BOUND PRINTED MATTER

JOSEPH J. T. KOERNER
3144 Brereton Court
Huntington, W. Va. 25705
Address Correction Requested
Forwarding & Return Postage Guaranteed

FOR PERSONAL INFORMATION ONLY OF:

Mr. J. D. Paschke
Asst. to Superintendent Motive Power
ELGIN, JOLIET & EASTERN RWY. CO.
P. O. Box 880
Joliet, IL 60434

1977 ANNUAL PROCEEDINGS – 1978 PRE-CONVENTION REPORT
HYATT REGENCY – CHICAGO, ILLINOIS
OCTOBER 2, 3, 4, 1978

Special Notice to All Concerned: Information in this book MUST NOT BE REPRODUCED OR QUOTED WITHOUT WRITTEN PERMISSION

Official Discussion Record of 39th Annual Meeting

LMOA

LOCOMOTIVE MAINTENANCE OFFICERS ASSOCIATION

LOCOMOTIVE MAINTENANCE OFFICERS ASSOCIATION

ATTENTION ALL MEMBERS

1979 - RENEWAL FORM

Attach Your Personal Printed Check in Favor of

LOCOMOTIVE MAINTENANCE OFFICERS ASSOCIATION

Mail to Joseph J. T. Koerner, Secretary-Treasurer

3144 Brereton Court, Huntington, W. Va. 25705

$10.00 RAILROAD MEMBERSHIP

$15.00 ALL OTHER THAN RAILROAD MEMBERSHIP

Please do not send cash unless absolutely necessary; there's no way to trace lost cash payments. Dues for year ending September 30, provide for a copy of all Technical Committee Reports and Discussion of reports in an Annual Publication.

All Members attending the Annual Meeting will pay an additional registration fee there.

IMPORTANT: Complete ALL information below. ATTACH YOUR PERSONAL PRINTED CHECK.

Name (Print) . . . .

Position . . . .

Company . . . .

Your Company address:

Street . . . .

City. . . . . State. . . . . Office Zip Code. . . . .

INDEX

LOCOMOTIVE MAINTENANCE OFFICERS ASSOCIATION

MONDAY, SEPTEMBER 19, 1977

TUESDAY, SEPTEMBER 20, 1977

WEDNESDAY, SEPTEMBER 21, 1977

1978 Advertisers Index

This space is dedicated to the firms listed below for their cooperation and assistance in making possible the publication of our 39th Annual Proceedings in the year 1978.

1978 Advertisers Index

LOCOMOTIVE MAINTENANCE OFFICERS' ASSOCIATION APPRECIATES THESE 1978 SUPPORTING ADVERTISERS

ABEX CORPORATION	J. L. CLARK MFG.	HEGENSCHEIDT	MODERN TRANS. SUPPLIES	SCIENTIFIC-ATLANTA
AEROQUIP BARCO DIV.	COBB INDUSTRIES	HEXCEL SPECIALTY	MORRISON-KNUDSEN	SNAP-ON-TOOLS
AEROQUIP (RR GROUP)	CONTINENTAL OIL	HOESCH AMERICA	F. J. MORSE	SNYDER COMPANY
AJAX CONSOLIDATED	CONTROL CHIEF	ERNEST HOLMES	MOSEBACH	SOUTHEASTERN SPC'LTIES
AMERICAN AIR FILTER	CREUSOT-LOIRE	HOUDAILLE INDUSTRIES	MOTOR COILS MFG.	STACKPOLE CARBON
AMERICAN STEEL FDRY.	DEARBORN CHEMICAL	HOUSTON COMPANY	MOTOR OILS REFINING	SUNDSTRAND DATA
AMOCO OIL	J. P. DEVINE	HUGHES RWY. SUPPLIES	NALCO CHEMICALS	SUN OIL
ASHLAND OIL	DONALDSON COMPANY	HULCHER EMERGENCY	NAPORANO	SUPERIOR DIESEL FILTER
ATLANTIC RICHFIELD	E. I. DUPONT KAPTON	ILLINOIS AUTO ELECTRIC	NATIONAL ELECTRIC COIL	SURRETTE STG. BATTERY
AUTOMATIC EQUIPMENT	DUROX	ILLINOIS CENTRAL GULF	NEW YORK AIR BRAKE	TAME INC.
AYLOR ASSOCIATES	EBCO MANUFACTURING	INGERSOLL-RAND	NL INDUSTRIES	TELEDYNE MTL. FNSHRS.
BAIRD-ATOMIC	L. C. EITZEN	JAGGERS EQUIPMENT	NORMAN CHEMICAL	TEXACO
BEARINGS, INC.	ELECTRO-MOTIVE DIV.	J & J CASTINGS	OAKITE PRODUCTS	TORSION & FLUID PROD.
CAM INDUSTRIES	ELLCON NATIONAL	KELTY RADIATOR	OGONTZ CONTROLS	TOUCHSTONE
CARDWELL WESTINGHOUSE	EX-CELL-O	LITTLE GIANT	PENETONE CORP.	TRIANGLE ENGINE REBLD.
C & D BATTERIES	EXIDE POWER SYSTEMS	LIX CORPORATION	PERFORMANCE POLYMERS	TRW REPLACEMENT
CHAMBERSBURG ENGRG.	EXXON	JOHN W. MAHON CO.	POLYMER CORPORATION	TURCO PRODUCTS
CHANDEYSSON ELECTRIC	FARR COMPANY	MANGANESE STEEL FGE.	POWER PARTS	UNION CARBIDE
C. & H. CHEMICAL	ALEX C. FERGUSSON	McCONWAY AND TORLEY	PRECISION NATIONAL	VAN DER HORST
CHEVRON OIL	FREIGHTMASTER HLBTN.	McGRAW-EDISON CO.	PRIME MANUFACTURING	VAPOR CORPORATION
CHROMALLOY RADIATOR	GENERAL BATTERY	McLEAN IND. SUPPLY	PULSE ELECTRONICS	WAGSTAFF BATTERY
CHROME CRANKSHAFT	GENERAL ELECTRIC	MICROPHOR	RWY. EDUCATIONAL BUREAU	WEST CHEMICAL
CHROMIUM CORPORATION	GE — APPARATUS	MILLER FELPAX	RINGSDORFF CORP.	WHEEL TRUING BRAKE SHOE
CITATION CHEMICAL	GRAHAM-WHITE	M & J DIESEL FILTER	RR FRICTION PRODUCTS	WICKMAN MACHINE TOOLS
CITIES SERVICE OIL	GRIFFIN WHEEL	MOBIL OIL	SARDELLO INC.	WIX CORPORATION

ADVERTISERS HONOR ROLL

ATTENTION ALL MEMBERS:

WE DO NOT ENDORSE ANYONE'S PRODUCT, BUT WE DO APPRECIATE OUR ADVERTISERS!

Listed above are the names of the ADVERTISERS whose ads appear in our ANNUAL PUBLICATION.

We appreciate the fine financial support these advertisers provide. These cards are displayed immediately above and behind the speaker's table during the entire Convention. They are referred to with appreciation daily, and their attractive appearance draws much favorable comment.

We hope to see these and many more advertisers' names displayed in this fashion at all of our future Annual Meetings.

Be sure to read their ads in the Annual Publication.

MONDAY MORNING SESSION
September 19, 1977

T. A. TENNYSON
PRESIDENT
Asst. Mgr. Engrg.-Tech.
Southern Pacific Trans. Co.
San Francisco, CA

The Annual Meeting of the Locomotive Maintenance Officers Association, held at the Conrad Hilton Hotel, Chicago, Illinois on September 19-21, 1977, convened at 10 a.m.

MR. J. G. GERMAN [Vice President-Engineering, Missouri Pacific Railroad Company, St. Louis, Missouri]: Good morning, ladies and gentlemen. I am John German, Vice President of Engineering, Missouri Pacific. It is indeed a pleasure to attend this meeting. I was at the very first LMOA meeting that was held after World War II in this hotel. They hadn't quite converted it from the Signal Corps School back into a hotel. As I recollect, eight of us from the Great Northern shared one room on Army cots throughout the session. We didn't sleep in them very much, but we were here, and I had my first exposure to the coordinated meetings at that time.

This morning we have all four groups in joint session — the Air

Brake Association, the Car Department Officers Association, the Locomotive Maintenance Officers Association, and the Railway Fuel and Operating Association. Welcome!

I would like to take this opportunity to introduce Reverend David Jones, minister of the Presbyterian Church of Western Springs. He is a graduate of McAllister College and McCormick Seminary, and presently he is serving a two-year term as moderator of the Chicago Presbytery. Reverend Jones will give the invocation.

REVEREND DAVID B. JONES: Let us pray.

Dear God, we stand before You as another week of work begins. As we do so, we are mindful of both time and space—time because we understand it is the most precious gift that You give to us, for You are the Author and Creator of time.

As this work week begins, we thank You for time and its opportunities. It is a gift we cannot give ourselves. We can but use it, and we acknowledge that there are many pressures and demands upon our lives and the way we choose to use our time. Help each person here to use the days to learn, to share, to enhance their lives and their professions, and thereby to give continued service to our society.

As we are mindful of time, we are also mindful of space. We know that You are everywhere in the universe through Your Spirit, but we are limited to single spheres of space. We have traveled from various places in this universe to be here today, and we know we need the minds of persons to design waves of movement and transport, to move people and equipment and supplies to meet the complexity of our needs and our desires.

This day we thank You for pioneers of the past who have designed ways for our being together, ways of bringing people and supplies together in our systems of travel; for we know that we are interdependent one upon another, relying and assuming that our needs will be met.

And so we do thank You with remembrance for the pioneers of yesterday. But we are in the midst of pioneers for today, concern for those needs that face us in our time —power, energy, safety, service.

Grant, O God, Your presence and direction in these Associations as they meet these days. Be with men and women as they work, that their work is done each day not only well but that it is done in such a manner that reflects the glory of Your gift of life to us. Be in the midst of work, that those standards of integrity and fairness and just one to another might permeate all that is done, so that in fact it can be done in Your Name and for the welfare of Your people.

Thank You, therefore, for the gift of time, for the bringing of us together in space, and for the directions that You grant to us that we may live good lives. Amen.

MR. GERMAN: Thank you, Reverend Jones.

Gentlemen, the LMOA chose such an outstanding speaker for their session this year, whose message is of such interest to all four of the groups, that they extended an invitation to all of you to join with them this morning. It gives me great pleasure to introduce our speaker this morning.

Dr. W. J. Harris, Jr., is a native of South Bend, Indiana, attended Purdue University, graduating with a Bachelor of Science degree in Chemical Engineering in 1940. He received his Master of Science degree in Engineering that same year. He served in and became the head of the Aircraft Armored Section of the U. S. Navy from 1941 to 1945. Then he re-entered the Massachusetts Institute of Technology, where he was in the graduate school prior to his military service. In 1948 he was awarded the degree of Doctor of Science in Metallurgy.

In 1947 he joined the staff of the Naval Research Laboratory in Washington as head of the Ferrous Alloys Branch. In 1951 he was named Executive Secretary of the Metallurgical Advisory Board of the National Academy of Sciences, National Research Council. In 1954 he became the Assistant to the Director of the Columbus Laboratories of Batelle Memorial Institute, and three years later he rejoined the National Academy of Sciences, National Research Council, as Executive Director of the Materials Advisory Board.

In 1960 he was appointed Assistant Executive Secretary for Planning of the Division of Engineering. In 1962 he returned to Batelle as Assistant to the Director of the Columbus Laboratories and head of the Washington office, and later he was designated as Assistant Director of the Laboratories.

J. G. GERMAN
Vice President — Engineering
Missouri Pacific Railroad Co.
St. Louis, Mo.

In January, 1970 Dr. Harris joined the Association of American Railroads as Vice President of the Research and Test Department. When he first came on board I thought to myself, my goodness! what is a metallurgist going to do for the railroads? Well, he has done many marvelous things in reorganizing our Research and Test Department and putting the railroads back on the map as a viable and vigorous industry.

He has served as President of the Metallurgical Society of the American Institute of Mining and Metallurgical Engineers; President of the Engineers Joint Council; Chairman of the National Materials

Advisory Board of the National Academy of Science; Chairman of the Materials Division of the American Ordnance Association; Chairman of the Research and Development Advisory Committee of the National Security Industrial Association. Presently Dr. Harris is Chairman of the Special Committee on Rail Transport Activities of the Transportation Resources Board. He is a member of the Advisory Panel of Materials of the Office of Technological Assessment.

In 1976 Dr. Harris was selected Railroad Man of the Year by MODERN RAILROADS magazine, and was honored here in Chicago. Earlier this year he was honored with membership in the National Academy of Engineering, the highest honor that can be given to an engineer in this country. This was in light of his activities in both the materials work he had done prior to and the work he has done on the railroads since he has come to the AAR. He has written about forty technical papers, and was co-editor of **Perspectives in Materials Research,** published by the Government Printing Office.

DR. W. J. HARRIS, JR.
Vice President
Research & Test Department
Assoc. of American Railroads
Washington, D. C.

It is my pleasure to introduce Dr William Harris, Jr. [Applause]

DR. WILLIAM J. HARRIS, JR.: It is a great honor for me to be with you this morning. I have always appreciated the opportunity to work with the officers and personnel of LMOA, and I look forward to our continued close association. It is only through you that we can learn about the problems we ought to be devoting our resources to, and it is particularly through you that we have the means for applying things that we learn and making them useful.

If I were speaking to you in 1975 (and I use 1975 because that is the date when data are available) as a representative of the Japanese railroad community, I would have to report to you that in the last year we had suffered a loss of $265,000,000, a federal subsidy of $3,113,000,000, or a net loss in 1975 of about $3,400,000,000.

If I were speaking to you in 1975 as a representative of the German federal railroad system, I would report to you a loss of $1,665,000,000, with a federal subsidy of $2,386,000,000, or a loss of over $4 billion.

If I were speaking to you in 1975 as a representative of British rail, I would report earnings of $11 million but a federal subsidy of $1,829,000,000, or a loss of over $1 billion.

If I were speaking to you as a representative of the United States railroad community, excluding Amtrak, I would report earnings of

$317 million, with subsidies of $152,000, for an income of $165 million, but I would report to you that we paid federal taxes of $173 million and state taxes of $441 million.

These are very sobering numbers. The railroad industry in the Western world is in great financial difficulty. These financial issues affect its decisions about investment, its decisions about research, and its decisions about change.

In the United States the railroad community is more fortunate, but it is limping along because of economic problems. We have a very serious challenge facing us.

The Western European railroads and Japanese railroad systems are plagued by far too many employees per track mile for maintenance, by more employees for operations than necessary by aging equipment. As a result, they are very active in pursuing programs to abandon lines and to reduce employment.

In the United States, our earnings are not adequate to sustain much-needed new facilities and equipment. Our problems arise for the reasons that many of you know. There is imbalance in government treatment of the various modes. The great fight that many of you have been involved in on waterway user charges is of crucial importance in relationship to our opportunity to compete effectively in the future. No user charges on waterways, and far too low user charges on highways, cause us to depress our rates by perhaps $1 billion a year, enough to make a profound difference in our whole economic capability to cope with the future.

Another serious issue that we confront is the regulatory environment. It is pervasive, insidious and, I think, totally counterproductive to the kind of competitive economic system that has made such a great contribution to the United States in the past. But as far as our mode is concerned, we have more extensive and greater enforcement of regulations than in other modes. Many regulations are either irrelevant or far too slow in becoming operative.

On Friday of last week the **Federal Register** published a new regulation on tank car safety. It becomes operational October 19, 1977. We have known that we have had a tank car safety problem for the last two decades. We have been working very actively on tank car safety research since 1970, cooperatively with the tank car producers and then with the federal government. We knew in 1972 how to make tank cars safer, but because of regulations we were prevented from putting our knowledge to work. The tank car companies petitioned for improved design intended to reduce tank car accidents 18 months ago. Finally, as of last Friday, the wheels of the regulatory bodies ground and we have a set of regulations.

Technically the regulations are consistent with the findings of our extensive research programs. Without any question these regulations will contribute to significantly improved tank car safety in the future. But all the lead times necessary for the $7,000 to $10,000 per tank car conversion processes have been used up by the regulators. Now we are required to comply far too soon. That fight over necessary time extension is about to be joined, but we do have the authorization for doing technically what we know how to do.

However, for other modes that have safety problems in the movement of hazardous materials, there is not a single regulation in place that requires them to do anything. As a consequence we are going to have improved tank car safety, but there will be a substantial modal shift because our costs are going to go up significantly to take care of the increased investment in tank car modifications. The safety record of the other modes is not as good as ours. Thus, as a result of federal regulation we may end up with a less safe transportation system for hazardous materials. I consider that absurd, and yet it is a consequence of the incredible lack of a systems view on the part of the federal regulation bodies as they are presently constituted.

Our problems in this industry arise, then, from the problem of imbalance in treatment of the modes and from the difficult regulatory processes we confront. We also have problems in freight car utilization. We are being pressed by shippers to increase the size of our fleet so as to make cars available when they wish them. The consequences of making more cars available tend often to be that the new cars are used and the older cars are not used. The number of cycles from load to load for the average car are gradually being reduced. The investment by this industry in freight cars in terms of replacement costs is about 45% of the total capital investment of the industry. The problem, therefore, of improving utilization is absolutely crucial. This problem is largely within the capability of the industry to solve.

We have serious difficulties in connection with agreements arrived at in collective bargaining. I need not tell you of the important negotiations now in progress which, if successful, will provide an opportunity for making progress in this crucial area but, if not successful, will continue to bind us to a pattern of utilization of our resources which is unsatisfactory and forces a number of operating compromises on us that contribute to our economic problems.

Technology has a role to play in bringing this industry from where it is today, marginal economically, to the great potential it has to offer to this economy. I am a metallurgist. I haven't concentrated on improved materials since I have been with the AAR, but there is no question but that we now know how to bring some of the more modern material sciences to bear on railroad problems. We have many failures of couplers and truck components and other components that result in train delays, in derailments, and in far too many bad order cars.

The application of material science, particularly fracture mechanics, to heavy castings and other steel products is about to take form.

For five years we have participated in cooperative programs with the coupler and the truck component industry, and of course with many railroads. We are very close to having a dynamic test for truck bolsters. We are very close to recommending a way to achieve so-called fracture-safe couplers.

As we apply life-cycle costing philosophies to the selection of materials and the design and ordering of new equipment, I am confident we are going to be better off as we take advantage of these technologies. You will all have a chance to see the improved specifications, because they will go to letter ballot in the near future. It has taken five years to get there, but it took thirty years to get M-203 adopted, the dynamic test for truck side frames. Five years is not a long time interval, given the complexity of the problem.

We have the potential for improved designs. Many of the designs we now have have been arrived at by a long, interative process. We don't have a balanced and consistent design requirement for many components that go into cars. Therefore, there is no way in which to launch a preventive maintenance program, based on the assumption that X component will last for Y miles or Y months. Each component has its own philosophy of design, its own set of requirements for inspection and maintenance.

Through the track-train dynamics program in Phase II that John German and many others have devoted so much of their time to, we are identifying the service environment. That is being translated, through modern analytical design tools, into a philosophy of design which will contribute to improved effectiveness of equipment.

The problem of understanding the service environment is enormously difficult. You all know about the controversy in the industry about 4-axle versus 6-axle locomotives. With the help of many of you, we have been engaged in a detailed study and comparative road test of 6-axle versus 4-axle and HTC versus Flexicoil trucks for some of the 6-axle locomotives. The problems are so subtle that it has taken thousands of miles of road testing and hundreds of hours of computer time by Dr. Vijay Garg and his associates in our technical center to try to determine whether there are differences in derailments and, if so, what those differences are. I don't have the answers yet.

Dr. Garg promised this morning to give me the draft of a report based on our analysis. If I were speaking to you two weeks from now I might be able to say something constructive about the problem. But I want to tell you that understanding the quantitative detail of the service environment and its relationship to the behavior of equipment is subtle. It is going to require a large amount of experimental testing to continue to improve that insight.

The concern for improved track-train dynamics that began to emerge in the last decade, and surely has advanced in the last ten years, is recognized by all of you today, and necessarily by all the people in this industry. The vertical action of equipment, the longitudinal action affected by train handling, the issue of track stability under a variety of dynamic inputs, are surely better understood today than ten years ago.

You make up trains differently than before. You provide better instructions to your locomotive engineers on how to operate their equipment. You have a much clearer awareness of things to look at to explain what used to be mysterious derailments. I think we have made a major step ahead in this field. But we are not home free yet.

I have been pressing my associates on the track side to tell me the dynamic strength of track, particularly when a locomotive or freight car wheel lifts partially off the track and you have a substantial reduction in vertical force. This occurs regularly as a result of some rocking or bouncing. Under that dynamic unloading, we do not know the remaining lateral strength of the track. And since we don't know, it is very hard to determine what the track response will be to combined vertical and lateral forces exerted by a wheel on the track. Until we know the forces on the track, and the strength of the track, we don't know how close we are to track displacement or rail overturning.

The program, instrumentation, and experimentation to establish track strength will be starting soon. I received the first formal planning document last week. I will be discussing it with the AAR Research Committee at its meeting in October, and I am confident that in a matter of two years, if not less, we will have a firm quantitative insight on this problem. That is one of the next important steps to take in the track-train dynamics interactive processes.

There is no question but that in-service monitoring is going to continue to be important and is going to increase in its relevance in terms of your jobs. We will have in service experimentally a wayside detector on one railroad, a different kind of wayside detector than you are accustomed to. It is a detector that measures the stress introduced in the track by a passing train. We have found, not by intention but inadvertently, that excessively high forces in the track could be introduced by badly worn or cracked center plates, by cracked side frames, and by other failures of the suspension system that caused the truck to be canted.

As the train moved over a section that was properly instrumented, higher stresses were introduced in the track. Through monitoring, we may be able to tell the mechanical departments that the trailing truck on the seventh car in the next approaching consist is behaving peculiarly. This gives focus to inspection. As this technology becomes available, I am confident that our ability to utilize our limited mechanical forces to greater advantage will emerge.

But we have other opportunities for in-service monitoring that we are just beginning to appreciate. Micro processors and their application to minicomputers are amazingly effective systems when the sensors are properly distributed through a system. With their incredibly fast operation and their capacity for immediate on-line analysis, they can present information to an operator that heretofore he could not get at all.

One per cent reduction or improvement in fuel efficiency in this industry means $12 million. The motor truck industry, in part through better on-line monitoring of the behavior of their motive power, has improved fuel efficiency at about twice the rate we have.

One of the contributions that a properly disposed micro processing system in a locomotive cab can make is to continuously monitor fuel consumption. It will be a decade before this is widespread through this industry, and it is not on any productive piece of equipment today. But if we could monitor fuel consumption regularly, and on each run, we would have one of the best diagnostic tools in terms of the effectiveness of the diesel engine, something that would begin to do for the diesel unit what SEARCH does for the electrical part of the diesel locomotive.

Micro processors to monitor the internal condition of the diesel component, as well as to help monitor the train behavior itself, represent one of the great potentials for technology. We have a research program on this subject. It will take a while before it pays off. We look forward to your continued advice and counsel on how we can be most effective in serving your needs.

The coupling system we have on the American railroad system has been a very effective one for a very long time, but it leaves a lot to be desired. I am not talking about the absence of an exotic addition such as a train line of electricity for a monitoring function. I think that will not come for many years, and therefore I am not making much of an investment in it.

But we need couplers that always have an open knuckle so that you don't have to have a crew arranging for recoupling in a makeup yard. We need couplers with a wider gathering range. Couplers with an automatic air connection have been invented by the scores, indeed by the hundreds, but not yet applied because we couldn't justify the investment. An analysis that is just being completed may set the stage for a commitment to improve the coupling system.

Having accepted the present coupling system and its limitations for the last eighty years, it is difficult to recognize the conditions of operation that can be improved by a new coupling system. It will require a major change in operating philosophy in order to exploit improvements, but the potential is there. If our economic studies continue to justify the change, we hope to exploit this opportunity for improving operations and reducing costs.

These few selected issues set the stage, I believe, for an understanding of where we can go in the future to improve this great industry. We are coping with some of them in our research program because we are coping cooperatively. Without the railroads, the brotherhoods, the suppliers, government and international participation we would not be able to make the kind of progress that we are making today.

If I had addressed you before the turn of the century, I would not be discussing today the problem of competition with other modes of transportation; I would not be discussing diesel power; I would not be discussing modern computer-based analytical techniques.

At the turn of the century I do not think I would have come close to predicting World War I. But of all the results I cited, World War I had a more profound effect on this industry than those internal issues.

If I had addressed you in 1930 I do not believe I would have said much to you about diesel power. I wouldn't have said anything about modern computer technology. I don't think I would have been perceptive enough to discuss with you World War II. World War II had a more profound effect on this industry than any of the other changes.

If I had been addressing you in 1950 I would not, I think, have said very much about modern analytical techniques and computers. I don't think I would have had the insight to discuss with you the Vietnamese war and the OPEC embargo; and yet those factors had a more profound effect on this industry than modern analytical techniques.

And now, when I talk to you in 1977, I haven't the faintest idea what I am leaving out of the equation for the future. My crystal ball is fairly clouded in this regard. But I do know that we must give attention to and be prepared for change. That is what research is all about, and that is what analysis is all about. If we are prepared for change, and if we are advancing our capabilities as rapidly as we can, then we will have a real opportunity to be prepared to accept and cope with change as it comes to us.

Thank you very much.
[Applause]

MR. GERMAN: Bill, many thanks for your fine talk. It brings us up to date on what is going on now in the industry and what we can expect in the near future, and you have told us to tighten our seat belts and be ready for long-term change.

I would now like to introduce the group at the head table. On my extreme right is Mr. F. J. Broaderip, President of the Air Brake Association and General Superintendent of Air Brakes, CP Rail.

Next to him we have Charlie Parker, President of the Car Department Officers Association, Assistant Chief Motive Power and Rolling Stock of CP Rail. It looks like you Canadians have control over us this year. That's great. We welcome you.

Next is Mr. V. E. Cole, President of the Railway Fuel and Operating Officers Association, Division of Road Foremen for Conrail.

On my extreme left is Tom Tennyson, President of the Locomotive Maintenance Officers Association and Assistant Manager of Engineering and Technology, Southern Pacific.

Last but not least, my good friend Mr. W. J. Burrows, President of the Railway Supply Association, a fine group that has backed this coordinated convention for many years. He is with the Vapor Corporation. All the supply men get together and give the backing that really helps get this show over every year. Many thanks to you and your people, Bill. [Applause]

And now, my good friend and the best used car salesman, from the Southern Pacific, Tom Tennyson. Tom, the meeting is all yours.

PRESIDENT TENNYSON: Thank you, John. The used car business hasn't been very good lately. [Laughter]

LMOA President Tom Tennyson presenting Dr. William J. Harris, Jr., Vice President, Research and Test Department, AAR, traditional General desk set emblematic of Honorary Life Membership in LMOA.

Dr. Harris, I would like you to stand, please. We of the LMOA certainly appreciate your coming to be with us here and giving this address at our meeting. We hope you will come back to keep us up to date on the trends of the times. We would like to make you a Honorary Life Member of LMOA. Emblematic of this membership is this pen and pencil set for your desk. We appreciate your being here.

[Applause]

DR. HARRIS: Thank you very much, Tom. I am highly honored.

PRESIDENT TENNYSON: Gentlemen, before we close this part of the session I have a sad announcement to make. Our old friend and Past President, Jack Dailey, passed away in August of this year. We will miss Jack a lot. He was a fixture at all of our meetings, and we were saddened to hear of his death.

Now I would like to have you give Dr. Harris a rising vote of thanks. Then we will ask Mr. Cumbea to bring his Committee to the front table for their report.

[The audience arose and applauded.]

PRESIDENT TENNYSON: I will ask Mr. Harley, as officer of the session, to present this next portion of the program.

MONDAY MORNING SESSION
September 19, 1977

REPORT OF THE COMMITTEE ON NEW DEVELOPMENTS

B. A. CUMBEA, Chairman
Manager Locomotive Data
Systems & Procedures
Chessie System
Huntington, WV 25718

E. T. HARLEY
2nd VICE PRESIDENT
Gen. Mech. Supt.-Eng. & Res.
Consolidated Rail Corp.
Philadelphia, PA 19104

MR. E. T. HARLEY [General Mechanical Superintendent - Engineering & Research, Consolidated Rail Corporation, Philadelphia, Pennsylvania]: Our first report will be by Mr. B. A. Cumbea, Chairman of the Committee on New Developments.

[Mr. Harley introduced Mr. Cumbea, who presented the members of his Committee.]

MR. CUMBEA: Before getting into our presentation of this year's paper, I would like to express the appreciation of myself and the Committee for the excellent hospitality shown us in our preconvention presentation at the Chicago

Railway Club. This is one of the very active clubs, and they go all-out to host the preconvention presentations.

[Mr. Cumbea presented Part I of the report, Data Exchange Systems.]

MR. CUMBEA: Are there any questions on the proposed Data Exchange Systems?

VOICE: The Committee has indicated that data exchange systems can be implemented through the LMOA or AAR. Which is considered the better alternative?

MR. CUMBEA: I look at the AAR more as a means for implementing legislative procedures. I think this type of proposal does not require regulatory action, and it offers the LMOA an extremely good means of advertising the fact that they are accomplishing something more than informal discussions. So, we should submit this to the American railroads as an LMOA project.

The second section of our paper will be presented by Chris Cox.

[Mr. C. W. Cox presented Part II of the report, Systems Control Centers.]

MR. COX: Are there any questions on this subject?

MR. R. W. LEEDY [Manager, Contract Control, Illinois Central Gulf Railroad, Paducah, Kentucky]: How many major railroads have this system in effect right now?

MR. COX: The one I can think of that has it laid out completely, as we have given it here, is the Chessie System. There are a lot of other railroads, such as yours and the Santa Fe, that have a system in use partially. The only one I know of that has the complete central system is the Chessie System.

MR. LEEDY: Can you give a little more detail on the mechanics of, let's say — well, today or yesterday we had five units out there that weren't properly loading. This could mean a variety of things. From the moment that happened, and assuming all of our personnel were present and the communication system was going great, from the moment those reports came in what happened to the report after the correction was made and repairs made and the unit was back on the road? What happens to that information that is going back and forth between the control center and the shops?

MR. COX: That information in most cases is fed into a computer through a code system. The entire communication of course is not recorded because it is not feasible, but the generalities and the basics of the failure can be fed into a computer system that will record this information for further use.

MR. HARLEY: How many of the systems allow for direct radio link between the engineman on the train affected and the man in the control center who is doing the actual advising?

MR. COX: This is one important item which we mentioned previously, that is, the expense of the communication system. This would be a rather large expense for a railroad that was not set up this way. There are some railroads that are set up this way, and this is a requirement of the system — that you have to be able to communicate directly to your on-line locomotives from the operation control center. We did not take a survey to determine how many railroads have this type of communication system.

MR. W. R. JAMES [General Manager Locomotive Maintenance-Engineering, Chessie System, Huntington, West Virginia]: In response to your inquiry, Mr. Harley, I might say the L&N currently has a system whereby they talk directly with the crews as they learn of a malfunction. We on the Chessie do not have that capability. However, we have just recently converted our communications system over to microwave, and we are presently working with our communications department to determine whether or not we wish to add this feature to our control center in Huntington.

MR. COX: I believe the ICG is set up that way, because they have a centralized dispatching system in which you can communicate from the control center directly to the locomotive; is that correct, Mr. Leedy?

MR. LEEDY: I will refer that question to Jim Boline or Tom Thetford.

MR. R. T. THETFORD [Superintendent Motive Power, Illinois Central Gulf Railroad, Chicago, Illinois]: We utilized that during the bad weather we had last winter. We are not currently utilizing it; but our central dispatcher radios, yes. We had men in the control center who could talk directly to the crews.

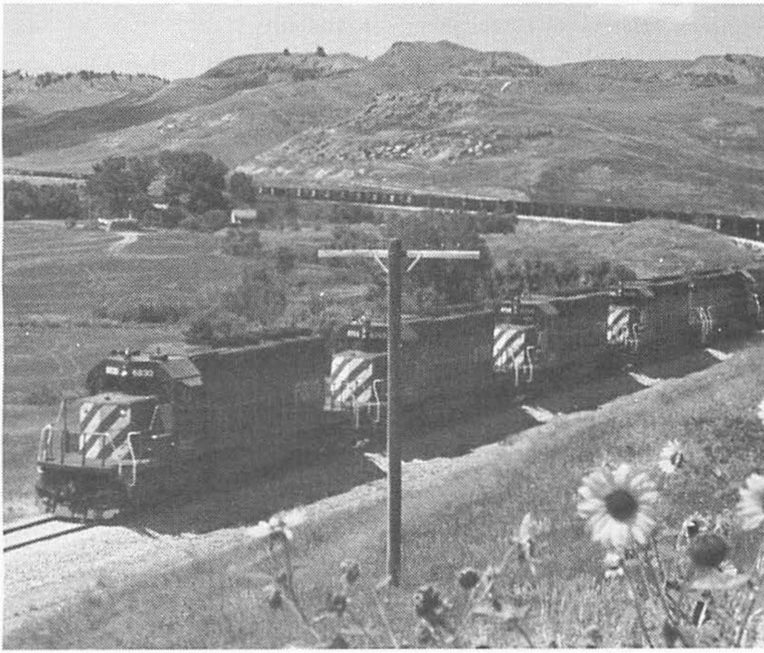
MR. COX: How effective was it?

MR. THETFORD: It held down quite a few road delays. It saved us a lot of diesel engines, the prime movers themselves, especially when they shut down. When everyone was losing prime movers we saved quite a few during that period of time.

MR. LEEDY: Chris, specifically how does this system improve availability? How does that come out at the end, when all these failures have happened and the repairs have been made? What happens next? How do you improve availability with that?

MR. COX: The entire approach of this system is directed toward improving the availability. Whenever you can find out more quickly what is going wrong, and have competent people involved in solving it, you can improve the availability. Failed locomotives can be moved to the proper shop for repair in a timely manner. When the reporting system becomes more accurate and up-to-date through better communication, this can only help to improve locomotive availability.

MR. JAMES: Speaking for the Chessie, when we established our system control center, one important aspect we wished to determine was the effectiveness of such a system. Over a period of three



months we kept track of what we were doing prior to the establishing of the control center, measuring it against the new system, and in that three-month study we averaged 150 unit days a month, which, when translated into a 30-day month, yields five units per day. We consistently run between five and eleven units per day, which contributes to our unit availability by that amount.

MR. LEEDY: I gather from this that what you are actually saying is that from the data base you can alter your maintenance programs or change them around, or install new ones, and this is how you accomplish your availability.

MR. COX: That is one of the ways, Bob. As I said, when competent mechanical department personnel know what the problem is, it becomes easier to solve. The information provided can be used to improve maintenance programs. This information makes needed changes more evident.

MR. T. F. KELLY [Superintendent Heavy Repair-Locomotive Shops, Chicago, Rock Island & Pacific Railroad Company, Silvis, Illinois]: Have the systems presently in effect resulted in an improved reporting of the actual condition of the locomotive, and have the locomotives been further instrumented so that those that are doing reporting can give more factual information so that the shop crews can better trouble-shoot or analyze the failure and make the correction without going into loadbox and all the other long, drawn-out tests that would improve availability?

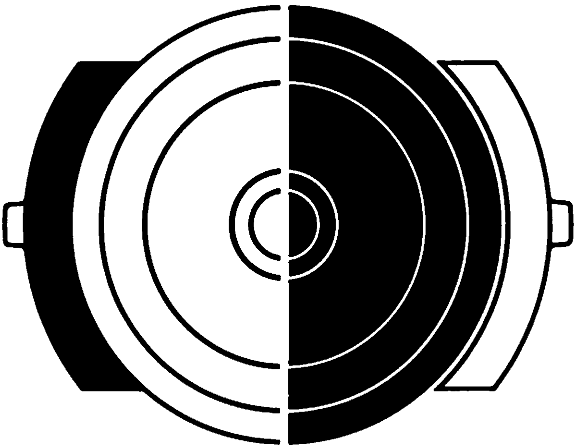
MR. COX: Bill, would you speak to that?

MR. JAMES: Yes. On the Chessie, unit availability is a direct by-product of two basic inputs. One, we learn of the online failures as close to real time as possible, and at the next maintaining station where maintenance personnel are available we will meet the train. Depending on train makeup, we may have a man get aboard and go with it; or based upon interrogation of the engine crew and a real time inspector, we may decide to advance the unit to the closest shop that has the facilities and material to effect repairs.

Secondly, by keeping track of our troubled units we are in real-time communication with every shop on the system through trained mechanical department personnel who can and do offer their expertise in diagnosing troubles.

Finally, on your question relative to the particular locomotives that are repeaters: Through personal interrogation with our line maintenance personnel we will follow a particular unit if we don't feel we have a positive fix on the current case of trouble. We will follow it through its assigned maintenance terminal, verifying its condition inbound, and then shopping it and following it at that particular terminal to validate the temporary repairs that were made en route. We have found this to be quite effective.

[Mr. J. J. Boline presented Part



III of the report, Use of Microfilm/ Microfiche Equipment.]

MR. LEEDY: First, I would like to know if one pretty girl can operate all those machines at the same time. [Laughter]

How does Microfiche or microfilm help reduce the sometimes unnecessary volume of reports we are now receiving?

MR. J. J. BOLINE [Manager Computer & Quality Cost Control, Illinois Central Gulf Railroad, Chicago, Illinois]: Hopefully nobody is receiving reports they don't want. If you are, simply write a letter to your computer center and tell them you don't want that report any more. Don't go through the process of having an unwanted computer paper listing transferred to computer output microfilm that will probably cost you more. If you are getting something you don't want, stop it. If you are getting something you want now that is very large and voluminous, you might consider putting it on Microfiche or microfilm.

MR. JAMES: Looking at your system, I would briefly define it as an advanced management information system. With that definition, then, in terms of net results on your railroad, the ICG, how have you translated the day-to-day management of your locomotive fleet into a more effective locomotive department in performance, in terms of the end product, that is, unit availability, with minimum physical plant facilities and high effective utilization of labor and material? How is this information system translated in those terms.

MR. BOLINE: We have a lot of information on the ICG, and to get all of the information out to the field where it can do some good simply is impossible with the use of ordinary paper. We think we have relevant, timely information in the computer so that all twenty-one of our major shops have the ability to inquire on our computer in real time with online terminals to get all kinds of information.

But we don't have everything available out there. We don't have all the historical data on locomotives, and things like the traction motor serial numbers, all warranty data, and things like that. You can't have everything online. You can't have the computer tied up, say, with several hundred thousand characters of information on each locomotive.

We have about 650 characters of information available on each locomotive online, but with the use of microfilm there is a cheap, low-cost way of getting the type of relevant information that is more historical than we have online out to the field where it should do some good. We have all major components on microfilm, so a man out in the shop environment can determine when, where, and why a component was changed. This can be very important for warranty.

If you look at warranty as a vehicle for translating failed components into cash, then I think there is a good potential payoff for using COM, either fische or

film, for getting the information out to the field so that when a part is changed out the shop manager can determine if this specific part is under warranty.

There is a lot more to it, of course. But to spotlight that one aspect, we think we have a pretty good handle on warranty, and that certainly can translate into hard cash. Is that what you had in mind?

MR. THETFORD: Maybe I can answer Bill's question. Bill, Jim pours paper across my desk like it was a bucket of water. It is an early-warning type of thing. We get indications of trends where we are beginning to get into trouble, for which I can go back to him and get complete details, and we can make judgments on actions to take to nip these things in the bud on locomotive problems. It has saved us enormous amounts of money.

Recently we got into a problem with connecting rods. The trend was indicated by the computer immediately, and we got into an immediate retorquing program that saved somewhere in the neighborhood of twelve prime movers that we know of that would have ultimately lost connecting-rods. When you are talking about $40,000 or $45,000 for a prime mover to replace one, this can amount to a substantial savings.

MR. DAVID W. HOPPER [Coordinator Locomotive Maintenance, Delaware & Hudson Railway Company, Watervliet, New York]: Mr. Cox, am I also to believe that this Maintenance Control center is in direct communication with all points on the system, and it records historical information as well as deferred maintenance information also?

MR. COX: Yes. The information gathered from this system can be extended into this area. The whole idea of the operation's control system is to be a central point where not only can it help improve locomotive availability by being able to fix them faster and move them to the right places, but to supply information into a computerized information system to allow for the watching of trends, scheduling shop loads, and all the multitude of things we all do with the information systems on our locomotives.

[Mr. Cumbea presented Part IV of the report, Training.]

MR. CUMBEA: This concludes the paper. Are there any questions on this or any of the preceding parts of the report?

MR. KELLY: Has experience with apprentice training programs been sufficient to warrant the cost? In other words, are the railroads that are training these people retaining them in their service or are they losing them to other industries after they are trained? Is the expense justified? What is the competition for the labor market in the areas where this training takes place?

MR. CUMBEA: It is our understanding, in discussing it with the two properties we visited, that they are able to pretty well hold onto their people. However, I can't really attest to that as a fact. I realize that we have a very highly competitive labor market, and a good qualified man is subject to leave at any time.

VOICE: It would appear from the description of these programs that there may have been some conflict with union working agreements. I wonder how you got around this.

MR. CUMBEA: In each case each of these two new contractural agreements had to be negotiated before the system could be put into effect. In the one central training center we visited, where the trainee goes from 8 to 22 weeks, theoretically they have to serve a 3-year apprentice program. However, they have found that with the extensive training the trainees receive at the center, they are qualified and they do more work than many other apprentices did in the past, and that the organizations are more inclined to upgrade them at an earlier date. But it still has to be handled through labor organizations.

Do we have any other questions on any other sections of the paper? I might depart from standard procedures just a little bit here. In the opening section, when we discussed the data exchange system, we made a firm recommendation that the LMOA submit this to the chief mechanical officers of all railroads. Is there any opposition to this? [No]

If there are no further questions, I would like to ask Lee Townley to summarize our paper.

L. O. TOWNLEY
REGIONAL EXECUTIVE
Mechanical Engineer
Atchison, Topeka & Santa Fe Railway
Topeka, KS 66616

MR. L. O. TOWNLEY [Mechanical Engineer, Atchison, Topeka & Santa Fe Railway, Topeka, Kansas]: I think this was certainly good planning. I don't know who planned it, whether Mr. Tennyson did or someone else, but to have this paper follow the wonderful address we heard at the opening session, "A Search For A Better Way," was certainly good planning and good programming.

This subject comes through loud and clear. With our increased amount of exchanging locomotives we do certainly need a standardized way of exchanging data that will not require someone or some committee to take incoming data from some road that you are interchanging with and put it into a form that will fit into your system. A standard system that will in fact allow one railroad to feed directly into the data system of another railroad can provide a very good tool for giving each railroad a very clear picture of what their locomotive did or what it needs, a system for a centralized control.

One message comes through to me loud and clear, and that is that we need to expand the effectiveness of our shops so that they are not just small entities where locomotives come in, and you fix them and pat them on the back and hope they will make it back to you, or you might even have the opinion that if they ran in they will run out.

We on the Santa Fe did a little about this several years ago, when we had some of our foremen actually go out and ride locomotives on the road. It was a rude awakening to find out what the locomotives were doing after they left the shop.

This centralized system of data feedback into these shops, so that they know what the locomotives are doing, so they know where the failures are, and what kinds of failures they are experiencing, gives them a much better tool to get the locomotives up to where they won't have that kind of failure when they go out the next time.

The volume of paperwork—well, you get a readout from a computer, and a stack of paper this thick. Where are you going to find what you want in that? The approach this Committee is suggesting, using Microfiche or microfilm, is certainly a step in the right direction. You can at least get the information you want on a small piece of paper, and can read it, and toss it in the waste basket when you get through with it. You don't have a ton of paper being hauled out the back door every day, 99 per cent of which you never look at because you don't have time to thumb through it.

The last part of the paper, on the apprentice program, is dearest to my heart, because probably nowhere is there an industry that has more technical things their people have to know that are different from any other industry than the railroads. Railroaders have always been a different breed of cats. You can't take a lineman or an electrician who has been wiring houses, or whatever, and make a railroad electrician out of him without putting him through a schooling system.

Our apprentice system is something we have to revise constantly, and bring it up to date, improve it, and give our people who are going to be working on the locomotives the expertise and knowledge that they need to do a real yeoman's jobs to make the locomotive do the job it is supposed to do.

With that I will turn the meeting back to President Tennyson.

PRESIDENT TENNYSON: Thank you, gentlemen.

[Announcements.]

PRESIDENT TENNYSON: We want to thank all of our advertisers. The board at my right displays the names of all those who have helped us this year to meet our expenses and avail themselves of the wide circulation of our Proceedings, in which they can present

a description of their products or whatever they want to say.

Now I would like to ask you to give this Committee a rising vote of thanks, after which we will recess until 2 p. m.

[The audience arose and applauded.]

[The meeting recessed at 11:50 a. m.]

MONDAY AFTERNOON SESSION September 19, 1977

The meeting reconvened at 2 p. m., President T. A. Tennyson presiding.

PRESIDENT TENNYSON: Gentlemen, according to the official guidelines this afternoon session is supposed to begin with a ten-minute address by the President. Dr. Harris gave us his address this morning. This President is going to talk for about ten minutes, beginning right now.

This 39th Annual Meeting of the Locomotive Maintenance Officers Association has had a great beginning. Our attendance totals at this time sound good, and promise to get better before the sessions wind up on Wednesday. And while we would like to see more and more people at these meetings, it appears that we are going to have to look more and more at the quality of attendance and less at quantity. There may be smaller numbers, but there is no limit to participation in the discussions, and that is what will bring us a meaningful and enthusiastic "SEARCH FOR A BETTER WAY."

We have had the opportunity of listening to an outstanding address by Dr. W. J. Harris, Jr., Vice President-Research, AAR. The first paper of this session, presented by the New Developments Committee under the leadership of Bud Cumbea, has set the mood by introducing our theme, "SEARCH FOR A BETTER WAY." With such a start can we expect anything less than one of the best and most informative of all LMOA Annual Meetings thus far recorded?

To make this become a reality, we have only to add your participation in the discussions. Get on your feet and either ask questions or give us answers, we don't care which. All those members who did not have the privilege of attending this meeting will lose if each of us does not participate.

In planning for this short discussion, my most difficult task has been the selection of a topic of general interest which would come within the scope of my qualifications. We all know that our Association is an asset which must not only be protected but must continue to grow and become stronger.

Doubtless every man here today appreciates the forum offered by

LMOA, but this could some day be subjected to misunderstanding, with all of the changes likely in the future. Our young officers must understand the LMOA and learn what we know of its value from years of personal experience. Therefore, I would like to speak briefly of committee work and its potential for the development of locomotive maintenance officers.

The life blood of this organization is its technical committees. To the individual who serves on these committees, the experience means a broadening of his thinking. The investigations made by these groups into the various problems and phases of work bring to him, and through him to his employer, a very rich return for the time and effort spent.

I speak from experience when I say that everyone in LMOA should be a member of a committee and participate in its work to the fullest extent. I direct my remarks particularly to the younger men who stand to obtain the most benefits not only from the committee work but also from their association with other committee members in the exchange of ideas, methods, practices, interpretations, and so on, which they can evaluate and apply on their respective properties. To the committee member the opportunity is afforded of intensive study of interesting problems that arise in his daily work.

Instead of struggling alone with these problems, he has the great advantage of conferring with a group of others who are equally interested in the same problem and who have varied experience on other railroads affected by different conditions of organization, traffic, physical formations and climate. This, coupled with the opportunity to meet and get to know personally men in the same line of endeavor, is a distinct advantage to any man, broadening his point of view tremendously and, consequently, enhancing his value to the company he serves.

Committee service, of course, is voluntary, similar to the service given by other organizations of like aims and similar activities. But such service has a most beneficial reaction on each individual concerned, and may well engender in him the satisfaction born of a consciousness that LMOA has in no small degree contributed to the development of better motive power for the railroad industry, along with the railroad knowledge required for its maintenance in line with the time and budgeting requirements placed upon us. Such work has in this way contributed its share to the general railroad knowledge upon which our transportation system is based.

In this discussion of committee membership I cannot help but mention that participation is, again, one of the key words. Any man selected for committee membership must be willing to give of his own time to assist in the committee assignments. Management must also accept its obligation to provide the time and money needed for committee participation. There are meetings which must be attended, and it is well known that empty chairs, even with fancy signs on the table in front of them, do not produce the knowledge we are searching for.

Very soon Chief Mechanical Officers will receive a letter from Joe Koerner, our very able Secretary-Treasurer, asking them to select committee members to represent their railroads for next year. At this time not all railroads are participating fully in the committees, and we urgently need more railroad members on several of our committees to be sure that the work is by and for the cross-section of the railroad family, and not simply based upon limited opinion.

We urge that you select your best men, the young men who have a definite career path into key mechanical positions. Follow their work, show an interest in how they function in LMOA committee work, and you will find that your investment in travel expenses to permit this participation will be one of your best investments in the development of locomotive maintenance officers for the future.

Before I close I want to take this opportunity to express my appreciation to the LMOA officers, committee chairmen, and committee members for their untiring efforts and their cooperation during this banner year of my career. For many of them my expression of appreciation will also have to include a lot of past years, too. I have been in LMOA work for a long time.

It would take more time than is available if I attempted to give you details of the value of the unselfish devotion of our Secretary-Treasurer, Joe Koerner, and his good wife Lou, to the operation of our great Association. For now I will just have to say, thank you very much.

To our supply friends, whose names are before you on the board I want to express my gratitude for their support and cooperation. They are also partners in our SEARCH FOR A BETTER WAY.

And now my time is about up. Before I close, let me thank all of the membership of LMOA for giving me the honor of serving as your President this past year. As I close my railroad career in just a little more than a week, I shall always remember this year with a great deal of satisfaction.

Thank you. [Applause]

I will now call on Fifth Vice President Nelson Buskey, who will be officer of the session.

MR. NELSON BUSKEY [Chessie System, Huntington, West Virginia]: Thank you, Tom. Gentlemen, there is a good bit of business to be handled before the next committee report, so we will proceed.

First, I would like to call on our good friend from the Santa Fe. Fourth Vice President and General Membership Chairman Bob Clevenger, for the membership report.

MR. R. G. CLEVENGER [Atchison, Topeka & Santa Fe Railroad, Kansas City, Kansas]: I would like to apologize for not having a more up-to-date list here. The list I have is as of last night, but the girls are pretty busy outside and they don't have the final tally up to 2 p.m. today. I will give you some running totals.

On the first of the month we had a total railroad membership of 1,310, also 269 Associate members and 114 Advertisers, for a total of 1,693. As of last night we had a total membership of 1,794. Our total membership for 1976 was 2,033, so that leaves us 239 short over last year. We certainly need all these members, and we would like all of you to speak to your supply buddies and anyone else you know and invite them to become members of the LMOA.

There is one bright spot on the horizon, and that concerns our Advertisers. Last year we had a total of 109. This year we have 114, so we are five ahead. Thank you.

KY PRUCHNICKI
(Retired)
Genl. Supvr. Loco. Maint.
Southern Pacific Trans. Co.,
San Francisco, CA 94105

MR. BUSKEY: Thanks, Bob.

Next on the agenda is the report of the Nominating Committee, which will be presented by Past President Ky Pruchnicki.

MR. KY PRUCHNICKI [Retired General Supervisor, Locomotive Maintenance, Southern Pacific Transportation Company]: Gentlemen, the Nominating Committee presents the following recommended slate for 1978 as follows:

PRESIDENT: E. E. Dent, Superintendent Motive Power, Missouri Pacific Railroad Company, St. Louis, Missouri.

1st VICE PRESIDENT: E. T. Harley, General Mechanical Superintendent-Engineering & Research, Consolidated Rail Corporation, Philadelphia, Pa.

2nd VICE PRESIDENT: James H. Long, Manager Locomotive Department, Chessie System, Cincinnati, Ohio.

3rd VICE PRESIDENT: R. G. Clevenger, General Electrical Foreman, Atchison, Topeka & Santa Fe Railway, Kansas City, Kansas.

4th VICE PRESIDENT: N. A. Buskey, Superintendent Locomotive Department-Operations, Chessie System, Huntington, West Virginia.

5th VICE PRESIDENT: F. D. Bruner, Assistant Chief Mechanical Officer-Research & Development, Union Pacific Railroad, Omaha, Nebraska.

6th VICE PRESIDENT: C. M. Smith, Manager-Mechanical Engineering-Passenger & Locomotive, Consolidated Rail Corporation, Philadelphia, Pa.

7th VICE PRESIDENT: R. R. Holmes, Chief Chemist, Union Pacific Railroad, Omaha, Nebraska.

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

EXECUTIVE COMMITTEE:

L. O. Townley, Mechanical Engineer, Santa Fe Railway, Topeka, Kansas.

D. M. Walker, Diesel Superintendent, Southern Railway Company, Atlanta, Georgia.

Kjell Axelson, General Manager, Work Equipment & Machinery, Burlington Northern, St. Paul, Minnesota.

R. W. Leedy, Manager, Contract Control, Illinois Central Gulf Railroad, Paducah, Kentucky.

W. R. James, General Manager-Locomotive Maintenance Engineering, Chessie System, Huntington, West Virginia.

D. H. Propp, Engineer of Tests, Burlington Northern, Inc., St. Paul, Minnesota.

B. A. Cumbea, Manager Locomoitve Data Systems & Procedures, Chessie System, Huntington, West Virginia.

Those are the recommended nominees for 1978. All those in favor of the slate, please raise your hand. Are any opposed? They are elected unanimously. Thank you.

MR. BUSKEY: It is indeed a pleasure to call Charlie Smith, from Conrail, and Dick Holmes, from the Union Pacific, to the podium for the presentation of their scarlet

Newest Vice President Dick Holmes is being helped into his red LMOA blazer by President Tom Tennyson and 1st Vice President Eldon Dent.

blazers, emblematic of the office of Vice President. This presentation will be made by our President, Tom Tennyson.

[Mr. Smith and Mr. Holmes received their red blazers.]

[Applause]

Charlie Smith, also elected at this meeting, displays his red blazer, complete with personalized LMOA emblem, signifying his ascension to the vice presidential ranks of LMOA.

PRESIDENT TENNYSON: I know that this organization, with the fine group of officers you have selected for next year, and these two new officers, will keep this Association going for quite a while. Thank you. [Applause]

MR. BUSKEY: Welcome to the club, gentlemen.

And now it is time to hear about our financial status. I will call upon our good friend from the Burlington Northern, Past President and Chairman of the Board, John Schroeder, to give his report.

[Mr. John Schroeder presented the financial report of the Association on opposite page.]

J. D. SCHROEDER
CHAIRMAN OF THE BOARD
Asst. C.M.O.-Locomotive
Burlington Northern, Inc.
St. Paul, MN 55101

MR. SCHROEDER: Are there any questions about the details of this report? If not, may I ask for approval of the statement as given by a show of hands, please? Thank you. The report is approved.

MR. BUSKEY: Thank you, John.

Finally, gentlemen, last but not least, we will call on our faithful and hard-working Secretary, the man who makes the organization go, for his report. Joe Koerner.

SECRETARY JOSEPH J. T. KOERNER: Thank you, Nelson. I have to explain why we are losing money. If you will remember, last year I cautioned you that our expenditures were exceeding our modest income, because printing,

LOCOMOTIVE MAINTENANCE OFFICERS' ASSOCIATION STATEMENT OF RECEIPTS, EXPENDITURES AND CASH BALANCES — CALENDAR YEAR 1976

BALANCES IN FUNDS JANUARY 1, 1976:			
Checking Account — Security Bank		$31,130	
Reserve Account — Security Bank		6,558	
Total Balance			$37,688
RECEIPTS:			
Interest on Reserve Account	$ 337		
Active Membership Dues	6,542		
Assoc. Membership Dues	3,350		
Convention Registration Fees	2,455		
Advertising Revenues	17,919		
Miscellaneous	162		
Total Receipts		$30,765	
EXPENDITURES:			
Convention, Publication and Travel Expense	$17,151		
Office Expense, Office Assistance, Supplies, Postage, Stationery and Payroll Taxes	19,715		
Total Expenditures		$36,866	
EXCESS EXPENDITURES OVER RECEIPTS			$(6,101)
Balance Carried Into 1977			$31,587
BALANCES IN FUND DIVIDED AS FOLLOWS:			
Reserve Account — 1/1/76 Balance		$ 6,558	
Transfer From Checking A/C — 10/23/76		1,500	
Interest Income — 1976 (Per 1099)		337	
Total Reserve Account			$ 8,395
Checking Account Balance 12/31/76			23,192
Total Cash Balance			$31,587

APPROVED:

(Signed) T. A. TENNYSON, President

(Signed) E. E. DENT, 1st Vice President

Approved this 4th day of April 1977, Chicago, Illinois.

JOSEPH J. T. KOERNER
Secretary-Treasurer

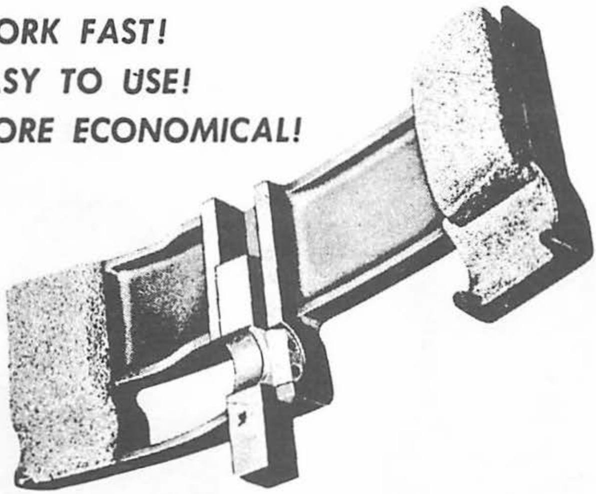
postage and the general increase in cost of doing business have caught up with us, including the IRS. They came back at us for three past years for unrelated income, and they hit us for a sizeable sum. This didn't help us. So, as I warned you last year, we were going to have to increase our dues or advertising fees. We have made a modest increase in our advertising rates for this coming year, as you will notice, but we haven't as yet touched the membership dues. We are keeping them as they are for the coming year, in the hope we can get more members and remain solvent.

The big comment I want to make is that my association with Tommy Tennyson this year has been great. I think Tommy is a giant in the LMOA, and we are going to miss him in the LMOA movement. He has served as an inspiration to all of us.

If there are any questions from the floor, I will try to answer them. No questions? That's about all I have to say.

MR. BUSKEY: Thanks, Joe.

Photographed following the Official Family Annual Stag Luncheon are, seated left to right: Past President Ky Pruchnicki, 1st Vice President Eldon Dent, President Tom Tennyson, Chairman of the Board John Schroeder. Standing, left to right: Vice Presidents Dick Holmes, Nelson Buskey, Frank Bruner, Bob Clevenger, Charlie Smith, Tom Harley, Jim Long and Secretary-Treasurer Joe Koerner.



MONDAY AFTERNOON SESSION
September 19, 1977

REPORT OF THE COMMITTEE ON DIESEL MECHANICAL MAINTENANCE

M. GOGOL, Chairman
Committee on Diesel Mechanical Maintenance
Regional Manager-LRM
Southern Pacific Trans. Co.
Los Angeles, CA 90039

N. A. BUSKEY
5th VICE PRESIDENT
Supt. Locomotive Dept.-Oper.
Chessie System
Huntington, WV 25704

Now will the Diesel Mechanical Maintenance Committee members please come forward. It is a great pleasure to introduce to you the chairman of this Committee.

[Mr. Buskey introduced Mr. Michael Gogol, Chairman of the Committee on Diesel Mechanical Maintenance. Mr. Gogol then introduced the members of his Committee.]

MR. MICHAEL GOGOL [Regional Manager-LRM, Southern Pacific Transportation Company, Los Angeles, California]: At this time I would like to extend the Committee's and the LMOA's thanks to the Great Lakes Railway Club for hosting us at the pre-convention presentation in May in Cleveland, Ohio. The turnout was splendid. There were a lot of questions and a lot of interest. I hope we have the same interest here today.

[Mr. Gregory presented Part I of the report, AIR COMPRESSORS].

MR. GREGORY: This subject covers only one of the many problems we in the mechanical department must eliminate in order to assure reliable motive power for the movement of freight. We must work together sharing our experiences, our knowledge of problem solving and equipment innovations. Working as a team, we can and must take advantage of the golden opportunity to attract more traffic by offering a faster, cheaper and more reliable mode of transportation.

MR. GOGOL: Thank you, Mr. Gregory, for your presentation. We will take a few questions at this time. Are there any questions on air compressors?

MR. LEEDY: Mike, can you give us a little more information on the gear-driven oil pump on the Gardner-Denver compressor? It sounded like the Committee has approved this, and I am wondering when the builders will make it standard on new locomotives rather than the customer having to specify it.

MR. GOGOL: The Committee felt the advantage is the gear-driven oil pump delivers positive oil pressure, getting away from cavitation and pulsations. As I understand it, EMD and GE both can make it available on new power providing you can give them sufficient lead time.

MR. C. R. BATTLEY [System Mechanical Officer, Motive Power, Canadian National Railways, Montreal, Quebec]: I noted Mr. Gregory said the practice, certainly in the United States, is now to sleeve air compressor liners. We have not been doing that. I think you also said, Mr. Gregory, that you would get perhaps eight years out of a sleeved application. Could you in any way compare that to what you might have obtained previously with the chrome? That is my first question.

Secondly, I wonder if anybody would like to comment on the virtue of welding up air compressor crankshafts prior to chroming.

MR. GOGOL: Are you talking about service life of a sleeved air compressor versus a chromed?

MR. BATTLEY: Yes. I wonder if there is a significant difference.

MR. GOGOL: What Mr. Gregory was quoting was the experience of a railroad particularly represented on the Committee—their experience with sleeve versus chrome. They are claiming they obtain eight years' service life. In other words, they will go through two air compressor overhauls of four years each, depending on the filtration, the oil practices of a railroad, and many other things.

MR. BATTLEY: I would be very happy if he had said that there was a double benefit; one, that the life of the liner was extended, and two, that it cut down the carryover of oil by a considerable margin.

MR. GOGOL: I would say the main advantage of the cast iron bore is the oil carryover. This outweighs the chrome liners. That requires certain porosity that causes oil carryover every time the piston makes a stroke. Whether it is loaded or unloaded, you have the oil carryover. It is probably worse in an unloaded condition because the seal between the ring and the piston is lost.

MR. BATTLEY: My second question is, should we be welding up air compressor crankshafts? What is the experience?

MR. GOGOL: There are a number of firms reclaiming air compressor crankshafts by building up with weld, with the proper techniques. First it starts with the inspection. You cannot take a burned-out piece of metal and expect to rebuild it or reclaim it. It requires inspection and qualification of the shaft. You need to set up specifications or parameters to qualify shafts for reclamation.

This work is being done successfully by a number of railroads. Other railroads have it done on the outside. Shafts are stress relieved after the reclamation work is completed. With proper controls and inspection, air compressor crankshafts can be reclaimed successfully. Some people in the audience are probably involved and might like to comment on this process. We would like to hear from them.

This is not a panacea. If you do not exert proper inspection controls, qualification and stress relieving of shafts, you cannot expect adequate service life.

MR. JAMES: Would you comment on what you would consider to be normal oil consumption on an OEM, properly maintained compressor, with a typical duty cycle as found on a 100-car train in mainline and manifest service?

MR. GOGOL: I am not aware of any data on air compressor oil consumption. Some years ago on our railroad we had the Wren oil makeup system where we had some data available, but they have all been removed. You can tell by the condition of the air brake equipment. The oil carryover is much less on air compressors with cast iron bore. This is one of the big advantages of staying with a cast iron bore, because of the oil control.

Do any others on the Committee have any information on oil consumption?

MR. LEEDY: Mike, since last winter's severe cold weather, have any of the members on the Committee, in contact with other railroads, seen a shift to air-cooled compressors on GE or EMD units?

MR. GOGOL: Yes, Bob. I understand railroads operating in severe cold climates were plagued with damaged air compressors when they lost an engine. Even when they drained the cooling system there were cavities in the air compressor cylinders that did not drain completely and froze, cracking the cylinders, especially low pressure cylinders where the cavity at the bottom would not drain completely. Since that time, I understand, some railroads have experimented with soft plugs. I understand tests to date have indicated they are beneficial.

MR. J. D. SCHROEDER [Assistant C.M.O.-Locomotive, Burlington Northern, Inc., St. Paul, Minne sota]: Mike, I would like to go back to the first question asked by Mr. Leedy. I am not quite clear on the answer given in regard to


BEFORE Switch Pac®, locomotive air cleaners were not only a messy maintenance headache, but costly because of frequent servicing requirements.
AFTER Switch Pac® installation, oily maintenance mess is eliminated . . . reduced servicing requirements and improved locomotive efficiency bring costs down too.

the gear driven oil pump in the air compressor. My understanding is that there is still the option of the reciprocating pump versus the gear driven. If the gear driven pump is preferable and more advantageous, why do we even have the option? What is the possible advantage of the older pump?

MR. GOGOL: The only advantage of the older pump, as I see it, is with the interchangeability with the compressor you now have. You cannot easily convert your old-style compressors to the gear driven type. It takes a new shaft and a new pan.

MR. SCHROEDER: You do not have the ability to retrofit, but by buying new you make a decision at some point in time that you are going to take advantage of this better oil supply, and from then on you will have it. One builder has it at the present time, and another is investigating it. They both buy their air compressors from the same concern.

MR. GOGOL: Standardization of parts would be the only reason to stay with the old reciprocating pump.

MR. SCHROEDER: One builder is trying to stay with his policy of making his parts interchangeable, and the other one has taken the step of getting better lube oil supply.

MR. GOGOL: Would the Committee have any recommendation about which might be the most economical way to go?

VOICE: On new power, or when you buy a new compressor. When you have a basket case, buy a new compressor. Give consideration to it at that time, also.

MR. PETER J. SASGEN [Triangle Engine, Chicago, Illinois]: I think we require a little clarification here on lube oil consumption and a centrifugally driven pump versus a reciprocating type pump. First of all, I don't care which type of pump you have in the compressor, if you don't have good oil control neither one is worth a damn.

The question came up about chrome-plated liners versus cast iron liners. I would like to bring out one more thing. Centrifugally cast cylinder sleeves: If that compressor is put together with a properly honed finish on the cylinder sleeve, if it has the right microinch finish, if it has the right combination of piston rings, and if it is broken in properly, you will not have high oil consumption. I don't know what normal consumption is on a compressor, but you should have very little if any oil consumption in the compressor if it is built properly.

The pump itself will supply proper oil to the compressor, whether it is centrifugally operated or if it is gear driven, or if it is a reciprocating type pump. It is when the compressor runs out of oil that you have problems. The compressor doesn't care what kind of oil pump it has in it. You have to have a good piston ring and liner combination to control oil consumption.

MR. GOGOL: That's right, Pete. In addition, you can't forget about proper air filtration.

MR. E. E. DENT [Superintendent Motive Power, Missouri Pacific Railroad Company, St. Louis, Missouri]: I would like to address myself to these pumps that have just been discussed—the strap type, the gear driven type, and the advantages of one over the other. It hasn't quite been made clear to me from Bob's initial question about that.

What is the advantage of the gear driven over the pump strap? Is it because we might have shutdown devices available now, low oil shutdown or low pressure shutdown, that are more sensitive to the gear driven type than the pulsating type, as the strap would be? Are we leading into this?

MR. GOGOL: That is an item the Committee has recommended. Apply a shutdown device so that when the oil pressure is below a certain amount the engine will shut down. Such a device is available. Some railroads are using it on switchers.

MR. DENT: Which is more sensitive?

MR. GOGOL: With the strap type oil pump there is possible cavitation or pulsation that the shutdown device would sense, giving undesired shutdowns.

MR. DENT: So the gear type would be more effective?

MR. GOGOL: It would work more favorably with gear type, right.

MR. DENT: Then, with that in mind, if in fact this would be a superior means of protecting the compressor under low lubricating oil conditions, why doesn't the builder come out with the gear driven type and make it a basic price on the locomotive instead of dangling it before us as an add-on?

MR. GOGOL: My experience with builders is that if enough railroads request this as an extra, they will make it standard rather than keeping it as an option.

MR. DONALD L. ANDERSON [Electro-Motive Division, LaGrange, Illinois]: The biggest advantage of the gear pump air compressor is that it carries a full-flow lube oil filter. This is about the same change as was made in the engine when we went from bypass filtration to full-flow oil filtration.

When there is some internal failure, the debris doesn't carry through all the bearings because it has been filtered out. It does deliver additional oil, and it is not sensitive to oil viscosity like the piston pump. The piston pump has two little balls that act as check valves, and when the oil gets cold the viscosity increases and these balls will float. Therefore, the pump will not deliver oil. This insensitivity to oil viscosity is the other advantage of the gear pump.

MR. LEEDY: One last question. How about this breakaway coupling that drives the air compressor shaft? Is there anything new on that? That was in limbo and it came back out again. Where does that stand?

MR. GOGOL: We did not include any update on that in the Committee report this year. We will keep it in mind for the coming year or until the next time we have something on air compressors, Bob.

Mr. Burchett will present the next section of the report, on Crankshaft Failures and Vibration Dampers.

[Mr. Burchett presented Parts II and III of the report.]

MR. GOGOL: At this time we will pause for questions from the floor. Does anyone have any questions?

This is an area, especially the vibration damper, that has been sadly neglected and overlooked by many railroads. I have talked to representatives from many railroads and asked them if they had any vibration problems, and they said, "What's that?" This indicates that you may be having a problem but you are not aware of it.

We are dealing with a piece of machinery here that is manufactured to very close tolerances. It has a silicone material inside with a certain viscosity that gives it the desired vibration dampening properties. A railroad that is not maintaining its cooling system in proper condition, and operates in a high ambient territory, can expect a shorter life than a railroad that is maintaining the cooling system and that operates in a more normal ambient condition.

Any questions?

MR. JOHN M. GALLAGHER [Manager Quality Control, Chicago and North Western Transportation Company, Chicago, Illinois]: At what frequency do you perform this torsional vibration analysis, and can you plot a linear regression of degradation of the viscous damper? Can you tell precisely when you expect it to go out, or do you have upper and lower control limits on it?

MR. F. I. BURCHETT [Mechanical Assistant-Locomotive, Atchison. Topeka & Santa Fe Railway Company, Chicago, Illinois]: I will ask you to talk to Hal person to person. It is very complicated, and if anybody wants to talk to Hal about it, fine. On this one formula it is very complicated, and unless Hal has a brief remark—you can't describe it briefly, can you, Hal?

One of the gentlemen who has been a work horse particularly in instrumentation and Z formulas and many other little gimmicks, is a gentleman I met this morning for the first time, Hal Hershkowitz. I would like to ask him to stand. Hal has done a lot of work for this Committee. Hal, we expect a lot more from you.

MR. HAROLD HERSHKOWITZ [Manager Applications Engineering, New Jersey Division, Scientific Atlanta, Inc., Randolph Township, New Jersey]: History is still being figured on this. We only have information on about 52 units as far as degradation of dampers is concerned. We are measuring the fifth order response of the system.

MR. GALLAGHER: I am talking about a time frequency such as on a 30, 90, 180 or 360.

MR. HERSHKOWITZ: We have made periodic measurements but they haven't shown any degradation potential yet.

MR. LEEDY: Mike, how can we detect these viscous dampers without this machine? What can we do now to tell whether we have a bad one while it is still in the engine?

MR. GOGOL: That is why Santa Fe has been working with EMD, trying to develop a method of procedure that can be easily used on the unit itself with minimum connection, and locating viscous dampers suspected of not functioning properly.

MR. LEEDY: If the road crew reported a vibration, would that give you an indication that you might have one going bad?

MR. COX: May I answer that? In the series of tests we have found only one locomotive that was transmitting excessive vibration, but usually this will only happen after the damper has reached a condition of complete failure, at which it has entirely failed and the rotor has locked up, and placed an imbalance in the system. Pure torsional vibration, even when it is excessive, normally can't be felt on the locomotive. That is why we are trying to derive a test method.

MR. T. L. WESTERFIELD [Electrical Engineer, Chicago and North Western Transportation Company, Chicago, Illinois]: We haven't gone any farther than to play it as a hunch at this point, but we find that the engine water pumps may be an indicator of vibration damper failure. That is, we often find that a second water pump failure occurs on the same engine. We will find a failed vibration damper on that locomotive. That is possibly one simple check.

MR. COX: In the 12-cylinder engine we have experienced a number of water pump shaft failures definitely linked as an indicator of damper failures through testing. We haven't noted any failures on the 16- or 20-cylinder engines that have been related to water pump shaft failures, but that isn't to say they do not exist.

MR. BURCHETT: We would like to find a way to identify the failure before we break water pump shafts. We feel we may be in an area of damaging the crankshaft. What do we say, shaking the turbos apart? We would like to get down to finding the cause.

MR. JAMES: Based upon the inherent design of the viscous damper used by EMD, I would like to ask Mike or his Committee what criteria EMD used in determining the 9-year service life that they recommended.

MR. GOGOL: As pointed out by EMD's POINTERS, there was improvement made in the viscous damper after a certain date. Only those after that date should be taken off on a time basis and sent back. They sent them back to the original manufacturer. The other firm involved in this work on rebuilding recommends testing and qualifying, because both firms say that you cannot say how long a life the viscous damper has after it is tested. All you can say is that at that particular moment in time it passes the parameters set up by the original manufacturer. This is material that you are depending on for the dampening, and it is affected by age and heat, and it is encapsulated. There is no way to take a sample of it.

MR. COX. May I add to that, Mike? Taking into account all the testing we have done, and the failures we have experienced, the 9-year life is not always true. The life of the damper is determined by how close the original manufacturing tolerances were held, and the amount of work the damper performed while it was in service. We have found many early failures that were not anywhere near 9 years. So, I don't think it is possible to actually give a "straight line" life of a viscous damper.

MR. CARL R. STAHL [President, Torsion & Fluid Products, Memphis, Tennessee]: On testing, and being able to determine residual life, they are using an approach which is electronic. Through a series of tests you can determine whether there is a change in the pattern.

Another thing is being able to sense heat within the part itself. When the part operates it absorbs energy, so the temperature will rise. If you make the same kind of scheduled checks you can determine the differential heat within the part itself, and possibly get a pattern and determine how far along it is toward failure.

MR. GOGOL: That means you would have to have a separate identity for each of the dampers. It would be similar to correlating it with an oil sample taken from the same damper over a period of time, trying to establish some trend there.

MR. STAHL: That's right.

MR. LEEDY: Mike, I want to go back to water pumps for just a moment. Does it make any difference whether it is right-hand or left-hand? What is the period between the first failure and the second failure, on an average, in terms of days, weeks or whatever?

MR. BURCHETT: Is there anyone here from EMD who would care to answer that question?

MR. LOUGH: We normally go back to the computer any time we have a water pump failure, and then if it has been a repeat failure within the last three or four months we have the viscous damper checked. This is kind of hit-and-miss. We don't actually have any criterion.

MR. GOGOL: I gather that any time you have a water pump shaft failure you look further into the vibration damper?

MR. LOUGH: Yes.

MR. GOGOL: Are there any other questions? If there are no further questions on this subject, we will move to the next part of the paper.

[Mr. Gogol presented Part IV of the paper, FIRES — MECHANICAL.]

MR. GOGOL: Any questions?

MR. JAMES: Mike, in regard to your comments and slides on GE locomotive low pressure fuel systems, at what frequency has your Committee members found it necessary to retorque those nuts that you referred to in the slide?

MR. GOGOL: I would say the emphasis should be on proper torquing initially, rather than retorquing at a later date.

MR. JAMES: Assuming you do torque up properly during initial installation, have you reassessed the system thereafter to find out what frequency would be ideal in retorquing or going over the system?

MR. GOGOL: We have not come up with any recommended retorque. Does GE have a comment?

MR. A. C. HILLHOUSE [Manager Locomotive Service, General Electric Company, Erie, Pennsylvania]: They are torqued initially.

MR. GOGOL: The initial torque is important. If you exceed the recommended torque you will have deformation, and any further torquing will further deform the parts.

Any other questions?

MR. R. G. CLEVENGER [General Electrical Foreman, Atchison, Topeka & Santa Fe Railway, Kansas City, Kansas]: Mike, doesn't GE, on their low pressure fuel lines, recommend a certain time interval for changeout of them completely?

MR. HILLHOUSE: Are you talking about the low pressure fuel oil line, Bob?

MR. CLEVENGER: Yes.

MR. HILLHOUSE: I believe it is in the maintenance manual. I am not sure whether it is on the yearly basis or not. Normally, if a machinist feels the low pressure fuel line, it will weep before it does anything else. If it is weeping it can be removed.

MR. GOGOL: GE states in its literature that the line will weep, but because of the location and natural aging from the heat the flexible lines become stiff, and any disturbance of the line — a man working on an adjacent cylinder, or a mechanic using the line for a handhold, may cause damage. Their assumption is that the line will not be disturbed. I have not seen lines reach the point where they will weep. Usually it has one of the other failures before weeping occurs. On our railroad we replace them after a specified time period, and change them out 100 percent.

MR. COX: In view of all the problems the railroads have had with fuel fires, what is GE planning in the way of design changes to curb this problem?

MR. GOGOL: They have a very active program under way at the present time. They have at least one engine on test. I will let GE speak about this after I finish.

They are using steel tubing. They have lowered the manifold and are using steel tubing risers, and have eliminated the low pressure flexible fuel lines altogether. They have had this design on test a number of months. They hope to have some out before the end of this year. I don't know if they have debugged all the problems yet. Maybe Andy can answer that.

MR. HILLHOUSE: The last I heard, they are trying to get them shipped by the end of this year.

MR. GOGOL: This is an all-steel type of tubing, with a riser to each of the cylinders. It looks very promising. As I understand it, the problems that have arisen have been in an area not in the riser but in the header itself.

Any other questions?

[Mr. Gogol summarized Part V of the report, FAILURES ON ROAD.]

MR. GOGOL: Gentlemen, that concludes the paper by this Committee. We will open the floor for additional questions, if you have any.

MR. D. M. WALKER [Diesel Superintendent, Southern Railway Company, Atlanta, Georgia]: I don't have a question, but I think your Committee has brought out two very difficult problems for the railroads today.

I was a little disappointed that we didn't get an expert bit of advice from GE and EMD, EMD in particular, on viscous dampers, and GE on fuel lines. When the What's Your Problem session comes up I would like GE and EMD to state a position on these two subjects.

MR. GOGOL: Thank you. That is a very good recommendation. Does either GE or EMD want to comment at this time.

MR. L. F. TURNEY [Manager Technical Section, Electro-Motive Division, LaGrange, Illinois]: The subject of dampers covered in our paper was the experimenting and research being done by some of the railroads. EMD is also researching and looking into the possibility of using the newer methods for trying to determine vibration levels in locomotives. We are testing, and hopefully will have a device better than the ones available now, in about a year. At this time, however, we are not in a position to release any pertinent information. We have worked very closely with the railroads involved in this testing.

EMD is not sitting back, doing nothing. Some of the railroads represented on our Committee worked closely with Electro-Motive in compiling some of our thoughts and data for use in evaluating tests covered in the paper.

MR. GOGOL: Would GE care to comment about low pressure fuel lines at this time?

MR. HILLHOUSE: Let's talk about the fuel system in general. We had problems originally with the high pressure fuel lines. We solved that by using a gun drilled rod, and high pressure fuel system seems to be relatively good right now. On the low pressure we found the majority of machinists were using them for handholds and footholds. They were over-torqued or under-torqued. That is why we came out with special tooling.

We are looking at the new type of system, which is a solid pipe system that you described earlier, Mike. So, we are not sitting back. Whether the new system when it comes out will be retrofittable, I

can't say right now. Maybe somebody here from GE knows.

MR. GOGOL: The Committee felt very strongly about some type of identification marking on the high pressure fuel line and the adapter tee, because we have noticed in service that they will be interchanged from unit to unit, and there is no way you can tell how long they have been in service. If you try to change them out on a periodic time basis, normal mixing makes it difficult. It is difficult to tell how long any of the components have been in service.

GE has not made much comment, but the steel tubing, replacing the low pressure flexible armored hose, does look very promising, if they can get the system de-bugged. They have been very skeptical about this. I might add that certain railroads have kept pressure on GE to see what they can do, because fuel fires cause very expensive damage, and we feel it is something that can be prevented with proper design and inspection.

If there are no further questions, I will ask Mr. Leedy to summarize the paper.

MR. LEEDY: Thank you, Mike.

Better management of mechanical maintenance. With the increasing cost in labor and material, no one needs to explain that to you, because you live with it every day in your own shops and on your own railroads.

We have had a good thing going on air compressors, and I hope the Committee will follow up with some more information on this. There are some good recommendations in the report on air filtration, oil sampling, and scheduled changes. If you have air compressor problems this report can help you.

Crankshafts are always an expensive problem when one of them fails. Build up a good history if you have problems now. Search each one out. Investigate each failure, and you will come up with an answer. I think the railroads on this Committee that have had these problems will testify to that.

Vibration, Viscous Dampers: There is a lot of good information in the report on this, and apparently there is still a long way to go. We heard that one railroad is relating this to water pump failure, so there could be many other factors involved.

Fires are always expensive. A good mechanical inspection not only of the mechanical system but of the GE fuel lines and spark caps and electrical cabinets as well will probably save you a lot of headaches. If you are having fires, there is some information in the report you might be able to use when you get back home.

Online Road Failures. There is nothing new about this, but here again with the computers we have today, and the data you can build up, the history will probably indicate what you should change in the way of your maintenance program, and thus you can get a good handle on these points.

If you have further questions or ideas, the What's Your Problem session on Wednesday is a good soundingboard for them.

I will now turn the program back to Mr. Buskey.

MR. BUSKEY: Thank you, Bob. I too agree it was a fine report.

Gentlemen, I will call on President Tennyson for his closing remarks.

PRESIDENT TENNYSON: I will remind you about correcting your transcript, and staying out of the hospitality suites while the meeting is in session. At this time you should visit them. This is a good time to do it.

Now I would like to ask you to give this fine Committee a rising vote of thanks, after which we will recess for the day.

[The audience arose and applauded.]

[The meeting recessed at 4:25 p. m.]

TUESDAY MORNING SESSION
September 20, 1977

REPORT OF THE COMMITTEE ON FUEL AND LUBRICANTS

D. H. PROPP, Chairman
Committee on Fuel & Lubricants
Engineer of Tests
Burlington Northern Inc.
St. Paul, MN 55101

F. D. BRUNER
6th VICE PRESIDENT
Asst. C.M.O.-Research & Dev.
Union Pacific Railroad
Omaha, NB 68179

The meeting reconvened at 9 a.m., President T. A. Tennyson presiding.

PRESIDENT TENNYSON: Good morning, gentlemen. Whether you know it or not, this organization is gaining somewhat of an international reputation. Of course we always have Canadians here, and they help run this organization. We very frequently have people from Mexico, and last year we had people from both Mexico and Denmark. We are becoming known all over the world.

This year we are pleased to announce that we have three gentlemen attending this session from outside the continental United States, who are members of oil companies or oil company affiliates. We certainly want to welcome them and anyone else who wants to participate in this work with us.

We have with us Mr. Stan Walker, of British Petroleum, from London. Richard Steinke, of Shell Chemical, Chester, England. Mr. Bernard Dones of Esso International, Johannesburg, South Africa.

We want to welcome you gentlemen. It is an honor to have you here.

I am told that our manual for testing new lube oils has spread pretty much over the world, and Jack Hoffman tells me he gets requests from all over for the booklet. This is a compliment to our Committee that worked so hard to put out that publication.

Now I would like to call on our 6th Vice President, Frank Bruner, who will be the officer of this session.

MR. F. D. BRUNER [Assistant C.M.O.-Research & Development, Union Pacific Railroad, Omaha, Nebraska] Thank you very much, Tommy. Good morning, gentlemen.

Our first report this morning is by the Committee on Fuel and Lubricants, Dale H. Propp, Chairman.

[Mr. Bruner introduced Mr. Propp, who then introduced the members of the Committee. Mr. J. D. Smalling presented Part I of the report, Engine Lubricating Oil Developments. Mr. J. P. Fite presented Part II of the report, Progress in Spectrographic Analysis and Computer Data System. Mr. William Cain presented Part III of the report, Air Compressor Lubrication. Mr. Propp presented Part IV of the report, Diesel Fuel and Their Additives, and Mr. Shackleford presented Part V of the report, Method of Measuring Lube and Fuel Oil Consumption.]

MR. PROPP: That completes the brief overview of the paper as printed in the Proceedings. We will now open the floor for questions.

MR. H. C. CUMMINGS [Atchison, Topeka & Santa Fe Railway Company, Topeka, Kansas]: In your paper you showed a slide with piston ring groove deposits of some 31%. Jack Hoffman, isn't 25% about the upper limit for approval? Of course this is in a Caterpillar engine. Some of the tests that I have seen on even these second- and third-generation oils show the top groove ring filling is much lower than 30%, so what are we actually talking about when we say 30% deposits in the ring groove?

MR. J. G. HOFFMAN [Fuel and Lubes Engineer, General Electric Company, Erie, Pennsylvania]: In the overview of the paper we did not clearly define what test procedure was used. I believe it was included on the slide. You are correct, that in one particular Caterpillar type test groove fill of 25% at a given number of hours is the acceptability limit.

In the specific test which is defined more clearly in the full paper, that is not so. For example, oils of the Generation 2 and Generation 3 performance level, produce in this test, ring groove deposit levels of approximately 75% and 45% respectively, whereas in older types of Cat. tests to which you refer, those values are reduced to about half of present test values. Does that help you?

MR. CUMMINGS: Thank you. The other part of the question is addressed to Mr. Kwiatkowski.

In the work done on the high VI oils in the EMD engines, traditionally, of course, EMD has insisted on a 75 maximum VI, but now we know high VI oils do work in their engines. Have they made some engine change designs that have eliminated the hard carbon deposits and broken rings?

MR. M. KWIATKOWSKI [Technical Engineer, EMD, LaGrange, Illinois]: At this point we feel that the high VI oils will prove a viable source with the disappearance of Naphthenic base stock. We do see slightly higher deposits.

MR. PROPP: About 85% of the crude oil is in the paraffinic range, so maybe that is going to be a problem. To date, this Committee doesn't feel the Naphthenics are in short supply. I do not believe EMD has made any definite statement regarding the use of paraffins.

MR. KWIATKOWSKI: No, we haven't.

MR. PROPP: In other words, it is still 75 VI maximum, at least for the United States?

MR. KWIATKOWSKI: That is correct. That is what our limit is presently. However, if the oil picture does change, we obviously will be putting something out on that.

MR. PROPP: Many of the foreign countries require paraffinic oils due to availability.

Is there another question?

MR. FRANK FINDLING [Chief Mechanical Officer, Chicago, Rock Island & Pacific Railroad Company, Chicago, Illinois]: I have a question for Mr. Smalling. I noticed in Fig. 5 he showed a viscosity of D7-2. That is great, except it is a 2-cycle Engine. That is the kind of engine we are having problems with. The 4-cycle engine is having all the deposits in the ring groove area. What about the viscosity on a 47 engine, the D7-2 spec?

MR. PROPP: Do you mean the viscosity index? Certainly the 4-cycle engine can tolerate the higher VI. I am quite sure that GE will agree it is an ideal oil for their engine, but I would like to ask Jack to speak about that.

MR. HOFFMAN: I think I heard Frank's question a bit more clearly than possibly you did. The acoustics up here are terrible.

First, to complete your thought with respect to viscosity index, which was not Frank's question, the answer is this: Our engine is not sensitive to viscosity index, per se, or to paraffinic base stock oils. Obviously someone can formulate a high viscosity index base stock oil which will be miserable, in the same way they can formulate a medium viscosity index oil which will be miserable.

However, Frank's question dealt with the viscosity increase exhibits in the paper. He related it to ring groove filling. The two things are related but not as directly, in my view, as Frank indicated.

Certainly viscosity control, which is a measure of oxidation stability of the oil, influences ring groove deposits. The viscosity problem which is most typically observed by railroads, however, is in reaching upper limits with shortened oil

life. The improved oxidation stability of the oils as they have developed over the years is reflected in longer life in the 4-cycle engine as well as in the 2-cycle engine.

I think most people (even Marty) will agree that right now upper viscosity limit — in other words, reaching condemning high viscosity — is not a general problem in the industry in either the 2-cycle or 4-cycle engine. It is more characteristic in 2-cycle engines generally than 4-cycle engines when it does occur.

Improvements in viscosity control or oxidation stability and ring groove deposits or detergency that Frank talked to in his question, both reflect themselves in improved performance in the 4-cycle engine. There are lab data and field data to substantiate it.

Frank, that was a long answer to your question. I hope I answered it correctly.

MR. FINDLING: You did, Jack. Thank you.

MR. PROPP: I can testify to that, also. From a user's standpoint, another major railroad I am quite familiar with has not experienced viscosity increase problems, and it has been directly related to the various generation oils. As the oils have been improved those problems have disappeared.

Another question?

MR. DENT: Are any of the railroads having any problems using the lithium based lubricant in traction motor gear cases? If so, what are they?

MR. PROPP: That question has been brought up. As I understand it, there has been one railroad that has utilized the lithium product in lieu of the previous sodium product, and had the experience of problems, in that they were losing a lot of grease from the gear cases. Is there anyone who has some firsthand information on this issue? Would you like to say something, Pat?

MR. P. A. SHACKLEFORD [Manager of Tests, Illinois Central Gulf Railroad, Paducah, Kentucky]: The primary reason has not fully been determined yet, but our preliminary findings are that our gear cases are in such bad condition that it just won't stay in them.

MR. PROPP: Then it is a gear case problem, rather than seals with cracks in the case housing. So, if your railroad has that problem, I suggest examination of cases before making any change in grease.

VOICE: In Mr. Smalling's report on the low sulfur content of U.S. fuel oils, are the 13 TBN oils required by U.S. railroads?

MR. PROPP: I will speak to that for a moment, and I know there are others on the Committee who wish to speak to this issue.

Certainly 13 TBN does have some advantages, and probably more advantages in one engine than another, but I believe many railroads have experienced that lower TBN oils around the 10 range have done a satisfactory job for them. I will ask John Smalling to speak to this subject.

MR. J. D. SMALLING [Engineer of Tests, Southern Pacific Transportation Company, San Francisco, California] The higher alkalinity oil of course has its advantages. I think the railroad itself would have to treat it as an individual problem in respect to whether or not they need a Generation 4 oil at the present time. I know from our position on the Southern Pacific, Generation 3 oil is doing a wonderful job for us at the moment. If we have to get into a higher sulfur fuel, then that would require a higher alkalinity oil.

Another thing you might look into is the reduced wear rate that you might have with the Generation 4 oil. These are some of the things that the railroad itself will have to evaluate as to the extra cost of the Generation 4 oil, and place it on a comparison basis with what benefits are being derived from Generation 3 oil.

MR. PROPP: As the slide pointed out, sulfur content in the United States has been reasonably good. I know on our railroad the average sulfur is about 0.3%, which is below the problem area as shown in the paper. I know the builders desire to reply on this issue, so I will call on Jack Hoffman of GE.

MR. HOFFMAN: I was hoping this question would be asked. It was asked at Louisville. I think it is extremely important, and it takes more than a "yes" or "no" answer. I hope you will bear with me as I go beyond "yes" or "no".

First, there are really two key words in the question. One is "need" and the other is 13 A. V. or total base number. Let me speak first to the 13 A. V. total base number part.

You will recall that in both the overview of the paper and in the total paper in the book, what we are choosing to call Generation 4 oils exhibit improved performance in addition to increased alkalinity. Certainly the major step, the major obvious elevation in oil performance properties of this type of product, is its increase in akalinity. But there are also major improvements in detergency, dispersancy, and the oxidation stability that we talked about in connection with the gentleman's question. Therefore, I am going to turn the question just slightly, and assume that what was asked was: Do the railroads need Generation 4 oils?

Certainly, in terms of needing Generation 4 oils in the United States to keep your locomotives in operation today, you know very well that you don't. The answer has to be no. You are operating locomotives generally without it. Since Tommy Tennyson recognized that our Association has become international in flavor, it is proper to state that I believe the need by railroads outside the United States (many of them) is obvious and apparent right now.

In terms of need, to have a product of this performance level available to you to evaluate for possible economic advantages by utilizing the latest technology, I certainly think there is a need.

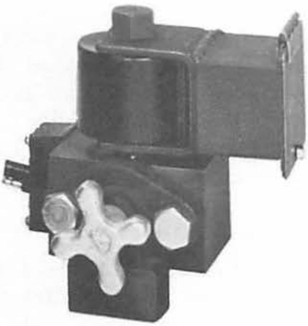
PRIME MANUFACTURING CORP.

7730 South 6th Street Oak Creek, Wisconsin 53154
Telephone (414) 764-1400 Telex. 2-6857

PM-981 SERIES DRAIN VALVE & PM-768 TIMER

ALSO OTHER FINE PRIME PRODUCTS

Electric and Pneumatic Sanding, Electronic Bells, Pneumatic Bell Ringers, Locomotive Air Conditioners, Warning Beacons, Solenoid (Magnet) Valves, Toilets (Locomotive and Caboose), Automatic Drain Valves, Air Gauges, Portable Gauge Testers and Fittings, Air Filters, Lubrication Equipment, Metals Cab Awnings, Horns (Pneumatic) Windshield Wings, Locomotive Refrigerators, and Rear View Mirrors.



PM-981 Drain Valve

PM-768 Timer

Prime's new All Electric Drain Valve will solve your freeze-up problems. Uniquely designed with no pneumatic control, with heater and thermostat strategically located for freeze-proof efficiency.

PRIME
MANUFACTURING CORP.
7730 So. 6th Street
Oak Creek, Wisconsin.

The oil industry should be congratulated for making it available.

A further look at need? You will recall in the overview, and you will see when you read the complete paper, that the operating conditions that are converging upon the United States railroads will make this type oil a requirement in the near-term future. For example, the kinds of crude oils that are being imported into the United States for refining, the kinds of crude oils that are coming down from Alaska, both have a much higher sulfur level than previous U.S. crudes. The U.S. refineries are geared to and are used to refining products much lower in initial sulfur. It will take time for them to gear themselves to handle much higher levels in large quantity.

There is certainly the competing need to improve environmental atmospheric conditions. The EPA is going to say, keep sulfur emissions down. But in the real world, energy requirements are most likely to cause the sulfur level of fuel oil in the United States to increase somewhat, at least on a short-term basis.

All of us are working in the direction of reducing fuel usage or, I should say, petroleum usage. For example, take the fuel saver approach, or the different methods of operating trains. Dale told me earlier that in one of the tests made on one of the large railroads instead of having an 8th notch or full load usage in the range of 11% to 20%, different operating methods shift it to 50% or 60% full load. That is a drastic difference, and it reflects itself in the job the lubricating oil is required to perform.

Lubricating oil consumption reduction and stretched life of lubricating oil both put added burdens on the crankcase oil.

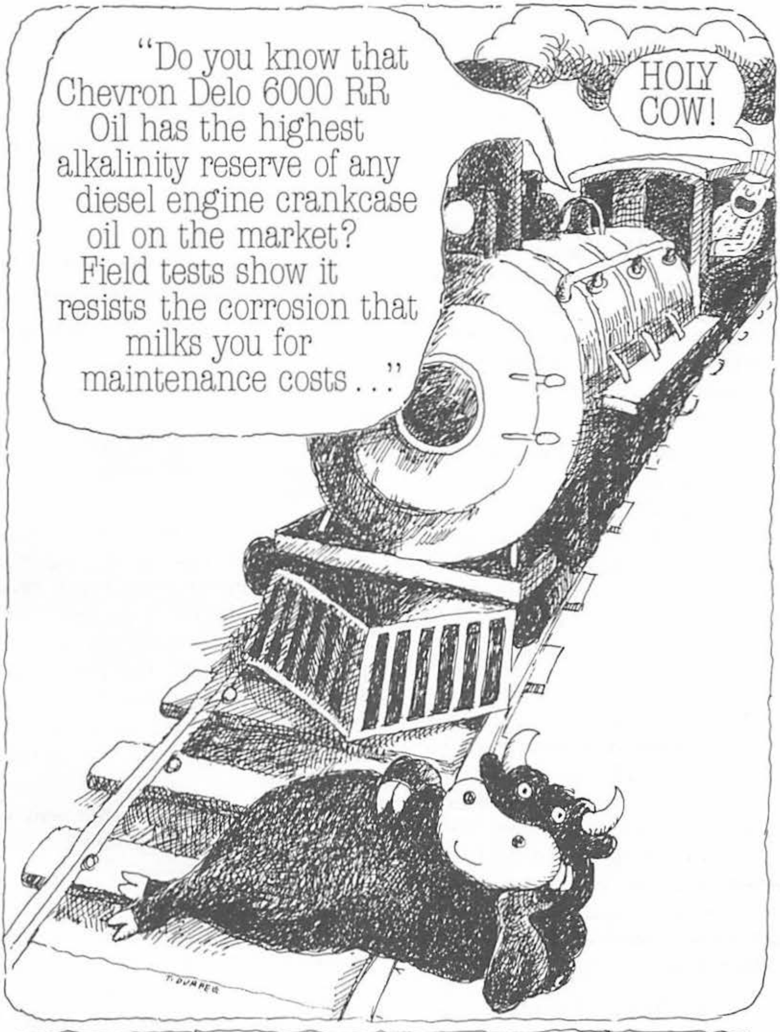
Longer life of lubricating oil: A 25% increase in lubricating oil life is the same as many millions of gallons of diesel fuel oil or energy saved.

All of the things in these areas that each of us in this room is required to do, and wants to do, reflect themselves in the need for better oils in the future; and for the first time since I have been in the business, as pointed out in the paper, there is a product being made available to the railroad industry that is here before the engines are begging for help. So, I believe the total answer is yes, there is a need in the United States for this performance-level oil.

MR. KWIATKOWSKI: I would like to solicit some help from Tom Pratt. I am sure Tom might want to say something about this.

Our opinion at this point is that we do feel there is a crying need in export areas for a higher TBN oil where high sulfur fuels are being used. However, as Mr. Smalling said, each railroad should evaluate which way to go.

Our experience has shown, in low sulfur fuel areas, a slightly higher additive ash build-up has appeared on pistons and ring belt areas.


"Do you know that Chevron Delo 6000 RR Oil has the highest alkalinity reserve of any diesel engine crankcase oil on the market? Field tests show it resists the corrosion that milks you for maintenance costs . . ."
HOLY COW!

MR. THOMAS PRATT [Engine Design Engineer, EMD, LaGrange, Illinois]: You summed it up very well, Marty. The only thing I might add is that it was stated in the paper that there was a wear reduction observed of some 25% nominally. We can understand that such a wear reduction was observed, but I think we should all recognize that within the field test evaluation of a lube oil many things are involved and must be looked at. Among them, there is usually an attempt to try to determine wear rates.

Within the limitations of such a test, wear rates are very difficult to ascertain since there are a limited number of power assemblies that are subjected to measurement and we would appreciate looking at this wear rate not as a solid 25% figure but, instead, an an optimistic trend.

We have seen other tests on the 7 to 10 TBN oils where we have seen some tradeoffs in wear rate. We don't feel these tradeoffs are significant, but we do feel we will have to develop considerably more experience in this area through field testing and fleet testing to get these kinds of figures firmly established.

MR. PROPP: I know there is an economic situation with these things, and it can easily be offset by wear rate changes.

MR. RICHARD STEINKE [Shell Additives, Thornton Research Centre, Chester, England]: This discussion of what the railroads need reminds me of an old country-and-western song where a brash young lady told her sweetheart, who was being wooed by a rather high-class sorority girl, "She may know what you need, but I know what you want."

The purchasing agents for the railroads certainly know what they want, and in many cases it is the cheapest approved oil they can buy.

The fourth-generation oil, however, may well be what they need. There is a great deal of homework yet to do for the railroads to determine the cost/performance relationships for such oils, not just the cost.

I have a somewhat difficult question, and that is the question of AV versus TBN, or the D-28-96 versus the D-6-64. I noticed on all of these charts that you had the 28-96, yet Jack Hoffman has stated, I believe, that he prefers the 6-64 method for describing the alkalinity level used for railroad oils.

Would you care to comment on which method you prefer?

MR. KWIATKOWSKI: Yes. I am not a lab man, but as I understand it the D-28-96 method involves a bit of risk as far as running the test is concerned, and the D-6-64 is relatively easy to run. Why not give them both? Is there an index that you have to translate one to another?

MR. PROPP: There is a differential between the two tests, and as long as you know the differen tial a correlation is possible between these tests. Mr. Smalling referred to the perchloric acid risk, but this can be controlled in the laboratory.

MR. CUMMINGS: To begin with. we have satellite labs that run pH's and TBN's. We want to know what the TBN is. We want to know what the initial pH is. You don't get that with the perchloric acid Furthermore, the EPA is currently putting more restrictions on benzene, and I am sure chlorobenzene will be right behind them.

What do our satellite labs do with all the chlorobenzene they have to get rid of? In other words, we are not going to use the perchloric acid procedure on the Santa Fe. We will continue to use D-6-64 even though some people say the other is more precise and easier to run. We do want to know what the initial pH is, and we want to avoid the use of copious quantities of chlorobenzene, to say nothing of glacial acetic acid, in our little labs out in the field. If you have a nice central lab with a hood that is well ventilated, fine; use D-28-96. But our labs don't have that, and we run a lot of pH's and base numbers. This is why we just don't favor D-28-96.

You may recall originally it was intended for the determination of total base number on new oils and concentrates, and with some misgivings the ASTM expanded this to use on used lubrication oil. I think Mr. Jim Wilkison, of Shell, among other people, might have some thoughts. Perchloric acid is such a strong oxidizing agent that it seems it goes after things that may or may not be there. As far as the Santa Fe is concerned, we are still going to use D-6-64 for this procedure.

MR. ROBERT E. TAYLOR [Assistant Vice President-Mechanical, Burlington Northern, St. Paul, Minnesota]: Has the state of the art on synthetic lubricating oils reached the point where the industry should be doing some serious cost/benefit studies in this area? I don't mean for air compressor oil — I mean for diesel engine oil. Would one of the oil company representatives care to respond to that, or a locomotive builder?

MR. PROPP: Before I call on an oil company representative, may I say I know in our studies of this last year we found that the synthetic oil still was in a price range that was unacceptable for the 400 or 450 gallon diesel engine crankcase. However, I believe the tests should continue in that regard. Basically, we find that 65% of our adverse engine codes are based on water and fuel leaks, and consequently you would have to drain and recharge the high cost of $6 to $12 per gallon.

I would like to have the oil company representatives respond to that question. Jim Wilkison, may I put you on the spot?

MR. JAMES L. WILKISON [Products Application Engineer, Shell Oil Company, Houston, Texas]: Sure. In regards to synthetics, some of the major companies are promoting synthetic oils for passenger cars, but all of the base stocks that I know about for synthetic lubricants are in the low viscosity range — that is, in the 10W range or even lower.

In order to get the higher viscosities that are needed for locomotives, some sort of thickener or VI improver must be added. Of course this brings up certain performance questions.

Specifically, I know of no major oil supplier that is working toward or that anticipates supplying an SEA40 grade synthetic oil for locomotive engines. There are two or three independent companies that are working in this area, but my opinion is that the performance and benefits that can accrue from synthetic oils may not be worth the additional cost of such products over conventional oils.

MR. PROPP: Thank you.

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

MR. R. R. HOLMES [Chief Chemist, Union Pacific Railroad Company, Omaha, Nebraska]: Before I get into the summary, I think a very important aspect that was explored in the paper on locomotive lubrication is the subject of traction motor gear lubricants. There is a lot more to think about in this change in specification, and a much greater reason to consider the merits of this new type of lubricant, as opposed to some problems of keeping it in the gear case that have been expressed. I think

R. R. HOLMES
REGIONAL EXECUTIVE
Chief Chemist
Union Pacific Railroad
Omaha, NB 68179

in the What's Your Problem session the merits of this new specification and this new type of lubricant should be brought out more thoroughly, so that there is a greater understanding in the industry of what this actually does for the user.

Further, as we all know, we are accustomed to higher viscosity base oils in present lubricants that have been found suitable for high-speed, high-temperature operation in the summertime. One of the purposes of this new specification is to lower the operating temperature of the traction motor gears, but has it been proven that we are going to get better wear characteristics from this?

I will now proceed to summarize the paper. Every year before I get up here I make a few notes so that I might emphasize selected points from the paper. However, by their superior presentation here today, the Committe has out-performed the need for any type of comment. It would merely be repetition on my part, because they were excellent and explored all of the subjects as well.

The paper is certainly exemplary of a better way; which our President Tom Tennyson chose for the convention theme. It is a better way of reaching the goal of getting the job well done by improving practices, reducing maintenance, and better utilizing our resources, to select alternatives available as needed. These objectives can be accomplished through the adoption of innovations, some of which include more sophisticated techniques, procedures and equipment.

Therefore, I recommend that all of us give Dale Propp and his able Committee a vote of thanks for their important contribution today. [Applause]

I will now turn the proceedings back to Mr. Bruner.

MR. BRUNER: Thank you, gentlemen. The Committee has done a great job.

TUESDAY MORNING SESSION
September 20, 1977

REPORT OF THE COMMITTEE ON DIESEL MATERIAL CONTROL

J. J. GREGORY, Chairman
Committee on Diesel Material Control
Production Control Manager
Consolidated Rail Corp.
Altoona, PA 16603

E. E. DENT
1st VICE PRESIDENT
Supt. Motive Power
Missouri Pacific RR Co.
St. Louis, MO 63103

Now will the Diesel Material Control Committee please come to the podium.

PRESIDENT TENNYSON: The last report is an example of what we have been talking about for some time — that is, not enough time to get around to all the questions. So, if any of you have any unanswered questions, please turn them in to either Bill James or any of the red-coated gentlemen around here, so they can be brought up tomorrow during the What's Your Problem session.

Now I will call on Eldon Dent, First Vice President, who will chair this next session.

[Mr. Dent introduced Mr. J. J. Gregory, Manager, Production Control, Consolidated Rail Corporation, Altoona, Pennsylvania, who in turn introduced the members of his Committee.]

MR. GREGORY: I would like to thank the members of the Southwestern Railway Club and Mr. Carriere for their hospitality during the presentation of our paper.

[Mr. Gregory summarized Part I of the report. Mr. Cruise, Mr. Fette and Mr. Vermillion summarized Part II. Mr. Ward and Mr. Jacobson summarized Part III, and Mr. Gregory summarized Part IV.]

MR. GREGORY: One advantage of the system we are putting into effect is that Mr. Runyen, a rather unique computer man, asks the Mechanical Department, "What do you want? How do you want it? At what frequency do you want it?" In the past other railroads and other departments have had the computer people say, "This is what you should have, and this is how you should have it." In this case we hope to have as complete a locomotive information system as anything that is compiled on the American railroads today.

We started approximately 11 minutes late, and we are ending on time. When we presented our report at Little Rock we had 39 questions and we ran over about 30 minutes. Should you have any questions, we will gladly answer them at the What's Your Problem session tomorrow morning.

I will now call on Regional Executive Darrell Walker to summarize our report.

MR. D. M. WALKER [Diesel Superintendent, Southern Railway, Atlanta, Georgia]: Thank you, Mr. Gregory and members of the Committee, for a fine report. We are sorry we didn't have time for questions now, because I am sure there are many in the audience who would like to know how to obtain 90% to 95% availability from a material standpoint; and the manufacturer's role in trying to get the material to the various railroads has been very educational.

In the interest of time I will now turn the meeting back to President Tennyson.

PRESIDENT TENNYSON: Don't forget, we will reconvene at 2 p.m.

[Announcements.]

PRESIDENT TENNYSON: Let's give the Committee a rising vote of thanks.

[The audience arose and applauded.]

[The meeting recessed at 12 o'clock noon.]

TUESDAY AFTERNOON SESSION
September 20, 1977

The meeting reconvened at 2 p.m., President T. A. Tennyson presiding.

PRESIDENT TENNYSON:
Gentlemen, we will reconvene. I would like to call First Vice President Eldon Dent to the podium. Eldon, if you wait long enough you finally get through all the chairs and become President of this Association. The job of President is very rewarding. You will never work with better people. All the committee chairmen, members and fellow officers are great people. The job doesn't have too many hazards. I don't think we have ever had a President assassinated in the whole time the Association has been in existence. You will enjoy every minute of it. The pay isn't so great — in fact, it is less than modest, but the rewards are still there.

In handing you this gavel, I now transfer the Presidency to you. Good luck. [Applause]

[Mr. E. E. Dent assumed the Presidency of the Association.]

Tommy Tennyson (left) passes gavel on to newly installed president Eldon Dent, Superintendent of Motive Power, Missouri Pacific Railroad, in a ceremony at the 39th Annual Meeting of LMOA, held at the Conrad Hilton Hotel, Chicago, Illinois on September 19-21, 1977. Witnessing the exchange are LMOA President Frank Bruner and Jim Long.

PRESIDENT DENT: Woodrow Wilson said that every new President would like to write his own record from the start on a blank sheet of paper. Not me. I am glad to be able to begin, not with a blank sheet of paper, but with a tradition of high-quality leadership to build upon. I am grateful and honored to begin with you what I trust will be a year of building upon the excellent leadership our Association has enjoyed in the past.

The accomplishments of our Association in the coming year will be carried out by you out there. The job will be done far more by you than by me. In this regard, I am reminded of a story about Queen Victoria. It seems the Queen never looked behind her to see if there was a chair when she wanted to sit down. Why? Because she knew it would always be there. Her team backed her up. I know you of our Association team will be backing me up, and I want to thank you in advance.

Our team depends on many qualities and talents to function well. One essential ingredient is communication. We need communication in our efforts to make railroad management more aware of this Association's value to the work of locomotive maintenance officers. We need communication to continue and increase the exchange of information concerning problems and developments. We need communication to convey to people in our respective companies the advantages of LMOA membership.

And I expect, in the coming year, that our Association and our industry will need communication more than ever as we become more involved in answering a trio of public concerns — dwindling energy resources, pollution, and land usage. Because of the railroads' efficiencies in these areas, we can expect public policy will dictate that an increasing amout of freight will be diverted to the rails in the years ahead. The better informed we all are—the better we communicate—the better we will be equipped to meet these demands.

I am encouraged, too, by signs that the future will see better communication and cooperation between our industry and the regulatory agencies. I read recently that OSHA, the Occupational Safety and Health Administration, EPA, the Environmental Protection Agency, and others have been instructed to get to know each other better. These agencies are developing plans to share laboratories, vehicles, libraries, and other resources.

And most important, they are looking into the possibility of increased cooperation in enforcing laws and regulations. An OSHA official has said the new cooperation may eventually result in one-stop service for business, and therefore should be to the liking of business people. I am sure our managements would say a hearty AMEN to that.

It is time for me to say AMEN, too. We have work to do.

Winston Churchill once expressed this thought in his own unique way. At age 79, he was crossing the Atlantic on the Queen Mary, and he wondered — out loud to his scientific adviser — if he had drunk enough liquor in his lifetime to fill the ship's main salon. The adviser calculated for several hours, returned to Churchill, and said, "If all the wine, brandy and whiskey you have drunk in your lifetime were poured into this salon, it would come right up to eye-level."

Churchill gazed at the ceiling and replied, "So much left to do and so little time to do it!"

[Laughter]

Thank you. [Applause]

Now I would like to call on Past President Schroeder, who will present the Life Membership Award to Mr. Tennyson.

MR. SCHROEDER: Thank you, Eldon. I consider it an honor and pleasure to present the Association's Life Membership to Mr. Tom Tennyson. Tommy said that if you wait long enough, and go through all the chairs, you will finally become President of the Association. I have been around here for quite a few years, and I never saw the time Tommy was waiting. He was working, and he worked hard with the committees through the Vice Presidential chairs, and he certainly has worked hard as our most recent President. He has done a great job for us.

Tommy, we have seen a lot of improvements in the work of this Association that came forth under your leadership. Not only is it appropriate to thank you for the leadership you have provided the

Retiring LMOA President Tom Tennyson (second from left) is shown accepting the General desk set from LMOA Chairman of the Board John Schroeder. A life membership is conferred with the award. Adding to the ceremony are LMOA Vice Presidents Nelson Buskey and Bob Clevenger.

Association in the past year, but also in the years before that.

Also, I extend to you officially from the LMOA our best wishes to you and your family for a very happy, prosperous and successful time in retirement, as you announced to us yesterday. God bless you, and may you enjoy it. [Applause]

Now, emblematic of your Life Membership, here is your desk set. Look at it and enjoy it, and think back to all the happy years and hard work you have had.

[The audience arose and applauded.]

MR. TENNYSON: Thank you, John; and thank you, gentlemen. I'm darned near speechless. Thank you so much for the opportunity to serve you.

PRESIDENT DENT: I would like to call upon Past President Ky Pruchnicki, who will present the Past President's pin to Mr. Tennyson.

MR. PRUCHNICKI: Having known Tommy since the day he started with LMOA at the bottom of the totem pole, and working himself up through the Presidency, this is a pleasure for me. Now he is retiring, so he won't be able to be Chairman of the Board.

Tommy has done a splendid job. He has burned a lot of midnight oil to see that everything went right. Joe Koerner told you yesterday that Tommy was a good man to work with. He had no problem with Tommy. If there is anyone who can't work with Tommy there's got to be something wrong with him, not with Tommy.

Past President Ky Pruchnicki places past president's pin on coat lapel of Tom Tennyson, as Chairman of the Board John Schroeder beams his approval.

Tommy, may I present to you this pin, and also tell you that next year you will get the diamond that goes with it. Thanks for the hard work you have done. You have earned this. You have done a marvelous job for the LMOA. Keep on working for us.

[Applause]

PRESIDENT DENT: In addition to all of these compliments, so well earned by Tommy, I would like to ask Ky Pruchnicki to present the bound volumes to Past Presidents Schroeder and Tennyson.

MR. PRUCHNICKI: Tommy, during your retirement days I want you to look at this book every once in a while so you won't forget us.

John, please do the same thing. You are going to be around a long time.

PRESIDENT DENT: Now I would like to call on Mr. Pruchnicki to present an Honorary Membership to Mr. Taggart. Jim, will you come forward?

MR. PRUCHNICKI: This is going to be a big loss to the LMOA. Jim Taggart, Third Vice President of the Association, is leaving us. He is going to work as a consultant for the Transport of Canada. His going will be a big loss to us, but I am sure he is going to continue to pull for us, and maybe when he gets through with his consulting work he will come back to the LMOA.

We want to present Jim with a Life Membership for the good work he has done, and for working himself up to Third Vice President. Jim, we hope you will come back. Remember us, will you?

[Applause]

Past Presidents Tom Tennyson and John Schroeder receive bound copies of LMOA Annual Publication covering their tenure as president. Making the award is fellow Past President Ky Pruchnicki. Looking on in approval is Vice President Bob Clevenger.

PRESIDENT DENT: We will certainly miss Jim, and will look forward to his coming back and being with us and helping us again.

Now I will call on Fourth Vice President Bob Clevenger to come forward. Also, will the Committee on Diesel Electrical Maintenance please come to the front table.

MR. CLEVENGER: While the Committee is coming up, I would like to make a brief announcement.

Yesterday I told you our total membership as of Sunday night was 1,794, and that we were short 265 of the number we had last year. Joe told me a little while ago that we now have 1,912 members, but we are still 117 short. Over the past three or four years our membership has gradually declined each year, so we ask each and every one of you to go back to your individual railroad and put a bug in somebody's ear about the LMOA and see if we can stop this gradual decline in membership.

This afternoon we are going to hear the report of the Committee on Diesel Electrical Maintenance. It always seems to be one of the high spots on the LMOA agenda. In the past couple of years we have had a gentleman work with the Committee by the name of Don Morrison, who in all the publications you received this year was listed as the chairman of this Committee. For some reason or other, which was Don's choosing, he has dropped out of this Committee as chairman, but we want to publicly express our thanks to Don for the fine work he has done with the Committee.

Jim Taggart, on retiring from the Canadian National Railways and the LMOA as 4th Vice President, accepts General desk set and best wishes of the LMOA official family. Making the life membership award is Past President Ky Pruchnicki. Newly elected President Eldon Dent and 1st Vice President Tom Harley join in the presentation.

TUESDAY AFTERNOON SESSION
September 20, 1977

REPORT OF THE COMMITTEE ON DIESEL ELECTRICAL MAINTENANCE

W. E. KELLEY, Chairman
Committee on
Diesel Electrical Maintenance
Mgr.-Electrical Engrg.-Equip.
Consolidated Rail Corp.
Philadelphia, Pa. 19104

R. G. CLEVENGER
4th VICE PRESIDENT
General Electrical Foreman
Atchison. Topeka & Santa Fe Ry.
Kansas City, KS 66106

Bill Kelley, of Conrail, has been Vice Chairman of this Committee for some years, and he is going to pinch-hit today for Don Morrison. So, at this time I would like to present Bill Kelley, Manager of Electrical Engineering-Equipment, Consolidated Rail Corporation, Philadelphia, who will present the paper today in place of Don Morrison.

MR. W. E. KELLEY [Manager Electrical Engineering-Equipment, Consolidated Rail Corporation, Philadelphia, Pennsylvania]: Gentlemen, it is a pleasure to be here to present the annual report of the Diesel Electrical Maintenance Committee of the LMOA. I hope we will come up to our usual fine standards. We regret that Mr. Don Morrison, who guided the Committee through a fine preconvention presentation in St. Louis, could not be with us today. We have a very able Committee and I would like to introduce them to you at this time.

[Mr. Kelley introduced the members of the Committee.]

MR. KELLEY: We would like to thank the officers and members of the St. Louis Railway Club for hosting our preconvention paper and giving us some material to knock the rough edges off of it.

[Mr. Chambers presented Part I of the report, Mr. J. R. Anderson presented Part II, Mr. Carl Palme presented Part III, and Mr. G. W. Whittaker presented Part IV.]

MR. KELLEY: This concludes our formal presentation at this time, and now we will get into any questions or discussion you might have.

MR. WESTERFIELD: There are several companies that have been advertising extensively in many magazines lately, inspection equipment for all sorts of industrial equipment which is non-contact. infrared radiation. I am thinking now in terms of loose contacts causing electrical fires. There are several systems available to examine the switch gear under load from a safe distance, and if there are any loose contacts they stand out like a sore thumb. I have seen a demonstration of this equipment. I wonder if any railroads have made use of this yet for switch gear or high voltage cabling inspection.

MR. KELLEY: To my knowledge there have not been any railroads that have used this, but we will poll them here. I have seen a demonstration of this equipment by both Westinghouse and General Electric. It is a very expensive piece of equipment and is not too portable. Getting it into switch gear or under a locomotive to see traction motor leads and terminals that are overheated would be a good thing, but the matter of getting the equipment there at the right time might be a big problem. I would like to ask if anyone on the panel representing a railroad has tried anything like this.

MR. HARRY QUINN [Electro-Motive, LaGrange, Illinois]: We have tried to use them in the laboratory. We tried to get infrared detection equipment to look at the control circuits as well as the power circuits. They are very sensitive to the angle at which you look at the piece. Looking over our own high voltage cabinet, you would have a hell of a time getting in there and really getting the proper angle. If you are truly energetic, your touch system is probably as good as any.

MR. T. PAUL SULLIVAN [General Electric Company, Schenectady, New York]: I would like to put in a little plug. GE Service Shops have a thermo-vision service that will offer a portable inspection. It is primarily aimed at detecting hot spots in switch gear and that sort of thing in switch yards. There may be applications that may be worth looking at as a study. The service shops can offer this kind of service. It has been used extensively in switch gear and in power distribution applications.

MR. KELLEY: Do you think it is portable enough to carry onboard a locomotive at the time the part

would come in from a trip overheated, and be able to detect that condition?

MR. SULLIVAN: Yes. Certainly it could be used for detecting hot spots in electric type locomotives, and I think there are some models that can be used where it is like taking a picture with a camera. It can be used at fairly close distances.

MR. KELLEY: Thank you very much.

MR. JAMES: We have not used this type of heat detection equipment on our electrical equipment, but for several years we have been using portable infrared and optical equipment to measure main bearing temperatures, exhaust base leg temperatures, and other aspects of the mechanical components on the locomotive, and have done so very successfully.

MR. KELLEY: Onboard the locomotive?

MR. JAMES: Yes.

MR. BURCHETT: Bill, I have three questions that bother me. The first question refers to your Committee's recommendation about the AC auxiliary generator combined with the low idle. Has anyone experienced any problem with these two devices dropping out the charging relay, losing the locomotive? It is disastrous if you have cold weather.

MR. L. D. EDSON [Supervisor, Electrical Design and Maintenance, Union Pacific Railroad Company, Omaha, Nebraska]: We haven't had the low idle system long enough to really evaluate that.

MR. C. E. PALME [Diesel Electrical Engineer, Chessie System, Huntington, West Virginia]: I know exactly what you are talking about. In the early stages of the AC Aux. Gen. we ran into some of these situations. Low idle with cab heaters on full: quite often you are not charging. You can't supply the power. I believe we were tripping the 5 amp. breaker in the field circuit. You gave us an intermediate 10 amp. You went to 10 and back to 6. No arguments about it. That was an interim fix.

We experienced the problem of permeability in the makeup of the generator itself. EMD has a specific test where you use a 6-volt battery and 308 rpm, and you must get 74 volts output. We had to change one recently and one early. We have experienced what you are talking about.

MR. BURCHETT: We in the maintenance field would like very much to have this resolved before we get a lot of them in the field.

MR. KELLEY: Along that line, in about two weeks or so we are going to investigate the problem ourselves by putting on a recording ammeter in the auxiliary generator circuit and running some locomotives with various types of auxiliary generators and with electric cab heat. They are going to be on an over-the-road operation so we can have as many functions operating as possible, including headlights, control circuits and battery charging. We hope to get a true evaluation of what the load actually is with the electric heat on.

MR. BURCHETT: I feel the Honorable Harley Quinn will go home and do his homework and be ready for the What's Your Problem session here tomorrow.

My next question refers to your recommendation to go to an 18 KW generator when you apply electric cab heaters. I believe there is at least one railroad represented here that has made some electric cab heater applications with a 10 KW auxiliary generator, with good success as far as I know. Am I correct that that railroad is represented here?

MR. KELLEY: Does anyone on the panel know?

MR. WALKER: We have 18 KW DC auxiliary generators with electric cab heat and they have been very succesful. We have had them on for about three or four years.

MR. KELLEY: Are you talking about the 18 KW DC type?

MR. BURCHETT: Yes.

MR. KELLEY: On Conrail we have a number of them. I thought your question was about 10 KW. Are you talking about 18 KW?

MR. BURCHETT: I referred to 10 KW.

MR. KELLEY: At the present time we do not have any installed with a 10 KW generator. We are presently going to put electric heat on with the 10 KW auxiliary generator and see what does take place, and we are going to measure the currents at the same time.

MR. WALKER: I misunderstood the question. I thought you were talking about 18 KW. Harry Quinn might offer some comment from the builder as to the capacity of the 10 KW auxiliary generator.

Harry, is it not true, according to the builder, that the 10 KW would be too small in capacity for electric heat and to carry the normal load for at least some railroads?

[Discussion off the record.]

MR. BURCHETT: Harry, I appreciate your rising to the challenge. I will refer back to the air conditioner. At one time we had to put an 18 KW air conditioner on a locomotive. Now, if you try to buy a DC air conditioner from EMD, I think you will find it will be an air conditioner run off the alternator. That is the challenge, Harry.

MR. QUINN: What do you want run off the D14 now?

MR. BURCHETT: Run the cab heater off of it.

MR. QUINN: We will have a separate discussion on that.

[Laughter]

MR. BURCHETT: I have a third question. Some time back, probably as far back as when Eldon Dent and Bob Clevenger were both young men, we had a device on a locomotive that we referred to as an RHR. Eldon and Bob will remember it. Not many of you youngsters will. It was a rubber hose relay. When the engineer did something wrong it would beat him on the head.

One of the devastating, unscheduled preventive maintenance items you can see is to crawl under a locomotive and see all six or four traction motors blasted out from under the unit. The rubber hose relay would prevent this if the engineer was going to brake, and reached down and got hold of the reverser, and reversed the locomotive.

Then we thought we could prevent it by going to an AAR control stand. We did that, and left the RHR off the locomotive, but still it didn't help us.

One item you didn't mention in your modifications, that is apparently a very good modification, is the delay in reversal of locomotives. If you have ever gone under a group of locomotives and seen three units with the motors blasted clear out from under them, and two units that didn't have them, and you wondered what had happened, you can figure that the RHR was delayed and the engineer reversed it, and thought about what had happened, and went back to forward. The two units that didn't have the motors blasted out from under them were protected by the delay in reversal.

MR. KELLEY: That is a very good idea, Fred. Thank you.

MR. JAMES: One comment relating to electric cab heat. I walked in here an hour or so ago, not recognizing that we on the Chessie were having problems with the 18 KW AC brushless auxiliary generator that is used in conjunction with electric cab heat.

I would like Carl Palme to expand briefly on the problems we have had. To my knowledge, we had two or three instances that Carl referred to a moment ago. Most of those in the audience know where Chessie operates geographically, and we have many units with this system onboard and have not experienced any problems whatever with battery charging.

Carl, if you will, please.

MR. PALME: I agree with you basically. We did the pilot study, I believe, for EMD on the first AC auxiliary generators, and I guess they came out every six months or so. We inspected basically the battery condition. We looked over the engine for souping in the exhaust system, and such as that, and really could come up with no basic problems.

I believe it was the first group of production ones that came out on our railroad, and I will say they came out with a 5 amp field fuse in them. I don't really remember the time of the year, but we found initially that coming into cold weather, when we turned on the electric cab heat full, we started tripping the field breaker at 5 amps. So, basically, we talked to EMD. If I remember rightly, you wanted to use no greater than a 6 amp breaker in that circuit, for particular reasons of the design of the machine. They were not available.

They allowed us to go to a 10 amp. We put them on and that solved the basic problem. Then we retrofitted back to the 6 amp breaker, and that area hasn't given us any problems. We have had one or two low idle units, and if

I remember correctly in both cases we found the low idle rpm was too low, if I may put it that way. It should be 255 rpm. We were down around 240 or so.

On our locomotives we have a feed off of an NVR interlock. If we drop the NVR, indicating no charge out of the auxiliary generator into the D14, we drop the interlock and that puts us back into basic idle. It cycles the engine from low idle to basic idle, and the engine will change speeds in what people call hunting. It is really a loss of charge under full cab heat. We have found the low idle had drifted below the setting we wanted.

We just had a recent case, and apparently we have just lost an AC auxiliary generator. As far as I know, that one and another very early are the only two we have lost on our railroad so far.

MR. QUINN: I think, Carl, what Fred is talking about is when you go to low idle with the AC machine your balanced voltage is somewhere around 44 or 66 or even 70 volts. Up until last winter the battery people have always hollered that we overcharged the batteries. Last winter, it was my understanding from dealing with the battery people, they told you fellows you didn't put enough charge on the batteries.

What you are saying is right. During the investigation of the AC aux. gen. and low idle, the evaluation showed no deterioration on the batteries using that combination. But I am sure what my good friend Mr. Burchett is referring to is that it does look wrong, because you are charging the batteries at idle at a very low rate, or you are not charging at all.

We did design into the AC aux. gen. voltage regulator with a rising characteristic. We decided to use it to advantage, and in the high throttle position we do get a higher charge rate. You will notice there is a curve on the voltage regulator that tells you to set it in the 8th throttle position.

What we were trying to do when we developed that system was that the idle, which our investigation shows for most railroads the locomotive spends 50% of its time in an idling condition, it would then be at an idle level of 70 volts. The battery people told us we ought to be at that level, but after last year the problem was that batteries weren't up to charge, and that is why you froze all your batteries. Fred, is that what you are talking about?

MR. KELLEY: You are right, Harry. Even with 8th throttle notch the batteries aren't being charged properly. Manufacturers of all kinds of batteries recommend 2.31 volts per cell, which means 74 volts. You need 74 volts at the battery to get 2.31.

The regulators are set at 74 volts, but you won't get 74 volts at the battery. You will get something like 72.5 or 73, maybe as low as 72. I think many units through the dropping resistor and the diodes will have at least a 2

volt drop. I think a lot of winter problems with batteries can be alleviated by raising the voltage setting. We are planning to do just that.

MR. QUINN: The S. P. men were told to charge their batteries at 72 volts at the battery. The battery people are changing their opinion as to what they have asked us to do in the past.

MR. KELLEY: I don't think that is a good recommendation. It won't save the batteries. If a battery isn't properly charged it deteriorates sometimes at a very rapid rate, just as a battery that is overcharged might deteriorate. You get sulfation if a battery is left in a discharged state over a long period of time.

MR. QUINN: Now we need a winter/summer setting.

MR. KELLEY: I believe that is true.

MR. WESTERFIELD: One last shot at this question. I think it is folly to compare the voltage regulator settings on the Burlington Northern and Southern Pacific and say that both of these railroads in January should have their voltage regulators set at the same voltage, because the charging voltage for that battery is going to depend on the cell temperature, and the cell temperature in Montana is going to be a lot different from the cell temperature in Southern California in January.

This is a case where each railroad will have to look at its own operating conditions, talk to their battery people, and set their own policy. I don't think we can use one setting across the country, given the conditions under which we are operating.

MR. KELLEY: That is very true. They do recommend a certain charging rate, and different railroads are going to have different problems.

MR. WESTERFIELD: I would like to bring up another topic. I am not particularly fond of fuses, for many reasons. The information your Committee has presented concerning the reliability of circuit breakers would bring up the overall question about whether we really want circuit breakers on our locomotives, given the information you have presented concerning their probable lifetime in anything other than circuits which have to be operated extremely often. I am thinking of the generator field circuit where it is used as a switch.

MR. KELLEY: I think it does present a problem as to whether circuit breakers might be the way to go, or not. I think all railroads should go back and take a look at the situation and see what it is on their own particular railroad.

MR. QUINN: I have an answer to that. I really don't know what the statistics were that went into the Committee's report, but I wouldn't dispute them. Circuit breakers in the past have been subject to dirt. As the locomotive gets older the breakers get dirtier and just simply malfunction. I don't think a circuit breaker on a locomotive is quite like one in the house, and yet the same thing exists.

You should check your circuit breakers in your house once a year, just like on a locomotive. Recognizing this problem in the past since our own Dash 2's, we have tried to go to sealed circuit breakers that really try to keep the dirt out. It is my feeling that these have a much better performance than the older breakers you are looking at.

We haven't done anything about asking what your experience has been, but this is what we have been able to develop in the laboratory, and if anybody can confirm it we would like to hear from them. We believe it has been a dirt problem, but the circuit breaker is better than fuses because the breakers have been requested by a good many of you people. My good friends from the U. P. probably are the biggest promoters of all circuit breakers.

The problem in the fuse is with the vibration in the locomotive tending to give up the ghost just from mechanical fatigue. I believe that is why there is so much emphasis from the railroads to go to circuit breakers, because it is just due to fatigue, not overload. We have tried to fix the circuit breaker problem by making them more dust-tight.

MR. KELLEY: When it fails, it fails in a much better mode than the circuit breaker.

MR. LEEDY: I would like some more information on circuit breakers. Are these confined to a certain model of locomotive, or a certain age group, or a certain ampere rating?

MR. R. P. CHAMBERS [Supervisor Locomotive Maintenance-System, National Railroad Passenger Corporation, Brandon, Florida]: Those tests were conducted on a variety of locomotives, GP7 up through GP40, and of course we are talking about circuit breakers. We removed some new breakers from the storeroom and most of them failed the test. You get into a problem when you fail to question the integrity of all breakers on a scheduled basis.

MR. LEEDY: So far you have just mentioned EMD units. How about GE?

MR. CHAMBERS: GE was in the category also. We took four different types of breakers. I don't have the specifics, but I can get them for you. I can get for you the test values and the manufacturer's design specifications used during the tests.

MR. LEEDY: I understand from the report that we had a $100,000 fire in a cabinet that could have been caused by a faulty circuit breaker. It is pretty disturbing to think this can happen.

MR. CHAMBERS: We had one this week on a turbo, and the cause was a faulty circuit breaker.

MR. LEEDY: I would like to follow up on this matter of low idling and this AC auxiliary generator. This is my personal opinion. No. 1, I don't believe in low idling. Many of you remember that during the severe winter last year we had to keep our engines in the 3rd to 5th notch because of the weather. Quite a bit has been said here this afternoon about the battery people, and if you are operating in the northern part of the country you set your regulators at one setting, and if you operate in the Southwest you set them at something else.

The ICG is a north-and-south railroad. We leave Chicago and tomorrow morning we wind up in the swamps. Will somebody explain to me how we should set those voltage regulators from Chicago to New Orleans? I think we are being a little ambiguous here about these AC machines and these voltage regulators.

MR. KELLEY: I think it was pointed out that you have to temper settings on any particular railroad according to that railroad's operation. When a railroad does operate in a two-temperature range they have to pick out the mean setting that is best for them.

I don't think we have any two-level temperature sensor type of regulators developed for the battery charging circuits as yet. That would be the ideal, but I don't think we have them. I think the best thing to do is to investigate your own railroad's needs, and go with the mean setting that will give you a charging rate that is what the battery manufacturers recommend.

MR. HENRY LIBAN [Electrical Engineer-Locomotive, Consolidated Rail Corporation, Philadelphia, Pennsylvania]: I would like to comment on one aspect of the electrical fires overlooked in your report, that is, fires caused by locomotive overload. Frequently the locomotives are overloaded in low-speed drag service. The abuse of a locomotive that is operated beyond its continuous rating will cause fires. I think we could enlist the transportation people to help us out on that.

MR. FRANK D. BRUNER [Assistant Chief Mechanical Officer-Union Pacific Railroad, Omaha, Nebraska]: Gentlemen, I have listened to the pros and cons of low idle, and before considering it is impossible, take another look at the fuel savings to be gained.

No matter what your personal opinion, a saving of 10% or 11%, as claimed in some tests, must be the prime issue, and with 50% of the locomotive's time spent idling there is a tremendous potential for saving fuel. So, before you give up, take a second look.

MR. KELLEY: Thank you, Frank. Your point is well taken. A particular railroad can have many situations where fuel savings can be an advantage. On the other hand, just to put it on across the board may not be an advantage.

VOICE: Speaking of circuit breakers, I know in the past I have seen many fires and many apparatus failures related to a circuit breaker that did not kick. The circuit breaker had been used On and Off. When the locomotive was shut down the breaker was put in the Off position.

I looked into that a little bit. and I asked a gentleman with a locomotive manufacturing background whether putting a circuit breaker On and Off month after month would affect its capabilities, and he said it would. He said you have to test that device. I came from the Erie Lackawanna originally, and I don't know that they ever tested a circuit breaker on an active locomotive. The more the circuit breaker is used, would this weaken its potential to do what it is designed to do?

MR. KELLEY: Circuit breakers in railway substations for electrification are designed for so many operations, and then they are torn apart and are reworked. They are definitely designed, and they have a number of operations, and they are not safe after that number of operations. So, I would assume this would apply to the type of circuit breakers we use on locomotives. However, with those types of circuit breakers I would expect they would have many more operations than a substation circuit breaker. I would think they do have that limitation.

Harry, you said you tested circuit breakers in your lab. Did you do anything along that line, as to the number of operations?

MR. QUINN: Yes. We don't use them.

MR. KELLEY: You don't know of any test that was conducted to see how many operations they might make before they fail?

MR. QUINN: I can't give you the figures, but their life in just an operating mode is much lower.

MR. JAMES: If I heard the gentleman from Amtrak correctly, he said the fellow advised him that the integrity of the breaker was a function of how many times they are turned on and off manually. Generally speaking, it depends on the specific of the breakers, both magnetic or thermal actuated systems. The automatic unlatching mechanism within the breaker upon receipt of current fault is not involved with manual turning off and on, so I don't see any relevance between the two in that case.

MR. CHAMBERS: In reference to what you said, Bill, looking at the calibration of these devices, it appears that an overload breaker tends to lose calibration much quicker than a breaker that is used as a switch. In other words, you can switch it on and off very often and maybe not destroy its calibration, but when you allow the breaker to trip repeatedly on overload you get into an entirely different situation. So, most breakers are short-lived when you overload them constantly.

MR. BRUNER: Someone brought up the matter of low idle and the danger of freeze-up in the wintertime. As a suggestion, I might recommend the use of a non-adjustable type switch to detect temperatures, installed in the circuit to nullify low idle if the temperature dropped below some predetermined value.

MR. KELLEY: What has been your experience on the reliability of those fixed temperature sensors?

MR. BRUNER: Reliability has been very good over nearly ten years' service experience. About a year ago we had a minor problem with engine water treatment attacking the cadmium coating which was field corrected on approximately 400 switches by application of a copper and tin overlay. The manufacturer has now changed to a stainless steel jacket to further improve the switches.

As far as the temperature stability is concerned, we have had no trouble, and no switches have been removed for this reason.

MR. LEEDY: We have been putting these on our ICG remanufactured locomotives as standard for some time. To my knowledge we have had no failures.

MR. KELLEY: I believe we have had at least one. Henry, you are close to that. Have you any record of it?

MR. LIBAN: About three weeks ago we had one failure in a hot engine, and we also had some damage.

MR. BRUNER: Granted, you will have one once in a while, but one is not very great compared to the other switches, gentlemen. I might point that out to you.

MR. LEEDY: I would like to go back to the AC auxiliary generator. Correct me if I am wrong. Did I understand you to say in the report that you anticipate more auxiliary devices will be operated off this machine?

MR. KELLEY: Yes. I don't think that was too clear. I have an idea what some of them are. John, I think you mentioned that. Do you want to elaborate on some of the devices?

MR. ANDERSON: I am not aware of any. The only one I can think of is an air conditioning unit that I am afraid is going to come up.

MR. KELLEY: Talking about safety devices, I think there is a push to have strobe lights put on locomotives as a warning at grade crossings. They do now require a sparate AC system which comes off the 74 volt DC system. Possibly they could operate off an AC auxiliary generator directly.

MR. LEEDY: What is the nominal AC voltage off that machine?

MR. QUINN: The reason you can run the air conditioner off the D14 today is because you run at constant volts per Hertz. If you remember, the AC aux. gen. must hold the 74 volts DC constant, so you are holding a constant 55 volts AC while the Hertz are changing. Watch out. You will have to have a very special and big motor because you are not running constant volts per Hertz. Don't look at what you can do with the D14 as working with the AC aux. gen. unless you take into account that the volts are staying constant but the Hertz are changing.

MR. LEEDY: Bill, what is the nominal voltage of the 18 KW?

MR. KELLEY: I have no idea.

MR. PALME: 55 volts AC normal. It is a 3-phase machine.

MR. LEEDY: In the last part of your paper, regarding the electric locomotive versus diesel locomotives, have you any cost figures on the fuel or energy difference between the two operations, where two SD45s take 4 hours and one electric would take 3 hours 50 minutes?

MR. KELLEY: No, I don't have any figures like that. We could develop theoretical figures. I don't have those figures with me, but under an ideal condition where you make a run from one end to the other, we could develop that.

MR. LEEDY: Fuel is about 35 cents a gallon. How much is 1 kilowatt?

MR. KELLEY: It depends on where you are buying your electricity. The electricity you buy right now is generated, unfortunately, in large part by generating stations which use fuel oil, and they are paying high prices for fuel oil, and they pass that high price on to us.

We not only have energy and demand charges, but for our electrification it is now over $1 million just to buy special fuel for the generation of electricity by power companies. So, when you figure you generate from fuel and then you have your losses of transmission and through the catenary, the advantage of an electric locomotive with fuel generated by oil is not good at all.

MR. HARLEY: I would like to comment about the cost of energy, electric operation versus diesel operation.

It is generally true, in this country, that the cost of energy for electric locomotive operation will be greater than the cost of energy for diesel electric operation. We did see one very short period of time immediately following the Arab oil embargo when diesel fuel sykrocketed in price and electric energy did not follow that same trend line because, as you are all aware, electric energy cost increases require the permission of state utility commissions before the rates are raised. So, for a period of about 22 or 25 months following initiation of the Arab oil embargo we did see an unusual situation, where electric energy for traction purposes tended to be somewhat lower in price than diesel-electric energy.

Given about two years of public utility commission action on electric rates, electric rates have now assumed their historic position, where energy costs are higher than for diesel-electric operation.

But there are a couple of other factors you must look into when you are looking at electric operation. One of them, of course, is the question of whether diesel fuel will even be available, which may force you into unusual fuels in diesel-electric locomotives or to electrified operation.

The other factor which is involved when you look at electric locomotives is the factor of maintenance costs. It is probably the biggest single factor in favor of electrified operation. Horsepower for horsepower, the electric locomotive costs less to maintain — about 3 to 1 compared with the diesel-electric locomotive. Even if you compare a 3000 HP diesel-electrci and a 6000 electric unit you will still see differences in the cost of maintenance, and the electric locomotive will still be cheaper. I think this is generally true around the world. The electric locomotive sells itself on the basis of lower maintenance costs.

MR. WESTERFIELD: The graphs that you showed on the relationship between testing of the locomotives and road failures of the locomotives showed that defects in the locomotives are being generated on a continuous basis and at a rather high rate, because as soon as you reduce your testing the failure rate goes up immediately and sharply.

Would anyone care to comment on what the sources of these bugs are that are continually creeping into the locomotive? Has anyone done any component reliability studies to attempt to pinpoint the parts that are associated with this high rate of generation of trouble?

MR. C. W. DRAKE [Assistant Manager, Quality Control, Southern Pacific Transportation Company, Sacramento, California]: In reference to the items that are being continually regenerated, in almost every instance there is human error. Miswired components and that type of thing.

MR. KELLEY: I would like to sneak in a question myself. On our GM10 locomotive we have different configurations of the trucks, and we have a 3-truck arrangement, three 2-axle trucks with one truck swinging back and forth in the center of the locomotive. I know Harry Quinn has been looking at this quite a bit. I would like to know what your opinion of that truck operation is on the GM10 locomotive, Harry.

MR. QUINN: Do you mean whether we think it is good or not?

MR. KELLEY: Yes.

MR. QUINN: Well, we have seen no adverse effect either on rail or on the truck itself. Obviously, the reason for going that way was because of those big motors. If we were able to go to a 3-axle truck it would be very long; and the 3-axle truck, although we didn't know it at the time, is not the most favorable truck today.

We thought if we were going to sell the American railroads, especially our friendly western railroads, on a 3-truck configuration, we had better show them that it does work. But as I said, we have seen no adverse effects. As you well know, the locomotive is restricted to a 23 degree curve. The center truck can move only so far back and forth. It moves 9¼ inches either side of center, and that is all. We were almost like people who build a boat in their basement and then can't get it out. We had to negotiate a 24 or 25 degree curve right as we brought it out of the building. Each lead axle tried to come off the rail and we had to take the lateral stops off completely.

Other than its limitation on curvature, I don't think there has been any comment adversely to having that center truck move back

and forth. It adds some complication, obviously. That is one heck of a swinging pendulum, with the spring plank, and so on. We have had one broken spring but it was on the end truck, not the center truck.

MR. KELLEY: Talking to our maintenance people, they didn't indicate they had any particular problem with it, but I was interested in hearing if you had any particular comments. Thank you very much, Harry.

MR. QUINN: We tried to design those trucks so they were interchangeable and we would have to have only one spare, and within reason they are interchangeable. As I said, we have seen no mechanical problem with the truck.

MR. C. R. LOUGH [Manager Locomotive Maintenance Planning, Chicago and North Western Transportation Company, Chicago, Illinois]: Concerning your Failure charge on the SEARCH-tested units, are these electrical failures or total failures?

MR. G. W. WHITTAKER [Superintendent Locomotives- Electrical, Illinois Central Gulf Railroad Company, Chicago, Illinois]: In answer to your question, Charlie, the failures that were shown on the three graphs were failures on systems that are SEARCH evaluated. In other words, we knocked out things like MU cables, traction motors, and things like that which SEARCH really does not have an impact on.

MR. LOUGH: In other words, 50% of your failures were mechanical, and these weren't considered, and we just went into the 30% that are tested?

MR. WHITTAKER: Right.

MR. LOUGH: I have a second question along the same line. When we SEARCH test a locomotive we normally do it with a well-qualified supervisor as well as a well-qualified machinist and electrician who also makes visual inspections along with the SEARCH testing.
How much of this reduction would you equate to the manpower you have available, and how much to the machine? I know that is a big question.

MR. WHITTAKER: We have just gotten this thing off the ground, so we really don't have any dollar figures as to what it will save.

MR. LOUGH: I wonder whether we wouldn't also show pretty drastice improvement if we just put the engine across a loadbox on a 3- or 6-month basis, the same as we are doing with SEARCH, with a well-qualified supervisor and mechanical force.

MR. WHITTAKER: This is something we debated when we got into this type of SEARCH program, Charlie. What we have found is this:

The SEARCH test of course has a load test written into it, but it is only an abbreviated load test. This is all done before the locomotive goes through the inspection line or into the shop. If it turns out to be annual or biennial, or if it is repowered, or whatever company policy dictates, it goes out to

the loadbox and goes through a full load test. The SEARCH is there to iron out any bugs before we get it into the shop. It doesn't replace any ordinary load test.

MR. HARLEY: Bill, one of the topics in your discussion was on "fuel-saver" type devices. There has been a considerable amount of interest in these devices at this meeting, not only the Touchstone device but also certain devices that have been built by railroads themselves.

I would like to ask your Committee if any of the savings that have been attributed to these devices have possibly been made through the train moving at a slower speed as a result of using these devices. I think you are all well aware that the amount of fuel you use is very sensitive to the speed at which you operate the train, and with devices that will isolate trailing units is there a possibility that the train might indeed operate at a slightly slower speed than it would have operated with all the units on the line, and thus achieve at least part of its savings due to lower train speeds?

MR. EDSON: If Mr. Bruner were here he could probably bring you up to date on this.

MR. PALME: I was personally involved in some preliminary testing that we did in this area, and we set some basic ground rules. I will justify one in that area.

We will use all the power available, all the locomotives available that we have in the consist, until we reach the authorized speed. Rather than then throttling off the entire consist, we would take off the line a locomotive whenever we deemed it necessary to maintain authorized speed without exceeding it. That is the method we use. In our computations, that is how we approach the problem, to eliminate the one possibility. Certainly if we went 5 mph slower I think you would find you would save some fuel stretching out over time.

MR. HARLEY: Say you have a 50 mph speed limit and you drop to 48 or 47. At which point do you actually plug another unit on the line? While the sawtooth pattern sounds very trivial, it could give you a fuel saving as a result of train speed and not from the use of the "fuel-saver" device. It doesn't seem to me that taking great blocks of power like 3000 HP on and off the line can maintain an exactly constant train speed.

MR. PALME: Absolutely not. If it makes speed at 60 mph we attempt to maintain 60 mph. If we took a unit off the line and this would reduce the speed too much, we would then put it back on the the line and reduce the power of the entire consist one notch. We drifted over-speed and under-speed, no argument about that. We tried to operate as nearly normally as you would on your cross-test runs which were run with normal throttle operation.

MR. QUINN: Bill, I think the best test being run right now (and even here there has been a lot of

confusion) is on the S.P., where they are actually measuring the amount of kilowatts used and the fuel burned, and trying to get a handle on it. We suspect the same thing, but you can't prove it. We have run trains over the computer until hell won't have it, and we can't come up with any kind of fuel savings like those being reported.

The only thing you can conceive of is what Mr. Harley was alluding to, that is, something hidden there, like the sawtooth pattern, acceleration rates when you have all the units on and when you don't. Three railroads have now measured cases where it actually hurts them. The computer does show that there are times when it can hurt you, and we can't come up with any figures anywhere near that. I think we really have to see what the Southern Pacific comes up with, and whether they will publish their data.

They did try to measure continuous kilowatts being used and fuel being burned. You can look at it at a kilowatt per pound of fuel and see whether they have an accurate figure or not. It is not an easy thing to measure. The savings that have been reported are fantastic, and it is difficult at least on simulations to come up with anything like that being reported.

Carl, did you actually come up with savings?

MR. PALME: Yes. These numbers I have here, of 9% and 16%, are fabulous. We did not approach even half of 9% on some of the runs. I can't remember the exact numbers, but I think we saw general savings of 4%. The best case I had I believe was 6.2%. Generally we are in that area. If you want a number you might say 5%, that is, if you select the particular runs. You have to select one where you think you can save fuel. This is a ruling grade that is very short, with a long run time at a relatively low top speed; and you can possibly save maybe 4% or 5% this way.

MR. KELLEY: Frank, Tom Harley asked if there was a correlation between the speed of the train and whether the train speed was reduced as a result of fuel saving devices or not. Do you have any feeling for that?

MR. BRUNER: Yes. The tests we are running daily are taking into account the actual running time versus schedules with and without the use of fuel saving systems.

A recent series of tests involved a unit coal train between the Dana, Wyoming coal mine and Kansas City, Missouri. These tests concluded that use of a fuel savings system could save approximately 10% on the east bound loaded run. due primarily to the major portion of the run east of Cheyenne, Wyoming is downhill, "water grade". The west bound empty movement developed only an approximately 3% savings mainly due to the continuous water grade uphill movement toward Cheyenne, Wyoming. Train schedules on these tests were maintained since there is plenty of time designed in the schedule. Where fuel savings systems were in use, very little time difference was found. Other test runs on manifest trains have developed savings over some areas as high as 23%, and of course some areas show little if any savings. When grade conditions require all the power to make schedule, there is no chance to take an engine off the line to save fuel.

The Union Pacific and other roads operating in mountain territory can benefit most since considerable horsepower must be used to make the grades, and this becomes excess horsepower when downhill and level territory is reached. Trains which are normally dispatched with higher horsepower per trailing ton to make faster schedules can on many occasions take advantage of fuel savings systems. So-called "drag trains" and one or two unit locals have near zero potential. However, where units move in and out of this service to other class service, it may be worth equipping them for other service.

Accurate fuel tests are difficult to run, in that more than routine care must be given to all parameters of the test. Meter accuracy should be cross-checked and paralleled wherever possible, and operating variation should be held to a minimum. Fortunately, the Union Pacific test crew has had years of experience in this area.

New digital fuel and horsepower meters feed directly into our new HP 2100MX computer on board the test car. Data gathered is quickly and accurately analyzed, and the information extracted is presented to management for further action or as background for future planning. In some cases recommendations are made which might change or alter operating procedures to improve efficiency.

Each test run on the Union Pacific also includes coordinated effort on the part of the operating department. The engineer and the head-end crew are given a tour through the test car and shown what information is being taken. He is given an outline of the objectives of the test and asked to perform engine reductions he feels possible when favorable operating conditions prevail. This has worked out quite successfully, and he is later assessed as to the success of his effort. A commitment to save fuel must start with the engineer. and this is one approach which appears to have been favorably accepted by most crews.

There is a possibility that some of this information can be made available for presentation at next year's meeting. Tests will continue to be run to determine where there is possible saving to be made in fuel and reduced operating expenses.

MR. KELLEY: Thank you very much, Frank.

At this time I might quote Tom Tennyson and say there is so much to be done in some of the rooms upstairs, and so little time to do it.

I will call on Bill James to summarize the report.

W. R. JAMES
REGIONAL EXECUTIVE
Gen. Manager Locomotive
Maintenance-Engineering
Chessie System
Huntington, WV 25718

MR. JAMES: In summarizing this report I would like to highlight the following areas:

Subtopic #1: Fires originating with electrical equipment. To maintenance officers, a reassessment of your maintenance policies and on-the-job evaluation of day-to-day compliance with the stated policies is absolutely a must.

To locomotive manufacturers and remanufacturers, which includes certainly the railroad shops during heavy class repairs: I respectfully request that you have your engineering and maintenance staff officers re-evaluate the location and routing of wiring, conduit and wiring distribution systems, as much remains to be accomplished in these areas if we are to indeed achieve a significant improvement in locomotive reliability, maintainability and resulting cost reduction.

The General Electric Company has recognized this problem area and has redesigned their locker layouts and locations that should minimize secondary damage when and if high current and/or high voltage faults develop in associated systems. Compliance with the AAR recommendations covering these subjects will go a long way toward minimizing fault problems, as indicated.

Subtopic #2: Rebuilding Locomotives. We as maintenance officers must recognize and take advantage of previous proven improvements brought about by technology. Specifically, the introduction of the 18 KW brushless AC auxiliary generator accords the industry a means by which maintenance system requirements are lessened, and does require the power supply for conversion to cab heat systems electrically, which have proven to be both adequate and reliable.

Subtopic #3: Profit Oriented Modifications. With our federal government so deeply involved with the development of national energy policies, we would be remiss in the discharge of our duties if we failed to recognize and act upon proven fuel saving opportunities such as the inherent efficiencies of the 4-cycle diesel engine, EMD's reduced idle speed modification, adoption of practical shutdown policies, and good management of over-the-road train operations.

Further down the road, I am certain that once again technology will provide completely new systems for on-board management of fuel, air and timing functions that will optimize an efficient use of fuel-consuming combustion engines, through functional sensing of those processes and characteristics as we learn how to measure and integrate these functions through the extended use of microprocesses and minicomputers that have already demonstrated this capability in the automotive industry.

With that I will turn the meeting back to Bob Clevenger.

MR. CLEVENGER: I think you will all agree that today's discussion has been excellent, and that we have had splendid discussion from the floor.

I will now call on President Dent for a few final remarks.

PRESIDENT DENT: I would like to ask that all of you who have written questions for the What's Your Problem session in the morning should turn them over to the nearest LMOA officer. Please remember we will reconvene at 8:30 in the morning. We will appreciate your being on time.

Now I would like to ask for a rising vote of thanks to Bill and his Committee for a job very well done. Following this the meeting will be recessed. Have a good evening.

[The audience arose and applauded.]

[The meeting recessed at 4:45 p. m.]

WEDNESDAY MORNING SESSION
September 21, 1977

REPORT OF THE COMMITTEE ON SHOP EQUIPMENT

E. R. HAFLING, Chairman
Committee on Shop Equipment
Asst. Mechanical Engineer
Santa Fe Railway
Topeka, KS 66616

J. H. LONG
3rd VICE PRESIDENT
Manager Locomotive Dept.
Chessie System
Cincinnati, Ohio 45225

The meeting reconvened at 8:40 a.m., President Eldon E. Dent presiding.

PRESIDENT DENT: Good morning, gentlemen. We thank you for being here with us to get the meeting off to a good start. We have two fine programs this morning, and at this time I would like to turn the meeting over to Mr. Long, our Third Vice President, who will act as officer of the session.

MR. J. H. LONG: Thank you, Eldon.

The first report this morning is that of the Shop Equipment Committee. Mr. E. R. Hafling is Chairman, and I would like to introduce him.

[Mr. Long introduced Mr. Hafling, who in turn introduced the members of his Committee.

[Part I of the report was summarized by Mr. M. B. Smith; Part II by Mr. Tom Kelly; Part III by Mr. P. F. Hoerath; Part IV by Mr. Hafling and Mr. K. O. Anderson; Part V by Mr. J. F. Flores, and Part VI by Mr. G. B. Sweeney.]

MR. HAFLING: This concludes our report. We are now open for discussion on any of the sections in the report. Are there any questions?

MR. LEEDY: Elmer, in your wheel truing slide you showed some cutters and a tracing tool. Are any wheel truing grinders adapted to these machines rather than a metal cutter?

MR. P. F. HOERATH [Superintendent Plant Maintenance, Consolidated Rail Corporation, Altoona, Pennsylvania]: I know of no grinders that are on the present wheel truing machines. I can remember a few years ago we used to grind passenger car wheels, but the time element there was rather great compared to the time element that is being used on these wheel truing machines. They are a fast machine, and I think grinding would be much, much slower.

MR. LEEDY: When you are wheel truing a locomotive that comes in with some flat spots perhaps on just one pair of the wheels, is the wheel diameter automatically gauged or is it still done manually?

MR. HOERATH: It is done manually on the older machines. Some of the new machines have gauging equipment included so that one can gauge the individual wheel. Sculfort is working on multiple wheel turning machines that will turn more than one pair of wheels at a time, and I feel when they get finished they will probably couple in a relative measurement system for the several pairs of wheels that they are turning.

Your point is well taken. If you have flat spots on one wheel and take it down, unless you take the other one of the pair down you are going to have an unbalanced condition on the traction motors.

VOICE: I would like to direct a question to Mr. Hoerath. In regard to truing wheels on EJ&E, we have a wheel truing machine. Our problem is sharp flanges. I would like to know what you would recommend. At what point, in terms of the finger reading, would you recommend truing sharp flanges?

MR. HOERATH: That is a good question. I can't answer it offhand. Of course your problem is what would be the over-all best way of restoring tread contours to get the most life out of the wheel. I think that is what you are driving at. You could turn it down and restore full tread contour, but you might be wasting some metal in that process.

VOICE: That is very true. On our railroad we have had a controversy for years as to whether or not it is economical to true the wheel rather early as the flange becomes sharp, or to wait until the flange becomes very sharp and then true it. I would like to hear your recommendation.

MR. HOERATH: There are several other things that should be thought about. As the flange becomes sharp you have probably lost the entire taper of the rim, and thus you are no doubt getting a bit of back-and-forth slap as the locomotive proceeds down the railroad. This is probably wearing some other components, including track.

But since we are mechanical people, I am thinking more of the components of the diesel locomotive — the suspension bearings, the wheel bearings, the traction motor is getting more shock loading because of that slap back and forth as you approach a sharp flange wheel. You are probably losing a certain amount of traction also because of having lost the taper. I assume by the time you are heading toward a sharp flange you have lost all taper on your tread.

I would say it would depend more on whether the locomotive was able to be brought in without holding up your transportation department. I think that would probably be more important than the question of whether you save a little bit of wheel wear or not by turning them earlier or later.

I'll bet we would get a discussion going and we couldn't find many in the room in agreement on either side.

MR. J. L. GREGORY [Assistant Shop Manager, Southern Railway, Chattanooga, Tennessee]: I know there are bilingual areas, but are the railroads considering the ramifications that will be involved if we ever go into the metric system? Are there plans on having a dual system? What is the future of the metric system compared to the English system?

MR. HAFLING: Do you mean on the railroads? As it stands now from our manufacturers, it looks like we can only go when the locomotive manufacturers go metric.

MR. GREGORY: Will we eventually go to the metric system and forget about all the others? In the future will we be using two systems?

MR. HAFLING: Eventually, I presume, it will all be metric, but in the meantime we probably will have two systems. I have done a little homework on the metric system, and maybe I can answer your question. It has been quite controversial even in local periodicals in the last year or so.

As far as going metric is concerned, there is a lot of controversy and there are probably as many questions to be answered as there are people. I have picked out two answers on the metric system that may be as good as any. One of them is from the National Geographic magazine of August 1977, which I would like to quote. This is on the English system. The title is, "How Soon Will We Measure in Metric?" The writer said:

"Our English units of length are as follows: We split our mile into 8 furlongs, 80 chains, 320 rods, 880 fathoms, 1,760 yards, 5,280 feet, and then divide the foot into 12 to get inches. Actually there are three types of miles. There is a survey mile which is ⅛ inch longer than the international mile, also known as the statute mile, and both are shorter than the nautical mile.

"Our measure is a dry quart. It is larger than a liquid quart,

both smaller than the British quart. The ounce for fluid measure is not the same as the ounce used for weighing. Avoirdupois ounce is lighter than the Troy ounce.

"There is a long ton, there is a short ton, there is a registered ton, there is a measurement ton, there is a wheat ton, and there is a metric ton.

"Our barrels range from 31 gallons to 42 gallons. The gallon is divided into 4 quarts, 8 pints, 16 gills, to say nothing of the 5/5ths.

"We deal in hands, cords, drams, scruples, pecks, grains, points, firkins and hogsheads, and an all-glorious mingle-mangle for some 70 separate measurement inputs.

"Second, we must remember our world is hundreds of times smaller than it was 25 years ago, and if we did not try to sell in foreign markets the metric language would not be necessary. But then we try to communicate these outside the United States, and many do not understand if we use our quantities.

"Controversially, we do not understand their non-S. I. metric language, and so an answer is to now change to the language of the S. I. metric which is international. I have an uncle who says he will try to learn the metric system if need be, but he will find it hard to measure freeway distances by anything but exits."

If there are no other questions, gentlemen, this concludes our part of the program. I would like Mr. "Swede" Axelson, General Manager of Work Equipment and Machinery, Burlington Northern, to summarize our paper.

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

MR. KJELL AXELSON [General Manager Work Equipment and Machinery, Burlington Northern, St. Paul, Minnesota]: Thank you, Elmer. From the looks of the big turnout this morning, so early in the day, I would guess the Pink Pussycat A-Go Go suffered a business setback last night. It is rewarding to see such a good crowd here this morning.

To summarize a straightforward and self-explanatory presentation such as this would really do it an injustice. Elmer and his Committee have certainly done a fine job of boiling down some hard facts of the problems that force us to work smarter, not harder, in order to help maintain a desirable economic balance.

Problems are not new to mechanical people, but they are continually shifting. This has been evidenced through things such as transition from steam to diesel, improvements in diesel locomotive operations, noise, air, and ground pollution standards, modern computer and shop machinery technology, energy crises, metrification, and so on. The list seems to go on in an ever-changing pattern.

It is indeed fortunate that we have hard-working committees such as this to provide the industry with continual probing and provocative approaches to today's problems, as well as looking ahead to the problems looming on the horizon.

As you all know, hindsight is always 20/20, and it is easy. But foresight requires considerably more effort if our economic goals are to be achieved. I personally feel you have just been given a good example of leadership effort by the presentation of this paper on Shop Equipment to work smarter, not harder, and I further feel this Committee deserves a vote of thanks for their effort. So, if you will join me in a standing round of applause, we will get that happy chore done.

[The audience arose and applauded.]

MR. AXELSON: Now I would like to turn the session back to Jim Long.

MR. LONG: Thanks, "Swede". I think this Committee is really to be commended. They have done a fine job.

I would like to ask the What's Your Problem committee to come forward, please.

WEDNESDAY MORNING SESSION
September 21, 1977

PANEL ON WHAT'S YOUR PROBLEM?

W. R. JAMES, Chairman
What's Your Problem Panel
Gen. Manager Locomotive
Maintenance-Engineering
Chessie System
Huntington, WV 25718

C. M. SMITH
7th VICE PRESIDENT
Mgr.-Mech. Eng.-Pass. & Loc.
Consolidated Rail Corp.
Philadelphia, PA 19104

PRESIDENT DENT: I would like to call on our 7th Vice President, Charlie Smith, to introduce the chairman of the What's Your Problem panel, Mr. Bill James.

MR. C. M. SMITH [Consolidated Rail Corporation, Philadelphia, Pennsylvania]: Thank you, Mr. Dent.

The What's Your Problem panel is chaired by Bill James, General Manager, Locomotive Engineering Maintenance, Chessie System, Huntington, West Virginia. His panel consists of the chairmen of our standing committees.

MR. JAMES: Thank you, Charlie. Good morning, ladies and gentlemen. We are in the final stretch of what appears to have been a very successful annual convention of the LMOA. It is at this time that we have the opportunity to make known to the members of this fraternity those areas that we consider to be problems, and hopefully we can solicit solutions from members of this Committee or those in the audience this morning.

This is a real opportunity to let each of us know about the areas that are confronting us in the field of locomotive maintenance.

[Mr. James introduced the members of the What's Your Problem panel.]

MR. JAMES: Before we open the floor for discussion, I earnestly ask that you avail yourselves of this opportunity to stand and make your problems known in order that we, the members of the LMOA, the supply fraternity, the locomotive manufacturers and remanufacturers, can benefit from what appears to be a problem, in the hope that solutions will be found that will be beneficial to each of us in attendance today.

To start this session, may I hope you will give us the opportunity to answer your questions. In looking in the Editor's Mailbag I find a question that was submitted in the hope we can provide a solution. This is addressed to the General Electric Company:

"What is being done by the General Electric Company to find and develop an approved method for reclamation of failed crankshaft journals for application to 3000 HP diesel engines?"

Would a representataive from the General Electric Company please address himself to this question?

MR. WILLIAM SPEICHER [General Electric Company, Erie, Pennsylvania]: I was formerly manager of engineering for the General Electric Company. We are and have been for quite some time working on a method of machining the crankshaft undersize, rewelding, re-heat treating it if necessary, and putting a flash of chrome over it as a wearing surface.

I would like to report that we have had 100% success, but that would be a lie. I think we have had about seven different kinds of treatment that did not work. We have two or three that are currently working. We will very soon be field testing these on a number of railroads. We see no restriction at all on horsepower if this procedure works and we can reclaim the induction hardened or nitrite hardened crankshafts.

MR. JAMES: Thank you very much, Mr. Speicher. It certainly is encouraging to know that it appears the General Electric Company has found a successful means by which damaged journals on the engine's crankshaft can be restored and brought back to normal service. This certainly should aid our industry in making a contribution toward cost reduction. Thank you.

Gentlemen, how about a question from the audience?

VOICE: I would like to ask the Committee or anyone in the room if they have had any experience grinding the cylinder head seat ring on the EMD 645 engine with reference to reducing lube oil consumption, and whether or not they feel this might be a reason for obtaining high lube oil consumption.

MR. GOGOL: There has been limited grinding of top seat ring using a thicker ring, and it does contribute to oil consumption. It often gets so bad that you have to bring the unit in for a complete assembly change. I think EMD is finally aware of this problem. They might like to comment on their latest findings. I believe we would all benefit from it.

MR. JAMES: Is there a representative of EMD in the audience who could comment further? If I understand the question, the gentleman is talking about brass cylinder head seat ring; is that correct? Or the counterbore on the top deck?

VOICE: It is the counterbore on the top deck.

MR. GOGOL: There have been various devices for grinding or machining it for a thicker ring.

VOICE: I understand that, but my question is, have you had any experience in resolving the problem by doing this?

MR. GOGOL: Yes, it does correct the problem.

MR. JAMES: I would like to add a further comment in regard to the question. On the Chessie, like most of you, we have encountered loose power assemblies, and we have adopted as part of our preventive maintenance policy an annual retorquing of all crabs on the EMD engine, with particular reference to high horsepower, 2000 HP and above.

MR. GOGOL: That's right. A regular retorquing program does help this situation, especially on the high horsepower.

MR. JAMES: I would further add that it has very measurably reduced the problems we had encountered prior to establishment of the retorquing program.

VOICE: May I ask one more question regarding this problem. Would you recommend doing this at the time of power assembly changeout — that is, the entire engine, overhauling the entire engine?

MR. GOGOL?: Yo can do it at either a complete engine overhaul or an assembly changeout that does not require removal of the engine. You can do it in place with portable grinding fixtures.

MR. FINDLING: I have a question relating to the black box. I noted in the report of the Committee on Diesel Electrical Maintenance that the modification kit is approximately $575. I wonder why they didn't make it $600, but that isn't my question.

What is the cost of labor and material and other expenses related to equipping the lead and trailing units? Does the $575 cover everything?

MR. KELLEY: I will call on Lloyd Edson to give an idea of what their costs were on the Union Pacific. Is Lloyd in the room?

MR. LLOYD EDSON: I don't have the dollar figures for the black boxes. Harry, do you have them?

MR. FINDLING: I would like to know what the cost is in labor and materials.

MR. HARRY PITTNER [Engineering Department, Union Pacific Railroad, Omaha, Nebraska]: The labor cost is approximately $575. It might go up to $700, but I

really don't have the latest figures with me.

MR. FINDLING: How many units have you equipped to date?

MR. BRUNER: Just over 100 units have been equipped so far. As a matter of further information, and to get back to your original question about installation cost, I can advise that it requires three men approximately 6 hours each for each locomotive application. This time can vary depending upon the extent of modification to the locomotive done by a particular railroad.

MR. FINDLING: Can you tell me approximately what your estimated fuel savings are on an incremental basis, say, on a 100-mile run?

MR. BRUNER: There is no information available at this time as to the incremental saving per 100 miles. As stated previously, the savings depend upon several variables, including the horsepower per trailing ton ratios, the grade and operating territory and, again, the extent of cooperation by the crew in taking advantage of all possibilities to implement its use.

Some geographic locations on the Union Pacific are prime targets to save fuel. In many, we must dispatch trains with a high horsepower per ton ratio in order to take the train up one or two steep grades. However, up to 95% of the trip could be made with half or less horsepower.

There are also many occasions when high horsepower ratios are used to maintain schedules and can be reduced when favorable operating conditions have placed the train ahead of schedule and many hours of reduced throttle would normally be encountered.

I hope this partially answers your question, Mr. Findling.

MR. FINDLING: I would like to pursue this matter farther because it is of interest to all of us. This is almost a prototype application. I don't know anyone else who has applied these and has the experience the Union Pacific has.

From what you told me, the cost of equipment is $575, and based on a manpower figure you gave it would be around $200 for manpower; so that would be a total of about $775. Does this black box, in reducing your trailing units, the selectivity of it, when you select the unit that is to go to throttle #1 — does that negate the wheel slip? Is the wheel slip functional on that unit?

MR. BRUNER: I believe there may be locked wheel protection when in notch #1. However, I am certain wheel slip protection is lost at high speed. We have not tested this aspect; however, we feel commutator protection is worthwhile.

MR. FINDLING: Thank you. I am glad you clarified that, Frank.

There was an article in RAILWAY AGE, I think in August, in which it was said that the Union Pacific saves fuel by assigning specific power to trains. I think we are all interested in saving fuel.

Can you explain how you do that, and use the train performance calculator? What do you do on assigning power?

MR. BRUNER: The use of train performance calculations is very important in saving fuel. Union Pacific Operation Control, with the aid of charts and information furnished by the Mechanical Department, adjusts and assigns units and horsepower ratios for most of the Union Pacific Trains. These calculations and recommended power ratios are the result of many train performance tests that have been run throughout the years.

Movement of traffic and the schedules on which it must move is established by needs to meet transportation demands and competitive pressures from other modes.

Fuel saving procedures through the most advantageous use of horsepower to meet scheduling without excesses have too many variables to be properly discussed here on the floor today. However, one of the major faults is the tendency to over-horsepower a train when it is received or falls behind schedule.

Speed restrictions due to curves, terrain or track conditions will on many occasions prevent making up scheduled time, regardless of the amount of horsepower on the train. Train calculators can help here. There are occasions when derailments or terminal problems can place traffic off schedule, and information necessary to assist operating personnel in the most advantageous use of available power to correct the situation is essential.

MR. FINDLING: Thank you for bringing us up to date on the state of the art. I think the state of the art is really in the embryo stage. I think a combination at some point in time will probably have to be made, because this black box is left to the engineer's discretion at this time.

I can foresee the use of train performance calculations based on the route of the train, the tonnage, the wind resistance, fed into a small computer on the engine, which in turn will also take whatever engines have to be taken off line when you achieve maximum speed and have additional unused horsepower. I can foresee that in the future. But it would be very good if you would keep us informed on a yearly basis as to your progress.

Thank you.

MR. HARLEY: I have one very quick comment. In a paper presented here nine years ago, we included a graph on fuel consumption versus speed, and the graph indicated the difference between 50 and 70 mph was an absolute fuel consumption difference of 39%. In actuality it is somewhat less than that.

I just want to reinforce what Frank said about the undesirability of bringing a train in 3 hours ahead of the market, and the cost involved in that kind of operation. I know our operating people many times tell us we have to meet the competition of motor trucks and everything else. But remember, meeting this competition by running at high speed and then leaving a train in the yard for 4 or 5 hours is not a realistic practice.

MR. PROPP: I would like to speak to that. Frank has certainly answered the question, but yesterday the subject was brought up regarding the speed and its effect on the fuel saver device. In the tests performed on the Burlington Northern, which were quite extensive and covered two 1400-mile runs with a 14,000 ton coal train of 110 cars, it was well documented that we achieved a 9.5% fuel saving on the full run.

I wish to point out that our results certainly were not affected by the speed, because no fuel was saved in the loaded run. All fuel saved was noted in the unloaded return trip. So, basically we experienced a 20% saving on the unloaded trip.

The speeds during the unloaded run were always right up to the maximum for the respective track section. Unit coal trains with similar operating conditions is a good application for this kind of equipment, and therefore we should begin utilization. There will be applications which will not attain similar savings. But if you are utilizing the same power on the empty train, especially in flat terrain, savings can be accomplished.

We consumed 14,000 gallons on the test run without the fuel saver, and about 1,300 gallons less using the fuel saver. So, considering the same locomotives on both runs, and noting the lead engine consumed 1,800 gallons versus 400 or 500 gallons on trailing units, it certainly is a viable tool to save some fuel for the railroad industry.

MR. QUINN: I want to clarify one point. IDAC and WS10 equipped units will not have locked wheel protection in throttle #1.

MR. WALKER: We can't pass over this without saying that other railroads have made tests and have failed to obtain the 10% to 20% savings. We on the Southern have made some tests that are still incomplete and can't announce our results at this time. We all agree that fuel must be saved whatever the percentage, but let it be known that several railroads have made tests with results of substantially less than 10% to 20% or, in other words, the same benefits may not apply universally among the railroads.

MR. JAMES: That is a very valid figure, with particular emphasis on interdepartmental cooperation that is an absolute must if we are going to improve fuel efficiency in our over-the-road train operations.

Are there any further comments in regard to improvement of fuel economies through better train operations?

Okay, gentlemen; will someone else please introduce a problem that we can try to answer?

MR. LEEDY: This is for Jim Gregory. It is directed mainly to railroads that have centralized or decentralized repair shops for components.

The question is: If you decentralize your component repair shops, are you going to have enough repairs going back and forth to make all the component repairs you need? Will it improve or will it deteriorate?

MR. JAMES: The question is: If you are decentralizing your component repair facilities, is there adequate means by which material inventories can be shuttled to and from, to minimize the increased cost of inventories through the process of decentralization? Is that your question?

MR. LEEDY: That's right.

MR. GREGORY: Initially you should ask, should you decentralize? The opinions expressed here will be my personal views — under the same railroad but under three different names of three different managements.

I personally do not believe in decentralization, because there are several factors involved. First and foremost are the economics. I don't believe many railroads can justify the equipment and machinery involved to set up several repair facilities. I presume you are talking about backshops and component part repairs. The second factor is the expertise of the work. With one centralized location you should obtain better quality work.

The third factor is responsibility. I can remember when we had more than one shop years ago. Where does the responsibility rest if you start having trouble with injectors? Were the injectors repaired at the backshop or large terminals? I say that you should centralize because of economics, because of the expertise, because of the responsibility, and I don't think you will reduce your inventory.

On Conrail, at Altoona we rehabilitate more than 200,000 diesel component parts a year, EMDs primarily. We have another backshop at Collinwood for ALCO and GE work. Centralization will give you better results, in my opinion.

MR. LEEDY: I missed the morning session yesterday with Dale Propp's fine committee, and I don't know whether this subject came up, but I want to ask something about synthetic lube oils.

I don't know if you care to comment on their application to the diesel engine itself, but how about the other areas — the engine governor or the air compressor? Is there any market here for a synthetic lube oil in these two machines or some other place on the locomotive?

MR. PROPP: Bob, our Committee has discussed this in the last couple of years, and it is the consensus of opinion that the synthetic oil does have an application in a small engine some place in an extremely cold temperature climate. Certainly there can be tests performed in the air compressor scene, but presently we feel the costs are still too great on that particular

application, and especially in the diesel crankcase.

Yesterday someone mentioned to me about cost studies he had done on synthetics for a locomotive, and as I recall it it is something like $4,500 per year for lubrication. So, it really would be a very expensive operation.

MR. LEEDY: I was thinking perhaps of the motor support bearing area. EMD has come out with a new motor support bearing that may save us some oil. We are looking at it. I am thinking of an area like that, where there is a lot of heat and loss of oil.

MR. PROPP: I am sure the oil companies are working on it. Maybe the costs will come down. There will be many more tests performed in the years to come, and there may be applications. I know many people are trying it. In fact, there is a synthetic being made by one oil company that may be utilized for the locomotive market. It is brand new, and this Committee will follow it in years to come.

MR. LEEDY: One more question. In Mike Gogol's presentation yesterday we talked about air compressors, and I think we pretty well covered it. Apparently the air compressor has gone the way of the batteries and radiators. We are not paying too much close attention to it.

Yesterday afternoon we got into a discussion about the AC auixiliary generator. It seems to me this is another machine that is going to get the same attention batteries, radiators and air compressors got.

I would like to ask Bill Kelley what the recommended maintenance is to take care of this. What problems are we having with the AC auxiliary generator today? Has your Committee looked into this?

MR. KELLEY: I think maybe it is a little too soon to answer that, because I hope we don't have any of them fail that quickly. They should have reduced maintenance. It is a rotating machine, however, and all rotating machinery on a piece of railroad equipment is subject to failure because of the beating it takes, and the fact that it is a rotating part that has a definite life span.

But you have reduced the brush problem, and the commutator problem you have with the 10 KW and the 18 KW DC machine, and that should buy you a lot of reduced maintenance. I think the Chessie did have one failure of an 18 KW AC machine recently. Is it too early to get a feedback of what the problem was?

Mr. PALME: We haven't returned it to EMD yet, but it did fail. There is a very simple two-stage test that EMD gave us to check it out. It is an internal failure somewhere.

MR. JAMES: To specifically answer Bob Leedy's question, how many units does the Chessie system now have equipped with the AC 18 KW brushless auxiliary generator?

MR. PALME: The number is 102 on our railroad.

MR. JAMES: How many failures have we had to date?

MR. PALME: We have removed two of them over four years now.

MR. JAMES: With zero intermediate maintenance, nothing to inspect, I believe that is real progress. No commutators, brushes, and so on. If that isn't headed down the road of reducing maintenance that in turn reduces unit downtime, then, gentlemen, I don't know what other way to head.

They measured these evaluations with EMD in its early days. We critically followed specific gravities of batteries based upon Chessie's duty cycle, evaluated power assemblies to see what problems we might encounter at low rpm's, and we took no exceptions. If there is a representative here from EMD who would like to elaborate on it, I would like him to do so.

MR. LEEDY: What bothered me yesterday was that the AC machine came out with the low idling speed and you couldn't keep the batteries charged. They were going to blame the batteries. I think this is wrong. If this machine on low idle won't live, then I think it ought to be resolved, and let's not blame it on the batteries.

MR. JAMES: Your question is fair, Bob; but the point I am trying to make, without getting into a lot of finite detail, which must be evaluated on each respective property predicated upon the particular duty cycle, is that the state of charge in a battery has a direct relationship with the ampere hours input versus output. In our duty cycle the relationship was such that we could maintain the specific gravities in the area that was deemed essential for our operation, keeping in mind that even at reduced idle, on normally functioning auxiliary generators, you do have sufficient voltage output that does not demand the battery to supply part current for the system control system. Concluding, the battery may not be being charged at all times; however, it is not called upon to augment the needs of the control devices, either.

MR. BENJAMIN LIEBENTHAL [EMD, LaGrange, Illinois]: In answer to the first question, I would like to say that we had a very long field evaluation before we went into production with the AC auxiliary generator. We had some early problems with voltage buildup which were cleared up. The record has been very good on that machine. We hope and have every reason to expect it to continue to be so.

Mr. Leedy asked about the maintenance. We recommend removal at four years, the same as with the DC auxiliary generator.

In regard to the question about compatibility of charging the batteries at the low engine speed, I think you covered that very thoroughly, Bill We did run thorough tests on this, and our conclusion was that it would maintain the charge on the batteries, as you reported.

MR. WESTERFIELD: Something that was mentioned yesterday in this particular discussion seems to have gotten lost along the way, and that was that in those instances when charging difficulties were encountered, or where engine operating problems in cold weather were encountered, it was found that the governor speeds had dropped. You had lost the calibration of the governor speeds.

We have seen the same problems on locomotives that were equipped without low idle — that is, the governor speeds were not stable over even relatively short periods of time, due apparently to some aging in the parts of the governor.

I would be interested to know if anyone else has had problems like this. Is it just that everything got well over the summer, and when the first cold spell hits we will find out which locomotives have low-low idles, or is this just a transient problem?

MR. C. W. DRAKE [Assistant Manager Quality Control, Southern Pacific Transportation Company, Sacramento, California]: We have seen considerable speed sag on our governors primarily due to wear in the rotating pilot bushing. As the governor comes up to temperature the oil thins out. We have seen as high as 45 rpm charge.

MR. JAMES: Is this on the Woodward governor?

MR. GOGOL: It is on the Woodward governor, Bill. When the governor goes in for overhaul some people are not critical on the wearing items, and to keep the control of the rpm by the governor where it should be as new, the wearing parts should be replaced if you expect to keep the standards up; otherwise you will get poor control from the governor. If you try to skimp on replacement parts you will get poor performance out of the governor.

MR. DAVID I. SMITH [Senior Factory Service Engineer, General Electric Company, Erie, Pennsylvania]: The Woodward Governor Company has addressed themselves to two problems on speed drifting. One is the temperature problem Chuck Drake talked about. The second one is a slight change in the speed setting mechanism due to wear.

They have found various reasons for the wear, and have now made a modification of the internal parts to make these mating surfaces out of tungsten carbide. This wear dropped the engine speeds about 30 rpm some time during the early history of the governor. After that the speed remained stable and could be readjusted. So there was a speed shift of 30 rpm as well as a temperature problem if the governor runs at too high a temperature. The General Electric governor runs about 140°F, and has no speed shift with temperature.

MR. GOGOL: The temperature of the governor itself when the calibrations are being made is very important. Anybody calibrating governors has to keep that in mind.

Take the time to get the complete governor up to temperature, and then make your calibrations. If you are trying to hurry and save time, it will give you a false indication and will cause a drop or loss of horsepower later on.

MR. LEEDY: Bill, there is some kind of device to overcome or forestall a hydraulic lock. The engine turns over the first two revolutions at 30 rpm. I assume this is on an EMD engine, as brought out yesterday. Does this mean that during the two revolutions at 30 rpm, if it turns over it won't bend the rod? What happens? I don't understand. What is the advantage of that thing? If you have the cylinder full of water it won't go anywhere, anyway.

MR. JAMES: It is extremely difficult to hear up here, but I believe the question was: How does the EMD-designed limited-energy starting feature function if we have a cylinder undergoing hydraulic?

MR. LEEDY: Could Harry Quinn or Ben address themselves to that?

MR. QUINN: What the system does is to actually monitor the start motors and holds the speed down to 30 rpm. The inertia in the generator is enough to carry you over and bend the rod. At 30 rpm you don't get enough inertia into the system, and we have tested it with the cylinders full and partly full, and it will come up and just stop.

If you listen to an engine — and Chessie and the Milwaukee have quite a few of them — it sounds like the engine is dying. The worst problem is that the mechanic tends to grab the lay shaft and tends to override it. He has to keep his hands off the lay shaft. It is not quite two full turns, just a turn and a half, just to be sure every cylinder has gone to the top.

MR. JAMES: On the Chessie we have quite a few units equipped with the limited energy starting system, and it has been successful. As Harry stated, energy input into the rotating mass is sufficiently lower than the level of energy required to deform the rod if you are undergoing hydraulic ram. We have demonstrated and intentionally tried it, taking the power assembly out and putting the road assembly across the rod fixture to confirm dimensions.

MR. LEEDY: Earlier in the session it was brought out that GE is welding some crankshafts with some measure of success. I know we have welded a couple of EMD crankshafts with very good success, and I wonder if Mike has any more information on that or if anybody else would like to comment on the feasibility and practicality of welding undersized shafts and bringing them back to standard size, and whether it is the main journal area or the con rod journal.

MR. GOGOL: We have been following GE's development in this field. We have not done anything on our own, but I believe their experience to date (and we have talked to other people about it,

mainly those in the crankshaft field) is that it is feasible, and in time it will probably be practical to extend it to all the horsepower size engines up through the U33's.

MR. LEEDY: The thing that bothered me about the crankshafts is that you can get the 16-cylinder crankshaft on an EMD engine and put it in a 567. It used to be 1350 HP. Now we are up to 3000 HP. It seems to be a problem with GE engines. You can't do that. It has to go into a lower horsepower engine.

MR. GOGOL: GE's recommendation is that if you chrome plate the shaft now, they recommend it in lower horsepower only because of the performance of that shaft, mainly peeling. The process they are talking about now is machining the shaft, either the main or the crank or both, down below the heat-treated area, and building up with new material and then putting a thin chrome over it. They hope by this process (it is an art more than anything else) that it will live in the environment it will be subjected to. That is the best answer I can give you.

MR. LEEDY: I am not talking about new shafts. Like everything else, the price is going up on everything. I think the more we can dwell on this reclamation, whether it is a crankshaft or a head or whatever it is, it is going to save us a lot of money.

MR. GOGOL: I agree with you, Bob, because on the GE now whenever you have an overheated main or crank on that shaft you have lost it and you have to replace it. I would say this is true in probably a very high percentage of cases. I am talking about engines that have had overheated mains or cranks or both. I would say some 90% of those shafts are lost and require replacement. So, you have a very large potential for saving, and I think GE realizes this.

MR. JAMES: You are certainly right as to the cost of reclaiming diesel engines. I am happy to note Mr. Speicher's comments included that they feel they have now found a successful method and have perfected it to the point that they are going to commence field evaluation with various customers to validate their engineering design. So, we should see the benefits of reclaiming GE diesel engine crankshafts in high horsepower diesel engines. I believe the limits now acceptable to GE are .015, up to 2500 horsepower.

Before I ask for other questions from the floor, I would like to ask if Harry Quinn would perhaps comment, so that he doesn't leave us all in the dark here, since so much has been said about fuel conservation, as to what the problems are that set up the situation wherein we lose locked wheel protection under these fuel saving modes that he referred to, and perhaps what can be done that would be acceptable to EMD in these areas.

MR. QUINN: The worst locomotive is the SD. If you can visualize the two motors in series, and you lock one of them up, there is no detection of current. The other motor is still turning, so the current differentials are low enough that they don't pick up the locked wheel, and there is no bridge relay on the 1-4 and 3-6 pairs on the SD; so you have to put the bridge relays back in.

On a GP it is a little different problem, in that when you lock up you will have the current differential. But for those of you who are aware of the self-test circuit on the module or the IDAC, at times you have had to go to throttle #2 to get enough voltage to make it work. We don't have a solution for that. Most people are putting the fuel saver on right now on SDs, and our recommendation is that you then go back and put the bridge relays back on the 1-4, 3-6 pairs.

MR. PROPP: Wouldn't you also have protection if you dropped back to #2?

MR. QUINN: #2 is questionable. You don't really get locked wheel protection until throttle #3. You would have it on throttle #2 on a GP, but if the fuel savings are there you would not want to run in the throttle #2 position.

MR. PROPP: On our railroad we may want to drop back to throttle #3 in the wintertime operation for other reasons; and this can be accomplished.

MR. QUINN: Yes, it could. You could set it up to drop anywhere you want to.

MR. JAMES: I noticed one of the questions from the audience touched briefly on further conservation of petroleum products. We have a question that was submitted along those lines, that we might bring up at this time. It is addressed to the Diesel Mechanical Committee, and perhaps needs to be addressed also to the Fuel and Lubricant Committee. Question:

"Have any of the member roads conducted a test evaluation of the latest EMD traction motor support bearings with regard to performance and oil consumption? If so, will they advise their findings?"

Perhaps Dale Propp might offer something on that.

MR. PROPP: I am not aware of any tests at this time.

MR. WALKER: We do have a few locomotives on tests, but the results are not known at this time. All locomotives on test are new, and oil consumption on the new style and old style bearings are both low at this time.

MR. JAMES: Dale, in your prior maintenance practices with regard to running gear lubrication, what was the time cycle on suspension bearings relubrication?

MR. WALKER: We checked them every 15 days.

MR. JAMES: Are you going to extend them?

MR. WALKER: No, not at this time.

MR. GOGOL: We have tested a similar system that GE came up with. It has been a number of years now, and it is similar in design to the EMD. We did not test the EMD, but the GE design did show reduced oil consumption in the support bearings. They are probably more hesitant about making it standard, but it is similar to the EMD and it did show improvement in oil consumption in the support bearings.

MR. JAMES: With the interest being shown by our government and all of us in the industry to conserve petroleum products, this seems to be another step in the right direction.

Are there any further questions from the audience? If not, I will reach into the Mailbag and find another one.

Bob Leedy is still pursuing the air compressor, so it might be appropriate to go back to that area. I addressed this question yesterday to the Mechanical group, which had no previous experience in the area of the question. I will ask if Dale Propp will address himself to the question now:

"What should be considered as normal lube oil consumption on the latest Gardner Denver 3-cylinder watercooled compressor operating on board a GP40 locomotive assigned to mainline manifest service?"

MR. PROPP: What is the lube oil consumption?

MR. JAMES: What would be considered as normal, Dale? Specifically, we, like all roads, experience too many catastrophic type air compressor failures. One is too many. In furtherance of centralized maintenance we have reduced many of our outlying points to gas station-type servicing. Of course our maintenance cycles are predicated upon the needs of the various systems. We are now trying to establish, in light of too many of these failures with compressors, what is normal consumption for a properly functioning, well-maintained compressor.

MR. PROPP: I don't have any results handy, but I would like to ask a couple of members of our Committee if they have some remarks on that subject, either the builders or other railroad people.

MR. JAMES: Is there a representative here from Gardner Denver? If not, I would add this comment: In trying to answer this question for ourselves on the Chessie, two months ago we set up a four-unit test with a captive closed circuit piping arrangement, with a lock type valve installed so that it could not be filled. Two of the units are one year old from the date of delivery new. One of the other units has an air compressor five years old and another is seven years old.

Bearing in mind that the extent of testing to date has been a total elapsed time of 2 months, the two new air compressors are consuming on an average of one gallon of oil per month. The 5-and 7-year-old compressors under the same maintenance concept are using in the neighborhood of 2 to 2½ gallons per month. I wonder what the experience of other roads has been.

MR. LEEDY: May I comment on that question? I would hope no-

body will put out any specific figures on what lube oil consumption should be on an air compressor, simply because there are too many factors involved, whether it is a high type or low type crankcase. I think with all the talk we have had about air compressors, and our own problems on our own railroads, if we take the time to use the dipstick and check the oil level when the units come into the shop for inspection we will know what the oil consumption is, because you can do this very easily with the engine running. Let's check it and be sure. Too many things can happen.

MR. JAMES: On the Chessie we are certainly concerned with oil consumption from an economic point of view, but more importantly we are trying to establish what the causes may be that contribute to these catastrophic type failures. With the oil reservoir capacities found in compressors today, it should be able to operate for at least a 30- to 90-day cycle without adding makeup oil.

Next year at this time, if there is an interest, we will have an answer, so we can then temper our maintenance requirements on that basis, because again our theme has been and is to further centralize maintenance.

MR. GOGOL: I would like to make one comment. We made some inspections of why oil was low on various air compressors on various units. We found we were losing the oil by the various types of air compressor oil drain systems the builder has applied over the years, and the maintenance of these drains. If you will take a close look at them you will find every type of valve and all kinds of makeshift repairs on the oil drain system.

It is amazing that oil can be kept in the crankcase of an automobile with a plain plug, but we can't keep the oil from leaking out of the compressor because of the drain system the builder has applied over the years. Air compressors found with low oil levels usually had valves partially open, defective, or a leak in the oil drain line.

MR. JAMES: In looking into the Editor's Mailbag we found a question addressed to the New Developments Committee, on data exchange:

"In your paper your proposal calls for a paper form for exchange of data. Why not develop an industry standard data system with the ability to exchange magnetic tapes?"

MR. CUMBEA: About ten years ago there was a very concerted effort made to develop an industry-wide coding structure for computerized locomotive information systems. Even that long ago it was found that too many railroads had progressed their own systems to the point that it would not be practical to develop a standard industry-wide coding structure. Hopefully, with the further development of computer technology and the ability of computers to talk to each other and convert codes, this may some day be a feasible proposition.

MR. JAMES: Another question addressed to the Diesel Electrical Committee:

"In regard to the discussion on replacement of switch gear on a rebuilt locomotive, which type of switch gear does the Committee recommend, i.e., electromagnetic or electric motor driven cam actuated switch gear, and on what basis are your comments made?"

MR. KELLEY: I think in the paper we did recommend the electromagnetic, and we did specifically say we felt there was a lot more maintenance on the electropneumatic type of switch gear. John Anderson, of the Burlington Northern, might have some additional comments on that.

MR. JOHN R. ANDERSON [Electrical Foreman, Burlington Northern, Livingston, Montana]: The electropneumatic has been known to feed some fires, and that was one of the reasons we recommended the magnetic switch gear. The cam operated or the motor driven operated — we recommend some of that in the reverser area.

MR. JAMES: Bill, why doesn't the Committee go all the way and recommend that if you have to rebuild an older locomotive, take the next step and retrofit EMD's latest standard of electric driven cam actuated gear? It appears on the surface that the many interlocking functions needed for sequencing the switch gear properly would be minimized with such type equipment, thus reducing control circuit configuration.

MR. KELLEY: I think that is a good point. When you start talking about massive replacement of switch gear, however, it is a matter of economics, and you really have to have a cost-effective study to see whether you want to spend that much money and throw a lot of switch gear away and go to completely new switch gear on rebuilds.

MR. WALKER: One of the first questions asked at the meeting concerned the air compressor. The Diesel Mechanical Committee recommended the gear-driven pump as an improvement over the old pump. Several attempts were made to find out why the builders would not make this standard rather than an option. I don't think we have received an answer satisfactory to the audience, although I have been satisfied personally directly from a builder.

I am asking the builders to either state at this time why they do not agree with the Committee or, if they do, whether they intend to change over to the standard gear-driven pump.

MR. JAMES: It is regrettable that there is no representative here from the Gardner Denver Company. I see someone here from GE.

MR. HILLHOUSE: We consider the gear driven pump an improvement, and it has been standard on GE locomotives since 1974.

MR. JAMES: As was mentioned yesterday, Darrel, we do understand why in part the gear type pump should offer improvements over a piston type pump. Certainly you would reduce the pulsations in lube pressure system.

I wonder if somebody from EMD would address himself to this question, as to when perhaps it will become standard application with the Gardner Denver air compressor on EMD power.

MR. TURNEY: I answered this question yesterday. I guess I gave it more specifically in our Committee meeting.

EMD is all for the gear-driven pump, and worked closely with Gardner Denver during its development. Many railroads are not in a position to feel the need for it, and EMD is not going to force it on the railroads until the demand reaches the point where the majority of railroads want it. Why pay extra for the gear-driven pump when it is not necessary? It is available as an extra for any railroad desiring it. When the demand becomes great enough, EMD will make the gear-driven pump standard.

MR. JAMES: Lou, can you comment with regard to what the feelings are of the Gardner Denver Company?

MR. TURNEY: Gardner Denver goes along with EMD's feeling in the matter.

MR. JAMES: Going one step farther, is it an improvement? I don't think it is satisfactory to state that they will do this or that. We are trying to improve the rail mode of transport, and if we can come up with components or products that will improve performance, and reduce maintenance, then I think we should take the step and make it a standard in the industry in order to achieve the end result.

MR. TURNEY: It is definitely an improvement, because oil will flow as long as you have oil to the pump. In the present system you must be sure to maintain the proper level.

MR. JAMES: Thank you. Next year we will try to have a representative of Gardner Denver here.

MR. HAROLD STRINGER [Manager Motive Power, Canadian Pacific Railroad, Montreal, Quebec]: I would like to return to the switch gear problem. We have rebuilt a couple of GP9 units and equipped them with motorized switch gear, and I agree it makes a big improvement in switch gear life.

One difficulty we ran into is the time delay in reversing with motorized switch gear. It presents a problem when you use the units in switching service. I wonder if any of the other roads have come across this difficulty, or if perhaps EMD has been able to speed up this transfer cycle on the motorized reverser.

MR. PALME: We had many complaints of GP40s in the yard service because of the 6- to 8-second reversing time of the motorized switch gear. EMD did speed it up. It is at about its maximum now.

MR. QUINN: It should be around 2 or 2½ seconds. There used to be a resistor around the motor that was used as the dynamic braking to slow the motor down as it came

into the stops. Just pull that resistor off and you will get the maximum speed you can get out of the motor. The rest is just switching. That should get you down to about ¾ second transfer time.

MR. STRINGER: Is this also on the reverser?

MR. QUINN: Isn't there something out on speeding up the transfer time, Dennis?

MR. STRINGER: Does this apply to both the cam switch and reversing switch?

MR. QUINN: Yes. We can provide that information to you.

MR. STRINGER: Thank you very much.

MR. JAMES: One final comment. It is certainly encouraging to note that our railroad yard operations have reached the point of efficiency that we are beginning now to be concerned with a 3-second time delay function in reversing equipment.

MR. BRUNER: In the area of new developments, I might mention a new axle gear contouring machine that has recently been placed in operation at our Omaha Shops. Although having some growing pains at the present time, we are re-contouring three axle gears per 8-hour shift.

The detrimental effect of worn traction motor pinion and bull gears has been discussed and covered in previous papers, and this machine which uses an electrical discharge process appears to be an answer.

MR. JAMES: Mr. Hafling just called my attention to this, and they are planning to incorporate it in their paper for the following year. Have you put this into effect on the Union Pacific? How long do you think it is going to take to amortize that investment, based upon your rate of return.

MR. BRUNER: No intermediate or final cost studies are available at this time. However, parameters which determine potential savings and justification for expenditures have been met. It appears that if a shortened cycle per gear can be achieved which is now looking good, the return on the investment will surpass previous expectations.

A second benefit, of course, is the shop time and room necessary to remove gears, store axles, and reapply gears, which is the present practice. The chance of the gear being destroyed when removed or reapplied is also diminished.

MR. JAMES: Another question sent in is directed to the subject, "What is being done to improve cylinder head performance on EMD GP40 type locomotives? Our industry is experiencing a failure rate that is considered excessive in this area."

Does anyone on the Committee want to tackle that?

MR. GOGOL: I agree that the failure rate is excessive. It is very high. The builder is in the process of coming up with an improved design head. At this time I can't say what his experience has been, but he has made claims it is going

to be a marked improvement over the past. This is an item we are continuously running short of on our railroad, and I think most other railroads could not keep cylinder heads in sufficient supply because of the failure rate.

MR. JAMES: Is there a representative from EMD who would like to address himself to that question?

MR. TURNEY: I collected a few figures just to see how the current failure rate on heads look. The failure rates EMD developed are based on the two-year warranty period. We do not get enough feedback from the customers to give us any further data than during the warranty period.

For the past 24 months our current head used on the turbocharged engine has had a failure rate of .13% and the Roots blown engine .06%. You are addressing yourselves to failures much beyond that time.

EMD is currently introducing a head which has a reduced fire face thickness. It is reduced about $\frac{1}{16}$ inch to allow the head to run cooler, and will be included on the GP40X locomotives which are coming out shortly. After a due period of time, if all goes well, it will become standard.

One of the reasons for some of the failures you are experiencing on older heads is reuse of heads subjected to severe overheat. On occasions, where an engine overheats all heads will be pulled and inspected. The only heads replaced at that time are those which are cracked.

An important factor overlooked is that overheating of an engine which causes complete deterioration of the grommets is an indication that the head was subjected to temperatures far in excess of what the microstructure of the head can withstand. As a result of this, the head, once it is subjected to this high overheat, cannot transfer the heat that it normally would transfer. EMD can attribute many subsequent head failures to this condition.

MR. JAMES: Lou, I have another similar question. "When processing cylinder heads in railroad shops through a reclamation line for requalification and further use, is there an easy method of evaluating if the head has undergone previous over-temperature?"

Keep in mind that in many shops these heads arrive randomly in various type containers, and so on, that may not have any identity of having been removed from an engine that suffered high temperature operation.

MR. TURNEY: I personally don't know of any easy method for doing it, other than dissecting the head and checking it out in the lab. The best way to minimize reuse of heat-damaged heads is an all-out training program for the mechanics. They should be responsible for tagging the heads properly. In the meantime, EMD can certainly make it a point to explore something in the form of a

POINTERS to warn against reuse of grossly overheated heads.

MR. JAMES: You lose the correlation between the grommet conditions, because on many properties they still remove the heads in a piecemeal fashion. We are fortunate on the Chessie in that we apply 95% of our power assemblies in the Power Pack configuration.

MR. GOGOL: As far as failed heads are concerned, we have made some checks on torques of engines and we find that overtorquing of crabs on the injectors are contributors to short life of the heads.

MR. TURNEY: That has definitely been a problem for quite some time.

MR. JAMES: On those roads that have a reclaimed cylinder head policy, i.e., welding, if we are concerned with affecting the microstructure or upsetting the metallurgy of the cylinder heads due to temperature in the engine, what are we doing to the cylinder head while it is undergoing rebuilding, such as welding? Any comments on that?

MR. LEEDY: I think that goes to a normalization process in heating, bringing it up and taking it back down.

MR. JAMES: Temperature gradient and maximum temperatures, I think, are the key factors here.

MR. LEEDY: Yes, but if you are worrying about simply overheating the head by welding, I think the process in this reclamation will take care of the molecules.

MR. JAMES: If we over-temperature a cylinder head and the temperature base is determined by cooking out of the grommets, I think this is in the neighborhood of 450 degrees. In the reclaiming of cylinder heads by welding, they are far in excess of this temperature range.

Going back to Lou's statement, if that indeed upsets the head metallurgically speaking, with regard to its capability of properly dissipating heat thereafter, then there apparently is some concern in reclaiming heads through welding.

MR. KELLEY: Bill, I have a question. GE recently put out a notice that they have had bearing problems develop on new or repaired traction motors built up with the armature in the traction motor frame during shipment, and in the notice they said they were going to take out two bolts on the cover on the commutator end and put in longer bolts and hold the armature in place. I think they used a figure of 30 footpounds torque on the two bolts on the commutator end.

What was the incidence of failures that would bring on something like that? I feel we have more problems putting these extra bolts in than we would have with the bearing problem.

MR. JAMES: I would like a representative of GE to offer a comment on that. We on the Chessie do not agree with that policy, and have issued necessary directives to refrain from doing it. Does anyone from GE wish to comment?

MR. ROBERT B. HALL [General Electric Company, Erie, Pennsylvania]: I don't have any specific figures on the number of failures we have had, but we have definitely attributed such failures to brinelling of the bearings as a result of vibrations through transporting the motor from one place to another. It doesn't necessarily have to be a long distance; it can be over a short distance. It depends on how it is mounted within the truck or car. Now, as a standard practice we do put in these bolts Bill mentioned, in an effort to reduce or actually eliminate that problem. That will be our practice from now on.

MR. KELLEY: How did you determine that 30 footpounds were enough to hold that armature in place?

MR. HALL: I don't know whether we have anyone here from Engineering or not, but that was the established figure. I don't know how they arrived at it. We have determined, however, that 30 footpounds are adequate to hold the armature and prevent vibration problems on the armature bearings.

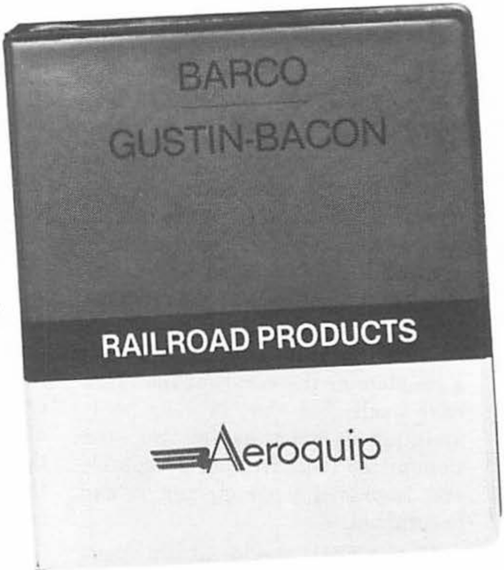
MR. KELLEY: That is what I figured. If it is not really enough to hold all the weight of the armature when it is bumping over the road, particularly if it is in rail service, I think we are building a trap for ourselves, because in the literature that comes out you suggest that railroad people do the same thing. I am afraid a lot of people would feel that maybe 30 footpounds is good and so maybe 130 would be better, and we might wind up with more commutator problems.

MR. HALL: You can't avoid somebody deciding that is what is better. I don't think we just randomly picked a number. Somebody gave it some thought.

MR. R. R. HOLMES [Chief Chemist, Union Pacific Railroad, Omaha, Nebraska]: Yesterday there was some discussion on traction motor gear lubrication which I don't believe was fully explored. I am sure the new type gear lubricants have been in the field long enough, judging from the initial comments that were made. Evidently there were some problems keeping it in the gear case, a fact which should be discussed. Is that generally a problem, or has the lithium gear lubricant had enough field service to prove that it is satisfactory in generally well maintained gear cases?

Secondly, it is a fact that lithium base grease is better than sodium base grease. We are considering lithium base grease, but maintaining the high viscosity base oil for various reasons. We have been hesitant to change from a 2000 second base oil in the grease to the 1000 second base oil, which is required to meet the new EMD specifications. Will this new traction motor gear lubricant provide as good or better service under the various ambient conditions? Obviously, the merits of the new grease aren't getting across to the potential users, and it hasn't been completely explained as to what the merits are.

The Gustin-Bacon Barco link-up gives you better service from a single sales team



FREE!

New Gustin-Bacon/ Barco Catalog

Now get all your information from a single catalog

• Air Brake equipment parts (L) • Brake cylinder release valve (L) • Vent protector (L) • Weld flange fittings (L) • Hose and fittings for brake connections (L) • Locktite cotter (L) • Electronic speed information systems (B) • Mechanical speed recorders (B) • Locomotive performance verifier (B) • Automatic ground protective relay reset (B)

Air brake equipment parts are stocked at these Gustin-Bacon regional warehouses:

- Little Rock, Arkansas
- Lawrence, Kansas
- Sacramento, California
- Cranbury, New Jersey
- Tucker, Georgia

Write Aeroquip Corporation, Gustin-Bacon Division, *a subsidiary of Libbey-Owens-Ford Company.* P.O. Box 927, Lawrence, Kansas 66044 for products coded (L), and 500 N. Hough Street, Barrington, Illinois 60010 for products coded (B).

Do it right with Aeroquip Products

Aeroquip

MR. PROPP: As far as the lithium versus the sodium traction motor gear lubricants are concerned, I believe that was answered in our paper last year. The Committee does feel that it certainly has advantages. The engineering work has been done. Obviously EMD has agreed and has provided the new specification.

One of the questions brought up yesterday was the fact that one particular railroad had experienced trouble keeping it in the gear cases. That was substantiated this morning. I talked to the individual again, and he told me that their railroad definitely felt it was not a problem or the result of the lubricant itself, but that of very badly maintained gear cases. So, our Committee feels it is an acceptable and improved product, and it can be utilized.

Maybe EMD would care to speak to that question.

MR. LIEBENTHAL: As far as keeping it in the gear case is concerned, we should not have any more problems with the new lubricant than with the old. We have maintained the same viscosity and the same viscosity spec on the lithium based as we did with the sodium based. We think it should be a much better lubricant.

You have covered the most important reasons for the improvement, that is, because of its resistance to water, and the EP additives. We think it will be better and should prove that way in service. Certainly the field tests have shown that.

MR. HOLMES: The old M.I. specified a 1600 second base oil. To meet the current EMD specification, the base oil runs about 800 to 1000 seconds, which under certain conditions could result in a much thinner grease at higher ambient temperatures. I don't recall if EMD specified the viscosity range of the grease according to the Brookfield method under the old specification. It just mentioned the 1700 seconds as the base oil viscosity.

We are still using the grease with this 1700 second base oil. Actually, there is a much lighter base oil in the new EMD specification grease, which could make some difference in the lubrication. Probably that characteristic improves the slumping characteristics of the grease in the gear case. These are the points I would like to have clarified, as to what advantages really have proven from the EMD field testing.

MR. LIEBENTHAL: I am not prepared to give the exact values. We do use the Brookfield viscosity test, and we did establish and specify a closely controlled range of values for the jet lube. This is the same range we used for the lithium soap thickened lubricant.

Lou, do we have some literature on that?

MR. TURNEY: We can get some literature out.

MR. JAMES: Lou or Ben, in your field evaluations of lithium based grease for traction motor gear lubricants, did you evaluate against a time base and against a standard in other wheel positions under a given unit, as to the rate of gear wear? Certainly that has to be the tradeoff.

MR. ROBERT W. KUNTZ [Texaco, Inc., Oak Brook, Illinois]: We worked with the EMD Engineering Department in the initial development and testing of product to meet their new traction motor gear lubricant specification. There are several benefits to this new specification. One is an EP requirement. Product has to have Timken rating of 40 or above. Field service indicates extreme pressure additive has been successful in reducing gear wear. The EMD Service Department publication dated September, 1975 documented the large part that gear wear plays in electrical failures.

In addition to the above, during a 10-month test on the C & O Railroad new product was evaluated against sodium soap gear lubricant. It showed definite advantages — little or no leakage, no water problems, and reduced gear wear.

Most of the new products meeting new EMD specification are rheopectic in nature, meaning they resist leakage. Field service indicates leakage is less than with the sodium soap products.

One railroad said they had problems with dry gear cases caused by poorly maintained cases not holding the new specification product. From my observations, the problem is more a matter of lubricant not being put in the gear cases, as all locomotives are not brought in on a regular basis to be lubricated. Non-lubricated gear cases will certainly run dry.

MR. JAMES: We did run that test on the Chessie, but to the best of my knowledge we did not remove wheels and finitely measure any of the gears. We followed that test rather closely, and our observations in conjunction with EMD were that there were indications that it should improve the service life of the gearing.

MR. DENT: Assuming that the sodium soap and the lithium based lubricants are excellent lubricants in their own right, are the two actually miscible or compatible when mixed in the same gear case?

MR. PROPP: Our Committee has discussed this issue, and we agree that both lithium and sodium gear greases can be mixed and are compatible. However, there are some people who suggest that when you do make the change, increase the ratio of the lithium product as rapidly as possible.

MR. STRINGER: Along these lines, I wonder if I could have the benefit of experience with fiberglass gear cases, both from the standpoint of gear oil retention, over-all strength, and service life.

MR. GOGOL: We have had very limited test experience with fiberglass. Whenever a fiberglass-equipped unit is derailed there is no way of easily repairing it. We have never had them long enough to consider extended testing for that very reason.

MR. JAMES: I am not sure that completely answers your question, Harold, but I think two years ago there was discussion of the merits of one versus the other.

One other question in the field of petroleum usage: "With the world-wide attention being given to energy conservation, I would like to know if any railroad or any locomotive manufacturer is currently evaluating the differences in lube oil consumption between cast iron and chrome plated liners."

MR. GOGOL: The difference in consumption between the two types of liners, I think, has been known in general throughout the industry, but I am not aware of any trend in one direction or the other. However, I think some other factors are coming into it, especially on the EMD. GE has standardized on the cast iron from the chrome, which improved their lube oil consumption, and with EMD other factors are being considered that eventually will affect oil consumption on their engine. They have been doing some testing on chrome, but I think they are leaning right now toward cast iron. If they want to expand on this, they may.

MR. JAMES: Do we have a representative from the builders who would care to comment on that subject?

MR. HOFFMAN: I will make a quick general comment on chromium versus iron liner oil consumption. The first caution I would give you is that many things can be done in chromium plating that affect the resultant oil consumption. I don't think there is a way that one can say "iron versus chrome, consumption ratios," because the way in which the chromium is finished affects chromium plated liner oil consumption so much that the variation is often 2:1 or 3:1 between types. So, I don't think we can make a general statement.

MR. PROPP: This question was handed to me: "Has your Committee discussed the possibility of using SAE30 lube oil in place of SAE40 to reduce engine drag and thus increase fuel economy?"

Our Committee has not discussed this issue. The SAE30 lube oil, of course, would be a very low viscosity, of about 650 seconds at 100°F. I personally feel it may have some problems, but I understand one of the builders has been doing some work in this regard. Would GE care to respond to this subject?

MR. HOFFMAN: Dale, you are quite correct that we are very seriously evaluating the effect of lubricating oil viscosity, including more than just SAE30. We are including in the span of our look the higher levels too, because there is a rather wide range in the viscosity of oils being used by different railroads in the country. We are looking at the conceivability of multiple viscosity ranges with respect to reducing friction losses and potential fuel consumption savings. Yes, we are looking at it. I have no data that I wish to present at this time.

MR. JAMES: Gentlemen, it is time to bring our What's Your Problem session to a close. Prior to doing that, I would like to offer our sincere thanks to each of you for your attention, your response, and your endeavor to make each of us aware of the areas you consider to be problems. The sharing of information will allow us to help one another, and in so doing perhaps make a significant contribution to further our mode of transport.

Now I would like to turn the meeting back to Mr. Smith.

MR. SMITH: Thank you, Bill. You have conducted a most interesting and educational forum. You and your Committee and the experts on the floor deserve our thanks for the wealth of information that has been presented to us, which we will all find very useful. Furthermore, I think the committee chairman received a number of suggestions for topics that they might consider for the coming year.

With that I will turn the meeting back to President Dent.

PRESIDENT DENT: Gentlemen, your response and interest in these programs has been most gratifying.

[Announcements.]

PRESIDENT DENT: Our next meeting will be at the Hyatt Regency Chicago, downtown, on October 2, 3 and 4, 1978.

Now let's give these committee chairmen and Mr. James a rising vote of thanks for a job well done, after which the meeting will be adjourned.

[The audience arose and applauded.]

[The meeting adjourned sine die at 12 o'clock noon.]

PRE-CONVENTION PRESENTATIONS

INDEX

LOCOMOTIVE MAINTENANCE OFFICERS ASSOCIATION

REGENCY - 'C'

MONDAY, OCTOBER 2, 1978

TUESDAY, OCTOBER 3, 1978

WEDNESDAY, OCTOBER 4, 1978

ATTENTION EVERYONE COMING TO THE MEETING!

REGISTRATION FEE AT ANNUAL MEETING $5.00 PER MEMBER

LADIES FREE

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

SPECIAL INSTRUCTIONS

1. **STUDY these reports closely.**
2. **SEND OR BRING written questions to the Committee Chairmen.**
3. **BRING THIS BOOK TO EVERY SESSION OF THE ANNUAL MEETING! There are no extra copies.**
4. **BRING your 1978 LMOA membership card for identification in registering.**

ALL RAILROAD MEMBERS! The ground rules of this Annual Meeting require:

"THAT ALL SUPPLY COMPANY HOSPITALITY SUITES MUST BE CLOSED TO AND OFF LIMITS TO **ALL RAILROAD PERSONNEL** WHILE THE MEETINGS ARE IN PROGRESS." ALL HOSPITALITY SUITES CLOSE AT 8:30 A. M., 1:45 P. M., 11:00 P. M.

Please do not **embarrass** your Supply Company friends by calling at their suites while the meetings are in progress; it will cause them:

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

   or

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

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.

OUR OFFICERS

E. E. DENT
PRESIDENT
Supt. Motive Power
Missouri Pacific RR Co.
210 N. 13th Street
St. Louis, MO 63103

N. A. BUSKEY
4th VICE PRESIDENT
(General Membership Chairman)
Supt. Locomotive Dept.-Oper.
Chessie System
Huntington, WV 25704

MEMBERSHIP THRU THE YEARS

	Advertisers	Associate	Active	Total
1939	0	27	60	87
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
1974	124	384	1735	2243
1975	103	326	1579	2008
1976	109	314	1610	2033
1977	114	317	1508	1939

OUR OFFICERS

E. T. HARLEY
1st VICE PRESIDENT
(Program Chairman)
Gen. Mech. Supt.-Eng. & Res.
Consolidated Rail Corp.
Philadelphia, PA 19104

J. H. LONG
2nd VICE PRESIDENT
(Advertising Chairman)
Manager Locomotive Dept.
Chessie System
Cincinnati, Ohio 45225

R. G. CLEVENGER
3rd VICE PRESIDENT
(Meeting Procedure Chmn.)
General Electrical Foreman
Atchison, Topeka & Santa Fe
Kansas City, KS 66106

F. D. BRUNER
5th VICE PRESIDENT
(Co-ordination Chairman)
Asst. C.M.O.-Research & Dev.
Union Pacific Railroad
Omaha, NB 68179

C. M. SMITH
6th VICE PRESIDENT
(Supply Membership Chm.)
Mgr.-Mech. Eng.-Pass. & Loc.
Consolidated Rail Corp.
Philadelphia, PA 19104

R. R. HOLMES
7th VICE PRESIDENT
(Advertising Vice Chairman)
Chief Chemist
Union Pacific Railroad Co.
Omaha, NB 68179

OUR OFFICERS

PAST PRESIDENTS

F. A. UPTON
Asst. Vice President-Mechanical
Chicago, Milwaukee, St. Paul & Pacific RR
Milwaukee, WI 53201

W. F. DADD
Chief Mech. Officer-Locomotive
Chessie System
Huntington, WV 25718

C. P. STENDAHL
General Manager
Motive Power-Electrical
Burlington Northern, Inc.
St. Paul, MN 55101

T. A. TENNYSON
Asst. Mgr. Engrg.-Tech.
(Retired)
Southern Pacific Trans. Co.
San Francisco, CA 94105

OUR OFFICERS

PAST PRESIDENT AND CHAIRMAN OF THE BOARD

J. D. SCHROEDER
CHAIRMAN OF THE BOARD
Asst. C.M.O.-Locomotive
Burlington Northern, Inc.
St. Paul, MN 55101

SUPPORTING STAFF

T. C. SHEDD
PUBLICATIONS CHAIRMAN
Editor, Modern Railroads
5 S. Wabash Ave.
Chicago, IL 60603

JOSEPH J. T. KOERNER
SECRETARY-TREASURER
3144 Brereton Court
Huntington, WV 25705
Phone (304) 523-7276

K. G. ELLSWORTH
PUBLICITY CHAIRMAN
Railway Age
350 Broadway
New York, NY 10013

OUR OFFICERS

SOUTHERN REGIONAL EXECUTIVE

D. M. WALKER
Diesel Superintendent
Southern Railway
ATLANTA, GA 30303

SOUTHERN REGIONAL EXECUTIVE COMMITTEE

Florida East Coast Rwy. — S. D. Smith, General Mechanical Superintendent, St. Augustine, Florida 32084

Louisville & Nashville R.R. — J. L. Kuhns, Assistant Superintendent M. P. Maintenance, Louisville, Ky. 40202

Norfolk & Western Rwy. — M. M. Early, Mechanical Supervisor - Locomotive, Roanoke, Va. 24011

Richmond, Fredericksburg & Potomac R.R. — H. T. Rainey, Jr., Chief Mechanical Officer, Richmond, Va. 23230

Seaboard Coast Line R.R. — J. K. Baldwin, Superintendent - Motive Power, Jacksonville, Fla. 32202

Southern Railway — D. M. Walker, Diesel Superintendent, Atlanta, Ga. 30303

OUR OFFICERS

WESTERN REGIONAL EXECUTIVE

L. O. TOWNLEY
Mechanical Engineer
Atchison, Topeka & Santa Fe Railway
Topeka, KS 66616

WESTERN REGIONAL EXECUTIVE COMMITTEE

Atchison, Topeka & Sante Fe Rwy — F. I. Burchett, Mechanical Assistant - Locomotive, Chicago, Ill. 60604

Chicago, Rock Island & Pacific R.R. — E. M. Dobbels, Superintendent of M. P. - Inspection and Maintenance, Kansas City, Kansas 66105

Denver & Rio Grande Western R. R. — J. E. Clancy, Chief Mechanical Officer, Denver, Colorado 80217

Southern Pacific Transportation Co. — C. E. Gable, Regional Manager, San Francisco, Calif. 94105

Union Pacific R.R. — F. D. Bruner, Assistant C.M.O. - Research & Development, Omaha, Nebr. 68179

Western Pacific R.R. — J. S. Miller, Superintendent Locomotives, San Francisco, Calif. 94105

OUR OFFICERS

SOUTHWESTERN REGIONAL EXECUTIVE

D. H. PROPP
Director of Energy Conservation
Burlington Northern, Inc.
St. Paul, MN 55101

SOUTHWESTERN REGIONAL EXECUTIVE COMMITTEE

Illinois Terminal R.R. — G. J. Huggins, Superintendent, Motive Power, Alton, Illinois 62002

Kansas City Southern Rwy. — T. T. Souter, General Manager - Mechanical, Kansas City, Mo. 64105

Missouri - Kansas - Texas R.R. — P. W. Larery, Superintendent Motive Power, Parsons, Kansas 67357

Missouri Pacific Railroad Co. — E. E. Dent, Superintendent Motive Power, St. Louis, Mo 63103

St. Louis - San Francisco Rwy. — L. M. Allison, Superintendent Field Locomotive Maintenance - East/West, Springfield, Mo. 65802

OUR OFFICERS

CENTRAL CHICAGO EXECUTIVE

R. W. LEEDY
Contract Administrator
Illinois Central Gulf Railroad
Paducah, KY 42001

CENTRAL CHICAGO REGIONAL EXECUTIVE COMMITTEE

Belt Railway of Chicago — R. M. Campbell, Diesel Superintendent, Chicago, Ill. 60638

Elgin, Joliet & Eastern Rwy. — M. R. Seipler, General Manager, Joliet, Ill. 60434

Illinois Central Gulf R.R. — R. J. Chinn, Mechanical Engineer, Chicago, Ill. 60601

Indiana Harbor Belt R.R. — S. A. Papa, Superintendent Equipment, Hammond, Indiana 46323

OUR OFFICERS

NORTHEASTERN REGIONAL EXECUTIVE

B. A. CUMBEA
Manager Locomotive Data
Systems & Procedures
Chessie System
Huntington, WV 25718

NORTHEASTERN REGIONAL EXECUTIVE COMMITTEE

Bessemer & Lake Erie R.R. — R. W. Keller, Assistant Superintendent Locomotive Department, Greenville, Pa. 16125

Boston & Maine Corp. — W. J. Grabske, Vice President - Equipment, N. Billerica, Mass. 01821

Canadian National R.R. — L. M. Daniel, Senior Mechanical Assistant, Montreal, H3C 3N4 Quebec, Canada

Canadian Pacific R.R. — W. A. MacRae, Supervisor Diesel Equipment, Toronto, Ontario, Canada.

Grand Trunk Western — Hubert L. LeDuc, Mechanical Officer - Motive Power, Battle Creek, Mich. 49016

Long Island Rail Road — J. W. Yaeger, Chief Mechanical Officer, Jamaica Station, Jamaica, N. Y. 11435

OUR OFFICERS

NORTHWESTERN REGIONAL EXECUTIVE

KJELL AXELSON
Gen. Mgr. Work Equip .& Mach.
Burlington Northern
St. Paul, MN 55101

NORTHWESTERN REGIONAL EXECUTIVE COMMITTEE

Alaska R.R. — G. V. Randall, Chief Mechanical Officer, Anchorage, Alaska 99510

Burlington Northern, Inc. — J. D. Schroeder, Assistant Chief Mechanical Officer, St. Paul, Minn. 55101

Chicago & North Western Rwy. — M. H. Crandall, Superintendent Motive Power, Chicago, Ill. 60606

Chicago, Milwaukee, St. Paul and Pacific R.R. — R. H. Maas, Assistant Mechanical Engineer - Locomotive, Milwaukee, Wisc. 53203

Duluth, Missabe & Iron Range Rwy. — J. M. Masterson, Locomotive Superintendent, Proctor, Minn. 55810

Soo Line R.R. — T. F. Kearney, Chief Mechanical Officer, Minneapolis, Minn. 55440

OUR OFFICERS

EASTERN REGIONAL EXECUTIVE

W. R. JAMES
Gen. Manager Locomotive
Maintenance-Engineering
Chessie System
Huntington, WV 25718

EASTERN REGIONAL EXECUTIVE COMMITTEE

Amtrak — J. F. Roseman, Assistant Vice President, Chief Mechanical Officer, Washington, D.C. 20024

Chessie System — J. H. Long, Manager Locomotive Dept., Cincinnati, Ohio 45225

ConRail — (Shops) M. J. Chandler, Superintendent Locomotive Shops - Electric, Altoona, Pa. 16603

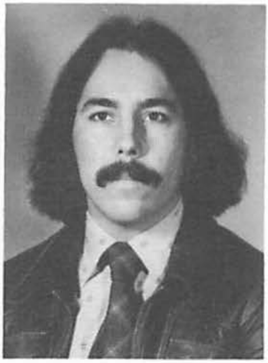
ConRail — (General) L. W. Brennan, Director - Locomotive Maintenance, Philadelphia, Pa. 19104

Pittsburgh & Lake Erie R.R. — C. H. Derner, Master Mechanic, Pittsburgh, Pa. 15219

OUR OFFICERS

TECHNICAL COMMITTEE CHAIRMEN

J. D. SMALLING, Chairman
Committee on Fuel & Lubricants
Engineer of Tests
Southern Pacific Trans. Co.
San Francisco, CA 94105



C. W. COX, Chairman
Committee on New Developments
Assistant Roundhouse Foreman
Santa Fe Railway Co.
Kansas City, KS 66106

M. GOGOL, Chairman
Committee on Diesel Mechanical Maintenance
Chief Quality Control Officer
Southern Pacific Trans. Co.
San Francisco, CA 94105

E. R. HAFLING, Chairman
Committee on Shop Equipment
Asst. Mechanical Engineer
Santa Fe Railway
Topeka, KS 66616

OUR OFFICERS

TECHNICAL COMMITTEE CHAIRMEN

J. J. GREGORY, Chairman
Committee on Diesel Material Control
Production Control Manager
Consolidated Rail Corp.
Altoona, PA 16603

C. E. PALME, Chairman
Committee on Diesel Electrical Maintenance
Diesel Electrical Engineer
Chessie System
Huntington, WV 25718

B. A. CUMBEA, Chairman
What's Your Problem Panel
Manager Locomotive Data Systems & Procedures
Chessie System
Huntington, WV 25718

OUR OFFICERS

ADVISORY BOARD

B. D. VENABLE
Vice President
Illinois Central Gulf RR Co.
Chicago, IL 60601

T. P. HACKNEY, JR.
Asst. V. P.-Mechanical
Chessie System
Huntington, WV 25718

F. D. ACORD
Chief Mechanical Officer
Union Pacific Railroad Co.
Omaha, NB 68179

F. B. FINDLING
Chief Mechanical Officer
Chicago Rock Island &
Pacific RR Co.
Chicago, IL 60605

OUR OFFICERS

ADVISORY BOARD

J. G. MOORE
Asst. Vice President—Mech.
Southern Railway Co.
Atlanta, GA 30303

W. H. CYR
Chief of M. P. & C. E.
Canadian National Rwys.
Montreal, Quebec, Canada

D. M. TUTKO
Chief Mechanical Officer
Missouri Pacific Railroad Co..
St. Louis, MO 63103

O. H. SUMMERS
Chief Mechanical Officer-M.P.
St. Louis-San Francisco Rwy. Co.
Springfield, MO 65802

OUR OFFICERS

ADVISORY BOARD

H. L. SCOTT, JR.
Gen. Mgr. M. P. & E.
Norfolk & Western Rwy. Co.
Roanoke, VA 24011

R. E. TAYLOR
Asst. Vice Pres.-Mechanical
Burlington Northern Inc.
St. Paul, MN 55101

D. F. HANEY
Asst. Chief Mech. Officer
CP Rail.
Montreal, Quebec, Canada

W. O. BROWN
Chief Mech. Officer—System
(Retired)
Southern Pacific Trans. Co.
San Francisco, CA 94105

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

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, Retired Asst. Vice-Pres. - Equipment, Seaboard Coast Line R.R., Jacksonville, Fla.

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

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

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

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

1954 & 1955 — F. D. SINEATH, Retired Chief of Motive Power, Seaboard Coast Line RR., Jacksonville, Fla.

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

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

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

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

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

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, Retired Chief Mechanical Officer, Louisville & Nashville R.R., Louisville, Ky.

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

1965 — J. J. EKIN, Retired Supt. Marine & Pier Maintenance, B. & O. R.R., Baltimore, Maryland

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

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

1968 — G. F. BACHMAN, Retired Chief Mechanical Officer, Elgin Joliet & Eastern Ry., 612 E. Bevan Drive, Joliet, 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 Equipment Engineering. Penn Central Co., 516 Bryn Mawr Ave., Bryn Mawr, Pa. 19010

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

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

1973 — W. F. DADD, 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

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

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

HONORARY LIFE MEMBERS

F. W. BUNCE, Retired Chief Mech. Officer, Missouri Pacific R.R., Co.

OWEN CLARKE, Retired Vice-President, Chesapeake & Ohio Ry., Cleveland, Ohio

W. P. COLITON, President, Western Maryland Railway, Baltimore, Md. 21201

J. J. DWYER, Retired Engineer Environmental Control, Chessie System, Huntington, W. Va. 25712 (P. O. Box 907)

W. T. FARICY, Retired Chairman of the Board, A.A.R.

J. G. GERMAN, Vice-President - Engineering, Missouri Pacific Railroad Company, St. Louis, Mo.

S. GRAHAM HAMILTON, General Manager, Locomotive Products Division, General Electric Company, 2901 East Lake Road, Erie, Pa. 16501

W. J. HARRIS, Vice President, Research & Test Dept., Assn. of American Railroads. 1920 L St.. NW, Washington, D. C. 20036

H. W. HAYWARD, Retired Chief M.P. & R.S., CP Rail, Montreal 101, Quebec, Canada

JOHN H. HERTOG, Vice-President - Operations, Burlington Northern, Inc., St. Paul, Minn. 55101

E. A. KUHN, Retired Chief Mechanical Officer, Baltimore & Ohio R.R., 107 Palmetta Lane, Harbor Bluffs, Largo, Fla.

S. T. KUHN, Retired Chief Mech. Supt., New York Central R.R., Box 113, Shelburne, Vt. 05482

C. M. LIPSCOMB, Retired Secretary-Treasurer, Locomotive Maintenance Officers Association, 1721 Parker Street, North Little Rock, Ark 72114

R. M. McDONALD, Retired Director of Operations, Board of Transport, Commissioners for Canada, Ottawa, Ont., Canada

F. K. MITCHELL, Retired Asst. Vice-President, New York Central Sys., Sleights Wildwood, Manitowish Waters, Wis. 54545

C. E. POND, Retired Gen. Mgr., M. P. & Equipt., Norfolk & Western Ry.

H. P. RODES, President, General Motors Institute, Flint, Mich.

F. E. RUSSELL, Retired Chief Mechanical Officer, Southern Pacific Co., San Francisco, Calif.

R. D. SPENCE, President, Consolidated Rail Corp., Philadelphia, Pa.

J. TAGGART, Retired System Mechanical Officer, Canadian National Railways, Montreal, Quebec

E. F. TUCK, Retired C. M. O. St. Louis - San Francisco Ry., 1638 E. Walnut Street, Springfield, Missouri

C. N. WIGGINS, Vice-Pres. and Asst. to President, Louisville & Nashville R.R., Louisville, Ky.

H. C. WILCOX, Retired Editor, Railway Locomotives & Cars

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB, INC.

Continuous Operation Since Organization in 1890

D. M. WALKER
PRESIDENT
Diesel Superintendent
Southern Railway
Atlanta, GA 30303

J. S. MASTRANGELO
SECRETARY
Norfolk and Western Railway
P.O. Box 1744
Roanoke, VA 24008

A mutual intercourse for the acquirement of knowledge, by reports and discussions, for the improvement of Railway Operations, Construction, Maintenance, and Equipment, and to bring into closer relationship men employed in Railway work and kindred interests.

Many major developments in the Railway Industry have been by participating Railroads in this Club.

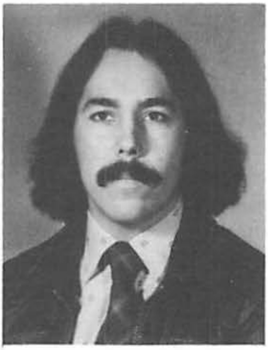
"Why not write our Secretary today and request a membership application?"

Monday, October 2, 1978

10:00 A. M.

REPORT OF THE COMMITTEE ON NEW DEVELOPMENTS

Pre-Convention Presentation: The Southern and Southwestern Railway Club



April 20, 1978
Ramada Inn
South Point, Ohio

C. W. COX, Chairman
Assistant Roundhouse Foreman
The Atchison, Topeka & Santa Fe
Railway Company
c/o Diesel Shop
22nd and Argentine Boulevard
Kansas City, KS 66106

VICE CHAIRMAN

J. J. Boline, Manager Computer & Quality Cost Control, Illinois Central Gulf Railroad, 233 N. Michigan Avenue, Chicago, IL 60601

COMMITTEE MEMBERS

G. R. Abernathy, Chief Mechanical Officer, Delaware and Hudson Railway Co., Watervliet, NY 12189

R. M. Campbell, Diesel Supervisor, Belt Railway of Chicago, Chicago, IL 60638

M. H. Crandall, Superintendent Motive Power, Chicago & North Western Transportation Company, Chicago, IL 60606

J. Gordon Dunlap, Master Mechanic, Missouri Pacific Railroad Co., Kansas City, MO 64120

David G. Goehring, Manager Maintenance Planning, Amtrak, Washington, DC 20001

A. C. Grover, Assistant Manager-Locomotive Engineering, Southern Pacific Transportation Co., San Francisco, CA 94105

Mark E. Kane, Manager-Locomotive Information Systems, Consolidated Rail Corp., Philadelphia, PA 19104

Walter Weck, Assistant General Service Manager, Electro-Motive Division, LaGrange, IL 60525

T. C. Whittle, Manager Product Planning, Locomotive Products Dept., General Electric Company, Erie, PA 16501

Bob Woods, General Diesel Supervisor, Florida East Coast Railway Co., St. Augustine, FL 32084

1978 TOPIC:
"NEW DEVELOPMENTS — HOW WILL THEY HELP SOLVE MAINTENACE PROBLEMS?"

PERSONAL HISTORY

CHRIS W. COX

Born in San Bernardino, California on Christmas day, 1947; thus the name Chris.

Began employment with the Santa Fe in June 1970 working as a machinist apprentice during summer vacations.

Upon graduation from San Diego State University, with a B.S. degree in Mechanical Engineering in February 1972 he entered a Management Training Program offered by the Santa Fe. On completion of the nine month program he was appointed to an assistant position in Santa Fe's Industrial Engineering Department at Kansas City Shop, and in July 1973 to Barstow Shop.

In December 1974 he was promoted to Locomotive Maintenance Supervisor for the system with headquarters in Chicago. In April 1978 he was moved to Kansas City to the position of Locomotive Gang Foreman.

Special interests are: antiques, woodworking, sports cars and many other crafts, including rebuilding antique guitars and antique furniture.

Is presently single.

INTRODUCTION

In following the topic of how new developments will help solve maintenance problems, the committee has developed five major areas which offer promise and bear discussion:

I

Application of Micro-Processing Equipment for Locomotives: While still in early development as far as locomotive maintenance is concerned, this new tool could bring about substantial improvements in the traditional way locomotives are maintained.

II

Locomotive Warning Light Systems: This overview of warning light systems is presented along with the history of some recent technical development in this area, alternatives, etc.

III

Fuel Conservation and Measurement: This has been, without a doubt, one of the most talked about topics on any railroad since the energy crisis began. Nevertheless, much research remains to be done by most railroads.

IV

The Recording of Events in Locomotive and Train Operation: A recording system on board locomotives used to monitor train operation and supply information that will allow for better train handling and thus reduce maintenance costs.

V

New Concepts in Locomotive Development: There is little doubt that with improved design of locomotives the maintenance dollar would be better protected. New concepts and future designs are presented.

While not presented as an exhaustive list of all possible "sky

blue" developments now under way by all research labs in the industry, we believe the above items deserve merit and consideration, and seem to be practical for railroads at the present time. As each of these topics is presented, bear in mind that we are looking for alternatives or approaches to new developments but by no means intend to imply that the search ends here. There will always be new developments. It will depend on all of us to determine if they are applicable to our industry, practical in the shop environment and are used to optimum advantage.

I. APPLICATION OF MICRO-PROCESSING EQUIPMENT TO LOCOMOTIVES

Background

A new form of computer technology was developed in the early 1970's — the micro-processor or micro-computer. A couple of years after its development in the laboratory many of us first began to notice the technology in such commercial products as video games.

Application of these small computers, however, are not limited just to toys. The typical micro-processor is capable of performing nearly as many complex jobs as the big computers, but is normally dedicated to a special purpose or function, accomplishing one task at a time. The capability of the micro-processor to accept programs that can easily be changed by a programmer allows for great flexibility and a wide range of applications. Loading different software (programs) into the same machine at various times for different applications further extends the utility of the device.

A micro-processor can rival the speed and general-purpose nature of the big centrally located computers at a fraction of the cost. In fact, the cost of the basic component of the micro-computer, the central processing unit (CPU), has fallen to about $10.00 per chip and is smaller than a postage stamp. However, when adding to this the cost of internal memory, controller, power source, input/output devices, etc., the cost of a basic system will probably climb to the $500-$1,000 range or more depending on the extent of peripheral devices or sensor required. This is still, however, a many orders of magnitude reduction in cost from the larger scale computers of a few years ago.

Railroad Applications

Since the technology of micro-processors (the computer on a chip) is so new their use has not invaded the railroad arena in force as yet, but there is little doubt that they are coming faster than most of us probably realize. In the specific locomotive maintenance area the applications for micro-computers seem to fall into two basic categories at present.

1. Those applications that monitor and/or record relevant events at timely intervals (this can be in the micro-second range) on board the locomotive.

2. Those applications that process data at the shop level on a stand-along basis or as a front-end to a host main frame computer at a remote site.

As one example, the first category is being used by one of the locomotive builders to monitor turbocharger performance on line of road. The computer accepts input from sensors (transducers) that detect (thru an analog to digital converter) such signals as barometric pressure, compressor input pressure, inlet manifold air pressure, exhaust manifold pressure; and remotely mounted thermocouples that provide ambient, inlet manifold, exhaust manifold and inlet water temperatures. The program evaluates the data by comparing them to various program parameters. For output, display lights provide a visual method to indicate a dirty inlet port, dirty radiators, dirty intercooler, dirty air filters, incorrect horsepower, air system problems, etc.

The micro-computer can handle a wide range of sensor inputs from multiple sources on the locomotive. A typical machine is capable of handling up to 256 separate inputs and/or outputs from as many sensors, almost simultaneously for extensive performance evaluation.

Other areas of current interest include such applications as utilizing already equipped on-board electrical harness to provide for line-of-road diagnostics; measurement of fuel and power output for fuel saving evaluation; and, recording of events (actual current level of electrical devices) for later shop evaluation.

While these are only a few possible uses for an on-board computer, one needs only to use his imagination to visualize the number of applications possible with this new tool. The one consideration, however, is the reliability and initial cost of the sensors and peripheral hardware. The computer itself is relatively inexpensive and reliable, but once the additional hardware (including special housing to reduce vibration, dirt, etc.) is added to the complete on-board system the initial cost per unit may well approach $10,000 or more, plus periodic maintenance. In recent equipment testing, sensor reliability in most cases has been more of a maintenance problem than the micro-computer itself.

The second category, using a computer at the shop level, employs the micro-processor typically with more off-the-shelf hardware and at lower cost than the on-board monitoring approach. One of the applications will probably be in processing recording media removed from locomotives containing relevant information about events that took place on line-of-road. Such events might well be in the train handling area - e.g., throttle notch, brake application (dynamic, independent and automatic), wheel slip, reverser position, sand application, speed and possibly distance (location of event). Other recorded events could very well be more maintenance oriented, such

as temperature of lube oil and cooling water, air box pressure, smoke detection in the top deck, current output of main generator and auxiliary generator, state of governor and load regulator, etc.

Once these recorded events in the form of say, a magnetic tape, are removed from the locomotive consist at its maintenance terminal, the micro-computer can immediately begin analyzing the raw data. Due to the speed of the processor, information relative to the operation and/or maintenance functions can be produced before the unit is ready for servicing.

The computer can perform complex relational tests on this data based on many parameters within the program. Some of the relationships that are meaningful are wheel slip to ruling grade, and traction motor amps to time. In other words, the event in itself may not necessarily be important, but when observed in relation to other interacting events, may become very meaningful. With proper programming, the machine can produce a concise summary of meaningful information without the need to perform the same analysis manually on streams of input data.

While this report probably raises more questions than it answers, the intent is to acquaint you with this new tool. There is little doubt that in the years to come it will be used in a variety of applications, some of which are only suggested here, in the locomotive maintenance function.

II. LOCOMOTIVE WARNING LIGHT SYSTEMS

The purpose of locomotive warning lights is to increase visibility of a moving train as it approaches grade crossings, stations and locations where the right-of-way may be fouled by persons or machinery.

It has been determined that there are 370,000 grade crossings in the United States of which only 50,000 or 13.5% are protected by active warning systems (flashers, gates, etc.). The remaining 320,000 crossings have passive systems, or in the case of many of the 170,000 private crossings, no warning at all.

Locomotives are presently equipped with two warning systems:

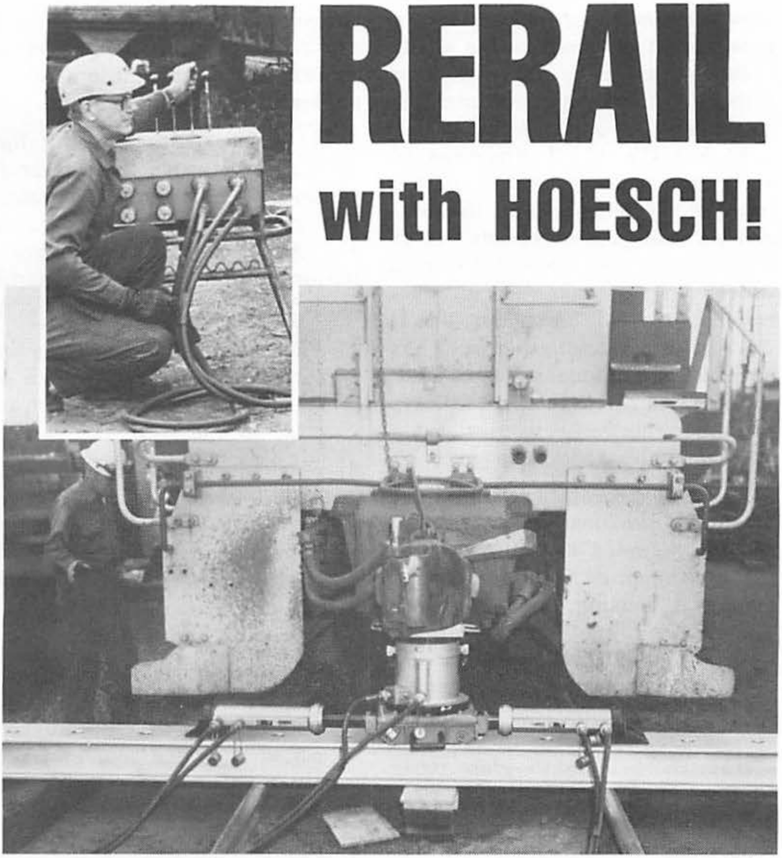
—Audible — consisting of the horn and bell.

—Visible — consisting of a headlight.

With the advent of the totally enclosed, air conditioned, stereo-equipped automobile, audible warning devices have become ineffective beyond the immediate area of the grade crossing.

Some railroads have been using additional locomotive lights to help warn motorists. One is the white, oscillating or "Mars" light. This was extensively used on passenger trains operating in the Midwest, West and South. One Western railroad has used the oscillating light on all of its road locomotives since the mid-sixties. This warning light

RERAIL with HOESCH!



The Hoesch hydraulic rerailing system is comparatively inexpensive, and highly dependable, versatile and efficient. It can be purchased as a complete system, or components can be bought separately. If you already have trucks equipped with jacks for the lifting operation, you can add Hoesch components to handle lateral car movements. Write or call for complete information.

HOESCHAMERICA

3340 Peachtree Road, N.E., Tower Place 2470, Atlanta, Georgia 30326
Telephone 404/261-7111

is particularly effective when viewed from the front of an approaching train and can be easily seen for distances of a mile or more, depending upon atmospheric conditions. At night the oscillating light has the added dimension of a moving beam of light projected into the sky out ahead of the locomotive. This beam reflects off of telegraph poles, trees, hills, etc., which further enhances its eye-catching appeal. A major disadvantage of the oscillating light has been the maintenance cost associated with drive motor failures and the relatively narrow beam area in which it can be seen.

A more recent warning light originally developed for automotive use and adapted to railroads was the roof-mounted rotating light in a colored housing, usually amber. The rotating light has been more effective as an attention getting device when viewed from an angle to an approaching train. When viewed from directly in front of a train the headlight's glare tends to mask the rotating light. Several railroads using this device have reported problems with motor and bulb reliability, especially on poor track. However, roof rotating lights have been well-rated as attention getting devices in either of two possible configurations:

1) Rotating beacon.
2) A sealed beam lamp fixed in the upper dome which is aimed down on a rotating wedge-shaped reflector.

A third type using three 75 watt sealed beam lamps which were flashed sequentially was judged poor in daylight because the fixed position lamps did not provide full brightness at all angles.[1]

The most recent warning light systems use xenon high intensity strobe lamps. After approximately five years of testing on as many as 300 locomotives the following parameters have been generally agreed upon:

1) Flash frequency—not more than three flashes nor less than one flash per second. Preferably close to one flash per second.
2) Flash duration—Most effective at 0.1 second. Since a xenon tube flashes at approximately 2 milliseconds, a double pulse flash within a tenth of a second will simulate or appear as a single, 0.1 second flash.
3) Arrangement of lights—as high and as far apart as possible. This dictates that the lights be mounted on the roof of the locomotive and close to its outer edges.
4) Flash sequence—There is not agreement on whether the lights should flash alternately or in unison. Alternate flashing is claimed to give a sense of motion and for a given repetitive rate will double lamp life. Lights flashing in unison are said to eliminate the need for the viewer remembering the position of the previous flash on a moving locomotive and help the viewer sense the speed of the approaching train by the

change detected in the separation of the lights.[2]

Most locomotive mounted lights in use today flash alternately.

5) Time during which lights should flash—The most desirable, to avoid crew annoyance and enhance attention getting, is to have the lights flash only when the horn and bell are operating and for a duration of 30 to 60 seconds after the horn and/or bell are finished sounding.

6) Beam size—At least a 180 degree spread out in front of the locomotive. Vertically about +2 degrees through -5 degrees.

7) Intensity—
Day: 4,000 to 10,000 candela.*
Night: 40 to 1,000 candela.
*A candela represents 1,000 candle power in a 3 millisecond flash. Therefore, 1,500 candela equals 1.5 million candle power. One candle power equals the light intensity of one candle at a distance of one foot. A sealed beam headlight has an output of 260,000 candle power or 260 candela.

8) Color—White or unfiltered xenon strobe.

Durability tests of strobe lights were begun in 1973 on switch engines. These operated for 7,000 hours without a reported failure. Road testing was begun in 1974 and within a year compiled over 3,000 hours of operation. Some complaints were recorded by crews because of reflections from very near surfaces such as canyon walls, buildings or passing trains. Concern was also expressed by crews and personnel working in yards. These lights have a single intensity of 800 candela which is above that required for nighttime effectiveness. The negative comments of the crews reinforced the desirability of using a multiple intensity lamp which would permit greater intensity while operating on line of road and a lower intensity when approaching opposing trains and operating in yards.

By tying into the front headlight control switch it is possible for:

a) Bright to select an intensity of 1500 candela.

b) Dim to select an intensity of 200-300 candela.

c) Off to prevent the strobes from operating.

Four railroads have been testing DOT supplied strobe light systems with lights manufactured by three vendors. In addition, one railroad has equipped at least 130 locomotives with strobe units. Maintenance problems, to date, have mostly occurred as a result of high-voltage spikes damaging the power supplies. One manufacturer reported he has corrected this problem by adding extra heavy duty suppression to both the positive and negative leads. Xenon strobes eventually burn out and must be replaced. There has also been damage caused by vandalism.

A feature added by some railroads is a red strobe mounted in a sealed beam lamp and located in the front of the locomotive. This light is tied into the brake pipe and is activated when the brake pipe is in emergency or reduced to a pressure of less than 20 psi.

One railroad has a contract with DOT to determine the effectiveness of strobe light warning systems in reducing grade crossing accidents. The locomotives involved in the test were made up into two pools. One pool of 43 units was not equipped with strobe lights. A second pool of 43 units was equipped with strobe lights. (Lights were manufactured by two suppliers.)

Routes between various city pairs were selected and by analysis of the National Railway — Highway Grade Crossing Inventory conducted in 1973, the number of grade crossings on each city-pair route was determined. Each time one of the selected 86 locomotives traversed a city-pair route as a lead locomotive, the amount of exposure to automotive traffic was calculated. The calculations took into account the number of crossings, the traffic volume due to type of road or highway traversed and the hour of the day the train was operating. Therefore, by multiplying the number of crossings by the average daily vehicle exposures at each crossing allowance is being made for differing traffic volumes between the city-pairs.

At the time this paper was written (April 1978) there have been no published results of these tests. When the final report is made it will include three histograms. The vertical or y-axis will contain the number of times a locomotive has transversed crossings. The x-axis will contain increasing ranges of traffic exposure and the number of crossings in each range. The graph will provide a comparison of accidents per mile travelled between strobe-equipped and non-equipped locomotives.

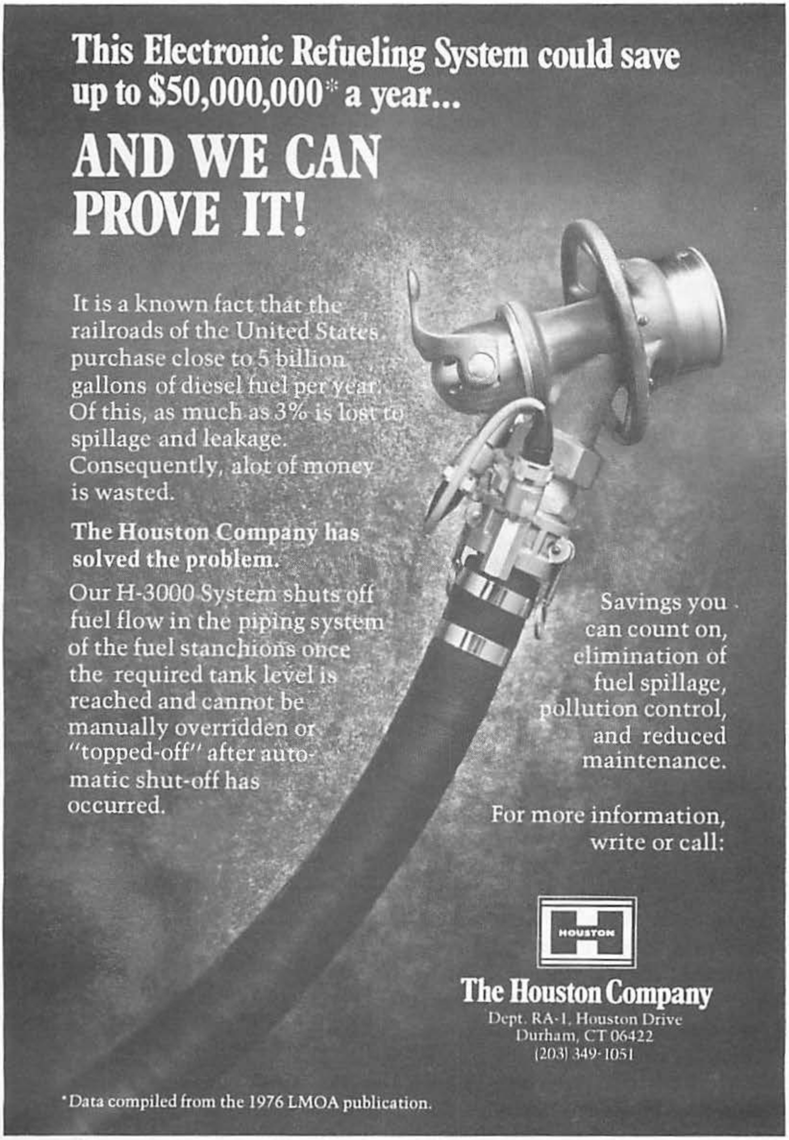
SUMMARY

Two reports published by the FRA[1, 2] have stated that bright, flashing lights make a locomotive more conspicious or "attention getting." These reports also state that the xenon strobe best provides the source for the light flashes. Not until test reports are published will there be an indication whether the flashing strobe light mounted on a locomotive contributes to a reduction of collisions between automobiles and trains at grade crossings.

The cost of maintenance of strobe light systems is still not known. Because the strobe light is relatively new to railroad applications there have been high failure rates of some of the components. Improved design and application will eventually reduce the failure rate and consequently reduce the maintenance cost from present levels. Whether these costs will ever achieve acceptable levels for general railroad use still remains to be determined.

[1]FRA—OR + D — 75-74
Field Evaluation of Locomotive Conspicuity Lights by Devue & Abernathy.

[2]FRA—OR + D — 75-71
Guidelines for Enhancement of Visual Conspicuity of Trains at Grade Crossing by Hopkins & Newfell.


This Electronic Refueling System could save up to $50,000,000* a year...
AND WE CAN PROVE IT!
It is a known fact that the railroads of the United States purchase close to 5 billion gallons of diesel fuel per year. Of this, as much as 3% is lost to spillage and leakage. Consequently, alot of money is wasted.
The Houston Company has solved the problem.
Our H-3000 System shuts off fuel flow in the piping system of the fuel stanchions once the required tank level is reached and cannot be manually overridden or "topped-off" after automatic shut-off has occurred.
Savings you can count on, elimination of fuel spillage, pollution control, and reduced maintenance.
For more information, write or call:
HOUSTON
The Houston Company
Dept. RA-1, Houston Drive
Durham, CT 06422
(203) 349-1051
*Data compiled from the 1976 LMOA publication.

III. FUEL CONSERVATION AND MEASUREMENT

The rapidly accelerating fuel costs of the 1970's have made fuel conservation a No. 1 priority for both railroads and locomotive manufacturers. From the railroad standpoint, the emphasis has been placed on locomotive operation, maintenance and fueling facilities. From the builder's standpoint, the thrust has been on improving overall locomotive efficiency by reducing auxiliary load and improving transmission and engine efficiency.

The railway Fuel and Operating Officers Association published a booklet entitled "Fuel Conservation From an Operating Viewpoint." In this publication, they point out that fuel can be conserved by proper attention to the following:

- initial charging of train brake system
- reduced speed operation
- power braking
- shutting down engine to avoid prolonged idling
- locomotive operating condition.

It may be of interest to take a quick look at one or two of these items. For example, with reduced speed operation, the saving results from the fact that the train resistance decrease with lower speed. Figure 1 covering operation on level track shows that a 5 MPH reduction in train speed will result in approximately an 8% savings of fuel. A 10 MPH reduction will produce a 15-16% reduction in fuel consumption. Some people who have been involved in tests of Fuel Saver equipment believe this is one of the primary reasons the Fuel Saver shows a reduction in fuel consumption.

Locomotive operating conditions play an important part in fuel economy. Cooperation by the Operating department in reporting such things as locomotive exhaust conditions, abnormal turbo air pressure, low fuel oil pressure, and fuel oil leaks will greatly help the Mechanical department in doing its portion of the job.

When evaluating locomotive performance, at least two basic measurements should be made. These are locomotive fuel consumption and locomotive power output. The procedures for obtaining this information from stationary testing have been refined to the point where results are quite accurate and repeatable. While stationary testing is adequate for evaluating some design changes, actual over-the-road service measurements are required to prove out many changes that are aimed at fuel economy. This applies to some design changes being considered by the builders, but especially to changes in operating procedures. The study of the Fuel Saver equipment that has been going on for the past year is a good example of the need for reliable and accurate equipment for over-the-road testing. EMD and GE have been working on equipment for over-the-road fuel consumption measurement.

The fuel consumed by a locomotive can be measured by a system devised by Electro-Motive Division using commercially avail-

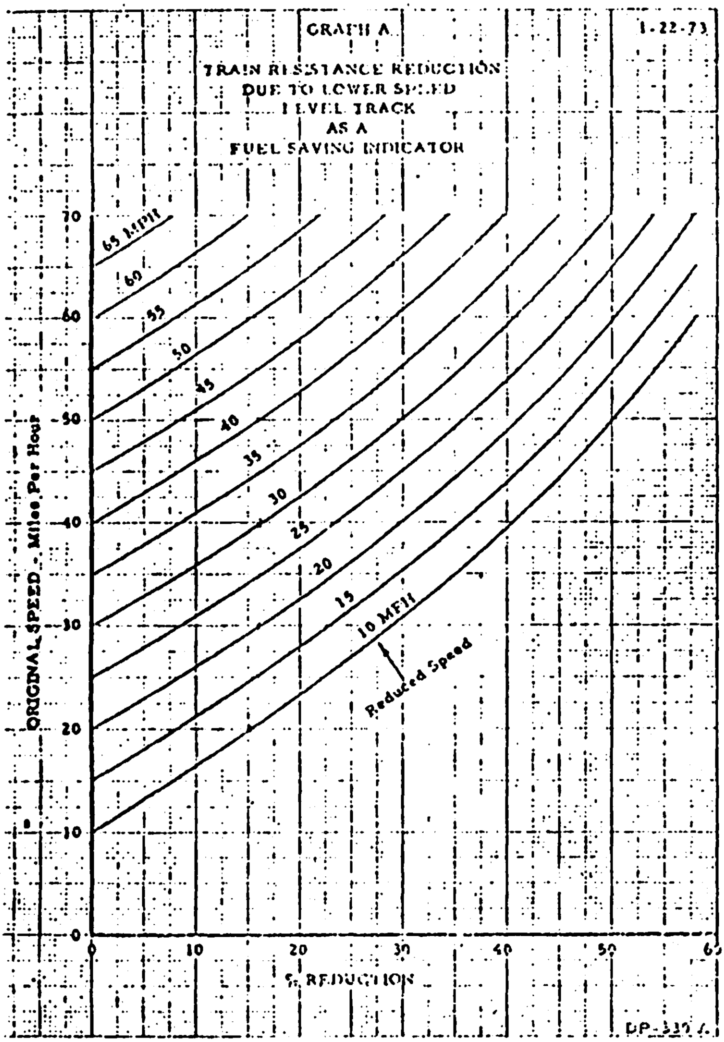

GRAPH A
1-22-73
TRAIN RESISTANCE REDUCTION
DUE TO LOWER SPEED
LEVEL TRACK
AS A
FUEL SAVING INDICATOR
65 MPH
60
55
50
45
40
35
30
25
20
15
10 MPH
Reduced Speed
ORIGINAL SPEED - Miles Per Hour
70
60
50
40
30
20
10
0
10
20
30
40
50
% REDUCTION

FIGURE 1

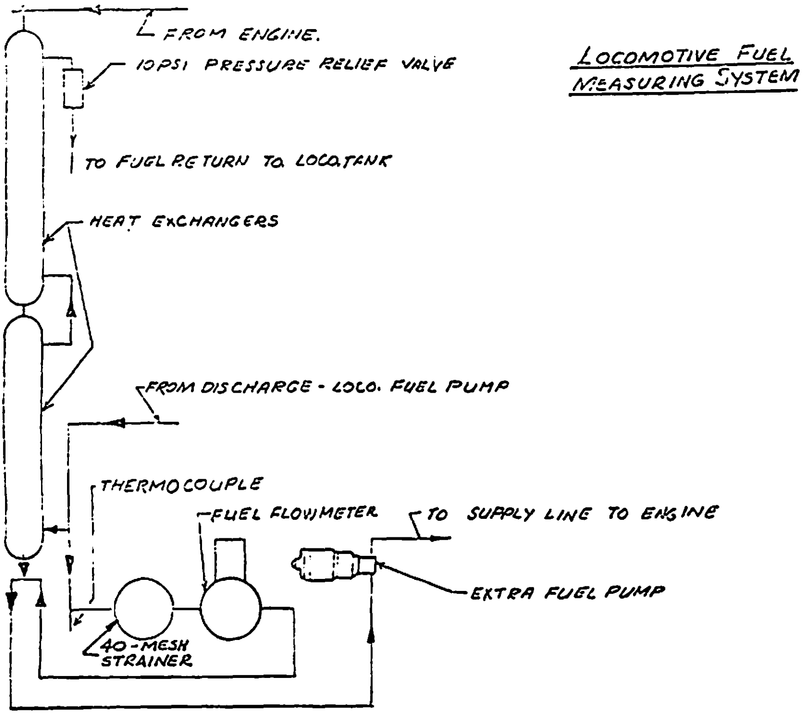


FIGURE 2

able components. This system has proved to be quite accurate and can be applied to EMD locomotives without removing any elements of the present onboard locomotive fuel system. However, several pieces of equipment must be installed on each locomotive. A list of the fuel equipment required including unit prices and approximate procurement time is available from the locomotive manufacturer.

Figure 2 indicates the schematic piping diagram of the fuel measurement system components which must be added to the existing onboard fuel system. An unique feature of this fuel measuring system is that only one fuel flow meter is required per locomotive. The fuel flow meter is a positive displacement meter which provides a digital reading of total gallons of fuel consumed similar to a domestic water meter. This meter requires fuel which is free of particulate matter. Therefore, care should be exercised to assure that connecting piping and hose are clean when applied.

The General Electric system for onboard fuel measurement is combined with a system for power measurements. When the program

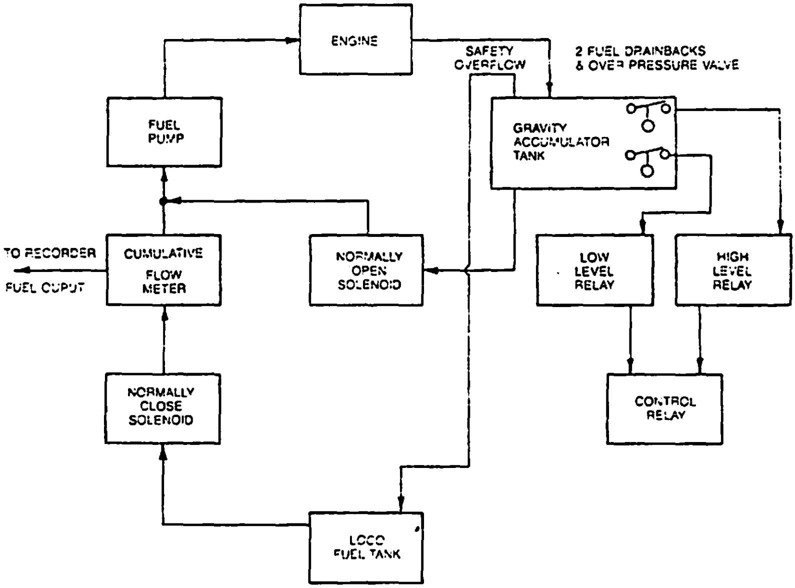


FIGURE 3

was undertaken, the objective was to develop an engineering tool accurately to evaluate design changes directed at fuel economy.

The fuel measuring equipment is a self-contained package. The flow diagram is shown in Figure 3. It contains a single flow meter, an accumulator tank and a system of solenoids and relays that control the source of fuel for the locomotive fuel pump. During a typical cycle starting with the accumulator tank empty, the two solenoid valves are energized. Fuel is supplied from the locomotive tank and the flow meter measures fuel at the full flow rate of the pump. The meter can be matched to this single flow rate assuring a high degree of accuracy.

The fuel that would normally return to the locomotive fuel tank is held in the accumulator tank. When the accumulator becomes full as signaled by the upper float switch, the solenoid valves are de-energized. The locomotive fuel pump is then supplied from the accumulator tank by-passing the flow meter. This mode of operation continues until the lower float valve signals that the accumulator tank is empty and the relay system energizes the solenoid valves. The cycle then repeats.

The flow meter has both recording dials and a recorder output signal. The recorder provides a record of total, motoring, dynamic braking and idle fuel.

The same recorder is used with the power measuring equipment. The following measurements are totalized.

Power	Fuel	Time
Total	Total	Total
Motoring	Motoring	Motoring
	Dyn. Brake	Dyn. Brake
	Idle	Idle

The power measuring equipment utilizes traction alternator volts and amps. Voltage isolation amplifiers protect the equipment. High accuracy static multipliers perform the power calculations. A time base, generated within the equipment, is used to obtain kilowatt hours.

The recorder stores information in "E" cells. These are precision devices in which an electrical pulse transfers metal from one plate to another. When the cells are placed in a readout instrument the process is reversed and the number of input pulses determined. The pulses are readily converted to time, kwh's or gallons of fuel.

A commercially available set of equipment for onboard power measuring is being utilized by the Southern Pacific Transportation Company. From all indications, it is very reliable. The equipment includes a computer which calculates instantaneous load over a span of 0-3600 kilowatts. The computer integrates instantaneous load and produces one count per 1/10 kilowatt hour. The kilowatt hours are displayed on both a six-digit manually resettable counter and an eight-digit non-resettable counter. Inputs of current and voltage to the computer are provided by current and voltage meters.

With the emphasis being placed on over-the-road measurements, it is just a matter of time until the systems perfected will be as accurate and reliable as those used in stationary testing.

IV. THE RECORDING OF EVENTS IN LOCOMOTIVE AND TRAIN OPERATION

What will save the mechanical supervisor who inspects those scores of "over-amped," overheated" and "unwound" traction motors in the repair line, and that road foreman of engines whose eyes crossed as the speed tape ran blank 10 miles before that "million-dollar crash"? Will these men see peace in the age of electronic train operation recording systems?

In the Progressive Railroading issue of May-June 1973, an article was published describing Vapor's new Train Operation Recording System. A more current article appeared in Railway Age dated November 29, 1976. Since these articles were published, a great deal of interest and growth has taken place in train operation recording systems. Another type of recording system was developed on the Southern Railway and is being manufactured by Pulse Electronics, Inc. A number of railroads are

presently using both of these systems.

The basic goal set forth by management to justify the acquisition of this equipment is to obtain safer and more economical train operation. This goal can be reached by reducing train accidents, improving fuel economy, improving train schedule performance, reducing loss and damage claims, gaining more efficient use of motive power; and last but not least, maintaining a quality of locomotive operation to prevent equipment damage.

The recording equipment taps into locomotive functions at various sensing points and measures various parameters. A wide range of equipment is available so that any particular railroad can choose the functions most fitting to its particular type of operation. The following functions are the ones most commonly recorded with the present systems:

1) speed
2) distance
3) reverse movement
4) train brake application
5) train line sanding
6) train line wheel slip
7) "power on" notch 1-8
8) independent brake cylinder pressure
9) dynamic brake amp level
10) horn
11) track location
12) traction motor current

The track location is obtained by passive inductive elements located on the track ties. The number of track locating elements used will determine the accuracy of the recording system when comparing record information to track chart information. The number of track locating elements can be minimized by programming track chart information into a central computer master file.

The functions listed above are recorded on magnetic tape. The information retained on the tape can be used in a number of ways. Portable playback units are available for immediate field investigations. The playback units can be used by road foremen of engines to "spot check" train crews for training purposes. The information stored on the tapes can also be fed into main computer systems which have been programmed to generate exception reports for the territory covered by a particular train movement.

Exception forms can be generated with various formats based on the user's needs. The primary function of the exception report is to review the information recorded during train handling and compare this information with specified train handling information which is stored in the computer for the particular territory in question. The computer program is designed to print out on the "Exception Report" deviations from specified train handling rules.

Examples of exception printouts are: speed violations, improper use of air brakes, excessive amperage

in traction motors beyond short time rating, excessive wheel slipping, improper use of dynamic brakes, malfunction of alternate control system and failure to use horn and bell at highway crossings.

The exception reports can be furnished for particular train movements or particular crew members to judge their performance. The most cost effective program would be to check on a random sample basis. Random sampling would keep the reports generated at a minimum so that all exceptions found could be handled in the proper manner with the train crews in question to provide feedback for training purposes. Random sampling would also maintain a more effective surveillance system to keep overall performance at an optimum level because no one would actually know when his train handling performance was being monitored.

The magnetic tape information stored in the computer will eliminate the requirement for the cumbersome use and storage of speed recorder tapes. If the information is required for documentation at a later date, a hard copy can be generated.

The train recording systems will require a certain amount of maintenance to insure they are functioning properly. The manufacturers have available verification systems to check the validity of the recording systems. The time periods between verification checks will, of course, be dictated by the reliability of the equipment.

This brings to mind the question: "How reliable are these recorders and their associated equipment?" Reports thus far have shown the reliability to be quite good; however, more service life will be required before judgement can be passed.

The recording systems appear to have merit in their goals and basic design. Like any new system, the train operation recording systems still must prove their economic effectiveness. The basic question still remains: "Will the cost of purchasing and maintaining this equipment be offset by the savings derived?" The only way to make this system effective is to use the exception reports on a regular basis to provide the necessary feedback to the operating crews so they can be trained to reach the goals set forth for this system.

Future goals of this system might be directed toward recording actual locomotive performance and utilization information. This information could be used in conjunction with micro-processing equipment (as discussed in the first section of this paper) to predict maintenance requirements and alert maintenance officers.

V. NEW CONCEPTS IN LOCOMOTIVE DEVELOPMENT

Current developments are directed in two areas; toward improvement in standard production locomotives and field testing of experimental designs and components. The railroads in general are show-

ing less interest in obtaining the highest horsepower units available and are expecting reduced maintenance costs and improved reliability from the moderate horsepower models. The builders have responded to this trend by placing considerably more emphasis on improving standard versions, as noted in EMD's "-2" and GE's "77" series locomotives.

Some interesting new concepts and features now being tested or recently approved for use are listed below:

1. **Improved traction motor and axle gearing.**
   Gear tooth profiles have been redesigned for more contact, reduced wear and less susceptibility to transmission of harmful vibrations to traction motors. Applications so far are limited and undergoing service testing.

2. **Improved EMD gear case.**
   The new EMD gear case is side mounted to increase stability and reduce loosening. The overall construction is heavier to reduce welding and fatigue cracking. Outline changes increase sump capacity. Axle seal rings and gear labyrinths reduce leakage. The new design allows use of improved gear lubricants by providing better sealing.

3. **Engine pre-lube systems.**
   The purpose of these systems is to automatically provide lube oil to the engine prior to starting and thereby prevent damage due to "dry starts." A separate pump, piping and time delay control is required to assure desired pressure or oil flow is reached before engine cranking can begin. Application arrangements should be designed as needed for various engine models to provide desired protection with minimum delay for starting.

4. **Other engine starting protection systems.**
   A system has been developed which prevents starting if a set lube oil pressure is not obtained in a given time interval while cranking. This is intended primarily to protect against a failed lube oil pump. This feature is available from GE on new units and also for retrofit purposes.

   Another system has been designed to protect against cylinder damage due to hydraulic action when starting. This provides a slow initial turnover to allow detection of fluids in the combustion chamber. EMD can provide this feature on new units and for retrofit also.

5. **Blended brake system.**
   A combination of air brake and dynamic brake that is applied automatically when the enginemen applies the air brakes. The blending of the two systems occur in the proper proportion without any action on the part of the engineman other than the application of air.

6. **Use of 42-in diameter wheels.**
   Presently 42-in. wheels are

being used by one railroad on new and older units having HT-C trucks. The use of these wheels with one inch thicker rims allows an additional wheel truing cycle and extends service time before wheel renewal is required.

Reports indicate savings are possible in labor and material costs as well as locomotive out of service time.

New technology needed for solving existing maintenance problems:

1. Propulsion system featuring
   a. Thyristor or equivalent control
   b. Three-phase AC brushless fully suspended motors
   c. Individual axle wheel slip correction.
2. Cab design — complete noise and vibration isolation.
3. Control layout emphasizing human engineering design.
4. Use of dynamic brake energy on board locomotives.
5. On-board vibration analysis to detect equipment problems to predict failures.
6. Redesigned braking systems to reduce pins, bushings and linkages.
7. A better lubrication system for traction motor suspension bearings.
8. Electronic governor system.
9. On-board malfunction and performance monitors operating in conjunction with a microprocessor for parameter comparison.
10. Replacement of reversers and power contactors with solid state devices.
11. Compartmented locomotive carbody — broken down such that all major components would be accessible.
12. Plug-in high voltage cabinet.
13. A true cold weather locomotive — a unit that could be shut down and started at 0°F temperature.

Presently undergoing field testing are two experimental locomotives, the EMD GP40X and the Morrison-Knudson TE70-4S. A brief description of these units follows.

The GP40X is a 4-motor unit with a 3500 horsepower rating. These prototype units are being tested on four major railroads.

The TE70-4S is a 4-motor unit rated at 2800 horsepower for traction. Power is supplied by a Sulzer 12ASV25/30 diesel engine made in Switzerland. This is a 4-cycle, turbocharged, V-12, 250 x 300 millimeter bore and stroke (approximately 10" x 12") engine running at a top speed of 1000 RPM. This will be the first use of this engine in a locomotive application.

The cooling system was designed and built by Behr & Co. in Germany. The equipment blower and radiator fans are driven by hydrostatic motors supplied by engine-mounted hydrostatic pumps. Fan speed is variable from zero to full speed with this arrangement. The engine lube oil filtration system employs reuseable, cleanable fine mesh screen elements and small centrifugal filters for additional by-pass oil cleaning. All parts are readily cleanable.

Other than the special features mentioned above, the TE70-4S units utilize mostly standard components and parts common to other U.S. locomotives. Four of these units are now being tested in general service.

SUMMARY

In discussing new developments and how they will help solve maintenance problems, we presented five areas which we felt either showed good potential or were of general interest. It is our sincere hope that the presentation has given you something to think about and that in the years to come we will all be fortunate enough to be able to utilize some of the technology only mentioned briefly here. We are certain there are many other areas to be explored including new materials and products of the locomotive builders and suppliers perhaps only now on the drawing board. Space would not allow their inclusion in this paper. However, practical new developments will be closely followed and discussed in future papers. We will continue to search out new developments and determine how they will help solve maintenance problems.

Chicago Railroad Diesel Club

G. W. SCULLY
PRESIDENT
General Foreman
Elgin, Joliet & Eastern Railway Co.
Joliet, IL 60434

We of the Chicago Railroad Diesel Club were again pleased to be hosts to the Locomotive Maintenance Officers Association for their April 3, 1978, Pre-Convention Presentation.

Mr. Mike Gogol, Chief Quality Control Officer, Southern Pacific Transportation Co., and his committee on Diesel Mechanical Maintenance presented their paper entitled "Problems, Causes, Prevention and Repairs."

Meetings: We meet on the first Monday of each month except July, August and September.

Monthly Publication: Issued to all members.

Membership: We welcome all railroad and railroad supply personnel. For further details please contact our Secretary-Treasurer.

CHARLES R. LOUGH
SECRETARY-TREASURER
Manager Locomotive Maintenance Planning
Chicago and North Western Transportation Co.
504 South Edson
Lombard, IL 60148

Monday, October 2, 1978

2:00 P. M.

REPORT OF THE COMMITTEE ON DIESEL MECHANICAL MAINTENANCE

Pre-Convention Presentation: Chicago Railroad Diesel Club

April 3, 1978 Midland Hotel Chicago, Illinois

M. GOGOL, Chairman
Chief Quality Control Officer
Southern Pacific Transportation Co.
One Market Plaza, Room 303
San Francisco, CA 94105

VICE CHAIRMAN

F. I. Burchett, Mechanical Assistant-Locomotive, The Atchison, Topeka & Santa Fe Railway Co., 80 East Jackson Boulevard, Chicago, IL 60604

COMMITTEE MEMBERS

I. L. Bonsall, Manager Special Projects, Consolidated Rail Corp., Philadelphia, PA 19104

W. A. Brown, Assistant Manager Motive Power, Burlington Northern, Inc., St. Paul, MN 55101

L. M. Buffington, Assistant Superintendent Locomotive Shops, St. Louis-San Francisco Railway Co., Springfield, MO 65802

L. M. Daniel, Senior Mechanical Assistant-Motive Power, Canadian National Railways, Montreal, Quebec H3C 3N4

R. W. Diamond, Master Mechanic, Missouri Pacific Railroad, North Little Rock, AR 72116

E. M. Dobbels, Assistant Superintendent Motive Power, Chicago, Rock Island & Pacific Railroad, Kansas City, KS 66105

M. M. Early, Mechanical Supervisor-Locomotive, Norfolk & Western Railway, Roanoke, VA 24011

J. L. Gregory, Assistant Shop Manager, Southern Railway Co., Chattanooga, TN 37402

A. C. Hillhouse, Manager Locomotive Service, General Electric Company, Erie, PA 16531

J. M. Masterson, Locomotive Superintendent, Duluth Missabe & Iron Range Railway Co., Proctor, MN 55810

R. T. Thetford, Superintendent Motive Power, Illinois Central Gulf Railroad, Chicago, IL 60601

B. L. Thomas, Manager Component Rebuild, Chessie System, Huntington, WV 25718

L. F. Turney, Manager Technical Section. Electro-Motive Division, LaGrange, IL 60525

1978 TOPIC:
"PROBLEMS, CAUSES, PREVENTION AND REPAIRS"

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 and Research, became Chief Mechanical Engineer in 1966 and Assistant Superintendent Mechanical Dept. 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.

I. POWER ASSEMBLY WATER LEAKS ON E.M.D. POWER

E. M. D. maintains records of power assembly water leaks on original equipment warranty failures. These records reflect failures handled under warranty on new locomotives January 1, 1976 through December 31, 1977. The population of locomotives involved 18,348 assemblies. These assemblies had an average age of one year. Failures may include assemblies two or three months old up to possible 1 year - 11 months.

Total Failures 81: Failure Rate 0.440%

32 Water inlet tubes—0.283%
- 32 cracked tubes
- 14 leaking at joint
- 4 leaking at gasket surface
- 1 broken tube
- 1 broken saddle strap

12 Cylinder heads—0.065%
- 6 water leaks
- 4 cracked injector wells
- 1 cracked firing face
- 1 cracked (location unknown)

8 Cylinder liners—0.040%
- 4 water leaks
- 4 cracked

3 Head to Liner grommet leaks —0.016%

6 Water leaks (location unknown)—0.016%

E.M.D. has furnished a Pointer (No. 8L-77 June 27, 1977) on "Water Leaks in the Water Outlet


8335
8335
ILLINOIS CENTRAL GULF

Area of the Engine Power Assembly." This article provides instruction in the following areas related to water leaks in the water outlet area of the power assembly.

1. Troubleshooting water leakage in the water outlet area.
2. Applicability of water outlet elbow, O-ring seals and head gasket kits by model number.
3. Lubrication of O-ring seals for installation.
4. Procedure for detecting cracks in the water outlet area of the cylinder head.
5. Re-use of heads cracked in water outlet area in lower horsepower units.

To minimize failures, it is very important that the latest head design to be used in high horsepower units, as shown in Fig. 1.

Water elbow leaking seals have been reported periodically. These problems are generally traced to use of improper seals or elbows—use of red seals on nozzle (crankcase end) of elbow or use of single groove elbows in 645 engines. Investigations have also determined that elbow seal leaks can result if the power assembly crab bolts are applied and maintained at low torque, allowing "working" of the power assembly in the crankcase, resulting in accelerated elbow and seal wear.

A. SOURCE OF ENGINE WATER LEAKS CYLINDER HEAD

Injection Wall Crack

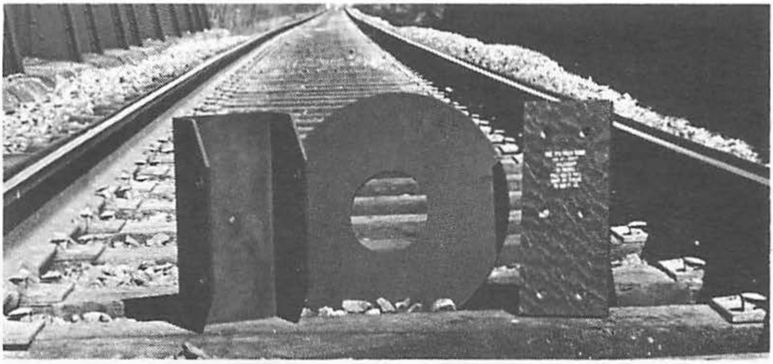
Water may show around injector nut as well as water "track" originating at the injector and traveling to the oil drain hole in the head flange, or emulsified oil in recess face of cylinder head. If injector is removed, beads of water may form

N - Not Recommended
X - Preferred Application
S - Secondary Application
O - Optional Application In Which Head Design Exceeds Requirements

				Inconel Valves Must Be Used					
Head Type Number	6, 8, 12, & 16-567C	16-567D1	16-567D2	16-567D3	16-567D3A	8, 12, & 16-567E	8, 12, & 16-645E	8, 12, 16, & 20-645E3	16, 20-645E3A
① And Earlier	X	X	N	N	N	N	N	N	N
②	O	O	X	X	X	X	N	N	N
③④⑤	O	O	O	O	O	O	S	S	S
⑥ ◇3	O	O	O	O	O	O	X	X	X

Cylinder Head Applicability

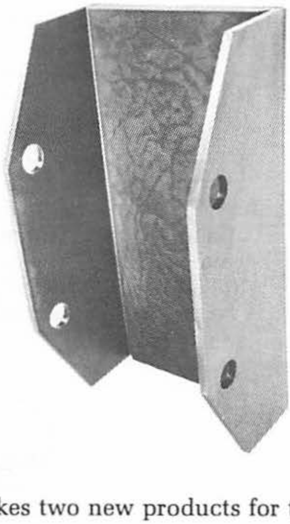
FIGURE 1



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 . . . .

in crack area one inch up from fire face circumferentially in injector well.

These cracks originate above the water discharge hole and adjacent to the crab "footprint." Water tracks may be visible leading to the recessed face.

Recess Core Plug Leak

Water beads may show around a leaking plug and a water "track" may show, originating at the leaking plug and traveling to the oil drain hole in the head flange, or emulsified oil may show in the recess face of the head.

Fire Face Cracks

These cracks are located on the fire face from the injector hole to valve seat or from valve seat to valve seat. They do not generally cause water to go into the oil except when the engine is shut down. They can generally be detected through the liner ports by seeing water on the piston crown or running down the liner walls.

Cylinder Liner Bore Cracks

This crack is almost always located on the thrust side of the liner (inboard in the left bank and outboard in the right bank), extending vertically from 1½ inches from the top of the liner to 1½ inches above the ports. It is always associated with a badly scored liner and usually a scored piston. The crack and evidence of water can generally be detected by an airbox inspection of the left bank, whereas the right bank is more difficult because the crack is not in view. A scored piston skirt and liner as well as evidence of water in the cylinder is cause to suspect the possibility of a cracked liner in the right bank.

The liner bore crack will generally only leak water into the cylinder in large quantities when the engine is shut down. When the engine is running, exhaust gas will be forced into the water system. A dirty, sooty, water sight glass can be an indication of a cracked liner bore.

HEAD GASKET FAILURE

Burned or Bulged Gasket and Damaged Grommet

Generally it is necessary for the metal gasket to bulge or burn out and destroy a grommet before a leak path can be achieved into the cylinder and therefore, into the oil. A grommet failure alone will usually only result in a leak around the outside of the liner into the airbox. If the airbox drains are operative, water should not find its way into the oil.

If the gasket is failed, it can be detected by finding water in the cylinder as in a cracked fire face on the cylinder head and running down the outside of the liner into the airbox.

Reconditioned liners can contribute to these failures unless proper attention is given to the condition of the liner surface finish, pilot bore and depth of the grommet counterbore. Fig. 2 includes some of the most critical dimensions and finishes.

It is equally as important to have liner outside diameter maintained to proper specification.

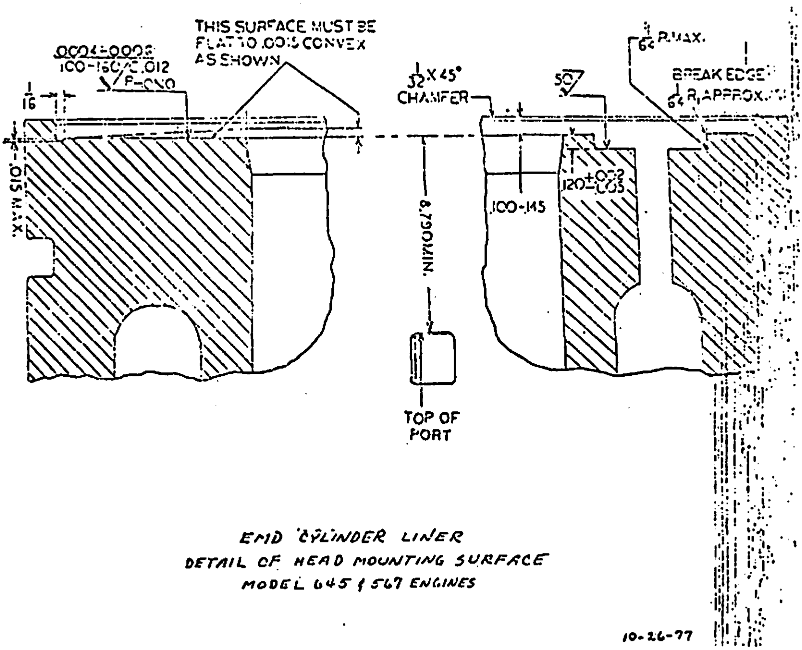


FIGURE 2

Length of studs above top of liner — 9½"

Crankcase upper pilot bore —

New	12.091" - 12.094"
Limit	12.104"

Cylinder liner O. D. (at upper pilot)

New	12.0865" - 12.0895"
Limit	12.085"

Cylinder liner O. D. (bottom of liner)

New	10.3725" - 10.3755"
Limit	10.371"

Insert bore (installed in crankcase)

New	10.377" - 10.384"
Limit	10.386"

Crankcase lower insert bore

New	11.063" - 11.067"
Limit	11.068"

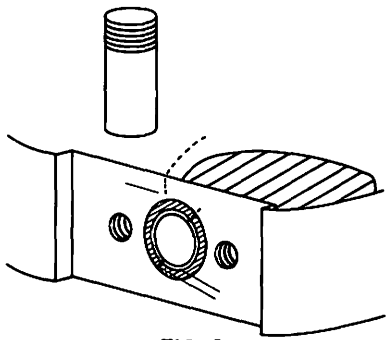


FIG. 3

Cylinder liner stud torque

Min.	50 ft. lbs.

B. LOCATING THE LEAK SOURCE

Cracks at the water outlet area have occurred in heads since the introduction of the 645 engine. Cracks at the rim of the water outlet hole result from sensitivity to high crab bolt torque, and also the extreme thermal cycling of the engine.

Seal failures and cracks in the water outlet area of the cylinder head appear as water leaks in the water outlet elbow area.

These leaks can be found by careful examination for darkened areas surrounding the leak and migrating toward the top deck oil drains. When engine is at idle, water can occasionally be seen leaking. But more often, only the darkened water "tracks" can be seen. Whenever a top deck inspection is made, the following areas should be scrutinized, using a flashlight to detect a darkened water "track."

1. The area where the water outlet elbow enters the crankcase.
2. The side of the crankcase head retainer below the elbow.
3. The area on the top flange of the head near the crab over the water outlet hole.
4. The top of the crankcase airbox section where the water would drain.

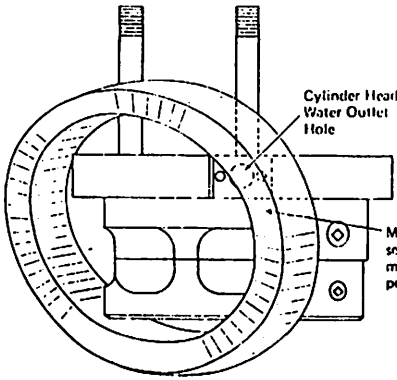
If any darkened water "tracks" are present, the heads should be removed. By and large, most railroads have determined it is not feasible to change cylinder heads only. If a defective head is noted, the entire assembly is changed. History has proven that in renewing only the head, the mechanics have a tendency to knock carbon down on top of the liner sealing surface, causing a continued leak. When an assembly is applied, it must be torqued as per current instructions and retorqued at the next maintenance period.

It is difficult to differentiate a seal leak between the elbow and the head from a crack at the rim of the water outlet hole in the head from the appearance of the darkened water "track." See Fig. 3 as to probable location of crack. When the water outlet elbow is removed from the head, the flange seal should be replaced. If the seal appears to be in good condition and there is a bright ring around the water hole for 360° where the seal was contacting the head, it may be assumed that the head is cracked at the water outlet hole, and the head should be changed. These cracks are very fine and the presence of a water hole crack should be verified by Magnaflux as outlined below.

C. Magnafluxing Heads for Water Outlet Hole Cracks and Water Outlet Flange Cracks

Cylinder head water outlet hole and flange cracks are extremely fine cracks which are difficult to detect visually. In the case of the top flange crack, visual inspection cannot be relied upon. Heads have been unnecessarily scrapped because heavy crab marks on the top flange over the water hole have appearance of a crack. Magnaflux must be relied upon to find these cracks, and possibility of rejection based on less rigorous inspection procedures must be emphasized.

A simple procedure for magnafluxing the water area using a coil is shown in Fig. 4.



Magnaflux Procedure For Water Outlet Area Of Cylinder Head

FIGURE 4

D. Recommendation for Re-Use of Heads Cracked in the Water Outlet Area

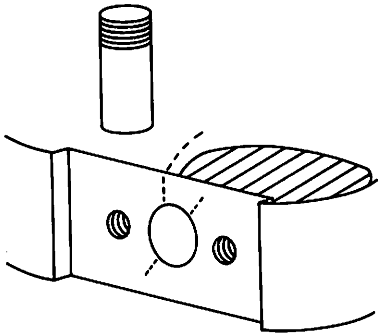
Cylinder head water outlet hole and water outlet flange cracks have been found to propagate very slowly. The following recommendations are made to avoid scrapping heads with substantial useful service life remaining, and minimize water leaks due to cylinder head water outlet area cracks.

Running Repair:

1. Do not over-torque power assembly crab bolts. Crab torque in excess of 1800 ft-lbs greatly increases the chance for heads cracking at the water outlet hole on the top flange above the hole.
2. Do not remove heads cracked in the water outlet area unless water can be seen leaking or a darkened water "track" is evident.

Rebuild (See Fig. 5):

1. Scrap any head found to leak on water test.



Cylinder Head Water Outlet Hole Cracking

FIG. 5

2. Review Magnaflux practices to ensure accurate detection of cracks in the water outlet area. Refer to the paragraph on Magnaflux above.
3. Re-use heads cracked from rim of the hole to less than halfway across O-ring seal contact area.

Maximum usable crack is 0.220".

4. Re-use heads cracked on top surface of flange if crack does not extend more than one-half the distance from the flange edge to the water hole on milled surface for the elbow. Maximum usable crack length down milled surface is 0.220.
5. Any heads found with Magnaflux verified cracks of acceptable size should be restricted to use on 567 power assemblies.

E. Replacing Leaking Seals

Since March 1969, the double-seal water outlet elbow 8414444 has been applied to all new and rebuilt 645 engines at E. M. D. In addition to providing an extra seal for back-up, the upper seal protects the lower seal from the hot oil environment of the top deck. Hot oil causes embrittlement of the seals.

This committee strongly recommends that double seal elbows be applied to all 645 engines because of the higher thermal loading on this area. Single-seal elbows 814-1612 should be used only in 567 engines, but the double seal elbow should be used in 567E engines because of improved sealing. ("E" crankcase has a thicker section at the outlet elbow holes.)

The double-groove elbow is not recommended for 567C and D engines, since these crankcases have thinner section at the outlet elbow holes, which does not provide a sealing area for the lower seal on the double-groove elbow. Single-groove elbow 8141612 should be used on all 567C and D engines. Two siphon tube elbows 8190364 must also be used on 567C and D engines to ensure proper draining of the crankcase top deck. The 645 crankcase has the siphon tube built in and does not require special elbows.

Since August 1968, brown O-ring seal 8413892 has been applied in the grooves at the nozzle (crankcase end) of both the single and double-groove water outlet elbows on all new and rebuilt engines at E. M. D. Red O-ring seal 8305815 is still applied at the flange of the water outlet elbow (as well as at the flange of the cylinder liner water inlet tube). The brown seal has a smaller inside diameter for increased seal compression. Because the inside diameter of the brown seal is smaller than the red seal, the brown seal will not fit in the groove on the flange of the outlet elbow or inlet tube.

CAUTION: In no instance should these seals or any other silicone rubber seal such as head-to-liner grommets be applied with Lubriplate, lube oil, or any petroleum base grease, since such products cause embrittlement of the seals.

The O-ring seals should be installed with a light coating of E.M.D. recommended silicone lubricant which protects and retains the O-rings during installation. It can be purchased thru E.M.D. under the following part numbers:

8 oz. tube	8425724
10 lb. can	8425725
50 lb. can	8425726

Another source of water leaks in the 16-645 engine is caused by vibration of the water manifold.

Braces have recently been applied to this manifold in the field that are expected to reduce the vibration. In addition, a hardened steel bushing part No. 8433263 has been applied to reduce the wear in the block at the generator end. Any block being repaired should be bored out to accomodate this bushing as this will reduce the wear on the block as well as make replacement possible in the future (EMD Pointers, August 22, 1977).

Water temperature control is also being improved and this should reduce temperature changes in the engine, thus reducing the vulnerability to wear of the seals and development of water leaks.

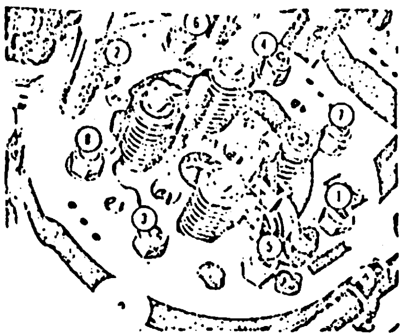
After all of these previous inspections and checks have been completed and you are assured all items are correct, this committee recommends a return to basics that are equally important or perhaps preventative of some of the types of failures previously referred to.

F. Torquing

If you have the facilities to preassemble the power assembly prior to application to the unit, this committee strongly recommends application of the complete assembly as one unit.

Regardless of how you apply power assemblies, we view torquing as a very important method of reducing failure of components.

Snug the four top basket bolts to approximately 10 ft-lbs to firmly mesh the serrations. Give each washer a "finger tightness check." Now torque the lower basket bolts to 75 ft-lbs. Now torque the upper



Head-to-Liner Nut Tightening Sequence

FIG. 6

basket bolts to 190 ft-lbs.

Apply proper lubricant to cylinder head to liner stud nuts (E.M.D. recommends Texaco Threadtex No. 2303).

Snug the nuts down and then torque to 75 ft-lbs. (See sequence pattern — Fig. 6).

If you have the ability to apply complete power assemblies, continue with the tightening sequence to 240 ft-lbs.

Apply proper lubricant to crab nuts and torque them to 200 ft-lbs. Check to make certain the crabs are positioned so that the wrench can be applied to head-to-liner stud nuts.

Using a torque multiplier final torque the crab nuts to 1800 ft-lbs.

Install the overspeed trip mechanism and torque the bolts to 24 ft-lbs.

Place the injector in a clean injector well and make certain the locating dowel is properly seated. Lubricate the threads of the stud and apply injector crab, spherical

washer and snug the nut down. Check to make certain timing tool will enter the injector. Torque the injector crab to 50 ft-lbs.

Apply valve bridges and rocker arms, lubricate rocker studs and apply caps and hardened washers. Torque shaft nuts to 150 ft-lbs. Final pass torque to 300 ft-lbs. Apply water inlet tube torque strap nuts to 15 ft-lbs. Check position of flange to liner and if no movement is detected torque liner bolts to 30 ft-lbs.

Apply piston cooling pipe as per instruction and torque to 20 ft-lbs.

After 30 days of service

All new or replaced power assemblies should have the crab nut checked for tightness to 1800 ft-lbs. Do not tighten further.

Annual Retorque

All crab bolt nuts should be loosened to approximately 1,000 ft-lbs. (one flat on nut) then, retorque nuts to 1800 ft-lbs.

G. Improved Gasket Used On Cylinder Water Connections

To reduce the incidence of leaks, a new seal ring (square-cut O-ring) now replaces the older style flat gaskets at the flange on cylinder water and discharge header connections.

Basic Differences:

Figs. 8 and 9 show the difference between the two types of gaskets and connections.

Designated Part Number 115 X-1860-3, the flat gasket is made of asbestos fiber with a styrene- butadiene binder.

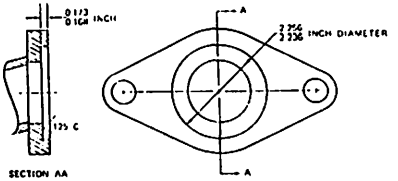
While having some compression capability as well as excellent resistance to treated hot water, this gasket is not as tolerant of slight misalignment as the number 115-X 2241-1 neoprene seal ring.

On the old style connection, the flange was flat. The newer style has this flange face counterbored to accommodate the seal ring.

Converting Flat Flanges:

Old-style flat flanges can be converted to use the seal ring.

Modify as illustrated in Fig. 7 using a counterbore bit on end mill in an appropriate machine.



OLD STYLE FLAT FACE FLANGE MAY BE MODIFIED TO ACCEPT THE SEAL RING BY MACHINING AS SHOWN ABOVE. DEPTH AND SURFACE FINISH ARE VERY IMPORTANT, IF LEAKS ARE TO BE AVOIDED.

FIG. 7

To minimize the possibility of leaks, it is important to maintain depth control of the counterbore within the tolerances listed and achieve a 125-microinch or better surface finish.

The flat-face discharge section was 140 X 1492. Same piece, with counterbored flange, is now 140 X-192 X 1.

II. TURBOCHARGERS—DIAGNOSIS OF FAILURES TO REPLACEMENT

A. Analysis of Turbocharger Failures

For the development of this portion of the paper, a questionnaire

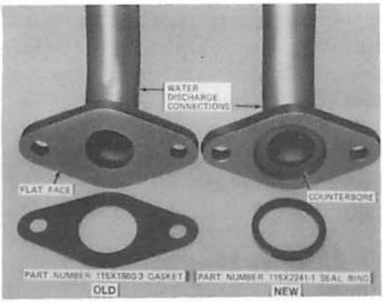


FIG. 8

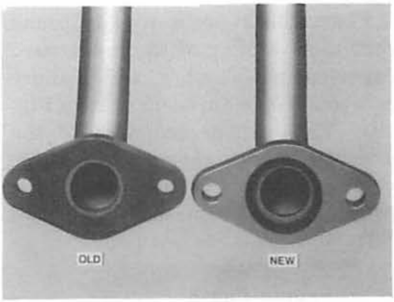


FIG. 9

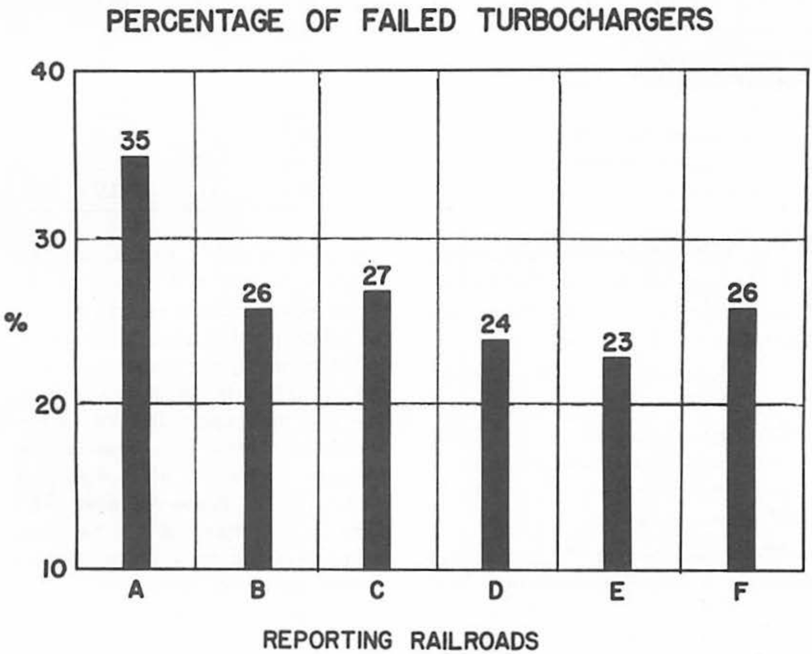


FIGURE 10

was submitted to members of this panel. From the response it was determined that all reporting roads were using the manufacturers' guides to qualify reported defective turbochargers. The guides being used were:

For EMD — The Turbocharger Troubleshooting Guide issued by the Service Department in December 1975

For General Electric — Service Instruction, GEK-61249 issued March 1977

From the reports it was found that the majority of the roads were experiencing about a 25% failure rate on EMD turbochargers (Fig. 10). This, when compared to the average age reported of three years, indicates a number of the failures were premature. Only two members report thoroughly investigating for premature failure causes, which are generally external in nature.

The following table summarizes EMD findings by type of failures on turbochargers received for repair from four different railroads:

	% of Total Removals (1976)			
Failure Cause / Railroad	A	B	C	D
Overheat/Overspeed	27.1	34	11.9	31
Foreign Material — Turbine	24.0	19	26.7	22
Nonfailed, Running	16.4	15	21.0	10
Thrust Bearing	8.8	9	7.5	18
Foreign Material — Impeller	7.3	2	3.0	4
Clutch	6.1	7	23.9	4
Cradle Gasket Oil Leak	2.3	1	1.5	—
Fire Damage to Impeller	1.9	3	1.5	0
Miscellaneous	6.1	10	3.0	10

The following table summarizes GE findings by type of failures on turbochargers received from one railroad:

Failure Cause	% of Total Removals
Nonfailed, Running	13.7
Foreign Object Damage	45.7
Oil Seal Failure	31.1
Miscellaneous	9.5

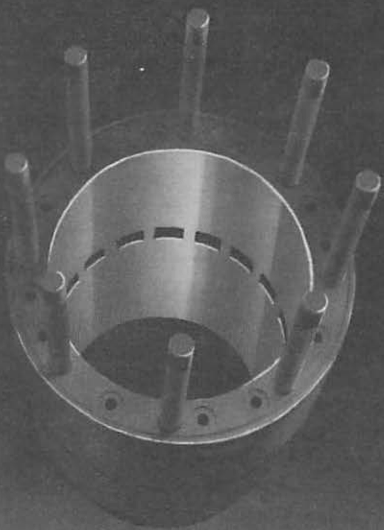
These results from EMD findings indicate a basic maintenance program deficiency for railroads A, B, C and D, with approximately 40-60% of all failures due to external causes such as overheat/overspeed and foreign material damage. The predominant mode of failure on railroads A, B and D was overheat/overspeed. This is the most costly type of turbo failure which results in higher than average rebuild costs. Overheat/overspeed, which also accounts for impeller bursts and many of the thrust bearing failures, can be prevented by good engine "preventive" maintenance programs. It is a poor practice to inspect and tune engines only upon failure. From the above tables, it is questionable if these railroads are doing so even after a turbo failure. This point is emphasized by repeated failures on the same engine within a short period of time.

The results from GE findings indicate the predominant mode of failure was foreign object damage, which is external in nature.

B. Turbocharger Inspection and Investigation on EMD Locomotives

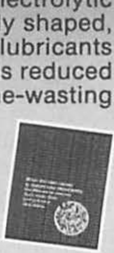
There are four basic external problems that cause turbocharger failure:

You're looking at 1,500,000 oil wells



On the hard chrome finish inside this cylinder liner, there are enough oil wells to make even a petroleum company jealous. These random "wells" are created by our patented electrolytic process — no drilling or templates are used. Irregularly shaped, isolated pockets establish a capillary attraction to keep lubricants from quickly draining off the liner wall. The end result is reduced break-in time, longer performance life and fewer time-wasting changeouts.

For more information write or call today for Brochure 775.



TELEDYNE METAL FINISHERS

Plants and Sales Offices at:

1725 East 27th St., Cleveland, OH 44114 Ph: 216-696-0511
TWX: 810-421-8318
3125 Brinkerhoff Rd., Kansas City, KA 66115 Ph: 913-371-8501

(1) Overspeed/overheat
(2) Foreign material thru turbine
(3) Foreign material thru impeller
(4) Clutch or gear train

This committee recommends that when a turbocharger has failed, a good visual inspection be made to determine if one or more of the above mentioned causes has occurred. The following is a brief explanation of what should be checked and some of the causes that need to be investigated.

1. Overspeed/Overheat

Overspeed/overheat is the most destructive and costly type of failure and can result in almost total destruction of the turbocharger. Since it is caused by excessive heat energy in the exhaust system which increases turbine wheel speed to an unacceptable level, this excessive heat source must be removed. EMD has reported 40 to 60% of turbochargers returned, failed from overspeed/overheat.

An overspeed / overheat failure can be recognized by:

a. Turbine blades that are stretched and have rubbed the shroud.
b. A warped exhaust diffuser and bulged shroud. Both may be torn by broken blades.

The following is a list of the normal sources of excessive heat energy. One or more of the following will be the probable cause of the turbocharger failing from overspeed/overheat:

a. Airbox fires — caused from excessive carbon deposits, ring blow-by.
b. Injectors — caused from leaking, damaged tips, or maladjusted.
c. Valve blow — caused from malajusted or defective lash adjusters.
d. Exhaust manifold fire — mistimed valves, late injector timing.
e. Dirty aftercoolers.
f. Broken compression rings.
g. Plugged turbocharger exhaust inlet screen — water treatment, carbon, or ring tips.
h. Excessive electrical overload — engine governor out of adjustment and electrical system out of adjustment, causing poor combustion.

2. Foreign Material Thru Turbine Wheel

Foreign material damage can be found by inspecting blades and nozzles, through the turbine inlet scroll. The leading edges of the blades can be viewed through the nozzles at the 1:30 o'clock position, and all blades can be viewed by rotating the impeller. Examine the leading edges of the blades for nicks, and in some cases, a broken blade.

If damage has occurred because of foreign material thru turbine, the following should be looked into:

a. Ring Breakage — Make ring inspection to locate defective power assembly. It is recommended that top ring clearance be taken to determine if

other rings are entering a dangerous stage.

b. Valve Breakage — Make inspection to determine which valve has broken. It is recommended that power assemblies be air-tested periodically to locate valve problems before they progress to total failure.

c. Other miscellaneous material — such as broken exhaust stack pieces, etc.

3. Foreign Material Thru Impeller

To determine if failure has occurred at the impeller, it will be necessary to remove the turbocharger boot. Remove the clamps, clamp wedges, and rubber boot, then the impeller can be examined for possible failure. This failure usually results from one of the following:

a. Previous turbocharger failure — when pieces are broken off impeller, the force drives the pieces into the air filters. If not removed, they may pull loose and damage new impeller.

b. Misapplication of compressor inlet boot — if boot travels, a clamp may enter the impeller and destroy it. When reapplying clamp, make sure clamp wedges are reapplied.

c. Miscellaneous loose material in air filter housing — foreign material left in air filter housing can be pulled thru impeller, causing it to damage impeller.

d. In some cases, rubbing and and loss of pieces from the impeller are caused by an unbalanced condition within the turbocharger. Therefore, the turbocharger should be inspected for defects that cause imbalance.

4. Clutch or Gear Train

If none of the topics covered appears to have caused the turbocharger to fail, a check of the gear train can show probable reasons for failure. Poor gear involute, causing torsional vibration in the rotating equipment, can lead to turbocharger failure. Clutch failure can be suspected as the predominant mode of failure in most cases where a good preventive maintenance program is followed. This is to be expected since the clutch is metal-to-metal contact during operations and, therefore, is a wear item of the turbocharger. A scheduled maintenance change interval should be developed.

Fig. 11 shows a check list developed by one member railroad and is considered to be an excellent guide. It is this committee's recommendation that this check list or one similar be utilized when investigating turbocharger failures.

Once it has been determined that the turbocharger is defective, it must be changed out.

The following steps show the correct procedure when installing a new turbocharger. Some of the first steps will be a repeat of what has been covered in the first portion of this paper.

The following items of work must be done as marked by A, B, C, D corresponding to the type of failure:

A. Overheat/Overspeed
B. Foreign Material Thru Turbine (Exhaust Side)
C. Foreign Material Thru Impeller (Fresh Air Side)
D. Internal - Clutch, Bearing, Seal, etc.

ABCD	Remove and examine air intake (paper filters).
ABCD	Remove and examine exhaust screen.
ABCD	Remove and examine aftercoolers.
ABCD	Remove and examine old turbo.
AB--	Remove and examine exhaust manifolds.
ABCD	Examine air intake filter housing for cracks and foreign material.
ABCD	Examine stubshaft and bracket.
ABCD	Examine gear train and spring drive gear (update to latest style).
ABCD	Examine aftercooler ducts.
ABCD	Examine air boxes, internal vee, and around liners for accumulation of carbon and oil sludge.
ABCD	Examine and clean crankcase eductor system.
AB--	Examine for scored pistons and liners, broken and worn rings.
AB--	Examine heads-make pressure test for valve blow by.
ABCD	Check turbo lube system, include relief valve and oil line.
AB--	Apply clean exhaust manifolds.
ABCD	Apply new turbo lube filter.
ABCD	Apply new or rebuilt turbo.
ABCD	Apply clean aftercoolers.
ABCD	Apply new air intake (paper) filters.
A---	Change all injectors.
ABCD	Check rack settings.
ABCD	Check timing.
AB--	*Blow out exhaust manifold-examine for debris.
ABCD	Apply clean exhaust screen.
ABCD	Make final inspection for proper installation of boots and clamps.
ABCD	Check cylinders for firing (running).
AB--	**Wash air boxes (engine must be at operating temperature). Then bar over by hand before restarting.
ABCD	Check for proper engine speeds.
ABCD	Check for proper operation of inertial filter dirt blower.
ABCD	Take manometer readings and record.
ABCD	Load box (Search if equipped). Record horsepower found and left.

*Blow out exhaust system by running the engine thru all throttle speeds with the turbo screen removed and the turbo exhaust inlet covered to prevent any dirt or foreign material from entering the turbo - CAUTION - KEEP EVERYONE CLEAR OF FLYING OBJECTS THAT MAY BE BLOWN FROM THE EXHAUST SYSTEM.

**Also wash air boxes for C and D failures if excessive amounts of carbon and oil sludge are present. (EMD Advance Service Memo June 20, 1969, No. 34)

FIGURE 11

1. **Before removing the turbocharger, make ring, piston and liner inspection.**
2. **Air-test cylinders for valve blow, then remove defective turbocharger.**
3. **Check turbocharger screen for foreign material damage or plugging from water treatment.**
4. **Check air filter housing for foreign material.**
5. **Check camshaft gear train and bushings.**

6. Check No. 2 idler gear (renew if not spring-loaded, doweled gear assembly) for proper torque on all bolts.
7. Check No. 2 idler gear bearing wear.
8. Check turbocharger compressor impeller clearance before applying turbocharger and record.
9. Apply turbocharger and secure and torque all turbocharger bolts. Check compressor impeller clearance again and record.
   NOTE: If clearance changed from original reading before turbocharger was applied, turbocharger is in a bind and must be relocated.
10. Apply auxiliary generator drive gear assembly and secure and torque bolts.
11. Record backlash of auxiliary generator drive gear assembly (manufacturer's specification - .010 to .022).
12. Apply right turbocharger air duct and check clearance between air duct and turbocharger scroll, minus gasket. If clearance is above .007, relocate air duct.
13. Apply gasket, torque all bolts on right air duct and check compressor impeller clearance which should still be the same as the original reading.
14. Repeat steps 12 and 13 when applying left turbocharger air duct.
15. Record compressor impeller readings after both air ducts are torqued. (Should be same as when turbocharger was initially applied).
16. Clean aftercoolers.
17. Check condition of aftercoolers and if found OK, apply same and torque. (Make sure dowels are proper for holes in air duct bracket.)
18. Check condition of turbocharger boot and clamp. If found OK, apply same.
19. Change turbocharger oil supply filter and soak back pump filter.
20. Set racks, time injectors, and set all valves.
21. Check soak back pump operation.
22. Wash air boxes.
23. Change air intake filters.
24. Blow out exhaust system by running the engine thru all throttle speeds with turbocharger screen removed and the turbocharger exhaust inlet covered to prevent foreign material from entering the turbocharger. Take proper safety precautions.
25. Load test for performance.

C. Turbocharger Inspection and Investigation on GE Locomotives

The turbochargers applied to GE engines are exhaust driven only and, with proper maintenance and periodic overhauling, can last the life of the engine. Most turbo failures are the result of conditions external to the turbo. Routine examination of the turbo and its systems will prevent failures or recurrence after a failure.

Unless noted otherwise, all statements apply to both Elliott and GE turbos.

1. **Inspection—engine not running**

EXTERNAL EXAMINATION

1) Inspect for leaks or cracks in casings.
2) Look for evidence of leaks in intake system and air and exhaust manifolds.
3) Inspect seal air piping for tightness and to make sure piping is clear.
4) If seal air piping has check valves, be sure that shuttle moves freely (by shaking) and that flow is towards turbo.
5) Using shop air, blow air into seal air casing openings and listen for flow into exhaust casing. If air is not flowing, the internal seal air passages are plugged, and must be cleared.
6) Inspect oil hoses to make certain they are open.

IMPELLER INSPECTION

1) Remove rubber boot and intake flange.
2) Examine impeller for evidence of foreign material passage (rough edges, sharp marks).
3) Rotate rotor — should turn freely with no rubbing.
4) Apply dial indicator to nosepiece and check rotor play — rotor should have .007" to .020" axial play and less than .006" radial play.
5) If "CHEC" unit, check for proper probe clearance (0.028" to 0.090").

TURBINE INSPECTION

1) Examine exhaust casing for evidence of oil.
2) Working down the exhaust stack with inspection mirror and flashlight and using a bent ⅛" rod to rotate the turbine disc, inspect the disc buckets for:
   a) Missing buckets
   b) Bucket distortion
   c) Bucket damage
   d) Damping wire breaks or distortion (Elliott turbos only)
   e) Bucket tip rubbing
   f) Disc plugged with carbon

2. **Inspection — engine running**

Prior to a running inspection, it is recommended that a thermocouple be installed, to measure preturbine temperature, and a 0.40 psi gauge be installed, to measure manifold air pressure. By looking at these conditions on comparative locomotives, under full rated load, many improper operating conditions become evident and corrective measures can be started.

Some conditions that cause high preturbine temperatures and / or low manifold air pressure are:

A) Failed or damaged turbocharger
B) Air filter plugged
C) Intercooler plugged or dirty
D) Air manifold or turbo discharge elbow leaking
E) Faulty or improperly adjusted fuel pump racks and/or nozzles
F) Fuel line restrictions or dirty or plugged fuel filter
G) Exhaust manifold leaks

H) Carbon plugged turbo
I) Carbon in cylinder inlet ports

3. Inspection for reported "oil out the stack"

Most turbos returned for rebuild for this fault were found to have either another type of failure or no mechanical failure. Failure of the oil seals alone should not occur because they have a running clearance and should not wear.

PRIOR TO RUN TEST

1) Inspect exhaust stack for evidence of oil. A trailing unit can get oil coated by lead units of a consist.
2) On units with locomotive seal air, make certain that locomotive air is being supplied to the turbo.
3) Make sure that turbo seal air lines are clear and in good condition.
4) Make sure that any seal air check valve is installed right and operating freely.
5) Remove intake boot and flange and test rotor for rubbing and excessive side or end play.
6) Remove turbo oil supply line and verify correct orifice in the flange that bolts to the front end cover.
7) Remove turbo oil drain line and check for obstructions.
8) Check that crankcase exhauster pipe is not plugged.

RUN TEST—AFTER PROPER ENGINE WARMUP

1) Idle engine and check for oil out stack.
2) Run engine to full speed, no load (dynamic braking mode) and check for oil out stack.
3) Run engine up to full load and check for oil out stack.

If oil out of stack only occurs during dynamic braking mode operations, the probability of mechanical failure is low. The use of locomotive air for seal air should help alleviate this condition. The locomotive air also helps prevent oil seal leakage under idle engine operations.

Oil out of stack under full load can be either from the engine or the turbocharger. Inspection of the exhaust manifold will determine whether the source of the oil is the engine or the turbo.

Some of the sources for the oil are a scored liner, cracked piston, or worn or broken piston rings. One unusual source of oil out the stack is, if the pipe plug is missing from the front end cover upper cavity, oil coming through the crankcase eductors.

4. Inspection for reported low power output

A) Set governor gap and adjust fuel pump racks to instruction specified setting for engine. Adjust valves and pump timing. Check fuel supply pressure.
B) Install pressure gauge on manifold. Installation of a temperature probe in the exhaust transition section is also useful in determining turbo problems or conditions that will lead to turbo problems.

C) On "CHEC" equipped locomotives, make sure that the "CHEC" control is not limiting the power improperly.

D) Run engine under load.

1) If engine will not load and if governor operations are normal, and fuel and air systems good, then suspect that turbo has stalled or failed.
2) If engine will not load to full power rating, check air manifold pressure and pre-turbine temperature. Check for dirty filters, air restrictions or leaks and dirty intercoolers. If these are all satisfactory, suspect turbo failure.
3) If engine will load properly but pre-turbo temperature is too high: if pre-turbine is over 1200° F, shut down immediately. Find the cause of the high temperature before restarting. Operating a turbo above 1200° can cause it to fail in an exceedingly short period of time. Replacement turbos have failed on initial load box testing from overheating.

5. **Turbo surging and smoking**

A) If new turbo, make sure that turbo is proper model for engine, including orifice size in oil supply line.

B) If rebuilt turbo, make sure that correct nozzle ring and diffuser were used in assembly.

C) Inspect air system — make sure air filters and intercoolers are clean, and that manifolds are not leaking.

D) Check cylinder inlet parts for carbon.

E) Adjust valves and fuel pump timings.

F) Measure and compare manifold air pressure.

G) Check for faulty excitation circuit.

6. **Failure prevention**

A) After a failed turbo is removed from an engine procedures to prevent failure of the replacement turbo commence. Since most turbo failures are caused by problems external to the turbo, these problems must be corrected to prevent the new turbo's failure.

Examination of the turbo will reveal many causes of failure.

1) Compressor inlet — damage to the inducer's leading edge indicates that material has probably passed through. The air filter system and intercooler should be examined for foreign material. Oil or dirt deposits on the inducer mean that the air cleaners and intercooler are, possibly, similarly coated and should be cleaned. Rubbing indicates bearing failure, which is usually secondary damage, and in the absence of leading edge damage, means that the turbine should be examined for damage.

2) Scroll case — evidence of dirt or foreign material passage in the scrolls should be followed with a check of the intercoolers for similar substance, and subsequent cleaning.
3) Turbine inlet — evidence of foreign material should be followed by making sure that all material is cleared from the exhaust manifold. Heavy soft carbon in inlet to nozzle ring is from engine sources, and should be looked into. Engine-caused carbon between turbine disc and inlet can cause rotor seizure; however, a rotor seized due to other problems can cause the buildup of such carbon.
4) Turbine disc — using a mirror, examine the turbine disc buckets for distortion, damage or rubbing. Overheat/overspeed is evident by stretched buckets, humped or pulled damping wires (on Elliott turbos only), rubbed bucket tips, and possibly broken buckets. With this type of evidence, look for conditions such as plugged filters, plugged intercooler, manifold leaks or maladjusted valves or injectors. Twisted buckets or broken edges are the usual indications of foreign material. Damage indicated only by rubbed bucket tips is probably bearing failure.
5) Turbo casing — cracks in the turbine casing that are not near mounting or fittings are sometimes the result of overheating, due to loss of cooling water. The cooling system should be checked for proper operation. Cracks near fittings may be caused by distortion of some mountings, so connections should be checked for correct fit.

7. "CHEC" Speed Probe

The "CHEC" speed probe is a pickup coil used to sense the passing of the rotor nosepiece magnets, thus determining the turbo speed. Many probes and turbos have been damaged through improper installation of the probe.

The probe should be mounted, if possible, onto the turbo prior to mounting the turbo on engine. This allows the mechanic to see exactly where the end of the probe is in relation to the rotor nosepiece, and to properly adjust the gap.

When the probe is removed from an engine mounted turbo, care must be taken to reinstall all gaskets and spacers when reassembling. To ascertain that proper reinstallation has been accomplished, slide back the rubber air intake boot and view the probe to nosepiece gap with a light and mirror.

Committee Recommendations — EMD and GE

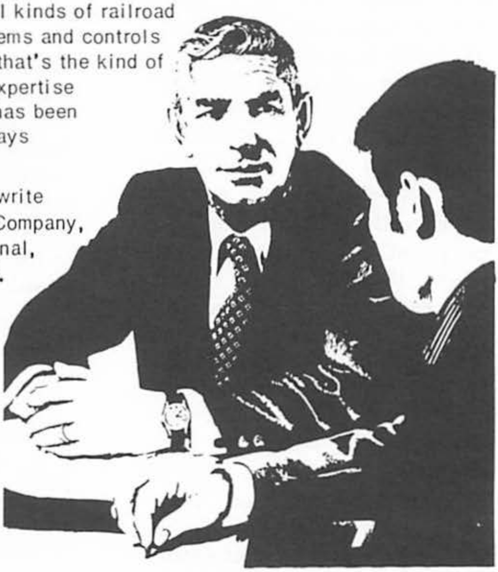
The preceding report reads like an autopsy, since it is after the fact, and an operation is required to replace the defective component. This committee would now like to make some recommendations for preventive maintenance. We recommend that:


3601
3601

1) A scheduled changeout program be installed to replace EMD injectors at intervals of no more than two years. Some high mileage roads may find, after review, that an interval less than two years will be required. GE units should have the fuel nozzles changed on a 12-month interval and the fuel pumps changed at a 24-month interval. One member road reports changing GE nozzles every six months and pumps every 12 months.
2) Units be tested for valve blow at least once every six months. Valve blow on turbocharged units can seldom be heard when the engine is running, until it is on the brink of total failure.
3) EMD lash adjusters be changed every two years, whenever the power assembly is changed or when found defective at time of top deck inspection.
4) Ring side clearance readings be taken and recorded at 90 day intervals on EMD units. Power assemblies should be changed when readings exceed .020". One member has reported that using rings chromed on face and sides in cast liners has reduced air box fires.
5) EMD air hoses be washed as required based on a visual inspection.
6) Aftercoolers or intercoolers be removed and cleaned every two years.
7) No welding be allowed on exhaust stacks while on engine. Welding should only be done on stacks removed and in strict compliance with manufacturer's recommendations.
8) Turbocharger exhaust inlet screen on EMD units be inspected annually and whenever a unit is suspected of having internal water leaks.
9) Engine governor be changed every three years.
10) Injector racks and engine timing be set annually. This also applies to individual power assemblies when replaced.
11) Compressor inlet boot be inspected annually for cracking or any sign of deterioration that would lead to failure.

Routine periodic examination of a turbo's performance can go a long way towards extending turbo life. Operating conditions that overwork the turbo can be detected and corrected. Turbos that are in the early stages of failure can be found and replaced, before they get into conditions that can cause total destructive failure.

If an engine is routinely put on load and checked for preturbine temperature and manifold air pressure, any unusual conditions will be quickly evident. While each engine/turbo unit has its own operating characteristics, similar combinations should not vary more than 5% between units. Any variations beyond this point should be investigated for conditions that could cause turbo failure, or for the presence of a turbo that has failed.



III. WINTERIZATION

GENERAL

The recent winter weather conditions in this country have been the most severe in railroads' history since changing from steam to diesel-electric locomotive operation.

In addition to standard winterization procedures, railroads have made a number of projects and modifications on their locomotives that they hope will eliminate some of the problems that occur during extreme cold weather.

The following are winterization items that have been initiated on various railroads:

1. Issue special instructions to drain the cooling system on dead diesel units in a train. A dead diesel unit is any diesel unit that because of mechanical failure, accident, or any other reason is incapable of producing power either as a single unit or in a multiple unit consist.

   One railroad has modified a group of EMD units by repiping the cab heater return line, cab heater inlet line and main engine cooling water drain so that all three lines can be drained by pulling three handles at one location adjacent to the scavenger lube oil pump.

   When handling dead diesel units plant to plant in a train, the engine must be shut down, the engine cooling water drained. If unit is equipped with a water cooled air compressor, the plate (head water opening) and water jacket cover (cylinders) must be loosened to allow trapped water to drain. One railroad removed the lube oil cooler on GE units. Some railroads back flush air compressors with air.

   A number of railroads have applied automatic engine cooling system drain valves that will automatically drain the cooling system if the engine dies en route. Some of the early design automatic drain valves experienced undesired drains but we understand this condition has been corrected. Some railroads have installed drain valve handles in the cab for the crew to use to drain the cooling system when engine dies. Other railroads have applied a decal in the cab showing the location of drain valves and instructions on draining the cooling system. Also drain valve handles are painted a specific color to make them more distinguishable. Some railroads wire the valves closed.

2. Preheat the water when refilling cooling system for makeup.
3. Convert water cooled air compressors to air cooled on GE U-30, U-33 and U-36 units.
4. Run water cooled air compressors dry during winter. (Not recommended by builders or air compressor manufacturers).
5. Install fuel preheaters. Some railroads leave fuel preheaters

on all during the year. One railroad routes water from the engine direct to the fuel heater first instead of through the cab heater first.

6. Remove the fuel primary strainer at 10°F or lower temperature. This has been done by one railroad, but is not recommended by the committee.
7. Increase idle to throttle No. 3 during extreme temperature when unit is in plant.
8. Apply electric cab heaters.
9. Install modulating governors on GE locomotives. Reduce transient shutdowns en route. (One railroad uses lighter oil in GE governors.)
10. Install lube oil cooler screens on GE locomotives. GE oil coolers are extremely susceptible to freezing damage when units are shut down and drained on the road. Water passages in core bundles are plugged with debris, and scale and water are trapped in the tubes when the unit is drained. This water subsequently freezes and bursts the tubes.
11. Modify piping to the low oil pressure device on the governor of GE locomotives to eliminate unexplained low oil shutdowns in extreme cold weather caused by thickening of the oil in the dead end pipe to the governor. This modification is explained in GE GEMS dated September 30, 1972.
12. Install fuel pump shutdown time delay on locomotives equipped with electric emergency fuel shutoff system.

Railroads operating in extreme weather conditions report that they experience excess operating problems when the temperature drops to -20°F or lower.

The committee recommends the following winterization procedures (in general, they will be applicable for period October 15 to May 15):

ALL UNITS:

1. Thoroughly inspect cabs for condition of weatherstripping, doors and windows, and repair as required.
2. Check cab heaters and defrosters for proper operation. Blow free of dust and debris.
3. Check windshield wipers to insure proper operation.
4. Fill cooling system to proper height ("G" valve level on EMD's so equipped).
5. Drain water condensate from fuel tanks not less often than every monthly inspection.
6. Drain condensate from main reservoirs and from moisture and dirt collectors each trip, or daily on switchers. Automatic drain valves must be in good operating condition.
7. Check air horns and bell and air horn filters.
8. Add antifreeze to recirculating type toilets.
9. During cold weather (below +40°F), units must be run at idle while at plants. When temperature reaches +10°F or lower, the throttle should be

advanced to the No. 3 throttle position to increase the volume of water circulating.

10. Check radiator shutters for tight seal in closed position (repair if necessary).
11. Examine electrical cabinet door seals, locks and latches. Repair to ensure proper fit.
12. Check lower portion of high voltage cabinet and underframe, and seal all openings especially around wiring, electrical equipment.
13. Inspect traction motor inspection covers for proper seal and bolts. Check traction motor lead connector sleeves and clamps if so equipped.
14. Check traction motor air duct boots for damage (punctured or torn). Ensure that boot is properly secured to adapter plate.
15. Check all electrical receptacles, ensure that cover hinge spring and casing gasket are in good condition and that covers close tightly for proper seal.
16. Check axle generator conduit and Pylet covers, also cable to ensure good condition to prevent moisture entry.
17. Place summer/winter switch in winter position and remove handle (EMD). (Fan sequence switch.)
18. Ensure that all radiator compartment access covers are in place. Repair or replace defective covers.
19. Follow freezing weather precautions in operating and service manuals covering locomotive cooling system and steam generator.
20. Ensure that all roof hatch and bulkhead winterization dampers are in closed position to prevent entry of unfiltered air into engine compartment.
21. Blank body filters and louvers on classes of locomotives requiring this, per freezing weather instructions in instruction manual.
22. When necessary to add battery water during freezing weather, do so just prior to battery charging period so that water will thoroughly mix with the electrolyte to prevent freezing. Check specific gravity and maintain minimum of 1250 for each cell by frequent charging.
23. During period from mid October through March, it is advisable to add isopropyl alcohol to the fuel in the amount of at least one to two gallons per 1000 gallons of fuel, to prevent formation of ice crystals that plug fuel filters at temperatures below freezing. Many railroads require suppliers of diesel fuel to supply a product with reduced cloud and pour points to preclude interference with flow by formation of wax.
24. If a diesel unit is to be shut down for extended period of time or is to be towed dead-in-train during freezing weather, drain the engine, water pumps, cooling system, fuel oil preheater, cab heaters, steam gen-

Save on filter maintenance costs

with AMER-kleen replaceable filters

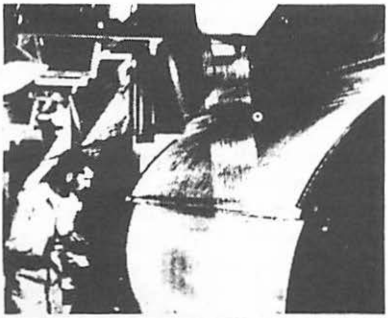
AMER-kleen nonflammable filters are ideal for engine intakes. They cost less to use and throw away than washing and reoiling metal filters. With AMER-kleen filters, you don't need filter cleaning equipment at all.

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.

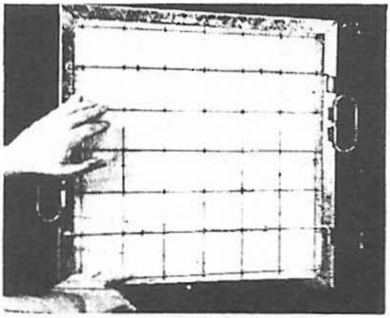
And because AAF glass-fiber filaments are spun continuously, and bonded with a heavy-duty adhesive, fiber particles cannot be dislodged despite air volume and dirt buildup. For additonal information on the most practical filter for engine intakes, write Manager, Railroad Products, American Air Filter 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.

erator water systems, drinking water and hopper water systems.

25. Drain traction motor support bearings and replace pinion end felt wicks. Inspect commutator end support bearing wicks and refill with new oil. Replace missing or damaged oil filler caps. Turn caps sideways. Caulk support bearing caps at split line and around dust guard when traction motor is applied.

EMD WINTERIZATION

1. **System Description**

The winterization system available as an extra on EMD road locomotives is designed to alleviate snow accumulation in the clean air compartment, and associated problems with the electrical equipment supplied with cooling air from the compartment. This protection is accomplished by drawing hot air from the engine room and mixing it with the cold ambient air drawn through the inertial filters. The resultant air mixture in the filter compartment yields an air temperature above freezing so that any snow passing through the inertial filters will melt. The filter compartment temperature is approximately 50°F above ambient; therefore, the winterization system is effective with ambient temperature down to -20°F.

2. **System Components**

The hot air from the engine room is supplied by the main generator air discharge and the No. 1 fan of the cooling system. An air duct is mounted over the No. 1 cooling fan and is equipped with a manually operated damper. With the damper in the winter (open) position, a portion of the fan discharge is drawn into the engine room. This air is heated by being drawn across the engine exhaust manifold and top deck area. At the rear end of the engine, this air mixes with the generator discharge air and passes through the engine room partition into the filter compartment.

The flow of air into the filter compartment is controlled by automatic temperature actuated shutters mounted in the partition. When the ambient temperature drops below 35°F, the shutters open allowing the hot air to enter the filter compartment. When the ambient temperature rises above 45° F, the shutters close to block the air flow.

In 1969, two protective features developed for the winterization system were made basic on all road locomotives. First, a cover was applied over the AR10-D14 slip rings and brush holders. This cover provided protection against loss of excitation due to ice build-up on the rings and in the brush holders, both of which caused loss of contact between the brushes and slip rings. Second, the resistor panel compartment, which was exposed to the filter compartment on the back side of the electrical cabinet was enclosed to prevent moisture grounds due to snow and moisture accumulation. This area is now totally enclosed and ventilated by

the electrical cabinet ventilation system. Both of these changes are now incorporated on all locomotives with or without the winterization systems.

The remaining two components supplied with compartment air, the traction motor blower and engine air intake filters rely on the warm air mixture in the filter compartment to eliminate the snow before the air enters these two areas.

A special cooling system shutter operating sequence is also provided with the winterization system on any three-fan cooling system locomotives (GP/SD40-2, SD45-2). The special sequence results in more frequent actuation of the shutters in order to prevent the shutters from freezing in either the open or closed position. This option is also available as a separate option if the complete winterization package is not required.

3. Railroad Usage

To date the winterization system has only been applied to turbocharged engine locomotives. However, a new system developed for normally aspirated units, which offers comparable performance to the existing system, is currently being field tested. After performance verification this winter, this system will be available for GP/SD38-2 units.

The basic improvements incorporated into the standard road locomotive models provide adequate winter operation protection from snow in the inertial compartment for most northern climate railroads to the extent that no further winterization modifications are necessary. However, for railroad conditions where severe snow drifting is experienced and heavy snow plowing results in large quantities of snow introduced into the inertial filter system, the aforementioned winterization package provides the additional performance necessary to satisfactorily cope with these conditions.

GE WINTERIZATION

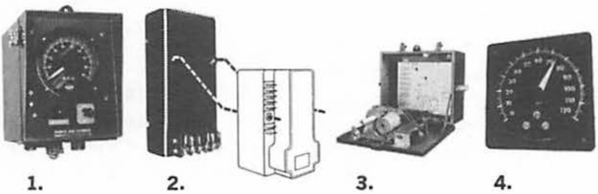
A number of modifications have been issued covering the winterization of various components and functions of GE locomotives. These modifications can be purchased and added to locomotives in the field to overcome cold weather and snow problems encountered during the winter months.

1. Corrugated Air Inlet Screens

The corrugated screens have a year round advantage: keeping dirt and leaves out of the compartment, keeping snow accumulation out, catching debris on the exterior where it can be removed easily, keeping radiators clean, providing up to 50% more air inlet area and reducing maintenance by keeping compartment clean. This has been standard on units since 1970.

2. Automatic Water Drain System

In freezing weather, it is practically impossible to manually drain a locomotive that shuts down enroute. As a result, railroads need a simple, positive, fail safe system that will automatically drain a locomotive cooling system whenever it is in danger of freezing. The



1. 2. 3. 4.

General Electric automatic water drain provides a temperature sensitive switch and valve for rapid draining of the locomotive water system if the engine shuts down in freezing weather. This item is an extra that can be applied to new and old GE locomotives.

3. **Radiator Fan Ice Guard Ring**

This adds a 4" high ice guard ring (dam) to the radiator fan shroud to prevent ice from falling into the radiator fan and, in turn, from being propelled back into the radiator and causing damage.

4. **175 psi Safety Valve**

Many air compressor problems and failures in the winter months can be traced to moist air from the air compressor condensing and freezing in the air piping system. When the 175 psi Safety Valve is added to the air compressor discharge piping it will relieve air pressure build-up under these conditions, thus reducing damage to the air compressor and air piping.

5. **Sliding Plate to the Engine Cab Air Door**

A sliding plate can be added to the early U28 and U30 locomotives which will allow the locomotive to run through high snow without snow entering the locomotive through the engine cab air doors. This is particularly important for locomotives going through deep snow or in bad snow storms.

6. **Disposable Air Filters for Control Compartment**

This is a modification to add a disposable air filter to the control compartment air system to aid in keeping snow and dirt from entering the control compartment. In heavy snow operation, this filter element should be checked from time to time to ensure that it has not become plugged by snow or debris. The new series units have filters to the control compartment locker.

7. **Engine Air Filter Warm Air Supply**

This modification changes the tunnel configuration of the locomotive (adds coupling guards, doors and panels) so that air can be obtained from the engine room during winter operation to help keep engine air filters free from ice build-up.

8. **Air Compressor Filter Hoods**

A permanently installed hood can be applied on the air compressor air filters which will allow for the warmer pressurized platform air to be delivered directly into the hoods during the winter. The platform air can be capped off for summer operation, and cooler ambient air used.

9. **Fuel Oil Heaters**

Locomotives operating in subfreezing temperatures frequently need fuel heaters to prevent paraffin or ice crystals from plugging the fuel filter element.

10. **Air Compressor Lubricating Oil Heater**

This component adds heat to the compressor oil in cold weather to maintain proper lubrication.

FUTURE CONSIDERATIONS

The committee feels that the builders should do the following:

1. Design a battery cabinet that will utilize waste heat from the engine to keep the batteries warm when the ambient temperature is -10°F.
2. Develop a method to heat fuel other than the present fuel heat exchanger.
3. Develop an improved cab heating system.

IV. UPDATE ON:

A. Viscous Dampers

Viscous dampers on EMD engines are presently limited to approximately six years' service. When removed, they are qualified by visual inspection before being returned for remanfacture. If a damper has any of the following four conditions, it cannot be rebuilt:

1. The housing has any severe physical damage.
2. The roll edges have severe dents.
3. The cover is raised (check with straight edge)
4. The damper has already been remanufactured once.

When shipping, be sure the damper is properly boxed and protected from handling damage.

Remanufactured dampers are completely disassembled and cleaned. All internal surfaces are given a complete visual and dimensional inspection. The flywheel receives a new set of bearings finished to original size and gaps. The damper is reassembled with new cover plate and new fluid and given a leakage and damp test. New part numbers and serial numbers are assigned.

Dampers 705170-1 (Reference 8404560) and 707780 (Reference 8452042) can be remanufactured only once to 709505 (Reference 9320867) and 709510 (Reference 9320868). A 709505 or 709510 damper cannot be remanufactured. Remanufactured dampers cost $110 to $365 each less than equivalent new dampers with the same warranty.

A report on development of a method to qualify the condition of viscous dampers on the EMD 645 20-cylinder engine has been prepared and is available by contacting F. I. Burchette, Locomotive Maintenance Supervisor, Santa Fe Railway, 80 East Jackson Blvd., Chicago, Illinois 60604.

B. Grooveless Main and Connecting Rod Bearings—GE

General Electric has released instructions on modification of the present main bearing cap to accept the grooveless bottom main bearing. The cap modification is necessary because the new grooveless bearing has an extra tang that prevents its application in the upper position. The grooveless bearings in first test units showed good service life and they can extend service life 30 to 50% under the same conditions.

General Electric is progressing development of the grooveless connecting rod bearing. It has released this bearing for field test.

C. Solid Low Pressure Fuel Lines—GE

General Electric has not developed the solid fuel line system

THE ORIGINAL

Every Viscous Torsional Vibration Damper we build is an original. Because WE build them.

And we build them in just about any size you need. From seven inches in diameter to forty-three inches. And sometimes larger. We build them to *your* engine specifications.

And into each unit we build Houdaille quality and experience and integrity. We build in all of the things that made you choose Houdaille in the first place.

We do our best. To build you an original. We invented the Viscous Torsional Vibration Damper, so we can build it best.

Hydraulics Division,
Houdaille Industries, Inc.
540 E. Delavan Ave.
Buffalo, N. Y. 14211

HYDRAULICS HOUDAILLE

to the confidence level it desires to release this design for field test. It continues to experience cracks and breakage on the laboratory engine. It is continuing its development.

D. Air Compressor—
Gear Driven Oil Pump

Electro-Motive Division and General Electric have offered for the past several years (EMD as an extra) air compressors with gear type lubricating oil pumps incorporating a full flow lube oil filter.

The following advantages are realized from this system:

1. The gear pump is less sensitive than the plunger type pump to oil viscosity changes.
2. The gear pump provides increased oil flow.
3. The full flow lube oil filter feature has demonstrated definite reductions in crankshaft, bearing, and cylinder liner wear.
4. With the full flow filter, the compressor is protected against possible bearing damage caused by debris from other component failures such as loose valves, piston pin failures, etc.

The gear pump oil compressor will continue to be provided by EMD on a customer option basis, until such time as it becomes apparent that a majority of the locomotive customers are exercising this extra cost option.

EMD offers a conversion kit consisting of all necessary material to convert a WBO compressor from the plunger type pump to the gear pump system. It has also developed a method to convert the crankshaft in the plunger type WBO compressor to accept the gear pump.

Many parameters influence oil consumption in air compressors The most important are listed below:

1. Oil type (engine type oils usually cause the rings to stick which results in excessive oil consumption)
2. Oil viscosity
3. Cylinder hone pattern, surface finish, and bore dimensions.
4. Type of compression piston rings
5. Type of oil control ring
6. Piston ring material
7. Cylinder bore material (chrome plated bores have resulted in excessive oil consumption)
8. Air filter type (adequate filtration efficiency)
9. Air filter maintenance (Filter elements must be changed before the compressor blows holes in filter medium. Failed filters cause compressor wear to accelerate and oil consumption becomes excessive as the compressor wears.)

Visual inspection of compressors through the discharge valves is the normal way of monitoring oil control. A machine with normal oil control should have a damp oil ring about one inch wide on the outside diameter of the low pressure piston crown. The valve pockets should be damp, but there should be no standing oil. The high pressure piston crown should be damp.

Electro-Motive has oil control figures for compressors at full speed and load. However, it does not have oil control information for compressors at variable speeds and loads (locomotive cycle). This information must be established by railroads monitoring their oil consumption. This can most reliably be done on units that are in captive service.

It is the opinion of this committee that the compressors provided in locomotives offer entirely satisfactory lube oil consumption control when maintained according to builders' recommendations.

Southwestern Railway Club

Started in 1946, the Southwestern Railway Club this year is celebrating its 32nd 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, P. O. Box 309, Sedalia, MO 65301.

W. R. SPAHR
PRESIDENT
Purchasing Agent & Materials Manager
Atchison, Topeka & Santa Fe Railway Co.
Cleburne, TX 76031

F. R. HICKERSON
SECRETARY-TREASURER
General Car Foreman
Missouri Pacific Railroad
P. O. Box 309
Sedalia, MO 65301

Tuesday, October 3, 1978

9:00 A.M.

REPORT OF THE COMMITTEE ON FUEL AND LUBRICANTS

Pre-Convention Presentation: Southwestern Railway Club

April 27, 1978
Camelot Inn
Little Rock, AR

J. D. SMALLING, Chairman
Engineer of Tests
Southern Pacific Transportation Co.
San Francisco, CA 94105

VICE CHAIRMAN

B. C. Cain, Chemist, Atchison, Topeka & Santa Fe Railway, Topeka, KS 66616

COMMITTEE MEMBERS

M. B. Abernathy, Manager, Transportation Sales, Continental Oil Co., Houston, TX 77046
R. A. Bjorndal, Senior Staff Engineer, Chevron, Inc., San Francisco, CA 94104
V. E. Broman, Project Engineer, Atlantic-Richfield, Harvey, IL 60426
J. P. Fite, Engineer of Tests, Frisco Railway, Springfield, MO 65802
L. E. Gaucher, Mechanical Inspector, Norfolk & Western Railway Co., Roanoke, VA 24042
E. A. Goff, Industry Sales Executive-Railroad Sales, Mobil Oil Corp., AMF O'Hare, IL 60666
W. C. Hamilton, Director Lubrication & Metallurgical Analysis, Louisville and Nashville Railroad Co., Louisville, KY 40201
John F. Hillard, Senior Project Engineer, Texaco Inc., Beacon, NY 12508
J. G. Hoffman, Project Engineer, General Electric Corp., Erie PA 16501
M. Kwiatkowski, Technical Engineer, EMD, General Motors Corp., LaGrange, IL 60525
W. R. Land, Product Engineer, Amoco Oil Co., Chicago, IL 60601
J. V. Lawson, Jr., Technical Sales Coordinator Railroad, Sun Oil Co., Wayne, PA 19087
C. Lenzini, Engineer of Tests, Missouri Pacific Railroad Co., St. Louis, MO 62103
R. T. Newman, Senior Chemist, Southern Railway Co., Chattanooga, TN 37401
K. D. Reed, Director, Research Laboratory, Consolidated Rail Corp., Cleveland, OH 44110
R. P. Schmidt, Marketing Technical Services, Exxon Co., USA, Houston, TX 77001
P. A. Shakleford, Manager of Tests, Illinois Central Gulf, Paducah, KY 42001
S. P. Spargo, Engineer of Tests, Bessemer & Lake Erie Railroad, Greenville, PA 16125
J. C. Templeton, Chief Lab Supervisor, Chessie System, Huntington, WV 25718
J. L. Wilkison, Products Application Engineer, Shell Oil Co., Houston, TX 77002

1978 TOPIC:
"PROBLEM PREVENTION THROUGH LUBRICATION"

PERSONAL HISTORY

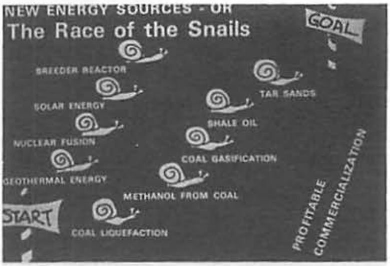
JOHN D. SMALLING

Born in El Dorado, Arkansas on July 13, 1926 Mr. Smalling attended local public schools and upon graduation from High School enlisted in the United States Air Force. Following his tour of duty in the Air Force he attended Louisiana Polytechnic Institute at Ruston, Louisiana for two years, afterwhich he started his railroad career as a Laboratory Technician for the St. Louis Southwestern Railroad in 1947 in Pine Bluff, Arkansas. He was married to Betty Goodwin of El Dorado, Arkansas the same year and they have a married daughter who received her degree in Architecture from the University of Houston and is now a registered architect working in Corpus Christi, Texas.

In 1958 Mr. Smalling returned to school at Little Rock University (which is now the University of Arkansas at Little Rock) attending evenings and also working weekends in order to attend day classes. Six years later and after some 80,000 miles of commuting between Pine Bluff and Little Rock he received his Bachelor of Science Degree in Chemistry.

In 1969 Mr. Smalling was transferred to San Francisco as a Special Assistant in the Mechanical Department of the Southern Pacific Transportation Company. He later moved to Sacramento, CA as Superintendent of Laboratory Operations for four years, subsequently returning to San Francisco in 1974 as Engineer of Tests where he is presently assigned.

Mr. Smalling has been active on the LMOA Fuel and Lubricant Committee for twelve years. He is presently serving on the Executive Committee of the National Railroad Lubrication Council and is a member of the National Association of Railroad Engineers of Tests.



I. NEW ENERGY SOURCES — THE RACE OF SNAILS

It is a safe assumption that nearly everyone has been exposed to the idea that we have an "energy problem;" that the problem is a real problem; that it is not a deliberately contrived problem. Rather than dwelling on emotional issues which in the last few years have generated so much heat, but virtually no light, we will focus instead on an examination of those new energy sources which have the potential of making a significant contribution to our energy needs in the forseeable future, including diesel fuel supply for railroads. These new energy sources are moving to commercialization at a very slow pace. As we discuss this subject, perhaps you will see why this is so. You will also see that

what we describe as our energy problem is really an economic problem.

Innumerable ideas have been advanced as solutions to our energy problem. As a matter of fact, it is well known that you can make a combustible fuel by fermentation of a wide variety of organic wastes including chicken manure, but this energy source is not likely to make a significant contribution to our energy supplies even though it might be desirable as a waste disposal method.

In considering a new energy source, we should keep the following points in mind:

(1) Our energy requirements are enormous and will continue to grow even with conservation.

Because our total energy requirements are large, any new source must be capable of delivering large quantities of energy if it is to make a significant contribution. Furthermore, no single source is capable of delivering the amount of energy in the form required, for example, railroad fuel in a portable form. Therefore, we must look to multiple energy sources rather than to single sources.

(2) Very long lead times are required to bring major new projects to commercialization even when the technology is known.

A classic example is the Alaskan pipeline which was finally brought on stream nine years after the giant oil reserves were discovered on the north slope. The line was originally projected to be completed in five years and cost only $900 million. During the numerous delays, the cost escalated to something over $8 billion, a staggering increase which was accounted for only in small part by some increase in capacity from the original design.

(3) Economics must be considered.

Many energy sources may be technically feasible but would be ruinously expensive if practiced on a scale large enough to be significant.

With these factors in mind and with particular emphasis on economics, lets look at how these new energy sources are moving towards commercialization.

Of the five snails in the first wave of racers, we must place the tar sands snail nearest the finish line since one commercial plant is already operating, albeit unprofitably, and a second commercial plant is under construction. Keep in mind, however, that we are talking about Canadian tar sands. They are not available to us as a domestic energy source. U. S. tar sands are lower quality and are not amenable to the surface mining methods being used in Canada. Also, the coal liquefaction snail is placed slightly behind the other four snails in the first wave as the technology for coal liquefaction has not yet been demonstrated on a large scale. As a matter of interest, it is possible to make diesel fuel from tar sands, shale oil, or by coal liquefaction.

In order to briefly deal with the five snails in the first wave, we will not attempt to describe retorts,

reactors, mines, process flow diagrams, etc., but rather step right in "where angels fear to tread" and look at comparative economics The snails must at least be evaluated on a consistent basis using the same evaluation procedures. To do this, four "actual" Synfuel projects have been selected.

For oil shale, we chose the Colony project which was suspended in the fall of 1974. The Colony data were taken from testimony before a House committee and are probably the most realistic information presented to date on oil shale.

For coal gasification, we selected the American Natural Gas - Lurgi Gasification Project. The American Natural Gas data came from their FPC filing. This process is the one demonstrated on a commercial scale at Westfield, Scotland, several years ago.

For the conversion of coal to a liquid hydrocarbon we used technical information and studies on a proposed large scale project by Conoco.

The Canadian tar sands data were taken from a recent study of the Syncrude Project by the Canadian Petroleum Association. The Syncrude Consortium of Arco-Cities Service-Imperial-Gulf was disrupted in early 1975 by Arco's withdrawal, and the project was finally salvaged only through provincial and federal Canadian government financing. The Syncrude Plant is now under construction with completion scheduled in 1978 and full production capacity of 125,000 barrels per day to be reached in 1982. The project will now cost more than $2 billion. In 1972, when approval was first obtained from Alberta to go forward, the project was estimated to cost $500 million.

Before we delve any further into the economics, please reflect for a moment on this four-fold increase in cost of a tar sands plant since 1972 and you can immediately see the impossibility of even approximately predicting the exact future cost of any synthetic fuel. We do, however, believe that our comparative economics provide a framework for understanding why the various snails are almost standing still.

The capital investments on a daily barrel capacity basis are quite close and range from $23,000 to $27,000. In the case of the Coal Gasification Project, we have included the investment required for a coal mine. In the case of coal liquefaction, the mine investment is not included. It was assumed that the coal would be purchased at 46c/MM BTU or $8/ton. Please also note that the methanol-from-coal economics are not shown because on a BTU basis they are essentially the same as the coal gasification economics and therefore only the latter is shown.

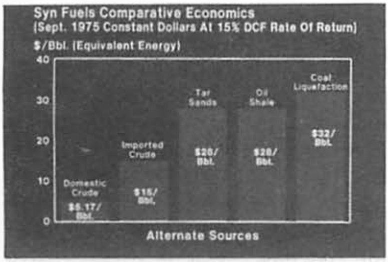
Synfuel Comparative Economics
Capital Costs—Sept. 1977 Dollars

Project	Capacity BPCD (Equiv.)	Capital Billion $	$ Per Daily BBL
Oil Shale	44,200	1.2	26,400
Coal Gasification	46,800	1.3	27,300
Coal Liquefaction	71,600	1.6*	23,000*
Canadian Tar Sands	100,000	2.4	24,100

*Mine Not Included

Energy Costs

Figure 1 shows the energy costs of the synthetic fuels at a 15% return on investment. At 15% return, the costs for tar sand oil and oil shale are about $28/barrel. Coal gasification and coal liquefication are slightly higher at $32/barrel on an equivalent heating value basis. The oil shale economics are based on a specific project using 35 gallon/ton shale. This is a very high quality shale.



Compare these costs to either imported oil at $15/barrel or domestic old oil at $5.17/barrel, which constitutes 60% of our domestic supply, and you see exactly why the snails are barely moving—they just cannot compete with conventional domestic oil and gas production under price controls or with imports at current prices. For example, gas is being imported from Canada for around $2/MM BTU; however the average domestic producer of natural gas received about only 50c/MM BTU on a weighted average. As long as gas is being controlled at these unrealistically low levels and as long as we are willing to pay foreign producers more than we are willing to pay our own producers, there doesn't seem to be any way that new energy projects can get off the ground.

We have attempted to first deal with the economics of the five front-running snails for a definite reason. Let's now ask ourselves — how can these economics be improved? We look first at the chances for better technology and, unfortunately, this avenue is disappointing. It is extremely unlikely that improved technology will provide anything but slight improvements to the economics of any of the first five snails. Also, lower raw material costs, lower capital requirements, or lower operating costs in the future all seem rather unlikely, and so one arrives at the rather distasteful conclusion that **government incentives** will be needed if any one of our five front-runners is going to surge forward. Don't look for any "technical fixes" for these five.

So, let's examine the second wave of snails — solar energy, breeder reactor, fusion energy, and geothermal energy. These snails, although they may not look it, are different from the front-runners in that in each case there at least exists the **possibility** for order of magnitude technical improvements. However, the other side of the coin is all of the five front-runners are at least operable, whereas some of the second wave may not even be operable and, none of them present any real potential as fuel for railroad locomotives in the near future.

What about our breeder reactor snail? Uranium contains only 0.7

of one percent natural radioactive U235; therefore, in today's light water reactors we are not using about 99% of the uranium most of which is in the form of U238. Successful breeder reactors could enable burning of 50% or more of the total uranium; also thorium could be used as a fuel to supplement the uranium. Without breeders we will prpobably exhaust our known uranium supply shortly after the turn of the century.

Small scale breeders have been run in the U.S. as well as in other countries. The Fermi I breeder in Michigan produced 32 million kilowatt hours of electricity before the project ended in 1972. Demonstration plants in the 250-350 megawatt range are now being operated in France, Great Britain, and Russia. The French Super Phinix Program plans to have a 1200 megawatt commercial breeder in operation by 1985. The British and French breeders are about as far ahead of our reactors as the Concorde is ahead of our airplane.

In spite of its potential economic advantages, opposition to the breeder in the U.S. continues at a high level, and even President Carter has called for a moratorium on breeder reactor development. Opponents argue that many questions, particularly in the safety area, have not been resolved and that the breeder accentuates the potential problems of nuclear fuel diversions and sabotage. They are also concerned about the additional environmental hazards of the breeder.

In our opinion, the U.S. breeder snail is now almost immobile; and even after something is done to get him moving, many years of demonstration will be required to establish breeder reliability and many issues must be resolved before commercialization can be considered. Unfortunately, this will take a considerable amount of time and our breeder snail will not reach the finish line before late 1990's at the earliest.

Because the nuclear reactors now in use use only about 1% of the uranium, we will exhaust our uranium supplies in the U.S. shortly after the turn of the century unless breeder reactors are developed and put in use. In other words, the reserves of uranium on this basis are no better than the reserves of oil and gas.

So let's look at nuclear fusion. The fusion reactor would combine deuterium and tritium to make helium while releasing nuclear energy. This is the process by which energy is produced in the sun and is very simple in concept, but exceedingly difficult to accomplish in practice. Man has never tackled a harder engineering problem than the development of a fusion reactor. No one has yet made controlled nuclear fusion produce more energy than it consumes, although scientists have been trying for about 20 years using powerful magnets, lasers, electron beams and other exotic tools. The latest survey lists nearly 200 controlled fusion experiments in 14 countries. Researchers in the Soviet Union,

Western Europe, Japan and the United States have steadily inched closer to the goal of energy break-even. Recent experiments in the U. S. were disappointing. However, even after breakthroughs come, the engineering problems are still so enormous that fusion can hardly be expected to make an impact on our energy supply until well into the next century, and the possibility still exists that the fusion snail may not get to the finish line in the foreseeable future.

The Solar Energy Outlook

Let's examine our solar energy mollusk and first look at solar heating and cooling. Solar units for home heating and cooling are available today, but at high cost. Technical improvements in such units are likely to be small. About two years ago, a New York Times article stated that in Tucson, which has one of the nation's best climates for the use of solar energy, solar heating adds $5/sq. ft. to the cost of a house.

The same New York Times article noted that the cost of installing a solar energy unit to both heat and cool a 2,000 sq. ft house in Austin, Texas is about $12,500 or $11,000 more than a conventional fossil fuels heating and cooling system.

Except for special situations, solar heating and cooling doesn't sound too attractive. Let's look at the photovoltaic effect, i.e., the direct conversion of sunlight to electricity. Here we find plenty of room for technical improvement—the maximum thermal efficiency of current good photovoltaic devices is very low — about 11% — and the cost is very high — about $20-30/watt. Thus a single 1,000 megawatt power plant would cost $30 billion using today's solar cells. However, you can immediately see what a doubling or tripling of the thermal efficiency could do to the power plant cost. Also a halving of the solar cell cost would obviously cut the power plant cost about in half. Solar cells require no fuel other than sunlight, are relatively indestructible, and require little, if any, maintenance. Whether or not the technical improvements or cost improvements ever occur remains to be seen, but at least that photovoltaic solar snail bears watching.

Our geothermal snail also comes in several varieties. Geothermal reservoirs are classified as vapor dominated (dry stream), liquid dominated (wet stream), and hot dry rock reservoirs.

The geysers area of Northern California is a vapor-dominated reservoir and is the largest geothermal electrical generating installation in the world. Its output is presently only 502 megawatts; even with the projected doubling of its capacity its total output will equal only one large modern power station of a conventional type. Unfortunately, such vapor-dominated reservoirs are very, very rare, and also, contrary to popular belief, are probably depletable. On the basis of one well per five acres in the geysers area when develop-

ment is completed, the reservoir is predicted to have a half life of five years.

In liquid dominated reservoirs such as those in the Imperial Valley of California, energy appears at the surface as a hot saline water or stream-brine mix. Power production is complicated and the brines are highly corrosive. There are no commercial geothermal hot water plants on liquid dominated reservoirs generating electricity in the United States today.

The hot dry rock reservoirs can be reached from anywhere on the earth's surface by drilling deep enough, but the technology for economic extraction of the energy is essentially non-existent. The hot dry rock reservoirs usually occur at depths of over 10,000 ft., and a heat transfer fluid must be provided from the surface. Hot dry rocks are ranked lowest in probability for commercial development. Prospects for large scale exploitation of our geothermal snail lie far into the future.

We have briefly considered several of the potential new energy sources. If we have failed to mention some of the far out entries in this race, we don't apologize because it was intentional to omit those snails who can't qualify for the race. We have talked about the long lead times for major new projects. We have seen how delays hamper construction and increase costs of projects such as the Alaskan pipeline offshore deepwater terminals, offshore drilling, and nuclear power plants. These projects which use existing technology are requiring up to ten years to complete. Lead times stretch out much longer when technology must be developed, demonstrated, and then placed in commercial use. In some cases, hoped-for technology breakthroughs may never happen.

There is a need however, for an orderly development of logical, major new energy sources. For projects of this size, we cannot afford to ignore economics, but even the cheapest of these alternate energy sources are considerably more expensive than imported oil and are vastly greater than price controlled oil and gas. Therefore, if even the least expensive of these new energy sources are to come into being, government policy must be changed and government incentives of some sort will be needed.

The move towards alternate energy sources should not mean any significant reduction in quality of diesel fuel. It is felt that technology will be forthcoming to produce diesel fuel from these alternate sources of the same quality as that from petroleum crude oil.

As mentioned previously, the best alternate source for portable fuel such as railroad diesel fuel is from coal liquefaction, shale oil and tar sands.

During the next few years we see no evidence of a shortage of diesel fuel for railroad use unless we are faced with another embargo. Even if that occurs, we feel that steps will be taken to provide railroad fuel on a priority basis because of the railroads' importance to the economy and because of their relatively high efficiency in the use of fuel.

As for the potential use by railroads of other exotic fuels such as methanol from coal, alcohol from agricultural products, or L.P. gas, it is felt that they are at the best, impractical. They may, however, be used in other applications, thereby releasing diesel fuel for railroad use.

There is concern that the quality of diesel fuel produced from petroleum may decline due to changes in crude mix and refinery operations. However, current technology can prevent this if the economics justify it. As an alternative, railroads and locomotive builders can take steps to live with lesser quality by design changes and by installation of such devices as fuel heaters.

Now what does this all mean to the railroad man, and what can he do about it?

It means that, although it is a necessary step, the move towards alternate fuel sources will be an expensive one and, therefore, your fuel costs will increase accordingly. It is a price we must pay, however, to insure a future supply of energy and reduce our dependence on foreign imports.

As to what we can do about the problem, we can make it known to our elected officials in Washington that government policy must be changed to encourage the development of the capacity to produce the alternate energy forms, and to provide sufficient incentive for the free enterprise system to do so through elimination of price controls and through subsidizing some of the enormous investments necessary.

II. LUBE OIL CONSUMPTION USING STRONTIUM 88 AS A TRACER

A. Theory and Method of Analysis

Though a variety of ways of measuring oil consumption exists, of the most simple and accurate would appear to be the monitoring of a trace element added to the oil. The trace element chosen should be one that is available in oil soluble compounds, does not naturally occur to any appreciable extent in the oil or its additives, and that is compatible with the lube oil used at the operating temperature. Strontium 88 was believed to meet the above criterion and was the element selected by the Santa Fe for the lube oil consumption tests.

A 5.4% oil solution of strontium sulfonate was obtained from Continental Oil Company and added to the locomotive crankcases in the proper volume to produce an initial concentration of 100 parts per million strontium. The locomotives were then put in service. Oil containing no strontium was added when oil was required and a sample of the crankcase oil was analyzed for the strontium content by an atomic absorption method. It was generally believed that a decrease in the strontium content would be proportional to the amount of oil consumed. The oil consumption ratio determined would be the number of gallons of oil consumed per 1000 gallons of diesel fuel burned.

B. Test Design and Results

Early tests were conducted on SD-45 EMD locomotives in service. The results showed erratic oil consumption ratios which should have been relatively constant over the long haul, making them suspect when comparing experimental corrective measures with the standard design.

The mathematical formula used to deduce lube oil consumption from atomic absorption data (see A*, Fig. 2) was found to apply to relatively small additions of oil or, more appropriately, infinite dilution. This does not take into account the number of times oil is added to the crankcase, and neither the amount of the addition. Under extreme circumstances, this formula breaks down, yielding erroneous results.

A new mathematical formula (B*, Fig. 2) that takes into account the number of times oil is added to the crankcase between sampling periods, had to be derived. It can be shown to apply in every case, even in the most extreme circumstances.

After having overcome the early difficulties, the Santa Fe designed new tests that would determine the correlation of tracer depletion with lube oil consumption. The new test involved physically measuring the lube oil consumption on two round trips between Kansas City, Kansas and Barstow, California, while simultaneously measuring strontium depletion in the lube oil. Four locomotives were chosen for the test and held in consist until the test was completed. The test results were both startling and revealing. All four locomotives were charged with the proper amount of tracer to produce about 100 parts per million strontium at the beginning of the test. After arriving at Barstow, California, the lube oil was sampled before any new lube oil was added. The expected result was that the strontium concentrate would be well mixed and would measure about 100 parts per million. The startling result was that in every locomotive the strontium concentration measured between 30 and 40 parts per million. The test results are summarized below:

Locomotive No.	Oil Consumpt. (Tracer Meth.)	Oil Consumpt. (Actual)
Kansas City — Barstow		
1	Not available	
2	16.8 gal.	26 gal.
3	46.6 gal.	30 gal.
4	13.8 gal.	25 gal.
Barstow — Kansas City		
1	24.0 gal.	41 gal.
2	23.4 gal.	34 gal.
3.	15.5 gal.	34 gal.
4	8.4 gal.	22 gal.
Kansas City — Barstow		
1	33.0 gal.	45 gal.
2	18.8 gal.	26 gal.
3	25.4 gal.	29 gal.
4	12.2 gal.	19 gal.
Barstow — Kansas City		
1	24.0 gal.	31 gal.
2	23.7 gal.	34 gal.
3	11.0 gal.	27 gal.
4	7.5 gal.	15 gal.

In almost every case the lube oil shown to be consumed by the tracer method was substantially lower than the amount actually consumed.

C. Theoretical Considerations

The oil in the locomotives, to which the tracer was added, was not new oil and, in fact, the additives were found to be almost depleted. We feel that the condition of the oil, the contaminants present, additives present, operapting temperature, or any combination of these factors caused the precipitation of or reaching with a portion of the strontium sulfonate. The remainder of the strontium sulfonate reached equilibrium with the conditions present at a concentration of approximately ½ the amount added. The reacted or precipitated strontium sulfonate was trapped in the sludge and/or on the oil filters and was taken up into solution a little at a time as new oil was added to the crankcase. This would account for the initial drop in tracer concentration and the erroneously low readings of oil consumption found by measuring tracer depletion.

D. Conclusion and Future Aspects

We believe that the measurement of tracer depletion as a means for measuring lube oil consumption can be an effective method, provided that the proper tracer can be found. In view of the recently completed tests, we do not feel strontium sulfonate is a proper choice for a tracer since it appears to be affected by certain lube oil conditions and due to those conditions yields erroneous results.

Other tracer materials will be explored and their performances evaluated under all lube oil conditions likely to be encountered in the field. If a tracer can be found that performs well under all circumstances, other lube oil consumption tests will be made using the tracer depletion method.

FIGURE 2

A*

Exchange Time = Gallons Fuel
2.303 log Sr-i
Sr-f

Lube Oil Consumption =
Crankcase Volume X 1000
Exchange Time

B*

Lube Oil Consumption =
Sr-f 1/X
C X-X Sr-i 1000
Gallons Fuel

Where C = Crankcase volume
X = Number of oil additions
Sr-f = Final concentration of Strontium
Sr-i = Initial concentration of Strontium

III. GENERATION 4 LUBRICATING OIL — PERFORMANCE UPDATE

Last year this Committee reviewed the laboratory data and preliminary field test experience with the first Generation 4 oil. It was the consensus of the Committee that we should present an update of the status of this type of lubricating oil to the 1978 LMOA meeting.

Attention was called in the last report to the fact that the Generation 4 oil is a product made available to the railroad industry somewhat in advance of the broad need for it. In the past, service field problems developed causing operational difficulties before lubricant solutions were developed and proven. This time an oil of an increased performance or reserve quality has been developed before the engine requirement is generally recognized by the railroads.

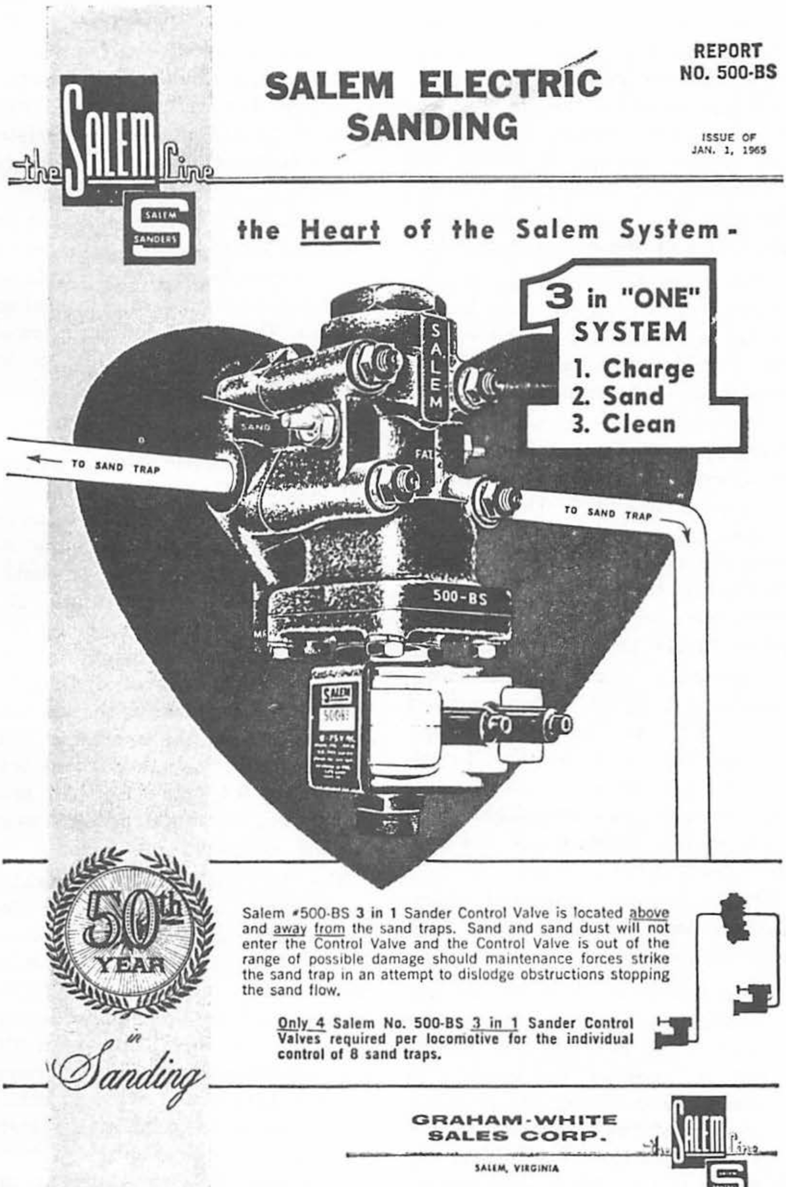
This 1978 Committee report will present observations on the field experience with the Generation 4 oil of one domestic U.S. railroad and a major foreign railroad system.

U. S. Domestic Operation

The first Generation 4 oil was evaluated in a Western railroad for a two-year period during 1974-76. Six 2-cycle and five 4-cycle locomotives were included. Toward the end of the test the railroad adopted the Generation 4 oil for its entire 150-locomotive fleet, so an additional two years of commercial experience has been accumulated.

The service evaluation involved four measured assemblies on each locomotive. The fleet fuel was a No. 2 diesel averaging 0.35 wt % sulfur. Filter changes followed the fleet practice of 45-day intervals. Oil was not drained except as dictated by used oil analysis.

Wear measurements were made on two assemblies from each test unit at the one-year and at the two-year inspections. Wear results from the 2-cycle locomotives are shown in Figures 2-4. It will be noted in Figure 2 that average top compression gap increase with Generation 4 oil was 30% lower at two years than with Generation 3 oil. The average top compression



SALEM ELECTRIC SANDING
REPORT NO. 500-BS
ISSUE OF JAN. 1, 1965
the SALEM Line
SALEM SANDERS
the Heart of the Salem System -
3 in "ONE" SYSTEM
1. Charge
2. Sand
3. Clean
SALEM
SAND
TO SAND TRAP
TO SAND TRAP
500-BS
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

ring face wear is shown in Fig. 3 was 25% lower at two years for Generation 4 oil. Fig. 4 is a bar graph of average ring gap increase and face wear for the No. 1, 2 and 3 compression rings, adjusted to two years' service. It shows the advantage for Generation 4 oil in the 2-cycle engines to be comparable at all of these ring positions.

The wear data from the 4-cycle engines unfortunately were landed by an air filtration problem, and the results were considered too erratic to be meaningful.

Typical deposit condition with the 2-cycle engines at the one and two-year inspections is shown in Figures 5, 6 and 7. These photographs show deposits on pistons, intake ports and rocker arm compartments to be very light, with little increase for two years compared to one year.

Figures 8, 9 and 10 are photographs of a typical piston ring belt area, rocker arm compartment and a crankcase view for the 4-cycle test engines. Here also, the general deposit level was very light, with little change between one and two-year inspections.

The following additional observations were made from the two-year program:

There was no evidence of ash related problems in either engine type. This observation is important in view of the concern in some quarters over the high ash content of the Generation 4 oils. The evaluation of oil filter deposits and oil filter flow characteristics has indicated that extended filter change periods will be allowed by Generation 4 oils. Further work will be required to verify and quantify this observation. The railroads may well elect to use this characteristic of a Generation 4 oil in different ways.

It was found that the 4-cycle engine could readily and safely accommodate increased levels of insolubles when using Generation 4 oils. The engine builder allowed the contamination limit to be raised to 5% pentane insolubles.

Foreign Operation

General Electric Co. evaluated the original Generation 4 lubricating oil additive system on a major foreign railroad to determine its ability to reduce power assembly wear caused by corrosion. The quantity of additive used in this formulation was sufficient to produce an alkalinity level of 13 by the 2896 test procedure. In the particular application, the operating conditions and fuel sulfur content (moderate 0.4% to 0.6% had previously been shown to produce wear by the corrosive mechanism.

The test utilized pre-weighted piston rings with measured cylinder liners and piston grooves. There were three control units, which were rebuilt in the same manner and at the same time as the six units operating with the test lubricating oil. The reference oil was formulated with a widely used Generation 3 additive system and had been in use on the particular railroad for two years at the start of the test. All power as-

FIGURE 2

TOP COMPRESSION RING GAP INCREASE
U.S. WESTERN RAILROAD
EMD GP-40 LOCOMOTIVES

o ● - Average 6 Rings in 3 Locomotives

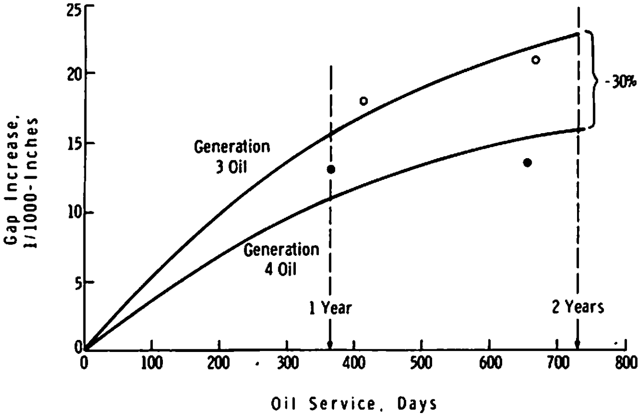


FIGURE 3

TOP COMPRESSION RING FACE WEAR
U. S. WESTERN RAILROAD
EMD GP-40 LOCOMOTIVES

o,● - Average Wear and Service for 6 Rings

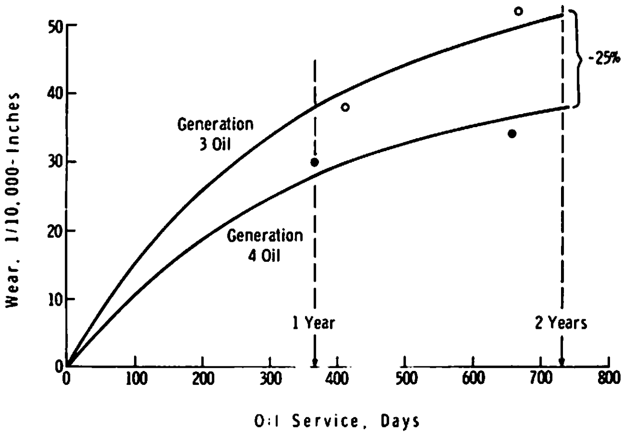


FIGURE 4

COMPRESSION RING WEAR - TWO YEAR'S SERVICE
EMD GP-40 LOCOMOTIVES - U.S. WESTERN RAILROAD

Average of 6 Rings Adjusted to Equal Service

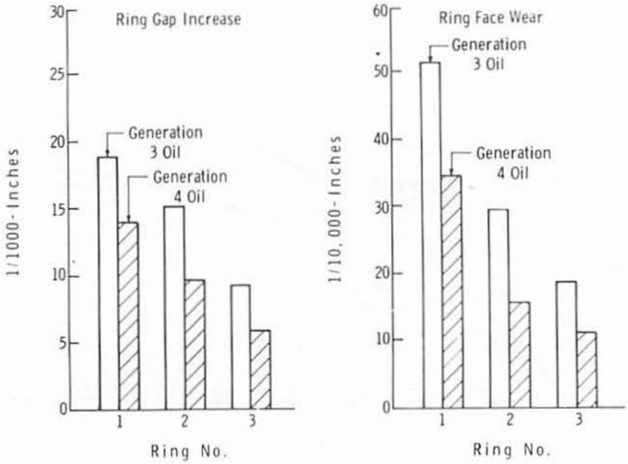
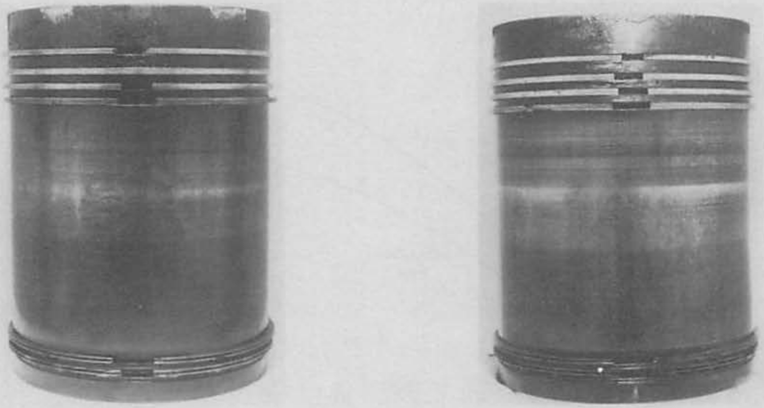


FIGURE 5

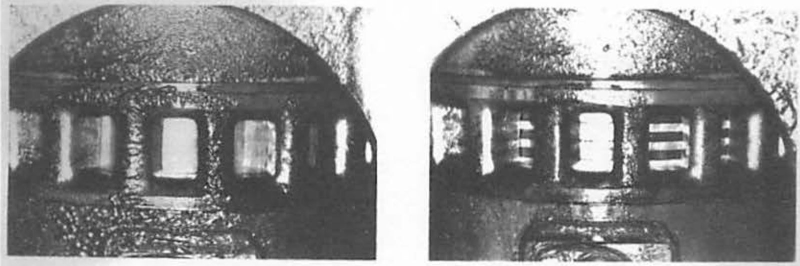
TYPICAL PISTON
U.S. WESTERN RAILROAD - EMD GP-40 LOCOMOTIVE
GENERATION 4 OIL



408 Days 792 Days

FIGURE 6

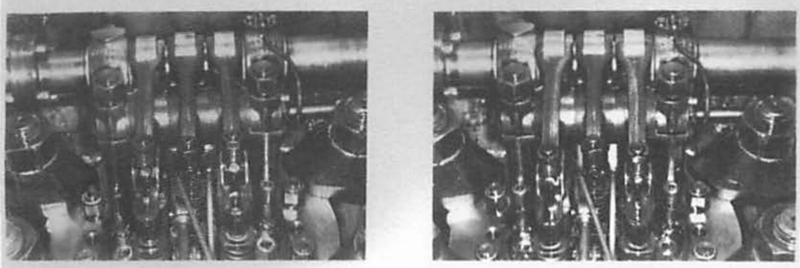
TYPICAL INTAKE PORT
U.S. WESTERN RAILROAD - EMD GP-40 LOCOMOTIVE
GENERATION 4 OIL



369 Days 870 Days

FIGURE 7

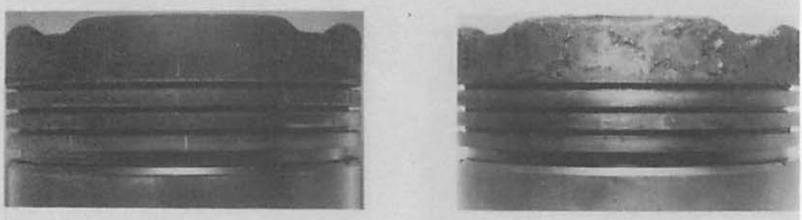
TYPICAL ROCKER ARM COMPARTMENT
U.S. WESTERN RAILROAD - EMD GP-40 LOCOMOTIVE
GENERATION 4 OIL



369 Days 870 Days

FIGURE 8

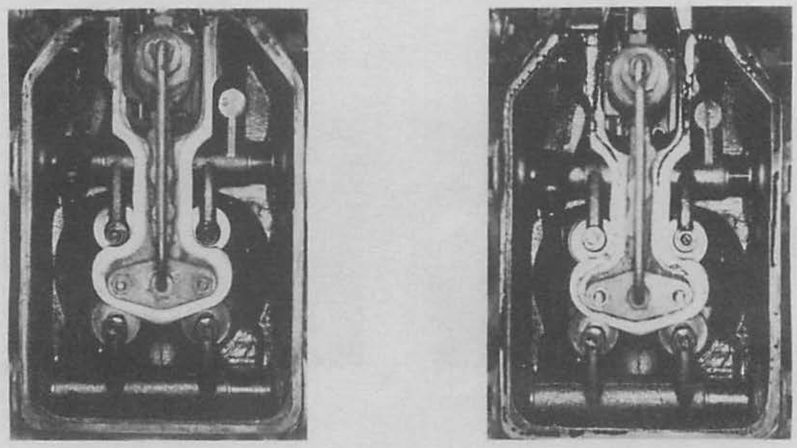
TYPICAL PISTON RING BELT AREA
U.S. WESTERN RAILROAD - GE U-23B LOCOMOTIVE
GENERATION 4 OIL



393 Days 749 Days

FIGURE 9

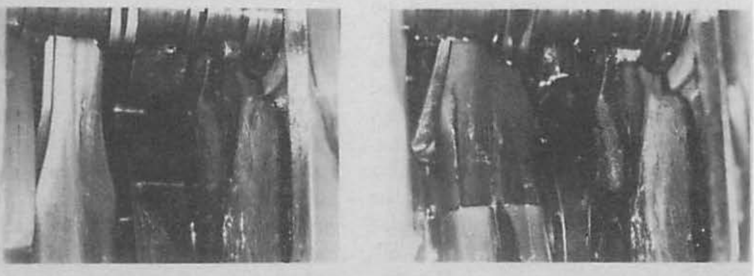
TYPICAL ROCKER ARM COMPARTMENT
U.S. WESTERN RAILROAD - GE U-23B LOCOMOTIVE
GENERATION 4 OIL



394 Days 914 Days

FIGURE 10

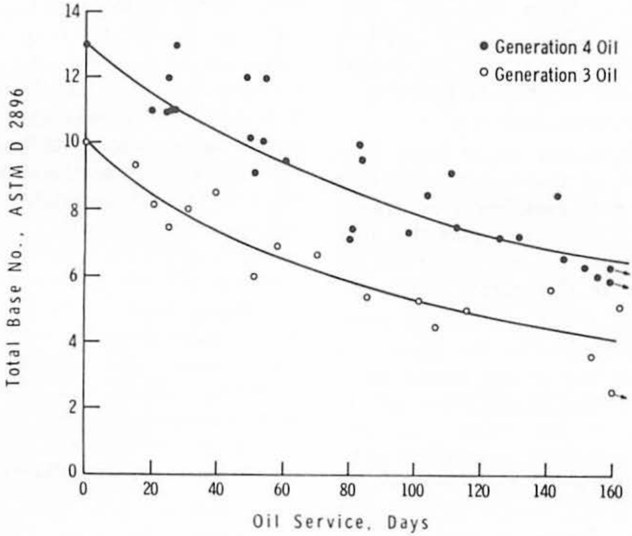
TYPICAL CRANKCASE CONDITION
U.S. WESTERN RAILROAD - GE U-23B LOCOMOTIVE
GENERATION 4 OIL



404 Days 914 Days

FIGURE 11

ACTUAL ALKALINITY RETENTION - ASTM D 2896
FOREIGN RAILROAD - GE U-15 LOCOMOTIVES
0.5 WT % SULFUR FUEL



semblies on these 8-cylinder engines were assembled with pre-weighted and pre-measured parts. Two power assemblies from each unit were evaluated at six months with two additional assemblies removed at the annual inspection.

Lubricating oil was changed on the basis of laboratory analysis. The permissible insoluble level for the Generation 4 oil was permitted to increase to 25 percent more than the insoluble level of the Generation 3 oil. As a result of this higher limit and as a result of the lower alkalinity decay curve, (see Fig. 11) for the Generation 4 oil, the oil change interval of Generation 4 oil was more than doubled compared to the Generation 3 product.

An evaluation of the power assembly measurement showed:

(a) The median top ring weight loss when operating with the Generation 3 product was 2.5 times the weight loss of the Generation 4 product and

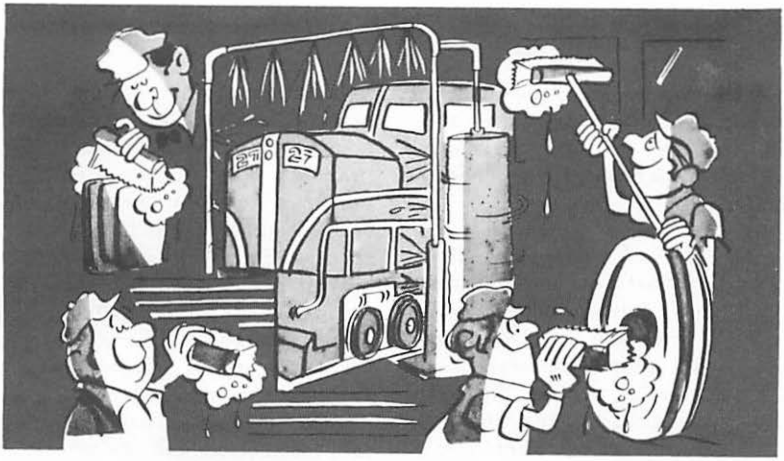
(b) Corrosion upper bore liner wear of the units operating on Generation 3 oil was 3 times as great as the liner wear of the units operating with Generation 4 oil.

Further, the Generation 3 product permitted twice the amount of top piston ring groove carbon packing than the Generation 4 oil. In addition, the Generation 4 oil completely controlled sludge deposits. In the years's test, no sludge formed in the rocker boxes or on the main frame. In contrast, the control units operating with the Generation 3 oil developed significant, though acceptable, amounts of sludge in the rocker box. In this connection, the Generation 4 oils even while carrying a higher burden of insolubles will provide longer service life on oil coolers and be able to better handle higher boiling range fuels which are coming onto the scene.

Since our 1977 report, two other extra performance additive systems have been evaluated and found satisfactory. One of these new products will be used in a lubricating oil handling all of the requirements of a foreign railroad. In addition, there are currently three additional extra performance additive systems awaiting evaluation.

A question clearly in the minds of many LMOA members last year was, "Who needs a Generation 4 oil?" In view of the limited application of the product type to date, the question undoubtedly remains. It is noteworthy that the oil supplier's assessment of the need has resulted in three approved oils and three additional candidate products on one engine builder's product recognition list. It appears that the railroads are not yet aware of the developing need for this oil type. Fuel quality changes, more severe engine duty, and possibly, EPA operating guides have not yet been evaluated. This is due in part to lack of adequate tools or methods to assess these effects.

The full and true value of extra performance oils will only be rec-



ognized if the benefits can be demonstrated and assigned some economic or operational value.

With this in mind, the following review of modern analytical techniques, some not fully developed, will be of interest to members of LMOA:

(1) **Wear of performance-limiting parts by lube oil analysis:** This procedure involves lube oil ash dissolved in acid with atomic absorption analysis for metals. The method approaches the sensitivity of radioactive techniques.

(2) **Oil filter deposit analysis for evidence of engine distress:** This technique uses energy dispersive x-ray fluorescence to analyze filter deposits.

(3) **Filter plugging — when and why:** Flow test of specimen of filter in laboratory rig.

(4) **Insolubles:** This technique involves radiation attenuation of residue on membrane type filter.

(5) **Oil consumption:** This is particularly important when evaluating extra performance oils. The low lubricating oil consumption designed into current engine models must be verified to assure severity of oil evaluation. Strontium sulfonate is used as the trace element (not irradiated). This has been discussed in another Committee presentation.

IV. LOCOMOTIVE WHEEL FLANGE LUBRICATORS

Introduction

Locomotive wheel flange lubricators have been in existence for many years. The DOT-FAST program at the Transportation Test Center in Pueblo, Colorado, is presently testing two different design concepts for flange lubrication.

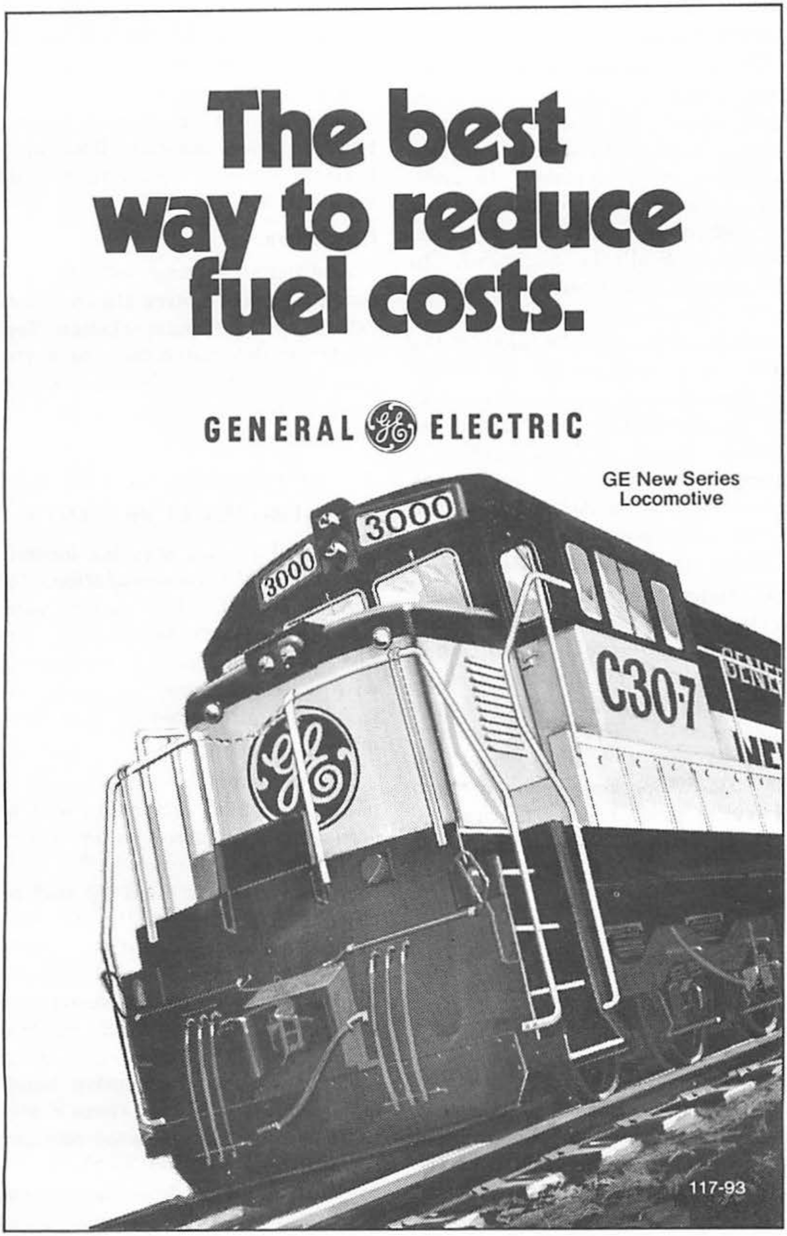
While these flange lubricators are designed primarily to protect locomotive wheel flanges, this test was performed to determine whether sufficient lubricant is being applied to prevent excessive wear of rail, locomotive, and car wheels on the FAST test loop.

General Description

The lubricators are designed to provide a thin film of lubricant on the wheel flange. Two different lubricator designs are involved in the test, an oil type manufactured in Japan and a grease type manufactured in the U.S.A.

As of the date of this report, the oil lubricator had only been in service for three days. During this period, the train operated a total of 386 laps on the FAST loop, accumulating 3.59 million gross tons of traffic on the rail and traveled 1841 miles.

At beginning of test during February, 1978, all trackside lubricators were terminated two hours prior to initiation of the flange lubricator test in an effort to clean the rail. While a considerable amount of grease remained on the gauge sides of the rails after this two-hour period, the flange lubricators were started and set in Posi-


The best
way to reduce
fuel costs.
GENERAL ELECTRIC
GE New Series
Locomotive
3000
C30-7
117-93

tion 3 as recommended by the manufacturer.

Finger gauge measurements were taken at one test point on each wheel of four locomotives. Flange height and thickness measurements were recorded. In addition, seven cars were selected and each wheel on the "A" end of these cars was similarly measured. In all cases, test points on wheels were identified so that future measurements could be taken at the same location. Flange lubricator oil reservoirs were monitored during the test and oil consumption recorded. Wheel and railhead contours were also drawn before the test in a few locations for future comparative purposes.

After the first 16 hours of train operations, the rail was inspected again and it was noted that the gauge sides of the high rails had only traces of oil and the area of the rails contacting the flanges was polished. There was no evidence of the "fish scale effect" on the rail, which had been observed in earlier tests without lubrication.

In an effort to increase lubrication, the flange lubricators were set to No. 6 (maximum flow) and continued in another 16 hours of test with slight improvement.

After each day's operation (16 hours) all wheel measurements were made and recorded.

Observations

Within the accuracy of measurement, there was no measurement wear on any of the wheels of the four locomotives or seven freight cars. The rail was highly polished and dry with slight traces of oil on the gauge side of the ball of the rail. While the short duration of test to date is insufficient for conclusive results on flange lubricators, it does indicate that units performed well enough to prevent excessive wear.

Conclusions

Additional testing will be performed on locomotive flange lubricators at the Transportation Test Center to determine their performance characteristics from the standpoint of both wear and operational maintenance.

V. DISCUSSION ON THE USE OF PROPER LUBRICANTS

We will discuss here the locomotive builders' recommendations for lubrication of the major components of their locomotives and reveal the degree of conformity with these recommendations of the railroads represented on your Committee.

Throughout this portion of the paper industrial lubricants will be occasionally referred to by S.A.E. designations, such as SAE 10 air compressor oil or SAE 30 turbine oil, etc. This is actually incorrect in that SAE designations apply only to crankcase oils and automotive axle and manual transmission lubricants. We use SAE designations here for industrial oils on occasion because locomotive builders' manuals often use these designations and it has become common for railroads to refer to these oils by SAE numbers to designate approximate viscosity ranges.

The correct classification of industrial lubricants is by the systems published in ASTM D2422-75, where grades have been established bearing numbers which correspond to the viscosity in Saybolt Universal Seconds at 100°F, or the new International Standards Organization (ISO) with numbers which represent the nominal viscosity in Centistokes at 40°C.

These viscosity classifications of industrial oils and the approximate comparison of the industrial oil classification with SAE classifications for automotive crankcase and gear oils are shown by the following table:

COMMONLY USED LUBRICANT VISCOSITY RATINGS

ASTM Viscosity Grade - SUS	ISO Grade	AGMA Grade No. (Approx.)	SAE Viscosity No. (Approx.)	SAE Gear Lubricant No. (Approx.)	Viscosity S. U. S. @ 210°F (Approx.)
32	2	—	—	—	—
60	10	—	—	—	—
105	22	—	—	—	—
150	32	—	10W	75W	40
215	46	1	10	—	43
315	68	2	20	80W	50
465	100	3	30	—	60
700	150	4	40	85W	75
1000	220	5	50	90	95
1500	320	6	—	—	110
2150	460	7	—	140	130
3150	680	8	—	—	140
4650	1000	—	—	—	—
7000	1500	—	—	—	—

For a more complete and accurate understanding of the viscosity classification systems used for industrial oils, greases and automotive lubricants, refer to the table appended to this section of the paper.

It must be remembered that these viscosity classification systems imply no evaluation of lubricant quality and apply to no property of the product other than viscosity.

A. DIESEL ENGINE

Crankcase

From almost the beginning railroad locomotive diesel engines have used crankcase oils that differed from oils used by diesels in other services. Originally the type of oil used in mixed fleets was governed by some unique requirements of E.M.D.'s two cycle engine. Unlike the oils used in highway, heavy equipment and marine diesel engines, the oils used in these locomotive diesels should not contain zinc dithiophosphate anti-wear additives, due to the silver wrist-pin bearing surfaces. Also, as a result of E.M.D.'s experience, the oils recommended for these two cycle diesels were compounded from medium VI naphthenic base oil to avoid hard carbon build-up in the ring belt area with resultant ring breakage and liner scoring.

More recently, changes in the type oil used in mixed fleets have been brought about by the advent and evolution of the G.E. four cycle engine. The higher soot production of this engine has required increased dispersancy and deter-

gency of the lubricating oil to get acceptable lube oil filter life, and the more recent reduction of lube oil consumption due to the Tuftride liner-ring combination has put higher demands on the oil due to reduced "sweetening" by make-up oil. This has resulted in oils with increased dispersancy and greatly increased alkaline reserve as measured by Total Base Number. In the last few years the alkaline reserve has jumped from an average of 5 to 7 T.B.N. to the range of 10 to 13 T.B.N.

E M.D. recommends an SAE 40 weight oil without zinc dithiophosphate or similar additives. The oil should have a high resistance to oxidation, a low tendency toward the formation of carbon deposits, and should be non-corrosive to silver metal at 285°F and 325°F.

Physical Properties	Unused Oil Limits
Viscosity Index	55 min.
Viscosity - S. U. S.	75 max.
at 100°F	1100 max.
at 210°F	70 min.
	85 max.
Flash Point F	420° min.
Fire Point F	475° min.
Pour Point F	40° max.

Oils that are submitted to E.M.D. and as a result of laboratory tests are demonstrated to meet the above requirements are given approval for field testing. At the conclusion of an extensive satisfactory field test the oil is classified by E.M.D. as proven suitable for use. After extensive satisfactory use of an oil in the field, the oil is advanced to an extensive use classification.

G. E. takes a more positive stand in approving an oil for use in its engines. Little is published regarding the properties of an oil required for consideration by G. E. A simple statement appears, "In general, the diesel engine requires a heavy duty oil of SAE 40 weight having a minimum viscosity index of 60." Oils submitted for the approval of G. E. are given laboratory bench tests and extensive tests in a laboratory installed engine of G. E.'s latest design, operated to simulate severe operating conditions. Oils that pass these engine tests of 600 hours duration are approved for field testing. At the completion of a successful field test, the oil is listed as approved under one of three performance levels, Extra Performance, Superior Class II Higher Alkalinity, or Superior Class II Regular. The classification given to the oil depends on the alkaline reserve, dispersancy and general performance in the series of laboratory, engine and field performance tests.

Nearly all railroads in the country use only oils that appear on G. E.'s approved lists, and are recommended as suitable by E.M.D. Railroads in the western part of our country that combine high altitude operation, tunnel operation, and the use of some higher sulfur fuel are most likely to use the oils rated by G. E. as "Extra Performance, or Superior Class II High Alkalinity."

Engine Governor

There is a diversity in the products recommended by the builders for engine governor lubrication, and even a greater diversity in the products used by the railroads.

E.M.D. recommends a heavy SAE 30 or light SAE 40 R&O Turbine Oil with the following properties:

Viscosity	65-75 S. U. S. @ 210°F
Viscosity Index	100 min.
Pour	0° F max.

G. E. on the other hand recommends the use of a 10W-30 Motor Oil of A. P. I. MS service or better.

The great range of products used for governor lubrication by the railroads is indicated by the following survey of ten railroads.

RAILROAD & AREA OF COUNTRY

A — South Central
E.M.D.—SAE 20W-40 Motor Oil
G. E.— SAE 10W-30 Motor Oil

B — North East
E.M.D.—SAE 10W-40 Motor Oil
G. E.— SAE 10W-40 Motor Oil

C — South Central
E.M.D.—SAE 10W-40 Motor Oil
G. E.— SAE 10W-40 Motor Oil

D — West & South Central
E.M.D.—SAE 30, High VI Turbine Oil
G. E.— SAE 30, High VI Turbine Oil

E — North East
E.M.D.—SAE 30, High VI Turbine Oil
G. E.— SAE 30, High VI Turbine Oil

F — North East
E.M.D.—SAE 40 Crankcase Oil
G. E.— SAE 40 Crankcase Oil

G — South Central & South West
E.M.D.—SAE 20W-40 Motor Oil
G. E.— SAE 20W-40 Motor Oil

H — Central & North West
E.M.D.—SAE 20 Turbine Oil
G. E.— SAE 20 Turbine Oil

I — North West
E.M.D.—SAE 20 Compressor Oil. Synthetic Oil Under Test in Ten E.M.D. Locomotives.
G. E.— SAE 10 Compressor Oil

J — North & South Central
E.M.D.—500 S.U.S. @ 100,39 VI Turbine Oil
G. E.— 500 S.U.S. @ 100,39 VI Turbine Oil

Fuel Control Linkage and Bearings

E.M.D. recommends a "light oil" for this application while G.E. recommends its Specification D6A-2C9 ball bearing grease. A typical product meeting this specification is Exxon Andok 260.

The railroads use a variety of oils where oil is indicated, such as SAE 10, 20 or 30 weight motor oils, SAE 20 R&O turbine oil or car journal oil.

Greases used varied from N. L. G. I. No. 2 greases of both sodium and lithium bases, molybdenum disulfide filled No. 2 lithium soap grease, to Dow Corning Silicone Grease.

Water Pump

The water pumps of both major engine builders run submerged in, or are supplied with oil from the diesel engine crankcase, so no periodic lubrication is required.

Fuel Pump Motor

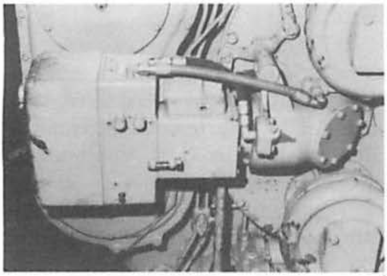
Fuel pump motors come from E.M.D. with bearings packed with Chevron SRI-2 or BRB-2 grease. G. E. fuel pump motor bearings are packed and sealed and cannot be relubricated.

When work is done requiring replenishing grease to these bearings, three greases are reported as being used by the railroads surveyed. They are Chevron SRI-2, Master Lubricants Company, Lubrico M-6, and No. 2 Multipurpose Grease.

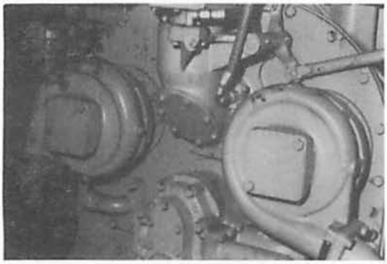
B. ELECTRICAL APPARATUS

Traction Motor Armature Bearings

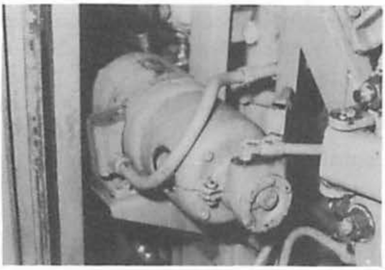
E.M.D. packs traction motor armature bearings with Shell Cy-



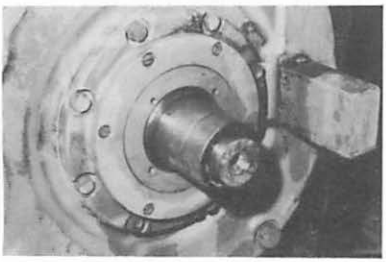
ENGINE GOVERNOR



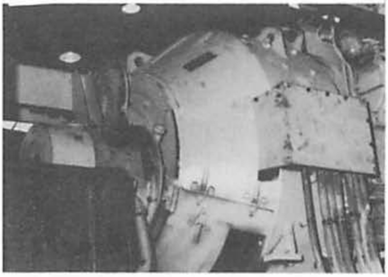
WATER PUMPS



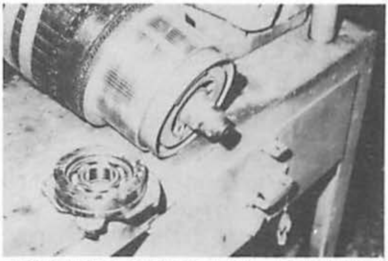
FUEL PUMP MOTOR



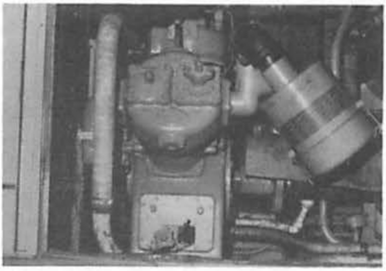
TRACTION MOTOR
ARMATURE BEARINGS



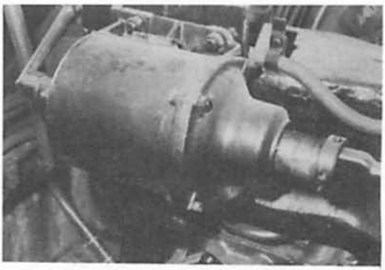
TRACTION ALTERNATOR
OR GENERATOR



AUXILIARY GENERATOR BEARINGS



AIR COMPRESSORS



AIR BRAKE CYLINDERS

prina RA Grade 3 Grease. G. E. uses its Specification D6A2C4 grease for this purpose. Only Exxon Andok BR grease is approved under this specification. This specification covers a sodium soap N.L.G.I. No. 2 grease, while E.M.D. uses a N.L.G.I. No. 3 lithium soap grease.

Of the railroads surveyed that rebuild these components most use Andok BR and Shell Cyprina as specified by the respective builders. However, some railroads indicated that Shell Cyprina was used in all units.

Traction Alternator or Generator

E.M.D. packs the bearing of its alternator/generator with Shell Cyprina RA Grade 3 grease. Due to the different design the bearing of the G. E. alternator or generator is lubricated from the generator gear case. G. E. recommends that diesel engine crankcase oil be used in this gear case.

With one exception, the railroads surveyed that rebuild these components use the grease in E.M.D. units specified by the manufacturer. The exception was one railroad that uses Master Lubricants Lubrico M-6 at this location. All railroads use crankcase oil in the G. E. generator gear case.

Auxiliary Generator Bearings

E.M.D. specifies Chevron SRI-2 grease for these units. The pinion end of G. E. auxiliary generators get its lubrication from the main generator gear case, with diesel crankcase oil. G. E. specifies its D6A2C4 Specification grease (Exxon Andok BR) for the commutator end bearings.

Railroads generally use the greases specified by the manufacturers, but several noted exceptions include the use by one railroad of Molykote 44 in G. E. commutator end bearings, and use by several railroads of Master Lubricants Lubrico M-6 in both the builders' auxiliary generator bearings. In addition, Shell Cyprina RA and Texaco Regal Starfak No. 2 are being used.

Exciter Bearings

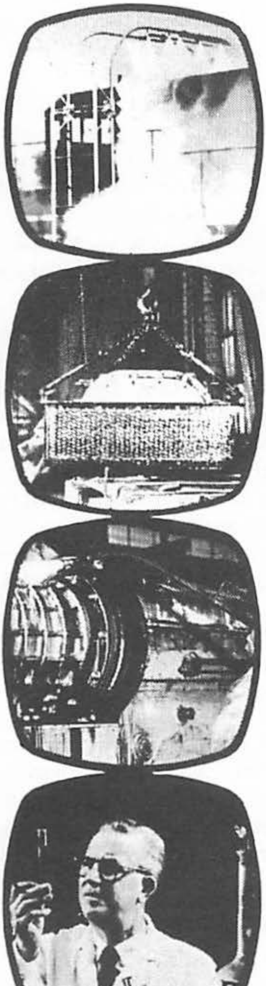
Like with the auxiliary generator bearings, G. E.'s exciter generator gets its lubrication for the pinion end from the traction generator gear case, and D6A2C4 grease (Andok BR) is specified for the commutator end.

In addition to the specified grease for this application, Lubrico M-6, Texaco Regal Starfak No. 2, Shell Alvania No. 2 EP, Shell Cyprina RA and Molykote 44 are being used by railroads for commutator end bearings on exciter generators.

Dynamic Brake Fan Motor Bearings

E.M.D. specifies for the upper fan end bearing Chevron SRI-2 grease and for the lower commutator end bearing American Supermil M-125 grease.

In addition to the greases recommended by E.M.D., as outlined above, railroads use for both upper fan and lower commutator end bearings, Lubrico M-6, American Supermil M-125, Shell Cyprina RA, and Dow Corning 41 and 44 Silicone greases.



C. AIR COMPRESSORS AND AIR BRAKE

Air Compressors

The recommendation for the lubricant to be used in Gardner Denver air compressors in E.M.D. locomotives is an SAE 10 R&O turbine type oil in the deep sump compressor and an SAE-30 R&O turbine type in the shallow sump compressors.

G. E. recommends its Specification D50E13A (SAE 10) in Gardner-Denver compressors, and in Westinghouse compressors, its D50E13B (nominal VIS @ 100°F of 200 S.U.S.) for low ambient temperatures, and its Specification D50E13C (SAE-20) for normal ambient temperatures.

It is interesting to note that E.M.D. recommends turbine type oils with just rust and oxidation inhibitors, while G. E. specifications, as well as Westinghouse specifications both recommend anti-wear additives in addition to the rust and oxidation inhibitors. Two railroads have reported difficulty with compressors lubricated with oil containing zinc dithiophosphate anti-wear additives. The trouble shows up as heavy deposits containing zinc on valves and the ring belt area.

A recent survey of nineteen railroads indicate that most are ignoring O.E.M.'s recommendations. Of the nineteen replies, the breakdown was as follows:

One railroad uses SAE 10 oil in all Gardner-Denver Compressors.

Five railroads use SAE 20 oil in all Gardner-Denver Compressors.

Eight railroads use SAE 30 oil in all Gardner-Denver Compressors.

One railroad uses SAE 40 oil in all Gardner-Denver Compressors.

Three railroads use SAE 10 oil in deep sump compressors and SAE-30 in shallow.

One railroad uses SAE 10 oil in deep sump compressors and SAE-40 in shallow.

A survey of your committee indicates that in addition to several railroads that follow O.E.M. recommendations for both Gardner-Denver and Westinghouse, one railroad uses a low VI SAE 20 turbine oil for all compressors of both manufacturers, several use a high VI SAE 20 turbine oil across the board. One uses a SAE 30 oil in all compressors and one uses a 500 S. U. S. @ 100°F, 39 VI, oil in all compressors.

Air Brake Cylinders

The locomotive builders recommend AAR Specification M-914 grease for this application and this recommendation seems to be universally followed by the railroads.

Air Compressor Flexible Drive Couplings

General Electric originally specified No. 370 Brooks Klingfast grease for this application, but its latest instructions specifies its D6A2C5 No. 2 lithium multipurpose grease. E.M.D. recommends E.M.D. Part No. 8102585 (Texaco Marfak No. 3 H.D.) grease for these flexible couplings. Most railroads on the committee follow the builders' instructions in this area;

however, the following products are also used in this application:

- Texaco Marfak MP-2 grease (E.M.D. units)
- Lubriplate Mo-Lith No. 2 (G. E. units)
- Lubrico M-6
- Arco Litholine H-EP-1
- Brooks Klingfast Heavy /S/ grease

Brake Slack Adjusters

E.M.D. does not recommend lubricating these devices. G.E. recommends ball bearing grease to slack adjuster fittings of older locomotives while newer models require no lubrication.

A great variation of lubricants is being used by railroads represented on your committee, such as No. 2 lithium grease with 10% graphite, Moluballoy 369 dry film, AAR M-912 triple valve oil, Valvoline Tectyl 858-C, Mil-G-10924C lubricant, Conoco Pressure Grease GW, journal box oil, Texaco Marfak MP-2 grease, Magnus Dri-Glide, and Molylube powder mixed with Texaco 85W-90 Multigear EP Lube.

Brake Slack Adjuster Cylinder

E.M.D. recommends AAR-M914 Brake Cylinder Lubricant at rebuild. G.E. has no brake slack adjuster cylinders on its standard locomotive.

Of the railroads on the committee, several use the builders recommended lubricant. However, journal box oil, Magnus Dri-Glide, Valvoline Tectyl 858-C, AAR M-912 triple valve oil and Moluballoy 369 Dry Film were also being used.

Automatic Brake Valve

Mil-G-4343B is recommended for the O rings and packing rings and AAR M-912 triple valve oil for piston rings and slide valves.

In addition to the recommended products used by some railroads, railroads on the committees also use S.T.P. (motor honey) Exxon Beacon No. 325, Lubriplate 930AA, Dow Corning 55M, Molykote 55M, Lubriplate Mo-Lith No. 2 and SAE 10 air compressor oil. One railroad responded with "grease lightly when rebuilt."

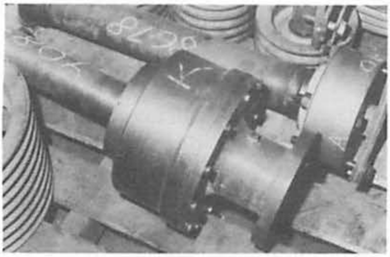
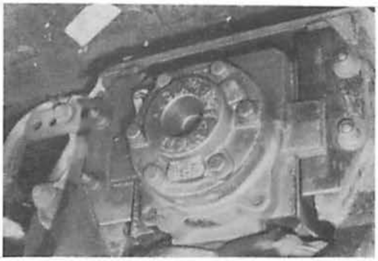
D. TRUCKS

Truck Center Bearings

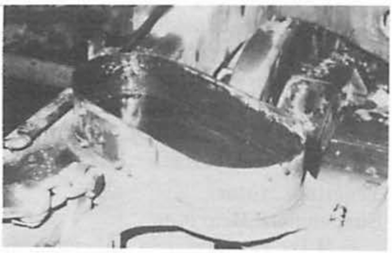
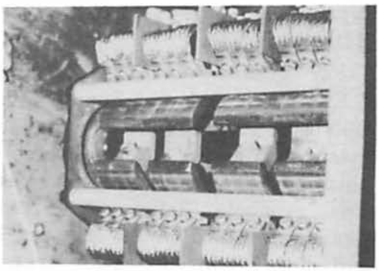
E.M.D. has a specification for all purpose lubricating oil which it recommends for truck center bearings. AAR M-906 car journal oil substantially meets this specification.

Viscosity at 100°F
  300 S. U. S. Min.
  600 S. U. S. Max.
Viscosity at 210°F
  50 S. U. S. Min.
Flash Point
  350°F Min.
Pour Point
  —20°F Max.
Pentane Insolubles
  0.15% Max.

G.E. truck center bearings with oil cups are to use AAR M-906 car journal oil. Installations without oil cups are to use a mixture composed of 1 gallon AAR M-906 car oil and ½ pint of AAR M-913 triple valve graphite. It appears that most railroads on the committee use AAR M-906 car journal oil for both E.M.D. and G.E. truck



center bearings. Other products listed as used are Sun 29835 Motor and RB Oil, Chevron HD No. 2 grease and Molytex No. 2 grease.

Truck Loading Pads

The recommended lubrication for G.E. three-axle trimount loading pads is the same mixture of car oil and graphite as is recommended for truck center bearings.

Railroads on the committee are using G.E.'s recommended mixture for truck loading pads. However, car oil only, car oil with phenolic liners and graphite grease are being used by some railroads.

Journal Bearings

For the lubrication of plain bearings and Hyatt roller bearings with thrust blocks, E.M.D. recommends AAR M-906 car oil.

For all other roller bearings E.M.D. basically recommends AAR M-917 Grade B grease. However, it does specifically recommend certain greases, namely Arco L-300, Rocolube RR No. 1 (Formula LB 1014), Exxon Arapen RB 300 and Texaco No. 1909-H.

For Hyatt journal bearings G.E. recommends its Specification D50E14B, medium 30 weight oil, typified by Texaco Journaltex 1697 HDS.

For grease lubricated bearings G.E. recommends its Specification D50 E20 grease and lists greases meeting this specification, which it notes are AAR M-942-75 greases. The products listed are Exxon Arapen RB 320, Shell Alvania D and Esso Sekiyu, Japan Arapen RB 320.

The railroads on the committee take several approaches to lubricating journal boxes. One railroad uses the new AAR M-942 specification greases or Texaco 957 Locomotive Roller Bearing grease or Exxon Ronex MP grease. One railroad uses Texaco 1559 Roller Bearing Oil in E.M.D. plain and Hyatt roller bearings, and Exxon Ronex MP grease in G.E. roller bearings. Another railroad uses Texaco 957 locomotive bearing grease in grease lubricated boxes and Texaco 1694 JB oil in oil lubricated boxes. One railroad uses Texaco 1909 H, an AAR M-917 Grade B grease, for grease lubricated bearings and all-year car oil for oil lubricated bearings. One uses Arco L-340, an AAR M-917 Grade A grease, and all-year car oil. One railroad uses M-917 Grade B grease in all roller bearings except for Hyatts, in which AAR M-917 Grade A grease is used. This railroad uses all-year car oil in plain bearings. Two railroads have all plain or Hyatt bearings, because one uses reclaimed car journal oil in all bearings and another uses only Sun 29835 motor and RB oil in all journal bearings. This Sun oil is a high VI straight mineral oil having a nominal viscosity of 550 S.U.S. at 100°F.

A recommendation on the part of the builders to use AAR specification lubricants for journal bearings, without restriction to certain brands would do much to simplify this area of lubrication.

Traction Motor Suspension Bearings

E.M.D. recommends all purpose lubricating oil for suspension bear-

ings. The E.M.D. specification for this oil was given previously under Truck Center Bearings. As noted, AAR M-906 car journal oil essentially meets the E.M.D. specification.

G.E. formerly recommended its D50E14A light 20 weight oil for Winter service and their D50E14B medium 30 weight for Summer. These two products approximate AAR M-906A Winter and Summer grade journal box oil; in fact, they are equivalent in essential properties.

G.E.'s most current instructions recommend D50E14B, medium 30 weight oil for year round use and delete D50E14A from its list of specifications.

The railroads on your committee predominately use AAR M-906 car oil for this application. However, three roads use additive all-year car oil, one uses Texaco 1694 JB oil, which is a medium VI car oil and one uses Sun 29835 motor and RB oil.

Traction Motor Gear Cases

E.M.D. recommends Texaco Traction Motor Gear Lube 7500, covered by E.M.D. specification EMS-1027 Type B. G.E. specifies its Specification D50E8C lubricant for traction motor gears. This is a sodium soap thickened grease not too different from that covered by E. M. D. Specification EMS - 1027 Type A. The products recommended under the G.E. specification are Arco and B.P. Jet Lubricant TM

Three railroads on the committee use E.M.D.'s new specification EMS-1027 Type B lithium based gear lubricant acquired from four different manufacturers. Most of the balance of the railroads use the sodium soap gear greases typified by Arco Jet Lube. One large railroad uses Asphaltic "Crater" No. 2 across the board and another railroad uses asphaltic "Crater" No. 3 in all locomotives below 1750 horsepower.

E. LOCOMOTIVE CARBODY

Traction Motor Blower

E.M.D.'s electric drive uses Chevron SRI-2 or BRB-2 grease. It specifies SAE 40 oil for its chain drive and ball bearing grease for its belt drive.

G.E. recommends its D6A2C5 specification grease for blower couplings (Spicer) and its equipment blower pillow blocks. G.E. recommends Shell Alvania No. 2, Atlantic 54-G.E. or Texaco Regal AFB-2 as meeting this specification which covers the typical No. 2 lithium based multipurpose grease.

Railroads again use various lubricants in this application. Several use the lubricants recommended by the builders; but one railroad uses Dow Corning DC 44 in E.M.D.'s sealed bearing on electrically driven blowers. One railroad uses Arco Litholine H-EP-1 on G.E. locomotives. Master Lubricants Lubrico M-6 and Shell Cyprina RA are also being used where grease application is required.

Cooling Fans

E.M.D. recommends that its grease lubricated electric drive

cooling fans be lubricated with Chevron SRI-2 or BRB-2 grease. Oil lubricated fans are to be lubricated with engine crankcase oil.

E.M.D. mechanical drive fans requiring grease should be lubricated with an N.L.G.I. No. 2 EP grease. Oil lubricated mechanical drives require engine crankcase oil. G.E. fan vertical shaft upper bearings are to be lubricated with D6A2C4 grease (Exxon Andok BR). G.E.'s radiator fan gear unit uses engine crankcase oil.

In addition to the recommended products as outlined, Arco Litholine H-EP-1 is used by one road for G.E. vertical shaft upper bearings. In addition Molykote 44, Shell Cyprina RA, Lubrico M-6 and Dow Corning DC 44 are being used at locations requiring grease.

Speed Recorder

For Chicago Pneumatic speed recorders C.P. Recorder Circulating Oil is specified for the hydraulic pump, light grease for the worm gear box and reversing mechanism and low temperature grease is recommended for the Right Angle Drive and Flexible Cable.

For Barco Recorders E.M.D. recommends SAE 10 oil for the instrument and G.E. recommends a paraffinic oil not heavier than SAE 10. For the link and cable E.M.D. recommends low temperature grease while G.E. specifies Amoco L Industrial Grease No. 31. For the wheel diameter compensator box, E.M.D. recommends SAE 90 Oil, while G.E. specifies "SAE 90 motor oil, such as Texaco Thuban SAE 90 or equivalent." The same is true of the axle drive head. Actually, there is no such thing as a SAE 90 motor oil, and Texaco Thuban is an API service GL-1 gear oil.

For Chicago Pneumatic speed recorders, C.P. Recorder Circulating oil is generally used by railroads on the committee, except for one that has its own formula recorder oil. For the grease lubricated portions of the C.P. recorder one railroad uses Amolith Grease No. 1 E.P. and one uses Amoco L Industrial Grease No. 31.

For Barco instruments most use SAE 10 oil for the instrument, except for one road that uses an SAE 20 R&O turbine oil. For the link and cable, in addition to the recommended products, Texaco 2309 RB Grease 942 is being used by one road. Several roads use SAE 90 gear oil in the Barco wheel diameter compensator box and axle drive head.

For the grease lubricated portions of both recorders AAR M-917 Grade A Grease, Alemite No. 30 E.P., Novatex O and Citgo P-O greases are being used. For flexible drives car journal oil and Sun 29835 Motor and RB oil are also being used.

Windshield Wiper

E.M.D. recommends its special Air Push Grease, part No. 8102474, for windshield wipers. G.E. recommends its D6B11B specification hydraulic oil, which is a high VI oil falling in the SAE 20 range, for this application.

MEASUREMENT STANDARD FOR OIL AND GREASE

VISCOSITY SYSTEM FOR INDUSTRIAL LUBRICANTS

Approximate equivalents (Saybolt Universal Seconds—SUS—compared with new International Standards Organization—ISO—viscosity system) published in ASTM D2422-75

Viscosity Grade SUS	ISO Vis. Grade cSt (mm2/s)
32	2
36	3
40	5
50	7
60	10
75	15
105	22
150	32
215	46
315	68
465	100
700	150
1,000	220
1,500	320
2.150	460
3,150	680
4,650	1,000
7,000	1,500

GREASE NLGI NO. & CORRESPONDING ASTM WORKED PENETRATION RANGE

NLGi Grade	Worked Penetration Range
000	445 to 475
00	400 to 430
0	355 to 385
1	310 to 340
2	265 to 295
3	220 to 250
4	175 to 205
5	130 to 160
6	85 to 115

VISCOSITY VALUES FOR CRANKCASE OILS

SAE Viscosity Number	Viscosity Range, Saybolt Universal Seconds			
	at 0°F		at 210°F	
	Minimum	Maximum	Minimum	Maximum
5W	—	less than 6,000	—	—
10W	6,000	12,000	—	—
15W	—	24,000	—	—
20W	12,000	48,000	—	—
20	—	—	45	less than 58
30	—	—	58	less than 70
40	—	—	70	less than 85
50	—	—	85	110

AXLE AND MANUAL TRANSMISSION LUBRICANT VISCOSITY CLASSIFICATION

SAE Viscosity Number	Maximum Temperature for Viscosity of 150,000 cP	Viscosity at 210°F (99°C)				
		Minimum			Maximum	
		cSt	SUS	mm2/s	cSt	SUS
75W	—40°F	4.2	40	4.2		
80W	—15°F	7.0	49	7.0		
85W	+10°F	11.0	63	11.0		
90		14.0	74	14.0	<25	120
140		25.0	120	25.0	<43	200
250		43.0	200	43.0		

Railroads use a great number of products for windshield wipers, such as Texaco Marfak All purpose grease, Dow Corning 55, Cosmolube 615, AAR M-914 brake cylinder lubricant, Texaco Stazon H grease, Lubrico M-6 and Texaco Regal Starfax No. 2. Generally these products are used to lubricate the wipers on both E.M.D. and G.E. units.

Master Controller

E. M. D. recommends Electric Equipment Grease, part No. 819686, for the control stand (cam type) movable cams to shafts.

G.E. recommends its D50E6B special purpose grease, which is a sodium soap N.L.G.I. No. 0 grease, for this purpose.

None of the railroads seems to use the recommended products for this application. Products that are used for both builders' equipment include Fiske Lubriplate Aero Lubricant, Vasoline, Lubrico M-6, Lubriplate 630AA and Dow Corning 55.

There are immediately several points brought out by the discussion we have just gone through. It is obvious that some components do not have critical lubricant requirements, as demonstrated by the successful operation of railroads that have deviated considerably from recommendations. This indicates that the proper level of lubricant is always of primary importance and for many applications is more important than the choice of product. It is also obvious that some railroads depart from recommendations and use a few products in as many locations as possible in order to reduce the number of lubricants that must be stocked.

Finally, it is obvious that the builders have been rather dogmatic in their approach to lubricating locomotives in that they have done little to reduce the number of lubricants required. Evaluating their non-critical areas of lubrication, being aware of their competitors' lubricating requirements, using multipurpose products and AAR specification products in as many applications as possible would do much to reduce the lubrication of locomotives to the simple procedure it should be and reduce the inventory of lubricants the railroads are required to carry.

The naming of proprietary products in this report does not constitute an endorsement of these products to the exclusion of others meeting the specifications mentioned. Many other products meeting the specifications are approved.

ST. LOUIS RAILWAY CLUB

D. M. TUTKO
PRESIDENT
Chief Mechanical Officer
Missouri Pacific Railroad Co.
St. Louis, MO 63103

A Pre-Convention Presentation was made to our regular meeting in St. Louis, Missouri on April 3 by Mr. J. J. Gregory, Manager Production Control, Consolidated Rail Corporation and his Committee on Diesel Material Control.

The members of this club sincerely thank Mr. Gregory, 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.

ROBERT W. HOPE
Secretary
P. O. Box 818
St. Louis, MO 63188

Tuesday, October 3, 1978

10:45 A.M.

REPORT OF THE COMMITTEE ON DIESEL MATERIAL CONTROL

Pre-Convention Presentation: St. Louis Railway Club

April 3, 1978 Stouffer's Riverfront Inn St. Louis, MO

J. J. GREGORY, Chairman
Manager, Production Control
Consolidated Rail Corp.
Altoona, PA 16603

VICE CHAIRMAN

D. L. Ward, Engineer Motive Power, St.Louis-San Francisco Railway Co., 3253 E. Trafficway, Springfield, MO 65802

COMMITTEE MEMBERS

L. W. Bellon, Assistant to Director Purchasing & Materials, Atchison, Topeka & Santa Fe Railway, Topeka, KS 66601

B. J. Cruise, Manager Electro-Motive Warranty Section, General Motors Corp., La-Grange, IL 60525

R. M. Darrin, Jr., Marketing & Sales Manager, Alco Engines Division, White Industrial Power, Inc., Auburn, NY 13021

C. F. Fette, Manager Business & Product Planning for Locomotive Parts and Unit Exchange, General Electric Co., 2901 East Lake Road, Erie, PA 16531

T. H. Field, Director, Regional Material Centers, Southern Railway Co., Atlanta, GA 30303

R. E. Jacobson, Assistant Director Material, Burlington Northern, Inc., 176 East Fifth St., St. Paul, MN 55101

M. A. La Torre, Assistant Plant Manager-Running Maintenance, Southern Pacific Transportation Co., Roseville Locomotive Plant, Church and Cedar Sts., Roseville, CA 95678

C. G. MacDermot, Engineer Locomotive Maintenance & Planning, Delaware & Hudson Railway Co., Watervliet, NY 12189

W. L. Rogers, Assistant Superintendent Motive Power Materials, Rock Island Lines, Kansas City, KS 66105

B. O. Vaden, Mechanical Supervisor-Locomotive, Norfolk and Western Railway Co., Roanoke, VA 24011

B. E. Vermillion, Superintendent Locomotive-Mechanical, Illinois Central Gulf Rail-Road, 233 N. Michigan, Chicago, IL 60601

M. L. Wall, Master Mechanic, Missouri Pacific Railroad, 1010 E. Whaley St., Longview, TX 75601

1978 TOPIC:

"PROBLEM SOLVING THROUGH ANALYSIS AND PROJECTION"

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 Sinclair 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.

GENERAL DISCUSSION OF COMMITTEE REPORT

The Material Control Committee presents five topics—three new and two that are carry-overs from last year's discussions. They are:

1. Warranty labels and their use
2. Economics of rebuilt components
3. What have we learned from the 1975 material crisis
4. Locomotives held for material
5. Computerized information systems

The need for warranty labels has been expounded by this committee for many years. In 1976, the AAR Mechanical Division on Manual of Standards and Recommended Practices approved a metallic, pressure-sensitive self-adhering label. Twenty-two items were initially recommended, ranging from diesel engines to load regulators to small components, such as fuel pump motors.

The procedures in use on the Burlington Northern are of interest—especially the use of labels on materials rehabilitated at the two BN backshops.

L. E. Jacobson, assistant director of material at BN presents the report on warranty labels titled "What can be done by railroads to obtain warranty on defective materials."

For many years there has been much discussion and controversy relative to the use of rebuilt components. Take the case of rebuilt heads—it has been on again-off again on some railroads. The topic of "reclaimed" components was recommended by several mechanical department officers and encompasses items sent to outside rebuilders. Findings to be presented are the result of a questionnaire sent to 20 major, intermediate, and minor railroads by B. E. Vermillion of the ICG and W. R. Powell of the Santa Fe.

The reclamation of radiator cores and the service life after reclamation should be of interest.

Mr. Vermillion's topic is "Justification for utilizing rebuilt components."

What have the railroads and suppliers learned from the material crisis of 1975, its effect on the mechanical department, purchases and stores and our suppliers?

1975 was a critical year in two aspects: the financial condition of many railroads and the peak of the "ecology syndrome" that affected the production of foundry cast items, such as heads, pistons and liners, etc.

L. S. Conti's slides will review the past two years of service, inventory and sales by GE and recommendations to improve opertions for both the railroads and suppliers.

Locomotives held for material has been a topic of discussion for several years although it was not until 1976 that railroads were able to agree on a definition:

> "A locomotive is held for material only after all inspections have been completed and work performed but unit cannot be placed in service due to material outages."

Percent held for power will vary with the size of the railroad, type of power in use, and method of maintenance. Some railroads have many terminals to service locomotives, whereas others limit repairs to one or two major terminals with units sent "dead in consist."

Too often a numbers game occurs as related to availability of power in conjunction with units held for materials. From past surveys we have noted that normally 3% to 4% of power is held for scheduled inspection, 3% to 5% undergoing overhaul or heavy repairs in backshops and 1% to 2% in terminals for unscheduled repairs. A good yardstick for units held for material falls between 0.5% and 1% maximum.

Don Ward of the Frisco will elaborate on the surveys made during November 1977 and also in February 1978. It had been hoped that the severe winter of 1976, which restricted our initial survey, would not be repeated in 1977. Unfortunately, that was not the case.

Do we run parts to "destruction" or can we not perceive predicted life of a part and replace it before failures and train delays occur? I believe that in this age of advanced technology, the use of computers will be the answer.

Computerized information systems to be of maximum service to railroads should be a real time recording system which will produce up-to-date reports. At the present time there are probably only three systems approaching this.

To function properly the recording system must make available to the mechanical department the following:

1. Updated record of running maintenance for each unit.
2. Dates for monthly, quarterly, semi-annual and annual and 24-month inspections.
3. All modifications required and modifications performed.
4. Data on diesel components — date applied, and reason for removal.
5. Warranty dates for major components.
6. Record for spectrographic analysis and other tests on lube oil.
7. Record wheel thickness and possibly wear rates per month by type of power.
8. Man-hours and material cost of repairs.
9. Program to systematically review, on a real time basis, any locomotive or group of locomotives for trend analysis by each terminal location for any symptom, defect action or combination thereof.
10. Program for projection of "next due date" for shop scheduled purposes.

WHAT CAN BE DONE FOR RAILROADS TO OBTAIN WARRANTY OF DEFECTIVE LOCOMOTIVE MATERIAL

Who profits from a warranty? —not the supplier, not the user,: no one profits from warranty.

The supplier does not profit, since he is obligated for replacement or reimbursement for the unexpired time remaining of the locomotive part. His selling price is based on his costs, which include labor, material, overhead, fixed facilities, heating, lighting, taxes, insurance and a margin of profit. Also, warranty costs must be prorated back, further inflating the price of the item. The manufacturer or supplier does not want to handle any more warranty than necessary, since this involves paper work and paper work is labor costs.

On the other hand, the railroad does not profit from warranty material, since it loses the use of the locomotive while repairs are made, along with potential loss of revenue, and paper work which, again, is labor costs. The railroads, however, can't afford not to identify subject warranty material, since warranty adjustments reduce operating expenses.

It is, therefore, the railroad's responsibility to identify warranty material and initiate the claim for adjustment. Let's look first at why it would be impractical, from the manufacturer's standpoint, for the supplier to affix an AAR or similar type of label to replacement parts, as defined by the AAR Mechanical Division's Manual Standards and Recommended Practices, adopted in 1976, under F78 and F79.

Two of the major suppliers of locomotive parts, General Motors—Electro-Motive Division, and General Electric Company, have replied to our previous request asking them if it would be feasible to perform the service of affixing labels to parts supplied. I quote, in part, response from EMD:

"To begin with, Electro-Motive Division believes it is the customers' responsibility to audit warranty material.

We have been asked by a few of our Railroad customers about the possibility of our (EMD) applying the metallic label to replacement parts prior to delivery to the customers' site.

We, as a manufacturer, have been asked to perform an almost impossible job and if such were to be accepted, would place an additional and unfair burden on our customers who intend to use the label as well as those who do not, due to price increases necessary to cover labor involved.

By complying with such a request, we would be placing an almost impossible workload on our Parts Supply Department. It must be remembered that many of these labeled items would be shipped not only overseas, but to many domestic marine, power unit, drill rig and stationary power customers who are not aware of, nor intend using, this label.

Thousands of items we furnish are purchased from outside vendors. These items are packaged, sealed and delivered to our Parts warehouses and stocked pending shipment. We would be required to open each package, carton or crate, apply the label and repackage. Some delicate items could and probably would be damaged during the handling. Some items could be possibly returned to the wrong carton, consequently mis-identified. Removing and replacing the item properly in the carton could be very time consuming as many are packed and blocked with packing so designed to be used during original boxing and defies anyone getting it back in the same box it was removed from. Additional damage possibilities.

To add to the manufacturer's negative response to this request, nearly all the items manufactured in the EMD Plant are serial numbered. I am sure you are all acquainted with the system we use as well as your other vendors. In these cases, it is a much simpler and economical process to have records set up for logging these items and following up for suspected warranty failures.

EMD as a manufacturer, therefore, wishes to remain associated with, yet not responsible for, the application of the metallic identification tag. Our association with the tag will be to the extent that our District Engineers would honor the information the tag furnished and, therefore, honor associated warranty claims."

General Electric also had a negative response, which in part is:

"New and Unit Exchange material originating at a General Electric Company manufacturing source is immediately packaged to assure integrity of assembly is preserved to the end user. This material is then stored (sometimes for months) before being dispositioned to an end customer that may represent the Domestic Railway, Export Railway, Marine, Off-Highway, Drilling or Diesel Derivative Market. Affixing of this tag for the Railway industry would require a repackaging effort in most cases.

New and Unit Exchange material originating at a General Electric Company authorized Vendor manufacturing site would create a real problem in logistics with respect to end market identity. Presently, most of this material is packaged by the Vendor for transhipment through the General Electric Company System. To assure that the Railway metallic tag is affixed would again require repackaging.

Additional problems that exist are:

1. Various Railway customers prefer different tags
   (a) Color-Date Coded
   (b) Metallic
   (c) Mylar-etc.
2. Various Railway Customers request identification of 'their bill of material'. Same as Railway 'A' except.
3. Cost of performing this service would be passed on to user.

In general, it is recommended that the individual railway attach the tag of their choice to the items of their choice to track warranty material."

As a member of this committee, I am familiar with the identification, warehousing and distribution of material and parts. I fully agree with the negative response that the two leading locomotive parts suppliers have taken. Therefore, it becomes the responsibility of the individual railroad, working closely between the material and supply people and the mechanical forces, to recognize and identify material to be handled under warranty.

Since it is obvious that we do not want to create a monster by setting up a procedure whereby an attempt is made to claim warranty on all locomotive parts regardless of value, how can railroads accomplish this task? First we must identify the items that we want to key in on, not only to obtain the life expectancy of new parts and rebuilt parts by an outside vendor but also parts repaired in our own shop complex. By capturing premature failures in our own shops, we may have justification for handling repairs directly with the OEM or other qualified dealers.

There is an alternative to establishing an elaborate computer system to identify all major parts on a locomotive with an Inquiry System to acquire the date of last renewal. A label, adopted in 1976 under F78 and F79—Mechanical Division, Manual of Standards and Recommended Practices, could be applied to selected items at the time the item is removed from the store shelf and delivered to the using department by material personnel. In the case of in-shop repaired, that label could be applied by mechanical forces prior to release to the Material Department for redistribution. It would be the Mechanical Department's responsibility to insert the date and unit number when application is made to the diesel unit. The information contained in the Manual of Standards and Recommended Practices, under F78 and F79 follows:

FAILED LOCOMOTIVE APPURTENANCES HANDLING OF WARRANTY

Recommended Practice
Adopted, 1976

1. Scope

1.1 The Recommended Practice "Failed Locomotive Appurtenances —Handling of Warranty" is intended to provide the railroads a date-marking system for the identification of a failed locomotive part that is still under warranty for the recovery of warranty credit and to assist in upgrading warranty recovery procedures to reduce the laborious paper work that accompanies transactions.

2. Procedure

2.1 Each railroad has to review its own practices and place this date-marking system into effect only as it suits its individual needs.

2.2 The railroad can obtain their own labels and instruct their store or maintenance forces to label and date new or unit exchange parts as a routine practice.

2.3 Locomotive builders and other material vendors must be required to accept the application date provided by the railroads as the effective date that warranty commences on the individual part.

3. Stickers

3.1 Based on actual field tests in the environment of the locomotive, below is the design recommended as the best to meet the requirements:

WARRANTY SEAL

Date
Applied
Unit
Number

NAME OF RAILROAD

.003" thick x ¾" wide x 1½" long, anodized and etched aluminum; ⅛" rounded corners; backed with 3M No. 469 or equivalent pressure sensitive adhesive; color various.

3.2 This particular label offers the following advantages:

a) Can be written on with common ball point pen of the type in use by most employees. While the ink can be wiped off, the impression left in the soft aluminum is permanent and legible.

b) The size is large enough to permit space for easily entering application date and unit number reference, yet small enough to fit most, if not all, parts listed.

c) The adhesive is good quality to assure that sticker remains in place in the environment of the locomotive.

4. **Applications**

4.1 Some of the items recommended for sticker application are as follows:

(See Exhibit A)

Your committee recently circulated a questionnaire to approximately twenty-five major railroads requesting warranty information. Fourteen of the twenty-five railroads responded to the following:

1. Does your railroad use any type of date marking system to identify in-service date of locomotive components received from locomotive builder or other supplier?

   Yes 4 No 10

2. Are any of your suppliers now applying a blank warranty seal to components prior to shipment so that maintenance forces need only to insert the in-service date on the label at time of application?

   Yes 0 No 14

3. Does your railroad use any type of date marking system to identify in-service date of locomotive parts repaired or remanufactured in your own shops to determine the quality of workmanship?

   Yes 7 No 7

4. Should the A AR Committee apply more pressure to all locomotive suppliers to use a uniform identification number which would not only identify the manufacturer of the part but also using the same type of serial numbers; i.e. 77D-1, two (2) digits indicating the year and one (1) digit the month, and then a sequential serial number?

   Yes 11 No 2

5. Does your railroad identify in-service date of major locomotive components by the use of a computer to flag out premature failures? If so, please furnish the listing of locomotive parts presently on this program and, if possible, your instructions to the field forces as how they are to report premature failures.

   Yes 7 No 7

Note, particularly, the "Yes" response to Question No. 4, requesting suppliers to use a uniform identification number to indicate the year and month in which the part was manufactured. The committee strongly feels that the Locomotive Maintenance Officers Association should go on record to have the suppliers of locomotive parts attempt to adopt a common identification using the first two numerical digits, i.e. 78, an alpha designation in the third position to indicate the month, along with a sequential serial number to identify the number of units produced in a single 30-day period.

While not wishing to single out any one of the many products that are not uniformly marked, diesel batteries are typical. They are supplied by seven or eight different vendors. They all use a different type of coding system to indicate the month and year in which the battery was manufactured. Thus, the mechanical and material personnel must look up an instruction to de-code their year of manufacture, as well as to locate the code. Exhibit "B" indicates the present coding system for several of our manufacturers of locomotive batteries. (Exhibit "B")

To summarize the railroad questionnaires, it appears that most of the railroads have identified their major components, such as traction motors, main generators and power assemblies. These are closely scrutinized; however, lesser components from vendors—either New, Unit Exchange, or Repair and Return—are not. Warranty is not recognized at the time of failure with the exception of one railroad that uses a 3-part "Repair and Return" tag, identifying the component to the unit and position. A further analysis will be made of the individual railroad systems and will be reported at the annual meeting in Chicago later this year.

EXHIBIT "A"

AFTERCOOLER ASSEMBLIES
AIR CONDITIONERS, Cab
COMPRESSORS, Air
CONTACTORS
CONTROL ASSEMBLIES
CONTROLLER ASSEMBLIES
COOLERS, Lube Oil
COOLERS, Drinking Water
CORES, Radiator
DRIVE ASSEMBLIES
ENGINES, Diesel
FAN ASSEMBLIES, Cooling
GENERATORS, Aux.
GENERATORS/
ALTERNATORS, Main
GRIDS, Dynamic Brake
GOVERNORS
INTERCOOLERS, Air Compressor
LIMITERS, Reset
MECHANISMS, Bare Controller
MODULES, Solid State
MOTORS, All Types
MOTORS, Traction
PACKS, Power, Governor
PANEL ASSEMBLIES
PUMPS, Fuel & Lube
RECORDERS, Speed
RECTIFIERS
REGULATORS
RELAYS
REVERSERS
SEPARATORS
SWITCHES
TOILETS
TURBO-CHARGERS
VALVE ASSEMBLIES

This is a good basic list to initiate your program of seal application.

EXHIBIT "B"

RAIL TITAN BATTERY

The actual month and year built is shown on name plate that is bonded to the end of each mono block.

EXIDE BATTERY

Location of date code and serial number: Intercell connector except the AG-420 is marked on positive post.

Date Code: Includes—
Purchase Order No.
Plant: Numerical
Month: A thru M
Year: O thru 9

C & D BATTERY

The date code serial number is located on one of the intercell connectors. The number following the letter of the serial number tells the year the battery was manufactured. Thus A54321 denoted 1965. C725 denoted 1967.

GOULD BATTERY

Beginning in 1969, Gould changed its number system to include:

1. ALPHA
   T, K, or M indicating Plant Manufacturing
2. ALPHA
   A thru M indicating Month
3. ALPHA
   A thru Z indicating Each Quarter Century
4. NUMERIC
   001 to 999 indicating Serial Number
5. Calculated Check Digit

KW BATTERY

The date code serial number is located on one of the intercell connectors at the positive end. Thus SN9A1010 — the 9 denotes the year 1969 and the A denotes the month January, B February, C March, etc. The 1010 is the serial number.

WAGSTAFF BATTERY

The date code is stamped on one of the end terminals. The first two numbers designate the year; the next number or numbers the month, and then separated by a gap another set of numbers which is the serial number.

7111-358

Example: Yr.Mo.Serial No.
This indicates that this battery was made November, 1971.

RECOMMENDATIONS

Most battery manufacturers have an unconditional warranty for eighteen months of service, with a total warranty of ninety-six months based on a pro-rata basis.

Battery manufacturers should all date code their batteries on the intercell connectors. Stamping should be as follows:

Yr.	Mo.	Serial No.	Plant Desig. if reqd.
78	A	1234	

Original manufacturer's name can be molded or stamped in any convenient location on the battery.

WHAT CAN BE DONE BY RAILROADS TO OBTAIN WARRANTY ON DEFECTIVE MATERIALS

The Burlington Northern, for a number of years, has realized that claiming of warranty material—not only received on new locomotives but the replacement parts secured from the OEM, other suppliers, as well as reworked material in our own shops—was not always reported upon failure. As a result, in late 1977 the Burlington Northern initiated a plan to obtain a supply of four different color coded tags that would be affixed to the material so that the "In-Service" date record could be maintained.

Sample of the four forms are shown as follows:

Yellow
Shop Repaired
at Livingston,
Montana Shops

Yellow
Shop Repaired
at W. Burlington
Iowa Shops

Flame Red
To Be Applied To
Select Items New
or Reworked Having
Warranty Period of
Less Than 1 Year

Dark Green
To Be Applied To
Select Items New
or Reworked Having
Warranty Period of
1 Year or More

We have prepared a list of the items that the labels will be affixed to. The red and green labels will be applied by the Material personnel at the time the parts are removed from the shelf for application. However, as of this writing, these two tags have not been put into use. The yellow tags, covering shop repaired material, were put into effect in December 1977 by our shop forces at both of our two major repair shops. The Burlington Northern is, as I am sure other roads are, limited as to subcontracting of repair work or unit exchange of material with outside vendors. As a result, the railroads must prove to Labor Union Representatives that we do not have the technical equipment or expertise, or that the cost of in-house repair exceeds that of outside repairs, before justification for sub-contracting of work can be made. Identifying premature failure of shop repaired material will enable us to recognize problem areas of locomotive components before we have epidemic conditions.

At the present time, there are approximately 100 discrete items being repaired at West Burlington, Iowa and Livingston, Montana that receive the yellow tags. While this list does not include any internal engine parts, we have included such items as slack adjusters, contactors, governors, water coolers, oil coolers, starting motors, cooling fans, regulators, relays and switches.

The warranty seals, applied to the repaired components by the Locomotive Shop personnel before turning the items over to the Material Department, will provide the Maintenance personnel at the regional maintenance points with space to write in the date and unit number as the part is applied to the locomotives. Later, when the part is removed, the in-service date information, together with the nature of the defect, will be noted on an additional "Needing Repair" tag form prior to being turned over to the Material Department to handle for the next repair cycle.

Up to this point, the responsibility was solely with the Mechanical Department. However, the quality of work being performed in the shops is further monitored. Material needing repair that is turned over to the Material Department is checked. Items bearing a yellow tag that had been applied less than one year ago, are noted by the Material Department on the invoice transfer form. One copy of the invoice transfer is sent to the Director Material Department, indicating the unit number, part number, date in-service and the date removed. The Director Material then reports the premature failures to Assistant Vice President Mechanical for necessary action.

While this system has been in effect for a very short time on the Burlington Northern, we feel it will be well worth the effort put forth.

JUSTIFICATION FOR UTILIZING REBUILT COMPONENTS

The rising cost of new components has made rebuilt components a necessity, rather than an option for the railroad industry. A rule of thumb is that a rebuilt component costs about two-thirds that of a new one. Another plus for the railroads is that all of them are capable of adopting at least a partial—if not total—rebuild program. But the question of whether railroad-rebuild and vendor-remanufactured components are as reliable as new components persists.

Questionnaires were sent to various railroads in order to find answers to that question. Power assembly sub-components (heads, liners, pistons, rod, injectors) and radiators were surveyed. Each of those components was identified as G. E., EMD 567, or EMD 645. The railroads were asked to indicate the percentage of new, railroad-rebuilt and vendor-remanufactured components presently in service, their average service life, and what percentages are not reclaimable during rebuild. Service life, for the purpose of this survey, was the length of time between applied and removed. Cause for removal could either be failure or scheduled change out. Replies to the questionnaire were received from all three sizes of railroads.

Graphs and Charts

The first three graphs will show the percentages of components surveyed and presently in service by individual railroads. Each component is broken down into three categories — new, railroad-rebuilt and vendor-remanufactured. (Exhibits 1, 2, 3).

Exhibit 1

Heads and liners are shown in this graph. The average percentages of new, railroad-rebuilt, and vendor-remanufactured are:

- Heads—14% new, 61% rebuilt, 25% vendor.
- Liners—18% new, 35% rebuilt, 47% vendor.

Rebuilt and vendor are predominant. In the case of vendor-remanufactured heads, one might expect this percentage to increase as time goes on due to new or improved reclaim procedures.

Exhibit 2

Pistons and rods are shown in this graph. The average percentages are:

- Pistons—42% new, 56% rebuilt, 2% vendor.
- Rods—23% new, 76% rebuilt, 1% vendor.

The reason for the high percentage of new pistons is the inability to reclaim in many cases. The high percentage of rebuilt (reclaimed) rods is to be expected.

Exhibit 3

Injectors and radiators are shown in this graph. The average percentages are:

Injectors—1% new, 74% rebuilt, 25% vendor.
Radiators—27% new, 30% rebuilt, 43% vendor.

Due to the fact that one or more parts of an injector are always reuseable, the rebuilt and vendor exceed new. The majority of the railroads listed are relying heavily on new and vendor radiators.

Exhibit 4

The percentages of components scrapped vary from one extreme to the other, possibly depending on how stringent each individual railroad's requalification specifications might be. However, the percentage of heads and pistons not reclaimable is consistently high.

Exhibit 5

The service life of power assemblies is shown on this chart. The reason for removal is shown as failure or scheduled. In either case, it is usually contingent on the failure of a sub-component or the one most susceptible to failure. For this reason, the indi-dividual service life of a head, liner, piston, or rod is dependent on power assembly failure or scheduled change out.

With the exception of the railroad using failure as reason for removal, all others using scheduled change out intervals show rebuilt service life equal to new. The asterisk denotes that one or more vendor remanufactured subcomponents were used in power assembly rebuild.

Railroad A —
567 heads (weld in new section — weld up and machine to Standard).
567/645 liners (chrome plated).

Railroad C —
567/645 heads (weld in new section).
567/645 liners (chrome plated).

Railroad D —
567/645 liners (chrome plated).

Railroad E —
567 heads (weld in new section — weld up and machine to standard).
567/645 liners (chrome plated).
567/645 rods (slipper surface of blade rod chrome plated).

Railroad F —
567 heads (weld up and machine to standard).
567/645 liners (chrome plated).

Exhibit 6

While there is only a relatively small number of new for comparison, perhaps you can in some way apply this to your operation. Here again, the majority of the railroads have scheduled change out intervals established.

Exhibit 7

It is interesting to note that all of the railroads able to furnish data are using failure as a reason for removal. Radiators seem to be the exception to the rule insofar as new service life surpasses rebuilt in every case. Those of us involved with rebuilt radiators have probably experienced similar results.

In reply to a question, "Does your railroad feel the service life of these rebuilt parts is as good as new parts?" The railroads surveyed answered as follows:

	Yes	No
Heads	3	3
Liners	6	0
Pistons	3	3
Rods	5	1
Injectors	4	2
Radiators	0	6

In conclusion, this committee feels that the rebuilt components mentioned in this report, with the exception of radiators, can provide service life equal to new components, if prescribed requalification and assembly procedures are followed. The scheduled change out intervals, as established by the respective railroads surveyed, also support our findings. Unless these intervals are increased, can we prove anything to the contrary? If increased, would we be forever limited by one of the sub-components, whether new or rebuilt?

EXHIBIT I

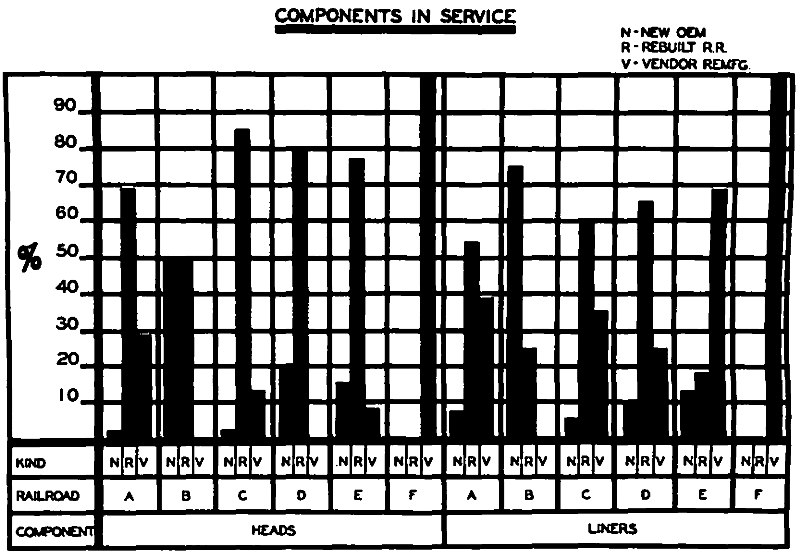


EXHIBIT 2

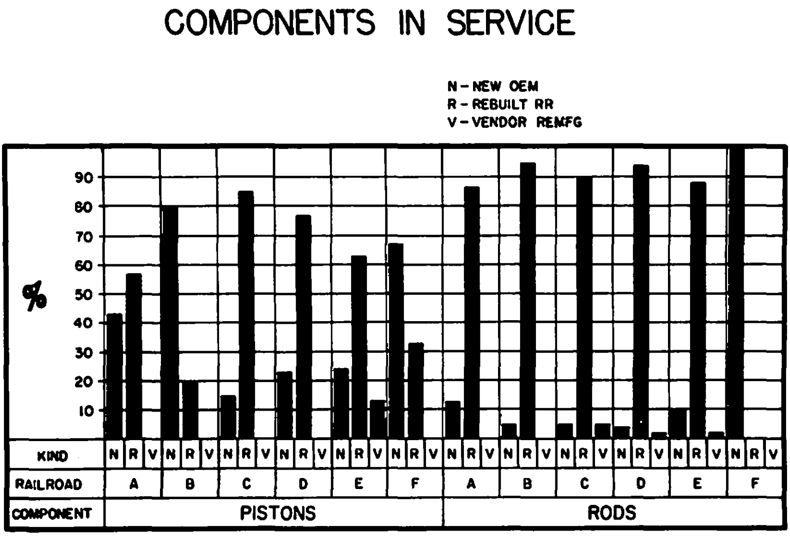


EXHIBIT 3

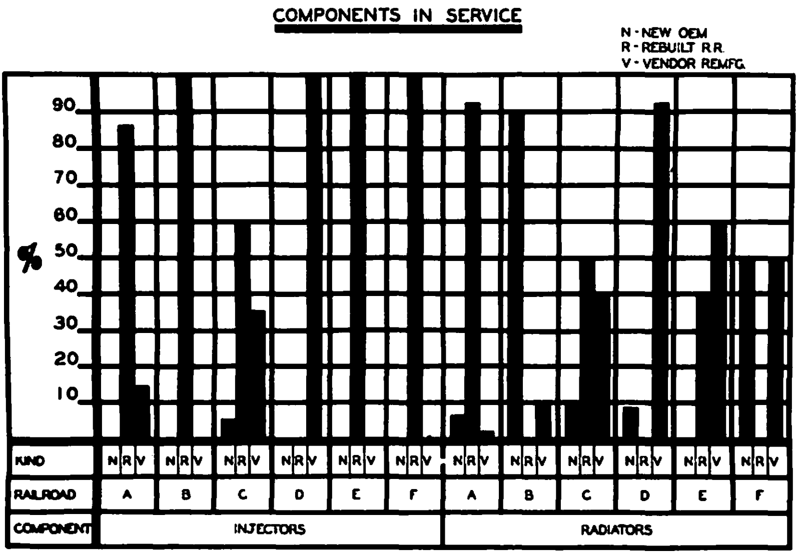


EXHIBIT 4

COMPONENTS SCRAPPED OUT (NOT RECLAIMABLE)

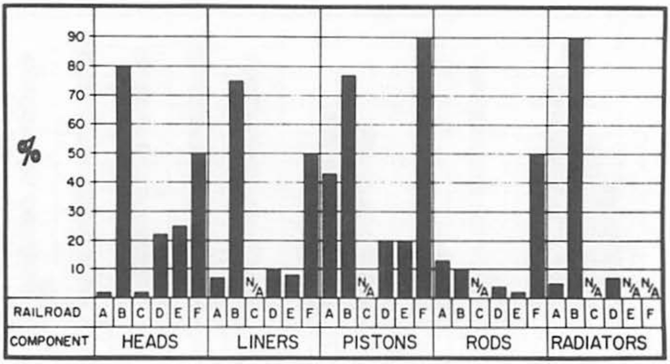


EXHIBIT 5

SERVICE LIFE - NEW vs REBUILT

RAILROAD	REASON FOR REMOVAL		POWER ASSEMBLIES						
			567 EMD		645 EMD		GE		
	FAILURE	SCHEDULED	NEW	REBUILT R.R.	NEW	REBUILT R.R.	NEW	REBUILT R.R.	UTEX
A	X	-	3.0 YEARS	* 2.4 YEARS	2.3 YEARS	* 2.1 YEARS	-	-	-
B	-	X	4.0 YEARS	4.0 YEARS	3.0 YEARS	3.0 YEARS	-	-	4.0 YEARS
C	-	X	5.0 YEARS	* 5.0 YEARS	4.0 YEARS	* 4.0 YEARS	-	-	-
D	-	X	-	* 300,000 MILES	400,000 MILES	* 400,000 MILES	-	-	3.5 YEARS
E	-	X	400,000 TO * 600,000 MILES		400,000 TO * 600,000 MILES		-	-	-
F	-	X	-	* 300,000 MILES	400,000 MILES	* 400,000 MILES	-	-	450,000 MILES

* - DENOTES ONE OR MORE VENDOR REMANUFACTURED SUB-COMPONENTS

EXHIBIT 6

SERVICE LIFE - NEW VS. REBUILT

RAILROAD	REASON FOR REMOVAL		INJECTORS											
			567 EMD				645 EMD				GE			
	FAILURE	SCHEDULED	NEW	RBLT RR	VNDR	UTEX OEM	NEW	RBLT RR	VNDR	UTEX OEM	NEW	RBLT RR	VNDR	UTEX OEM
A	X		2.4 YRS	1.7 YRS	–	–	2.2 YRS	1.5 YRS	–	–	–	–	–	–
B		X	–	4.5 YRS	–	–	–	3.5 YRS	–	–	–	–	–	2.5 YRS
C		X	2.0 YRS	2.0 YRS	–	2.0 YRS	2.0 YRS	2.0 YRS	–	2.0 YRS	–	–	–	–
D		X	–	–	150,000 MILES	–	–	–	200,000 MILES	–	–	–	1.0 YRS	–
E		X	–	4.0 YRS	–	–	–	4.0 YRS	–	–	–	–	1.0 YRS	1.0 YRS
F			INFORMATION NOT AVAILABLE											

EXHIBIT 7

SERVICE LIFE - NEW VS. REBUILT

RAILROAD	REASON FOR REMOVAL		RADIATORS											
			LHP EMD				HHP EMD				GE			
	FAILURE	SCHEDULED	NEW	RBLT RR	VNDR	UTEX OEM	NEW	RBLT RR	VNDR	UTEX OEM	NEW	RBLT RR	VNDR	UTEX OEM
A	X		INFORMATION NOT AVAILABLE											
B	X		–	–	6.0 YRS	–	9.0 YRS	–	6.0 YRS	–	–	–	–	6.0 YRS
C	X		10.0 YRS	5.0 YRS	5.0 YRS	–	–	–	–	–	–	–	–	–
D	X		10.0 YRS	–	7.0 YRS	–	5.0 YRS	–	4.0 YRS	–	–	–	5.0 YRS	–
E	X		250 – 500,000 MILES											
F			INFORMATION NOT AVAILABLE											

WHAT DID WE LEARN FROM THE 1975 MATERIAL CRISIS?

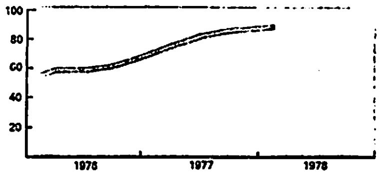
A crisis with replacement parts material takes two forms—either there is too much or too little inventory. When either situation occurs, both the railroad and the manufacturer share the results.

The first phase of the material crisis of 1975 occurred when General Electric's renewal parts inventories built to unacceptable levels as a result of the sharp drop in orders for renewal parts from railroad customers. The best forecast available at that time predicted a continuation of the slow demand for maintenance parts for at least 18 months more. In conformance with this glum forecast, steps were taken to reduce over-all inventories by cutting back production schedules for renewal parts and selling off overstocked items. The action to reduce inventory by GE preceded the second part of the material crisis of 1975 when the rate of orders for railroad renewal parts built to a point well above the level of inventory on hand needed to service this level of demand for parts.

The conclusion is: when inventory is out of phase with demand everyone shares in the results.

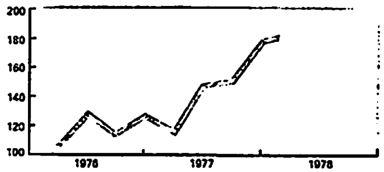
Recognizing the need to improve service in mid 1976, GE embarked on a massive inventory acquisition program designed to return service level to the 95% range. The results of this program are shown in Chart 1 which illustrates renewal parts service level, inventory, and sales

LOCOMOTIVE PARTS



SERVICE LEVEL

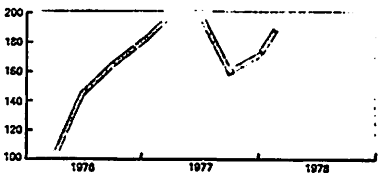
PERCENT OF ITEMS SHIPPED FROM THOSE AUTHORIZED FOR STOCK



INVENTORY

INDEX OF RENEWAL PARTS INVENTORY LEVEL

12/30/75 = 100



SALES

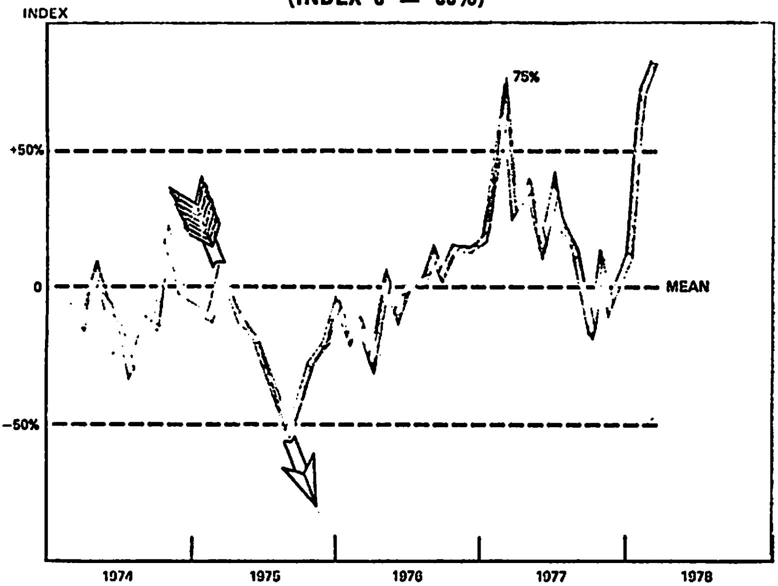
INDEX OF RENEWAL PARTS SALES

12/30/75 = 100

from 1976 through the first quarter of 1978.

The second chart illustrates the demand for renewal parts from 1974 to the first quarter of 1978. This graphs the index of railroad orders for maintenance parts per locomotive in service per week. The

DOMESTIC LOCOMOTIVE RENEWAL PARTS
DEMAND INDEX PER LOCOMOTIVE IN SERVICE PER WEEK
(INDEX 0 = 50%)



WHERE DO WE DRAW THE LINE IN 1978?

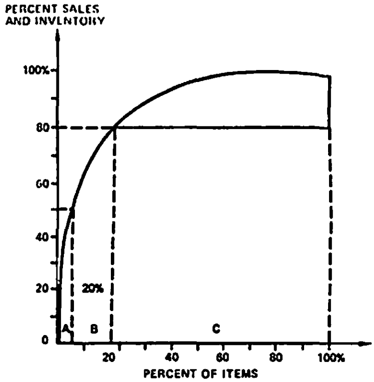
arrow drawn on the chart highlights the key period of 1975 when orders for parts from domestic customers almost dropped out of sight. With the best vision available in mid 1975, steps were taken to adjust inventory to match a demand for parts that approximates the lower dashed line. Obviously, this was the wrong decision as it was followed by a sharp rise in demand through mid 1977. As a result of this sharp drop in demand for parts in early 1975, GE incurred overstocked inventories of key items. The increase in demand in late 1975 resulted in poor service. An accurate and reliable forecast is critical to matching inventory and demand in order to achieve a high level of service.

The problem we face together is this: if the inventory acquisition plan is well below demand the result is much customer dissatisfaction. If inventory acquisition is well above demand, high inventories will result with much GE management dissatisfaction. The answer to this dilema is, of course, to balance inventory acquisition with demand and the only way to do this is to know every domestic railroad's maintenance plan, including "by-item timing." This is not an easy task. Inventory has to be right by item and there are 15,000 stock items involved. Many railroad locomotive maintenance plans are not defined and if they are, the plans are not always followed. Any one of our major customers that does not conform to its locomotive maintenance plan can seriously affect the supply of critical parts to all others.

A useful approach to this problem is through the development of a detailed sales budget that can be translated into a by-item inventory plan. The first step is to obtain the locomotive fleet maintenance plans from each one of our major customers. Secondly, to consolidate these plans on a per dollar basis with major programs expanded for understanding by the builder and the railroad, major items and timing of shipments highlighted. This sales package is then turned over to the renewal parts product planning group who collectively order material from manufacturing in order to support the sales budget. The key to success of this approach depends on how accurately the dollar budget aligns to actual demand. If the budget is below demand, the result is poor service; if the budget is above demand, we have inventory problems. The Renewal Parts Product Planning group translates the dollar budget into by-item procurement. The trick here is to stay within the constraints of inventory on the one hand and service level to railroad customers on the other.

One approach to this problem is through a differentiated ordering plan covering stock items. Renewal parts inventory is segmented into an A,B,C, descending value-volume analysis. The A items—that is the high-value, high-volume items—constitute only 5% of the total stock authorizations. However, they account for over 50% of sales and inventory. These Class "A" items

LOCOMOTIVE PARTS DIFFERENTIATED ORDERING — STOCK ITEMS



COMMENTS:

5% OF ITEMS = 50% OF SALES AND INVENTORY

- WE ENCOURAGE RATE ORDERS ON THESE ITEMS
- YOUR ORDERS/DEMANDS ARE MADE VISIBLE TO PERSONNEL WHO STAGE INVENTORY
- GENERALLY FAST MOVING AND/OR HIGH DOLLAR ITEMS
- CURRENTLY ONLY 15% OF THESE ITEMS ARE RATE ORDERED

95% OF ITEMS = 50% OF SALES AND INVENTORY

- WE UTILIZE HISTORICAL USAGE AS GUIDE TO ORDERING
- WE ORDER SUFFICIENT STOCK TO HIT 95% FROM THIS SEGMENT
- EFFORT IS 100% COMPLETE

STOCK ITEMS = 15,000

are the key parts to any maintenance programs and are those items that should be rate ordered in order to support locomotive maintenance programs. Class "B" and "C" inventory items account for 95% of the total parts authorized for stock, but only 50% of sales and inventory. This segment of renewal parts inventory is a significant contributor to the overall service level. However, a single B or C item doesn't have the same visibility as a high-value Class A item. Consequently, our past usage is the principal guide to ordering these parts from manufacturing. Sufficient renewal parts stock is ordered and kept on hand to attain a 95% off-the-shelf service level from this segment of inventory.

LOCOMOTIVE HELD FOR MATERIAL

The Diesel Material Control Committee, in its 1977 LMOA paper conducted a survey of locomotive units held out-of-service awaiting material for the month of February 1977. Since the response at that time was somewhat limited, the Committee repeated this survey again in November 1977 (one railroad also sent data for February 1978). Once again, the response to this survey was very limited (only three railroads actually responded). But the Committee felt the data received was significant enough to present to you at this time.

In an effort to determine why the response to the survey was once again so limited, we reiterate the two most significant reasons (mentioned in our 1977 paper), the Committee felt contributed to such a limited response:

1. The continuing reluctance of many railroads to submit data that might point to them in an unfavorable light.
2. The fact that many railroads do not keep data that tells them how many of their units and which ones are out of service and being held for material, and where the responsibility lies.

No matter what the reasons, the results of the 1978 survey seem to bear out the Committee's conclusions in the 1977 survey, that the primary reason locomotive units are out of service "held for material" is the railroad's inability to plan material requirements for both scheduled and unscheduled maintenance.

The following are some significant items pointed out by the survey:

1. The majority of the malfunctions causing units to be shopped were mechanical in nature. In fact, the mechanical malfunctions exceeded the electrical malfunctions by a factor of 4 to 1.
2. Unlike 1977, where the majority of units held was a result of, or found on unscheduled maintenance, this year's survey was equally disbursed between both scheduled and unscheduled maintenance.

3. The majority of the material that was needed to put units back into service was material normally stocked at the Diesel Store.

4. Unlike last year's survey, this year's survey revealed that the majority of the needed material was purchase material. In 1977, the majority of the needed material was items repaired (reconditioned by the railroad instead of being purchased).

5. In the area of responsibility for out of stock material, in most cases the local Diesel Store was responsible. It is significant that the survey also showed a major responsibility for out of stock items was in part the Mechanical Department's and its inability to do clear-cut planning for all of its needs. The area of responsibility for out of stock items is quite contingent on who is collecting the data, the Mechanical Department or the Purchasing-and-Stores Department.

6. Finally, in the area of contributing factors, the major factor was an unusual demand. This again relates back to the inability to effectively plan the total locomotive maintenance functions.

In conclusion, the survey revealed the need for better planning on the part of both the Mechanical Department and Purchasing and Stores Department, and the need to plan together to have the necessary material available to get locomotive units repaired and out of the shop as quickly as possible. It's only through such planning that locomotive units held for material will be kept at an acceptable level.

LIS — CONRAIL LOCOMOTIVE INFORMATION SYSTEM

Conrail's Locomotive Information System (LIS) is the foundation of a data processing system for locomotives that will provide a tool for management of this large and expensive fleet. The initial phases of this system were to keep track of locomotive maintenance, and also the utilization of locomotives.

Some general statements concerning the locomotive information system

It is a real-time system, which means: that there are input terminals at the major locomotive locations and that communications have been established between the input terminals and the main computer located in Philadelphia. This provides the ability to inquire and retrieve information immediately and the ability to update files as transactions occur. Processing takes place in the transportation computer, which provides access to common data files that contain large volumes of transportation information.

These systems use AT&T Data Speed 40 Terminals. The terminal consists of a keyboard that provides the ability to key in information for transmission to the computer. It also contains a cathode ray tube (commonly known as a CRT), which can be used to display data when it is not necessary to obtain a hard copy printout. Finally, there is a printer to satisfy the need for printed output.

The maintenance phase includes establishing a master file containing all Conrail locomotives. Along with this master file, a history file was established that contains all repairs to each locomotive, thus permitting the retrieval and analysis of the stored information when needed.

The maintenance system was implemented at Selkirk Diesel Shop in April 1976.

It is presently installed at 26 Diesel Shops and 7 Regional Mechanical offices. The objectives for installing terminals in regional headquarters were twofold: First, to report repairs to locomotives for locations too small to warrant having a terminal of their own and, second, to provide data to regional management.

Every location that becomes responsible for inputting locomotive repairs is expected to perform various functions. One function is to create a one-time master record for each Conrail locomotive assigned to them. This master record contains all important physical characteristics of the locomotive. Some of that information is, whether the locomotive has agreement seats, cab signal, class of locomotive, horsepower, capacities (fuel, sand, lube), federal inspection dates, continuous minimum speed, weight on drivers, component part date applied.

This master record will only need to be updated if the characteristics of the locomotive change. A portion of the data contained on the master record is updated automatically when repairs are reported on the locomotive. Another function, which must be provided by shop locations, is to report the work performed on locomotives. Those reports consist of identifying the locomotive involved, the reason the locomotive was shopped (the symptom), what was wrong or corrected (defect), how the problem was corrected (action), at which location the problem was corrected, and the date the locomotive was shopped and when it was released.

Another item which must be reported are train failures. Once each day those failures are transmitted to each shop manager so that they are made aware each day of the locomotives they are responsible for that have caused train failures.

From all the data that has been input the following data can be obtained from the system.

Although all locomotive history is saved on tapes, only four months shopping information can be obtained on any CONRAIL locomotive on a real-time basis. This data includes the five FRA inspection dates and the location the locomotive is assigned. It shows all shoppings, why the locomotive was shopped and what was wrong or corrected and how corrected. It shows which shop did the work and when.

—A report can also be obtained by location or "all CONRAIL" for any period of time that shows what locomotives are due what inspections in what period of time.

—A report of all locomotives that are in the shop. This report will show all locomotives that are in your shop, or will show all locomotives which are assigned a particular location which are anywhere.

—There also is the ability to analyze this 4 months history information in many ways, i.e., by locomotive number, by period of time, by symptoms, by defect, by action, by component part or by any combination of above items.

Monthly reports also are generated in order to analyze the CONRAIL fleet of locomotives. Those reports are as follows:

—The ten most frequent failures by assigned maintenance location, by class of locomotive.

—Components changed out by assigned maintenance location, by class of locomotive, with year to date figures showing numbers of components changed in last twelve months. It also shows the percent of components changed to the total possibility of change outs at that location.

—Locomotives causing train failures. Three different sequences are produced. One by assigned maintenance location which gives a three month comparison. The second is by cause of failure. The third is by train.

—Reports which show what modifications have been made to what units.

—Output reports also consist of graphs which show what the mean time (the number of days out of shop) is by class of locomotive.

Subjects currently being implemented and developed are the recordkeeping of oil analysis and the control of oil calls and also the establishment of a file containing locomotive material requirements.

Oil samples will be input to the system via Data Speed 40's. The Baird-Atomic Oil Analyzers also will be attached directly to the computer in Philadelphia from the oil test labs having the analyzers. Tests will be analyzed by the computer, and when they are found to be in excess, the history will be transmitted back to the test lab, where the lab technician will decide whether a call should be made. If a call is issued, it will be done through the Data Speed 40, which will then have letters transmitted to all locations which should know about the oil problem on the loco. Controls are established to assure the call is satisfied. The Material Requirements program maintains a file of material needed to repair out-of-service locomotives. Inquiry into the file is possible at any time in order to determine what material is needed.

Additional phases to be developed are in the recordkeeping (history), and control of component parts. Components will become part of the system so that locomotives and components are in a common data base, and control and projected life of components will be readily available.

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

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

Our Diesel Electrical Maintenance Committee's presentation was well received in what we trust was a mutually beneficial experience.

Our thanks again to Jim Butler and his forces at Altoona Shops.

Tuesday, October 3, 1978

2:00 P. M.

REPORT OF THE COMMITTEE ON DIESEL ELECTRICAL MAINTENANCE

Pre-Convention Presentation:
Altoona Shops
Consolidated Rail Corp.
Altoona, PA

April 13, 1978
Sheraton Motor Inn
Altoona, PA

CARL E. PALME, Chairman
Diesel Electrical Engineer
Chessie System
801 Madison Avenue
Huntington, WV 25704

VICE CHAIRMAN

H. Stringer, Supervisor Motive Power-Electrical, Canadian Pacific, Ltd., Room 903, Windsor Station, Montreal, Quebec, Canada

COMMITTEE MEMBERS

John R. Anderson, Electrical Foreman, Burlington Northern, Inc., Livingston, MT 59047
O. W. Aten, Morrison-Knudson Company, Blue Springs, MO 64015
R. P. Chambers, Manager Diesel Locomotives, Amtrak, Washington, DC 20024
D. W. Chirikos, Assistant Manager, Technical Section, Electro-Motive Division, LaGrange, IL 60525
J. H. Cox, Mechanical Assistant, Motive Power, Grand Trunk Western Railroad, Battle Creek, MI 49016
C. W. Drake, General Foreman, Southern Pacific Transportation Co., Roseville, CA 95678
L. D. Edson, Supervisor Electrical Design & Maintenance, Union Pacific Railroad Co., Omaha, NB 68179
J. F. Kearney, Jr., Quality Control Engineer, Southern Railway Co., Atlanta, GA 30315
R. Lauzon, Electrical Assistant Operations & Maintenance, Canadian National Railways, Montreal, Quebec H3C 3N4
H. Liban, Electrical Engineer-Locomotive, Consolidated Rail Corp., Philadelphia, PA 19104
K. D. Martin, Supervisor Locomotive Maintenance, Atchison, Topeka & Santa Fe Railway, Topeka, KS 66616
D. W. Mayberry, Supervisor Locomotive, Norfolk & Western Railway Co., Roanoke, VA 24042
F. R. Miller, Master Mechanic, Missouri Pacific Railroad, Dolton, IL 60419
D. I. Smith, Senior Factory Service Engineer, General Electric Co., Erie, PA 16501
F. A. Upton. Jr., Master Mechanic, Chicago, Rock Island and Pacific Railroad, Des Moines, IA 50309
T. L. Westerfield, Electrical Engineer, Chicago & North Western Transportation Co., Chicago, IL 60606
G. W .Whittaker, Electrical Engineer-Locomotive, Illinois Central Gulf Railroad, Chicago, IL 60601

1978 TOPIC:

"RECOGNIZING AND SOLVING ELECTRICAL PROBLEMS"

PERSONAL HISTORY

CARL E. PALME

Born in West Palm Beach, Florida, February 25, 1934.

Attended Queen's College, Long Island, New York and Marshall University, Huntington, West Virginia. Completed 1200 hours Technical Training in Electronics and Armament Systems Fundamentals with the U. S. Air Force from November, 1952 to January, 1957.

Joined the Baltimore and Ohio Railroad in 1965, after working for the Sperry Rand Corporation in Long Island, New York from 1957 to 1965.

He is married to the former Carol Miseles, and they have two children.

COMMON SMALL ELECTRICAL FAILURES

Small electrical failures on locomotives do not attract the attention of the more "spectacular" electrical failures, such as flashed or burned main generators, electrical locker fires, traction motor failures, etc. However, when a wire is disconnected or broken, when loading is not being accomplished, when the interlock is not making the relay with the coil open, the result is the same, a locomotive failure. That in turn results in a train delay and a reduction in motive power dependability. The following deals with small electrical failures.

What comprises a small electrical failure? In general, this type of failure is characterized by its unpredictability. It is created by a component that given the opportunity to fail does so, usually at the most inopportune time and place. In most cases, such defects either will cripple a locomotive on line of road, or severely curtail its proper performance. For specifics, refer to Exhibit I, which lists the ten most common line-of-road nuisance failures.

Data shown here were obtained from the member roads of this committee. Although the four railroads have somewhat different service environments, the nuisance failures of each are similar. Those ten items for each railroad are consistent failure producers, with the end result being reduced locomotive dependability and reliability. In addition, the problems faced by the line maintenance officer are compounded by the unscheduled shopping of locomotives because of a "nuisance" failure. In line with this year's L.M.O.A. theme, consider the failures common to our four representative railroads. Note two basic areas as follows:

- I. Low Voltage Wiring
  - A. Loose connections
  - B. Grounds
- II. Components
  - A. Interlocks and relays
  - B. Pressure, temperature switches
  - C. MU cables and receptacles.
  - D. Small motors

The two areas will be considered in the context of the following:

1. Technical aspects of field maintenance

2. New locomotive construction
3. Abstract aspects of field maintenance

TECHNICAL ASPECTS OF FIELD MAINTENANCE — WIRING AND TERMINATIONS

One approach to the reduction of nuisance line-of-road failures is in the materials and techniques used in field maintenance operations. Basically, this refers to using the right tool or technique at the right time.

In the area of low voltage wiring, the fast-on terminal has long been an industry-wide standard, and has helped to keep new equipment (and maintenance) costs down. However, this type of terminal also has the annoying tendency of loosening after several connections and disconnections. This can be minimized by the use of phosphor-bronze alloy terminals for normal connections, and nickel-steel alloy terminals for high temperature/current connections, such as are found in headlight systems and negative wiring. The cost differential between the normal tin-plated brass connector and either of the recommended types is minimal, especially when compared with road failure costs and/or component damage.

Low voltage wiring grounds will continue to occur as long as locomotives have electrical systems. However, field maintenance can have some impact on reducing failures from this source. For one thing, roads using SEARCH have the capability of measuring leakage to ground on virtually every wire in the electrical system. Normally, the manual leakage tests made as part of the FRA inspection are made at the rear of a particular circuit breaker, and it is possible to have partially or fully grounded controls without finding the ground. Except for a few isolated cases, a single ground can be coped with. But the odds of that unit or another unit in consist having (or developing) an opposite polarity ground are quite good. This problem is compounded by insulation deterioration due to age and environment. The field electrical maintenance officer can do little to correct for the age and deterioration problem, but can well keep the following points in mind:

1. A thorough visual daily and control inspection for signs of distressed wiring.
2. Being alert for consistent failure sources on similar type and age locomotives.
3. Aggressively pursuing and eliminating oil, water and snow leaks that allow moisture and carbon track grounds to develop.
4. Properly maintain seals and gaskets or electrical cabinets, and to periodically clean cabinets with suitable solvents and low pressure air.

Consideration could also be given to a selective rewire program on older units, with emphasis on replacing and rerouting wiring that consistently develops grounds. Such a program most certainly must be based on an in-depth cost-effectiveness analysis.

NEW LOCOMOTIVE ASPECT OF WIRING AND TERMINATIONS

In addition to the maintenance approach to the reduction of nuisance failures from low voltage wiring terminations and grounds, there are some areas the locomotive builders should pursue. There is the matter of the terminals mentioned above, and the additional per unit cost again would be minimal. In the case of wiring, the following recommendations are made:

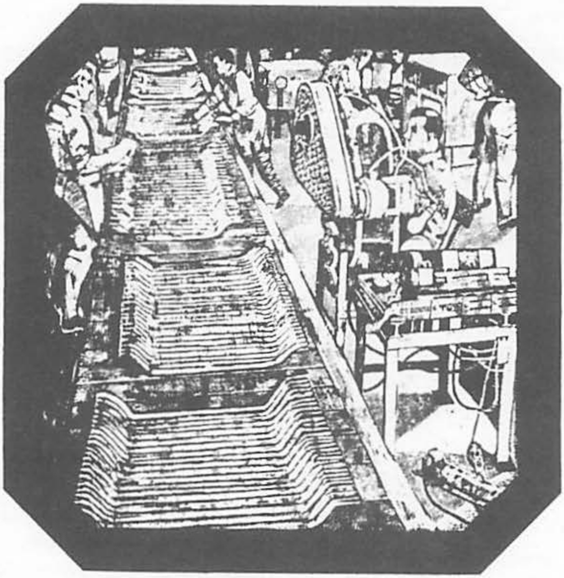
1. Totally enclose wire duct from front to rear of the locomotive with a gasketed duct lined with non-metallic wireway separating AC and DC circuitry.
2. Consider the use of non-metallic wire duct to hold wire bundles inside the electrical cabinets instead of taping rails.
3. Where No. 16 AWG wire is used in cabinet wiring, insulation thicker than that now supplied should be considered.

Maintenance forces can only affect minor changes in the environment in which wiring must exist once the locomotive is built; the response of equipment to this environment is primarily determined by the builder. The effect of this environmental factor can be seen in the difference in the control ground problem from one builder to another.

TECHNICAL ASPECTS OF FIELD MAINTENANCE—COMPONENTS

The second major division of nuisance failures involves components. A component failure is usually quite unpredictable and in virtually every case will disable the locomotive. Again, the proper techniques and materials are the key to reducing road failures from this cause.

Relays and interlocks are a common cause of road failures. As expected, relays such as the TR, FSA, BR, etc., and interlocks on power contactors that operate more frequently in a given time frame than others will have a higher probability of failure. This is a case where the locomotive designer has established certain performance standards, and the locomotive maintenance officer is placed in the position of either accepting failures from this cause, or developing a program to ferret out those potential failures. Again, railroads utilizing SEARCH have the ability, through either resistance or voltage checks, to determine contact condition. The key to this approach, however, is in strict adherence to the preprogrammed limits by the SEARCH operator. Railroads without SEARCH, however, can ascertain critical interlock and contact strings and perform the same type of tests manually. The only difficulty here is in relying on the abilities of personnel performing the tests, as well as developing a go-no-go base line set of limits. It should be pointed out that this



The Most Advanced Armature Coil... Insures Longest Life at Lowest Cost

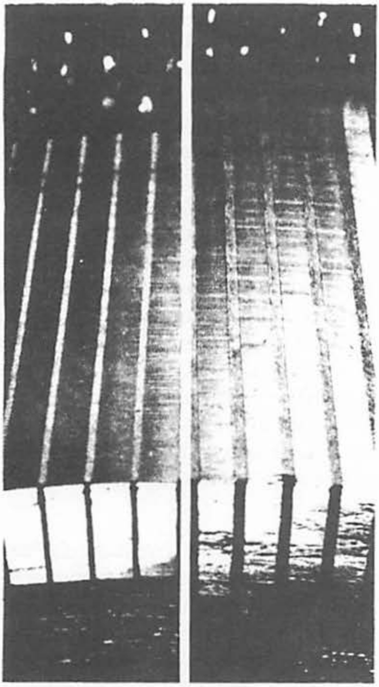
Motor Coils Manufacturing Company has developed the industry's most advanced armature coil production line. New, one-of-its-kind equipment and machinery has been developed to guarantee maximum uniformity, quality, fastest and easiest winding, and long life for armature coils.

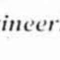
Before shipment, these Epoxi-Mica armature coils are subjected to exhaustive inspection and testing–the industry's most rigid quality control procedure.

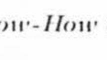
Needless to say, Epoxi-Mica Armature Coils are adding immeasurable life to traction motors – resulting in substantial savings to railroads.

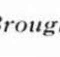
MCM MOTOR COILS
manufacturing company

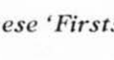
Talbot Avenue, Braddock, Pennsylvania 15104 ■ 412 271-1775
Emporium, Pa ■ IN CANADA: 639 St. Remi St., Montreal











method is not absolute, since contacts that operate a minimal number of times may exhibit resistance or voltage drops outside acceptable limits and still be useable.

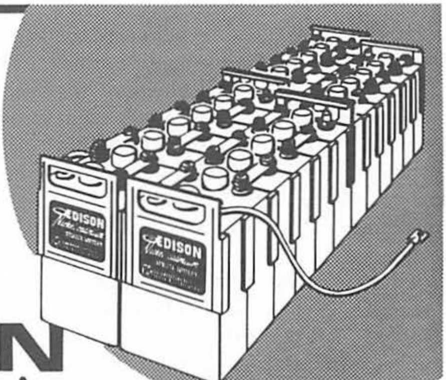
Another alternative available to the maintenance officer is that of a scheduled change-out program for key components in the locomotive relay logic system on a periodic basis. Such a program must be tailored to the particular railroad and must be soundly backed by a cost effectiveness analysis. One problem with a scheduled program is determining how many failures resulting from wiring errors are acceptable. The more involved the changeout program, the higher the probability of this occurring. In addition, a scheduled change program can provide for installation of improved components, again soundly based on a cost vs. effectiveness analysis.

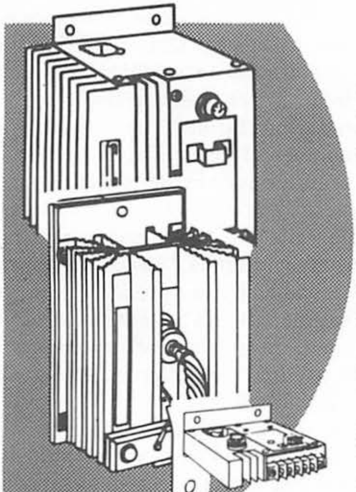
Basically, the only other solutions to relay and interlock failures are based on a thorough visual inspection where component construction allows, and a good electrical cabinet cleaning program. Failures of certain interlocks, particularly on high-voltage switch gear, can be reduced by ensuring that when these components rebuilt in-house are supplied with new interlock assemblies. The cost vs. effectiveness for this approach is favorable when considering the cost of new interlock assemblies compared to the labor and material needed to overhaul old assemblies.

Another common failure item are pressure and temperature switches. The environment in which those parts must operate is not the most desirable. Add the stress these components receive from weather and vibration, and failure results. The most effective approach to solving this problem is a scheduled change program. For the lack of anything better, pneumatic control switches would have to be replaced in kind. In the case of temperature switches, there are available positive snap action non-adjustable switches that should be considered as an upgrade. Those devices are currently available from Sundstrand at a cost that is somewhat less than that of the O.E.M. switch, with better reliability and repeatability.

A third area of constant failure are the MU cable and receptacle. Those two items have been consistent failure-producers since the diesel multiple unit concept was introduced, and will continue to be so with present technology. The only way to eliminate MU receptacle failures is through effective maintenance. A thorough inspection of insulating blocks, pin condition, cover gaskets, and the cover hinge/spring combination, and the proper servicing of bad-order parts is a must.

There are several things to be done in the field to reduce cable failures. First, a periodic test should be performed on the cable, generally on 90-day intervals. Continuity testing should be done with a current level of at least 2 amperes. Cross leakage checks should be performed with voltages on the





order of 110-150 volts. One railroad that utilizes SEARCH uses a standard MU cable between the No. 9 plug and the locomotive, thus obtaining a functional check of the cable. In addition, railroads that overhaul their own cables should consider a standard of No. 12 AWG on trainlines 4, 13 and 25 as a minimum. Use of No. 12 AWG could be considered for all cable wiring for the added mechanical strength it provides. (Use of all No. 12 AWG wire in rebuilding cables would cost approximately an additional $3.00 per cable.) Another alternative is the "Tri-Head" Power Parts cable, which reduces the possibility of damaged cables through improper handling. This type of a cable was discussed at previous conventions by this committee.

The fourth common road failure category is that of small motors—primarily fuel pump, turbo lube pump, cooling fan, and crankcase exhauster motors. There are two keys to acceptable small rotating equipment performance. One is field maintenance, dealing primarily with brush servicing, cleaning and equipment alignment. Proper attention to these three items will do much in eliminating failures.

The second key is that of overhaul policy. The use of proper procedures and the best available material, along with bearing renewal, is most desireable. A run-in period should follow the overhaul step. In conjunction with an overhaul, consideration should be given either to replacing small rotating equipment based on a predetermined age or on the deterioration of the core iron characteristics determined through proper testing. This recommendation is based on the fact that core material losses increase as a result of age, vibration and temperature variations, resulting in shortened life and inefficient operation. At present, no base line data of this nature is available to determine the optium life of small rotating equipment, but this data can be developed.

NEW LOCOMOTIVE ASPECT OF COMPONENTS

Most certainly, field maintenance practices have a definite effect on small electrical on-line failures. However, the locomotive builder can influence this, too. Improvements such as modules and motorized switch gear have helped in reducing failures by reducing the number of relay and interlock failures. Consideration should be given to the addition of spike suppression on coils fed by interlock and relay contact strings. Spike suppression technology has advanced to a great degree as an outgrowth of the space program, and numerous devices for this purpose are readily available. This suppression should be more effective than the diode suppression currently applied to electromagnetic reversers, where the diode fails shorted and causes control breaker trips in only one locomotive direction.

Another approach to the relay and interlock problem is to simplify circuitry. Nearly everyone in the rail industry is familiar with the improved locomotive performance through the elimination of field shunting on GP40 and SD40 units. Although this end has been accomplished on motive power now being produced, the problem of excess relay logic has been prevalent for years. In fact, since the concept of relay logic is virtually obsolete, this committee has discussed the possibility of replacing relay logic with solid-state programmable logic. The technology in this field is avaliable now, although locomotive applications of this technology gives rise to three major problems:

1. Currently, little programmable logic equipment is marketed that would operate from the present industry standard 74 volts.
2. The current mean time between failures in programmable logic of approximately 3000 hours is still too short to be acceptable to the railroad industry.
3. The capabilities of railroad craftsmen have not been sufficiently developed in most cases for them to readily cope with logic control of this nature.

Those three problems will most certainly impede the development of programmable logic locomotive control, but does not necessarily preclude taking advantage of it.

In regard to pressure and temperature switches, the comments in the discussion on field maintenance of components are applicable. Agreed, it is possible for the locomotive builder to provide more reliable devices. However, in some cases the end result cannot be fully justified owing to the additional costs involved.

Those are the two basic areas of small electrical items on which the locomotive builder can impact to reduce line-of-road failures. The preceding comments on MU jumper cables and small motors are applicable to manufacturers as well as field maintenance. Also, railroad maintenance personnel are not satisfied with the short life (mainly due to fan-end bearing failures) on dust bin blower motors on late model EMD power. The consensus is that the bearing arrangement on this motor is inadequate.

ABSTRACT ASPECTS OF FIELD MAINTENANCE

Up until this point, the discussion of small electrical failures has been viewed from the locomotive builder's standpoint and the technical aspect of field maintenance. However, the abstract aspect of field maintenance has been only indirectly touched upon. The abstract quantity in our context refers to the quality of workmanship performed by the craftsman—the man actually doing the work.

The major impact on either creating or reducing small electrical line-of-road failures can be made by the craftsman and his immediate supervision. For example, the fast-on lug that makes a loose connection, could be crimped or relugged (and should be) if the man will just take the time. The MU cable will no doubt live longer with proper handling. That fuel pump cannot be expected to perform unless it receives the proper periodic attention. Basically, we are referring to the quality of workmanship. Although a full development of this subject is beyond the scope of this presentation, it is mentioned to develop an awareness that the craftsman's attitude, working environment, tangible and personal reward, and relationship with management all play as important a role in the reduction of nuisance line-of-road failures as do the tools and materials he uses. This concept is no different whether applied to catastrophic electrical failures or to the small nuisance failure.

SUMMARY

Briefly, then, what we have done is define what a small electrical line-of-the-road failure is, where it comes from; and things that can be done to prevent it. The technical aspect of field maintenance viewpoint was chosen because this is basically the approach that we as locomotive maintenance officers normally consider. The new locomotive viewpoint was considered because unless the equipment we are provided is initially designed with reliability in mind, locomotive maintenance officers have less than a fighting chance of keeping it reliable and dependable. The aspect of the craftsman was mentioned as an abstract concept because it, too, has a definite effect on road failures.

The reduction of "nuisance" electrical failures represents a challenge — a challenge to maintenance officers, builders and craftsmen alike. We hope that this presentation has provided a basis for creative thinking to meet this challenge.

EXHIBIT I

TOP TEN NUISANCE ELECTRICAL FAILURES FOR FOUR RAILROADS WITH DIFFERENT OPERATING ENVIRONMENTS

RAILROAD A

A non-dynamic brake road with predominantly flat terrain, heavy seasonal loading, and with sizeable system temperature variations during winter.

1. Wires Off
2. MU Cables, Receptacles
3. Small Motors
4. Blown Fuses, Tripped Breakers
5. Snow and/or Water in Main Generator Compartment
6. Pneumatic and Temperature Actuated Switches
7. NVR Relays
8. Governor Plugs, Cable
9. Interlocks
10. Dead Batteries

RAILROAD B

Primarily a dynamic-brake road with mixed flat land and mountain terrain, generally stable loading, with extreme low temperatures during winter, moderate warm weather.

1. Control Grounds
2. Dead Batteries
3. MU Cables, Receptacles
4. Transition
5. Engine Temperature Controls
6. Axle Alternators and Speedometers
7. Circuit Breakers
8. D/B Damper Magnet Valve
9. Interlocks
10. Small Motors

RAILROAD C

Primarily a dynamic-brake road with mixed flat land and mountain terrain, fairly high speed operation, with severe

temperature and altitude variations, generally stable loading.

1. Contactors
2. Control Interlocks, Relays
3. Small Motors
4. Control Grounds
5. Blown Fuses
6. Interlocks
7. Transition
8. Governor Cable
9. Wires Off
10. Dynamic Brake Control

RAILROAD D

A dynamic-brake road with virtually all mountainous terrain, much drag speed operation, with moderate year round temperatures.

1. Small Motors
2. Contactors
3. MU Cable, Receptacle
4. Speed Indicator
5. Pneumatic Switches
6. Interlocks
7. Governor Controls
8. Transition
9. Wires Off
10. Control Grounds

Traction Motor Maintenance

The subject of traction motor maintenance appears frequently in LMOA discussions, attesting to its great importance both in performance and cost. For this discussion, motor maintenance is divided into three categories: running maintenance, light maintenance and overhaul.

Running Maintenance

This subject was described in a previous committee's paper as the three "MUSTS": brushes, gear lubrication, and support bearing lubrication. These maintenance actions are low in cost and aimed at preventing catastrophic failures. The interval at which this work is done varies according to individual railroad operating conditions. Continuing research has resulted in improvements in all three areas.

Light Maintenance

This term describes actions taken to extend or predict service life of the motor. Normally this type of work is done at the time of wheel change. That includes, but is not limited to:

Electrical Tests
Vibration Tests
Age Checks
Commutator Surfacing
Cleaning

The object of this work is to permit the motor to operate to the next light maintenance or overhaul without requiring unscheduled work. In other words, no road failures. In order to evaluate possible improvements in light maintenance, we must know the costs associated with road failures to prove savings. Those costs may be considered to have four components: train delays, fuel to move the disabled unit to a repair facility, capital costs of owning extra units to protect against repair time, and repair costs.

The following example may prove instructive:

Train Delay	
30 min. x $1.50/min.=	$ 45.00
Fuel Costs	
$.002/ton mile x 170 tons x 250 mi =	85.00
Capital Costs	
$10.50/hr. x 12 hrs. =	126.00
Labor & Material =	60.00
Total Cost of Failure	$316.00

Source: Modern Railroads
December 1977, p. 56

Note that only $60 or less than 20% of the cost associated with the failure are normally considered in accounting systems. This would suggest that, for example, a railroad with annual use of 1000 traction motors could save a MAXIMUM of about $300,000. This potential is reduced by such operational factors as overloading, overspeed and man failures in maintenance.

Overhaul

The overhaul shop is concerned with recondition vs. replace (rewind) decisions. This type of analysis is covered by accounting techniques, such as annual cost, present value, or rate of return. Our concern is with obtaining sufficiently accurate data to make good decisions regarding materials, techniques and suppliers.

The effectiveness of our work in improving light maintenance and overhaul is limited by our ability to predict results of a change in maintenance practice. Better performance will require quality data to support the predictions. Good evaluations require:

1. A large enough sample to obtain accuracy — in our case a minimum of 10 locomotives in the evaluation and 10 in the control group.
2. Accurate record keeping, particularly with respect to initial condition of equipment, conditions during testing, and detailed analysis of failed equipment.
3. Study of one and only one maintenance change at a time. This requires tight control of maintenance practices.
4. A long enough time to reduce such variables as weather, traffic, etc. to manageable proportions. This would require a 2-3 year study period.

New techniques in light maintenance and overhaul must be subjected to this kind of rigorous evaluation if we are to make further progress. The current business climate does not permit the luxury of operating without quality information.

It is interesting to note that the data from three railroads agree on the fact that a traction motor received from the Original Equipment Manufacturer has a mean mileage between failure, approximately 40% better than the traction motor built in our railroad shops. This sets a bench mark that railroads should strive to achieve as a first goal, based of course on a favorable cost benefit ratio.

In one railroad's evaluation, the average mileage to failure of rebuilt motors performed by the railroad shop was 250,000 miles. The average locomotive mileage per year was 87,000, this works out to 1.39 motor failures per year per locomotive. With an average cost to repair of $3,200 per motor, if we could raise the average mileage to failure by 40%, we would show a savings of:

.39 x 360 = $ 140.40
road failure cost savings

.39 x 3200 = $1248.00
motor rebuild cost savings

for a total of $1388.40 savings per 4-axle locomotive per year. Calculated on a fleet of 1,000 4-axle locomotives, the savings would be $1,388,400 per year. We could simply UTEX all motors with OEM. Average cost of UTEX EMD traction motors, 2nd half 1977= $6,125.

EMD Traction Motor Cost Mean Mileage to Failure 350,000	$6,125
Railroad T. Motor Cost Mean Mileage to Failure 250,000	3,200
	1,388
RR Total Cost Per Mtr. To obtain 350,000 Mil.	4,588
Difference Cost to UTEX per motor.	1,537

We see from this example that we could invest $2,925 more in the rebuild of the railroad traction motor to achieve an increase in its mean mileage to failure by 40%.

In order to obtain the most favorable cost/benefit ratio for our additional investment, we must evaluate the performance of the components that make up our traction motor and keep accurate records of their performance.

One railroad's evaluation of its traction motor failures indicated the following five most common component failures:

There were 1,317 Total Motor Failures in the sample year:

448 Armature — 34%
218 Main Fields — 16.5%
178 PE Bearings — 13.5%
167 Interpole — 12.6%
75 Pinions — 5.7%

Their evaluation of traction motor armature cost, which is all UTEX'd, is indicated in the following tabulation. Note the interesting relationship between initial cost vs. cost per 100,000 miles. The study was for a period of 3½ years and, of course, is continuing.

Vendors	No. Applied	Total Accum. Mileage	No. Failed	Mean Miles Before Failure
1	668	56,844,980	13	4,372,691
2	72	5,340,319	3	1,780,106
3	356	13,610,549	14	972,182
4	87	4,178,859	2	2,089,430
5	206	8,863,816	9	984,868

Vendors	Failure Rate Per Million Miles	UTEX Cost Each	Cost Per 100,000 Miles
1	.229	3,880	88.73
2	.562	3,530	198.30
3	1.029	2,935	301.90
4	.479	4,172	199.67
5	1.015	3,698	375.48

Information presented in this discussion is meant to provide methods of establishing costs and savings, not absolute values.

In order to make every dollar count, an accurate evaluation of all areas of traction motor repair must be recorded as outlined where "cost per mile" is the deciding factor, not initial cost. The road to better traction motor performance is not an easy one, but complete record keeping knowledge and knowledge of cost and benefits can reap large savings for railroads.

ELECTRICAL CONSIST CHECK OUT AT THE READY TRACK

First thoughts in this area tend to lean toward starting a list of all sorts of electrical tests to be performed, power checks, dynamic brake, wheel slip, train line functions and so on.

Before we get too carried away, we should ask ourselves what are the objectives of the ready track.

Basically, its objectives are to: fuel and service locomotives in the most efficient and shortest time possible to satisfy Transportation needs and comply with Rule 203.

Since ready track assigned personnel provide a non-preventive maintenance role, a careful study of the activity level should be performed at the ready track for a minimum of two weeks. The activity level should be noted by shifts, as well as days of the week. From this information, the peaks and valleys of ready track operation, which of course is controlled by arrival and departure of trains, can be forecast.

With this information, management can base the ready track work force on mean load rather than peak load, thus extra people could be redeployed from the shop area only during peak load times, providing more manhours for preventive maintenance in the shop. An operation of this type, where possible, would provide optimum utilization of personnel. It would require alert management control working closely with Transportation. It would be necessary to review changes in ready track work load four hours in advance so as to forecast ready track personnel needs far enough in advance to react in time to meet the change demand.

If we are to keep ready track personnel to a minimum, how can we effectively improve the performance of locomotives dispatched from the ready track?

The ready track supervisor should be reviewing at least the following areas.

1. The inbound inspection report performed by the ready track personnel.
2. The engineers work report.
3. Indications of annunciator panels on units so equipped.
4. Information received from other maintenance points on the system.
5. Spectrographic Report.

If all the above areas indicate no problems, the locomotive should be considered qualified for service.

Any defect noted should be reviewed by the ready track supervisor and the decision to repair at the ready track or shop the unit should be based on estimated time to repair the unit. A good basic rule would be to repair at the ready track if it takes one hour or less.

Units with annunciator panels on them which indicate road failures of the on-board safety monitoring equipment, even though they have been reset, such as:

1. Automatic ground relay operation

2. Low water shutdown
3. Crankcase overpressure shutdown
4. Low oil pressure shutdown
5. High oil temperature shutdown
6. Dynamic Brake overload
7. Hot engine
8. Excitation Limit.

If no lights are on and the engineer's work report is blank, this should be enough to consider the locomotive qualified, from a performance standpoint, for redispatch.

The final analysis and decisions on ready track consist check out is the responsibility of the individual railroad. Technological gains in the following areas lead to more reliability and fewer service requirements, thus releasing more manhours for use in preventive maintenance programs on the locomotive fleet:

1. Quality of lubricating oils and greases
2. Improvements in metallurgy
3. Composition brake shoes
4. Modularized electrical control systems
5. Spectrographic lube oil analyses
6. Larger fuel tanks
7. Larger sand capacity
8. Deep sump crankcase.

As a result of further technological progress in locomotive design and real time computer operations on the railroads, with computer terminals available at the ready track, the following information will become available on each locomotive, resulting in even closer control of manhours expended in ready track operations:

1. Location, date and amount of fuel oil added
2. Lube oil added
3. Water added
4. Compressor oil added
5. Last 5 spectrographic reports
6. Estimated amount of fuel oil consumed since last serviced
7. Last 5 engineers work reports.

That plus possible changes in ICC Rule 203 and Rule 331 (in response to technological advancement in the safety of modern locomotives and older locomotives that have been retro-fitted) will provide many precise controls of service of locomotives through use of computer printouts.

MODIFICATIONS

On most railroads, the majority of road freight locomotives purchased since 1966 contain traction alternators capable of supplying AC standby power when properly modified. If certain adaptors and cables are prepared beforehand, a locomotive can be modified to supply emergency AC power in less than two hours. This would allow the railroad to respond quickly to supply AC power whether needed for only a few hours while a transformer is replaced, or several weeks as during a coal strike. The ability to keep shops, hump yards, etc., operating in the event of a power failure can be a valuable asset.

Either manufacturer's locomotive is capable of delivering significant amounts of power as shown:

Manufacturer & Type of Locomotive—
EMD with GV Module — GP 40/SD40
1200 KVA 480 Volts 1500 Amps
Manufacturer & Type of Locomotive—
GE with Type E & GTA 11 — U30B/U30C
1080 KVA 480 Volts 1400 Amps

The following should be prepared in advance to convert either manufacturer's locomotive to an emergency AC power supply.

The following material will be required for one locomotive, either GE or EMD: Six power cables made up of 1100/24 cable with AMP Spade connector and Bussman inline fuse KRP-C-1000 as shown in Sketch A; and six EMD AR-10 Adaptors as shown in Sketch B.

The six EMD AR-10 adaptors attach to the top of each of the six groups of five fuses after the five diode leads are disconnected from the fuses. The same cap screws that were removed to disconnect the diode leads will then bolt the adaptor plate to the fuses. After the six adaptor plates are bolted in place, one power cable, as shown in sketch, is bolted to each of the six adaptor plates. Three of the cables are routed through the center diode inspection cover/window on the right side and the other three through the left side. The area where the cables comes out of the AR-10 must then be sealed to prevent loss of AR-10 cooling air.

The two A phase leads are then bolted together, then the two B phase leads and finally the two C phase leads. This then provides the three phase connection for the cables coming from the sub-station.

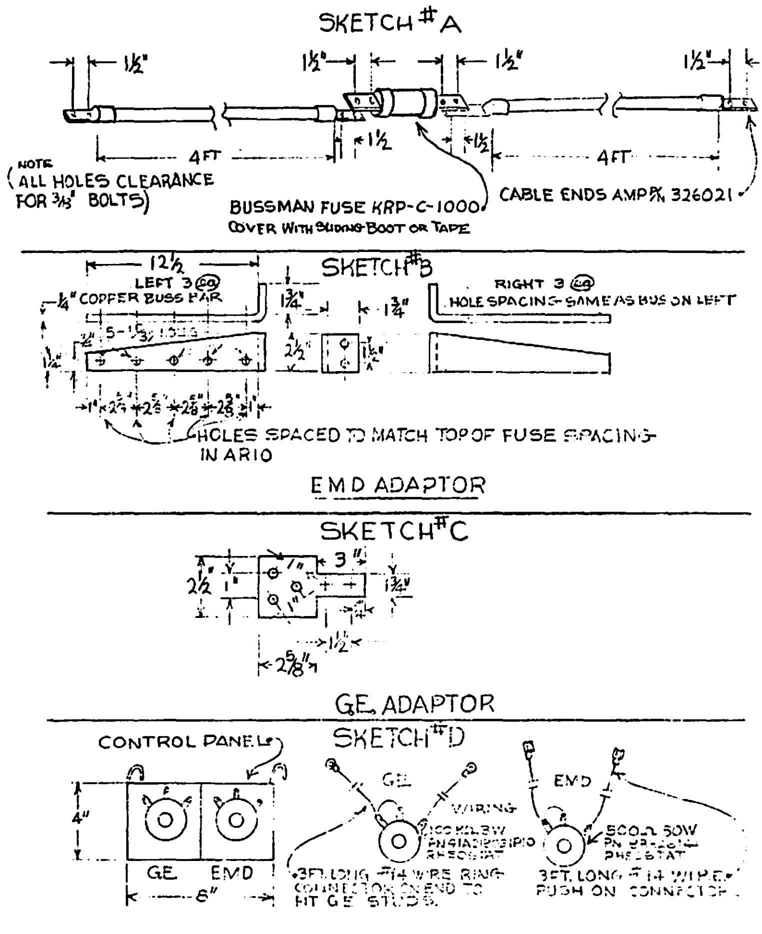
Three GE adaptors, as shown in Sketch C, are required. The three GE adaptors are applied to the bolted connection at the buss that comes from the alternator to each of the rectifier banks. Longer ⅜ bolts are needed (1½") and should be supplied with the adaptors. After the adaptors are in place, the power cables (see Sketch "A") are bolted to the adaptors two to each adaptor if the amps will exceed 1000. Use only one, if amps under normal operation will be under 1000.

A panel containing a 500 ohm, 50 watt rhoestat for EMD and a 100K ohm, 3 watt rheostat for GE (see Sketch "D") is required

With this material available ahead of time and properly located, a locomotive could be modified to deliver standby power in less than two hours.

The basic steps necessary to convert an EMD for standby power are as follows (refer to the actual locomotive print for wire numbers and locations).

1. Open the ground relay knife switch.
2. Open the feed to the line switches so they cannot pick up.
3. At the load regulator, disconnect the No. 3 wire and connect it to the No. 1 terminal of the load regulator.
4. Connect the 500R, 50w rheostat leads to terminals 4 and 13 on back of the GV module.



5. Jumper the "Pinterlock" chain so the GF will pick up with the line switches down.
6. With the GF switch down, advance throttle to No. 6 and check engine speed (it should be 720 RPM for 60 hertz). Adjust fulcrum nut if required.
7. With AC meter reading one phase of AR-10 output, push on GF switch; adjust 500 ohm, 50 watt rheostat for 480 VAC.

The basic steps necessary to convert a GE for standby power are as follows: Refer to the actual locomotive print for wire numbers and locations.

1. Open ground relay knife switch and jump out right side (fuel pump feed).
2. Open feed to line switches so they cannot pick up.
3. Disconnect the wire from the wiper of the load control pot and connect it to the top of the load control pot.
4. On the excitation panel, locate terminal and wires where GA feeds the VCR; disconnect GA wires and connect the 100K ohm, 3 watt rheostat between the GA wires and the terminal.
5. Remove the VCR Card using small alligator clip lead jumper out one series resistors on the card. Clip onto the posts on the opposite side of the card from the resistors. Reinsert the VCR Card.
6. With the GF down, advance throttle to No. 4; adjust engine speed to read 1070 at the tach drive (720 crankshaft RPM).
7. With AC meter reading one phase of the GTA 11 output, push on the GF switch; adjust the 100K ohm, 3 watt rheostat for 480 VAC.

The above portrays the general procedure for using either manufacturer's locomotive for standby power. Each of the manufacturers has available a much more detailed description of this application. This literature should be read and understood before attempting to modify a locomotive for standby power the first time (and are enclosed in this report).

The General Electric Company is offering as a modification, their two-stage CMR wheel-slip system for application to type "E" or CHEC excitation locomotives. This offers a first stage correction signal that is not dependent on the WSX relay. It is electronically developed and produces a finer control of wheel-slip than was possible with the WSX relay. This coupled with GE's fast standing module produces extremely good wheel-slip control, especially on heavy grades with frequent curves. The cost of the two-stage system is approximately $330 and requires four manhours to apply. The fast sanding module's cost is included in two-stage price and requires eight manhours to apply.

EMD now has available a modification to greatly reduce the time required to make forward transition on SD-40 locomotives. The time required to make transition with the new system is well under two seconds. This should help reduce slack action in train due to making transition. The average time required to make transition in the past on SD-40 series units was about 8 to 12 seconds.

The modification in most cases can be applied with no additional components. Review of recording oscillograph data also indicates less power in the system when first set of power switch gear transfers. With less contact arcing improved contactor life should result. The actual time indicated on the recording oscillograph charts to transfer to parallel and recover 75% of


CONVINCING REASONS WHY SUNDSTRAND THERMAL SWITCHES ARE THE BEST WAY TO CONTROL LOCOMOTIVE COOLING FANS.
Our snap-acting thermal switch cooling system offers these important advantages over filled linkage temperature control systems:
● Extreme accuracy with zero maintenance.
● Not affected by atmospheric pressure.
● No field adjustment or calibration necessary.
● Extremely rugged for long life.
● Helps achieve peak engine efficiency.
● Proven design, proven field reliability.
If you would like more information, please call Ken
at 206/885-8205, or write: Sundstrand Data Control, Inc.,
Attn: Ken McRae, Sales Manager—Thermal Products,
Overlake Industrial Park, Redmond, WA 98052.
DON'T LEAVE IT TO CHANCE.
LEAVE IT TO SUNDSTRAND.
SUNDSTRAND
Sundstrand Data Control, Inc. Unit of Sundstrand Corporation

rated horsepower is 1.5 seconds. This results in the feel on the locomotive, of not much more than a second stage wheel-slip correction.

EMD LOCOMOTIVE USAGE FOR EMERGENCY AC POWER OPERATION

PURPOSE:* To provide instructions for converting all 38/-2, 40/-2 and 45/-2 series locomotives equipped with AR10 generators and GV module into 480 VAC AC power generators for emergency use.

POWER RATING: All 40/-2 and 45/-2 locomotives converted for 480 VAC emergency power generation will be rated at 1200 KW at .8 power factor (balanced three phase load). The maximum generator phase current is 1900 amperes.

All 38/-2 locomotives converted for 480 VAC emergency power generation will be rated at 750 KW at .8 power factor (balanced three phase load). The maximum generator phase current is 1900 amperes.

AC POWER OUTPUT QUALIFICATION / RESTRICTION: When locomotive is used for emergency AC power, the AR10 three phase output is not a pure sine wave, however, it will be adequate to operate motors, lights and some electronic equipment.

When using locomotive for emergency AC power the AR10 output must be isolated from all other sources of AC power. The locomotive must not be paralleled with commercial power or another locomotive.

The AR10 three phase output has a A-C-B phase rotation. Before connecting to a load distribution panel/connection, check phase rotation to insure matching of rotation with load distribution panel/connection.

For 40/-2 and 45/-2 locomotives operating as emergency AC power generators the KW load must be kept above 900 KW as much as possible.

KW LOAD INDICATOR: Although AC voltage, current and KW metering is recommended and desirable, and approximate indicator of engine KW load can be obtained by observing the governor quadrant terminal scale while under load operation.

For 40/-2 and 45/-2 locomotives, assuming all three cooling fans operating at 1200 KW .8 PF approximate terminal scale position is as follows:

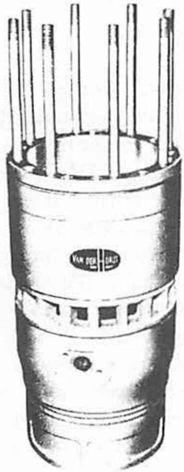
SD, GP 40/-2 — 1.16
SD, F 45/-2 — 1.26

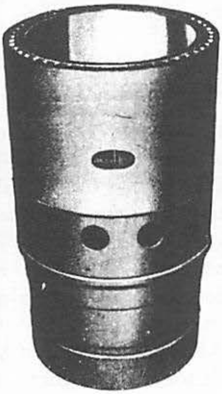
For GP38/-2 locomotives, assuming two cooling fans operating at 750 KW .8 PF approximate terminal scale position is 1.26.

* This instruction supercedes all previous instructions issued.

NOTE: Higher than rated KW loading on engine, which is not recommended, will be indicated on governor quadrant by a lower number than the 1.16 or 1.26 given. (Example: .96 is higher KW load (overload) than 1.16).

ENGINE OPERATION RECOMMENDATIONS: Since many loco-





motives may be used off railroad property the following general guidelines are provided:

Fuel Oil: A commercial good grade of No. 2 diesel fuel should be used at all times.

Lube Oil: The railroad supplying locomotives should be contacted to determine proper engine and air compressor lube oil type to be used. Maintain lube, fuel and cooling water levels within proper ranges during operation.

CAUTION: Do not shut engine down for extended period with ambient at or below 32°F.

NOTE: This instruction provides guidelines for using a locomotive for AC power generation under emergency conditions. The customer / operator is responsible for failures resulting from use of a locomotive in this manner.

Instructions For Converting 38/-2, 40/-2 and 45/-2 Locomotives For Emergency AC Power Supply Operation

Prior to starting conversion, shut locomotive engine down and open battery switch (observe time element prior to opening battery switch).

The conversion instructions are divided into three sections as follows:

1. **Locomotive AR10 Generator Phase Cabling Alteration**—This amounts to disconnecting thirty phase leads from the diode heat sink, and connecting each phase group to external power cabling that will bring the AR10 three phase AC power to an external load connection.

2. **Locomotive Engine Governor Readjustment**—This amounts to readjusting governor fulcrum nut while in throttle 6 to obtain 720 RPM.

3. **Locomotive Control System Alteration**—This amounts to recalibrating the generator voltage regulator module (GV) to obtain 480 VAC power output from AR10 on units equipped with GV modules. Also instructions are given on how to add a temporary GV module to accomplish generator voltage regulation on units not so equipped. Other connections are made to remove the load control system and provide external controls for engine speed and AR10 field control.

NOTE: These instructions are written for personnel having minimum knowledge of locomotive.

I
AR1O GENERATOR PHASE CABLING CONNECTIONS

All external power cabling connections are made at back end of generator at air box. Power cabling connection to generator phase leads is either routed thru two diode/fuse inspection windows or the slip ring inspection doors depending on generator vintage. Access to this portion of AR10 generator is thru the inertial filter compartment door located on right side of locomotive behind cab door.

A. Remove AR10 airbox cover panels as indicated in Figure 2. On units with slip ring snow shields—remove 4 bolts that secure shield to generator end frame and remove shield.

AR10 AIR BOX PANEL APPLICATION

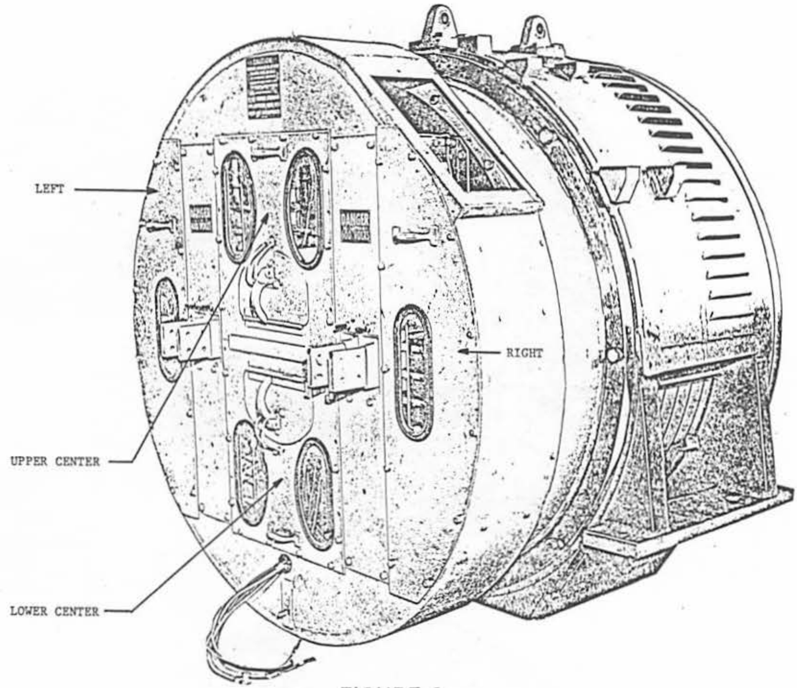


FIGURE 2

B. Disconnect all of the thirty (30) phase leads and the GPT leads [control wires labeled 1A, 9B, 10C (10B)] from the six paralleling bus bars on the diode/heat sink assemblies (Figure 3). Maintain phase leads passing through CT's.

NOTE: The thirty (30) phase leads are physically grouped as 6 groups of 5 phase leads. There are two groups of 5 phase leads (10 total) per phase as follows:

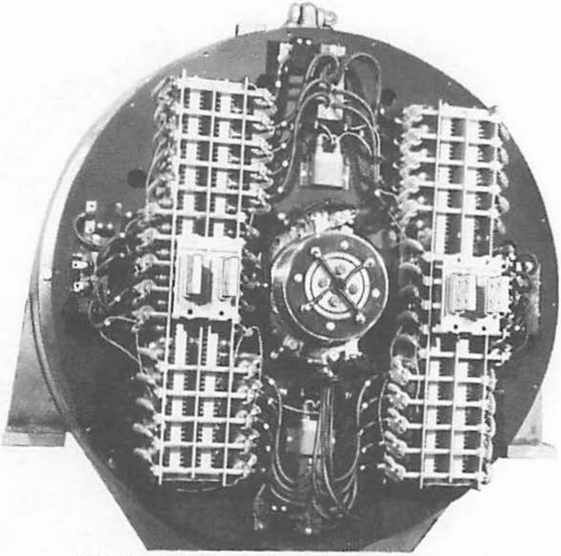
A - ODD 1A, 3A, 5A, 7A, 9A
A - EVEN 2A, 4A, 6A, 8A, 10A
V
Connected together = A phase

B - EVEN
B - ODD
V
Connected together = B phase

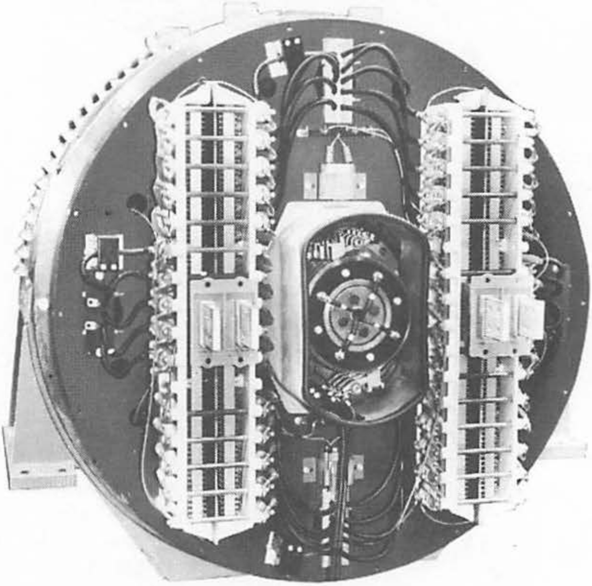
C - ODD
C - EVEN
V
Connected together = C phase

C. The power cabling hookup is accomplished by connecting a power cable capable of carrying 1000 amps AC to each of the six (6) groups of five phase leads (Total of 6 power cables). Cabling size of 535 MCM or larger is adequate for this application. (NOTE:

FIGURE 3



Fabricated Type Rectifier Bank Assemblies



Molded Type Rectifier Bank Assemblies

All 6 cables used must be same size, i.e. all 535 MCM) — EMD cable and blank lug part numbers are given in the 'Material Required section. The blank cable lugs should have five (5) 21/64 inch diameter holes drilled thru lug tang (total of 6 lugs involved). Space the 21/64 inch holes per Figure 4. Do not drill the holes larger than 21/64 inch as this will reduce the amount of contact surface area to the mating lug. Crimp the drilled lug to the power cable. Label cables A-odd, A-even; B-odd, B-even; C-odd, C-even.

CONNECTION LUG HOLE LOCATION
BLANK LUG PART NO. 8415634

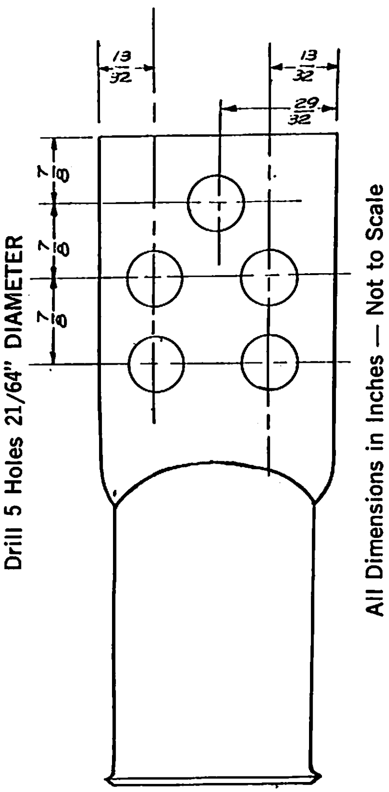


FIGURE 4

D. Route the drilled lug cable end thru the removed AR10 air box panels — panels still removed from generator — as follows:

1. On AR10's not equipped with slip ring snow shields, remove window/inspection cover plate from upper center panel left side position and pass the two 'A' phase and B-odd phase power cables thru this opening.

Remove the lower center panel right side position and pass the two 'C' phase and B-even phase power cables thru this opening. Make sure panels are oriented so they can be slid up cables and rebolted to generator.

2. On AR10's equipped with slip ring inspection access doors in center air box panels route the two 'C' phase and B-odd phase power cables thru the upper inspection door. Route the two 'A' phase and B-even phase power cable thru the lower inspection door. Make sure panels are oriented so they can be slid up the cables and rebolted to generator.

Reference Figures 5.A & B

Bolt the 5 phase leads in each group and associated GPT lead to their respective power cable with the 5 hole lug using the following guidelines:

1. Use 5/16 inch bolts with flatwashers installed under the bolt head and between lockwasher—nut and lug.

AR10 CABLE ROUTING FOR GENERATORS WITH
SLIP RING INSPECTION DOORS

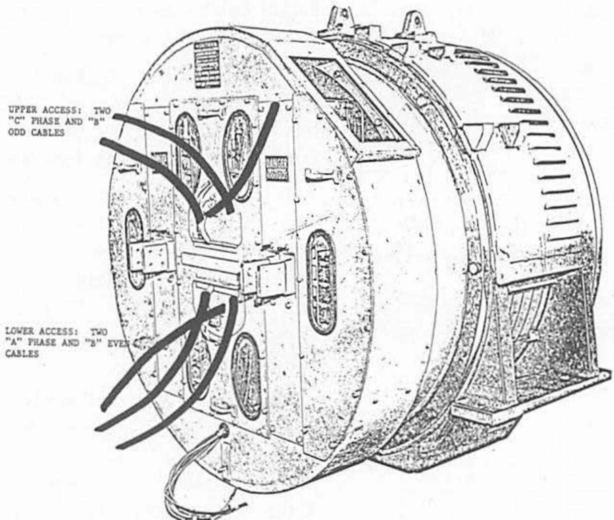


FIGURE 5A

AR10 CABLE ROUTING FOR GENERATORS WITHOUT
SLIP RING INSPECTION DOORS

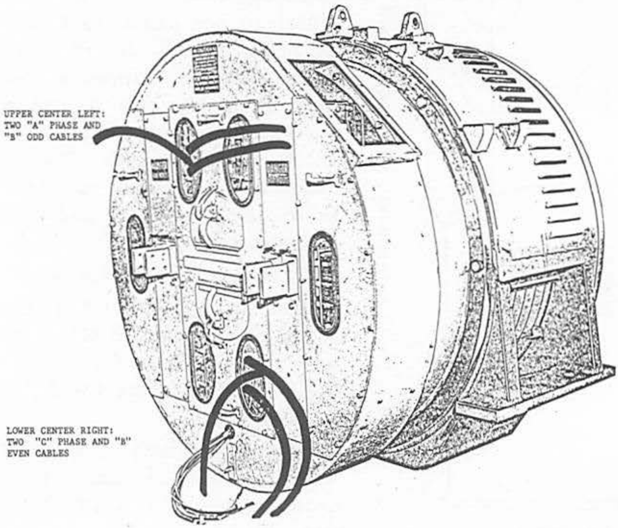


FIGURE 5B

2. Do not apply more than one phase lead per bolt.

3. Do not install the GPT wire lug between the phase lead lug and power cable lug.

Reference Figure 6.

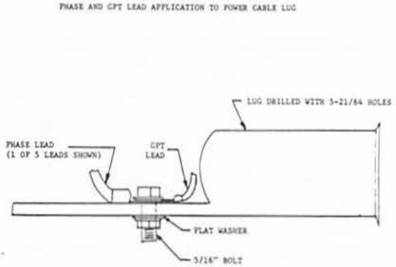


FIGURE 6

CAUTION: Make sure "A" and "C" phase odd and even leads are not mixed when connected to power cables. All "odds" must be grouped together and all "evens" separately grouped.

With phase leads properly connected to power cables and cables positioned properly, reinstall all AR10 generator air box enclosure panels. The openings which the cabling passes thru the enclosure panels must be sealed thru use of heavy cardboard, plywood, etc., to prevent any loss of cooling air thru the AR10.

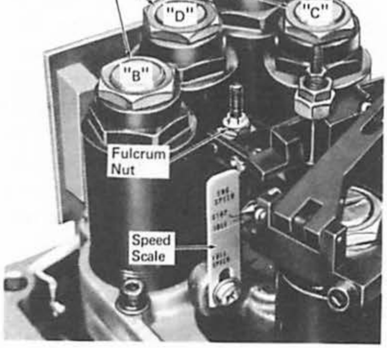
E. The AR10, when used as a source of emergency AC power, should have high current protection. This protection can be had by installing a fuse in series with each one of the six power cables connected to the AR10. The recommended fuse to use is Bussman Fuse KRP-C-1000. This is a one time fuse (not replaceable link type) with slow blow feature, rated at 1000 amperes, 600 volt.

The two power cables for each phase — A-odd, A-even, etc. — **must** be connected to the same terminal at the input to the load distribution panel/connection. This will prevent unbalanced loading of the two-three phase windings in the AR10.

II
LOCOMOTIVE ENGINE GOVERNOR READJUSTMENT

With engine set up for running —no load—put throttle in 6th position and with governor cover removed adjust fulcrum nut to obtain 720 RPM to provide 60 cycle/hertz frequency. (Fig. 7) Tachometer can be placed thru access provided in OST housing.

To provide optimum engine response to load fluctuations (frequency control) under load conditions turn the governor com-



pensating needle valve counterclockwise in ¼ turn increments until instability (load hunt) occurs and then turn clockwise ¼ turn to obtain stability. The farther out the compensating needle valve is will determine load response characteristics.

III
LOCOMOTIVE CONTROL SYSTEM ALTERATION

Two areas of control system alteration are required as follows:

A. AR10 AC Voltage Regulation (Locomotives with GV modules)—to provide AR10 480 VAC voltage regulation for all locomotives equipped with a GV module a simple addition of a 500 ohm rheostat rated at 5 watts or greater, connected between terminal 4 and 13 on the GV module on board the locomotives will allow adjustment of the GV module to obtain 480 VAC. The 480 VAC can initially be set on the AR10 output at no load but should be readjusted after load application. To remove the load control system from the excitation control circuitry consult applicable locomotive wiring diagram and at the AC cabinet terminal board remove the wire going to No. 3 load regulator lead (EB wire). Add a No. 14 jumper wire from terminal board connection for the No. 1 load regulator lead (EA wire) and connect to the terminal board terminal on which the No. 3 lead was connected. Reference Figure 8.

B. AR10 AC Voltage Regulation (Locomotives Without GV Module)—Obtain one of the GV module part numbers given under 'Material Required' and temporarily mount in electrical cabinet (can be accomplished by taping module to wire loom). Add No. 14 control wiring between GV module and NVR relay and Sensor and SBP panel as indicated on Figure 9. Also connect wiring from GPT — or PCP panel where GPT secondary connects — and GV module per Figure 9. Add 500 ohm 5 watt rheostat between GV terminals 13 and 4 and follow instructions given in 'A'.

C. Off-Locomotive Control Station—If off-locomotive controls for AR10 field excitation control and engine speed are desired it will be necessary to provide control wiring from locomotive to remote control station to bring 74VDC power to control switches designated for engine speed and generator field contactor. Refer to Figure 7 for recommended wiring scheme and connection points for GF coil, MR relay coil and ER relay interlocks that will provide this control function.

Operating Instructions

1. Set up locomotive for power operation as follows: (These are to be done on board the locomotive.)
    a. Center reverser handle on control stand.
    b. Close all circuit breakers.
    c. Close ER and fuel pump switches.
    d. Open GF Switch.
    e. Start Engine.

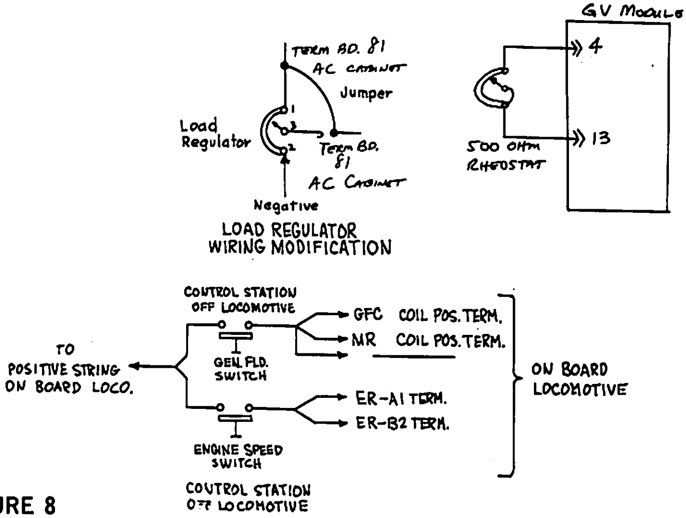


FIGURE 8

ADDITION OF
GV MODULE
ON UNITS NOT
SO EQUIPPED

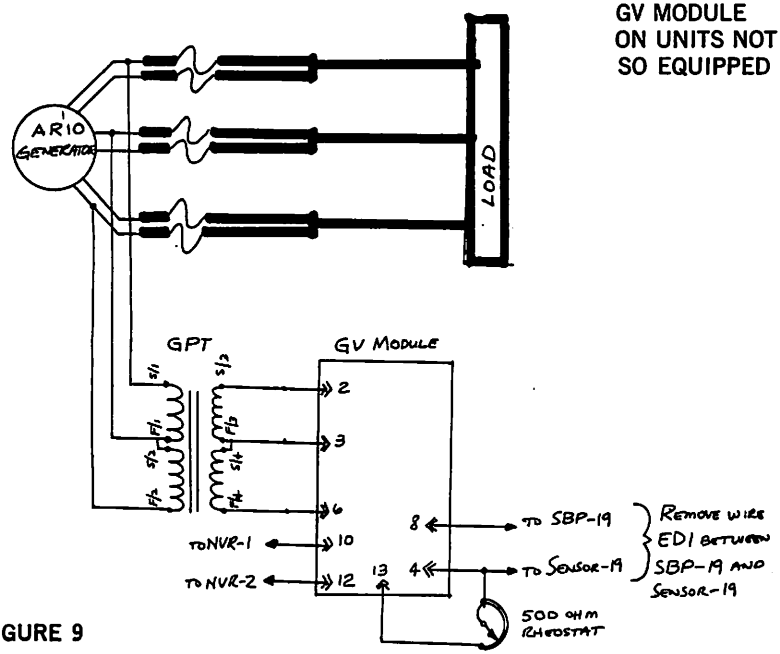


FIGURE 9

f. Put isolation switch in run position.
g. Leave throttle in idle.
h. Set engine brakes.

2. Close engine speed switch on the auxiliary AC power control stand and adjust the engine speed to 720 RPM (60 Hz) at the engine governor. Adjust fulcum nut to obtain the 720 RPM.
3. Remove line fuses.
4. Close the generator field switch on the auxiliary AC power control stand.
5. Adjust rheostat on regulator, for a line to line voltage of 480 VRMS.
6. Open the generator field switch on the auxiliary AC power control stand, and then replace the line fuses.
7. The system is now ready to take on load, when GF switch in AC power control stand is closed.

Should the operator wish to monitor this system, he can add a frequency meter, an AC rms voltmeter, an overvoltage relay, and an undervoltage relay. EMD has used the following two relays for over and undervoltage protection.

1. Overvoltage relay — Westinghouse CV-4288B584A13
2. Undervoltage relay — Westinghouse CV-12A8B549A13
3. Frequency meter — Westinghouse KR4-241

These two relays have 220 to 560 volt taps.

Material Required

The material required per locomotive is as follows:

Qty./ Loco.	Part No.	Description
2	8330133	Switch—Remote Control Operation
6	N.P.N.	Bussman Fuses KRP-C-1000
1	8332614 * 8398056 * 8331127	500 Ohm Rheostat
**6	8415634	Terminal Lug—Blank 1925/24 (777 MCM)
**6	8352379	Terminal Lug—Blank 1600/24 (646 MCM)
**6	8160274	Terminal Lug—Blank 1325/24 (535 MCM)
A.R.	8421214	Cable—1925/24 (777 MCM)
A.R.	8421213	Cable—1600/24 (646 MCM)
A.R.	8433444 (100 ft.)	Cable—1325/24 (535 MCM)
A.R.	8380932 or 8392583 (100 ft.)	#14 AWG wire #12 AWG wire

* Optional
** Dependent on cable size used.

GE RECOMMENDED PROCEDURE FOR EMERGENCY AC POWER

General Electric Company is preparing an instruction to describe the recommended procedures for using their locomotives for Emergency AC Power and it will appear as instruction GET-6332. Portions of that material have been extracted for this committee's report.

There are three variations of the equipment that might be used.

1. The early AC locomotives had a GTA9 traction alternator. This machine has 12 poles and will produce 60 Hz power at 600 rpm on the diesel engine. This speed is quite low and the capacity is reduced proportionately. Therefore, we do not recommend that this model be used for wayside power supply.

2. The GTA11 alternator has 10 poles and runs at 720 rpm to produce 60 Hz. This speed permits more normal operations of the cooling system and engine support systems. As such, this is our recommended choice.

We have provided two varieties of excitation for the GTA11. The early models used Type "E" excitation. This model has been used extensively for wayside service, and I will discuss its application.

3. Recent GTA11 machines have had CHEC excitation. This will require a similar but different control modification.

In each case I will cover three points in the procedure.

1. Hook-up of the power cables to the load distribution point.

2. Readjustment of the engine governor to provide proper frequency and response.

3. Modifications to the control to provide 60 Hz power

GTA11 WITH TYPE "E" EXCITATION

1. Power Connections

1.1 Connect three power cables from the AC connections at the rectifier panel and lead them to the load distribution connection for wayside load. Cable size should be appropriate for the load to be applied. For 1000 amps load the minimum size is 1325/24 copper cable. Do not disconnect the DC cables leading to the locomotive control compartment.

1.2 It is customary, but not mandatory, to provide current protection to the power supply. This would be a standard industrial control circuit breaker already in the system, set for 1000 amps, or could be some in-line fuses, such as a Bussman Fuse KRP-C-1000. This is a one-time fuse, (not a replaceable link type) with slow blow feature, rated at 1000 amperes, 600 volts.

1.3 Phase sequence for the alternator is 1-2-3. If required sequence is not known, a small three phase motor should be observed when power is first turned on to make sure that sequence is correct. If it is wrong, reverse any two of the three phase cables.

1.4 A neutral center tap circuit is not available from the alternator.

1.5 The locomotive ground relay will still be connected to the negative side of the DC power circuit. On older locomotives this is connected to the DC connection at the main rectifier panels. On more recent models it is connected at one of the traction motor field connections. If the external load has its own ground, it may present problems with the locomotive ground. If no other solution can be found, isolation transformers may be required between the locomotive and the load. If not available, the locomotive ground relay can be disconnected as long as the load is grounded.

1.6 The locomotive platform should be solidly grounded while in this service, for personnel safety.

1.7 If the installation is to be fairly permanent, additional meters might be installed. These could include:

1.7.1 Current transformers and meter to indicate current in each of the three phases.

1.7.2 A frequency meter to verify engine rpm.

1.7.3 A voltmeter across one phase. (Between two AC load cables).

2. **Engine Governor**

The engine speed closest to that for 60 Hz is the speed where the A and C solenoids are energized. This is Notch 4 engine speed, but with some older locomotive with a different speed schedule, the engine speed is not the same as the throttle position.

2.1 In any case, the throttle is positioned to get engine speed near 720 rpm (1070 rpm on engine tachometer drive) and trim the speed as desired to obtain 60 Hz. This is done by removing the engine governor cover and turning the "fulcrum" nut, which is a ⅜ in. hex nut on a threaded rod near the "C" solenoid. Clockwise will lower engine speed.

Notch 4 is 707 rpm for an engine with top speed set at 1050 rpm. 707 rpm will produce 58.9 Hz, which may well be close enough for many applications.

To restore the governor speeds, the engine idle speed can be set down to the correct value of 450 rpm (669 rpm tach drive) using this same fulcrum nut since this adjustment raises and lowers all engine speeds by the same increment.

Do not run the engine with governor cover removed. Oil will leak over the edge and dirt will enter.

2.2 The governor response time is adjusted for proper locomotive operation by the COMPENSATING NEEDLE VALVE in the lower governor column. It probably will not need readjusting for standby power service, but if a large block of load results in engine bogging slightly while the load is starting, the compensation needle valve can be readjusted to match the load. To do this...

Under maximum load conditions turn the governor compensating needle valve counterclockwise in ¼ turn increments until a small hunting is observed. Then turn the needle valve clockwise ¼ turn, noting that hunting stops.

2.3 To return the compensating needle valve to the original position for locomotive use, turn it clockwise until it bottoms (DO NOT FORCE IT) and then open it ¼ to ½ turn.

3. **Control Modification (Type "E")**

3.1 The locomotive voltage control is a DC voltage measuring reactor in the excitation panel. This reactor will permit voltage to rise until it exceeds the reference current provided by the throttle handle and the engine load control potentiometer. In order to set the voltage for 480 V AC, the system must be modified.

Two ways have been used, both with good results.

3.1.1 The reference current can be provided by a manual potentiometer which will replace the normal engine load control potentiometer.

To do this, disconnect the wire from terminal "M" of the excitation panel and tape it up. Connect a new pot and resistor in series as shown in Fig. 1. The operator can select the open circuit voltage without upsetting any of the normal locomotive excitation controls.

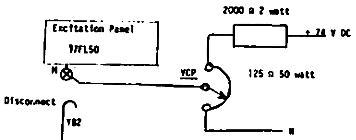
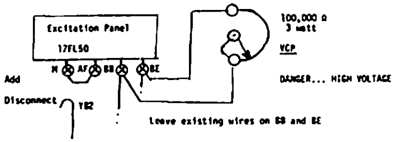


FIG.1

3.1.2 Another system, described in LMOA Proceedings 1975, pages 163-166 has also been used, but does not have some high voltage wiring that must be done carefully.

With this system, the reference current remains normal and the feedback voltage signal is increased to drive down the voltage to the 480 V level. This is done by connecting a potentiometer and fixed resistor circuit to by-pass some of the control resistors in series with the voltage measuring reactor. See Fig. 2.



GTA11 WITH CHEC EXCITATION

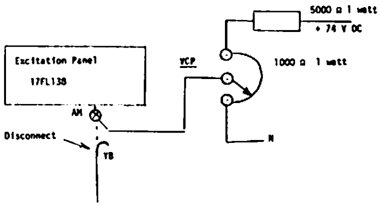
Parts 1 and 2 remain the same for power connections and engine governor adjustments.

4. **Excitation Modification. CHEC**

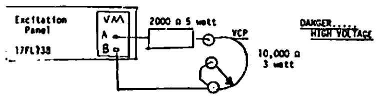
At the time of this writing, all of the GE locomotives used for this purpose have been equipped with Type "E" excitation. Although no CHEC units have been used, the following circuits have been designed for such use.

In the CHEC system, a voltage reference is established by means of the throttle position and engine load control potentiometer. To set the desired 480 V AC, either the reference voltage must be lowered or the feedback signal increased.

4.1 To reset the reference voltage, again disconnect the brush arm of the engine control governor from the CHEC panel at terminal "AM" and supply this same point with a manual pot. See Fig. 3.



4.2 The alternate method is to connect a 3 watt 10,000 ohm pot in series with a 5 watt 2,000 ohm resistor between studs A and B on the voltage measuring reactor under the right hand bolted on cover on the CHEC panel. The studs are VM-A and VM-B. See Fig. 4.



4.3 A third possibility, not highly recommended is to reset the voltage limit adjustment pot AM-P3 on the excitation panel. This is not suggested since it would require that the proper setting be restored by resetting open circuit voltage to the correct value when returning the locomotive to normal service.

OPERATION

After completing the cabling and installing the control devices, proceed with the following:

1. Apply full air brakes and block wheels if necessary.

2. Disconnect the EF wire at the reverser interlock and tape it up.

3. Shut off control air supply and blow down control air reservoir to zero. (This ensures that motor contactors will not pick up inadvertently while in standby power service.)

4. Make sure that the locomotive is isolated from wayside power.

5. Start the engine and allow for warm-up to 150°F water in the water tank.

6. Move reverse handle to FORWARD or REVERSE.

7. With GENERATOR FIELD BREAKER OPEN, position the throttle and verify engine speed to be 720 rpm (1070 rpm on tach drive) or 60 Hz power.

8. Close throttle and close GENERATOR FIELD circuit breaker.

9. Advance throttle to Notch 1 and note that open circuit voltage appears and is limited to some safe value.

10. Advance throttle slowly to proper position for 60 Hz, and adjust manual controls to obtain desired voltage.

11. With minimum shop load connected, close distribution breaker and observe operation of a three phase motor to note that it has correct rotational direction.

12. Start remainder of loads, large motors first, and note the position of the load control potentiometer on the governor.

12.1 If the governor runs in the full clockwise position at maximum load, it means that the engine is running at less than normal locomotive load for that engine speed. If this is the case, the engine can be considered to have a safe load and no adverse performance would be expected.

12.2 If the governor goes to the counterclockwise position, (minimum field) it means that the load exceeds the normal locomotive power for that position. With this condition some adverse characteristics might occur...

12.2.1 Engine may overheat and sound the alarm bell.

12.2.2 The exhaust may show unusual smoke.

If this load must be maintained, the locomotive attendant must watch for these problems and take corrective action.

THE ENGINE LOAD CONTROL POTENTIOMETER WILL NOT REDUCE THE LOAD REGARDLESS OF ITS POSITION. IT IS UP TO THE OPERATOR TO MONITOR THE OPERATION.

NOTES

The following precautions and warnings should be noted.

1. Check fuel level regularly and supply with a good grade of No. 2 diesel fuel.

2. Watch fuel system pressures (normally 30 to 40 psi) to make sure fuel filters remain clean.

3. Use a railroad approved engine lubricating oil.

4. Maintain cooling water level and treatment to normal railroad levels.

5. Do not shut down engine if ambient temperature drops below freezing unless quick restarting or draining is planned.

6. Electrical load should be a balanced three phase load. Highly unbalanced loads can overheat portions of the cabling or equipment.

7. WHEN USING LOCOMOTIVE FOR EMERGENCY POWER SUPPLY IT MUST BE CONNECTED TO AN ISOLATED BLOCK OF LOAD. DO NOT ATTEMPT TO PARALLEL IT WITH EXISTING POWER SUPPLIES OR ANY OTHER LOCOMOTIVE. THE LOCOMOTIVE EQUIPMENT DOES NOT INCLUDE ANY LOAD SHARING EQUIPMENT.

8. The AC voltage is not a pure sine wave. The wave shape should be inspected with an oscilloscope if wave form is of importance to any of the connected loads.

9. During load applications, the engine will make smoke. This happens primarily because all of the normal electrical rate control circuits have been by-passed with the manual controls and the engine governor will apply fuel as fast as the compensation system will allow.

10. All locomotive cab doors and control locker doors should be closed to keep out the weather.

11. If the connected load is reduced to a very low value, the engine may build up carbon in the exhaust system. This will normally clear itself out during next full load operation, but excessive time at light loads should be avoided, if possible.

12. If desired voltage is 220 V, use step down transformers.

R. E. TAYLOR
Asst. Vice Pres.-Mechanical
Burlington Northern Inc.
St. Paul, MN 55101

The Locomotive Maintenance Officers Association wishes to express its appreciation to the Burlington Northern for its fine spirit of cooperation in hosting LMOA Pre-Convention Presentation at Burlington, Iowa.

A special "thanks" to our Advisory Board Member and BN Assistant Vice President Mechanical R. E. Taylor, to BN Chief Mechanical Officer-Locomotive R. W. Spannring, and to LMOA Chairman of the Board John Schroeder for making it all possible.

Also to LMOA Regional Executive Swede Axelson for his excellent guidance of the program, and to R. V. Propp, BN representative on the Shop Equipment Committee for his valuable on-the-scene assistance.

Wednesday, October 4, 1978

8:30 A. M.

REPORT OF THE COMMITTEE ON SHOP EQUIPMENT

Pre-Convention Presentation:
West Burlington Shop
Burlington Northern, Inc.
Burlington, Iowa

April 12, 1978
Holiday Inn
Burlington, Iowa

E. R. HAFLING, Chairman
Assistant Mechanical Engineer
Atchison, Topeka & Santa Fe Railway
1001 N. E. Atchison
Topeka, KS 66616

VICE CHAIRMAN

R. E. Clawson, General Foreman-Locomotive, Missouri Pacific Railroad, North Little Rock AR 72114

COMMITTEE MEMBERS

J. E. Abramson, Shop Superintendent, Duluth Missabe & Iron Range Railway, Proctor, MN 55810
K. O. Anderson, Manager Maintenance Engineering & Education, General Electric, Erie, PA 16501
A. A. Enders, Superintendent Motive Power, Chicago & North Western Transportation Co., Chicago, IL 60606
J. M. Flores, Assistant Mechanical Engineer, Western Pacific Railroad, San Francisco, CA 94105
P. F. Hoerath, Superintendent Plant Maintenance, Consolidated Rail Corp., Altoona, PA 16603
T. F. Kelly, Superintendent Locomotive Shops, Chicago, Rock Island & Pacific Railroad, Silvis, IL 61282
M. G. Marler, Mechanical Superintendent Shops, Union Pacific Railroad, Omaha, NB 68179
J. S. Matthias, Manager Production Control, Southern Pacific Transportation Co., Sacramento, CA 95814
N. J. Nielson, Shop Superintendent, Chicago, Milwaukee, St. Paul & Pacific Railroad. Milwaukee. WI 53201
R. V. Propp, Shop Superintendent, Burlington Northern, Inc., Burlington, IA 52601
M. B. Smith, Plant Manager-Administration, Chessie System, Huntington, WV 25718
G. B. Sweeney, General Foreman, Southern Railway, Atlanta, GA 30315
J. J. Wheelihan, Supervisor Product Installation, Electro-Motive Division, LaGrange, IL 60525
T. E. Whitten, Manager, Production Planning, Illinois Central Gulf Railroad, Paducah, KY 42001

1978 TOPIC:

"NEW FACETS AND NEW CONCEPTS—PROBLEM SOLVERS IN SHOP EQUIPMENT"

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

Rare is the new tool or machine that is really "new" in the sense that it offers an extra dimension to the repair of locomotives. More commonly' new tools or machines offer a little more of the same — some added range, more speed, better materials, design improvements aimed at greater reliability, etc.

On the other hand, the truly new tool or machine might go unnoticed simply because the new dimensions it provides have not yet been recognized as important or useful.

The shop equipment committee is always on the lookout for the rare gem, the new tool or machine that offers a new dimension to the repair shop. This tool or machine could be the true problem solver — the new facet or concept in shop equipment for repairing or maintaining locomotives.

This committee is pursuing its goal by bringing to you the following:

I. Updating Fuel Facilities, Fastener Systems, Gear Grinding and Rerailing Equipment for Locomotives;

II. New Facets in Locomotive Painting Facilities;

III. More Managed Maintenance for Machinery;

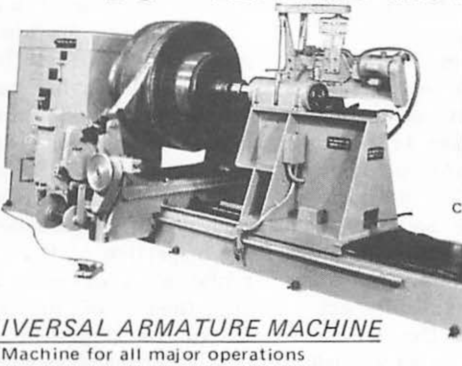
IV. New Concepts in Cleaning Traction Motors;

V. Radio-Control Cranes;

VI. Tool Control

We Can Help Your....

"DC" ELECTRIC MOTOR SHOP



C. A. McGough, Jr.
Pres.

NEW!

"DJ" UNIVERSAL ARMATURE MACHINE

One Machine for all major operations

Since 1910

PEERLESS MANUFACTURING DIVISION

SINGLE PURPOSE MACHINES	TS Bander CW Tig Welder Seasoning Mach.	DG Upenders MG Extractors DT Tester	MDU Undercutter DS Undercutter TFR Roll Over
MULTI-PURPOSE MACHINES	DJ Universal Armature Machine - Heavy Duty DJM Universal Armature Machine - Medium Duty EHP Universal Armature Machine		
SMALL TOOL & LATHE ATTACH.	Tension Devices Coil Winders Coil Spreaders	Winding Stands Taping Machines Undercutters	Coil Cut-Off Grinders Reroll

Complete Catalog Available on SINGLE PURPOSE/ MULTI-PURPOSE Machines and LATHE Attachments.

CONSULTING ENGINEERING SERVICE

Electric Shop Planning — Methods Development
Equipment Specifications — Machine Commissioning
Operator Training

PEERLESS TOOL DIVISION

CAM INDUSTRIES, INC.

P.O.BOX 227 HANOVER, PA. 17331 U.S.A.

TEL 717-637-5988 CABLE: CAM TELEX 840-470

750403

I UPDATING FUELING FACILITIES

Automatic refueling in railroading came of age in the late 1950's. Four companies began manufacturing equipment designed to fill fuel tanks on diesel locomotives to a predetermined point and then shut off, achieving a clean break when the nozzle was disconnected from the locomotive. The clean break literally means no spillage from either the coupler in the filler pipe or the nozzle. Two companies manufactured hydraulically actuated equipment. The Houston Company of Connecticut made such a system using line pressure as the motivating force and shut off, with closure of the fuel flow being achieved in the nozzle. Aeroquip Company of Michigan used hydraulic line pressure to achieve the same thing, except that its shut off occurred in the coupler on the locomotive filler pipe.

The • two companies using the pneumatic type of operation were Buckeye of Ohio (now known as EMCO-Wheaton) and Snyder Company of Maryland. Both of those systems operated on the principle of the sensing of escaping air. When the fuel level reached a given point, air was no longer sensed, and nozzle shut off was accomplished. The Aeroquip system was abandoned by most of its users after several years of operation. Three suppliers continue to produce refueling equipment for railroads.

All three systems had common inherent weaknesses. One was that since shut off occurred at the nozzle (which was attached to the coupler unit in the filler pipe of the locomotive), the nozzle had to be maintained in good working order to be able to sustain static line pressure when fuel flow into the unit ceased. Having been designed for this purpose, those units—when maintained in good order — could be expected to do the job for varying periods of time, depending upon each manufacturer's design. Regular inspection of the nozzles, with replacement of needed parts and adjustments of tolerances is required. Lacking such maintenance, nozzle performance could and often did vary widely.

Another inherent weakness was that the shut off level, at the discretion of the fueling operator, could be overridden. Known as "topping off the tank," this has become a common practice owing to a fear of allowing locomotives to run out of fuel, thus tying up the track. Of the three ways for the refueling operator to determine the level of fuel in the tank, he seems to prefer having positive evidence that fuel is running out the overflow vent. Fuel gauge sight glasses become dirty, and cleaning or repairing if broken is a chore not often accomplished. Furthermore, the fuel tank gauge commonly used on diesel locomotives sometimes reads on the low side of the scale; fuel can be pouring out of the overflow vent while the gauge reads 400 gallons below the full level mark.

About five years ago, diesel fuel cost the railroad about 10 cents to

11 cents per gallon. Today, it costs more than 40 cents, with figures of 50 cents to 60 cents a gallon in the offing. Compounding the problem, environmental controls have added cleanup expenses. Fuel spillage and other practices that for many years were accepted by the industry as standard operating procedeure, must be changed. And with environmental problems and the "fines" many railroads have had to pay, we have to contend with the energy crunch. This country is very obviously going to have to find supplemental sources of energy. However, other industries now using oil can be more readily converted to other fuel sources, such as coal. Railroaders in the meantime — especially those who are responsible for any equipment that uses fuel — must exert every effort to achieve the absolute minimum of fuel loss to reduce costs and save fuel.

The Houston Company has developed a new electronic circuitry approach to the problem of refueling diesels, whereby the fuel flow shut off is made in the plumbing system by means of a rugged 2½-inch full orifice solenoid valve that eliminates the need for the hose or nozzle to ever sustain line pressure. This greatly increases component life and virtually eliminates the maintenance required in the past on refueling nozzles. More significantly, the Houston H-3000 system cannot be overridden once the desired fuel level has been reached in the fuel tank. When the desired level has been achieved, the control circuitry prevents topping off the tank. The nozzle control module and solenoid valve in this system are installed at the fueling stanchion on the platform. The coupler valve and level indicator are locomotive equipment. The coupler valve fits in the end of the locomotive filler pipe to secure the nozzle and transmit low voltage to the level indicator. The level indicator is readily installed in the top or side of the fuel tank.

Operation of the system is as follows: The control module is powered by 120 V.A.C. and converts to an intrinsically safe D.C. voltage through a plug-in pack. This low voltage is passed through the hose to the nozzle, which is attached to the locomotive coupler valve when refueling. Both the nozzle and coupler valve are wired for center point-to-point contact. A complete circuit is attained when the units are coupled and the control handle is pulled back to the "flow condition." It is important to note that only one connection is necessary to couple and start the system. After the nozzle control handle has been pulled back to the flow condition, low voltage with milli-amperage (which is intrinsically safe) is transmitted to the level indicator, which incorporates a magnetically operated glass reed switch encapsulated in a brass stem. When the float is in the "down" position (tank needs fuel), the glass reed switch is closed. Under this condition the circuit is now complete, and the solenoid valve is energized and opens, permitting fuel to flow into the locomotive. When the rising fuel level

in the tank lifts the float of the level indicator to the proper point, the magnet embedded in the float "breaks" the contacts of the glass reed switch, which opens the circuitry permitting the solenoid valve to close, stopping the flow of fuel. Depending upon the fuel stand and hose configuration, the hose then drains into the engine and, prior to disconnecting, the control handle is returned to the "off" position. After the nozzle is disconnected from the locomotive, it rises into the air, suspended by the hose from the boom arm. This method is only one of many types of refueling applications possible. When the system has shut off as a result of the level indicator rising in the tank, the contacts of the reed switch were opened, breaking the circuit. It is now impossible to put any additional fuel into the locomotive, since the circuit cannot be "completed." Therefore, manual override of the system is impossible. Only after sufficient fuel has been removed from the tank, permitting the float to drop below the actuation point of the magnet, can the system be reenergized and fuel again be put into the tank.

Features of the components are as follows:

a. The nozzle and coupler valve have their center, point-to-point contacts Teflon insulated for "trouble free" service. The nozzle has no diaphragm or close fitting seals, since fuel flow is shut off at the solenoid valve, line pressure is never sensed in the hose or nozzle, virtually eliminating the need for maintenance of these parts.

b. The vertical level indicator used on most locomotives is readily adjusted to permit shut off within a desired range of two inches. A horizontal unit is available for use with saddleback tanks, as on the GP7 or GP9. The service life of the glass switch is rated in millions of cycles.

c. The control module incorporates a light which glows when fuel is flowing and shuts off when flow stops. The module also incorporates an emergency shut off handle switch for disconnecting power to the stand.

d. The solenoid valve is a U.L. approved 2½-inch NPT, normally closed unit designed to be mounted in either a vertical or horizontal position. It has been made for use with diesel fuel under railroad conditions. A manual override has been provided with a "key lock" so that gravity fueling to the engines is possible in the event a power failure is experienced at the fuel station.

e. A molded, polarized wiring harness is specially designed to withstand railroad service. It will perform under all weather conditions (as well as repeated soakings) with no deterioration in performance.

f. The nozzle is capable of delivering up to 400 gallons of diesel fuel per minute, depending upon the pressure available at the nozzle. With the increase in the size of locomotive fuel tanks in recent years, the ability to handle flow rates can become critical.

Eight years of design and test have been accomplished on this equipment to eliminate any possible service difficulties. It is felt that there are at least ten years of satisfactory railroad service built into this refueling system. It was designed specifically to eliminate the inherent problems common to the older systems designed in the 1950s.

The Snyder Equipment Company also has been working on its automatic fueling system to reduce overfilling and spillage of fuel at the nozzle and tank adaptor when fueling. Its new system seems to have accomplished this. At the same time the required maintenance of the fuel equipment on the locomotive is reduced. This has been attained by putting the sensing line on the locomotive equipment and doing away with it on the fueling nozzle.

The principle of operation of the Snyder II Locomotive Automatic System is the same as the Snyder Automatic Fueling System, namely an air or vacuum system. In the Snyder Automatic Fueling System, the sensing line was an external ⅜" line connected from the skirt of the locomotive to the nozzle.

The new system connects the sensing line to fuel tank adaptor vent assembly. This arrangement not only makes the sensing line a permanent part of the locomotive

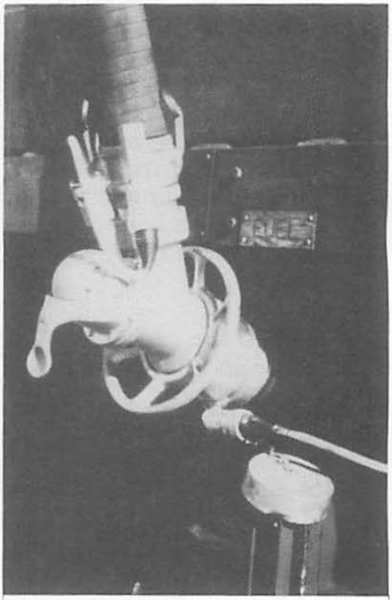


FIG. 1 — HOUSTON FUEL NOZZLE

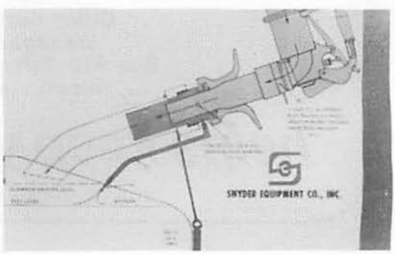


FIG. 2 — SNYDER FUELING SYSTEM

fuel equipment, but eliminates the sensing hose. It also is connected to the fuel tank adaptor assembly in close proximity to the nozzle connection. With low pressure in this area, it eliminates fuel leaking at this connection during fueling.

The basic operation of the Snyder II Automatic Fueling System is as follows: Fuel flows from the nozzle across the venturi, creating a vacuum, drawing air from the adaptor area, which is connected to the top of the fuel tank by the permanent sensing line. When the fuel covers the sensing line in the fuel tank, it shuts off the air flow and activates the shut off mechanism, releasing the operating lever and closing the nozzle.

UPDATING FASTENER SYSTEMS

Several new fastener systems suitable for use on locomotives have become available in recent years. Better design characteristics have made some of the new fasteners more desirable than some of the types used previously.

Fasteners with a variety of head designs have been used at different times. To speed up the application and removal of some fasteners, power tools are used. Better efficiency results in the use of fasteners with heads that are not easily damaged by the power tool driver and that do not cause excessive wear or damage to the driver.

Torx fastener drive systems were designed to provide a positive engaging, fast locating method of transmitting torque and optimizing worker efficiency. Several different screw types are available with either internal-style heads or external-style heads. The manufacturer of Torx fasteners recommends using stallmotor and clutch type drivers to apply its fasteners. With either of these pressure control systems, the proper amount of torque can be achieved without the unnecessary hammering of an impact driver. Torx fasteners are available with the same size head on as many as four different shank sizes; therefore, socket inventory can be reduced.

Una-Driv is a system designed for fastening two drilled parts together from one side with one man and one tool. A special air impact tool drives the nut with an outer socket while an inner bit holds the bolt to keep it from turning. The button-style head has a waffle configuration on the bearing face to aid in the prevention of bolt rotation. The bolt head is large enough, and the lock nut is flanged to provide large contact areas. These areas are also large enough to cover oversize or out-of-round holes, eliminating the need for washers. The lock nut provides quick visual proof that each connection has been wrenched because bolt threads can only protrude through the lock nut after torque has been applied.

Teks screws were designed to fasten metal to sheet metal or sheet metal to structures. The screws have drill points so that no holes have to be drilled prior to

FIG. 3 — TORX FASTENERS

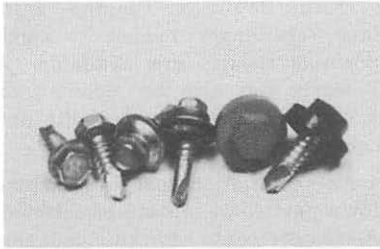


FIG. 5 — TEKS SCREW

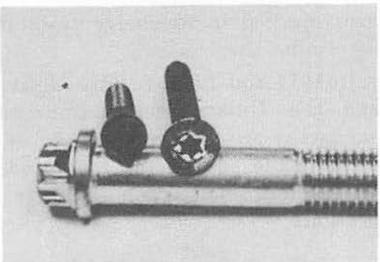


FIG. 4 — UNA-DRIVE FASTENERS

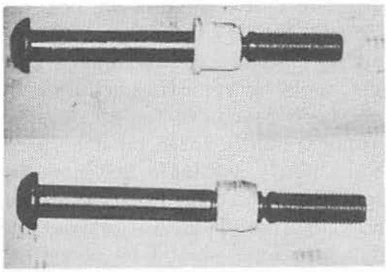


FIG. 6 — HUCK FASTENERS

their installation. The screws are inserted into a power tool and driven into place. They are available with a hex head and a washer consisting of a metal backing member with an extruded drive control ring bonded to a conically shaped neoprene seal. The washer is designed to prevent excessive torque and compressive loads from squashing the neoprene element and rupturing its seal. Another style Teks screw has a colored plastic hex head. A color can be selected to match the color of the metal to which the screw is applied. The plastic head is flexible on the screw shank so that it will seat squarely on the surface of the sheet metal even if the screw is not inserted perpendicular to the metal. Teks screws with plain hex heads are also available for use where no seal or color is required.

In the Huck fastening system a hydraulic powered installation tool cold forges a collar into zero-degree pitch annular locking grooves on a Huckbolt pin. The pins are available in various lengths, diameters, materials and head styles. Special thread-head pins are also available for applications where limited clearance necessitates putting the pin through the hole from the same side the collar is applied.

Huck Powerigs ranging from large stationary models to small portable models are available. A Powerig can also be mounted on a cart along with tools, bolts and collars.

An installation tool satisfactory for a particular job can be selected. As requirements have changed, new installation tools have been designed. Tools are available for installing Huckbolts in various locations on locomotives, such as: traction motor gear cases, pedestal liners, binders, shock absorbers, safety appliances and pilots. As yet, tools for removing collars have not been developed for all of these applications; a torch must be used. Each newly available fastener system should be considered for use on a locomotive. Their advantages and disadvantages should be investigated thoroughly. The proper selection of fastener systems can save many hours in the repair and maintenance of locomotives and can reduce the number of line-of-road delays.

UPDATING GEAR GRINDING

There has been extensive review and discussion of the condition of new, salvage-ground and worn pinion and axle gears.

Numerous tests have been conducted by railroad test departments, locomotive manufacturers and others. Test results have been reported in numerous technical papers and other forms of published information.

Following is a summary of available information and a progress update.

Traction Motors must operate in a severe environment that includes shock and vibration. Axle-hung motors are subjected to shock loads from wheel to rail forces that occur at every rail joint and turnout. More damaging shocks and vibrations, of high frequency, can be generated in the final drive gearing, depending on its condition, and transmitted to the traction motor armature and stator.

Observation of total motor failures has led to extensive tests to determine the cause.

In 1974 and 1975, Electro-Motive and the Union Pacific Railroad conducted an extensive test to determine the source and magnitude of traction motor component vibration.

THEORY OF GEAR ACTION

A pair of mating gear-tooth profiles are in reality a set of cams. Relative motion is generated by the action of one against the other. Constant or uniform motion is controlled by the tooth profile.

To transmit uniform rotary motion from one shaft to another by means of gear teeth, the normals to the profiles of each of these teeth at all points of contact must pass through a fixed point (the pitch point) in the common centerline of the two shafts.

The involute form is the most popular gear-tooth profile. It is the curve described by the end of a line being unwound from the

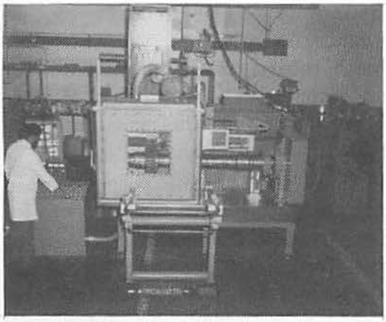


FIG. 7 — FRONT VIEW
ELECTROCHEMICAL GRINDER

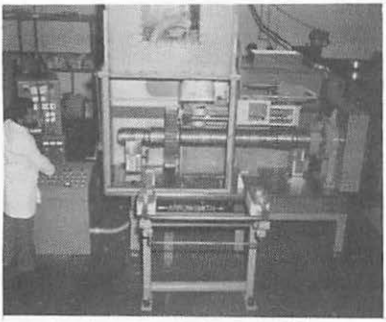


FIG. 8 — FRONT VIEW
SHOWING GEAR ASSEMBLY

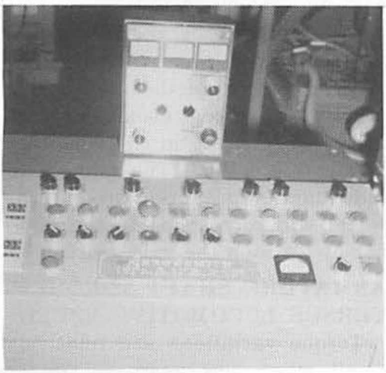


FIG. 9 — REMOTE CONSOLE

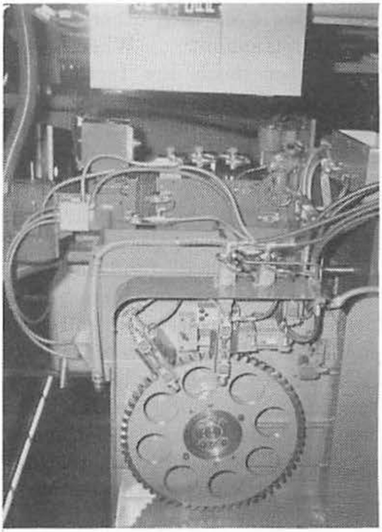


FIG. 10 — END VIEW
SHOWING INDEXING MACHINE

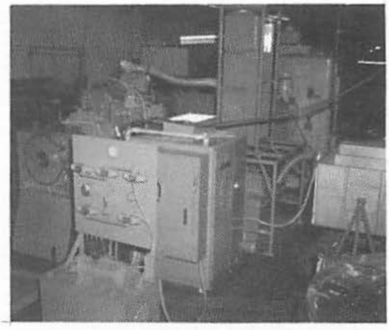


FIG. 11 — SHOWING RELATIVE
POSITION OF HYDRAULIC SYSTEM

circumference of a base circle. The distance between equally spaced points on the base circle gradually increases as these points are rolled off to generate the involute. This geometry is responsible for one of the most important factors in the operation of machinery. The gear teeth slide over each other as load is being transmitted. When gears first enter mesh the teeth slide. Near the tooth center they glide into a rolling motion. Finally they slide apart with increasing speed as they leave the mesh.

Sliding is greatest toward the tip and base of the gear teeth, and these portions will tend to wear. When wear occurs, a ridge will be formed where the teeth roll over each other. This uneven wear from tip to form diameter alters the all-important gear tooth profile. When such alterations cause violations of the law of conjugate action, they are classified as "profile errors."

When gear teeth in mesh encounter profile error they are forced to deviate from their normal path of contact. This forces their line of action away from the pitch point and the law of conjugate gear-tooth action is violated. At each violation severe forces are created that pound the gearing with each tooth contact.

Errors on gear-tooth profiles manifest themselves by changing the relative velocities of mating members. Each change of velocity induces a variation in the load on the gear teeth. The amount of error seems to determine the magnitude of these loads.

When the profile error is positive it acts to slow down the pinion or driving gear and to speed up the driven gear. When this accelerating action is completed, the gears are moving at different linear velocities. Therefore, the surfaces tend to seperate. The input torque, or resisting and torsional deflection, oppose this relative motion apart. As a result, the two gear teeth return into engagement with an impact. The intensity of this blow determines the maximum momentary load on the teeth.

This phenomenon occurs once for each gear tooth contact on defective gears. The frequency of the force depends on the motor speed and the number of teeth on the pinion gear. The force will stimulate vibration.

PINION AND GEAR TOOTH WEAR PATTERNS

The mechanism by which worn gear profile produces vibration is easily understood. A perfect involute shape on the axle gear and pinion gear means constant revolutions per minute (RPM) on the driven axle gear. A slight deviation from an involute shape on either gear produces a small RPM variation as the teeth mesh. This occurs almost instantaneously and results in rapid, large increases in both tooth loading and torque in axle and armature shafts.

In extreme cases, the increase in torque applied to an axle can be large enough to produce small, discrete wheel slips at each gear tooth mesh. Slip marks in the wheel indicate this action. The number of individual slip marks around the wheel will correspond to the number of teeth on the axle gear.

ARMATURE SHAFT TORQUE VERSUS LOCOMOTIVE SPEED

Torque variations are relatively small when new gears in proper profile limits are run together.

Torque variations will increase dramatically when gears with worn involute profile are run together. Torque variations can have a serious effect on the life of the armature windings and insulation. The high-frequency variations in gear-tooth loading produces corresponding high-frequency variations in loading on the pinion and armature bearing. This vibratory force subjects the entire stator frame to cyclical loading, producing fatigue failures in many different components.

APPLICATION

No distinction between pinion and axle gear should be made when evaluating gear tooth profile. The departure from profile of consequence is that which results from the engagement of the mating pinion and axle gear. Dynamic effects are the results of a violation of conjugate action. It matters little whether the violation originates in the pinion gear or the axle gear.

GEAR TOOTH PROFILE MEASUREMENT

A method of measuring tooth profile must be set up for use by maintenance personnel.

Recommended procedures are published by locomotive manufacturers in their Maintenance Publications.

a. Electro-Motive Maintenance Instruction 1518.

b. General Electric Maintenance Instruction G.E. K35824

Effort must be made to hold new gears and salvage-round gears within proper limits. Profile errors manufactured into new gearing will reduce the life of motors and drive components. Salvage-ground gearing with as much as four times normal backlash, properly profiled, will perform well. Salvage-ground gearing will transmit motor torque as smoothly as new gearing.

DEPARTURE LIMITS

Gearing with departure greater than recommended profile limits should be considered unserviceable.

Gearing 0.005 inch or less departure from correct profile is serviceable.

In the ranges between 0.005 inches and the recommended maximum departure limits, and possibly beyond, economic consideration should be made. An attempt to strike a balance between preventative maintenance and failure costs must be made.

FACTS

Large deviations of backlash have no detrimental effect on armature and other drive components' stresses and related physical results, provided a gear tooth profile is correct. Extensive testing illustrated a very important factor. Performance curves for salvage-ground gearing indicate that the system can accommodate excessive backlash without adverse effect of any significance.

The theory has been substantiated that where there is no profile error, there is negligible dynamic effect.

Tests substantiate the theory that departure from correct gear-

tooth profile creates dynamic effects that subject the masselastic drive system to many times normal loading. This increased loading will cause premature failures of mechanical components and electrical insulation.

Significant multiplication begins to occur when departure from profile exceeds 0.005 inch. In the range from 0.005 inch to 0.015 inch, loading increases rapidly from normal to as high as three times normal. Above 0.015 inch there is a continual increase in severity of load.

SUMMARY

Gearing having excessive departure from correct involute profile is responsible for a high percentage of traction motor removals. This is expensive in terms of motor overhauls and locomotive out of service time.

Pinion gears and axle gears should be checked with the same vigilance as other important locomotive components.

Gearing worn beyond recommended limits for wear and involute profile should be removed from service.

Salvage-ground gearing performs as well mechanically as new gearing, and reprofiling should be considered as an economic maintenance procedure.

SALVAGE GRINDING SERVICES AND PROCESSES

Railroads, based upon feasibility study, may salvage-grind gears in their own shops or have this done outside.

At present there are two methods employed to salvage-grind axle gears: Abrasive Grinding and Electrochemical Grinding (ECG).

Traditionally, reprofiling has been accomplished by abrasive grinding, a technique requiring several hours of work per gear. Before grinding, the gear must be pressed from the axle. Conventional grinders, such as the Hoefler and the Maag, are available

Abrasive grinding reprofiling service is offered to the railroad industry by Thompson Products, Inc. (TRW). Plants are located in Cleveland, OH and Montebello, CA.

The latest inovation in salvage-grinding of axle gears has been developed by Arrowsmith Tool and Mfg. Corp., of Los Angeles, CA. The process of Electrochemical grinding—not entirely new to the machine tool industry—shows great promise in reducing the cost of gear maintenance. Features of ECG are:

a. Time required to reprofile an axle gear is greatly reduced due to the speed of metal removal;

b. Eliminates the necessity of pressing gears off axles for reprofiling. Reduction in manhour and material costs;

c. Direct current is used to remove the metal required for reprofiling. There is no damaging heat or abrasion to create stress points or alter the structure or performance of the gears;

d. Gears that have been removed from axles for whatever reason can be reprofiled on an adjustable mandrel;

e. The eletrochemical technique can produce savings by reducing inventories and gear and axle losses due to damage created in demounting process required for abrasive grinding method.

As more interest is developed in the savings realized through proper gear profile retention, additional services from outside vendors will be offered to the railroad industry. Chrome Crankshaft of Illinois is presently installing an Arrowsmith machine and plans to offer gear reprofiling services, in addition to services already offered the railroad industry in engine components.

The Union Pacific Railroad has purchased a machine, which has been in service for several months.

CONCLUSION

This committee urges railroad personnel to thoroughly investigate the potential savings to be realized through a proper preventative maintenance program in pinion and axle gearing. We encourage a feasibility study on each property for the purpose of determining the most economical method available to effect maintenance cost savings through salvage-grinding of pinion and axle gears.

UPDATING RERAILING EQUIPMENT FOR LOCOMOTIVES

When a derailment occurs on the main line, the primary objective is to reopen the main line fast, safely and efficiently. Depending on the cirucumstances, this can be accomplished with the use of portable hydraulic rerailers and/or mobile cranes and derricks. For derailments on yard and industry tracks, the portable equipment is ideal and, in some situations, the mobile cranes are feasible.

Following is a brief discussion of portable hydraulic rerailing equipment and mobile railroad cranes available and in use in the railroad industry today.

PORTABLE HYDRAULIC RERAILING EQUIPMENT

Portable hydraulic rerailing equipment was introduced in the United States by Hoesch of America about seven years ago. Hydraulic rerailing equipment has been in use worldwide for over 50 years.

In 1926, Hoesch introduced the first hydraulic rerailer made of steel. In 1955, the German Federal Railway sought a lightweight aluminum alloy rerailer for portability. Other equipment in this category is the Simplex Rerailer manufactured by Templeton, Kinley & Company and the Lukas Hydraulic Rerailer. Except for differences in design and features, the systems are basically the same and operate on hydraulic principles.

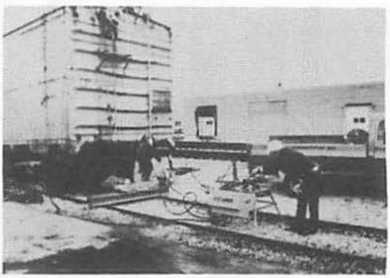


FIG. 12 — PORTABLE HYDRAULIC RERAILING EQUIPMENT

The hydraulic equipment consists of (1) the power unit for the hydraulic devices, (2) control panel with various lengths of hoses, (3) displacing jacks, (4) low-profile telescoping jacks, (5) rerailing bridges, and (6) roller carriages. The operation is not complicated; no sophisticated training is required. The equipment is easy to handle and transport and can be operated at a safe distance from the derailed locomotive or car.

In a typical rerailing operation, one or more jacks are placed on wooden blocking under the locomotive to be rerailed. With the control panel, one to four jacks can be simultaneously operated. When the locomotive is high enough, a rerailing bridge is placed under the coupler or trucks with roller carriages on top. The locomotive is then pulled sideways with a displacing jack held in a horizontal position by a counter support until the locomotive is back on the track.

If the locomotive is on its side or upside down, lifting cable ladders and step jacks can be used to right the locomotive and then rerail it.

One of the latest developments by Hoesch is the 132-ton multistage jack, especially developed for rerailing six axle locomotives with a coupler lift when there is a limited lifting height in the derailment. This jack can be built up by supporting rings and discs until the proper height is obtained for making the lateral movement.

For decades the traditional procedure for handling derailments was for the railroad to dispatch a wreck train. The train included a derrick, bunk car, dinercar and panel car, pulled by a locomotive and manned by about a dozen or so men. Valuable time was required to reach the derailment.

Today, many railroads have equipped hy-rail trucks with hydraulic rerailing equipment. Going by highway to the derailment site saves considerable time. The equipped trucks require no additional vehicles and only three railway personnel, making them more efficient and economical than wreck trains for minor wrecks and derailments. A wreck train is still essential for major derailments. But with the assistance of the hy-rail truck and hydraulic equipment, operations can be expedited at big derailments.

Derailments on bridges and in tunnels .present height and clearance restrictions that can limit the capacity of derrick or mobile crane. With hydraulic equipment, the wreck can be effectively cleared despite the clearances.

The versatility of this equipment has increased with use. There is no better investment than these small tools for big jobs.

RAILROAD WRECKING CRANES

For major derailments and for some yard derailments, mobile wrecking cranes have been especially designed for railroad operations. Equipped with hydraulic hy-railers, these mobile cranes can reach the derailment quickly via highway.

FIG. 13 — HOLMES CRANE

FIG. 14 — ISCO HYDRAULIC CRANE

Following are several mobile wrecking cranes available to railroads:

Ernest Holmes manufactures 75 and 100-ton wrecking cranes that revolve 360°. The road speed is 50 mph; maximum safe rail speed is 25 mph (15 mph in reverse and 5 mph on turnouts). The carriers are powered by Detroit Diesels 228-hp and 304-hp, respectively. The cranes are powered by 123-hp Detroit Diesels. They are mechanically operated power-up and power-down. The outriggers are hydraulically operated. Optional equipment includes: flood lights, rail tie-down clamps, dynamometer, auxiliary winch, heaters, automatic transmission (carrier), and a turbo-charged engine (carrier).

Isco manufactures an 85-ton mobile hydraulic crane/wrecker

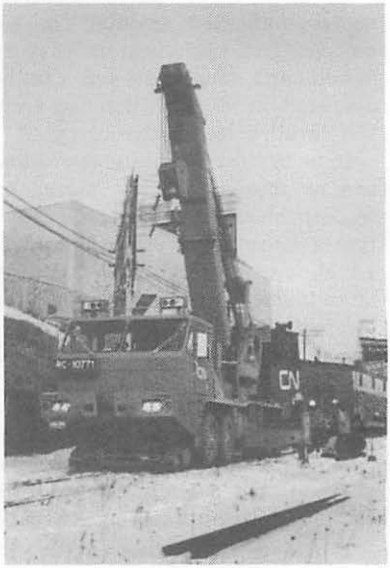


FIG. 15 — PETTIBONE HYDRAULIC CRANE

FIG. 16 — LITTLE GIANT CRANE

equipped with hy-railers. The Model IC-85-MNC comes with a 13-speed transmission which permits highway travel at maximum speeds. The carrier is powered by a 216-hp Detroit Diesel. The 85-ton boom is hydraulically powered and has a 30-ton telescoping inner boom extension. There are two hydraulic outrigger stabilizers mounted on the middle sides of the chassis to provide maximum lift over sides of the vehicle when using the inner boom extension. There is a 30,000 lb. capacity mechanically driven front winch, and a 35,000 lb. hydraulic rear winch, or a 45,000 or 100,000 lb. mechanically driven rear winch.

When not rerailing, this crane with its telescoping inner boom extension that provides a rated 80,000 lb. crowd force, can be used to adjust loads, straighten freight car ends, lay track panels and hang freight car doors.

Pettibone manufactures a 110-ton mobile hydraulic railroad crane equipped with hy-railers. The carrier is powered by a GM 8V-71, 8 cylinder, 2-cycle diesel with a blower through an automatic transmission. Maximum road speed is 50 mph, and maximum safe rail speed is 25 mph (14 mph in reverse and 5 mph on turnouts). The carrier diesel engine is disconnected from the carrier drive through a gear box to large capacity hydraulic pumps. The crane's boom, main hoist, and swing are powered hydraulically. This varies the controlled movement from very slow to fast. The hydraulic operated outriggers are the double box beam telescoping type.

The boom of the 110-ton hydraulic crane is box-type construction and pendant supported by a 13-part line. It rotates 360 degrees.

This crane is situated on a carrier frame between the front and rear outriggers, permitting the capacity load to be lifted over the rear without the need of front rail tie down clamps.

Little Giant Crane & Shovel, Inc., introduced a new concept in the 100-ton rerailing crane. It features detachable counterweight, which makes into its own trailer for legal highway travel.

This unit is powered by a Cat 3306 Diesel Engine, coupled to a 5-speed Allison Automatic Transmission. It has a split cab design to accommodate a crew of four, weighs approximately 89,000 lb. and has a total travel length of 54 ft 10 in.

II NEW FACETS IN LOCOMOTIVE PAINTING FACILITIES

Infrared Drying Oven Banks For Paint Facility

To meet increased locomotive production schedules and cope with varying paint specifications, one railroad installed auxiliary paint drying equipment in its existing paint facility. Before the installation, a locomotive would sit on location in the paint shop until a hand check for "tackiness" determined that the paint surface was dry enough for the next color application. The drying process was inconsistent owing to weather, atmosphere and other environmental conditions occurring daily.

It is necessary to mask between color applications for letters and numbers. This cannot be done until the preceding color application has dried. Drying times varied so much that they were impeding the ability to do the masking, stenciling, lettering and coding, all required to complete the painting cycle. No two color applications dry in the same amount of time, depending upon various paint specifications. Consequently, work scheduled for specific times would be delayed, resulting in shift over-runs and inefficient work assignments. In order to stay abreast of locomotive production from the erecting shop, overtime labor was necessary to make up work that had fallen behind in the paint shop while waiting for paint drying, which frequently occurred in the middle or end of a shift.

To relieve those conditions, one railroad installed two infrared heating sections along each side of an existing paint facility. The equipment is designed to preheat and bake freshly painted diesel locomotives on both the ends and sides. Each oven section is independent of the other, they can be moved the entire length of the paint facility and inwardly toward the locomotive three feet. The equipment has the ability to pass the paint booth at any point in the facility. This permits drying any locomotive at any time, at any position in the building. The oven sections are suspended from the ceiling by means of carriage mechanisms and tracks.

Oven framing is of 1⅝" by 1⅝", 12 gauge structural steel of bolted construction throughout and designed for portable mounting. The oven banks contain ceramic-type electric infrared generators, which generate the heat required for drying of any type of paint.

The ceiling suspension consists of two rail runway systems approximately 210 ft. long and each consisting of one double girder, hand pushed trolley to support the infrared oven bank, one double girder, under hung motorized crane 3'-10" span for movement toward locomotive, two pushbutton stations for crane forward and reverse. Oven section dimensions are: Height 16 ft. 6 in. Width 15 ft. 9 in. Other sizes are available.

It is proposed to employ a three-stage drying or curing cycle to consist of a preheat stage, a baking stage, and a curing stage (cooling). Approximate time for each stage is:

1. Preheat — 10 minutes
2. Baking — 15 minutes
3. Curing — 30 minutes

These times were determined in laboratory test run by Dri Clime Corporation. The oven sections are 15 ft. 9 in. in length, allowing preheat, bake and cure in 15 ft. segments. The average length locomotive is 60 ft. It requires four movements of the oven sections to completely cover the locomotive

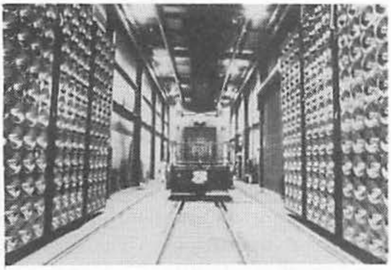


FIG. 17 — INFRA-RED OVEN

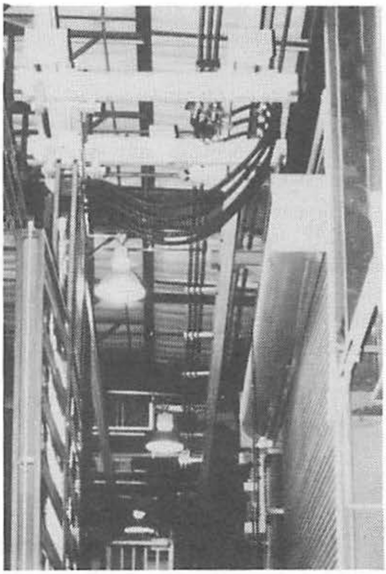


FIG. 19 — SECTIONS SUSPENSION

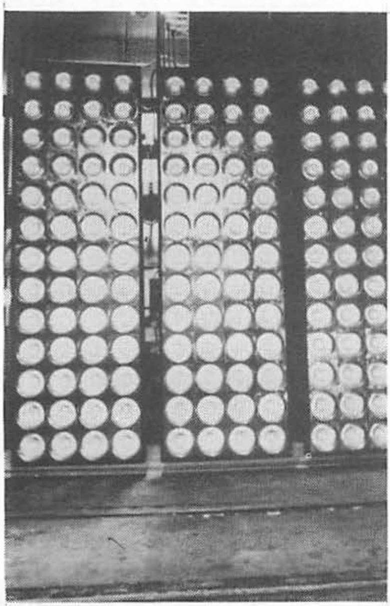


FIG. 18 — INFRA-RED SECTIONS

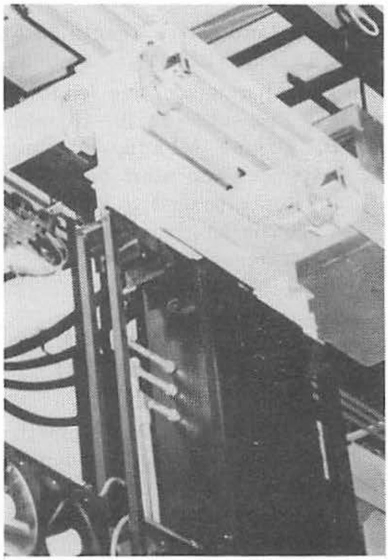


FIG. 20 — SECTIONS TROLLEY SYSTEM

length for each stage. The total stage times are as follows:

1. Preheat — 40 minutes
2. Bake — 60 minutes
3. Curing — 0 minutes
   Oven section movement twenty minutes.

The curing time does not affect overall cycle time because the first sections baked will be cured by the time the final sections are baked, thus allowing work to progress without delay.

Typical Locomotive Drying

1. Drying Cycle
   A. Preheat — 10 minutes
   B. Drying — 15 minutes
   C. Cooling — 30 minutes

This cycle and its associated times are based on a fifteen ft. section.

Average Locomotive Length 60 Ft.
60/15=four fifteen ft. sections

2. Time per locomotive length=
   A. Preheat — 4 x 10=40 min.
   B. Drying — 4 x 15=60 min.
   C. Work can start before the total locomotive length cools so there is no delay time.
3. Time complete cycle
   Preheat+Drying+Cooling
   =40 min.+60 min.+0
   =100 min.
   =1.66 hours
   =1 hour 40 min./locomotive

If we include a small amount of delay time — 20 minutes for moving banks — total cycle time is two hours per color.

For a three-color locomotive, it will take six hours drying time. Production delays will be eliminated and a consistent production schedule can be implemented in the paint facility. The equipment will eliminate or reduce the existing overtime expenses dependent upon production demands and schedules.

The equipment has the flexibility to handle any size, length or configuration of locomotive that can be painted in the facility. It in no way imposes any limitations on the existing paint booths' movements or operations. The drying equipment meets all OSHA requirements for apparatus of its type.

The equipment provides controlled atmospheric conditions. The paints will be baked and cured at constant temperature and humidity. The temperature can be controlled and maintained for varying outside conditions. For example, summer drying temperature will be lower than those required in winter. The equipment gives the flexibility to dry a unit that has been exposed to rain, sleet, or snow. On humid days and application of the drying process will quickly ready a unit for paint application.

III. MORE ON MANAGING MAINTENANCE

Last year, this Committee dealt with managed maintenance for machinery. We tend to pay the most attention to the biggest investments, such as locomotives, and generally have a well organized system of inspections and various classes of overhauls (including flow charts and even PERT diagrams, man-hour schedules and parts inventories, etc.).

What happens to our miscellaneous machines, the cranes and hoists, air compressors, boilers, fans and blowers, engine lathes, wheel and axle lathes, steam traps and all the other mechanical and electrical equipment we depend on for daily efficient shop operation?

All such machines, tools and equipment represent a large investment, and thus merit organized maintenance.

Last year's paper described a basic computer system in which weekly cards told the foreman what jobs should be done the following week. Those jobs might be on a weekly, monthly, annual or other schedule a particular item demands. In any case, the need for attention is brought to the foreman by the appearance of the card. If the card is not returned to the computer in the proper week as completed, that fact is noted on a printout of Work Not Completed, which lands on the desk of the foreman's supervisor. Obviously there are ways to cheat the system, but the first one to squeal will be the machine.

The computer card is one form of work report, and it covers the work that can be put on a regular schedule, year after year, monthly, weekly, or whatever. There is other work that is handled by the typical maintenance shop that is not programmable. Things have to be manufactured, modified or repaired. These are the things that prevent getting the scheduled things done on time.

A work order system for those time-demanding jobs will help to keep an orderly flow of work. The workorder system used will depend on the size of shop, number of people per craft, volume of work to be handled and the degree of cost control demanded by the accounting department.

For the ultimate in productivity, to assure getting a day's work for a day's pay, a work order should be thoroughly planned. It should include the following:

1. A concise statement of the job to be done, along with diagrams, sketches, etc.;

2. A list of material necessary;

3. A list of special tools required;

4. Any safety hazards to be aware of;

5. Estimate of man-hours and completion time or date.

To maintain the objective of maximum productivity, the material should be obtained and available at the job site when the crew is ready to start. The mechanic is paid to perform that job, not to chase after parts and material.

Depending on the size of the shop and the scope of the work handled, the planning can be done by the foreman, a planner-scheduler or a whole staff of planners and schedulers. A rule of thumb is one planner for every 30 mechanics.

Thus far we have covered (1) scheduled preventive maintenance by computer card work orders, (2) planned work that requires adjusting the work force to the jobs at hand, and (3) ordering and obtaining special material and doing

the job according to a preconceived plan and cost estimate. There also is emergency work that inevitably upsets all well laid plans and schedules.

The purpose of preventive maintenance as applied to machinery is to inspect and know the condition of machines so repairs can be made by scheduling a tear down short of an emergency breakdown. All machines do not necessarily get the same preventive maintenance treatment. Preventive maintenance is expensive and should be reserved for the machines and equipment most critical to the operation of the railroad. A wheel truing machine will demand preventive maintenance because it is vital to maintain locomotive availability. Scheduled inspections and lubrication, when done on time, will reveal when overhauling or repairs are necessary so they can be scheduled to suit work flow of the wheel shop.

Before leaving preventive maintenance, there is another PM worth mentioning. Predictive Maintenance is a modern tool of the maintenance man. It can be useful for determining in advance whether a machine is getting in trouble from a bad bearing, faulty lubrication, worn gears, etc. Predictive Maintenance uses instruments such as vibration meters, thermocouples, infrared detectors and electrical meters to establish normal parameters of a machine. Wi th periodic checks for vibration, temperature or power parameters, variations from the norm for that machine will indicate that something needs attention. The value of Predictive Maintenance is that a machine can stay in operation without a teardown inspection, which probably really was not necessary. On the other hand, it will show up a bad bearing that should have lasted much longer. Vibration analysis has been used by many shops to check traction motors. Applying it to machinery will keep productivity at a high level and minimum cost and emergency breakdowns to manageable proportions.

Whether a machinery maintenance department is big or small, it should have an organized system of planning and scheduling of repetitive work and the project type of work. The system should include elements for control of costs and means of measuring productivity. The machines and equipment critical to maintaining a high level of locomotive availability need the frequent attention imposed by a PM system. Other items, while not as critical, represent a sizeable investment that should not be neglected either.

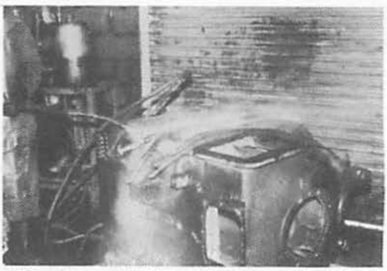


FIG. 21 — USING SAFETY SOLVENTS

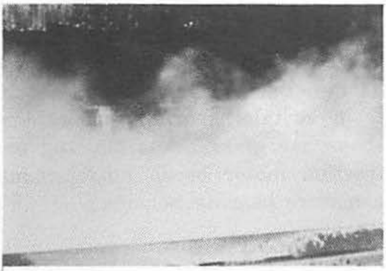


FIG. 22 — USING VAPOR DEGREASER

FIG. 23 — USING CORN COB GRIT BLASTING

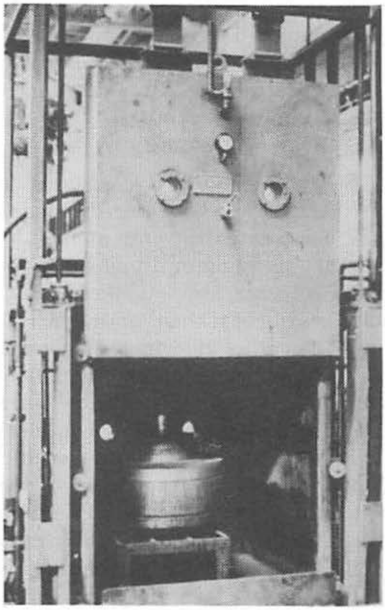


FIG. 25 — VACUUM CLEANING

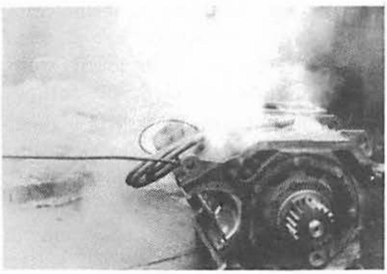


FIG. 24 — USING COMPRESSED AIR CLEANING

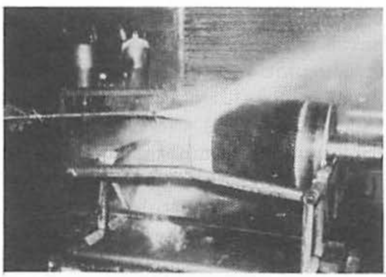


FIG. 26 — WATER CLEANING

IV NEW CONCEPTS IN CLEANING TRACTION MOTORS

There have been many methods used by the railroad industry to clean traction motors. Some are:

1. Safety Solvents,
2. Vapor Degreasers,
3. Corn Cob or Grit Blasting,
4. Compressed Air Cleaning,
5. Vacuum Cleaning,
6. Water Cleaning.

Safety Solvents are usually a mixture of petroleum distillates and chlorinated solvents applied by wiping, spraying or dipping. Petroleum solvents are less likely to attack varnishes than stronger solvents, such as chlorinated solvents (Trichlorethylene and Perchlorethylene). Safety solvents were used for many years to clean electrical equipment with fair results; however, safety regulations, the Clean Air Act of 1970, EPA, Fire Regulations and the cost of petroleum products have all but eliminated the use of safety solvents.

Vapor Degreasing was a popular method of cleaning traction motors during the 1950's and 1960's. However, this method would only remove grease-type soils and usually required a follow-up cleaning cycle using a corn cob grit blaster. The harsh effect of chlorinated solvents on insulation (silicone and neoprene rubber), Occupational-Health Regulations, the Clean Air Act of 1970 which eliminated the use of Trichlorethylene, and the cost of equipment to control the solvent emission to atmosphere have caused most repair shops to change to water cleaning methods.

Corn Cob or Grit Blasting has generally been used as a secondary (follow-up) cleaning system after all greasy soils have been removed by vapor degreasing or safety solvent cleaning. Grit blasting may be very destructive; however, it is a good method for removal of carbon from metal parts. Some repair shops use glass beads blasting on traction motor brush holders and armature bearing housings.

Compressed Air Cleaning has been a widespread method for cleaning electrical equipment; however, this method removes only loose soils and is used in combination with other methods. OSHA has imposed strict limitations on pressure when using a hand-type blow valve, thus, decreasing its effectiveness. Higher pressures may be used if blowing is performed in an enclosed cabinet.

Vacuum Cleaning has been a good method for cleaning dusty or loose soils on electrical equipment; however, it has not been successfully used in cleaning traction equipment.

Water Cleaning is a very good method for cleaning traction motors and is presently being used by most repair shops. Different methods of water cleaning follow:

1. The "Steam Jenny" is a portable unit that generates a high-pressure steam-water solution. It is applied by hose and nozzle (spray wand). The hot wash is generally followed by a clear water rinse to remove all traces of the cleaning solution. Excessive water

is then blown off with compressed air.

2. The high-pressure pump method generally consists of one or two air operated 10 to 1 piston pumps that transfer a heated water cleaning solution from a holding tank by pump to a spray wand or nozzle.

Pressure at the nozzle will generally range from 700 psi to 1000 psi and output from 3 to 5 GPM, depending on the air pressure used to operate the air motor and the orifice size of the nozzle. Hot wash solution temperature should be kept at 195° - 200°F for best results. The hot wash cleaning solution usually consists of a mixture of hot water and a mild (or nearly neutral) detergent such as "Dreft" or "Tide." Excessive alkaline detergents should not be used since they could be very harmful to many kinds of insulation, varnishes, etc.

3. Various other types of electric motor driven pumps are used to transfer hot wash cleaning solutions at high-pressure—high volume or medium-pressure—high volume. They are used primarily in recirculating-type systems.

4. Various mixing nozzles that mix high-pressure steam and cold water to give a high-pressure steam-water solution output have been used in some repair shops.

Various water wash methods are used to clean traction motors in most railroad repair shops. Most shops still use manual methods with a spray wand. However, a few shops are using semi-automatic machines that utilize the recirculating hot wash system.

The traction motors are usually washed off externally using a spray wand, and then disassembled. The field frame and armature then are washed using a mild detergent. Axle caps, nuts, bolts, flingers and other steel parts are usually washed in a strong alkaline "hot tank" cleaner. Brush holders are usually soaked in a "cold tank" cleaner, washed or blasted.

The traction motor armature then is manually loaded in a batch-type drying oven and dried from 8 to 16 hours in order to remove all moisture.

The field frame also is manually loaded in a batch-type oven and dried from 4 to 8 hours. Most ovens are heated by either gas or electricity.

With the increase in energy and labor costs and the inefficiency of the batch-type drying oven, it is clear that most traction motor facilities are outdated. New concepts and equipment are needed in the modern traction motor shop.

With new concepts and automation in mind the following is suggested:

1. Prior to disassembly, run all traction motors through an automatic external washer. Secure external motor leads (axle caps can either be removed or left on the motor as desired). All covers should be in place. The external washer should use a recirculating hot wash system to conserve water and heat energy. The hot wash solution could be more alkaline

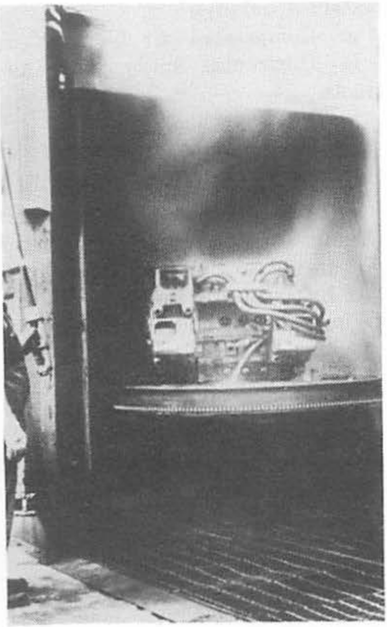


FIG. 27 — T.M. CLEANED BY HIGH POWER WATER

than "Tide" or "Dreft" since most of the fluid would not come in contact with the internal traction motor parts. A high-volume medium or high-pressure circulating pump transfers the solution from the storage tank to the multiple spray nozzles. The used solution returns by gravity through a large pipe to the holding tank and oil separator for reuse.

The nozzles could be mounted on a moveable lance or the motor could be rotated on a turntable. Concentrated cleaning effort should be given to the pinion end of the motor since this area would have a heavy accumulation of dirt and gear lube compound. It may be desireable to remove the pinion gear from the traction motor prior to external wash in order to keep the gear lubrication from plugging the system. A secondary solvent recirculating system might be incorporated in the cleaning system to clean the pinion gear area. Hot rinse water also could be used as make-up water for the hot-wash system and also to overflow the oil-dirt separator. The hot wash holding tank should be kept at a temperature of 195° - 200°F. The tank and related piping should be insulated to retain the heat.

Typical wash cycle for the external wash is:

a. Traction Motor placed on inbound position.

b. Tow chain moves motor into cabinet (motor on cart or on roller conveyor).

c. Door closes.

d. Recirculating-solvent system using transfer pump washes pinion end area for 5 minutes (if desired).

e. Hot wash cycle, approximately 10 minutes.

f. Hot water rinse cycle, approximately 30 seconds or less.

g. Compressed air blow off, approximately 1 minute.

h. Door opens.

i. Tow chain moves motor out of cabinet to outbound position.

2. The motor then moves to the disassembly area either by tow chain and cart or on roller conveyor. Disassemble motor in a horizontal position using gang-type impact or hydraulic wrenches to remove commutator end and pinion

end frame bolts. The armature assembly is broken loose from the frame using jack screws, and the armature assembly is removed in a horizontal position using "C" hook suspended from a 2-ton jib hoist on an overhead monorail. Put armature assembly on a roller conveyor for armature bearing removal.

Move field frame to the inbound position of the automatic field frame wash machine. Note that machines are available to assist in the disassembly of traction motors.

3. The automatic field frame washer would use a recirculating hot wash system. The circulating pump delivers a high-volume medium- (or high) pressure output to a reciprocating horizontal spray lance with a rotating nozzle or nozzles. The hot wash is followed by a hot water rinse with some of the used water to be used as make up for the hot wash solution. The hot wash solution should be a mild alkaline (near neutral) and heated to 195° - 200°F.

Typical wash cycle is:

a. Field frame moves to inbound position.

b. Tow chain moves frame into cabinet.

c. Door closes.

d. Horizontal spray lance moves into position.

e. Start hot wash cycle — approximately 20 minutes.*

*It is desirable to retain as much heat in the field frame as possible prior to vacuum-drying. A heated air blow off may be desired. The field frame then is moved to the automatic frame vacuum dryer by cart or roller conveyor.

f. Hot water rinse — approximately 1 minute.

g. Compressed air blow off.

h. Horizontal spray lance retracts.

i. Door opens.

j. Tow chain moves motor to outbound position.

4. The automatic field frame vacuum dryer can reduce the time for drying a field frame from 4 to 8 hours to less than 1 hour. The vacuum dryer should be heated by use of a steam jacket or electric heaters on the exterior of the chamber. It should also be equipped with a large vacuum pump for fast evacuation of the chamber with a large liquid handling capacity.

The following is a typical cycle:

a. Place field frame on inbound position.

b. Tow chain moves frame into chamber.

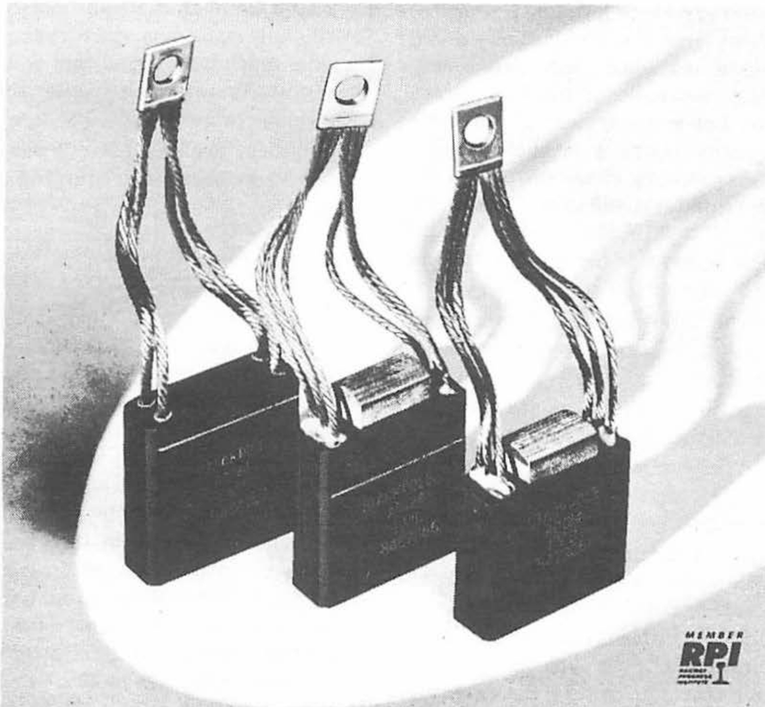
c. Door closes.

d. Vacuum pump and heating cycle starts — less than 1 hour.

e. Vent chamber — open door.

f. Tow chain moves field frame to outbound position. The field frame now is ready to be processed through electrical and mechanical qualifications.

5. Remove armature bearings and place components in baskets. The baskets move by roller conveyor to an automatic wash machine (turbulator type) for hot wash and rinse. The wash solution would be a strong alkaline type and heated to 195° - 200°F. This machine also could be used to wash all other steel parts, such as bolts, pole pieces, covers, etc.



6. The armature moves on roller conveyor to an automatic armature washing machine. The washer would use a hot wash system and a mild detergent (Tide or Dreft). The hot wash system would not be a recirculating type, but would be high pressure (700 psi - 1000 - psi at the nozzles) and low volume output (6 to 8 GPM). A recirculating-type system would tend to contaminate the armature.

The following is a typical cycle:

a. Armature moves to inbound position.

b. Tow chain moves armature into wash cabinet.

c. Door closes.

d. Armature pallet is clamped in place.

e. Armature lifted by Vee-block rollers on shaft ends using two screw jacks (air operated).

f. A rubber tire chain driven through a gear box moves down and starts to rotate the armature.

g. Hot wash cycle begins using a horizontal reciprocating spray lance and fixed spray nozzles at each armature end. Hot wash for approximately 3 to 5 minutes.

h. Hot clear water rinse — approximately 5 minutes.

i. Hot air blow-off — approximately 10 minutes. (It is desirable to retain as much heat in the armature as possible prior to the vacuum dryer process).

j. Rubber tire retracts and screw jacks lower armature into pallet.

k. Pallet unclamps, door opens.

l. Tow chain moves armature to outbound position.

7. The armature moves on roller conveyor to the inbound position of the automatic armature vacuum-drying machine. The dryer would be similar to but much smaller than the field frame dryer.

A typical cycle is as follows:

a. Armature on inbound position.

b. Tow chain moves armature into chamber.

c. Door closes.

d. Vacuum pump and heater starts for less than 1 hour.

e. Vent chamber — open door.

f. Tow chain moves armature to outbound position.

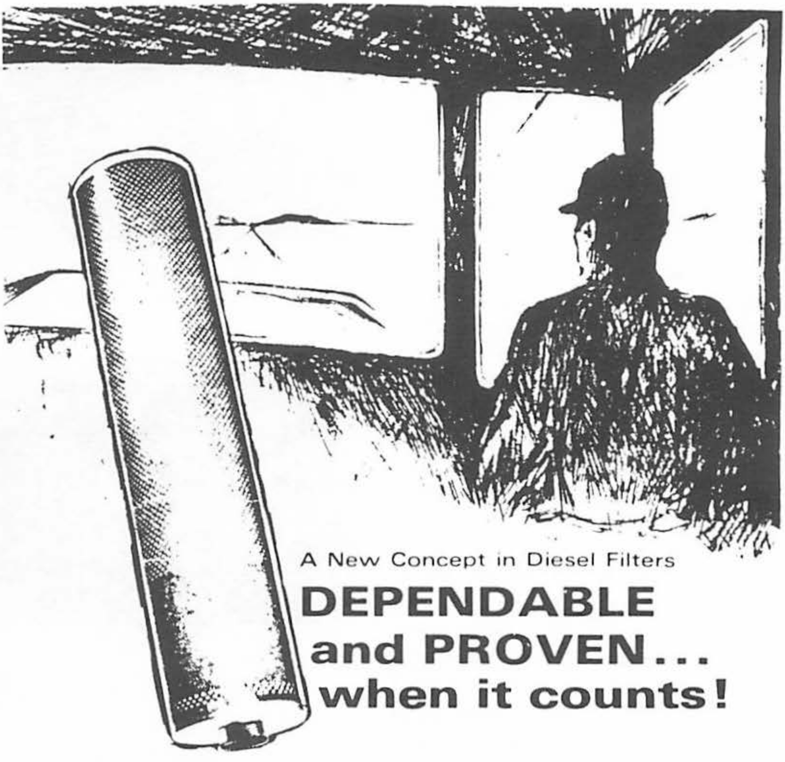
The armature now is ready to pass through the electrical and mechanical test stations.

8. The traction motor brush holders could be removed from the field frame after the vacuum dryer cycle and run through a small automatic glass-bead blast machine prior to repairs.

In conclusion, the cleaning and drying systems as proposed in this section should decrease energy costs, decrease labor and material costs, improve and control the quality of our component cleaning, and decrease the number of traction motors required to maintain a pool.

V. RADIO CONTROLLED CRANES

The basic reason for using radio-operated cranes is economics. However, the ancillary benefits derived from their use are enough to justify them. The non-radio manually operated crane is a two-man operation. In most instances, the use of radio can reduce this to a one-



man operation. The labor savings is enough to give a discounted cash flow return sufficient to pay for the installation of the radio controls.

Such additional benefits as increased safety, more precise control of the crane, and elimination of uncomfortable operating conditions can't be priced, but are very real and worthwhile.

Because of the fixed position of the operator in a manually controlled crane, he sometimes has to work in conditions of heat or cold, noxious fumes and poor visibility, relying on confusing hand signals that may be relayed through a second party. Under those conditions, it is difficult for a crane operator to accurately position a lift in the area desired, let alone have the precise control needed to replace a cylinder assembly or to position a generator. Conversely, with radio control the man actually doing the work has instant control over the crane. With no communication problems, he is much better able to accurately control the position of the item being moved.

A radio-controlled crane is available for operation 24 hours a day without a specially assigned operator, thus more efficient use — not only of the crane, but of the men working the second and third shifts — is possible. By allowing work to continue around the clock, the flow of work through the shop is accelerated.

Safer operation is another plus. The better visibility of the work area afforded the controller — in

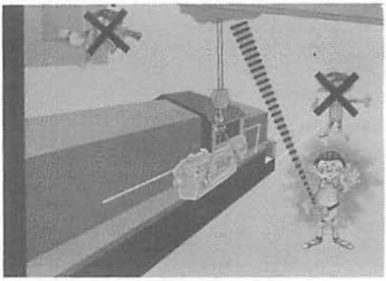


FIG. 28 — RADIO CONTROL CRANE OPERATION

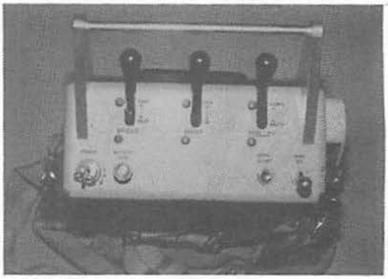


FIG. 29 — RADIO CONTROL - OPERATOR'S CONTROL

most cases on the floor — improves his control, thereby reducing the risk to personnel in the area. Elimination of easily misinterpreted hand signals, plus the "fail safe," and "called for action only," features of modern radio controls insure that there will be no uncalled for or inadvertent moves made by the crane. The variable range (50' to 900') of the radio-control system allows it to be matched to your particular requirements. At this point, the importance of proper training and motivation of the workers who will operate the system must be em-

the complete and dependable remote control system

Featuring . . .

selective range limiting.

stepped or full stepless control

72-76MHz,

or 450MHz carrier frequencies

(MADE IN U.S.A.)

Also Manufacturers of - Unitized Crane Magnetic Systems - Fail Safe Anti Collision Devices - and Short Range Remote Control Command Systems.

CONTROL CHIEF CORPORATION

P.O. Box 141 Bradford, Pa. 16701 Tel. (814) 368-4131

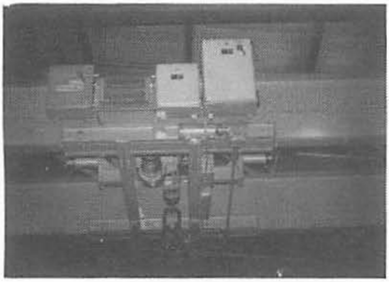


FIG. 30 — CRANE RADIO CONTROL EQUIPMENT

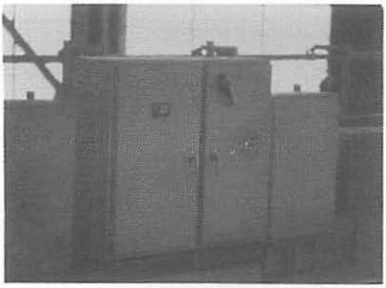


FIG. 31 — FLOOR EQUIPMENT FOR RADIO CONTROL

phasized, as the system can be no safer than the men operating it.

Although radio control systems are fabricated of rugged solid-state components mounted in a sturdy housing, they are still susceptible to rough or careless handling. This fact emphasizes the need for intelligent, well-trained maintenance personnel to keep the entire system in top condition at all times. Radio controls are an additional system, which means that they add to the maintenance requirements of the system. However, the addition of radio controls to an existing crane may lighten the overall maintenance load because the upgrading of the crane to accept radio controls — by replacing drum controls with magnetics, for example — will improve crane reliability substantially.

Conversion of an existing crane to radio control is relatively simple and inexpensive. Companies in this field include Control Chief, Femco, Square D, and Telemotive. When making such a modification, consider the individual characteristics of the crane as well as specific requirements of the job. For instance, the bridge speed must be matched to a man's walking speed if the crane is to move over a considerable distance. Older high-speed cranes may be slowed by the addition of a shunt to the bridge motor. Drum controls must be replaced with magnetics, and braking systems must be adapted to electrical control. Companies, such as those noted above, will make recommendations for modifying a system to make it compatible with radio control.

Disadvantages of radio-controlled cranes — some of which already have been mentioned. For example, the need to adjust the crane's speed to that of a man walking will slow longer moves. It is an additional system to maintain. And even though rugged, it still is electronic, requiring a higher level of care than a mechanical system. The control box is battery-powered — either with disposable or rechargeable batteries — and in accordance with "Murphy's Law," the batteries always fail when you most need them. The control is directional and is adversely affected by the juxtaposition of a large mass of metal, such as a locomotive. Welding equipment will broadcast spurious signals, causing the crane to stop in "fail safe" condition. There are times when control from a cab affords a better view, such as lifting locomotive cabs or engine covers. Braking efficiently with loads ranging from an empty hook to a full load is a problem. In addition, some operators complain of a lack of "feel" with a radio-controlled crane.

As part of the economic justification, it should be determined whether the local agreement covering crane-operator requirements allows realization of full savings by having the person in charge of the load operate the crane.

Despite the problems, the modern radio-controlled crane is safe, efficient and cost effective.

VI. TOOL CONTROL

All Chief Mechanical Officers were requested to comment on the principal problem areas confronting them in the maintenance of their locomotive fleets. A summary of the replies of CMO's on twelve railroads on tool control is:

1. At what repair cost factor should a tool be replaced versus repaired?

2. Are air or electrical power tools the most economical?

3. Are railroads using modern tools to offset increased costs and improve productivity?

4. Productivity — what can be done to bring about a significant improvement?

5. Control of hand and power tool costs — tool rooms versus personal tool assignment. How to control Pilferage?

This committee feels that those questions raise complex issues. Our answers thus are speculative.

1. At what repair cost factor should a tool be replaced versus repaired?

This factor can only be approached through a tool maintenance program, which if simple and regular is a key to long service life and effective use.

Few power tools can maintain perfect efficiency indefinitely. Most maintenance supervisors and engineers agree that a tool operating at 90 percent of its rating is acceptable. When the tool begins to fall below that level, operating costs rise. Costs in terms of manpower also go up, adding to maintenance costs. Frequently, tools are still being used with efficiency as low as 30 percent. Unless they are repaired or replaced, the people using them have to work longer and harder to do their jobs. The result is reduced effectiveness of maintenance and a related incidence of major equipment failures when the equipment returns to the field.

A number of factors contribute to the reduction of tool efficiency, some of which are not directly attributable to the tool itself.

a. Underpowered for the job—the tool never develops the power or speed to come up to the job. This increases the wear and tear on the tool.

FIG. 33 — IMPACT WRENCHES

FIG. 36 — AIR ANGLE NUTSETTER

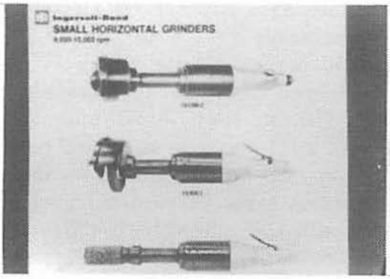


FIG. 34 — METAL GRINDERS

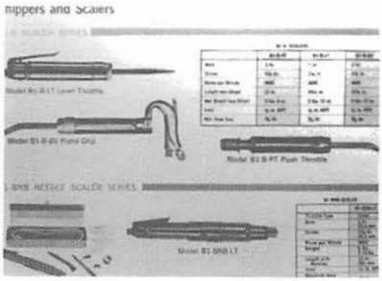


FIG. 37 — AIR CHIPPERS AND SCALERS

FIG. 35 — AIR GRINDERS

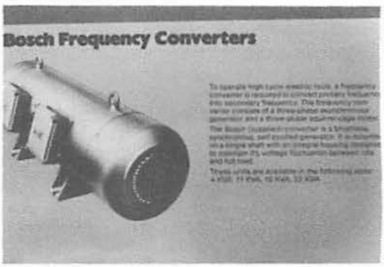


FIG. 38 — HIGH CYCLE CONVERTOR

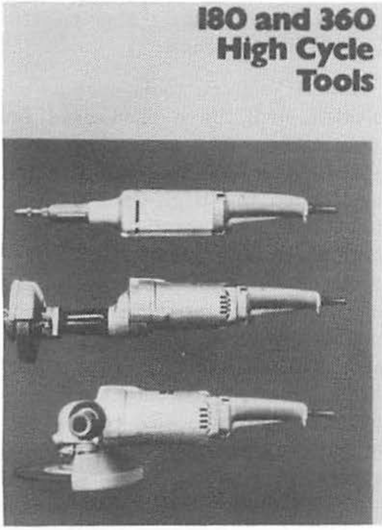


FIG. 39 — HIGH CYCLE GRINDERS

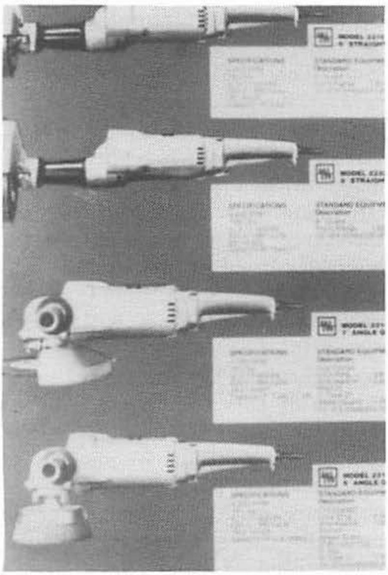


FIG. 40 — HIGH CYCLE GRINDERS AND SANDERS

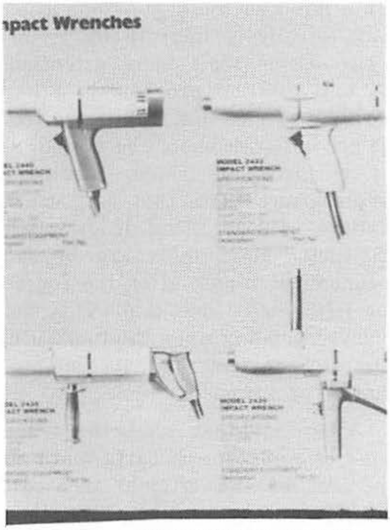


FIG. 41 — HIGH CYCLE IMPACT WRENCHES

b. Weight—the tool is too heavy for one-man operation and reduces his effectiveness.

c. Wear from use—lack of proper lubrication will reduce tool service life.

d. Lack of tool maintenance—this will be directly related to failure to lubricate and clean in accordance to manufacturer's instructions. In addition to wear and tear on the tool, continued operation can make it unsafe to use.

e. Obsolescence — superficially, it may seem to be economical to keep repairing and maintaining old power tools, but the replacement models usually have higher efficiency rates, meet current safety standards and reduce operator fatigue.

If your shop has just a few tools or a hundred tools, your operation can effectively improve by giving your power tools more attention. A tool rotation program is a key to long service life. While the tool is not in use, it should be thoroughly cleaned and tested; repair or replace any parts that may cause failure or substantial drops in efficiency. Most tools are beyond economical repair after the fourth or fifth major overhaul. This can vary depending upon the tool's use, its environment and its maintenance program.

A hard and fast rule is that when cost of replacement parts reach 50 percent of the original tool cost (add the cost of labor, downtime and further replacement costs) you will probably find the purchase of new equipment more efficient and economical.

2. Are air or electrical power tools the most economical? Let us see what each system has to offer.

The railroads for years have used air-operated tools to maintain locomotives, owing to the availability of compressed air. The pneumatic tool manufacturers have improved their tools by making them lighter, more efficient and very accurate.

There are small 25 ft-lb impact to 1500 ft-lb impacts; controlled torque wrenches; light, fast metal grinders; screwdrivers and nut setters; percussion tools, such as scalers, chipping hammers, and riveting hammers.

While these air tools were being refined, other types of tools have been developed also. One currently popular tool is the Tame electro-hydraulic wrenches.

The AC electric tools, such as the electric drill, have been used for small jobs. Now a new breed of electrical tool has been brought into use, called the High-Cycle electric tool. They are operated with small, high speed three phase 220 volt, 180 cycle or 360 cycle motors that are driven by non-wearing converter or motor generator sets. They have three times the power of an AC 60 cycle motor of equivalent size and weight. They are also comparable in weight and size to air tools of equivalent power.

With the energy crisis, the high-frequency tools are gaining favor because they do not need an air compressor system, just an MG set or a convertor plugged into 240 volt, 60 cycle three phase system. This MG or convertor increases the frequency from 60 cps to 150, 180, 200, 360, or 400 cps. The driving motor is a three phase motor with a squirrel cage rotor. By connecting the stator coils, to the three phase power supply, a magnetic field is created in the stator plates. This field has the property of rotating within the motor in accordance with the coil arrangement. The number of revolutions of this rotor field depends on the number of the stator poles and the operating frequency. If the smallest possible number of poles are used, a frequency of 60 cps will cause a rotary field or rotor speed of 3600 rpm, 180 cps will cause 10,800 rpm, and 360 cps, 21,600 rpm. The rotor drives a gear

train to give the desired tool operation.

The high-cycle tools most widely available are grinders and sanders (straight and angle), impact wrenches, screwdrivers and reamers.

There are advantages and disadvantages in the use of both the high-cycle and air-operated tools. Some advantages for the high-cycle tools are lower operating cost, less maintenance and lower parts replacement, less pilferage. The disadvantages are higher initial cost and restricted use because of the need for convertor or MG sets, they can only use the size of tools the convertor will take. On the other hand, air tools are lighter; there is a wider choice of types available for specific jobs; they have refinement in torque control; and the impact wrenches are more powerful. Their disadvantage is that the air supply has to be clean, dry and at a constant pressure in order to obtain good service life.

In conclusion, both systems can be used. However, in a major repair shop where air is available, air tools would be considered the most economical, owing to the wide range of air tools available for so many different jobs.

Where grinding or sanding is extensively done, a high-cycle tool could be the most economical. In a new installation where air is not available, high-cycle tools would be the most economical.

3. Are railroads using modern tools to offset increased costs and improve productivity?

In the last two years, this committee has described a great number of maintenance tools in use for locomotives by a good number of railroads. Some tools are the railroads' own innovations to increase productivity. Some are air-operated tools and some, electro-hydraulic tools. Although there are a number of productivity improving tools in use, they have to be incorporated into the work schedule and operated as intended by the manufacturer. Where the tool proves successful, in most cases it increases productivity as well as the service life of the equipment it is used on.

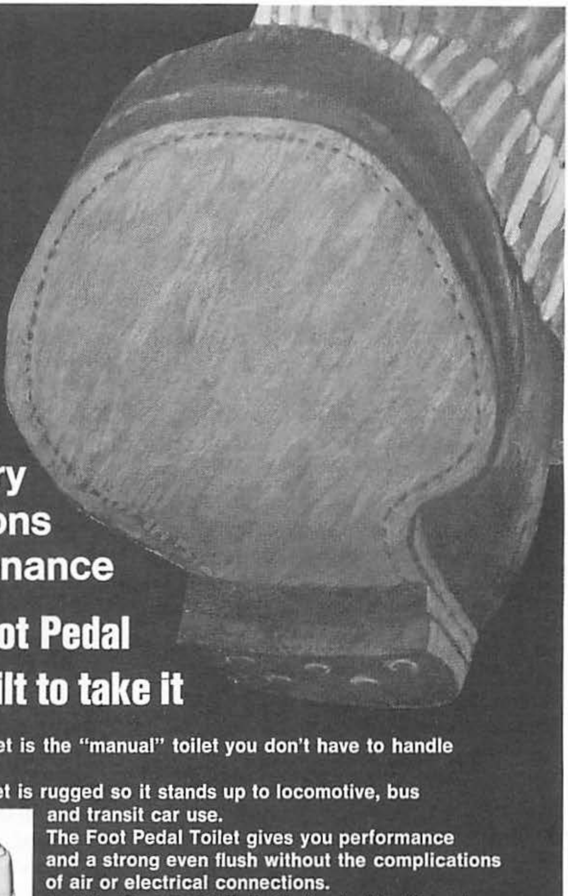
4. Productivity, what can be done to bring about significant improvement?

With the number of tools available today, increased productivity hinges on other factors. To identify those, we ask again, "What is productivity"? This question would seem, in the past to have been adequately answered as "a family of ratios of the quantity of output to the quantity of input." But productivity now must be really a system's concept, influenced by attitudes, actions, inactions and planning.

The Industrial Engineering Magazine said that productivity improvement doesn't just happen by "trying harder"; it must be planned.

The purpose of planning is to get better results in more effectively and efficiently achieving a goal.

Planning, as a goal-oriented process should have three stages:



1. Preparation.
2. Planning
3. Performance

The preparation stage provides the basis for planning and effective long-term performance. Here, principal goals and barriers to their achievement are determined. Human relationships are developed, and tentative alignments of key people are structured. Planning procedure is formulated to assure that the process of planning will be both effective and efficient.

The planning stage is the formulation of a plan of action based on analysis of available opportunities and options, focusing on objectives determined in this stage.

The performance stage provides evaluation and creative adaptation of the plan to reality. The planning activity of this stage determines the outcome of the plan.

The planning model encompasses an information system, without which all three stages of the planning process are jeopardized. Productive planning relies on the right information at the right place and at the right time. This implies not only an efficient selection and collection of the pertinent information, but also objective analysis of it and its prompt distribution or availability.

Each of the four components of the planning process make a distinct contribution to productivity. Yet it is the whole process that makes possible high productivity results.

To assure that planning is effective, however, the whole process must be highly participative. It is the proper involvement of people that converts the mechanics of planning into a living, productive process.

5. Control of hand and power tool costs—tool rooms vs. personal tool assignment. How do you control pilferage?

Tool control has many facets. They go from the old fashioned tool room checkout system to the personal tool assignments and to the automated control system of maintenance and renewal programs by the computer.

The old fashioned tool room checkout system still is practiced in some shops. However, it is subject to a high degree of pilferage and low control of maintenance.

The assigned tool to person system has the advantage of the tool being maintained, but use of the tool is not great while the number of tools needed is high.

Some shops paint their tools by colors and assign them to foremen of a particular section. Every week, the tools are turned into the tool crib for maintenance and overhaul or renewal. Pilferage declines; maintenance is good; and overall tool costs are down. Some foremen paint the cost of the tool on the tool to remind the user of the value of the equipment he is using in hopes of reducing rough handling or misuse of them.

General Electric has devised an Automatic Tool Control System for use in the Locomotive Department. Objectives of the system are:

1. Establish and maintain an accurate tool inventory record;
2. Establish a method for automatically ordering tools;
3. Provide an accurate record for tools being repaired;
4. Provide a record of tool chargeout;
5. Record maximum dollar allowance of tools charged to each employee;
6. Provide accurate records of tool usage;
7. Recall micrometers for calibration.

The intent is to limit tool expenses that occur when there are no accurate records and controls. A workman could charge out any amount of tools and keep them in his locker, thus making them unavailable to other employees on other shifts in an uncontrolled system.

The new system was designed for computer recording and processing on a daily basis, with reports generated for use in controlling tool expense and tool crib operation. Overdrawing of tools is noted for use by the foreman of the workman concerned. Special parts of the system deal with tools turned in and sent out for sharpening or repair, lost and broken tools, and those assigned to specific machines, rather than to individual workmen.

Annual operating cost of this system, providing the computer time is available, is about $1.00 per tool per year. This is less than one-half of the operating costs of the previous system, yet provides a much more rigorous system of control.

The new system has not been without growing pains. Making it work requires a high degree of discipline on the part of all concerned, especially the responsible foreman and the tool crib attendants.

In conclusion, there is no standard for tool control. Each railroad should analyze its system of tool use, maintenance and renewal methods. It is necessary to make sure that the new modern tools procured are incorporated into the locomotive maintenance program and used as designated by the manufacturer. If the use of such a tool increases productivity and increases the service life of the equipment it is used on and, if it withstands the rigors of rough use, then it is truly a new tool.

NOTES