be honed lightly to remove the glaze and provide the proper surface finish to seat the new piston rings and hold lubrication.
6. Check RMS of finished liner. The liners should have a surface roughness of about 90 RMS to 50 RMS (chrome liner) or 30-45 RMS, EMD or 24-35 RMS, GE (Cast iron liner).



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This measurement should be taken with electric surface roughness indicator (profilometer). A hand held motor drive unit should also be acquired to stroke the probe on the workpiece. A much more accurate reading will be obtained with the motor drive device than by stroking the probe manually. A certified surface roughness plate should be used to calibrate the instrument. A chrome liner can be checked for porosity with the use of faxfilm manufactured by Brush Development Co. Faxfilm is used in the following manner:

a. Brush solvent onto liner bore surface of area to be inspected.
b. Press faxfilm firmly onto surface. Allow film to dry for 45 seconds.
c. Remove film from liner bore and place in cardboard frame.
d. Place finished faxfilm into a projector or microfilm viewer for inspection and estimate porosity. The porosity of a chrome liner should be about 15 to 35 percent.

7. The finished liner dimension should be checked to see if the bore out-of-roundness and taper specifications have been maintained. A dial bore indicator is best suited for this purpose. The outside diameter should be checked. This can quickly be checked with an adjustable limit snap gauge (go-no-go).
8. A chrome thickness gauge should be used to make sure there is ample chrome left on the liner after the honing operation. The piston rings could wear through the chrome to the base metal if sufficient chrome is not present. A minimum of 0.20 in. per diameter should be present after honing.
9. After final inspection, the liner should be thoroughly cleaned, making sure that all loose particles and honing coolant are removed. A rust preventive should be applied to the liners after cleaning. The liner can then be placed in a plastic bag for protection during storage or shipment.

Cooling: The honing coolant is another important item that must be considered. When honing cast iron or chrome, a mixture of either 90 percent kerosene, diesel fuel or mineral seal oil and 10 percent Arco Tulkut by Atlantic Richfield Co. can be used. The coolant performs three basic functions:

1. It flushes away the abrasive and metallic chips
2. It carries away heat produced by the honing operation
3. It provides lubrication for the honing stones against the work.

A filter should be used in conjunction with the settling chamber incorporated in most honing machines. There are several commercial filters available. One filter unit is designed to clean dirty coolants automatically with two-stage cleaning using a magnetic drum in conjunction with an automatically changing filtering fabric. The filter element (Dispo type) is in the form of a continuous cloth type medium which is placed

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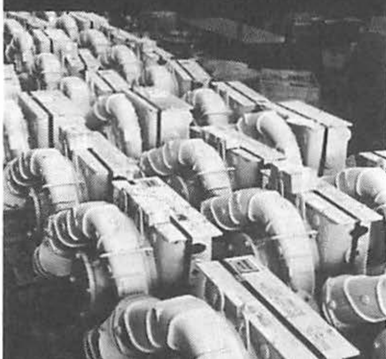

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on rollers. When the cloth becomes saturated, a new section is rolled into place automatically. The second stage utilizes a magnetic drum with permanent magnets. A great percentage of the ferrous particles are removed by the magnetic drum and deposited in a sludge pan.

Some railroads are using locomotive engine lube oil filters to filter the coolant.

Fixtures: The fixture is an important part of any honing installation. A honing fixture must hold the work securely without distortion and should provide a means for distribution of the coolant over the work. For maximum efficiency, it should permit the rapid loading and unloading of the work. If high production is desired, a two-position fixture can be used to speed up the loading operation. One workpiece can be loaded while another is being honed.

Size control: Due to the limited amount of stock that must be removed by a railroad during a repair operation, it is unlikely that automatic sizing gauges would be used to control size. The work can be accurately sized by determining experimentally the stock removal rate per minute and then setting the machine cycle times for the desired number of minutes. Careful attention to the stroke of the honing head, feed pressure and spark-out time is a must if accuracy and trueness are to be maintained.

Surface finish control: The surface finish in honing is primarily controlled by the honing stone used, although the coolant, rate of feed, surface speed and material honed have a considerable effect.

The porosity and surface finish in a chrome liner can be improved by honing with aluminum oxide stones after the diamond honing operation. Blasting the liner with abrasive-like glass beads or aluminum oxide beads can be used to reduce the surface finish as an alternative to the aluminum oxide honing method. Blasting the liner will also help to remove loose honed chromium.

Special tools: When honing a used EMD liner, it must be remembered that while enlarging the bore of the liner, the depth of the port relief section is being reduced; also, the inlet radius and outlet radius of the profile are being cut out.

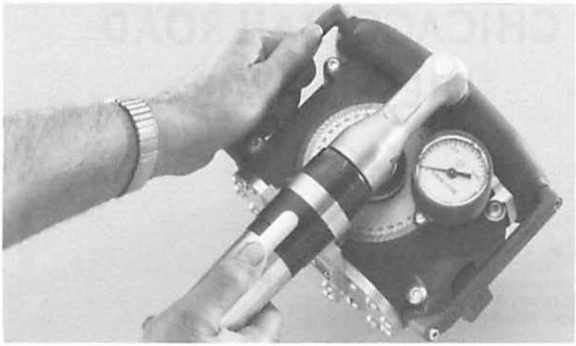
Special tooling must be used if the port relief profile is to be restored after repair honing is performed.

There are three types of tooling available to hone the port relief section:

1. A profiled stone, rotated but not reciprocated during honing.
2. A special hone body and stone carrier designed to allow the stone to rock in and out of the port relief area
3. A special formed stone, narrow at top and bottom, so it will cut deeper at the middle of the stroke.

Conclusion

In conclusion, we trust that this committee's contributions will enlighten you on some new or different ideas for improving your maintenance operation, so that you can reduce locomotive down time and increase service life.



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We of the Chicago Railroad Diesel Club were again pleased to be hosts to the Locomotive Maintenance Officers Association for their April 5, 1976, Pre-Convention Presentation.

Mr. D. H. Propp, Engineer of Tests, Burlington Northern, Inc., and his committee on Fuel and Lubricants presented their paper entitled "Projected Advances in Locomotive Fuels and Lubricants."

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Monthly Publication: Issued to all members.

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Tuesday, September 28, 1976

9:00 A.M.
REPORT OF THE COMMITTEE ON FUEL AND LUBRICANTS

Pre-Convention Presentation: Chicago Railroad Diesel Club

**April 5, 1976
Midland Hotel
Chicago, Illinois**

D. H. PROPP, Chairman
Engineer of Tests
Burlington Northern Inc.
St. Paul, Minn. 55101

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R. A. Wolfe, Engineer of Tests, Consolidated Rail Corp., Reading, Pa. 19601

PERSONAL HISTORY

Dale H. Propp

Born in Clinton, Minnesota, October 23, 1935. Attended public schools and graduated from high school in Clinton, Minnesota.

In June 1957, graduated from Gustevus Adolphus College, St. Peter, Minnesota, with a Bachelor of Science Degree in Chemistry. Postgraduate studies included Physical Metallurgy, Environmental Engineering and Management courses at the University of Minnesota.

After graduation, began employment with the Northern Pacific Railroad in 1957, with the first assignment as Chemist in charge of oil laboratory development in Livingston, Montana. Served in the capacity of Assistant Chief Chemist with NP and merged BN Railroad. Became Engineer of Tests of Burlington Northern in August 1974.

Married, with one son and one daughter.

Active member of technical organizations: ASTM — American Society for Testing Materials; LMOA — Locomotive Maintenance Officers Association, presently Vice Chairman of the Lube & Fuel Oil Committee; NRLC — National Railroad Lubrication Council; ASLE — American Society of Lubrication Engineers; NARET — present Chairman - National Association of Railroad Engineers of Tests.

Other activities include active member of Church Council, political organization, and community affairs (Boy Scout Commissioners Staff).

PROJECTED ADVANCES IN LOCOMOTIVE FUELS AND LUBRICANTS

The 1976 Fuel and Lube Oil Committee presents the following subjects for your discussion and reference.

I LMOA - Engine Lubricating Oil Evaluation Field Test Procedure
II Petroleum Industry Supply/Demand
III Fuel Alternatives - Gasification and Liquefaction of Coal
IV New Oils and Additives for the Future
V Traction Motor Gear Lubricants
VI Locomotive Filters

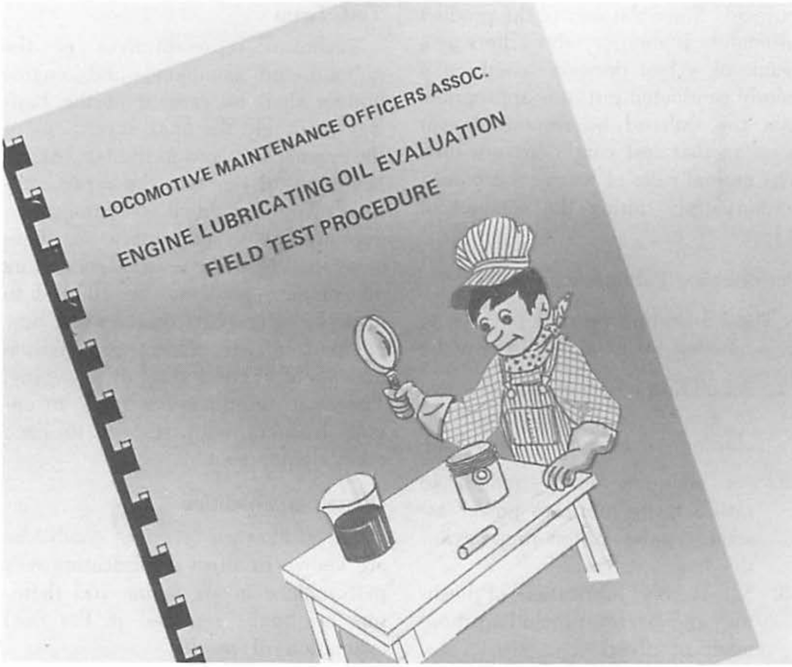
As exhibited in Figure 1, the LMOA Engine Lubricating Oil Evaluation Field Test Procedure is available in a separate manual designed to provide standardization of field testing and evaluating new locomotive oils.

Hopefully, each of these subjects will stimulate your interest and become a valuable reference.

I
LMOA DIESEL ENGINE LUBRICATING OIL FIELD EVALUATION PROCEDURE

Purpose and Scope

The purpose of this procedure is to provide a uniform method for the conduct and reporting of field evaluation tests to determine if a new lubricating oil has the necessary characteristics to enable it to satisfactorily lubricate main power plant diesel engines. This procedure may be used for the evaluation of proposed lubricating oils containing a new additive formulation not yet in commercial



service on United States railroads, or for evaluation of proven additives incorporated into base oil formulations of significantly different V.I. characteristics. It may be used for products containing an additive formulation already in commercial service. Under this condition, it would seem appropriate that the procedure be modified.

Oil companies usually conduct field tests of a "developmental" nature wherein extensive data concerning many lubricating oil performance criteria are required. It also is normal under these circumstances that the sample size be such as to yield statistically valid data in all of these areas. This procedure was not developed with that type of testing in mind.

A successful lube oil field evaluation test requires the close cooperation of the railroad, oil company, and engine builder. This cooperation should begin before the test is conducted. A field evaluation of a new product always entails some risk, otherwise there would be no need for test. The engine builders have historically screened new lubricating oils by the use of bench tests and/or stationary engine tests. It is expected that the engine builders will continue this process and will formally notify the appropriate oil company that its candidate lubricant is, in their view, worthy of field test. Since the oil company ultimately reaps financial benefit from a new product, it is appropriate for it to arrange for a test on a cooperating railroad. Since the user of the product ultimately is the one who suffers as a result of a bad decision based on a poorly conducted test, it is appropriate that the railroad be responsible for assuring that test conditions are met. The normal rules of warranty administration apply during the conduct of a test.

Performance Parameters

The lubricating oil under test is to be evaluated for its ability to provide:

1. An oil film which is non-corrosive to engine bearing materials including silver and copper-lead.
2. An adequate film strength to satisfactorily lubricate power assembly parts—piston rings, cylinder liners, valves.
3. Satisfactory lubrication of bushings and bearings including those made of silver.
4. Deposit control in critical areas, such as piston cooling cavities and piston ring belt.
5. Protection against power assembly corrosive wear.
6. Sufficient dispersancy to maintain open oil passages, provide satisfactory oil filter life and control oil cooler deposits.
7. A lubricant which will not *cause* ash, carbon, sludge, or varnish deposits to form on engine parts to a sufficient degree to interfere with the performance of those parts.
8. Stability toward oxidation, loss of alkalinity, dispersancy and detergency to provide reasonably long effective life.

Test Team

Technical representatives of the railroad, oil company, and engine builder shall be present at the halfway point and the final inspections of the engines involved in the test. At the beginning of the test, the representatives of the individual companies having primary responsibility in these areas shall be designated. A competing oil company shall *not* be allowed to inspect engine parts representing new oil performance except by written agreement of the testing oil company. The same requirements apply to engine builders with respect to each other's equipment.

Operating Conditions

The following service conditions are known to affect a lubricating oil's performance in an engine and therefore are to be reported in the final evaluation of results:

1. altitude
2. tunnels
3. ambient temperature
4. fuel quality
5. duty cycle
6. maintenance practices including parts replacement, incidents of fuel or water contamination
7. airborne contaminants—air filter c/o record
8. oil change schedule—oil filter c/o record
9. lubricating oil consumption
10. interchange of locomotives.

Severe operating conditions are defined as:

1. altitude 5,000 ft. or above.

2. ambient temperatures in excess of 115°F. (artificially created by tunnels).
3. fuel sulfur content of 0.5 percent or above.
4. operation at N5 and above.

It is desirable that tests be conducted such that 50 percent of the operating time would be under those conditions. Such a requirement would limit testing to a very few United States railroads. Therefore, other alternatives must be sought and/or the degree of deviation from these parameters considered in the final oil evaluation.

Fuel usage is a measure of duty cycle. During the course of the evaluation, the amount of fuel consumed for the normal assignment (run) for one of the units used in the test should be determined.

In the case of the General Electric engine, special pistons are available that increase the stress on the lubricating oil. These should be utilized and applied at test startup as covered in the following sections.

Duration of Test

A standard test shall require the accumulation of 100,000 miles and operate for one calendar year so as to incorporate all seasonal climatic conditions. The test may be terminated at a shorter period if the test team agrees that the oil has failed. It may be run longer at the discretion of the test team. If for some reason beyond the control of the test team and aside from failure of the test oil, the test must be terminated before reaching minimum time, it shall be declared void.

Selection of Locomotives

A complete evaluation should include EMD and GE locomotives. These evaluations may be performed on different railroads with operational conditions being duly recorded. The locomotives selected should ideally be those of highest commercial BMEP ratings available from the builder. Variations from this desirable goal require a statement of the builder that the evaluation in the substitute locomotive will adequately predict performance in the highest rated unit.

Each test oil should be evaluated in four to six locomotives manufactured by each builder. Normally, ten locomotives are considered a maximum to operate on a test oil. All three parties should be involved in decisions to operate a larger number of locomotives on the test product. A minimum of two of the same class locomotive operating on the railroad's regular lubricating oil which has proven satisfactory shall be considered as control units and treated in the same manner as those which are used for the test oil. This condition may be waived in the event that prior performance data is available for that lubricant in that service.

Parts Evaluated for Each Engine as Appropriate to Engine Type

Air Box
Bearings (Connecting Rod Only)
Bushing—Piston Pin and Articulated Pin
Cams
Camshafts
Covers—Top Deck or Rocker Box
Crankcase
Crankcase Covers
Heads (Combustion Face)

Inserts—Piston Pin
Liners—Cylinder
Mechanism—Valve
Pins—Piston and Articulated
Pistons (Ring belts, Crowns and Undercrowns)
Ports—Inlet
Rings—Piston
Valves—Inlet and Exhaust
Washers—Thrust

Test Inauguration

The engines used for test and control locomotives should be new or have been newly overhauled. The lubricating oil system external to the engine such as filters, cooler and the radiator system must be cleaned and inspected prior to satrt of test. A minimum of four power assemblies on each engine shall be new or rebuilt to factory standards. Two of these power assemblies are to be applied to each bank of the engine. In the case of GE engines two "oil test" pistons should be applied to the left bank assembly locations. If the power assembly parts are new, initial part measurement is unnecessary. However, *all* piston ring side clearances on EMD are to be recorded.

Conduct of Test

Locomotives should be load-tested prior to beginning service and as frequently as necessary during the conduct of the test to assure normal operation.

A schedule of inspections shall be established for each test and include, as a minimum, quarterly and end of test. Under normal conditions it is not necessary to remove parts from the engines at the quarterly inspection point.

Crankcase inspections and deposit ratings as well as top deck deposit ratings should be made in at least two cylinder locations at the six month point.

At the six month inspection, cylinders of GE engines are to be borescoped for evidence of piston ring sticking or cylinder scoring. This same evaluation is to be performed on EMD engines by "air box inspection." On EMD units, top ring side clearances are to be determined and recorded at this inspection.

Oil changes are to be made based on laboratory analysis. The limits are to be those published by the engine manufacturer for this purpose unless agreed to by all parties prior to the test. A record of all lubricating oil changes is to be included in the final report.

A lubricating oil sample is to be obtained and analyzed by the oil company at minimum of monthly intervals. The analysis should consist of the following determinations as a minimum: viscosity at 100° F., pentane insolubles, pH, Total base number and wear metal determination by spectrographic or atomic absorption procedures.

Every effort should be made to prevent mixing of the test lubricant and others available on the railroad. If at all possible, a supply tank complete with pump, hose and nozzle should be available at the major service point to facilitate proper oil addition. Where possible and necessary an onboard lubricating oil supply tank should be installed for service away from the main terminal. Decisions on these points should be reached prior to the beginning of test. The oil company involved should procure and analyze sufficient samples of lubricating oil to

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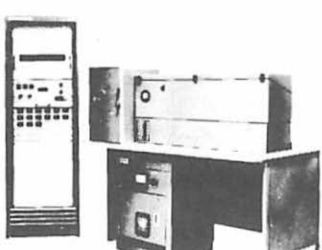


establish the degree of crankcase oil mixing.

A sample of fuel oil from the on-board tank should be obtained and analyzed at the start of test, at the mid point of test and at test conclusion. Tests should include: gravity, cetane index, sulfur and distillation. These analyses should form a part of the final report.

A complete record of all parts removed and all service performed on each test engine and each control engine during the course of the evaluation shall form a part of the final report.

At the end of the evaluation, the four "test" power assemblies shall be removed from each engine and completely evaluated as detailed in the appendix.

Rating Methods

In general the methods used for rating engine parts will be those developed by the Coordinating Research Council, Inc. These methods are covered in "CRC Manual No. 5." Parts of this manual are currently in the process of revision. The appropriate revised sections are included in Appendix A.

It is not necessary to rate all of the engine parts in as much detail as covered in the CRC Manual. In general there are three types of ratings: condition, deposits and measurement. The most complex of these rating techniques is that associated with deposits. Considerable experience is required to obtain consistent results. Rating symposiums are conducted periodically under the auspices of the Coordinating Research Council. The oil companies normally employ a number of individuals who are very competent in judging the degree of deposits and who regularly participate in these programs. It is recommended that the appropriate person in the oil company perform the end-of-test ratings. The following defines the type of rating believed necessary for the conduct of an oil evaluation test. At the discretion of the test team, additional ratings may be made.

Deposit Only

Air box, covers—top deck or rocker box, crankcase, crankcase covers, heads (combustion face) and ports—inlet.

Condition Only

Bearings, bushings, cams, camshafts, valve mechanisms and pins.

Deposit, Condition and Measurement

Liners—cylinder, piston and rings—piston

Valves—inlet and exhaust and washers—thrust

Appendix A lists appropriate extractions from CRC Manual No. 5.

Final Report

The oil company involved will present a written report to the participating railroad and participating engine builder. The railroad technical department and the engine builder will cooperate in preparation of the report, but their participation shall not constitute an endorsement of the product.

The final report shall include tabulated wear and deposit ratings, illustrative photographs, lubricating oil analysis data and maintenance records as defined elsewhere. The following photographs representing typical conditions are to be included. In addition any abnormal condition should be documented by photograph where appropriate.

Bearings, Rod
Bearing surface and back

General
Air box—left bank front and rear
Top deck or rocker box, their covers and valve gear
Main frame

Head
Full fire face with valves in place
Close-up of two valve seats

Piston
Side view close-up full piston with rings
Close-up of ring belt without rings
Top view of crown
Undercrown
Rings—Detail
Silver insert bearing

Valves
Close-up of entire set after removal showing faces and stem up to weld joint.

LMOA DIESEL ENGINE LUBRICATING OIL FIELD EVALUATION PROCEDURE

APPENDIX A
RATING TECHNIQUES

Condition

The condition of bearings, bushings, and washers should be evaluated by noting: wiping, abrasion, indentation, embedment, fatigue or other structural changes. These conditions should be described as a percent of bearing area affected and the degree of such condition. CRC Manual #5 contains reference photographs and definitions appropriate to describe these conditions. In the event that significant deposits are evident on these parts, this fact should be recorded, the type deposit noted and the degree defined.

Parts such as rocker arm shafts, piston pins and articulated pins should be observed for scoring, scuffing, scratching, fretting, etc. These conditions should be described and defined as the percent of bearing area affected. A visual examination of the liner bore should be made. Note carbon drag, port milling, scuffing, etc., if practicable.

Deposits

In general the types of deposits are: ash, carbonaceous, lacquer and sludge. The numerous parts of the piston which must be rated is likely to contain at least some of all of these types of deposits. The CRC Manual concerning piston deposits was revised in June, 1975. The most important features of the rating system will be covered in a separate section of this Appendix. The principal deposits which must be rated in the air box, top deck and rocker box covers, crankcase and crankcase covers will consist of lacquer and sludge.

Valve condition and deposit ratings are fully explained in the CRC Manual. Valve nomenclature, valve distress conditions (definitions and examples) and a valve deposit scale are contained in the manual.

The inlet and exhaust port deposits will most frequently consist of a mixture of carbonaceous and ash deposits. The rating assigned to these deposits is known as CRC Volume Factors, which is described in Appendix B of Manual 5. The texture of the material should be defined as follows:

1. **Hard:** Does not crumble when worked with fingers. Shatters when probed.

2. **Medium:** Requires moderate pressure to crumble. Yields as a tough material when probed.
3. **Soft:** Yields to light pressure, can be plastically deformed.

In many cases, it is desirable to describe these deposits based upon percent orifice restriction. In this case, both the exhaust passage deposit and valve tulip deposit must be considered in determining the percent restriction.

The combustion chamber surface of the cylinder head with the *valves in place* shall be assigned a demerit rating based on the same Volume Factor technique.

Measurement

The only parts considered necessary to evaluate for wear are: cylinder liner, piston rings, piston ring groove and thrust washer. Micrometers, a dial bore gage, feeler gages and a piston ring gage (an accurately machined and measured steel ring with the I.D. the exact dimension of the cylinder liner I.D.) are required. Engine manufacturers' instruction manuals are to be considered as most important method reference.

The cylinder liner should be measured at four locations as follows:

A. Just below top ring travel.
B. At mid-stroke.
C. At bottom position of top ring travel.
D. Below piston ring travel.

For two-cycle engines it is frequently desirable to measure at a point just below the port belt.

It is generally desirable to measure the I.D. in two directions; in the direction of piston thrust, and at the 90°, or parallel to the engine crankshaft.

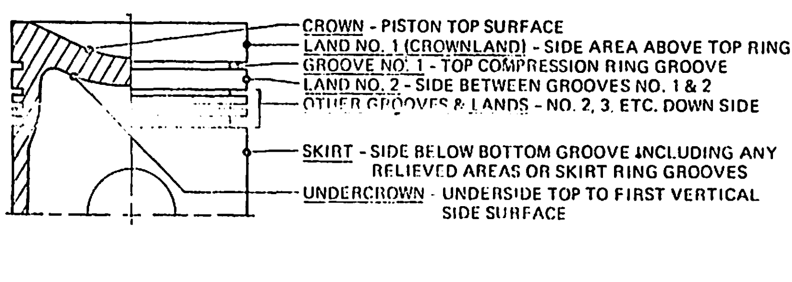
Piston ring end gaps are to be determined. Clean the carbon from the ends of the gap prior to measurement. Insert the ring in the gage and determine the end gap using a feeler gage. The piston ring thickness should be determined at five locations using a micrometer as follows: at each tip, 90°, 180°, and 270°. Report average.

The piston ring groove dimension may be determined using either gages provided by the engine manufacturer or feeler gages.

Thrust washer thickness should be determined using a micrometer. Measurements are to be made near I.D. and O.D. at 90° intervals (eight readings total).

Piston Deposits

The piston zonal terminology as used by CRC is shown here.



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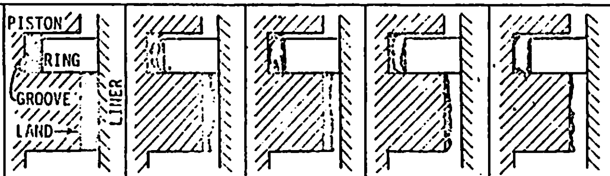
The CRC System defines a demerit rating method where 0 = Clean and 100 percent Heavy Carbon = 100. Five levels of carbon deposits are used in the method as illustrated below:



TYPICAL ILLUSTRATION					
CLEARANCE FILL	100%	>2/3	1/3-2/3	1/6-1/3	<1/6
SYMBOL	HC	MHC	MC	LC	VLC
DEPOSIT FACTOR	1.00	0.75	0.50	0.25	0.15

Note that any carbon deposits found on the inner ring face will be rated and noted separately. These deposits *should not* be added to the groove deposits. Groove deposits at the 100 percent clearance fill level are mostly polished. However, even low levels of carbon can exhibit polished areas due to an excess amount of carbon on the back of the ring and relative ring movement. When evidence of carbon polish occurs, the inner ring face will still be rated, but the level of carbon ,ll in the groove will be termed as 100 percent for that particular segment.

The carbon factors are designed so that the numerical demerit rating will approximate the estimated percent filling of a groove.

The range of lacquer deposit severity is divided into six categories representing increasing degrees of film thickness and oxidative state. These six categories are defined as follows:

DEPOSIT DESCRIPTION		SYMBOL	FACTOR
LACQUER	AVG. COLOR VALUE		
BLACK LACQUER	0	BL	0.100
DARK BROWN LACQUER	2.5	DBrL	0.075
AMBER LACQUER	5.0	AL	0.050
LIGHT AMBER LACQUER	7.5	LAL	0.025
VERY LIGHT AMBER LACQUER	9.0	VLAL	0.010
RAINBOW INTERFERENCE	9.5	RI	0.000
CLEAN, NO DEPOSITS	10	CL	0

An anodized aluminum color chip scale defining the maximum deposit level in each category has been developed and is available from the

Coordinating Research Council, Inc.
Thirty Rockefeller Plaza
New York, New York 10020

In rating field test engines it has been found practical to rate pistons in four quadrant segments. Each zonal quadrant is rated as an area containing 100 percent area. The four segments are averaged to obtain an overall zonal rating. The zonal ratings are obtained as follows:

$$\text{Quadrant Zonal Demerit} = \sum (\text{Area \%} \times \text{Deposit Factor})$$

$$\text{Zonal Demerit} = \frac{\sum \text{Quadrant Zonal Demerit}}{4}$$

Table 1 shows an example of a piston rated by this method.

Piston crown ratings and other areas containing carbonaceous deposits can be converted to demerit ratings by using the factors for the various carbon levels.

$$\text{Demerit} = \sum (\text{\% AREA covered} \times \text{FACTOR})$$

Piston Ring Rating

Rings should always be treated individually for ratings. The back, top and bottom of a ring are considered as the total ring area subject to deposits. Demerit ratings for such deposits can be calculated when desired.

Rings can exist in four states defined as follows:

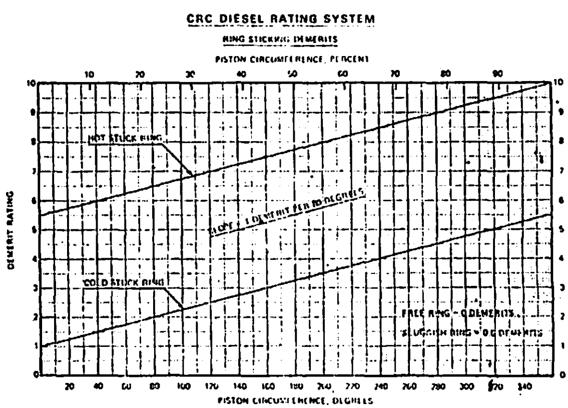
FREE RING—One that falls of its own weight as a piston is held on its side or inverted.

SLUGGISH RING—One that does not fall but yields to slight pressure.

COLD STUCK RING—One held firmly in the groove but showing no evidence of blow-by across its face.

HOT STUCK RING—One held firmly in the groove with blow-by streaks across its face.

Rings should be tested for sticking as soon as the piston is removed and before deposits and residual oil are disturbed. The rings are rated as to state of sticking and the degree of circumference stuck using the following demerit standard:



Sludge and Lacquer Deposits

A merit rating system similar to the method used in rating gasoline engines has been approved by the CRC Rating Group for inclusion in the rewritten Manual No. 5.

The sludge gage shown in Figure 1 is used to determine sludge depth. This gage can be obtained from the Coordinating Research Council. Tables 2 through 5 show the conversion tables and graphs for converting sludge depth and areas to merit ratings. Two examples of sludge ratings are as follows:

Example 1—Light Sludge Levels

Sludge Depth	Area Covered, %	Volume Factor	Merit Rating
Clean	10	—	
A	20	0.2	
AB	20	0.3	
C	50	2.0	
		2.5	7.0

Example 2—Heavy Sludge Levels

Sludge Depth	Area Covered, %	Volume Factor	Merit Rating
G	10	6.4	
H	50	64.0	
I	40	102.0	
		172.4	—2.1

Lacquer deposits are rated using the CRC Lacquer Rating Scale contained in Manual No. 5. The lacquer demerit rating is obtained by using the following formula:

$$\text{Lacquer Demerit Rating} = \frac{\sum(\%\ \text{AREA} \times \text{COLOR FACTOR})}{100}$$

$$\text{Lacquer Merit Rating} = 100 - \text{Lacquer Demerit Rating}$$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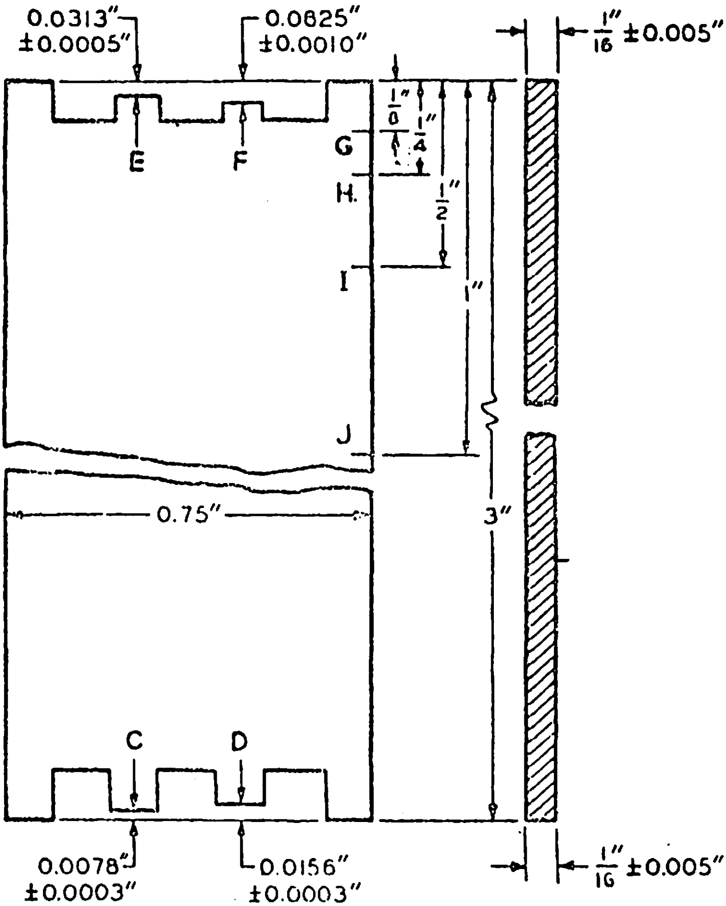
CRC SLUDGE DEPTH GAGE



ALL GAGE TOOTH DIMENSIONS TO BE FINISH-GROUND TO THE TOLERANCES INDICATED WITH NO BURRS, OR ROUNDED CORNERS. GAGE TOOTH SURFACES TO BE SMOOTH AND PARALLEL.

SCALE = 4:1 APPROX.

EXAMPLE OF PISTON RATING

PISTON ZONE	DESCRIPTION OF DEPOSITS AND THEIR LOCATION				DEMERIT RATING				
	1ST QUADRANT	2ND QUADRANT	3RD QUADRANT	4TH QUADRANT	1Q	2Q	3Q	4Q	AVG
GROOVE NO. 1	50 MC 50 LC	100 LC	80 MC 20 LC	100 LC	37.50	25.00	45.00	25.00	33.13
GROOVE NO. 2	5 MC 20 LC 75 VL	10 MC 20 LC 70 VLC	20 MC 10 LC 70 VLC	10 MC 20 LC 70 VLC	18.75	20.5	23.00	20.5	20.69
GROOVE NO. 3	30 MC 70 LC	70 LC 30 VLC	60 MC 40 LC	80 MC 20 LC	32.50	22.00	40.00	45.00	34.88
OIL GROOVE NO. 1	100 BL	25 BL 5 AL 70 LAL	40 BL 60 LAL	90 BL 10 AL	10.00	4.50	7.00	9.5	7.75
CROWN LAND	50 HC 20 LC 30 VLC	20 HC 30 MC 20 LC 30 VLC	5 HC 10 LC 85 VLC	20 HC 10 LC 60 VLC 10 LAL	50.50	44.50	20.25	31.75	39.00
2ND LAND	20 VLC 80 BL	20 VLC 70 BL 10 AL	30 VLC 70 BL	50 VLC 40 BL 10 AL	11.00	10.50	11.50	12.00	11.25
3RD LAND	30 VLC 70 BL	70 LC 30 VLC	30 LC 70 VLC	100 VLC	11.50	22.00	22.00	15.00	17.63
4TH LAND (TOP)	50 LC 50 VLC	30 LC 70 VLC	20 LC 80 VLC	100 VLC	20.00	18.00	17.00	15.00	17.50
4TH LAND (BOT)	100 VLC	80 LC 20 VLC	60 LC 40 VLC	100 LC	15.00	23.00	21.00	25.00	21.00
SKIRT	10 AL 10 LAL								0.75
UNDER CROWN	SEE SEPARATE SHEET								
RING STICKING	ALL FREE								

Conversion of Area and Depth to Volume Factor

% of Area Covered	Depth														
	1/4A	½ A	3/4A	A	AB	B	BC	C	D	E	F	G	H	I	J
5	.01	.02	.04	.05	.08	.10	.15	.2	.4	.8	1.6	3.2	6.4	12.8	25.6
10	.02	.05	.08	.10	.15	.20	.30	.4	.8	1.6	3.2	6.4	12.8	25.6	51.2
15	.04	.08	.11	.15	.22	.30	.45	.6	1.2	2.4	4.8	9.6	19.2	38.4	76.8
20	.05	.10	.15	.20	.30	.40	.60	.8	1.6	3.2	6.4	12.8	25.6	51.2	102
25	.06	.12	.19	.25	.38	.50	.75	1.0	2.0	4.0	6.0	16.0	32.0	64.0	128
30	.08	.15	.22	.30	.45	.60	.90	1.2	2.4	4.8	9.6	19.2	38.4	76.8	154
35	.09	.18	.26	.35	.52	.70	1.05	1.4	2.8	5.6	11.2	22.4	44.8	89.6	179
40	.10	.20	.30	.40	.60	.80	1.20	1.6	3.2	6.4	12.8	25.6	51.2	102	205
45	.11	.22	.34	.45	.68	.90	1.35	1.8	3.6	7.2	14.4	28.6	57.6	115	230
50	.12	.25	.38	.50	.75	1.00	1.50	2.0	4.0	8.0	16.0	32.0	64.0	128	256
55	.14	.28	.41	.55	.82	1.10	1.65	2.2	4.4	8.8	17.6	35.2	70.4	141	282
60	.15	.30	.45	.60	.90	1.20	1.80	2.4	4.8	9.6	19.2	38.4	76.8	154	307
65	.16	.32	.49	.65	.98	1.30	1.95	2.6	5.2	10.4	20.8	41.6	83.2	166	333
70	.18	.35	.52	.70	1.05	1.40	2.10	2.8	5.6	11.2	22.4	44.8	89.6	179	358
75	.19	.38	.56	.75	1.12	1.50	2.25	3.0	6.0	12.0	24.0	48.0	96.0	192	384
80	.20	.40	.60	.80	1.2	1.60	2.40	3.2	6.4	12.8	25.6	51.2	102	205	410
85	.21	.42	.64	.85	1.28	1.70	2.55	3.4	6.8	13.6	27.2	54.4	109	218	435
90	.22	.45	.68	.90	1.35	1.80	2.70	3.6	7.2	14.4	28.8	57.6	115	230	461
95	.24	.48	.71	.95	1.42	1.90	2.85	3.8	7.6	15.2	30.4	60.8	122	243	486
100	.25	.50	.75	1.00	1.50	2.00	3.00	4.0	8.0	16.0	32.0	64.0	128	256	512

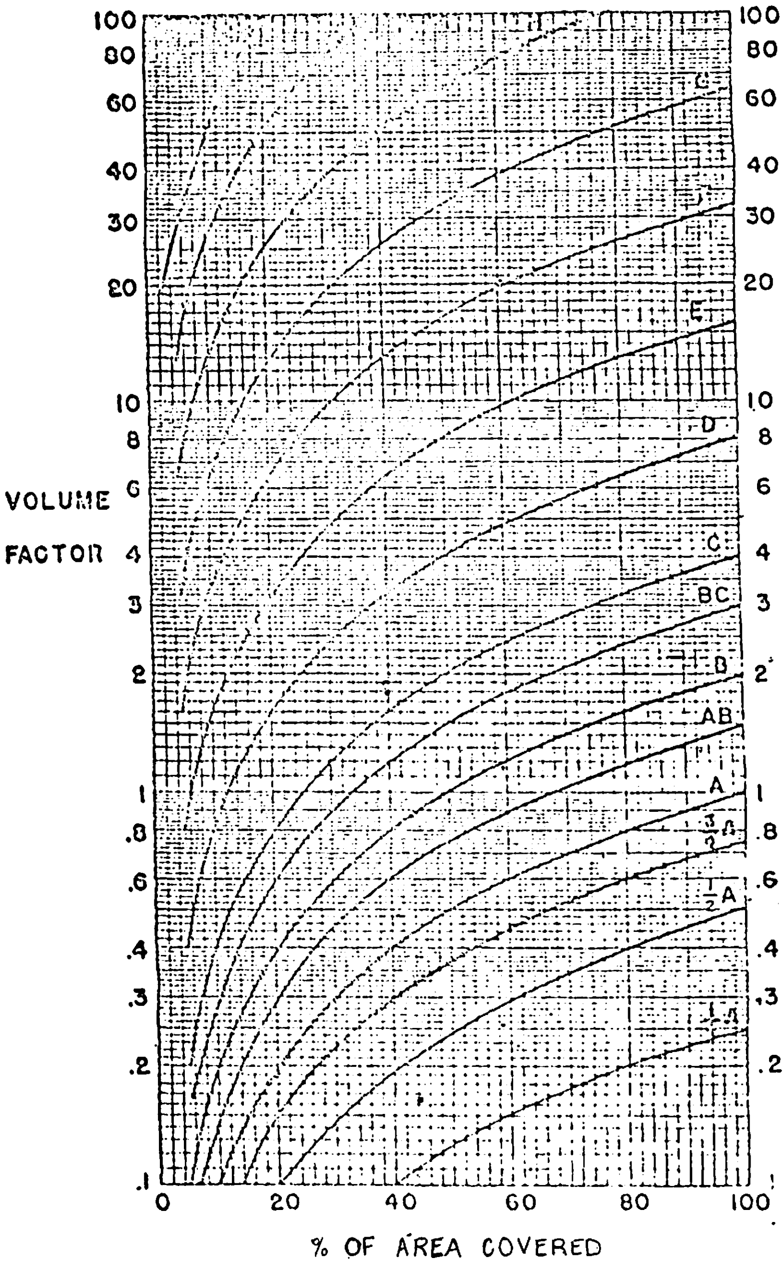
Note: All values are rounded off in accordance with the procedure given in ASTM E29

Conversion of Volume Factor to Merit Rating

Merits	0.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
9.0	1.0	.90	.80	.70	.60	.50	.40	.30	.20	.10
8.0	1.6	1.5	1.45	1.4	1.3	1.25	1.2	1.15	1.1	1.05
7.0	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.75	1.65
6.0	4.0	3.8	3.6	3.5	3.3	3.2	3.1	2.9	2.7	2.6
5.0	6.4	6.1	5.8	5.6	5.3	5.1	4.8	4.6	4.4	4.2
4.0	10.0	9.7	9.3	8.8	8.4	8.0	7.6	7.3	7.0	6.7
3.0	16.0	15.4	14.6	14.0	13.3	12.8	12.2	11.6	11.1	10.6
2.0	25	24	23	22	21	20	19.4	18.4	17.5	16.8
1.0	40	39	37	35	34	32	30	29	28	27
0	64	61	59	56	53	51	49	47	44	42
-0	64	68	70	74	77	80	85	88	94	97
-1	102	106	112	118	122	128	135	140	148	154
-2	160	170	176	187	194	204	212	224	236	244
-3	256	270	280	296	308	320	340	352	374	388

Merit Rating = 10 - Volume Factor, when Volume Factor ≤ 1

Merit Rating = 9 - 2.17050 ln Volume Factor, when Volume Factor > 1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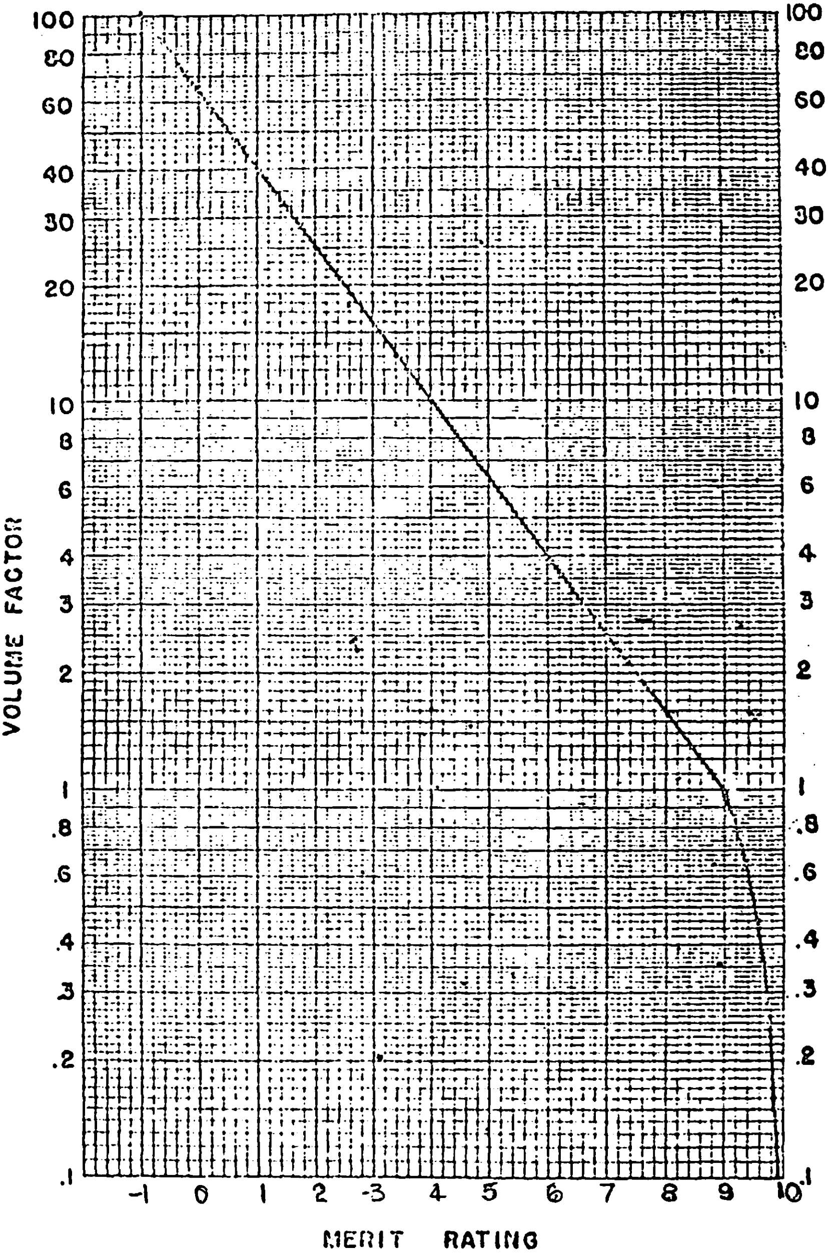
% OF AREA COVERED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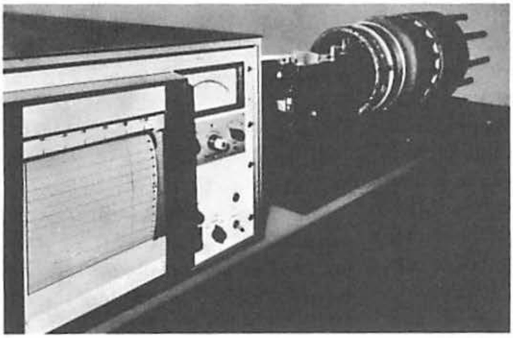
MERIT RATING



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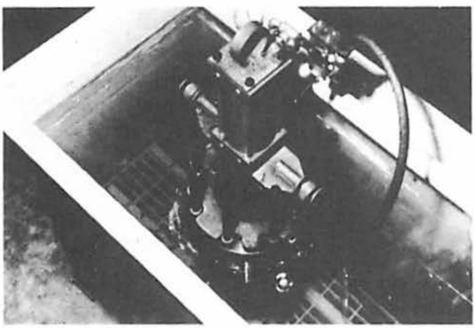

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II
PETROLEUM INDUSTRY SUPPLY/DEMAND

Between now and the end of this decade, the growth in demand for motor gasoline is forecasted to average less than 1 percent annually. This projection is based upon the present EPA regulations which require new cars to meet certain minimum MPG standards. Beginning in 1980, motor gasoline demand is projected to decline because of the EPA regulations, which will require the mix of new cars to average 20 MPG and by 1985 to average at least 26 MPG. MoGas sales in 1985, under these conditions, will drop to 6.1 MMBD—about the level experienced in 1971-1972. Two major assumptions in this forecast are: (1) the average annual mileage per car rises to 10,000 miles by 1980—currently 9,500 miles per year—and holds at that level, and (2) the net increase in registration will be 2 million cars per year.

Given the above gasoline figures and assuming a growth in distillate demand of about 4 percent annually from 1975 to 1980 and about 2.5 percent annually for the period 1980-1985, it will be necessary to lower gasoline yields and increase distillate yields from crude to the point where the industry will be maximizing distillate and minimizing gasoline on a year-round basis by the early 1980's. Between 1980 and 1985, the industry would find it necessary to modify or close down some of its cracking operations in order to provide the necessary distillate fuels.

Demand for other products, including residual fuel and petrochemical feedstocks, has been assumed to grow at between 2 and 3 percent each year.

It should be noted that at the growth rates used, total domestic demand increases at 1.4 percent annually from 1975-1985. At this rate of growth, refinery crude runs of 14.3 MMBD in 1980 and 15.0 MMBD in 1985 would be adequate to supply these needs. At the present time, industry refining capacity is 15.1 MMBD. Firm announced expansion plans will increase capacity to 16.6 MMBD by the end of 1978. Based on this level of expansion, the industry would be using about 86 percent of capacity in 1980 and about 90 percent in 1985.

Imports would have to be increased from 5.8 MMBD in 1975 to 6.7 MMBD in 1980 and to 7.6 MMBD by 1985.

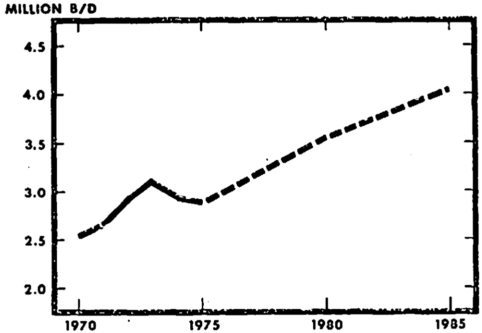
The demand growth rates for distillates and other products could prove to be optimistic if the supplies of other fuels, particularly coal and nuclear, are expanded and used as alternatives to petroleum. Should that occur, or if for other reasons the growth rates assumed prove to be optimistic, then the need to change or modify cracking operations would be delayed and import levels be less than projected.

GROWTH RATES

(AVERAGE ANNUAL PERCENTAGE)

	1975-1980	1980-1985	1975-1985
GASOLINE	+ 0.6	- 2.3	- 0.9
DISTILLATE	+ 4.3	+ 2.6	+ 3.5
ALL OTHER	+ 3.0	+ 2.0	+ 2.5
TOTAL - ALL PRODUCTS	+ 2.3	+ 0.6	+ 1.4

DISTILLATE DEMAND



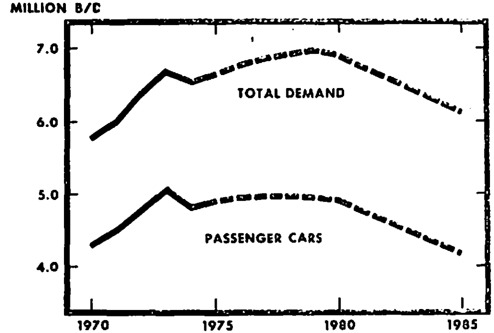
DISTILLATE DEMAND
(MILLIONS B/D)

	1970	1975	1980	1985
HEATING	1.4	1.3	1.5	1.6
INDUSTRIAL	.2	.2	.3	.3
ELEC. UTILITY	.1	.3	.4	.4
TRANSPORTATION	.7	1.0	1.3	1.5
OTHER	.1	.1	.1	.2
TOTAL	2.5	2.9	3.6	4.0

GROWTH RATES

1975 - 80	+ 4.3%
1980 - 85	+ 2.6%
1975 - 85	+ 3.5%

GASOLINE DEMAND



GASOLINE DEMAND
(MILLIONS B/D)

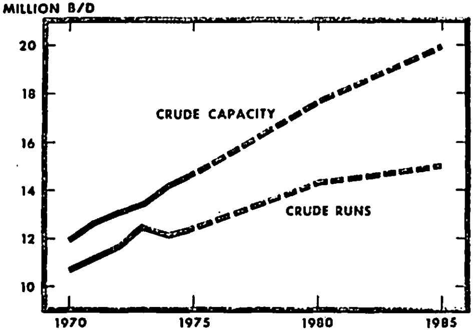
	1970	1975	1980	1985
PASSENGER CARS	4.3	4.9	4.9	4.1
ALL OTHERS (1)	1.5	1.8	2.0	2.0
TOTAL	5.8	6.7	6.9	6.1

GROWTH RATES

1975 - 80	+ 0.6%
1980 - 85	- 2.3%
1975 - 85	- 0.9%

(1) TRUCKS, BUSES, MOTORCYCLES, BOATS, TRACTORS, ETC.

REFINERY OPERATIONS

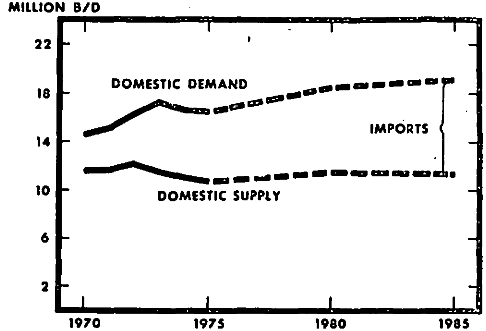


REFINERY OPERATIONS
(MILLIONS B/D)

	1970	1975	1980	1985
CRUDE CAPACITY (1)	11.9	14.8	17.7	19.9
CRUDE RUNS	10.9	12.4	14.3	15.0
CAPACITY USED	92%	84%	81%	75%

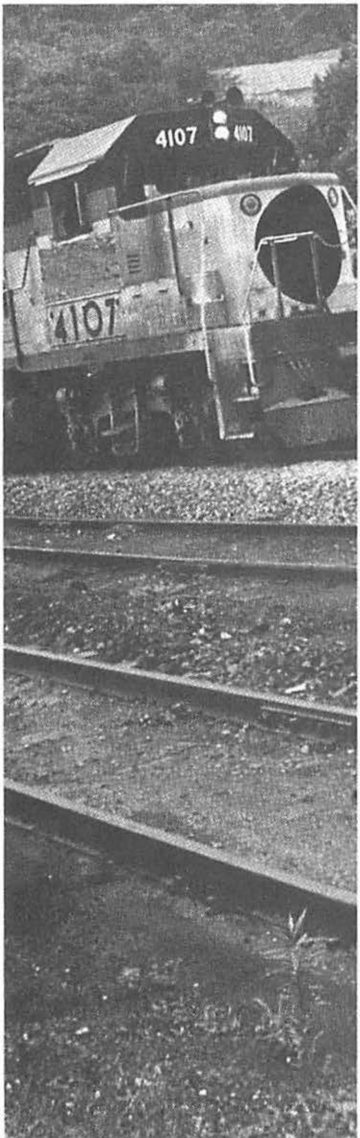
(1) MID-YEAR AVERAGE, HISTORY FROM B.O.M. AND FORECAST FROM F.E.A.

TOTAL PETROLEUM SUPPLY-DEMAND



TOTAL PETROLEUM SUPPLY-DEMAND
(MILLIONS B/D)

	1970	1975	1980	1985
DOMESTIC DEMAND (1)	14.7	16.3	18.3	18.8
DOMESTIC SUPPLY				
DOMESTIC PROD.	9.6	8.4	7.6	6.5
NORTH SLOPE	-	-	1.6	2.0
NAVAL RES.	-	-	.3	.4
PAC/ATL. OFF.	-	-	-	.3
NGL	1.7	1.8	1.6	1.5
PROCESS GAIN	.5	.6	.7	.7
EXPORTS	(.2)	(.2)	(.2)	(.2)
(TO) STOCKS)	(.2)	(.1)	-	-
TOTAL	11.4	10.5	11.6	11.2
IMPORTS				
CRUDE	1.3	4.1	4.8	5.8
PRODUCTS	2.0	1.7	1.9	1.8
TOTAL	3.3	5.8	6.7	7.6



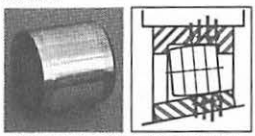
FACT:

In 1928, FAG developed a new cylindrical roller bearing. Today, it's still the standard for the railroad industry.

When yesterday's iron horse gave way to the diesel electric, railroad bearing technology was in for a change. Loads increased dramatically. Temperatures and speeds jumped. The shock hazard grew. FAG responded to the new mechanical environment with a traction motor bearing that has withstood nearly a half century of worldwide OEM and MRO applications.

A few facts:

• Crowned roller design eliminates roller edge-loading failures and accommodates armature shaft deflection without excess stress concentration.



FAG's crowned roller under stress

• Forged steel rings of vacuum degassed and heat treated steel provide maximum load capacity, shock resistance, dimensional stability.
• Machined brass drop-roller cages ease the disassembly of rollers and cage from the outer ring for inspection.
• Special precision tolerances maintain uniform load distribution and minimize vibration at high speeds.
• FAG produces traction motor bearings for all types of locomotives.

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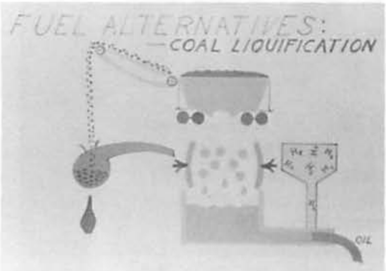
III
FUEL ALTERNATIVES – THE GASIFICATION AND LIQUEFACTION OF COAL



The United States has entered an era vastly different from any in the past. This is at least partially due to the changes occurring in traditional patterns of energy availability. We have used our energy resources as if they were essentially inexhaustible. The need for concern over exhaustion of these resources seemed so very far in the future. But, the present is now the future and the days of plentiful supplies of inexpensive energy have become the past.

We hear now of energy crisis, resource allocation, and high prices. Past progress in America in employment, standard of living, and the welfare of society resulted, in part, from abundant supplies of cheap energy. Without sufficient energy sources, the nation's present and future well being will be adversely affected. Greater capital investment is needed to maintain our standard of living. The energy crisis demands action!

Oil and gas account for about three-fourths of the energy used in the U.S. Coal, one of the most abundant mineral fuels, supplies only 17 percent of the nation's needs.

This report shows how coal, which has the reputation of being dirty, dangerous to mine, expensive to transport and awkward to handle, can be made into clean fuels, some liquid, other gas.

Coal is increasingly cast as the fuel of the future. Resources are estimated at 3,200 billion short tons. Of that amount 2,800 billion tons are less than 1,000 feet below the surface, 390 billion, or 12 percent, are commercially recoverable with present mining technology. There is enough coal to supply U. S. energy needs for 100 to 300 years and longer if recovery technology keeps pace with needs.

Research into ways coal can be utilized is important to all energy users. NOTE: railroads are relatively *low* users of energy on a ton-mile basis as well as in the aggregate, when compared to trucks. High energy consumers, such as electric utilities, heavy industry, and the U.S. Government have a high stake in converting coal into a more acceptable energy state. A reliable and available energy source undergirds the nation's prosperity and productive capacity. When that capacity decreases or is curtailed severely, all business activity slows.

Gasification of coal has been practiced for over fifty years. Originally, the product was a relatively low heating value "town gas" of 500-600 BTU per cubic foot. Today, by rather straightforward processing, high (900-1,000) BTU value pipeline quality gas can be produced by several methods. There is no need to go into the details of each process. COED, COGAS, and DYNTHANE are three of many processes that produce either liquids or gas or both from coal.

Each takes a "town gas"-like product produced by heating coal at high temperatures (2,000+°F). The product is carbon monoxide, hydrogen, a small amount of methane (natural gas), and crude oil. The raw gas mixture is compressed over catalysts (nickel, tin, or iron) to form methane. The reactions are: carbon monoxide with water to produce hydrogen and carbon dioxide.

$$CO + H_2O \rightarrow H_2 + CO_2$$

More carbon monoxide reacts with the hydrogen to produce methane and water.

$$CO + 3\ H_2 \rightarrow CH_4 + H_2O$$

This step is called methanation. It produces pipeline quality gas with 950-1000 BTU per cubic foot heating value.

An American Gas Association study shows there is sufficient uncommitted coal with available water to support 176 such synthetic pipeline gas plants each capable of producing 250 million cubic feet of gas per day for a total of about 540 trillion cubic feet of pipeline quality gas each day.

Coal liquefaction may be of more immediate interest to railroaders wanting to assure a supply of fuel to run their locomotives.

Liquefaction, in simplified terms, is carried out by increasing the hydrogen content of feed coal. Addition of 2 percent to 4 percent hydrogen yields a heavy crude oil that is fluid at room temperature. This fuel, when de-ashed and de-sulfurized, is suitable for use as a conventional electrical powerplant fuel. When hydrogen content is increased to 6 percent, the product consists of distillate light oils and diesel fuels. Going even further, 8 percent to 10 percent added hydrogen gives gasoline or lighter oils that have as much as 14 percent hydrogen content.

The prime aim of all coal liquefaction processes is to make clean fuel. This means, among other things, removing sulfur to insure an environmentally acceptable fuel. The sulfur is removed by hydrogen as hydrogen sulfide (rotten egg smell). Hydrogen sulfide is separated and converted to elemental sulfur.

Any fully developed process serves as the starting point for design of processes to make upgraded fuels by either more extensive one-step hydrogenation or additional secondary hydrogenation of the primary heavy fuel oil. In either case, the upgraded product can be fractionally distilled to yield light oils, gasoline, diesel oil, and minor quantities of residual fuel oil. After liquefaction, process waste disposal problems with coal are much less severe than with shale oil.

A million tons of coal processed per day to clean fuels would yield about 10 percent of the current daily U. S. oil needs. The coal mining industry could conceivably meet such a demand. Capital, manpower, and environmental problems would certainly occur during the development of such a program.

Two interesting spin offs from the hydrogenation procedures have been discovered: (1) solvent extraction or dissolving of coal and (2) waste-to-oil processing.

Solvent extraction or dissolution processes use a high-boiling solvent, usually derived from the coal, and a small quantity of hydrogen. This mixture is used to dissolve the coal at elevated temperature and pressure. A solution that contains about 90 percent of the carbon in the original coal is formed, and almost all the ash and sulfur are removed. The product then separates on cooling the extract. Any bituminous or lower grade coal can be solvent refined, and the resulting solvent-refined coal liquefied at about 350°F for use as boiler fuel if the volatile matter is not removed. This type of process can be used with high-sulfur coals. The product can also be converted to high-grade syncrude on hydrogenation.

Waste-to-Oil Process is very similar to liquefaction of coal. The same processing principles are used on waste materials to convert cellulose to oil in a reactor at 3000 psi and 650°F. In this process Na_2CO_3 is added as a catalyst. The net yield of oil is about 1.2 bbl/ton of dry organic waste. The heavy product oil has a heating value of about 15,000 BTU/lb. and contains less than 0.4 percent sulfur.

The process converts any cellulosic waste, such as urban organic refuse, agricultural and wood wastes, or cattle manure, to a low-sulfur fuel suitable for powerplant use. Since approximately 3 billion tons of raw waste are generated yearly in the United States, this process has the dual advantage of disposing of vast amounts of solid waste and at the same time producing a highly desirable fuel. The Bureau of Mines is currently sponsoring the construction of a $3 million process development unit at Albany, Oregon, which will process 1 to 3 tons per day of dry wood waste. Construction is estimated to take about 2 years and will be completed at the end of 1976. Shakedown operations should begin in early 1977.

What characterizes the liquids produced by the liquefaction of coal? Unlike petroleum oils produced from shale, liquefied coal is very aromatic. Certain hydrotreating conditions that remove sulfur, nitrogen, and oxygen but minimize saturation of aromatics, produce a naphtha with a 95 to 100 clear Research octane number. Aromatic content ranges from 69 percent to 86 percent.

Since coal yields highly aromatic gasolines, it comes as no surprise that the diesel fuels from coal are also highly aromatic. Limited data indicates a diesel index of 31. When boiling range products are saturated with hydrogen, a product with a 50 cetane number is produced—a very respectable fuel.

Characteristically, fuels produced from coal are high in oxygen, nitrogen, and some sulfur but low in hydrogen. Petroleum fuels are quite different. They are low in nitrogen, generally devoid of oxygen, can contain sulfur, but are high in hydrogen (14-15 percent). The secret of producing acceptable fuels from coal is hydrogenation. The greater the hydrogen content, the nearer the characteristics of the fuels become to that of their petroleum offsets.

Coal is an excellent starting material for making wood alcohol (methanol). You recall that gasification

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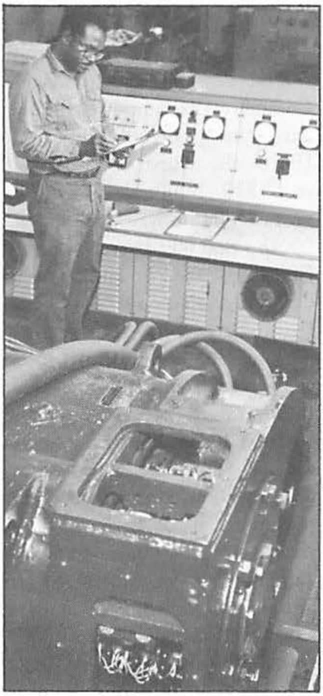

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produces carbon monoxide, carbon dioxide, and hydrogen. If these gases are passed over a zinc catalyst instead of iron, tin, or nickel, methanol is produced.

$CO + 2H_2 \longrightarrow CH_3OH + \text{Heat}$

Methanol is an acceptable fuel or blending agent for automotive uses.

Ammonia for fertilizer use can also be a coal gasification product. Nitrogen mixed with hydrogen (from CO and H_2O) over iron granules catalyst under high pressure and temperature gives ammonia. $N_2 + 3H_2 \longrightarrow NH_3 + 24$ cal. Feedstocks are generally semi-bituminous or low-quality coal (41 percent ash, 36 percent volatiles, and 1 percent sulfur).

How soon will coal be King?

Labor problems, uncertainty about environmental laws and their enforcement, plus a tendency to be backward about applying technological techniques will inhibit coal utilization. Capitalization required is also a hurdle. About 23 billion in 1972 dollars is needed for a 4 million barrels per day capacity (about $5,500 to $6,000 per daily barrel). Nonetheless, coal utilization seems certain to rise by the 1980's when the technology of burning coal insitu should be developed. If off-shore petroleum discoveries are large, coal usage might then be delayed until 1990's.

What will all this cost? Probably the biggest problem is finance. Few operating companies are willing or able to finance a major gasification or liquefaction project with their own funds. A typical plant is expected to cost $1 billion. Banks are not eager to put massive amounts of money into such major projects because of the uncertainty about the economic climate for coal conversion. The alternative for a coal conversion industry is to seek aid from federal and state government. Even the construction of a demonstration plant is beyond the means of most companies.

A Synthetic Fuels Commercialization Program is being designed to bring first generation coal conversion technology to the demonstration stage as soon as possible. The goal is a synthetic fuel industry that would produce the energy equivalent of 1 million barrels per day of crude oil by 1985. The first stage would be a 350,000 barrel per day plant expandable in the second phase to 1 million barrels per day.

The cost of the Synthetic Fuels Commercialization Program will vary with the price of imported crude. Under the worst conditions it would cost $15 billion over the next 20 years (about $.75 billion per year) for the 350,000 barrel per day phase. Likewise, the 1 million barrel per day program could cost $26 billion.

Illinois is very active in coal conversion. It has 1/6 of the nation's coal reserves and the necessary water. It has raised $70 million to combine with $237 million in Federal funds for a demonstration plant. The process (Coalcon) will consume 2,600 tons per day of high-sulfur coal and produce 3,900 barrels (ca 164,000 gallons) per day liquid fuels and 22 million scf per day of synthetic gas. Construction starts in 1977 with completion in 1980. A larger commercial plant is in the plans.

Summary

The basic liquefaction technology in commercial use or under development today with coal for syncrude production requires hydrogenation to achieve the higher H/C ratio of liquid hydrocarbons. The source of this hydrogen is wet coal burned to produce "town gas" (see page 2).

Coal liquefaction at high temperature alone tends to produce high aromaticity, while pyrolysis at lower temperatures yields liquids richer in paraffinic and hydroaromatic compounds. Thermal processing in the presence of hydrogen improves product yields of middle-distillate-type products.

Overall, the ideal process for converting coal to syncrudes would be one that avoids liquid-solid separation problems, is resid and char free, and produces high yields of low-sulfur, low-nitrogen syncrudes that are completely interchangeable with petroleum crudes. Annual coal production in the U.S. is equivalent to about 7 million barrels of crude oil per day.

Most of the development work carried out on hydrogenation of coal in the United States over the last several years has been concentrated on production of SNG. Synthetic natural gas from such processes costs about 6 to 8 times per 1000 cu. ft. compared to "new" natural gas. Integration of gasification and liquefaction technologies in a COAL-OIL-GAS Refinery could provide technical and economic benefits not possible in separate gasification and liquefaction plants. One of the benefits of integrating liquefaction and gasification is use of by-products of one process, such as char, as feed for the other process.

One of the factors that is notably absent from all of the reports on coal liquefaction technology concerns what might be called the Net Fossil Fuel Energy Production Efficiency. Little or no attention has been given to the total amount of fossil fuel energy expended in mining, transporting, and processing coal to produce syncrudes and syncrude derivatives. Since the overall objective is to produce new supplies of fossil energy, it seems essential to quantify how much energy is expended and how much is produced in each full integrated system.

Finally, it should not be forgotten that there are important environmental and social problems to be solved if mature syncrude industries based on coal are to survive. These problems need attention and effort now.

IV
NEW OILS AND ADDITIVES FOR THE FUTURE

One of the unique characteristics of the diesel lubricating oil market represented by the U. S. railroad industry is that many of the railroads specify a one additive system that must be used by the lubricant supplier. This policy may reduce the research incentives of lubricant suppliers, since it makes the use of proprietary systems virtually impossible for some companies. Some research is done by the additive suppliers who have the incentive of selling their products to oil suppliers. Most oil companies continue to research new products even with the prospect of not selling their own additive package.

The railroad diesel, or medium-speed engines including the two-and four-stroke models require the following characteristics of a lubricant.

1. Control deposits at elevated temperatures
   A. hard carbon
   B. ring sticking
   C. piston undercrown deposits
2. Adequate lubricity and corrosion protection
3. Protect against scuffing wear
4. Frictional properties to avoid clutch slippage–turbocharger
5. Performance for extended life.
6. High dispersancy for filter life and insoluble capacity
7. Tolerance to water leaks
8. Minimize valve train wear
9. Two-cycle engines – protection of silver wrist pin bushing from corrosion and lubricity failures.

Laboratory bench and engine tests of various types are performed to determine the initial effectiveness of any new oil to the above characteristics. After acceptance by engine builders, the oil undergoes field evaluation as outlined in Section I of this paper.

The so called "second generation" oils contain moderate levels of dispersant and calcium-based detergents, giving a base number (ASTM D-2896) in the 5 to 7 mg KOH/g range and sulfated ash levels of .5 to .8 percent.

The "third generation" oils have displaced many of the earlier types, with general characteristics as follows: SAE 40, medium viscosity index (75 max), high dispersant, calcium detergent, and 10 Total Base Number (TBN).

Tests performed by a high-speed freight fleet of high-horsepower engines have shown definite advantages for third generation oil.

1. Lower cylinder liner & ring wear
2. Less engine deposits
3. Improved dispersion qualities
4. Improved alkalinity retention.

Looking to the future, changes will likely include:

1. Conversion from medium viscosity index (naphthenic) base oils to high viscosity index (paraffinic) stocks due to oil supply shortages;
2. Improved oxidation & thermal stability to satisfy engines modified for emission controls or reduced fuel consumption;
3. Possible interest in multi-grade oils for cold weather starting resulting from curtailment of idling over long periods and fuel economy.

In the world today, 85 percent of proven crude supply is classified as paraffinic and 15 percent is classified as naphthenic. Due to the short supply of naphthenic base stocks, it is becoming increasingly more important that more industrial and diesel engine lubricants, oils, and greases, be formulated from high-viscosity index (paraffinic) base lubes. Some two-cycle engines are using high viscosity index (paraffinic) base stocks overseas and extensive field testing is beginning in the U. S.

The term "base stocks" refers to finished stocks as prepared by the refiner without additive components.

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Base stocks are refined to meet two categories of requirements:

1. Physical—viscosity level, viscosity index, pour point and flash;
2. Service performance—oxidation stability, corrosiveness and additive response.

Lubricant base stocks are manufactured from selected crudes using highly technical, complex, and carefully controlled processes. Through research it is known that all crudes are not good lubricant crudes. The following criteria are used to determine whether a crude is good for manufacturing lubes:

1. Supply—Availability, consistency of composition
2. Refining—Process yields and requirements
3. Product—Base stock quality, additive response, by-product quality.

Base stocks from paraffinic lubricant crudes are characterized as high VI, high wax content, low specific gravity, and low aromatic content. Paraffinic crudes require dewaxing to provide good low-temperature flow properties. On the other hand, naphthenic base oils have low VI, low wax content, high specific gravity, and good low temperature flow properties. Typical physical and chemical properties of paraffinic and naphthenic lube base oils are shown in the following Table No. 1.

	100 Sus. Neut.		500 Sus. Neut.		150 Sus. Bright	
Characteristics	Naph.	Para.	Naph.	Para.	Naph.	Para.
Specific Gravity	0.899	0.866	0.905	0.887	0.908	0.893
API Gravity	27.6	31.9	24.8	28.0	24.4	26.9
Pour, °F	– 35	0	– 20	20	20	20
Flash, °F	340	415	435	475	565	570
Vis at 100°F Sus.	108.9	115.1	557	500	3214	2291
at 210°F Sus.	38.9	40.7	59.1	63.9	156.8	145.6
VI	40	98	57	100	82	98
Distillation, °F						
5%	589	726	705	809	875	920
10%	610	742	732	856	926	935
30%	662	754	788	907	990	996
50%	700	771	825	936	1048	1049
90%	811	811	913	1005	1000	–
Composition						
Paraffins, % wt.	11.4	31.3	7.1	22.4	9.0	18.5
Naphthenes, % wt.	72.5	55.4	69.4	41.8	57.9	56.3
Aromatics, % wt.	16.1	13.2	23.5	35.8	33.1	25.2

Note: All Naphthenic Stocks From Same Crude, Paraffinic Stocks From Different Crudes.

The prime reason for use of naphthenic base oils has been the formation of softer carbon deposits rather than the hard carbon deposits produced by paraffinic lubricants that resulted in ring sticking and breaking. Through improved technology, it now is possible to formulate paraffinic lubricants that will satisfactorily lubricate the engine. Railroads in the U. S. almost exclusively use U. S. manufactured locomotives, and their lubricating oil specifications are keyed to the engine builders preference.

Owing to favorable field tests of paraffinic railroad oils in foreign countries, engine builders have been reevaluating long life oils of 10 to 13 TBN alkalinity with high VI base stocks.

In 1971, a 10 TBN paraffinic base lubricant was evaluated in 14 U. S.-made 2-cycle locomotives in West Europe. Excellent engine cleanliness was observed, and cylinder and ring wear were extremely low after 300,000 plus miles and 3 years without an oil drain. The filter change interval was every 25,000 miles and oil consumption averaged 7 gallons per 1,000 miles. Oil analysis revealed very low membrane insolubles of 0.8 percent wt. and the TBN reduced from 10 to 7.1. Other bench and engine test results showed that the oil performed satisfactorily and gave good overall protection to the engine.

Based on these tests it can be concluded that the conversion from naphthenic to paraffinic is possible, however it is not a simple base stock substitution but requires a complete formulation to optimize the base stock-additive package combinations.

Railroad engine oils have been converted to paraffinic base stocks in the foreign market. After continued laboratory tests and completion of U. S. field evaluations, we may assume that railroad diesel engines will be using higher VI (paraffinic) oils in the near future.

Based on laboratory evaluation and field testing marine and industrial oils, heat transfer oils, metal working fluids, greases and asphalts have been successfully converted to paraffinic base stocks. Transformer and refrigeration compressor oils have been more difficult to convert and will require more research.

Other research is continuing. The Mechanical Engineering Laboratory, Tokyo, Japan, has been experimenting with molybdenum disulfide as an additive in 20W to 40W high grade engine oils. An increase in the load carrying capacity was noted in the lubricity tests. Additional molybdenum disulfide is required in higher viscosity oils.

Synthetic lubricants and additives continue to expand, but as discussed in our LMOA paper last year, the economics of synthetic lubricants in high-capacity locomotive crankcases is not justifiable.

In the area of diesel fuel oils, while not directly related to this section, much research has been conducted resulting in new sources of products with advantages to the industry. Experiments have been performed by the two major Canadian railroads and the National Research Council of Canada in a stationary locomotive diesel engine. This involved laboratory bench tests and later locomotive field runs to evaluate synthetic crudes as fuels for locomotive diesel engines. These crudes were derived from the Athabasca Tar Sands and supplied by Great Canadian Oil Sands, Ltd. The research got its impetus from the potential price advantage of synthetic crude over conventional railroad diesel fuel. The tests were generally successful, even though the synthetic crudes had high cloud points and very low flash points.

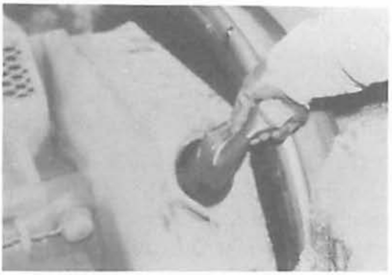
Subsequently, an aromatic distillate (gas oil sidestream) with more desirable flash and cloud point characteristics obtained from the Tar Sands plant was made available in limited quantities by Great Canadian Oil Sands Ltd. The fuel is being used successfully in spite of its low cetane number. A marked advantage for cold winter operation is the very low cloud point, below–40°C (–40°F), coupled with a normal diesel fuel viscosity.

This kind of research and testing is necessary to provide the petroleum products for the railroad industry in the future.

In summary, many railroads are lab and field testing new lubricants. Whether the oils are improved third generation or classified with a new designation, much more field testing is needed. Hopefully the new procedure of "Field Evaluation of Lube Oils" included in this paper will provide more rapid results with economic benefits for all concerned. Diesel lubricating oils may be changing in the future, with higher VI oils, improved dispersion, higher alkalinity retention, lower wear ratings, less engine deposits, improved oxidation and thermal stability. Hopefully each of these parameters can be improved without grossly affecting the production cost and railroad operating expense.

V

TRACTION MOTOR GEAR LUBRICANTS



Historically the lubrication of traction motor gears has been marginal at best. Originally, compounded residual oils were used that had viscosities of approximately 2,000 to 5,000 Saybolt Universal Seconds at 210 deg. F.

Long before the high-output diesel locomotive was developed, this rather primitive asphaltic lubricant found disfavor because its flow characteristics were nil at low temperatures and it thinned down excessively at high temperatures. Thus the sodium soap-thickened lubricant made with a petroleum resin having a higher viscosity index was developed.

Both of these types of lubricants were and are still used with some measure of success. However, the soda soap grease also has a few drawbacks; water is prone to get into gear cases, causing an adverse effect on consistency as well as adherence to the teeth and subsequent lubrica-

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tion. Both of these early lubricants were quite viscous; many times there were indications of gear lubricant migrating through labyrinth seals into the armature bearings.

With the development of high-output locomotives, particularly 3,000 horsepower from four traction motors, another problem soon developed with the asphaltic lubricant. As gear case temperatures went up, oxidation of the lubricant accelerated to the point the gear lubricant "solidified," so that it became necessary to chisel the asphalt from the gear case.

It was also noted during the inspection of gear cases that the heavy soap-thickened grease was clinging to the sides rather than slumping down to the bottom of the gear case where it could be picked up by the ring gear to continue the lubrication cycle. Occasionally channeling was observed; one example was at 60 deg. F., with a gear case that contained nearly twice the recommended 12 lb. of grease.

In an effort to find a better lubricant for the traction motor gears than the residual oil or the sodium soap-thickened petroleum resin, a number of lubricants were service tested. The most promising was a 1,000 Saybolt Universal Second at 210 deg. F., mild extreme-pressure gear oil. (Typical inspection values of this lubricant were as follows:

Viscosity, SUS @ 210° F.	975
Viscosity Index	85
Pour Point Deg. F.	50°
Timken OK Load, Lbs.	55

°Even though the pour point is 50° F., this gear oil would slump in the gear case when the temperature of the lubricant was as low as 20° F.

After a year's service in 90 SD-45 locomotives, the test of the 1,000 second gear oil was expanded to 625 locomotives including GP-7, SD-24, GP-30, GP-35, and SD-45 locomotives. During the time this gear oil was used, the number of scrap gears due to wear from this group of locomotives dropped from 100 per month to 25 per month.

The service test was again expanded from 625 locomotives to approximately 1800 locomotives. After about two year's service in the entire fleet, the test was terminated because it became apparent that all gear cases could not be maintained well enough to hold the 1,000 second gear oil. The higher load carrying capability, the greater resistance to oxidation, and the ability to lubricate better at lower temperatures than conventional gear lubricants then available could not be utilized because of the difficulty in keeping the gear oil in the gear case. This oil did a good job of lubrication, so a product was sought which would incorporate the desirable properties of this gear oil, but would be thickened in such a manner that it would not be lost from the gear case, or subject to water washing.

Since 1972, a number of refiners have been developing traction motor gear lubricants that will incorporate the advantages of gear oil and stay in the gear case. Most are thickened with lithium soap to resist water washing and all contain extreme-pressure additives.

The viscosity of a gear lubricant is very important in its formulation. In the case of a gear oil, the viscosity remains constant regardless of the rate of shear. It is normally expressed in Saybolt Universal Seconds at a specified temperature. In the case of a semi-fluid soap-thickened grease, the viscosity does not remain the same with varying rates of shear, and it is normally reported as apparent viscosity in centipoises at a specified temperature and rate of shear.

Most of the new formulations of traction motor gear lubricants have apparent viscosities between 5,000 and 15,000 centipoises when measured with a Model RVF Brookfield Viscometer at 200 deg. F. with a No. 3 spindle rotating at 4 rpm. There is considerable cooperative testing being done by locomotive builders, refiners, and railroads in order to determine the proper viscosity and the most practical method of measuring the viscosity.

In summary, a traction motor gear lubricant should have the following qualities:

1. It must have adequate load carrying capabilities;
2. It must slump easily in cold weather;
3. It must be resistant to oxidation;
4. It must adhere to the gear teeth in the presence of water;
5. It must stay in the gear case in all types of service.

With the prospect of new specifications forthcoming from locomotive builders, it appears railroads may be utilizing new products in the traction motor gear application.

VI

LOCOMOTIVE FILTERS

Locomotive filters are often looked upon as a nuisance to maintenance personnel. However, the importance of proper filter maintenance cannot be over emphasized. Although filters are low in basic cost as compared to other larger maintenance items, they can result in severe damage to vital engine parts if they are not properly maintained.

Filters are used to control the environment in which a piece of machinery operates. Filters are designed to prevent the passage of particles equal to or larger than a specific micron size. The micron size is generally determined by the clearances available between moving parts, for example, filtering lube oil for use in lubricating engine main bearings with the objective of preventing dirt scratches and decay of the bearing surface. In the case of fuel oil, the primary objective is to prevent fouling of the injector tip. Therefore, to keep machinery wear to a predictable, economical level, filters must not be allowed to deteriorate.

Proper filtration also plays a significant role in keeping machinery operating at an optimum level from the standpoint of fuel economy, gaseous emission quality, etc. An engine not properly aspirated will run at a lower fuel efficiency and will thereby increase fuel costs. Insufficient air will also lead to poor combustion and smoking. Now that fuel economy is so critical and ecological restraints so severe, the railroads can ill afford to let improper filter maintenance create engine operating problems.

With this in mind, maintenance supervisors should stress to personnel the importance of good filter maintenance. The engine builders have taken steps to facilitate filter maintenance by improving filter design and by locating them so that they are easy to change. To be discussed later, certain types of air filters tend to purge themselves of the dirt they filter, which results in less required cleaning and longer life. The builders also have facilitated detection of poor filtration by installing hose stems for manometer connections so that pressure drop across the filters can be easily and accurately measured.

The determination of required filter maintenance periods and change-out intervals is an important factor in engine maintenance. Each railroad operates under a different set of outside environmental conditions. Some roads have even established different criteria for locomotives assigned to specific areas or industries where dust levels in intake air are high. Some roads have extended their maintenance periods from the old standard of 30-day maintenance. This has, in turn, dictated a need to develop improved filter designs. We make no attempt to suggest these maintenance intervals since it depends on individual conditions. It is important to suggest, however, that each road give this careful consideration, including testing under controlled conditions, if not already done.

A locomotive has several different filtration systems. The following comments describe these areas in general and suggest items of particular importance. The reader should consult the builders' manuals or consult filter manufacturers for specific details and instructions.

Locomotive Fuel Filtration

Locomotive fuel filtration does not begin on the locomotive, but with the wayside storage equipment. This was discussed in detail in the EMD "Pointers" issued October 27, 1975. Specific mention was made of the fact that with the energy shortage, the level of many storage tanks is being dropped to a point where bottom sediment is being agitated. Although the quality of fuel may be excellent, the sediment that has accumulated over a period of time may enter the fuel system if not properly filtered by wayside stations. Growth of micro-organisms which cause fuel filters to be covered with slime can be accelerated under these conditions if water is not drained from storage tanks and locomotive fuel tanks. In some cases, biocide must be added to these tanks to stop growth.

Wayside fuel filters are generally of the cartridge type, consisting of a large housing containing a number of cotton fiber elements. Other systems are available, such as centrifugal filters that utilize the swirling action of the fuel to separate water and solids.

With any wayside system, periodic inspections should be made. Those inspections should include sampling of the fuel from the storage tanks and from the fueling nozzles. Microbe test kits should also be a part of the sampling procedure.

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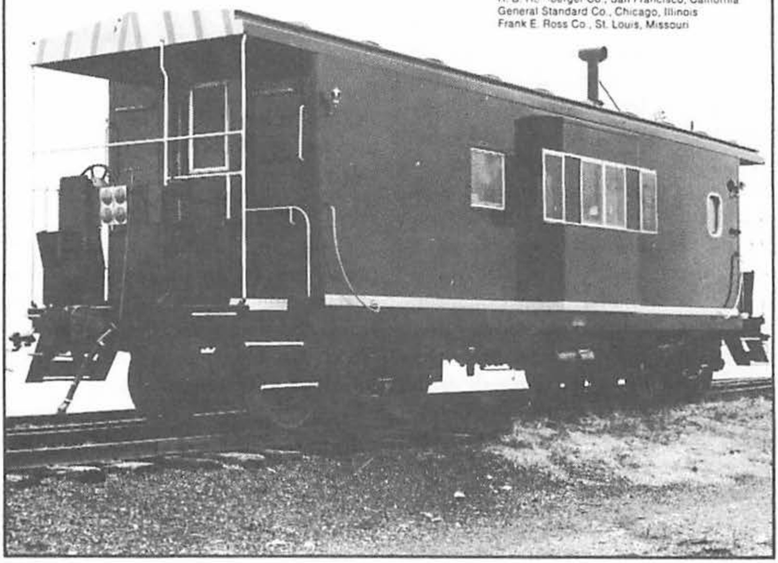
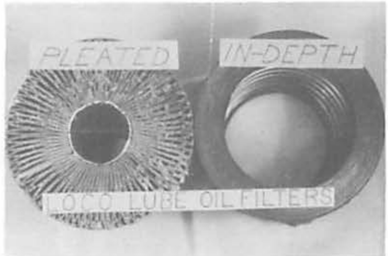


Locomotive-mounted fuel system filters generally include a fuel strainer, a primary filter and a secondary filter. The strainers are of wire mesh construction, while the primary filters are of the waste type. The secondary filters are usually of cotton fiber construction; some have the spin-on feature in which the housing and element are disposable.



Locomotive Lube Oil Filtration

Poor lube oil filtration can result in excessive part wear, premature engine shutdown, and possible engine failure. Therefore, selection of lube oil filters cannot be taken lightly. As an excellent reference to aid in filter selection, lube oil filter design, selection and performance was covered in detail as published in the 1972 LMOA Proceedings.

Engine lubricating oil filters used today are mostly of pleated paper construction and are designed to filter on their surface. The manner in which the paper is coated and pleated has a direct bearing on the filter's ability to withstand hot oil and resist deterioration. The EMD filter is rated 90 percent efficient on dirt particles of 12-13 microns or larger. This is commonly referred to as a 12-13 micron mean pore size. The GE filter is designed to have a mean pore size of about 20 microns. Filter selection and length of service have been studied by some railroads with the result that these roads have determined their own specifications for filter types and maintenance intervals.

GE has introduced a new "Long Life" oil filter element. It is a depth, rather than a surface filter. Depth-type elements were used in older locomotives. Those older type elements were not capable of handling the full pump output with a reasonable number of filter elements. The new GE element is full flow and is claimed to offer the benefits of large dirt holding capacity associated with depth elements. Additional claimed benefits are: resistance to deterioration—6 month life instead of present 2 month life, greater resistance to damage by abuse and greater tolerance to moisture.

The new element was developed jointly by General Electric Company, Shell Oil Company and a west coast manufacturer. This filter element appears to be a natural companion to the newer long-life lubricating oils.

Air Filtration

Good air filtration is critical in protecting piston assemblies, turbochargers and related air system parts from abrasive wear by particulates. Good air filtration is also essential for clean, efficient combustion.

Air filters employ several design principles, such as those involving impingement on a filtering media, those involving the use of the inertia of the heavy dust particles in preventing them from negotiating a sharp turn, and those involving the use of centrifugal force to separate the dust particles from the air stream.

Impingement-type filters can be of pleated paper or synthetic fibers. Some filters consist of fiberglass fibers interwoven into bag-type elements. Woven filters use the impingement principle of filtration for larger particles and the inertial principle for smaller particles as the air negotiates the almost microscopic turns between filaments. In either case, this group of filters collects dust and, therefore, must be cleaned or disposed of. However, they have a low initial cost.

Inertial filters are an arrangement of vanes that deflect air flow. Heavier dust particles cannot negotiate the sharp turns and thus are carried to the end of the filter and discharged. This type of filter requires occasional cleaning.

The centrifugal filter method employs a cyclonic effect to separate dust particles from intake air. This type of filter is made of durable plastic. Each filter consists of many tubes through which air passes. As air enters each tube, vanes molded to the inside cause the air to swirl. The heavier dust particles migrate to the outside and eventually travel to the end of the tube where they are discharged. This type of filter is self cleaning in this manner, and, therefore, requires no additional maintenance.

Engine air compressor filters cannot be overlooked. Compressor filters are made in both the fiber impingement construction and the more common pleated paper construction. Lack of maintenance and filter cleaning can result in dust particles attacking moving parts of the compressor. High compressor failure rates, ring wear and bearing wear can sometimes be tied into lack of filter maintenance.

In general, improper air filtration is easy to detect, and filters are simple to clean or change, and are relatively low in cost. Many engine wear problems can be related to poor air filter maintenance practices.

In closing, we emphasize the need for careful maintenance of all filtration systems. Each railroad should study its filter programs in detail. The result will be longer parts life, increased reliability and optimum use of maintenance dollars spent for filter elements.

GREAT LAKES RAILWAY CLUB

12351 Prospect Road
Cleveland, Ohio 44136

On April 1, 1954, representatives of eight railroads operating in Cleveland and representatives of railroad supply companies met to organize the Great Lakes Railway Diesel Club.

This club is dedicated to the purpose of promoting mutual and educational interest of its members by reports and discussions for the improvement of railway operation, construction, maintenance and equipment, and to bring into closer relationship men engaged in supervising any branch of railway work and railway supply with kindred interests, and to cultivate good fellowship.

Membership of the club is limited to supervisory railroad personnel and representatives of railroad suppliers or persons especially qualified in the opinion of the directors to promote the objective of the club.

Five business meetings will be held annually. One meeting will be scheduled in each of the following months: January, March, May, September, and November at the Sheraton Midtown Motor Inn, 3614 Euclid Avenue in Cleveland, Ohio 44136.

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Manager Glenwood Shop
Chessie System
Glenwood, Pa. 15207

R. J. KETTERINGHAM
Secretary
4236 Bentley Drive
No. Olmstead, Ohio 44070

Tuesday, September 28, 1976

10:30 A.M.

REPORT OF THE COMMITTEE ON DIESEL ELECTRICAL MAINTENANCE

Pre-Convention Presentation: Great Lakes Railway Club

May 12, 1976 Sheraton Midtown Motor Inn Cleveland, Ohio

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General Manager - Locomotive
Maintenance - Engineering
Chessie System
Huntington, W. Va. 25718

VICE CHAIRMAN

W. E. Kelley, Manager, Electrical Engineering - Equipment, Consolidated Rail Corporation, 6 Penn Central Plaza, Philadelphia, Pa. 19104

COMMITTEE MEMBERS

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O. W. Aten, General Diesel Supervisor, Chicago, Rock Island & Pacific Railroad Co., 624 Scott Avenue, Kansas City, Kansas 66105
J. M. Braly, Assistant Mechanical Manager, Southern Railway Co., 99 Spring St., S. W., Atlanta, Ga. 30303
R. P. Chambers, Supervisor Locomotive Maintenance - System, National Railroad Passenger Corp., Hialeah Diesel Shop, 413 Debra Drive, Brandon, Florida 33511
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F. R. Miller, Master Mechanic, Chicago & Eastern Illinois Railroad Co., P. O. Box 76, Dolton, Illinois 60419
L. D. Moneymaker, Locomotive Gang Foreman, Atchison, Topeka & Santa Fe Railway, 4515 Kansas Avenue, Argentine, Kansas 66106
D. J. Morrison, Electrical Engineer - Locomotive, Illinois Central Gulf Railroad Co., 233 North Michigan Avenue, Chicago, Illinois 60601
J. H. Ray, Chief Electrical Engineer, Consolidated Rail Corp., Midland Building, Cleveland, Ohio 44115
D. I. Smith, Senior Factory Service Engineer, General Electric Co., 2901 East Lake Road, Erie, Pa. 16501
H. Stringer, Supervisor Motive Power - Electrical, Canadian Pacific, Ltd., Room 903, Windsor Station, Montreal 101, Quebec, Canada

PERSINAL HISTORY — WILLIAM R. JAMES

Born in New Castle, Pa., December 11, 1928.

Education: Coyne Electrical School of Chicago 1947-1949 (Industrial Electrical Engineering), University of Baltimore 1964-1966 (Industrial Management).

Railroad Career: Joined the Baltimore & Ohio Railroad as an Electrician Apprentice in 1944. Made an Electrician in 1947 and promoted to Diesel Electrical Supervisor in 1948. In 1950 was appointed Engine House Foreman, then General Foreman in 1952. In 1954 he was promoted to Regional Diesel Superversor and in 1960 to Asst. Engineer-Electrical, 1966 Asst. Superindendent Motive Power. Promoted to Superintendent of Shops, Cumberland, Md. in 1968, and in 1973 was promoted to Superintendent-Locomotive Department of the Chessie System. And in 1976 he was appointed General Manager-Locomotive Maintenance-Engineering.

He is married to the former Ruth Sanfilippa, and they have three sons: Clifford, Daniel and William.

I
IMPROVING MECHANICAL DEPARTMENT CONTRIBUTION THROUGH MODERN MANAGEMENT TECHNIQUES

In the hope that we can offer a valuable service to our industry, this committee has spent many hours compiling, analyzing and reviewing maintenance systems throughout the Railroad Industry and has concluded that much remains to be done in improving the organization of these maintenance systems.

We believe that we can no longer afford the traditional ways and thinking that pervade our industry. Railroading today possesses little or no mystique; it is not an art based upon personal genius or intuition. Railroading is first and foremost a business. Failure in the past to recognize that we are a business and not just a railroad, failure to concentrate on the production of transportation as opposed to railroad service, failure to break ties with tradition, and in depending upon precedent to guide us, have contributed significantly toward the unproductive application of technology and organization within the mechanical department.

Each of us has the inherent desire to do those things we do well and to put aside those things that make us feel uncomfortable. Too many of us spend precious hours putting out brush fires and working in a defensive posture, rather than making time for analytical thinking that leads to true problem solving. Those too human failings should concern us deeply. They are probably the principal reason why new railroad technology and methodology are not being developed as fast as they might be, or implemented as efficiently as they should be.

Let us clearly establish that our product is: UNIT AVAILABILITY at the least cost.

A method of achieving cost reduction is through optimization of automated testing and manual inspection procedures in:

A. Electrical Systems

B. Mechanical Systems

To achieve tangible benefits from automated testing systems, we must integrate this tool into the locomotive maintenance system.

The method of incorporating automated maintenance techniques into an established maintenance program is as critical in influencing locomotive utility as are the specific functions selected for the automation. The addition of Search Testing as an appendage to an ongoing maintenance program has invariably brought increased unit downtime and labor manhours by inordinate amounts. Based on studies of Search, it is clear that to be most effective and beneficial, Search must be the nucleus of a program of periodic locomotive maintenance, with adjunct maintenance routines designed to supplement test results.

Following is a discussion of the application of a modern tool into an advanced, highly productive maintenance procedure. Agreeing that the Mechanical Department's product is Unit Availability at the least cost, we must consider the major factors that determine availability and costs:

1. Unit Reliability
2. Unit Maintainability
3. Maintenance Policies
4. Application of Labor (cost and effect)
5. Organization of the Maintenance Program

Unit Reliability

Unit Reliability is directly related to the original designers' performance objectives for each component in the complete system. After receiving the finished product on the railroad, it becomes the responsibility of the maintenance system designer to sustain the original design performance goal through timely maintenance actions. How better to determine when a specific part requires maintenance than to measure its performance against the designer's specifications and wear allowances? For electrical equipment, this is best determined through evaluation of electrical characteristics.

Unit Maintainability

Unit maintainability is directly related to systems layout. It is the result of systems designers giving proper thought to accessibility for parts renewal, which in large measure determines manpower and supporting facilities required to perform a given maintenance requirement.

Maintenance Policies

The economical life of a diesel-electric locomotive is considered to be 20 years. The committee believes FRA rules and regulations governing inspections and testing of locomotives to be outmoded and not in pace with technology. Rule 203 requires an inspection to be performed at least once each 24 hours. We believe that it should be revised to extend this requirement to a minimum of once each five days. Rule 331, requiring each locomotive unit to be shopped at least once each 30 days, should be revised to extend this requirement to a minimum of once each 90 days.

Until these changes are made, we recommend:

1. A ninety-day maintenance schedule;

2. A maintenance program formulated to balance FRA and preventive maintenance requirements in terms of

manhours per unit required spread over eight consecutive quarters or quarterly inspection;

3. Annual load testing of power plant;

4. Maintenance of air compressors on a condition basis, with specified means for determining fitness for service;

5. Power plant removal at a ten-year interval for complete overhaul;

6. Maintenance of trucks and draft gear on a condition basis in conjunction with the "Q" system;

7. Maintenance of traction motor-wheel assemblies on a condition basis consistent with FRA rules, and wheel renewals made in conjunction with scheduled maintenance, and preferably on the "Q";

8. Monitoring of engine and air compressor lube oils by spectrographic analysis.

The above recommendations are based on technological progress in the areas of electrical insulation, meallurgy, lubricating oil quality, on-board safety devices, and advanced quality assurance programs.

Application of Labor (Cost and Effect)

Increasing labor costs, shortages of skilled maintenance personnel and the increasing complexity of modern locomotives have made automated inspection through pre-programmed test parameters a must, if we as managers are to increase unit availability, maximize utilization of skilled labor and minimize cost.

Since technology has provided us with a practical, well-designed, automated tool that can perform the inspection and evaluation functions of all non-rotating electrical and some mechanical equipment, we consider the application of skilled labor to these services to be a waste of human resources, less reliable, and much more time consuming.

To optimize, automated testing techniques and manual inspection procedures require total integration of functions to achieve simultaneous maintenance actions.

Organization of the Maintenance Program

Prior to detailing the organizing of a scheduled maintenance program, let us agree that there can be no substitute for the use of quality materials, the application of quality, assured methods and procedures and a dynamic supervisory team, guided and monitored by an effective Quality Assurance Program.

To achieve cost reduction, optimization of automated testing and manual inspection procedures must be integrated. We must utilize automated testing where it has proven superior to human analysis, and utilize skilled labor in the principal area of work production and evaluation.

To program an automated tool, such as Search, to perform a desired diagnosis, only to duplicate the diagnosis by an additional manual routine previously established, defeats much of the benefits to be derived through automation.

With the shopping of a unit for scheduled maintenance, we must consider two basic work loads:

A. Scheduled Work (planned maintenance)

B. Unscheduled Work (inspector find items)

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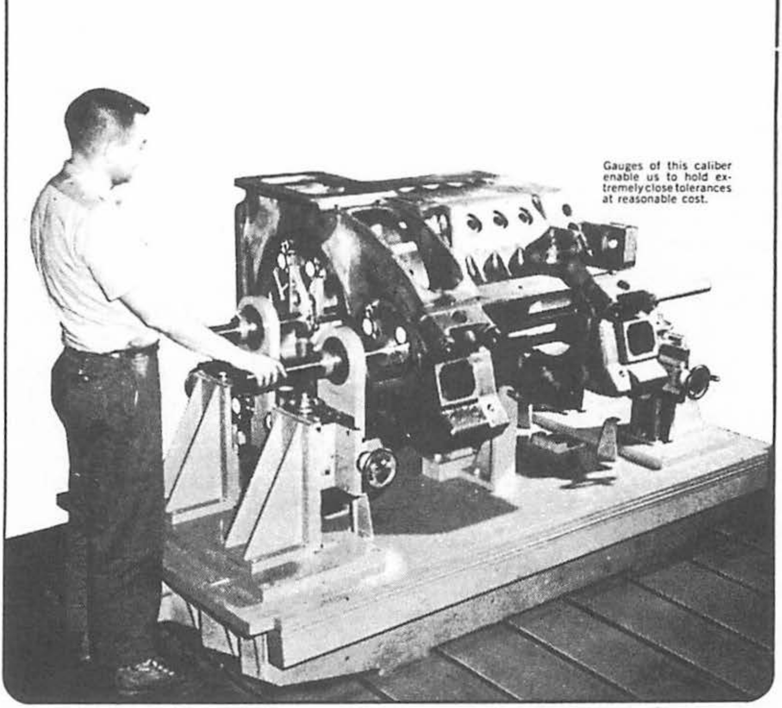

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When scheduled work is properly planned over eight quarterly periods, there will be no overloading of work schedules resulting from operations problems. This will greatly simplify the line maintenance officer's job. The number one problem facing a shop maintenance officer then is the unscheduled work.

To provide the basis for identifying unscheduled work, we recommend that a building be located ahead of the primary maintenance facility which will permit the positioning of three maximum length units in a series network at three work stations, and which will provide space for housing automated test equipment.

The primary work to be performed in the Pre-Maintenance building is: WS-1 Locomotive inspection, i.e., cab equipment, running gear, carbody, etc.; WS-2 Dynamic and static testing and evaluation of all electrical, mechanical and air systems and the renewal of disposable types of filters; WS-3 All laundry work, cab, engine room, trucks, etc.

Work performed at stations one and three are self explanatory. Work to be performed at station two is as follows: Our recommended scheduled, quarterly maintenance prescribes that engine evaluations be made through:

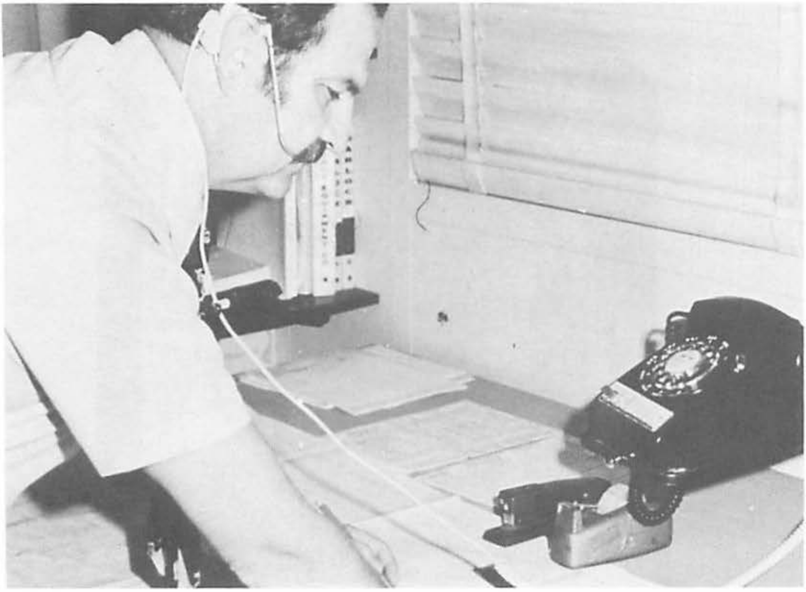
1. Air testing of cylinders (all Q's except annual)
2. Measurement of ring to land clearance, on an annual basis (Q4)
3. Load testing of Power Plant on an annual basis
4. Pop testing of injectors on each Q
5. Air compressor evaluation through orifice testing and crankcase depression.

To accomplish this simultaneously with electrical system evaluations, necessary fuel, lube and combustion air filter work, requires detailed planning to minimize work conflict between crafts and unit downtime. We recommend that the electrical systems be tested and evaluated through the use of automated test equipment. The electrical *"cold tests"* (engine shut down) to be performed while the fuel and lube filters are being replaced and cylinders qualified by air testing, using a regulated 60 psi air supply with a condemning limit of 55 psi.

The automated tester would be set up in the mode M-2 to print out exceptions only, with automatic advance. While the automated tester is performing the electrical systems cleckout, the electrician would be performing all topside electrical rotating equipment inspections and storage battery work.

Upon completion of the mechanical work, the automated tester, having completed *all* cold testing, would be reset for engine start up.

Engine cranking circuits would be energized and engine brought up to idle speed for confirmation of proper speed setting, thereafter the automated tester would command the engine governor to establish the speed setting for dynamic evaluation of the air compressor for compliance with FRA Rule 205. Once again, only exceptions would be printed; upon completion of this test, the engine governor would be commanded to eighth notch speed. After speed verification,

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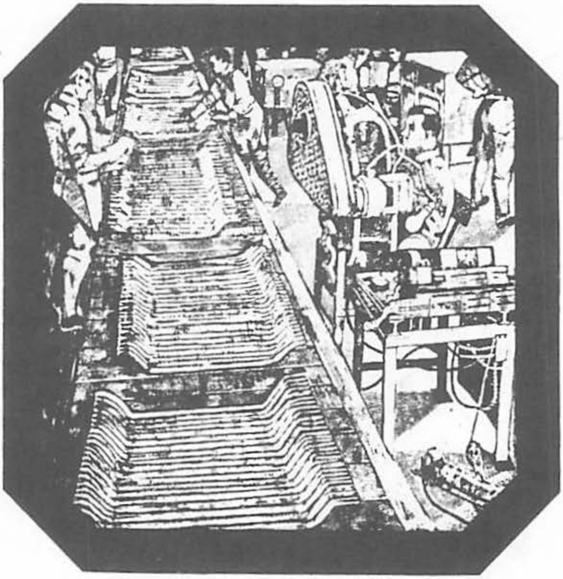

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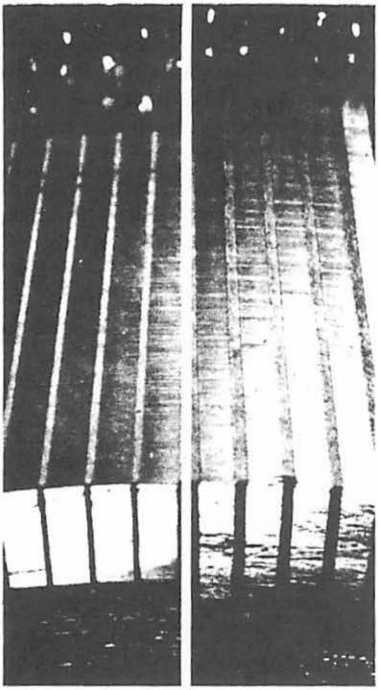


Left. Conventional commutator construction. Right: WIDE-MIKE construction, with extra-heavy mica segments.

Can WE help it if flashover is ruining your traction motors?

YES— with our advanced WIDE-MIKE commutator design!

TODAY'S HEAVY LOADS and high speeds have taken a costly toll of traction motors. Now several railroads are cutting down this cost by installing MCM-wound motors with the new WIDE-MIKE commutator design.

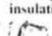
Essentially, this design has increased insulation characteristics to meet operational demands. The results are:

1. SIGNIFICANT REDUCTION IN FLASHOVER.
2. GREATER COMMUTATOR STABILITY AND RESISTANCE TO DAMAGE.
3. HIGHER PERCENTAGE OF MICA TO COPPER IN RISERS FOR FUTURE REWINDS.
4. ELIMINATION OF HIGH-BAR COMMUTATOR PROBLEMS.

If your rewind cycles are crowding you, it will be worth your while to look into this greatly improved commutator design. Write or telephone us for full information.

MCM **MOTOR COILS**
manufacturing company
100 Talbot Street • Braddock, Pa. 15104
Area Code 412-271-1775

The Engineering Know-How that Brought You These 'Firsts'

First epoxy insulation.



Potted field coils with flexible leads.


Increased armature copper.


Extra-strength aluminum end bell.


Exclusive 3-year warranty.

the engine primary and secondary air filtration systems would be checked through observation of permanently mounted manometers and the auxiliary generator voltage regulator would be monitored for proper operation, after which the engine speed will be returned to idle.

The printout would be removed from the printer and would serve as the inbound work report for determining electrical systems work requirements.

During the annual load testing, (Q4 and Q8) the automated tester would manage all speed-load requirements, along with verification of horsepower and performance control.

With the power plant operating at rated load and after the engine has thermally stabilized (15 minutes), power piston measurement would be taken, temperature readings of each cylinder recorded, air box temperature and pressure recorded, oil cooler temperatures measured and recorded, aftercooler efficiency confirmed and D. C. generators visually inspected for commutation.

All of this work can be accomplished in an elapsed time of 1¼ hours with a work force of one electrician and three machinists.

Upon completion of the work assigned to this station, the unit would then advance to the laundry work station for cab, truck and engine room cleaning; thereafter proceeding to the primary maintenance area for completion of the scheduled and unscheduled work, as determined through systems evaluation, at work station two.

As the electrical equipment repairs are completed, component and circuitry confirmation checks must be made to verify the correctness of the repair. By performing work and verification in this sequence, you are minimizing the possibility of developing trouble during final outbound testing, with resulting setback.

The ideal maintenance concept would include an analyzer, mounted on a mobile platform for use by the maintenance electricians. The analyzer would augment the automated inbound-outbound tester in that it would be utilized in the shop at the various repair stations and would be designed to include a programmable storage capability along with a mode selector for selecting those tests that failed inbound testing. Repairs could be effected and confirmed on the spot. This concept also would permit the analyzer to perform all outbound electrical testing.

This is the way to manage the unscheduled work load during scheduled shopping to achieve a significant cost reduction through optimization of automated testing and manual inspection procedures.

II
MAINTENANCE OF MODULARIZED CONTROL SYSTEMS

Modular control systems bring space age technology to motive power. This has done more to improve control system reliability than any previous electrical design improvement. This system of packaging has minimized the use of dynamic relays, reduced the total footage of wiring, enhanced the environment for electrical control equipment, and has provided the means by which many very important parameters can be finitely controlled and monitored. Such data as turbo speed, diode bank temperature, excitation current and fault detection circuits are continuously supplied to the various electrical control centers for the improvement of locomotive performance.

Modular controls also permit removal of the previous on-board electrical settings, calibration, and trouble shooting to the controlled environment of an electronic shop. The results are improved reliability and less out of service time for the locomotive.

While modular control systems have done all that we've said, they have introduced new problems. Further innovation in maintenance practices is needed to assure continued, long service life for motive power.

Periodic Testing of Modules

What are the advantages of removing and testing of cards on a predetermined time basis? The principal advantage of periodic testing is the detection of incipient failures to minimize running repairs through timely maintenance actions.

We have established by survey that the national failure rate is in the order of 2 percent. Thus, we do not recommend periodic renewals as a way to significantly improve locomotive performance. We recommend that modular cards be left in place until locomotive problems are reported. If a problem is encountered during scheduled annual load testing, this indicates a specific card to be defective.

Most card failures, especially excitation cards, will show up immediately in locomotive performance; however, there are a few that can go undetected until a costly failure results. A noted example is the W.S. card on General Electric locomotives that utilize the end of axle, alternator wheel slip system. That card has a simple transitor for control, which, if it should fail, negates the wheel slip detection system.

To those who do not agree with this recommendation, we suggest that you establish a positive system of monitoring reported defective cards versus actual repairs required by specific card identity, and compare the actual repair reports against the known or projected failure costs to determine the optimum policy for your particular operation.

We recommend that one spare set of critical cards be purchased for each one hundred locomotives equipped with modularized control systems. However, such factors as unit availability, failure rates, location of spare cards to unit assignments and locomotive builder parts centers must be carefully evaluated for your system before making the final determination.

On EMD locomotives there is a possibility of having 18 module cards, 10 of which are deemed critical. On General Electric locomotives, there is a possibility of 16 module cards, 15 of which we consider critical.

The cost of the 10 EMD cards is $3105.58, and for GE, $3450.30.

Module Testing

The primary concern of shop supervision, when a locomotive equipped with a modular control system arrives, is how best for electricians to determine whether one of the cards is defective.

As with conventional control systems, units arriving in trouble must be subjected to diagnostic evaluations to determine if there is a malfunction and, if so, in which part of the system.

Test adapters, which can be purchased from the respective builders, are a big help when troubleshooting module cards. The adapter provides a fast and easy method for reading module pin voltage signals and module circuit voltage signals. It also provides a means to open certain circuits or to connect a milliammeter in the various circuits.

After completing the diagnosis, a card suspected to be bad should be removed (after taking necessary precautionary steps to eliminate damage in the removal process). Replace it with a *spare, confirmed-good* card and run a performance check of the locomotive circuitry.

The defective card should be tagged with such pertinent information as location, date, reported trouble, unit number, and corrective action taken, thereafter forwarding to your repair center.

If the locomotive unit is located at an outlying point where it is not practical or cost advantageous to stock spare cards, and if a locomotive of the same class is nearby, and out of service for other reasons, we recommend interchanging the cards to make one unit available; thereafter, arranging for the forwarding of a confirmed, good card to the terminal for the unit from which the good card was removed.

All defective cards should be forwarded to your electrical-electronics repair centers for evaluation on the Oregon Technical Products, Model 444 module tester. If you have in-house electronics equipment repair capability, you will find that considerable savings can be achieved by repairing cards on your property. However, if you elect to unit exchange with the builder, we still recommend the purchase of a 444 tester to qualify the *suspected* defective cards prior to forwarding because the service charge for processing good cards is considerable. Many cards are removed at outlying points that are not defective; therefore, the quantity of cards carried in inventory can be minimal.

The model 444 module tester can qualify cards with speed, accuracy and reliability. It is simple to operate and requires no specialized skills. Tests are performed using procedures supplied by OTP through the use of a plug-in program block that contains the proper electrical setup for a particular type of card. Program blocks can be applied and removed in a few seconds, as required, depending on type of card to be tested.

If the locomotive manufacturer makes a change or modification to its cards, OTP will supply at no charge a revised test procedure and instructions for modifying the particular program block. If the railroad desires, OTP will modify the program block for a nominal charge.

Personnel—Repairing Of Cards

Although the module tester is easy to operate, the repairing of module cards requires a worker with an electronics background and the ability to solder small components on printed circuit boards.

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.

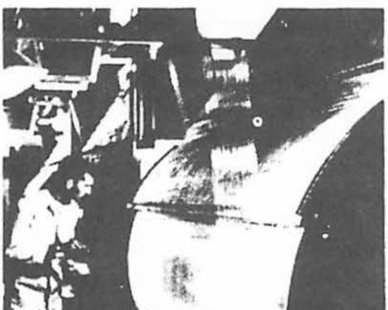
Air cleaning efficiency is greater than that delivered by any panel-type filters available for locomotive service. AMER-kleen filters are progressively packed for greater dust-holding capacity.

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.

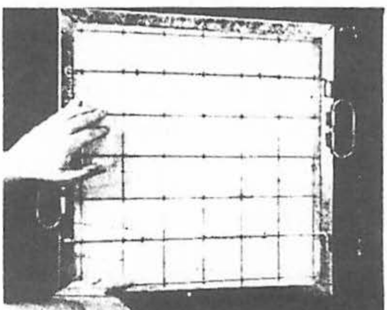
AAF American Air Filter

BETTER AIR IS OUR BUSINESS

Designed specifically for locomotive service.



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.

Since most railroads do not have the latitude of selecting a particular person for a specific job, it is essential that the supervisor in charge of the repair center be technically knowledgeable in these areas in order to give support and training to workers as required.

Cleaning of Cards

A survey of the committee members revealed the use of a wide range of cleaning solvents to clean module cards. After considering all facts, we believe the most effective method is warm soapy water (Ivory liquid) and drying with air.

Using a soft bristle brush with this cleaner effectively removes dirt and grease without discoloring the plastic face plates or deteriorating the epoxy resins. It does not leave an oily residue that can attract dust particles.

Since this cleaner is reasonable in cost, safe to use, and does an effective job of cleaning, we recommend it for your consideration.

While we know of no instance where dirt or grease have been the primary cause of failure, it is essential to perform a good cleaning job prior to performing repairs, in order that a detailed inspection can be made.

Card Repairs—Component Parts

If you decide to repair module cards in your own electrical component repair centers, you must consider two principal sources for component parts, the original equipment manufacturer or local electronics parts distributors.

We recommend that OEM specifications be rigidly adhered to in the interests of total costs as opposed to initial costs. Many of the components used by the OEM are burned in prior to being made available for general purchase, thus reducing infant mortality. Furthermore, virtually all of the components used by the OEM are designed and manufactured in accordance with military specifications, which, along with high manufacturing standards, accounts for the very good performance to date.

If you purchase components from local suppliers, we recommend keeping a record of each card, repaired by serial number, to accurately monitor the performance.

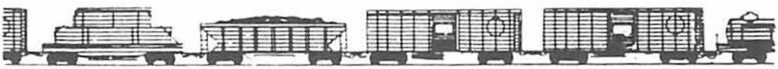
Generally, parts procured from the locomotive builder are higher in initial cost, but are of high quality, and have established an excellent performance record.

Storage and Shipping Requirements

Finally, we conclude this discussion with a few comments relative to proper storage and shipping containers. Module cards contain many fragile components. They must be adequately protected against external mechanical damage, despite the fact that they are very rugged within themselves, as is evidenced in their normal operating environment.

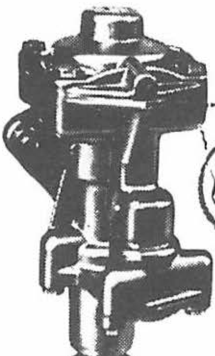
We recommend that special cabinets be built for in-shop storage that will provide protection against mechanical damage and the fire hose cleaning techniques that are common to railroad maintenance facilities. Those cabinets should have racks similar to the on-board equipment rack for card attachment. For in-transit protection, we recommend the use of the OEM packaging system appropriately marked to indicate contents to be fragile.

Terminal Test in 1/3rd the Time



Time to Charge System for Terminal Test

150 Car Trains—NO Cars Equipped with QRB Valve...50 min.
150 Car Trains—ALL Cars Equipped with QRB Valves...18 min.



5. On the proposition to modify Section (a) (11) of Interchange Rule 3 to require that all cars rebuilt on and after January 1, 1969 must be equipped with air brake cylinder release valves, approved types, as recommended by the Committee:

"In order to produce the potential savings which brake cylinder release valves can produce... Interchange Rule 3 (a) (11) be broadened to include all cars rebuilt *on and after January 1, 1969*". That's what the regulations say.

QRB

BRAKE CYLINDER
RELEASE VALVE

The Brake Cylinder Release Valve was conceived and developed by New York Air Brake Company. QRB Brake Cylinder Release Valve Kits (Left Hand or Right Hand) can be readily mounted on ALL existing AB Valve pipe brackets. Immediately available from stock.

The New York Air Brake Company QRB Valves—certified by the A.A.R. as meeting all requirements of these specifications—are available NOW—with Right Hand or Left Hand Adapters. They're furnished in Kits for greater convenience in installing and ordering. Order QRB Valves to update your cars NOW.

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A UNIT OF GENERAL SIGNAL
Starbuck Avenue • Watertown, N.Y. 13601

III
EDUCATIONAL PROGRAMS

Organizing Running Repairs

Running repair refers to those repairs requiring enroute correction and/or unscheduled shopping of a locomotive due to a malfunction. Running repairs are a result of:

1. Improper design and systems layout;
2. Lack of timely, scheduled maintenance programs;
3. Abuse of equipment;
4. Use of other than *quality materials;*
5. Improper work procedures.

We will continue to be plagued with running repairs until we develop a closer working relationship with the locomotive manufacturers; until a profit center concept is established within each department to provide incentives for superior performance; until the using department is given the right to dictate specifications covering procurement of all materials; and until Mechanical Department officers dedicate themselves to development of practical educational and quality assurance programs

Based upon a scheduled maintenance program as spelled out in Sub-Topic I, along with procurement of quality materials and a dedicated quality assurance program, the ratio of running to scheduled repairs should be in the order of .5 to 1., instead of the norm today of 1 to 1 or higher.

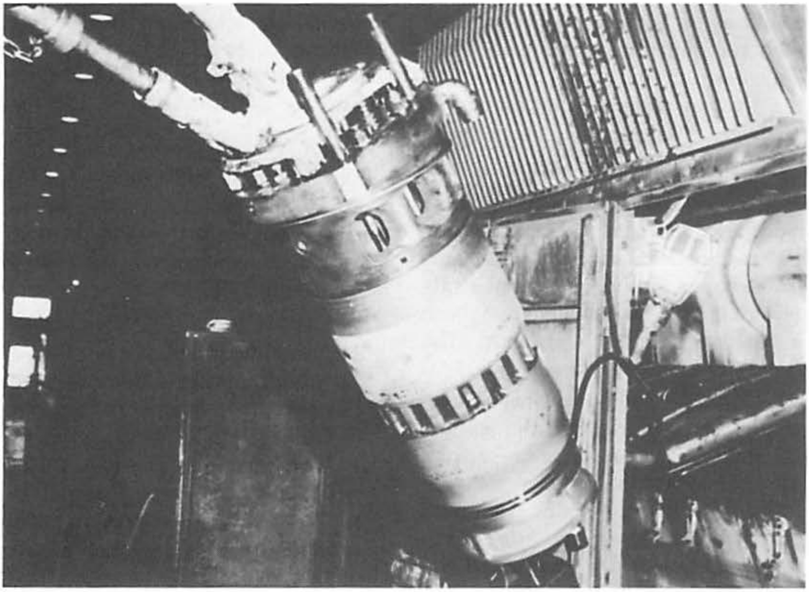
To begin the task of effectively organizing running repair, we must work closely with our road foremen of engines. We must develop a format for reporting of enroute malfunctions that will provide the most useful information for the technician who is to diagnose and repair the problem. The minimum, essential information to be recorded by the locomotive enginemen is:

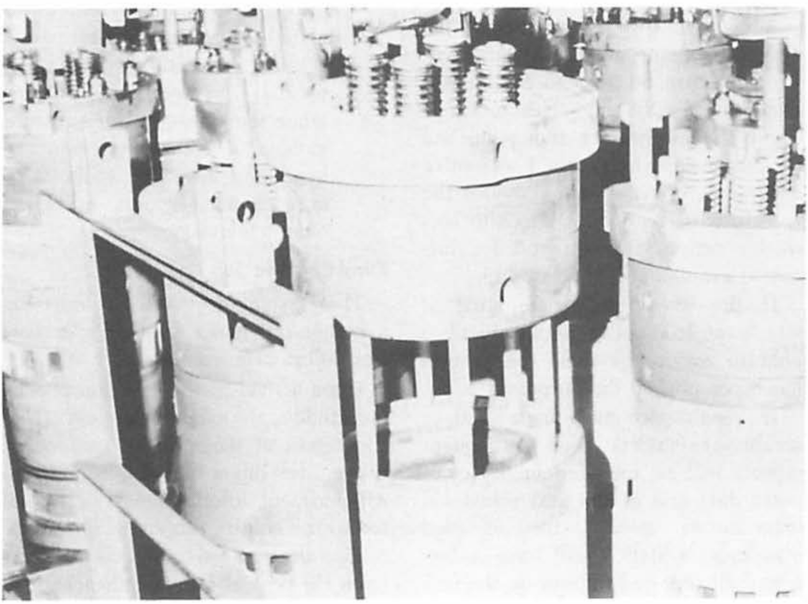
1. Unit position in consist;
2. Train speed at time of malfunction;
3. Throttle position at time of malfunction;
4. Mode of operation; i.e., power or dynamic braking;
5. Location of malfunction;
6. Brief statement relative to how malfunction was noticed, and enginemen's manipulators at time of occurrance.

Several railroads have found a shirt-pocket-size, plasticized reminder card a success. The cards are issued to all enginemen for aid in reporting enroute problems.

This system is organized and monitored by the System Supervisors of Locomotive Operation. They monitor (at major stations) all inbound reports every couple of weeks to compare the inbound reported items against the standard reporting procedure and the shop reports covering the actual conditions found and corrected.

Where the inbound report is found to be proper, the Supervisor of Locomotive Operation sends a letter of commendation to the particular engineman, outlining the condition found by the shop forces. A copy of the letter goes to his Road Foreman of Engines. When the inbound report has not been properly executed, the Supervisor of Locomotive Operation discusses the report with the Road





Foreman of Engines for his handling with the individual concerned. Thoroughness in reporting enroute malfunctions as outlined is a positive beginning.

L&N Reporting Method

A unique approach to improving the reporting of enroute problems, alerting the maintenance forces at the next maintenance station, and permanently recording the malfunction, has been initiated by the L&N Railroad. The system works as follows:

When a locomotive engineer recognizes that a problem exists, he notifies the train dispatcher by radio or wire. The dispatcher fills out a standard form, describing the malfunction from information received, and other pertinent data. He alerts mechanical department forces at the next terminal where the locomotive can be inspected.

A copy of this report goes to the Power Bureau at Louisville, Ky., which in turn notifies the Mechanical Department System Headquarters. There the information is keypunched for admission into the Locomotive data bank. This system provides the vehicle with both an immediate corrective action, and a report for historical evaluation and follow up.

If the forces at the terminal at which the locomotive next arrives are able to repair the unit, the process has accomplished the purpose.

If repairs are not made and/or conditions verified, then subsequent reports will be included in the computer data and at the next scheduled maintenance period, the assigned maintenance station will have a listing of all reported failures on the unit since its last appearance for routine maintenance. Special handling is then given the locomotive by trained technicians for trouble diagnosis and correction.

Recommended Facilities

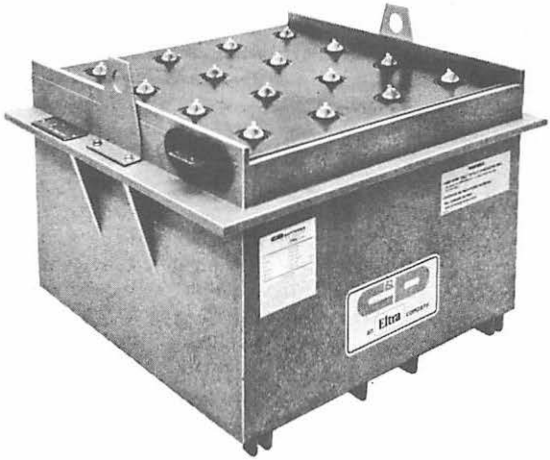
For major terminals, where running repair encompasses ten or more units per day, we recommend the following facilities:

1. Control center;
2. Communications system, comprising a base station and an appropriate number of Handie-Talkies;
3. Test track for dynamic testing of units with reported trouble;
4. One or more work stations equipped with inspection pits for underneath work, complete load testing capability, permanently mounted manometers, trainline testing equipment, semi-automated air compressor test panel, cylinder air testing equipment, optical pyrometers, various other temperature and pressure gauges, a full complement of hand and specialty tools, such as mechanical helpers and closed circuit television.

Directing the Job

That system provides the basis for a highly efficient, productive, organized effort. Here is how it works.

Upon arrival at the inbound servicing facility, the engineman leaves his trip report at the inbound inspector's office and offers helpful comments. All pertinent information is transmitted to the control center via the intercommunications system. Depending upon the type of failure indicated, the



C&D *introduces new concept in* 16-CELL UNITIZED DIESEL LOCOMOTIVE BATTERIES

• GLASS-REINFORCED MOLDED PLASTIC CASE Combines high strength and impact resistance. Virtually eliminates grounds and corrosion.

• INSTALLATION TIME CUT 75% New batteries can be easily installed with portable crane or lift truck.

• DEAD TOP CONSTRUCTION Virtually eliminates danger of accidental shorts.

• NO WATERING BETWEEN MAJOR OVERHAULS Lead calcium types have unusually low water consumption. (Lead antimony types require watering between overhauls.)

Custom designed for diesel locomotives, this new battery revolutionizes both battery life and maintenance. Write for brochure or call your nearest C&D representative.

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3043 WALTON ROAD, PLYMOUTH MEETING, PENNSYLVANIA 19462
an Eltra company

at which time he is literally talked through the case of trouble.

This system of effectively organizing the running repair aspect allows local shop personnel to utilize the best thinking available and under very favorable circumstances with regard to circuit analysis and unusual internal engine problems. That system helps overcome the difficulty of working under trying conditions in a locomotive cab, when the line supervisor is trying to read a twenty-five-foot wiring diagram, at 3:00 A.M., using cab lighting and an occasional flashlight and worrying about all other matters that he is responsible for.

The key to success in this system of managing is:

1. the individual selected as Director;
2. the organization of the Control Center with regard to Management Information Systems, availability, such as historical diesel data printouts, for ready reference in identifying previous maintenance actions, as they may affect the immediate problem.

Such a system can improve unit availability, effective utilization of resources, and relieve first-line supervisors of this burden, in order that they may properly execute their prime mission, and that is supervise production and quality of workmanship.

Edison once said, "There's a better way, let's find it." We think we have.

IV
ELECTRIFICATION—MANAGING CHANGE

In our 1975 presentation, we discussed the history of electric locomotives in the United States. This included the types of locomotives presently in use and those available for the future.

There have been numerous papers presented and many studies made concerning the economic and operating feasibility of electric freight train operation for particular railroad applications. It is our intention, therefore, to avoid this area and instead present a view of railroad operations, utilizing straight electric locomotives in place of diesel-electrics, which of course would vitally affect Mechanical Department management and physical plant.

Electrical Operating Instructions

Of prime importance is a general Electrical Operating Instruction governing the actions of and for the protection of all employees in electrified territory. These instructions are in addition to the normal Safety Instructions issued by the various departments of a railroad.

Some of the main items covered by these instructions of vital interest to Mechanical Department employees are:

1. General definitions with descriptive pictures of the overhead electrification system and of electric locomotives, particularly the pantograph collection system.
2. Rules for working on electric locomotives in de-energized areas and near overhead wires.
3. Rules concerning employees on top of any high locomotive or car equipment.
4. Operation of wreck derricks and maintenance of way machinery while under catenary systems.

REPORT NO. 500-BS

ISSUE OF JAN. 1, 1965

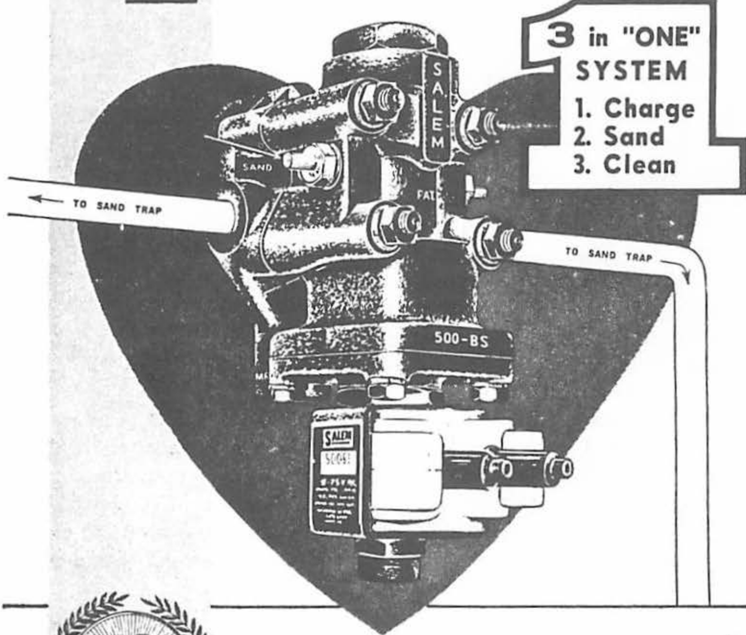
the SALEM Line

SALEM SANDERS

SALEM ELECTRIC SANDING

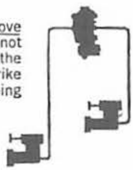
the Heart of the Salem System -

3 in "ONE" SYSTEM
1. Charge
2. Sand
3. Clean



50th YEAR in Sanding

Salem #500-BS **3 in 1** Sander Control Valve is located above and away from the sand traps. Sand and sand dust will not enter the Control Valve and the Control Valve is out of the range of possible damage should maintenance forces strike the sand trap in an attempt to dislodge obstructions stopping the sand flow.



Only 4 Salem No. 500-BS 3 in 1 Sander Control Valves required per locomotive for the individual control of 8 sand traps.

GRAHAM-WHITE SALES CORP.

SALEM, VIRGINIA

the SALEM Line

5. Instructions for releasing a victim from contact with a live conductor and means of resuscitation from electric shock.

Physical Plant Requirements For Inspection and Maintenance

Most electric locomotives fall heir to a facility designed for maintenance of either steam or diesel locomotives. This type of facility usually requires the use of a diesel switching locomotive for maneuvering electric locomotives in and out of the shop.

The foremost decision in designing a running repair and inspection shop for electric locomotives is whether the electric contact wire is to be carried inside the shop or terminated outside, with the capability of pushing units into and through the shop with energized electric units. In the latter case, the design should be such that no energized locomotive or pantograph will be inside the building. An attached sketch, Figure 1, shows a typical single-track maintenance shop without trolley wire. This facility serves as a scheduled repair location for 76 electric locomotive units. It also serves as a location for performing indoor running repair work on these locomotives and an additional 40 locomotives that have scheduled maintenance done at another location. This facility has a very good safety record, with no electrical accidents occurring to the work force over the 12-year period it has been in existence.

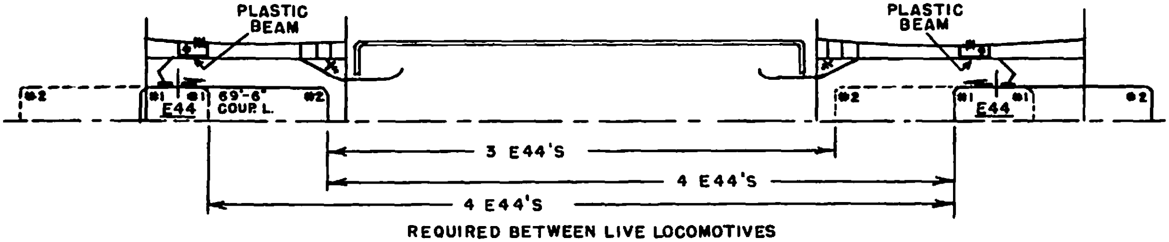
In contrast to the de-energized facility, the through trolley-type facility is shown in Figure 2. This building was built in 1970 to accommodate six Metroliner units for servicing and inspection. It is provided with a pit for under-car inspection and a roof access platform and has a contact wire through the length of the building. A switch for energizing the catenary system is equipped with a key-operated lock, designed so as to prevent the key from being removed from the lock when the catenary system is energized. The same key is required to unlock the only access door to the roof platform, preventing the use of the platform while the catenary is energized. In spite of those precautions, there have been serious electrical accidents at this shop, such as the one described in Federal Railroad Administration Report No. 141 dated July 1, 1975.

The advantage of a facility with a through trolley wire is that any final testing requiring an energized locomotive can be done inside.

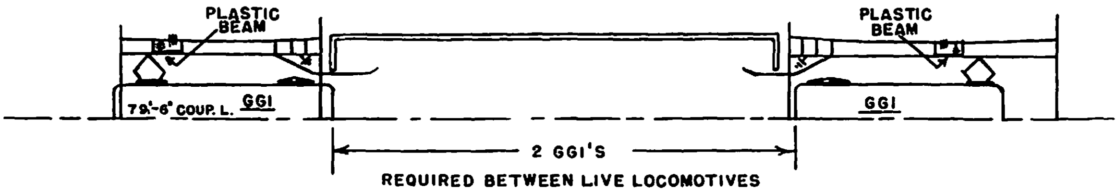
In addition to facilities such as these Inspection Sheds, a location with a de-energized wire and suitable pit and platform facilities is required for daily inspection and servicing of electric units at outlying terminal points.

Present day electric freight locomotives, such as the E-44, the freight version of the E-60-C and the GM-6, have a mechanical configuration similar to the diesel-electric road switcher locomotive. Presently, and probably in most future cases, electrified portions of a railroad will terminate near a major diesel maintenance point, so that such diesel maintenance facilities as drop tables and cranes can be used for electric locomotive truck, wheel and motor removal, and for removal of such large electrical items as trans-

TYPICAL SINGLE TRACK MAINTENANCE SHOP FOR ELECTRIC LOCOMOTIVES WITHOUT TROLLEY WIRE



E44 LOCOMOTIVES ON INSPECTION TRACK



GGI LOCOMOTIVES ON INSPECTION TRACK

FIGURE I

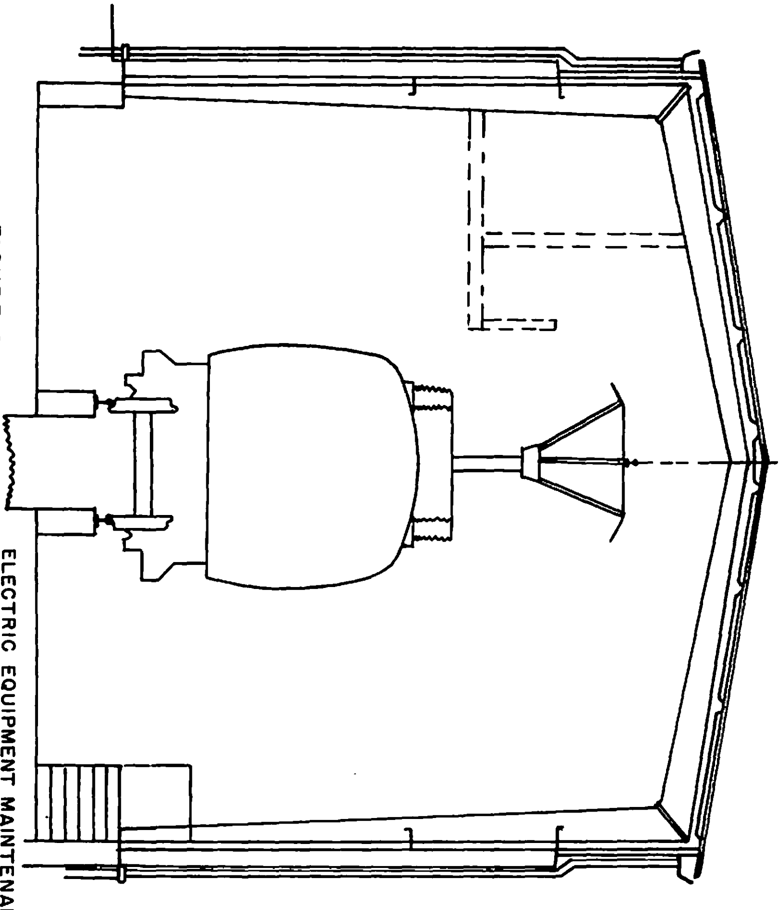


FIGURE 2

ELECTRIC EQUIPMENT MAINTENANCE SHOP WITH TROLLEY WIRE formers and smoothing reactors. In future electrification, present diesel maintenance terminals will be easily and readily adapted to electric locomotive maintenance. The ultimate in shop facility reuse is demonstrated by the fact that 40-year-old GG 1 electric locomotives, and now Amtrak E-60-CP units have running, scheduled inspections and heavy overhaul functions performed at a shop that was once a steam locomotive back shop.

The largest item to be applied and removed from an electric locomotive is the main transformer. Figure 3 gives a comparison of the weight and dimensions of typical electric locomotive transformers with the largest EMD and GE diesel engine generator sets.

Electric Locomotive Inspection and Repair

There are many different items to be inspected on an electric locomotive when compared with a diesel electric locomotive. The main items peculiar to an electric locomotive are the pantograph current collector, the main transformer with its associated top charging contactors (SCR's are replacing most contactors on newer electric locomotives such as the E-60 and GM-6), smoothing reactors, lightning arrestors, primary circuit breaker or other primary fault protection apparatus, ground brushes for conducting return current safely to the rail, and manual and automatic primary grounding devices. Access to the roof of an electric locomotive is through a hatch. The operating lever for this hatch is linked to the manual ground device to insure safety.

To further clarify the many differences between electric and diesel electric items of inspection and maintenance, a monthly inspection form for E-44 electric locomotives is attached. The items peculiar to electrics can be readily recognized by those familiar with diesel maintenance procedures. Later electric locomotives with SCR control and other static control devices will have additional items not completely in agreement with diesel electric nomenclature.

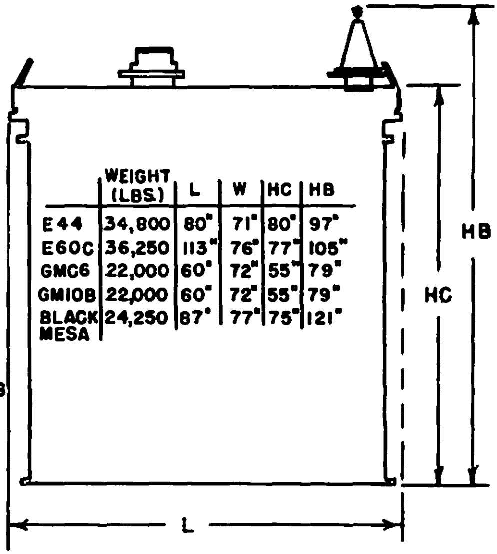
On electric locomotives inspection and maintenance of traction motors support bearings and locomotive ground brushes are particularly important to prevent support bearing failures due to electrical pitting. The newest designs of electric locomotives use roller bearings in this area.

Another requirement peculiar to electric locomotives is the need for apparatus to test the dielectric strength of the main transformer insulating liquid and a filter apparatus to filter and dry the insulating liquid in case it has to be removed from the transformer, due to a defective circulating pump or secondary terminal board repair.

In order to comply with FRA Rule 253 for an electric locomotive, the accepted procedure has been to apply 1.75 percent of the normal working high voltage to the pantograph or to the primary of the main transformer. By transformer action, all other connected circuits are tested at a voltage 75 percent greater than their normal voltage. Typical figures for an E-44 electric unit for these tests are:

PHYSICAL COMPARISON

ELECTRIC LOCOMOTIVE TRANSFORMER
VS
DIESEL-ELECTRIC ENGINE-GENERATOR



	WEIGHT (LBS.)	L	W	HC	HB
E44	34,800	80"	71"	80"	97"
E60C	36,250	113"	76"	77"	105"
GMC6	22,000	60"	72"	55"	79"
GM10B	22,000	60"	72"	55"	79"
BLACK MESA	24,250	87"	77"	75"	121"

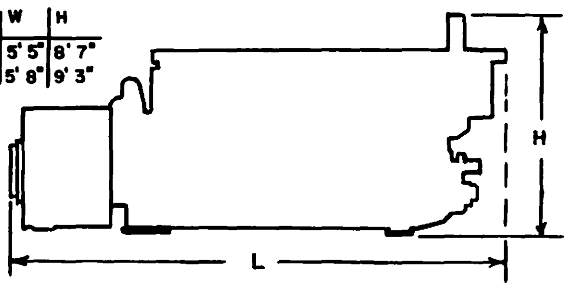
HC = HEIGHTH OVER COVER
HB = HEIGHTH OVER BUSHING
W = WIDTH

ELECTRIC LOCOMOTIVE TRANSFORMER

	WEIGHT (LBS.)	L*	W	H
EMD 20-645E3	42,885	20' 4"	5' 5"	8' 7"
GE 7FDL16	43,510	21' 9"	5' 8"	9' 3"

W = WIDTH

*L FOR EMD IS OVER ENGINE ONLY



DIESEL-ELECTRIC ENGINE-GENERATOR

FIGURE 3

CAUTION

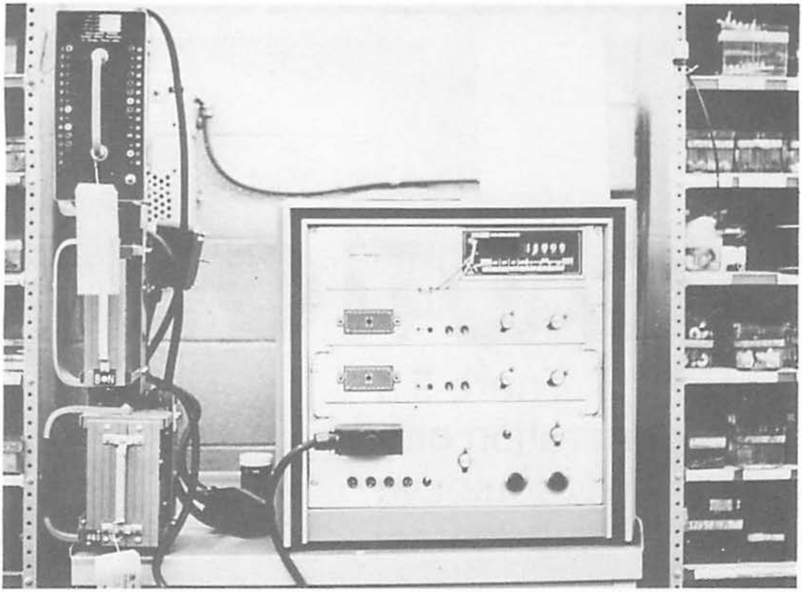
There's a "generation gap" in locomotive lubricants!

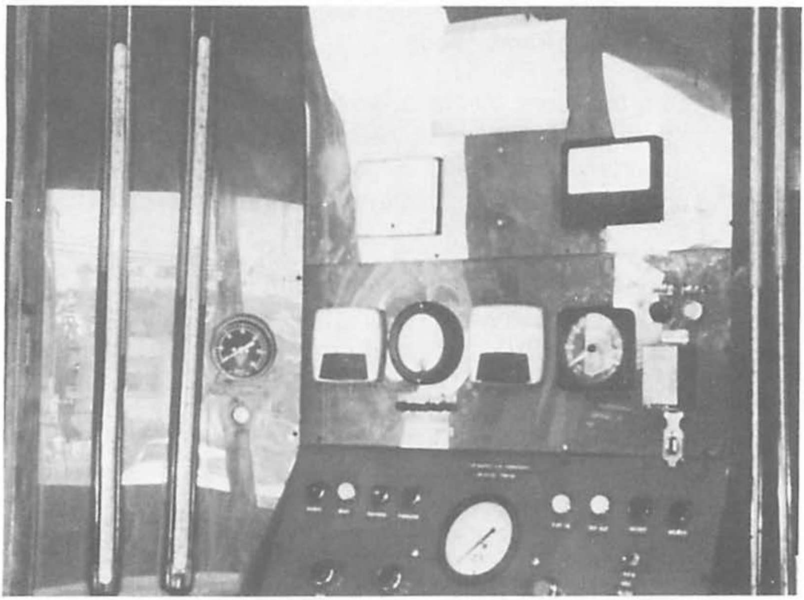
Some diesel lubricants that are called "third generation" oils are really just minor revisions to previous formulations.

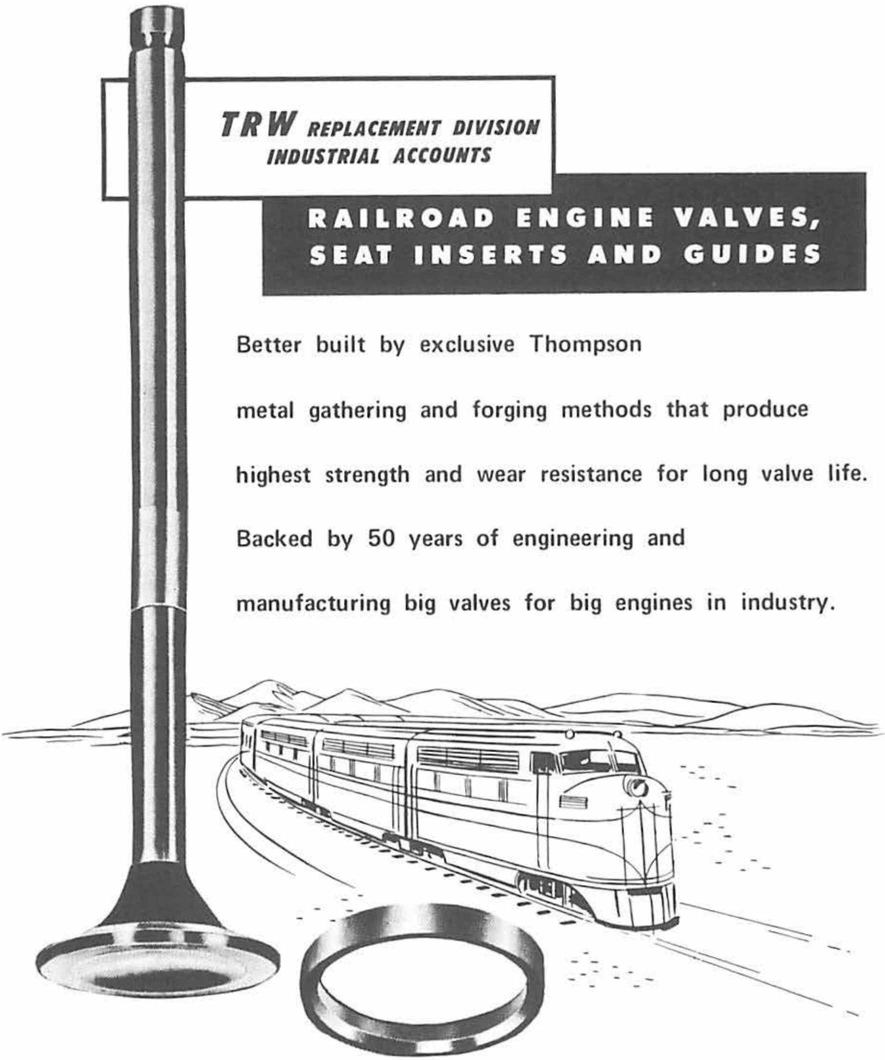
Only *one* lubricant—Mobilgard 443—is a true "third generation" oil in the sense of bringing important new benefits in locomotives operating under the severest conditions of fuel and service.

Mobilgard 443 has been tested in the lab and proven in service. ("For full details call") (312) 885-6210, Schaumburg, Illinois; (212) 883-4622, New York, New York; (415) 444-5568, Oakland, California.

Mobil







719 South Maple Ave. • Montebello, California 90640 Phone: (213) 722-6470

Name of Circuit	Normal Voltage (Volts)	Test Voltage (Volts)
Primary	11,000	19,250
Secondary and Traction Motors	2,520	4,410
Rectifier Circuits	350	613
Secondary, auxiliary, compressor, heater, blower motor circuits	210	370

It can be readily seen that these tests require a high potential test set, with greater capability than those commonly used with diesel-electric locomotives.

Maintenance Forces For Electric Locomotives

Shop Crafts utilized in maintaining electric locomotives do not vary greatly from those maintaining diesel locomotives. The main difference is in the greater number of electricians and fewer machinists required for electric locomotive inspection and repair. Since many of the personnel are used interchangeably on electric and diesel electric work, it is difficult to draw a strict comparison of the manpower requirements for each type. An estimate would indicate that a ratio of 3/1 for electricians and 1/2 for machinists are required for electric units as compared to a diesel electric unit. Generally, all other crafts and supervision remain the same.

As with diesel-electric locomotives, education and training of personnel for the inspection and maintenance of electric locomotives is very important. Training schools at locomotive builder plants for supervisory and key maintenance personnel is the first step. This should be coordinated so that classes are held while construction of the railroad's electric locomotives is being progressed at the plant.

Field instruction should be conducted by qualified locomotive builder representatives and railroad supervisory personnel at all locations where electric units are to be maintained. These classes should be for all operating and maintenance personnel and must include both classroom and on-board instructions for the electric locomotives being placed in service.

It is encouraging to note that 66 E-44 electric locomotives, which have an approximate overall age of 14 years have never required major overhaul work with the exception of programmed truck maintenance.

In conclusion, we have tried to enlighten you, the maintenance officers, of a few differences to be expected when straight electric locomotives are utilized in place of diesel-electrics, and to provide food for thought, for your future consideration, in managing change.

V
WIRING SYSTEMS

It is the recommendation of this committee that AAR's Recommended Wiring Practices be adhered to when wiring or rewiring all or portions of the locomotive circuitry. This should be insisted upon regardless of where the wiring is installed.

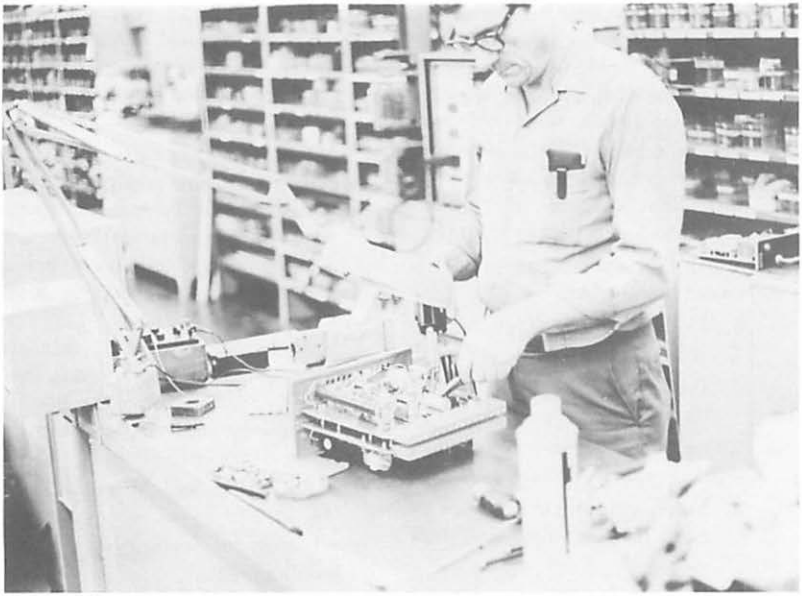
Following is a standard procedure for wiring the power, control, lighting and auxiliary apparatus of all cars and locomotive equipment (the internal wiring of devices is excepted).

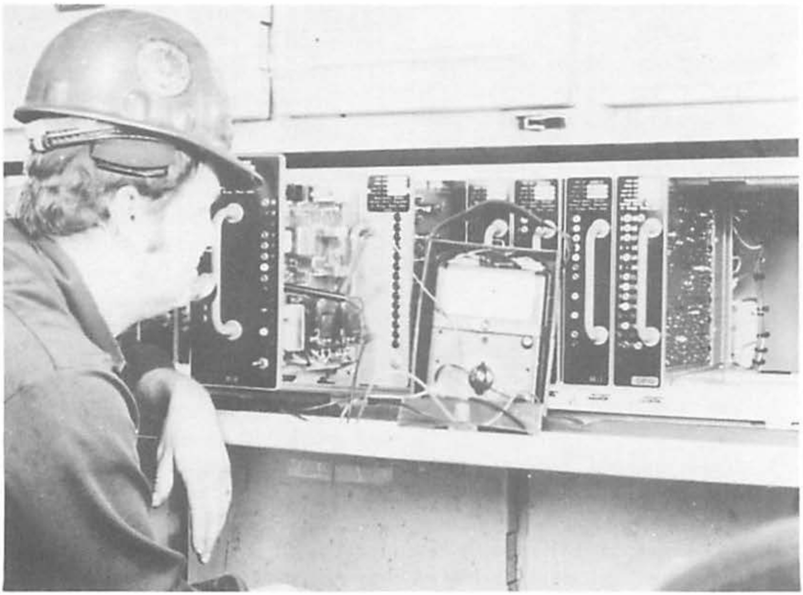
General:

1. The wiring in these electrical systems is to be an ungrounded

system protected in conduit or wireways or using adequately supported and protected cabling. Exceptions for use of grounding are permitted for fault protection devices and for ground return on electric car and locomotive equipment that use rails for ground return to a central power system.

2. Separation shall be provided between wiring for:
   a. High and low voltage circuits;
   b. AC and DC circuits;
   c. Positive and negative of DC circuits where possible.
3. Completely isolated wire runs shall be provided for:
   a. Safety control circuits such as cab signal and automatic train stop;
   b. Communication apparatus circuits;
   c. Battery supply and charging circuits.
4. No splices shall be permitted in the wiring of any circuits. All wiring shall terminate at terminal boards or at terminals of apparatus.
5. No soldering or solder-type terminals shall be permitted on wiring connecting terminal boards or pieces of apparatus.
6. All terminations are to be of the compression (crimp) type and are to be provided with properly fitting insulation grip where feasible.
7. "Quick-removal"-type terminals are to be used where feasible on apparatus or circuits which must be disconnected frequently for inspection and maintenance. Terminals at stud-type terminations shall be fastened by self-locking nuts. Physical polarization or color coding shall be provided for all DC terminals.
8. All high-heat radiating apparatus such as resistors and power static devices shall be placed at the top of electrical cabinets and shall be connected to equipment circuits with wire having high-temperature insulation. Large resistors not located in cabinets, such as dynamic brake grids, shall not be located under the floor of equipment unless they can be adequately ventilated.
9. All conduit and wireways shall be located so as to prevent the entrance of water, oil or other contaminants.
10. All open power cabling shall be adequately supported by neoprene cleats. No wood cleats shall be used.
11. Provide adequate and convenient means for external testing of power and control circuits.
12. All electrical cabinets shall be located and sealed to prevent contamination from dirt, oil, snow, rain and cleaning solutions and from contamination which might occur from failure of water, oil or fuel systems carried on the equipment. Temperature of electrical cabinets or compartments shall be no greater than 170 F with 110 ambient. Pressurization of electrical compartments is mandatory where requirements concerning contamination or temperature limits cannot otherwise be met.





rated to protect apparatus containing semi-conductor or electronic devices during all electrical tests.

While the wire specification in this standard does not include Exane or Flamerol X.L., insulated wires, these products have been used extensively by EMD and GE for the smaller sizes of wire found in the control circuits of diesel-electric locomotives and they have performed satisfactorily. These two insulations have a higher temperature rating than AAR-approved insulation systems and should provide a long service life.

these two insulation systems is that they are less flexible than the AAR-approved insulations, which has prevented their use in the larger power cable applications.

Both EMD and GE use AAR-approved wire tables. In view of the limitation we do not recommend the use of Exane or Flamerol X.L. in wire sizes above number 10 A.W.G. unless it is a controlled application to determine fitness for service in these areas.

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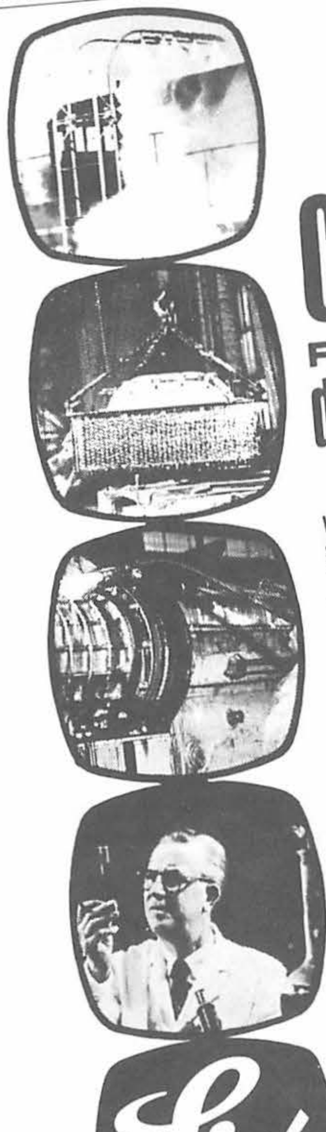

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13. All control and auxiliary circuits shall be protected by trip-free magnetic circuit breakers or by fuses unless specific applications dictate otherwise.
14. All wires shall be properly marked with non-metallic material at terminations or junction box locations.
15. All points of trainline connectors shall be connected through equipment by way of terminal boards so that they may be readily used for spares or additional functions.
16. All basic car and locomotive equipment wiring (exclusive of internal wiring of apparatus and special plug connectors) must have a minimum of 600-volt insulation and No. 14 AWG copper size.
17. Conduit to be 3/4" minimum size and conductor area is not to exceed 40 percent of the area of the conduit. Heavy wall rigid metal conduit is to be used for all underfloor applications. Electrical metallic tubing may be used for above-floor applications. Liquidtight Flexible Metal Conduit may be used where it is not practical to use either of the above mentioned types. Use of flexible conduit should be kept to a minimum.

    Conductor area in any wireways is not to exceed 40 percent of the wireway area. In general conduit and wireway installations are to be in accordance with National Electrical Code articles 346, 348, 351 and 362.

Wire Specifications

All wires for circuits not in high-temperature locations are to be copper with hypalon, rubber-neoprene or EPR-hypalon insulation. The conductor material, stranding, wire size and insulation construction are to be in accordance with latest issue of Specifications 581, 589 and 591 in Section 10 of the Electrical Manual of Standards and Recommended Practices.

Conduit Specifications

Rigid metal conduit is to be in accordance with ANSI Specification C-80.1.

Electrical metallic tubing is to be in accordance with ANSI Specification C-80.3.

Fittings for rigid metal conduit and electrical metallic tubing are to be in accordance with ANSI Specification C-80.4.

When flexible conduit is required for car or locomotive applications it must be Liquidtight Flexible Metal Conduit, Type UA, as approved by Underwriters' Laboratories, Inc.

Wireway Specifications

All wireways are to be steel or non-ferrous material of equal characteristics and to be neoprene coated after fabrication.

Tests

Individual circuits and complete control and auxiliary systems of all equipment shall have at least 5 megohms insulation resistance to ground when measured by a megger, a resistance bridge, or by the voltmeter-ammeter system, all using 500 volts DC. Power systems shall be tested in a similar manner using 1050 volts DC.

All car and locomotive equipment is to be high potential tested in accordance with ANSI C35/IEEE No. 16 for control and auxiliary circuits.

Wednesday, September 29, 1976

9:00 A.M.

REPORT OF THE COMMITTEE ON DIESEL MATERIAL CONTROL

Pre-Convention Presentation: Southern and Southwestern Railway Club, Inc.

April 15, 1976 Downtown Holiday Inn Huntington, W. Va.

J. J. GREGORY, Chairman
Manager, Production Control
Consolidated Rail Corp.
Altoona, Pa. 16603

VICE CHAIRMAN

E. H. Follweiler, Director-Asset Disposition ConRail, Consolidated Rail Corp., 399 - 30th Street Station, Philadelphia, Pa. 19104

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J. H. Sheridan, Master Mechanic, Missouri Pacific Railroad, P. O. Box 5494, North Little Rock, Ark. 72116

O. E. Smith, Material Co-Ordinator, Louisville and Nashville Railroad Co., 908 W. Broadway, Louisville, Ky. 40201

B. O. Vaden, Mechanical Supervisor-Locomotive, Norfolk and Western Railway Co., Roanoke, Va. 24011

D. L. Ward, Engineer Motive Power, St. Louis-San Francisco Railway Co., 3253 E. Trafficway, Springfield, Mo. 65802

PERSONAL HISTORY JAMES J. GREGORY

Jim Gregory was born in Baltimore, Maryland on February 20, 1918. Attended high schools in North Carolina, Texas, New Mexico and graduated from West Denver High School 1936.

Entered the University of Colorado in 1936 majoring in chemical engineering. Education was delayed for a period of ten years. After serving in the United States Navy, returned to University of Denver, graduated in 1949 with a B.S. degree in Chemical Engineering.

Upon graduation was employed for six years with Sinclaid Refining Company as Lubrication Engineer in the Railway Division serving railroads in the Central Rocky Mountain area.

Began his Railroad Career in October, 1954 with the New York Central as Assistant Chief in the Test Department. Served in the Mechanical Department as Assistant to General Mechanical Superintendent. Assigned to CMO's staff, serving as Manager in the following departments: Cost Control, Industrial Engineering, Engineering Service and Production Control. Is at present at the Altoona Shops as Production Control Manager.

Mr. Gregory has been a member of the LMOA since 1954, is a member of the American Society of Mechanical Engineers, and the American Institute of Industrial Engineers, American Production and Inventory Control Society. Outside activities involve fly-fishing and enamel art work. Is Vice President of church organization.

He married Irene Sudakoff of Denver, Colorado on October 18, 1937 and they have two daughters and three grandsons.

PROFITABILITY IN WARRANTY

This committee feels that "Profitability In Warranty" is a timely subject in view of the financial condition of many railroads. Warranty discussions in the past have been glossed over lightly; but warranty is an "untapped source of revenue." Our objective is to outline the three basics of warranty claims—"What" they entail, "How" to initiate warranty claims, and "Who" is responsible for initiating the claims.

Every manufacturer and supplier has built into his price structure a specific percentage to cover warranty, or premature failures. The manufacturer provides warranty information, but it is the *Mechanical department's responsibility to initiate the warranty claim.*

Hundreds of million of dollars are spent annually by railroads and even a 1 percent return to railroads through warranty is substantial. Do you actually know what your railroad received last year in warranty claim returns?

What constitutes warranty will be outlined in Mr. Follweiler's report to follow. As to how a claim is initiated, the manufacturer's representative has the responsibility for providing necessary guidance to the railroads in preparing warranty claims and also assuring that all available, and required, information is furnished and factual. The manufacturer's representative is also responsible for the preparation of all necessary paper work to file the claim, although the actual paper work is undertaken in

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for truck center plates and pedestals

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conjunction with the Stores-Purchasing department. Mechanical and Purchasing departments have available warranty procedures handbooks furnished by major suppliers.

For maximum return of warranty claims, documentation is essential. It is mandatory that the Mechanical department have in operation a system of proper documentation of all facts and data pertaining to any specific warranty claim. The accuracy of records the railroad maintains on end products, or replacement material, will directly affect the benefits which the railroad will receive from warranty dollars expended by the manufacturer. Data can be compiled through a computer as in the case of the Frisco Railroad, or can be manually tabulated.

Since it is the responsibility of the Mechanical department to determine and then inform the manufacturer that a failed part is under warranty, the importance of accurate records cannot be over emphasized.

In addition to monetary benefits, warranty claims can also benefit both the railroad and the manufacturer, since they constitute a controlled feedback to the manufacturer detailing *problem areas* requiring investigation and correction. Warranty claims can in many cases alert manufacturer to failure trends and/or potential trouble. The latter can in turn be corrected through the early warnings.

Railroads should undertake self evaluations of their "modus operandi." Warranty procedures normally fall into one of these three categories: the initial responsibility relative to warranty forms is assigned to (1) one of the clerks, (2) a staff member with instruction to check as time permits, or (3) a specific group with designated responsibilities. The first two categories mentioned will result in minimal benefits. Maximum effort will reap maximum benefits, but the reverse also holds true.

The extent of coverage of warranty items must be determined by each railroad, but the two controlling factors are (1) the cost of the program versus benefits derived, and (2) the cost of the item and/or quantity of use. The cost of the paper work and manhours expended will rule out low cost, low use items.

The LMOA Committee is not the only railroad organization concerned with warranty. At the present time the AAR Committee is likewise interested in warranty procedures. This is evident in Item 23 of the Mechanical Division Circular DV1845 which deals with a type of sticker to be applied by manufacturers to component parts. At the present time some of the manufacturers of component parts are testing a metallic pressure-sensitive and self-adhering sticker.

The Penn Central Railroad (now ConRail) has for several years utilized pressure sensitive stickers for new component parts applied to locomotives, primarily electrical items. A ball point pen can be used to imprint the date and shop making the application. Red labels were used in 1975 and yellow is designated 1976. Incidentally, Quality Control groups have been involved in warranty claim operations at system back shops.

Even though locomotive manufacturers and suppliers of component

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You hear a lot of talk about exclusive plating processes and how they restore any liner. But there's more to restoring liners than just plating. Every liner, before Mecrome plating, receives critical hydraulic and physical tests so you can be sure we'll never return a beautifully restored liner with hidden defects.

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Finally, our Mecrome plating process provides a tough, hard chrome finish matched to today's high performance engines. This patented electrolytic process creates microscopic pinpoint pockets on the chrome liner surface that retains oil to lubricate the liner wall which reduces friction and wear.

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and quality described in the specification referred to in the sales proposal and is suitable for the ordinary purposes for which such equipment is used.

"Seller further warrants the locomotive to be free from defects in material and workmanship which may develop under normal use and service within two years from date of delivery or before the locomotive has been operated 250,000 miles whichever event shall first occur. Seller agrees to correct such defects, which examination shall disclose to Seller's satisfaction to be defective, by repair or replacement F.O.B. factory and such correction shall constitute fulfillment of Seller's obligation with respect to such defect under this warranty.

"Seller warrants specialties not of its own specification or design to the same extent that the Suppliers of such specialties warrant such items to Seller.

"There are no warranties, expressed or implied, made by Seller except the warranties set out above."

(B) GE WARRANTY:

"The company warrants to the Purchaser that each locomotive manufactured or rebuilt by it hereunder will be free from defects in material, workmanship and title under normal use and service, and will be of the kind and quality designated or described in the contract. The foregoing warranty is exclusive and in lieu of all other warranties, whether written, oral, implied or statutory (except as to title). NO WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR PURPOSE SHALL APPLY. If it appears within two (2) years from the date of shipment by the Company, or within 250,000 miles of operation, whichever event shall first occur, that the locomotive delivered hereunder does not meet the warranties, specified above, and the Purchaser notifies the Company promptly, the Company, after verification as to condition and usage, shall correct any defect including non-conformance with the specifications, at its option, either by repairing any defective part or parts made available to the Company, or by making available at the Company's plant or warehouse, a repaired or replacement part. If requested by the Company, the Purchaser will ship the defective part or parts, with shipping charges prepaid, to the plant or warehouse designated by the Company.

"The liability of the Company to the Purchaser (except as to title) arising out of the supplying of any locomotive hereunder, or its use, whether on warranty, contract or negligence, shall not in any case exceed the cost of correcting defects in the locomotive as herein provided, and upon the expiration of the warranty period specified above, all such liability shall terminate. The Company shall have no liability for any locomotive or part thereof which becomes defective by reason of improper storage or application, misuse, negligence, accident or improper operation, maintenance, repairs or alterations on the part of the Purchaser, or any third party other than the Company. The foregoing shall constitute the sole remedy of the Purchaser and the sole liability of the Company.

In the following sections Mr. Follweiler (Director, Asset Disposition, ConRail) will discuss "Manufacturers New Locomotive Warranty Analysis." Mr. Ward (Assistant Engineer Motive Power, St. Louis-San Francisco Ry.) will outline in detail the Frisco Railroad computerized system of warranty controls. Undoubtedly, the Frisco has one of the most sophisticated and advanced systems in use on intermediate railroads. Its control system can be readily adapted by large and small railroads.

1. MANUFACTURERS NEW LOCOMOTIVE WARRANTY ANALYSIS

During the past several years, this committee has on numerous occasions provided brief and basic detail involving certain aspects of manufacturers warranty. Through these briefs, a certain amount of feedback has been generated indicating variances of interpretation between individuals within the membership representing our industry.

With the concurrence of the Executive Committee, we have therefore concluded it appropriate to explore and present in somewhat greater detail manufacturing or seller warranties. The aim is to acquaint the LMOA membership with what warranties entail through definition and hopefully to provide a better understanding, enabling all concerned to better administer and follow through on the procedures required to economically benefit and obtain the re-

to define "Warranty" as it specifically relates to equipment areas. By typical dictionary definition it can be briefly stated as:

"An act or an instance of assurance, an authorization, an engagement, expressed or implied, in assurance of some particular in connection with a contract, as of sale, an express warranty of the quality of goods."

More simply, it is a written guarantee given to the purchaser of a new appliance, equipment, or other item by the manufacturer or dealer, usually specifying that the manufacturer will make certain repairs, or replace defective parts free of charge within specified parameters for a stated period of time.

Warranty can also be considered as the manufacturer's commitment to its customers, which involves the parties in a transaction of sale, thus transferring title to the customer of an end product, or a piece of equipment, guaranteeing workmanship during manufacture and assembly, material and component part defects to the extent of the pertinent warranty agreement specified.

Pertinent warranty agreements generally differ in composition and legal phraseology, yet the meanings conveyed are very similar. To illustrate, and for your own analysis, let us quote two typical new locomotive warranties of competitive manufacturers:

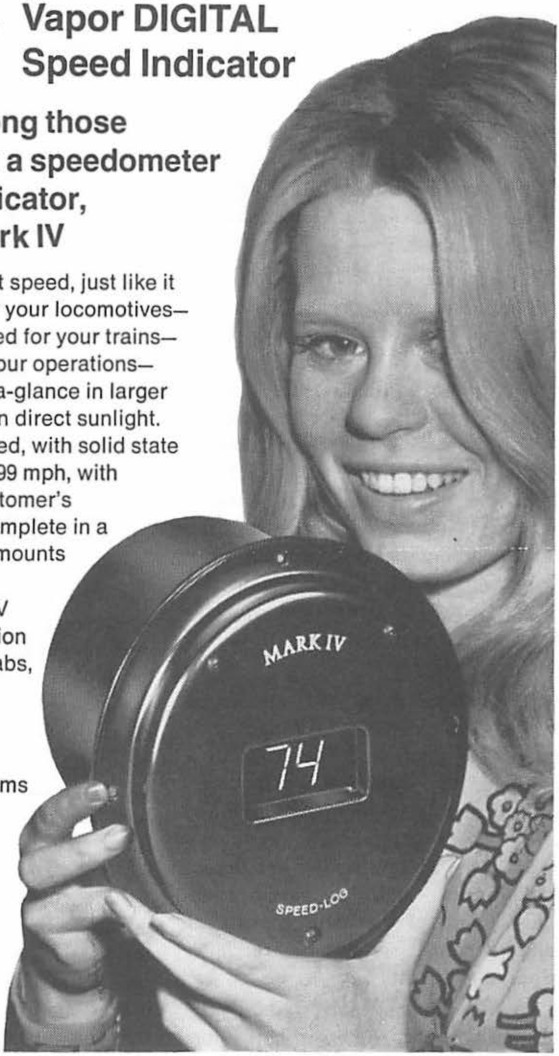
(A) EMD WARRANTY:

"Seller warrants to the original user that the locomotive is of the kind

NEW FROM VAPOR

there are speedometers and there is the Mark IV Vapor DIGITAL Speed Indicator

if you are among those who still think a speedometer is a speed indicator, look at the Mark IV



Shows only the exact speed, just like it is, the safe speed for your locomotives– The economical speed for your trains– The best speed for your operations– The exact speed, at-a-glance in larger numerals, readable in direct sunlight. The dependable speed, with solid state reliability. From 0 to 99 mph, with overspeed set to customer's requirement. Now complete in a single package that mounts anywhere. See for yourself–Put Mark IV digital speed indication in your locomotive cabs, and commuter cars.

See how–Write Vapor Corporation, Transportation Systems Division, 6420 West Howard Street, Chicago, Illinois 60648. In Canada– Vapor Canada Limited.

VAPOR CORPORATION
TRANSPORTATION SYSTEMS DIVISION

"It is understood that the Company has the right to make any changes in design and add improvements to equipment at any time without incurring any obligations to install, at Company's expense, the same on other locomotives sold by said Company."

The quoted warranty statements are or should be in possession of the owners and operators of locomotive fleets, including general explanatory data to provide a clear understanding of the administrative procedures to provide fair and equitable settlements where required.

Implementation of any viable and successful warranty program must be initiated by owners and operators of equipment fleets. They must bear the responsibility of initiating the required feedback to the manufacturer through the proper forms and procedures of reporting when the situation dictates. Remember, all manufactured material shipped involving a transfer of title, be it a complete end product or a replacement part or component for specific types of equipment application, is covered by some form of warranty statement.

Many benefits to all concerned parties are derived through this method of controlled feedback to a manufacturer. Many times it statistically details developing problem areas for investigation. They may cover initial design, review for design modification, material specification, readjustment of electrical component values, changes in periodic servicing requirements, etc.

To accomplish and obtain the desired benefits, owners or operators must by necessity maintain accurate historical records of each type and piece of equipment, unit replacements, component part replacements, appropriate service hours or mileage data. In the present age of computerization, appropriate programming functions most generally provide the most complete and timely feedback with the least amount of effort. However, the absence of a computer programming capability should by no means preclude maintaining such records which are generally basic anyway, in that normal maintenance programs dictate their formulation.

The generally accepted methods and procedures of handling warranty notifications and claims involving premature failures do not vary significantly among the types of equipment manufacturers we are concerned with here. Equipment, component parts, and/or material that has prematurely failed should first be handled directly with the manufacturer's assigned field representative. It is the field representative's responsibility to maintain contact with the appropriate personnel at several responsible maintenance and operating levels. As frequently as his schedule permits he should assist in identifying servicing and operating problem areas, provide counseling where necessary and help in the preparation of appropriate and bonafide claims for items that have failed within the parameters of the warranty statements involved.

Again, failure to maintain service, maintenance and operating data means the loss of required information for the claim form document. It also means the loss of timely feedback to the manufacturer, thus not only jeopardizing the legal validity of the ing warranty components and is easily adaptable to intermediate size railroads having between 200 and 1,000 locomotives. Although we are presenting only one phase of this maintenance system, that dealing with warranty handling, it should be noted that this is a total locomotive maintenance control system, encompassing every aspect of effective locomotive maintenance, including such things as reporting and correction of on-line failures, inspection notification and procedures, component part change-outs based on predicted life, etc.

The system is called Diesel Maintenance Control (DMC), and it was designed and is currently in use by the Locomotive department of the St. Louis–San Francisco Railway Company. The report generated by this computerized system which has proven invaluable in identifying warranty components is entitled the "Diesel Unit and Component Parts Mileage" record (see Exhibit A). The report is made once a month and is available for use by all diesel foremen on the railroad. Also, any specific information contained in the report is retrievable by direct inquiry to the computer; and, since the information in the report is updated on a daily basis, the inquiry will give the most timely data possible. By using the information contained in this report, it is relatively easy for the foreman to identify a component part as warranty, since he can readily determine both the application date and the accumulated mileage of that part.

Before demonstrating how this report is used to identify and handle warranty components, let us go over the report to point out some important warranty information contained in it.

The report begins with a header line giving the locomotive unit number, manufacturer, type of locomotive, and horsepower. The line also contains the terminal to which maintenance is assigned and its computer designation. It shows the date the locomotive was received on line, the last DOT federal (FRA) inspection date, the last railroad maintenance inspection date and miles the locomotive has accumulated since that date. The line is finished with such information as total miles the locomotive has accumulated since new, miles since overhauled, frequency of overhaul in years, date overhauled, total miles made during month the report is dated, and the month's scheduled and unscheduled maintenance costs.

Within the body of the report is a listing of the major component parts on the locomotive. In the first column after the locomotive unit number is the component part code used to identify specific component parts. Part codes preceded by the letter "M" are used for mechanical component parts and those preceded by the letter "E" are used for electrical parts. The next three columns contain the part location on the locomotive, its description, and the component part serial number. The serial number is followed by miles the part has accumulated since new and miles accumulated since applied to the locomotive unit number listed on the report. These two mileage figures would differ only if rebuilt parts were applied at the time of parts change-out.

EXHIBIT A

DMC - DIESEL UNIT AND COMPONENT PART MILEAGE SEPTEMBER 30,1975 PAGE 1207

UNIT-MFGR-TYPE	H/P	-USN-	-IN-	DACL	*-OUT DATE-*	*-FCO DATE-*	K-S-L-I	M-S-NEW	M-S-J/M	JM	C/M-DATE	CM-M	CM-S-C	CM-U-C	ST
M-0723 EMD GP35	2500	739	SDS	0565	2 05/20/75	2 04/20/75	2264	1438129	213874	06	10/17/73	7557	334.22	33,264.54	

UNIT	*-PART	LOC	NAME	SERIAL-NO	M-S-NEW	M-S-APP	DLF	N	M	DATE-APL	CDC	P/L	I/C	RS	ST
0723	E10200	01	MAIN GENERATOR DC	73F33016	213874	213874	606	7	S	10/30/73			27	YY	
0723	E10201	01	MAIN GENERATOR DC-BEARING	73F33016	213474	213474	606	7	S	10/09/73			27	YY	
0723	E10400	01	LOAD REGULATOR	6523144	355306	511061		0		04/28/71			54	YY	
0723	F20100	01	AUXILIARY GENERATOR	2147467	213874	213874	050	2	U	10/17/73			25	YY	
0723	F20200	01	BATTERY	71252E65	1438129	1438129		0		03/06/68			91	YY	
0723	F20400	01	VOLTAGE REGULATOR	67A35	355306	511061		0		04/22/71			54	YY	
0723	E30100	01	TRACTION MOTOR	75F33043	7325	7325	606	7	U	09/04/75			1	YY	R
0723	E30100	02	TRACTION MOTOR	75G33018	7325	7325	606	7	U	09/04/75			1	YY	R
0723	E30100	03	TRACTION MOTOR	75H33021	7325	7325	606	7	U	09/04/75			1	YY	R
0723	E30100	04	TRACTION MOTOR	75H33010	7325	7325	606	7	U	09/04/75			1	YY	R
0723	E30101	01	TRACTION MOTOR BEARING	75F33043	7325	7325	606	7	U	09/04/75			1	YY	R
0723	E30101	02	TRACTION MOTOR BEARING	75G33018	7325	7325	606	7	U	09/04/75			1	YY	R
0723	E30101	03	TRACTION MOTOR BEARING	75H33021	7325	7325	606	7	U	09/04/75			1	YY	R
0723	E30101	04	TRACTION MOTOR BEARING	75H33010	7325	7325	606	7	U	09/04/75			1	YY	R
0723	E40102	01	DYNAMIC BRAKE GRID		1435477	1435477		0		05/15/65			125	YN	
0723	E40102	02	DYNAMIC BRAKE GRID		1435477	1435477		0		05/15/65			125	YN	
0723	E40102	03	DYNAMIC BRAKE GRID		1435477	1435477		0		05/15/65			125	YN	
0723	E40102	04	DYNAMIC BRAKE GRID		1435477	1435477		0		05/15/65			125	YN	
0723	E40103	01	DYNAMIC BRAKE BLOWER MOTOR	65J50	721032	213874	606	2	S	05/05/73	2	72	27	YY	
0723	E41000	01	FUEL PUMP MOTOR	F73J0E	213874	213874	606	2	S	10/10/73			27	YY	
0723	E63000	01	TURBO SOAK BACK PUMP MOTOR	F73J11E	213874	213874	606	1	S	10/10/73			27	YY	
0723	E80100	01	COOLING FAN	65L180	213874	213874	606	1	S	09/05/73			27	YY	
0723	E80100	02	COOLING FAN	5765	213874	213874	606	1	S	09/05/73			27	YY	
0723	E80100	03	COOLING FAN	65L179	213874	213874	606	1	S	09/05/73			27	YY	
0723	E81100	01	INERTIAL BLOWER MOTOR	170L63	1234314	915936		3		05/07/68			39	YY	
0723	H20000	01	TRUCK	L22066	371361	7325	606	2	U	09/04/75	1		1	YY	R
0723	H20000	02	TRUCK	G262	371361	7325	606	2	U	09/04/75	1		1	YY	R
0723	H21300	01	WHEEL AND AXLE ASSEMBLY	KARCOM372	7325	7325	606	1	U	09/04/75			1	YY	R
0723	H21300	02	WHEEL AND AXLE ASSEMBLY	KARCOM373	7325	7325	606	1	U	09/04/75			1	YY	R
0723	H21300	03	WHEEL AND AXLE ASSEMBLY	KARCOM374	7325	7325	606	1	U	09/04/75			1	YY	R
0723	H21300	04	WHEEL AND AXLE ASSEMBLY	KARCOM375	7325	7325	606	1	U	09/04/75			1	YY	R
0723	M30202	01	AIR COMPRESSOR WATER COOLED	457827	213874	213874	606	1	S	10/12/73		72	27	YY	
0723	M30209	01	AIR COMPRESSOR HIGH PRESSURE ASSEMBLY		213874	213874	606	2	S	10/12/73			27	YN	
0723	M30210	01	AIR COMPRESSOR HIGH PRESSURE HEAD		213874	213874	606	2	S	10/12/73		24	27	YY	
0723	M30218	01	AIR COMPRESSOR LOW PRESSURE ASSEMBLY		213874	213874	606	2	S	10/12/73			27	YN	
0723	M30218	02	AIR COMPRESSOR LOW PRESSURE ASSEMBLY		213874	213874	606	2	S	10/12/73			27	YN	
0723	M30219	01	AIR COMPRESSOR LOW PRESSURE HEAD		213874	213874	606	2	S	10/12/73		24	27	YY	
0723	M30219	02	AIR COMPRESSOR LOW PRESSURE HEAD		213874	213874	606	2	S	10/12/73		24	27	YY	
0723	M40000	01	ENGINE-OVERHAUL	73H31532	213874	213874				10/17/73		72	27	YY	
0723	M40304	01	COOLING WATER PUMP	K69G9	213874	213874	606	2	S	10/15/73			27	YY	
0723	M40304	02	COOLING WATER PUMP	LC5031	213874	213874	606	2	S	10/15/73			27	YY	
0723	M40400	01	CRANKCASE	A694760	213874	213874	606	7	S	10/17/73		72	27	YY	
0723	M40401	01	CRANKCASE AND ASSEMBLY TYPES	56703AE3	154039	154039		5		06/01/74			18	NY	
0723	M40501	01	CRANKCASE PRESSURE DETECTOR		213874	213874				10/17/73		12	27	YN	
0723	M40600	01	CRANKSHAFT	MV5434	213874	213874	606	7	S	10/17/73			27	YY	
0723	M40602	01	CRANKSHAFT MAIN BEARING-LOWER HALF		213874	213874				06/09/73		36	27	YN	P
0723	M40603	01	CRANKSHAFT MAIN BEARING-UPPER HALF		213874	213874				06/09/73			27	YN	P
0723	M40702	01	CYLINDER HEAD	73G3147	213874	213874	606	1	S	10/17/73			27	YY	

EXHIBIT A

EXHIBIT A (Cont'd)

DMC – DIESEL UNIT AND COMPONENT PART MILEAGE SEPTEMBER 30,1975 PAGE 1268

UNIT	P-PART	LOC	NAME	SERIAL-NO	M-S-NEW	M-S-APP	DEF	N	M	DATE-APL	COC	P/L	1/C	MS	ST
0723	M40702	02	CYLINDER HEAD	7363227	213974	213674	606	1	S	10/17/73			27	YY	
0723	M40702	03	CYLINDER HEAD	7363679	213674	213874	606	1	S	10/17/73			27	YY	
0723	M40702	04	CYLINDER HEAD	7363471	213674	213674	606	1	S	10/17/73			27	YY	
0723	M40702	05	CYLINDER HEAD	7363656	213874	213874	606	1	S	10/17/73			27	YY	
0723	M40702	06	CYLINDER HEAD	7363301	213874	213874	606	1	S	10/17/73			27	YY	
0723	M40702	07	CYLINDER HEAD	7363224	213874	213874	606	1	S	10/17/73			27	YY	
0723	M40702	08	CYLINDER HEAD	7363139	213374	213874	606	1	S	10/17/73			27	YY	
0723	M40702	09	CYLINDER HEAD	7363332	213474	213674	606	1	S	10/17/73			27	YY	
0723	M40702	10	CYLINDER HEAD	7363045	213474	213874	606	1	S	10/17/73			27	YY	
0723	M40702	11	CYLINDER HEAD	7363691	213374	213674	606	1	S	10/17/73			27	YY	
0723	M40702	12	CYLINDER HEAD	7363304	213674	213874	606	1	S	10/17/73			27	YY	
0723	M40702	13	CYLINDER HEAD	7363303	213874	213674	606	1	S	10/17/73			27	YY	
0723	M40702	14	CYLINDER HEAD	7363735	213974	213674	606	1	S	10/17/73			27	YY	
0723	M40702	15	CYLINDER HEAD	7363669	213274	213674	606	1	S	10/17/73			27	YY	
0723	M40702	16	CYLINDER HEAD	7363330	213674	213274	606	1	S	10/17/73			27	YY	
0723	M40701	01	CYLINDER LINER	7331656	213074	213674	606	1	S	10/17/73		72	27	YY	
0723	M40701	02	CYLINDER LINER	7331860	213874	213374	606	1	S	10/17/73		72	27	YY	
0723	M40701	03	CYLINDER LINER	7331503	213074	213674	606	1	S	10/17/73		72	27	YY	
0723	M40701	04	CYLINDER LINER	7331679	213874	213674	606	1	S	10/17/73		72	27	YY	
0723	M40601	05	CYLINDER LINER	7331897	213674	213374	606	1	S	10/17/73		72	27	YY	
0723	M40701	06	CYLINDER LINER	7331092	213674	213874	606	1	S	10/17/73		72	27	YY	
0723	M40701	07	CYLINDER LINER	7331868	213674	213674	606	1	S	10/17/73		72	27	YY	
0723	M40701	08	CYLINDER LINER	7331040	213574	213874	606	1	S	10/17/73		72	27	YY	
0723	M40101	09	CYLINDER LINER	7245363	213674	213674	606	1	S	10/17/73		72	27	YY	
0723	M40701	10	CYLINDER LINER	7331068	213874	213874	606	1	S	10/17/73		72	27	YY	
0723	M40501	11	CYLINDER LINER	7331083	213674	213374	606	1	S	10/17/73		72	27	YY	
0723	M40701	12	CYLINDER LINER	7331221	213674	213874	606	1	S	10/17/73		72	27	YY	
0723	M40701	13	CYLINDER LINER	7331659	213774	213674	606	1	S	10/17/73		72	27	YY	
0723	M40301	14	CYLINDER LINER	7331920	213474	213674	606	1	S	10/17/73		72	27	YY	
0723	M40701	15	CYLINDER LINER	7331866	213674	213874	606	1	S	10/17/73		72	27	YY	
0723	M40301	16	CYLINDER LINER	7331204	213374	213674	606	1	S	10/17/73		72	27	YY	
0723	M41001	01	ENGINE AIR AFTERCOOLER		213674	213674				10/17/73			27	YN	
0723	M41001	02	ENGINE AIR AFTERCOOLER		213874	213874				10/17/73			27	YN	
0723	M41305	01	ENGINE AIR INERTIAL FILTER		134039	134039		5		01/01/74		18	26	YN	
0723	M41011	01	ENGINE AIR TURBOCHARGER	73G31126	213574	213574	606	7	S	10/19/73		36	27	YY	
0723	M41101	01	EXHAUST MANIFOLD		213874	213874				10/17/73			27	YN	
0723	M41101	02	EXHAUST MANIFOLD		213574	213374				10/17/73			27	YN	
0723	M41101	03	EXHAUST MANIFOLD		213874	213674				10/17/73			27	YN	
0723	M41101	04	EXHAUST MANIFOLD		213874	213674				10/17/73			27	YN	
0723	M41200	01	GOVERNOR	551896	213410	213410	606	7	S	10/17/73		72	27	YY	
0723	M41301	01	INJECTOR	84	213674	213674	606	1	S	10/17/73		36	27	YY	
0723	M41301	02	INJECTOR	819	213374	213374	606	1	S	10/17/73		36	27	YY	
0723	M41301	03	INJECTOR	821	213874	213874	606	1	S	10/17/73		36	27	YY	
0723	M41301	04	INJECTOR	827	213674	213674	606	1	S	10/17/73		36	27	YY	
0723	M41301	05	INJECTOR	8233	213474	213574	606	1	S	10/17/73		36	27	YY	
0723	M41301	06	INJECTOR	896	213474	213674	606	1	S	10/17/73		36	27	YY	
0723	M41301	07	INJECTOR	8230	213574	213574	606	1	S	10/17/73		36	27	YY	
0723	M41301	08	INJECTOR	A7660	213074	213074	606	1	S	10/17/73		36	27	YY	
0723	M41301	09	INJECTOR	8HK55	213874	223874	606	2	S	10/19/73		36	27	YY	
0723	M41301	10	INJECTOR	A5770	213874	213874	606	1	S	10/17/73		36	27	YY	
0723	M41301	11	INJECTOR	A9920	213674	213674	606	1	S	10/17/73		36	27	YY	

EXHIBIT A (Cont'd)

DMC - DIESEL UNIT AND COMPONENT PART MILEAGE SEPTEMBER 30,1975 PAGE 1269

UNIT	M-PART	LCC	NAME	SERIAL-NO	M-S-NEW	M-S-APP	DEF	N	M	DATE-APL	CDC	P/L	I/L	MS	ST
0723	M41301	12	INJECTOR	D0238	473690	57054	151	2	U	03/13/75	2	36	6	YY	
0723	M41301	13	INJECTOR	B216	213874	213874	606	1	S	10/17/73		36	27	YY	
0723	M41301	14	INJECTOR	B217	213874	213874	606	1	S	10/17/73		36	27	YY	
0723	M41301	15	INJECTOR	B93	213874	213874	606	1	S	10/17/73		36	27	YY	
0723	M41301	16	INJECTOR	B215	213874	213874	606	1	S	10/17/73		36	27	YY	
0723	M41401	01	LUBE OIL		213410	213410	606	1	S	10/17/73			27	YN	
0723	M41406	01	LUBE OIL COOLER		213874	213874				10/17/73			27	YN	
0723	M41407	01	LUBE OIL PRESSURE PUMP	L64C79	605419	213874	606	2	S	10/19/73	1		27	YY	
0723	M41410	01	LUBE OIL SCAVENGING PUMP	A54104	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41503	01	CONNECTING ROD-BLADE	65C1593	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41503	02	CONNECTING ROD-BLADE	67A321	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41503	03	CONNECTING ROD-BLADE	71A551	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41503	04	CONNECTING ROD-BLADE	64B778	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41503	05	CONNECTING ROD-BLADE	69G1121	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41503	06	CONNECTING ROD-BLADE	67A1C09	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41503	07	CONNECTING ROD-BLADE	64C572	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41503	08	CONNECTING ROD-BLADE	65L1075	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41504	09	CONNECTING ROD-FORK	65D1012	213874	213874	605	2	S	10/19/73			27	YY	
0723	M41504	10	CONNECTING ROD-FORK	69J39	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41504	11	CONNECTING ROD-FORK	69J290	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41504	12	CONNECTING ROD-FORK	67B518	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41504	13	CONNECTING ROD-FORK	66H1631	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41504	14	CONNECTING ROD-FORK	65K1202	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41504	15	CONNECTING ROD-FORK	65L77	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41504	16	CONNECTING ROD-FORK	69G1241	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41507	01	CONNECTING ROD BEARING		213874	213874				10/17/73			27	YN	
0723	M41507	02	CONNECTING ROD BEARING		213874	213874				10/17/73			27	YN	
0723	M41507	03	CONNECTING ROD BEARING		213874	213874				10/17/73			27	YN	
0723	M41507	04	CONNECTING ROD BEARING		213874	213874				10/17/73			27	YN	
0723	M41507	05	CONNECTING ROD BEARING		213874	213874				10/17/73			27	YN	
0723	M41507	06	CONNECTING ROD BEARING		213874	213874				10/17/73			27	YN	
0723	M41507	07	CONNECTING ROD BEARING		213874	213874				10/17/73			27	YN	
0723	M41507	08	CONNECTING ROD BEARING		213874	213874				10/17/73			27	YN	
0723	M41508	01	PISTON	73G1662	213874	213874	606	1	S	10/17/73			27	YY	
0723	M41508	02	PISTON	73G1661	213874	213874	606	1	S	10/17/73			27	YY	
0723	M41508	03	PISTON	73G1660	213874	213874	606	1	S	10/17/73			27	YY	
0723	M41508	04	PISTON	73G1666	213874	213874	606	1	S	10/17/73			27	YY	
0723	M41508	05	PISTON	73G1691	213874	213874	606	1	S	10/17/73			27	YY	
0723	M41508	06	PISTON	73G1692	213874	213874	606	1	S	10/17/73			27	YY	
0723	M41508	07	PISTON	73G1674	213874	213874	606	1	S	10/17/73			27	YY	
0723	M41508	08	PISTON	73G1659	213874	213874	606	1	S	10/17/73			27	YY	
0723	M41508	09	PISTON	69K6947	213874	213874	606	2	S	10/19/73			27	YY	
0723	M41508	10	PISTON	73G1676	213874	213874	606	1	S	10/19/73			27	YY	
0723	M41508	11	PISTON	73G1679	213874	213874	606	1	S	10/19/73			27	YY	
0723	M41508	12	PISTON	73G1652	213874	213874	606	1	S	10/19/73			27	YY	
0723	M41508	13	PISTON	73G1690	213874	213874	606	1	S	10/19/73			27	YY	
0723	M41508	14	PISTON	73G1659	213874	213874	606	1	S	10/19/73			27	YY	
0723	M41508	15	PISTON	73G1658	213874	213874	606	1	S	10/19/73			27	YY	
0723	M41508	16	PISTON	73G1675	213874	213874	606	1	S	10/19/73			27	YY	
0723	M70200	01	COUPLER		100559	100559	909	2	U	10/02/74		6	14	YN	
0723	M70200	02	COUPLER		137411	137411	124	2	U	06/20/74		6	18	YN	

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(Chicago Telephone)
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NOTES

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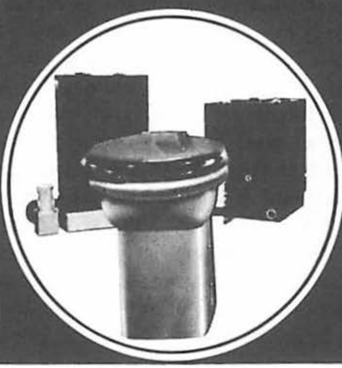

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The next item on the report is a defect code, which is a computer code showing the reason a component part was changed out. There are approximately 200 codes to denote defects contained in the computer master file. Following this are columns which show cost codes for use in computing cost of parts changed out, such as new, rebuilt, clean-up, etc.; type of parts change-out (scheduled or unscheduled); date part was changed out; and, if a rebuilt part, number of times the part has been used on different locomotives.

The last few columns pertain to predicted life of component parts. Predicted life in months or inspection periods has been established for selected parts in accordance with manufacturers' recommendations, and this then becomes part of the computer file. When a component part is applied to a locomotive, the computer begins recording the amount of time the part is on the unit. Then when the time reaches the predicted life, the computer instructs the shop to change out that part. It is hoped that from this many unnecessary component failures will be averted and costly train delays kept to a minimum.

On the last page of each report is a listing of the locomotive wheel rim thickness as of the last turning. The date of the last wheel truing is also given in this section. These data are then used as aids to the shop in planning whether the locomotive will need wheel work at its next maintenance inspection.

How can a report such as the one we have just reviewed aid us in identifying warranty components? In order to best answer this question, let's look at an example of how it can be used. Assume that a locomotive comes to the shop with a defective cooling fan. The shop foreman suspects that it might qualify as a warranty component. He would then go to this component parts mileage report to see when the fan was applied and how many miles it has accumulated since that time. From the report, let's say the foreman determines that the defective fan was applied to the locomotive only four months ago and does fall within the manufacturer's criteria to qualify for warranty adjustment. Having established this, he can then tag the defective part after it has been replaced and set it aside to be handled with the manufacturer's representative as a warranty claim. As a result, money which formerly might have been thrown into the scrap barrel would be given back to the railroad by the parts manufacturer.

In conclusion, it should be kept in mind that a computer system such as this one cannot be set up and put into effect overnight. A long period of time is required to build a file of such information; and even this system, as good as it is, required years to accumulate all of the stored information. It should also be kept in mind that a system of this type might not be the one best suited for your railroad in identifying warranty components. The important point is that any time and money spent to improve your railroad's ability to identify and handle warranty components would be money well spent. The dollar lost by improper warranty handling is easily one of the railroads' greatest sources of untapped revenue.

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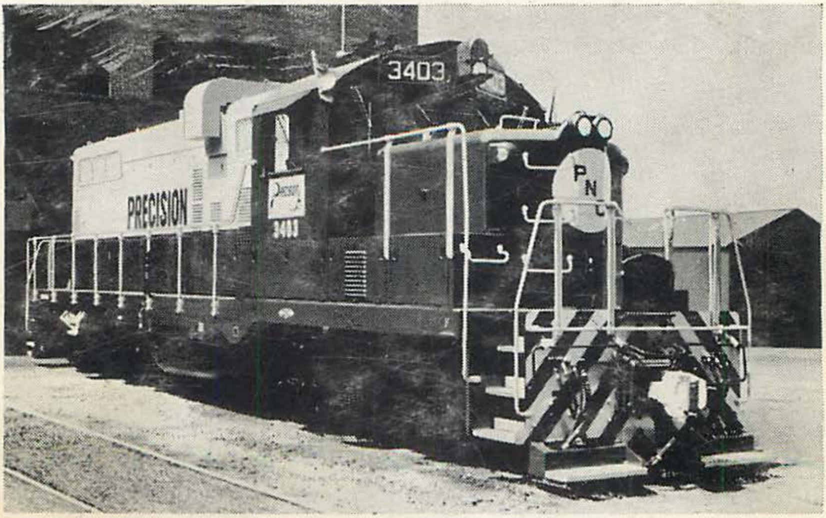

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