

Cost and Technical Feasibility Study

**IDENTIFIED IMPROVEMENTS TO THE EQUIPMENT FLEET  
OF  
THE TAZARA RAILWAY**

Dar es Salaam Corridor Project (630-2040)

IQC No. OTR-0000-I-6071-00

Work Order No. 5

submitted to:

**U.S. Agency For International Development  
Washington, DC**

prepared by:

**Parsons Brinckerhoff International, Inc.  
New York, New York**

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NEW YORK, NEW YORK

Submitted By: J.F. Forman  
Date: May 1987

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## EXECUTIVE SUMMARY

The study effort was initially defined as a determination of technical cost feasibility of continuing the re-engining of additional Chinese manufactured locomotives from TAZARA's fleet. This determination was to include evaluating the alternative action of acquiring new replacement main-line locomotives. After starting the study, it was recognized that efforts should also be expended toward investigation of the underlying causes of low performance in workshops that contribute to low (unacceptable) levels of locomotive availability.

This report resulted from three weeks of study including two complete workshop tours at each of two locations and interviews with key TAZARA personnel, including discussions concerning evaluation and determination of TAZARA's actual needs.

The study findings indicate a definite need for providing additional new motive power to TAZARA. It also indicates that additional life is obtainable from the DFH2 Chinese-manufactured main-line locomotives through a continuation of the re-engining program. However, in addition, a very important effort is required for developing, implementing, and monitoring management control systems for TAZARA's depots and workshops' operations. This effort is in systems for controlling:

- Materials, spare parts availability
- Production
- Work -- planning and measurements
- Quality of all work within TAZARA

The study recommendations are to fund:

- Purchase of 14 new General Electric (GE) U30C locomotives
- Purchase of U30C spare parts, consumable parts, and special parts including those identified for 4-year overhaul of the 14 new U30C locomotives
- Purchase of 20 MTU diesel engines (waiver required)  
Note: A cost-effective and timely substitute diesel engine to use in place of the MTU German-manufactured engine is not obtainable from the USA. The quantity of 20 MTU or equivalent diesel engines must be funded by TAZARA or another donor.
- Purchase spares for Chinese locomotives from USA manufacturers working to original parts drawings
- Purchase spares for 13 KRUPP/GE U30 locomotives
- Purchase spares for 58 MTU diesel engines installed -- 2 per locomotive (waiver required)
- Provide technical assistance for development of management control systems for materials, production, work planning and quality
- Provide technical assistance at MBEYA repair shop for additional maintenance work training for GE U30C locomotives
- Provide technical assistance for reallocation of work in workshops

- Provide technical assistance at MPIKA to train personnel to perform the reallocated locomotive work. MPIKA workshops will specialize in maintenance of DFH2/H1 locomotives
- Provide technical assistance at DAR to train personnel to perform the reallocated wagon work; DAR workshops will specialize in wagons
- Purchase shop equipment as defined
- Provide technical assistance for improving wagon maintenance

COST SUMMARY

<u>Item</u>	<u>Estimated Costs</u> <u>(U.S. Dollars in 000's)</u>
14 General Electric U30C locomotives	18,900
Freight and insurance - locomotives	1,050
Spare parts (consumable/protective/capital)	2,300
Freight and insurance - spare parts	120
20 MTU Diesel Engines (Waiver Required)	2,400
Spares for Chinese DFH1, and DFH2 (USA)	1,500
Spares for 13 KRUPP/GE U30C (USA)	600
Freight and insurance -- China & Krupp spares	105
Spares for 58 MTU Diesel Engines (waiver required)	580
Technical assistance for Management Control Programs	900
Technical assistance for Heavy (4 year) overhauls KRUPP U30C - MBEYA	470
Technical assistance for new GE U30C locomotives - MBEYA	500
Technical assistance for Work Reallocation Program	200
Technical assistance for MPIKA Maintenance Training	250
Technical assistance for MBEYA Workshop Addition	200
Technical assistance for DAR Maintenance Training	500
Technical assistance for Additional Re-engining Program	500
Shop Equipment for MBEYA (incl. wheel true)	1,600
Shop Equipment for MPIKA	800
Shop Equipment for DAR	800
Monitoring and evaluation by regional U.S.A.I.D.	150
	<hr/>
Sub-Total	34,425
Contingency (10%)	3,500
Escalation	2,000
	<hr/>
TOTAL	39,925

## PREFACE

The Tanzania-Zambia Railway Authority has had the responsibility of operating the TAZARA railway for a period of 10 years and 9 months. The Authority accepted this responsibility the first day of July 1976 at which time the TAZARA railroad tractive power was dimensioned for a capacity of 2.0 million tons per year. This capacity was equated as a practical level of operation of 11 pairs of trains per day.

During the 10 years of operations, a number of changes to the original locomotive fleet have occurred. These changes resulted from:

- The locomotive repowering project which is 95 percent complete and consists of replacing the original diesel engine with a more efficient, reliable diesel engine on a quantity of 30 units (2 shunting, 28 main-line locomotives).
- The addition of a quantity of 14 diesel electric locomotives of a power rating 50 percent greater than original main-line equipment.
- The continuation of workshop practices that result in ineffective maintenance and deferred maintenance of the fleet.
- The reduction in quantity of locomotives due to damage by collisions, fire, and derailments.

The Southern African Development Coordination Conference (SADCC) requested the assistance of the U.S. Government to determine the cost and technical feasibility of pertinent improvements to the equipment fleet of the railway. This report is submitted to provide the specifics, the conclusions, and the recommendations that resulted from the study.

## INTRODUCTION

The primary study objective was to determine the technical cost feasibility of rehabilitating the power plant of some added portion of the existing Chinese-manufactured locomotive fleet. This was defined to include the evaluation of alternative actions of:

- acquiring new replacement main-line locomotives
- rehabilitating more of the existing Chinese-manufactured locomotives

This evaluation consists of comparative economics considering the remaining useful life of the existing locomotives and their inherent anticipated high recurrent yearly maintenance costs.

The study was also to include the evaluation of needs for other types of wagons and rolling stock, and the tools and spare parts required to maintain the locomotives and wagon fleet.

A study of this nature cannot be completed without determining the reasons for the low availability of existing locomotives and evaluating alternative methods of improving their performance. This effort necessitated visiting the TAZARA railway workshops and depots to observe the operations first hand. It also required extensive review and evaluation of TAZARA performance measurement reports and the supporting information for such reports, including interviews and meetings with TAZARA's key management personnel from all organizational levels up to and including the General Manager.

The original scope for the study identified the primary objectives, i.e., the technical cost feasibility of repowering an additional quantity of Chinese-manufactured locomotives, including an analysis of alternatives. The authorized additional scope includes reviews of workshop management performance and results.

## STUDY EFFORTS

The study to determine the feasibility of rehabilitating the power plant for some portion of the existing Chinese-manufactured main-line locomotives at this point (mid-April 1987) included an evaluation of events occurring since the beginning of TAZARA's 10-year development plan submitted in 1984.

The events include:

- Re-engining of an additional quantity of 8 main-line locomotives
- Availability of additional re-engined locomotive performance history
- Availability of additional diesel electric U30C locomotive performance history
- Conclusion of CPCS operating and staffing study
- Conclusion/final report of training program by KFW
- Additional skill training for workshop personnel

The re-engining efforts to date have resulted in completing 95 percent of the planned installation work. This provided a quantity of 26 main-line locomotives refitted with MTU diesel engines (2 per locomotive), however, the remaining Chinese-manufactured equipment on each locomotive was not replaced, only rehabilitated. Approximately one-half of the locomotives re-engined were fire damaged, collision damaged, or otherwise out of service (see Appendix C, Item 5, Equipment Conditions).

The re-engining work was performed starting in 1981 as follows:

	<u>Number of Main-Line Locomotives</u>	
1981	4	
1982	2	
1983	12	
1984	2	
1985	2	
1986	2	
1987	2	
1987	2	in process of re-engining -- scheduled for completion in mid-1987.

The three categories of main-line locomotives and the status as of April 15, 1987 is:

	<u>In Operation</u>	<u>Out of Service</u>	
	<u>April 15, 1987</u>	<u>Repairable</u>	<u>Scrap</u>
DFH2 China	30	11	-
DFH2 MTU	25	1	-
U30C KRUPP	<u>11</u>	<u>2</u>	<u>1</u>
	66	14	1

Note: The above quantities are from Mr. Mkamba PME TAZARA, confirmed by MTU and KRUPP representatives, also Chinese CME. See Appendix A, Item 6.

The phrase "in operation" from the preceding listing does not signify that the locomotives are available for daily train service. "Availability", is the true measure of readiness to haul freight or passenger trains. The difference between "in operation" quantity and an "availability" quantity would be locomotives undergoing scheduled maintenance, servicing, held in workshops for missing parts, wheel truing, and other maintenance delays.

In accordance with data contained in the report -- "Ten Years of TAZARA Operations" -- dated July 30, 1986, the availability of main-line locomotives was a quantity of 52 in 1977/78. This availability quantity decreased to 23 in 1981 and then increased to 37 in 1986. It would appear from the latter data that an availability improvement of 14 locomotives had occurred during the 5 year period, 1981 to 1986. However, in 1983/84 the KRUPP/GE U30Cs were introduced to TAZARA with a quantity of 14 new locomotives. Also, it appears that the availability of the Chinese DFH2 original and the DFH2/MTU re-engined locomotives DID NOT CHANGE FROM THE LOW OF 23 in 1981, since what looks to be an availability improvement of 14 was actually due to the addition of 14 new locomotives. This points out the vital need for action by TAZARA to improve the performance in workshops in order to raise the level and quality of locomotive maintenance and service work.

The quantity of locomotives required for the freight and passenger traffic expected in 1990 according to one consultant's report is estimated to be 45 to 49 locomotives available each day. The availability (percent) of locomotives for the 1985-1986 year as indicated in TAZARA's 10-year report is only 46 percent. With a continuation of 46 percent availability, TAZARA would need a total fleet of 106 main-line locomotives to meet the demand of 49 each day. The locomotive availability for TAZARA should be at least 70 percent to 80 percent, this would still allow for more than a reasonable out-of-service percentage.

From the preceding, one can conclude that the difficulty facing TAZARA today is not a lack of total main-line locomotives in their fleet, but the low availability of these locomotives.

Visits to the workshops, reviews of performance reports, and analysis of production information provides some answers to the question of "Why is availability so low?" Though TAZARA has many technically well-qualified people who possess a reasonable dedication to their work, the real production effort must come from the foremen, work leaders, artisans, fitters, electricians, and other employees whose timely and adequate work effort would complete the tasks on schedule.

Observations of workshop personnel during periods when shop effort would be at its greatest show less than 20 percent working. There appears to be no attempt on the part of TAZARA's supervisory staff to correct such idleness.

Also, the absence of effective controls for material availability, production, quality, and work planning result in further lowering workshop performance. Published reports resulting from such studies as CPCS and SIDA include statements regarding work performance as "acceptable." The definition of acceptable needs qualification.

## EQUIPMENT NEEDS

A number of forecasts of TAZARA's freight and passenger future requirements have been made. Variation between forecasts of freight demands range from 1.5 to 1.9 million freight tons for 1990/91, and 1.9 to 2.5 million freight tons for 1995/96. Forecasts of passenger traffic also vary considerably from an actual of 1.16 million passengers in 1985/86 to 1.5 million for 1990/91 and 1.7 million for 1995/96.

TAZARA's actual experience of freight traffic since operational take-over has been cyclic from a low of 952,000 tons in 1980/81 to the 1,273,000-ton high in the early period of 1977/78. During the last 3 years of the 10-year period, the freight has leveled out to just under 1.0 million ton per year. Upturns in demands are forecast by TAZARA as well as groups who have studied the growth patterns of Zambia and Tanzania. However, recent action to reopen the Benguela Railway in Angola (forecasted to be fully operational in 1989) could provide competition for freight haulage from Zambia's copper belt.

For the purposes of establishing parameters for this locomotive study the freight demand forecast is 1.9 million tons for 1990/91 and 2.5 million tons for 1995/96. Other parameters set for this study are as follows:

Maximum ton haulage per train	-	950 tons
Net tons per car (average)	-	33
Targeted locomotive availability	-	80 percent
Targeted wagon availability	-	70 percent

With a maximum load of 950 tons per train, the average load would be 600 to 700 tons, approximately say 650.

Number of trains per year	-	2,923
Number of trains per day	-	8 (4 trains each direction)

Actual main-line locomotive availability (see Appendix A, Item 2) during the six-month period preceding date of this report was as follows:

		<u>Tanzania Region</u>	<u>Zambia Region</u>	<u>Total TAZARA</u>
DFH2	-	33.5%	61.6%	47.6%
DFH2/MTU	-	61.6%	78.2%	69.9%
DE U30C	-	60.0%	86.9%	73.5%

Considering the freight system:

Parameters Between Points <u>Locomotive Type</u>	Main-Line Locomotive Change Points					
	<u>DAR</u> TO	<u>MLIMBA</u> TO	<u>MBEYA</u> TO	<u>CHOZI</u> TO	<u>MPIKA</u> TO	NKM
	DFH2/ MTU	DE	DE	DE	DFH2/ MTU	
Track Speed (potential) km/hr	60 to 70	40 to	60 60	70		
Actual Speed	40	33	40	40	40	
KM Distance	493	353	189	375	439	
Hours	13	11	5	10	11	
Number and Type of Locomotives Required	16 DFH2	8 DE	8 DE	8 DE	16 DFH2	

Summary of locomotive requirements:

For purposes of this evaluation, the use of diesel electric (DE) locomotive quantities and equivalent diesel electric (1 DE=2 DFH2) is used:

Type of Locomotive - DFH2 - Quantity 32 Equivalent	<u>All DE</u>
Type of Locomotive - DE - Quantity 8 Equivalent	16 (2 DFH2 = 1 DE)
	<u>8</u>
	24 Total DES

Considering availability:

Need 24 with 70 percent availability = total 34 DES  
 Less current DES 11 (plus 2 repairable making total of 13)  
 23 equivalent of 46 DFH2

Using the above method of analysis:

Main-line locomotive needs 1987 - 1991 =	<u>DE or Equivalent</u>
	34
1992 - 1996 =	45

The present fleet is as follows:

	<u>Fleet Quantity</u>	<u>Percent of Availability</u>	<u>Service Quantity</u>	<u>DE/ Equivalent</u>
DFH2	30	47	14	7
DFH2/MTU	25	70	18	9
DE	<u>11*</u>	74	<u>8</u>	<u>8</u>
	66		40	24

\* Does not include a quantity of 2 U30Cs which have been deemed repairable but will most likely not be operational until 1988.

Theoretically, the present fleet size should be sufficient for 1987 freight haulage requirements. With anticipated increases in haulage requirements to 1990/91, the increase in fleet size would be equivalent to 14 DE locomotives. With anticipated increases in haulage requirements to 1995/96, the increase in fleet size would be equivalent to an additional 14 DE locomotives.

The life expectancy of the re-engined DFH2 main-line locomotives is estimated to be 10 years from the date of engine change-out, provided that full attention is given to rehabilitation of such major items as transmission, compressor and engine cooling system. This estimate is based on maintenance records, inspections and general observations of the equipment in present condition.

If TAZARA's top management would focus their interest and attention on performance of workshops to improve the maintenance practices, approximately 20 percent of the calculated increases in fleet size could be made up with increases in availability of DFH2 units as well as improved availability of DFH2/MTU and DE units. Additional increases in availability could also be realized through reallocation of work by workshop and additional re-engining.

Twelve new DFH2 locomotives were added to TAZARA in late 1979. It is reported that 10 of the 12 units are still operational. It is recommended that these 10 main line locomotives be re-engined as soon as practical. To maintain an acceptable level of maintenance performance, MTU engines must be used for repowering. Use of MTU's will avoid the addition of another manufacturer's engine and completely different sets of spare parts, consumable parts, and capital spares.

A quantity of 14 new DE locomotives should be added.

With these additions, the fleet by mid-1988 would be:

DFH2/MTU	35
DE	<u>25</u>
	60

Note: This does not allow for catastrophic accidents that could result in locomotives that are not repairable.

After re-engining the additional 10 DFH2 locomotives, the balance of operational DFH2 units should be assigned to shunting/yard duty. Non-operational DFH2 units should be used as a source of spare parts to keep the DFH2/MTU units operational.

Considering the forecasts of freight and passenger loads and the "state" of TAZARA's existing fleet, there is no question that the motive power availability must be increased. The alternatives for increasing the fleet are to add new locomotives, increase the number of re-engined Chinese-built DFH2 units, or a combination thereof. Doing nothing would certainly not be beneficial.

The life expectancy based on history of the DFH2 locomotive is very low (1 to 2 years) if used in 2 percent grade and high (900) tonnage. The designers and manufacturers have stated that their locomotives are severely underdesigned. The life of DFH2 locomotives can be extended for an additional 10 years through re-engining and provision of necessary maintenance!

## SUPPORT ACTIVITIES - TAZARA

Increases in motive power through addition of new diesel electrics and additional re-engining of selected (operational) Chinese DFH2 locomotives will reduce some short-range problems TAZARA will experience with the increase in freight and passenger traffic demands. However, without direct attention to some of the underlying causes of low availability of main-line locomotives, the unacceptable current performance in workshops/depots will continue and availability will remain low.

Observations, discussions, and analyses of regional performance reports all lead to the conclusion that deficiencies exist in management control systems. Many of the known deficiencies are correctable -- directly by action internal to TAZARA. Some of the observations in workshop areas include:

- Work sampling of personnel in all shops and laboratories in DAR ES SALAAM and MBEYA indicate less than 20 percent working.
- Supervisory/management personnel take little or no action with non-working employees to assure that the employee has a work assignment and material, tools, and equipment to perform the work.
- Disarray of material in storage areas including records that show no reordering of items that are depleted from stock, but still have requirements for future use.
- Unacceptable shop areas: disorderly work stations with unsafe scaffolding, oil (heavy-greasy) on floors, and general work arrangements not conducive to efficient performance.

Some of the material shortages reported in weekly production meetings and included in performance reports are:

- Lack of locomotive batteries causing out of service locomotives.
- Lack of sulphuric acid delaying locomotive work and return to service
- No emery cloth
- No transmission spares, reusing worn parts resulting in additional failures
- Steel stock material shortages
- No welding rod (3.2mm electrodes)
- No acetylene, kerosene
- No hard timber

Discussions with TAZARA key management and supervisory people invariably result in their suggesting numerous reasons (excuses) for work not being

completed as scheduled. Such explanations as -- "lack of shop supplies, spare parts, or good consumable replacement parts (such as correct gaskets)" -- result in unacceptable workmanship leading to low availability of locomotives.

Shop supply items such as welding rod, various sizes of steel, emery cloth, and acetylene are usually available locally. A method of funding application of TAZARA's local currency for the purchase of such items would reduce the time in performing the workshop tasks held up for lack of shop supply items. The importance of having a "petty cash" voucher routine available is measurable by the days of delay in completing maintenance tasks caused by lack of shop supply items.

A majority of the above problems could be corrected with an effective program of supporting activities conducted by TAZARA. Such support activities are deemed necessary in order for the Tanzania-Zambia Railroad Authority to execute its duties in a cost-effective manner.

The workshops and depot supporting activities vital to the success of projects dedicated to improving availability of locomotives for haulage of freight and passengers are:

- o Management control activities--development and implementation of systems to formally establish control of:
  - material and spare parts availability
  - stock control--bin reserve and A.B.C. stock control system
  - storage security procedures
  - advance order routines
  - material/work expediting
  - production scheduling
  - production reporting
  - work standards
  - work planning
  - work measurement
  - work incentives
  - performance measurements
  - quality measurements
  - effective inspections of material and work
  - quality documentation
  - employee awareness of his responsibility
  - employee awareness of his contribution
  - employee morale -- attitude

TAZARA has the capability and knowledge to correct many of the deficiencies in their present management controls; some forms of control systems are already in place. However, many inconsistencies exist from workshop to workshop. To develop their basic existing management controls, TAZARA will need direction, professional guidance, and assistance to develop and implement improved control systems, along with subsequent monitoring.

The work of developing and implementing the control systems is extremely important to the continued improvements of TAZARA's operations. To assure effective action in launching a new start on systems control, it is proposed that technical, professional assistance be provided to TAZARA. Two people

would be required to review present controls, determine the need and type of controls to best fit TAZARA's operation, and to develop needed control procedures and aid in their implementation. The first person must be qualified specialist on material and production controls. The second person should be knowledgeable about work planning, measurement and quality control.

The estimated time for conducting such an effort, including assisting in implementation and initial monitoring, is three months for each specialist -- with a start-up time for each of an additional month.

The overall management control effort will require a professional to overview the materials, production, work planning, and quality systems development. The time period for short-term systems development and implementation is estimated at six months. An individual in this capacity would also coordinate the control systems and assure the compatibility and necessary degree of consistency from workshop to workshop. The management control specialist will need access to the General Manager's office with a reporting relationship to TAZARA's Deputy General Manager.

The improvements to be gained in developing and implementing management control systems covering the four major control areas will not be obtainable unless a long-term effort is applied to training, follow-up, and monitoring of adherence to procedures. The short-term effort of three professional specialists is estimated to take a period of four to six months as described above. This effort will allow for the development of basic procedures, instruction documentation, and initial training and monitoring. Such effort will be effective only as long as the monitoring continues.

To assure long-lasting effectiveness, it is recommended that the technical assistance be continued for a total period of 3 years. Continued technical assistance would be provided by the management control specialist who overviewed the initial systems development. The management control specialist would assist TAZARA in their efforts to improve, modify, implement, and train for continued effectiveness of control systems. These efforts would be applied in the three major workshops -- DAR, MBEYA, and MPIKA -- as well as all the depot locations.

TAZARA personnel have operated for years with little or no effort to apply control procedures. With such operations, people develop ineffective habits that will be resorted to again if the adherence to procedures is not monitored and maintained. Railway personnel at all levels must not be allowed to give excuses for not meeting schedule requirements. They must be trained to develop and use initiative to meet the day-to-day, week-to-week challenges inherent in running a railroad.

Each of the major control areas -- materials, production, work planning and quality -- will require long-term efforts. However, the control of quality will most likely require the greatest effort. At present, there is virtually no quality assurance or control system. To reach the point where TAZARA people will follow quality procedures by force of habit will require continued effort. TAZARA management and supervisory personnel must be trained to be quality minded.

## Summary

Control systems development, implementation, and monitoring is vital to any plan to improve and increase the motive power in TAZARA's operations. If this important element is not carried out successfully with total support from TAZARA's management at all levels, the funding of new locomotives, spare parts, shop equipment and technical assistance should be held up. The addition of new locomotives, equipment, and parts will not have a lasting effect on improved operations unless their use is controlled effectively.

### Costs - funding requirements (estimated)

#### Initial Program

o Railroad management control specialist

Six man months	-	\$ 105,000	USD		
Direct expenses	-	<u>\$ 20,000</u>	USD		
				\$ 125,000	USD

o Materials/production system specialist

Four man months	-	\$ 58,000	USD		
Direct expenses	-	<u>\$ 15,000</u>	USD		
				\$ 73,000	USD

o Work Planning/quality systems specialist

Four man months	-	\$ 58,000	USD		
Direct expenses	-	<u>\$ 15,000</u>	USD		
				\$ 73,000	USD

#### Long-term assistance in monitoring and training

o Management control specialist

Thirty man-months	-	\$ 525,000	USD		
Direct expenses	-	<u>\$ 100,000</u>	USD		
				\$ 625,000	USD

o Total Cost Estimate

\$ 125,000	USD		
\$ 73,000	USD		
\$ 73,000	USD		
\$ 625,000	USD		
		<u>\$ 896,000</u>	
<u>\$ 900,000</u>	USD		

## EQUIPMENT RECOMMENDATIONS

After giving due consideration to TAZARA's present operations, forecasts of increased haulage, performance, and efforts to improve the overall operation, the recommendation is for:

- Purchase of 14 diesel electric locomotives, including
  - consumable spare parts
  - protective spare parts with sufficient quantity/type for the 4-year overhaul of each locomotive
  - capital spare parts
- Purchase spare parts for existing quantity of 13 GE/KRUPP U30C locomotives as per list in Appendix D, Item 1d
- Purchase 20 MTU diesel engines for repowering 10 DFH2 selected units (waiver required)
- Purchase spare parts for MTU diesel engines as listed in Appendix D, Item 1c (waiver required)
- Purchase spare parts for DFH2 locomotives from sources in USA; have parts manufactured per drawings provided by TAZARA at quantities shown in Appendix D, Items 1a and 1b
- Purchase workshop equipment listed in Appendix D, Items 2b and 2c

Efforts were made during the study to identify potentially suitable diesel engines manufactured in the United States for re-engining the DFH2 locomotives. Information concerning engine size, mounting and characteristics were obtained from four interested manufacturers (see Appendix A, Item 4). Each of the four diesel engines offered can possibly be used, but each would require either considerable modification for mounting, a change from the existing transmission, change of engine cooling arrangement, and/or fuel/oil piping. Also, the introduction of another type/manufacturer engine would require a prototype phase in the re-engining time cycle. This could add as much as 1- $\frac{1}{2}$  to 2 years to the overall re-engining time. The additional costs and increased time make an engine change not feasible.

The application of the MTU engine has proven successful in all respects -- that is -- fit, mounting, transmission line-up, cooling arrangement, and above all actual operation on the railroad. To date, the MTU-powered locomotives have accumulated over 290,000 running hours with acceptable performance. Based on the above, the application of another manufacturer's engine is not recommended.

## JUSTIFICATION OF PROPOSED PLAN

In each of the preceding sections of this report, the alternatives for increasing the motive power have been explored and analyzed. The addition of new locomotives is an absolute necessity if TAZARA is to meet its forecasted haulage requirements. The two-direction approach -- adding new locomotives and re-engining additional Chinese DFH2 -- is the only technical and cost-feasible action to meet the program objective.

### Addition of New Locomotives

The U30C KRUPP/GE locomotives have been in service for approximately 3-½ years. The operation of these locomotives in TAZARA service, particularly in the 2 percent grade sections, has been acceptable. The information in Appendix C, Item 1 -- both the brochure and the characteristic curves-show that the locomotive is an excellent fit for the services required in TAZARA's railway system. A change in equipment at this point would add difficulties to the operation in both the driving part as well as the maintenance and particularly in the spare parts and material items. Maintenance practices for the U30C units are known by the MBEYA shop personnel; to add locomotives of a different manufacturer would compound the maintenance problems. Note also the low defect rate of U30C units as shown in "summary of defects" included in Appendix C, Item 2.

### Re-engining of Additional Chinese Locomotives

In 1979, 12 new DFH2 Chinese-manufactured locomotives were delivered to TAZARA. Of these, 10 are operational as of the study date. These locomotives should be re-engined with the same diesel engine used in the re-engining program started in 1981. The re-engining program has proven that life of DFH2 locomotives can be extended for an estimated 10 years. To do nothing in upgrading these 10 locomotives would not aid TAZARA in increasing motive power. To upgrade these locomotives with an engine different than the existing 30 re-engined units would compound TAZARA's maintenance problems and double the spare parts stocking requirements.

## WORK REALLOCATION BY WORKSHOP

Numerous documents concerning TAZARA's production plans, annual maintenance and repair plan, performance reports, locomotive repair records, equipment performance reports, fuel consumption/oil consumption records, and defect summaries by locomotive have been reviewed and analyzed during the study effort (See Appendix C Items 2 thru 6). Interviews with key managers listed in Appendix G, such as the Chief Mechanical Engineer and certain members of his staff, have provided descriptions of work/performance patterns. The conclusions drawn from this information and interviews clearly indicate that currently the MPIKA workshops are better managed, better staffed, and more productive than DAR ES SALAAM workshops. MPIKA represents greater existing capacity, greater output per employee, greater output per square meter, and a lesser capacity-development requirement to raise performances to totally acceptable levels. For these reasons, all DFH1 and DFH1/MTU, DFH2, and DFH2/MTU locomotives light and heavy maintenance repair work should be reallocated; that is, assigned exclusively to MPIKA workshops.

The MBEYA locomotive repair shop performance equates to a level or levels above the DAR ES SALAAM work accomplishments. Tours of the MBEYA facility and discussions with the District Mechanical Engineer and his staff point to a greater interest by MBEYA employees in their work, inquisitive attitudes on ways to improve, and work ethics conforming closer to acceptable standards of workshop conduct.

The MBEYA facility was designed and built to provide for the light maintenance and repair work required on locomotives. MBEYA currently is the diesel electric locomotive shop. The 21-meter by 54-meter (1,134 square meters) light-repair shop is not sufficiently large to adequately perform both light- and heavy repair maintenance work on diesel electric locomotives. Heavy-repair work at MBEYA would require expansion of the repair shop to provide capacity for both light- and heavy-repair work. Considerable land area for such expansion is readily available at MBEYA (see Appendix F, Item 2), including area for the addition of a parts and material storage building for diesel electric equipment.

The expansion of the MBEYA repair shop would consist of a locomotive heavy-repair (maintenance) shop addition 27 meters by 54 meters (1,458 square meters) with three run-through tracks, each track having an underfloor pit arrangement similar to the existing facility. This addition would be made adjacent to the north wall of the present light-repair shop. The heavy-repair shop would be serviced with a 30 ton capacity bridge crane for removal and replacement of major components.

Adjacent to the north wall of the new heavy repair shop will be another addition of 24 meters by 54 meters (1,296 square meters) for parts and material storage and for the demonstration building. The 1,100 square meters on the east end of the addition is for the designated parts and material storage area, and the remaining area would be partitioned-off for a demonstration room.

It is strongly recommended that these repair-shop additions be constructed at MBEYA. The TAZARA management has advised that the new budget currently being established contains local funds for such construction (See Appendix F, Item 4).

The expansion of the MBEYA workshops will require the addition of locomotive maintenance personnel to handle all levels of maintenance including service for the following time periods:

One Month	One Year	Eight Years
Three Months	Two Years	Unscheduled/Casual Repairs
Six Months	Four Years	

Since the introduction to TAZARA of diesel electric (DE) locomotives, all DE maintenance work has been performed in the MBEYA repair shop. The KRUPP/GE maintenance engineer has provided engineering service and on-the-job training at MBEYA. Though proficiency is not at the level of fully trained, competent locomotive maintenance men, the engineers, technicians, and artisans currently at MBEYA are the only TAZARA personnel that have received training on DE maintenance and operation. This cadre of partially trained, experienced people will provide the nucleus for the DE maintenance work force required for the 4-year heavy repair of KRUPP U30C locomotives, as well as all levels of maintenance and rebuild for the entire twenty-seven (27) locomotive fleet of U30Cs that will exist with the addition of 14 GE U30C units in 1988.

Though the mobility of qualified staff personnel is heavily influenced by TAZARA's national quota system -- and lower levels of supervisory, technical, foreman and workshop personnel tend to resist assignments in the other country, the MBEYA location staffing for diesel electric locomotives should be the least difficult in the entire TAZARA system. Since MBEYA is close to the ZAMBIA-TANZANIA border (120 km), the reluctance of Zambians to move to MBEYA and the reluctance of Tanzanians to move to MBEYA should be minimal.

With the diesel electric locomotive fleet assigned to MBEYA and the DFH1/MTU, DFH2, DFH2/MTU locomotives assigned to MPIKA, the workshops at DAR ES SALAAM would be clear to specialize in wagon maintenance, repair, and rebuild. The wagon work requires less mechanical/electrical/electronics skill than locomotive work which provides an effective match to DAR's current workforce qualifications. The machine shops, forge shop and casting facility along with the furniture wood-working capability would continue to function and possibly increase production volume to serve TAZARA as well as outside business requirements.

#### Summary

The work reallocation described above would improve the overall proficiency and utilization of TAZARA's three major work/repair shop complexes by making best use of personnel trained to-date, their work habits, and attitudes. The reallocation also aligns the work location with the locomotive/wagon use location. It eliminates the dispatching of empty wagons to MPIKA just to provide a workload for the MPIKA wagon shop (as has been done frequently).

The construction of two additions to the MBEYA light-repair shop appears to be an acceptable investment for TAZARA funds and provides the expanded capacity required to handle the heavy maintenance of U30Cs as well as the larger fleet of U30Cs.

The assignment of all U30C maintenance work to MBEYA requires certain additional equipment, such as a large-capacity crane and an additional set of screw jacks. The costs for the added equipment would most likely be required at MPIKA if the U30C center were located there.

The program of training, as documented in the final report dated November 1986 and submitted to KFW, will require certain modifications. The plan currently calls for training modules 1-12 at MBEYA and modules 1-20 at MPIKA. The advanced modules 13-20 include curricula for training in such work as advanced DE electrical components; woodward governors; and the 24-, 48-, and 96-month scheduled service for diesel electrics. The advanced module training should be transferred to the MBEYA curricula.

Estimates of added facility and equipment costs are included in Appendix F, Items 4 and 5.

ESTIMATED COSTS

The costs for the identified quantities of recommended new locomotives and spare parts are as follows:

	<u>U.S. Dollars</u>	
Locomotives		
Quotation dated May 5, 1987		
from General Electric		
- Price of U30C locomotive	\$ 1,350,000	each
(see Appendix E, Item 1, Page 1)		
- Allowance for insurance/shipping	<u>75,000</u>	each
Price Each	\$ 1,425,000	delivered
- Total Estimated Price for 14 --	<u>\$ 19,950,000</u>	
Spare parts for new U30C locomotives		
- Consumable spare parts for 14 units	\$ 432,000	
(see Appendix E, Item 1, Page 2)		
- Protective/maintenance spare parts		
For Diesel Engines (14 units)	880,000	
For Mech/Elect Equipment	547,000	
For Governors	10,000	
(see Appendix E for spare parts lists)		
- Capital Spare parts	432,000	
(see Appendix E for list)		
- Allowance for Insurance/Shipping	<u>120,000</u>	
- Total Estimated Price for U30C Spare parts	<u>\$ 2,420,000</u>	
Parts for Existing TAZARA locomotives		
- Quotation from MTU-Meinhardt		
Quantity of 20 diesel engines	\$ 2,400,000	
(see Appendix E, Item 2)		
- Estimated price for DFH1/DFH2 Spare parts	1,500,000	
(see Appendix D, Items 1a, 1b and 1c)		
- Estimated price for Krupp Spare parts	600,000	
(see Appendix D, Item 1d and Appendix E, Item 3)		
- Allowance for freight and insurance covering the Krupp and DFH1/DFH2 Spare parts	105,000	
- Estimated price for spare parts for quantity of 58 MTU diesel engines including freight and insurance	580,000	
- Total estimated price for spare parts covering existing TAZARA locomotives	<u>\$ 5,185,000</u>	

The costs for technical assistance recommended for TAZARA management control programs, work reallocation program and maintenance training programs are as follows:

Technical Assistance for Management Control Program  
(see Section entitled support Activities - TAZARA herein)

Initial Program

-	Railroad management control specialist			
	Six man months	-	\$ 105,000	USD
	Direct expenses	-	<u>\$ 20,000</u>	USD
				\$ 125,000 USD
-	Materials/production system specialist			
	Four man months	-	\$ 58,000	USD
	Direct expenses	-	<u>\$ 15,000</u>	USD
				\$ 73,000 USD
-	Work Planning/quality systems specialist			
	Four man months	-	\$ 58,000	USD
	Direct expenses	-	<u>\$ 15,000</u>	USD
				\$ 73,000 USD

Long-term assistance in monitoring and training

-	Management control specialist			
	Thirty man-months	-	\$ 525,000	USD
	Direct expenses	-	<u>\$ 100,000</u>	USD
				\$ 625,000 USD

Total Cost Estimate

\$ 125,000	USD
\$ 73,000	USD
\$ 73,000	USD
<u>\$ 625,000</u>	USD
\$ 896,000	
<u>\$ 900,000</u>	USD

Technical Assistance for Krupp U30C Overhauls

Quotation dated May 5, 1987 from General Electric includes information on price for extended services of Mr. H. Anton (KRUPP) to provide technical support and training for KRUPP U30C overhaul work. The extended time required is estimated to be two years.

Total Estimated Price \$ 470,000

Technical Assistance for New GE U30C Locomotives

Quotation dated May 5, 1987 from General Electric includes information price for service engineer. The estimated time for technical assistance on new GE U30C locomotives is two years.

Total Estimated Price \$ 500,000

Technical Assistance for Work Reallocation Program

The reallocation of work between MPIKA, DAR and MBEYA will require the services of a maintenance shop specialist for an estimated period of nine months. Using the previously quoted prices for such services, the price for this technical assistance is:

Total Estimated Price \$ 200,000

Technical assistance for MPIKA workshop for maintenance training to improve performance of locomotive maintenance work. Using the previously quoted price for such services (one year period), price for this technical assistance is:

Total Estimated Price \$ 250,000

Technical assistance for MBEYA workshop expansion. Technical services for approximately nine months.

Total Estimated Price \$ 200,000

Technical assistance for DAR maintenance training on all wagons. Estimated time period one year with two wagon maintenance specialists.

Total Estimated Price \$ 500,000

Technical assistance for covering the re-engining of the additional quantity or 10 DFH2 locomotives. Using the previously quoted price for such services (two year period), the price for this technical assistance is:

Total Estimated Price \$ 500,000

Total Estimated Price for technical assistance \$3,520,000

The costs for shop equipment recommended to be funded as result of this study, including equipment for all three workshops MPIKA, MBEYA and DAR are as follows:

Equipment for MBEYA workshop as listed and cost estimated in Appendix D Item 2b (including wheel truing machine)	\$1,600,000
Equipment for MPIKA workshop (Appendix D, Item 2)	800,000
Equipment for DAR workshop (Appendix D, Item 2a)	<u>800,000</u>
Total Estimated Price (including freight and insurance)	<u><u>\$3,200,000</u></u>

The overall program for increasing and improving the motive power of the TAZARA Railway will require monitoring and evaluation over a three year period. The overseeing of program progress and measuring against planned action should be performed by a regional U.S.A.I.D. representative.

Total Price Estimated	<u><u>\$ 150,000</u></u>
-----------------------	--------------------------

The total estimated costs for locomotive equipment, spares, technical services, shop equipment and program monitoring is as follows:

	<u>USD</u>
New Locomotives U30C	\$ 19,950,000
Spares for new locomotives	2,420,000
Parts for existing locomotives	5,185,000
Technical assistance	3,520,000
Shop equipment additions	3,200,000
Monitoring	<u>150,000</u>
Sub-Total	\$ 34,425,000
Contingency 10%	3,500,000
Escalation	<u>2,000,000</u>
Total	<u><u>\$ 39,925,000</u></u>

## APPENDICES

### Appendix A

#### Item

- 1 - Locomotive Availability Chart
- 2 - Availability by Type and Region
- 3 - Locomotive Usage by Type
- 4 - Alternative Diesel Engines
- 5 - Condensed Railway Diagram
- 6 - Locomotive Status per TAZARA Performance Report (April 13, 1987)

### Appendix B

#### Item

- 1 - Material Control
- 2 - Production Control
- 3 - Work Planning
- 4 - Quality Control
- 5 - Management/Supervisory Control

### Appendix C

#### Item

- 1 - GE/KRUPP U30C Locomotive Application
- 2 - Summary of Defects
- 3 - Maintenance Plans
- 4 - Performance Reports (Tanzania and Zambia)
- 5 - Equipment Conditions
- 6 - Fuel and Oil Consumption

### Appendix D

#### Item

- 1 - Locomotive Parts Requirements
  - a - DFH1 Chinese
  - b - DFH2 Chinese
  - c - DFH2 MTU
  - d - KRUPP U30C
  - e - GE U30C
- 2 - Workshop Equipment Requirements
  - a - DAR ES SALAAM
  - b - MBEYA
  - c - MPIKA
- 3 - Maintenance Scheduled
  - a - DFH2
  - b - DFH2/MTU
  - c - U30C

### Appendix E

#### Item

- 1 - Quotation GE U30C
- 2 - Quotation MTU
- 3 - Quotation/Cost Estimates Spare Parts
- 4 - Annual Maintenance Costs (Estimated)

Appendix F

Item

- 1 - Work Reallocation by Workshop
- 2 - Workshop Layouts
- 3 - MBEYA Personnel Training
- 4 - Added Facility Costs
- 5 - Added Equipment Costs

Appendix G

Item

- 1 - Selected List of TAZARA Key Personnel Interviewed for Background
- 2 - List of U.S.A.I.D. and Equipment Supplier Representatives Interviewed
- 3 - List of Information Source Documents

TANZANIA ZAMBIA RAILWAY AUTHORITY

MOTIVE POWER AVAILABILITY FOR THE YEAR 1985-1986

MONTH	TANZANIA REGION								ZAMBIA REGION							
	TOTAL LOCOS DAYS ALLOCATED				PERCENTAGE LOCO AVAILABILITY				TOTAL LOCOS DAYS ALLOCATED				PERCENTAGE LOCO AVAILABILITY			
	U30C	REPWD	DFH <sub>2</sub>	DFH <sub>1</sub>	U30C	REPWD	DFH <sub>2</sub>	DFH <sub>1</sub>	U30C	REPWD	DFH <sub>2</sub>	DFH <sub>1</sub>	U30C	REPWD	DFH <sub>2</sub>	DFH <sub>1</sub>
July 1985	217	310	868	310	70.8	49.6	36.9	63.2	217	310	558	155	61.9	70.4	28.5	75.5
August	217	310	868	310	71.9	53.2	39.2	67.1	217	310	558	155	65.1	58.9	27.8	82.1
September	210	310	840	300	63.5	45.5	38.0	72.7	210	300	540	150	55.4	74.7	36.8	65.4
<b>Quarterly Total</b>	<b>644</b>	<b>920</b>	<b>2576</b>	<b>920</b>	<b>68.7</b>	<b>49.4</b>	<b>38.0</b>	<b>67.7</b>	<b>644</b>	<b>920</b>	<b>1656</b>	<b>460</b>	<b>60.8</b>	<b>68.0</b>	<b>31.0</b>	<b>74.3</b>
October	217	310	868	310	55.5	65.2	35.9	70.3	217	310	558	155	42.0	68.1	28.8	66.1
November	210	318	822	300	75.7	62.3	33.6	65.8	210	300	540	150	44.1	60.4	35.9	74.5
December	217	341	837	310	73.1	73.8	33.2	70.0	217	341	527	155	50.2	62.5	30.7	73.2
<b>Quarterly Total</b>	<b>644</b>	<b>969</b>	<b>2527</b>	<b>920</b>	<b>68.1</b>	<b>67.1</b>	<b>34.2</b>	<b>68.7</b>	<b>644</b>	<b>951</b>	<b>1625</b>	<b>460</b>	<b>45.4</b>	<b>63.7</b>	<b>31.8</b>	<b>71.4</b>
<b>Half Yearly Total</b>	<b>1288</b>	<b>1889</b>	<b>5103</b>	<b>1840</b>	<b>68.4</b>	<b>58.3</b>	<b>36.1</b>	<b>68.2</b>	<b>1288</b>	<b>1871</b>	<b>3281</b>	<b>920</b>	<b>53.1</b>	<b>65.4</b>	<b>31.4</b>	<b>72.9</b>
January 1986	217	341	837	310	58.3	65.9	35.8	73.8	217	341	527	155	48.6	43.3	34.8	76.8
February	196	308	756	280	67.6	63.1	30.7	68.5	196	308	476	140	52.4	55.1	32.4	60.0
March	217	341	837	310	62.9	50.8	28.1	44.4	217	341	527	155	65.3	55.6	39.3	82.2
<b>Quarterly Total</b>	<b>630</b>	<b>990</b>	<b>2430</b>	<b>900</b>	<b>62.9</b>	<b>59.9</b>	<b>31.5</b>	<b>62.2</b>	<b>630</b>	<b>990</b>	<b>1530</b>	<b>450</b>	<b>55.4</b>	<b>51.3</b>	<b>35.5</b>	<b>73.0</b>

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TANZANIA ZAMBIA RAILWAY AUTHORITY

MOTIVE POWER AVAILABILITY FOR THE YEAR 1985-1986  
(Continued)

MONTH	TANZANIA REGION								ZAMBIA REGION							
	TOTAL LOCOS DAYS ALLOCATED				PERCENTAGE LOCO AVAILABILITY				TOTAL LOCOS DAYS ALLOCATED				PERCENTAGE LOCO AVAILABILITY			
	U30C	REPWD	DFH <sub>2</sub>	DFH <sub>1</sub>	U30C	REPWD	DFH <sub>2</sub>	DFH <sub>1</sub>	U30C	REPWD	DFH <sub>2</sub>	DFH <sub>1</sub>	U30C	REPWD	DFH <sub>2</sub>	DFH <sub>1</sub>
April	210	360	780	300	69.0	61.4	34.8	58.9	210	353	510	150	69.0	62.0	41.2	91.2
May	217	372	806	310	67.6	53.0	25.1	54.6	217	372	496	155	68.8	60.7	42.4	87.2
June	210	360	780	300	67.0	52.1	36.2	52.8	210	360	480	150	58.9	62.4	37.7	78.4
<b>Quarterly Total</b>	637	1092	2366	910	67.9	55.5	32.0	55.4	637	1085	1486	455	65.6	61.7	40.4	85.6
<b>Half Yearly Total</b>	1267	2082	4796	1810	65.4	57.7	31.8	58.8	1267	2075	3016	905	60.5	56.5	38.0	79.3
<b>Yearly Totals</b>	2555	3971	9899	3650	66.9	58.0	33.9	63.5	2555	3946	6297	1825	56.8	61.2	34.7	76.1

Note: REPWD = DFH<sub>2</sub> locomotive with MTU diesel engine

Loco. Days = Number of days in period times number of locomotives in service

AVAILABILITY MAIN LINE LOCOMOTIVES BY THE TYPE AND REGION

PERIOD	PERCENT					
	TANZANIA REGION			ZAMBIA REGION		
	DFH2	DFH2/MTU	DE U30C	DFH2	DFH2/MTU	DE U30C
Oct. 1986	34.1	60.5	64.7	NA	NA	NA
Nov. 1986	35.3	62.8	59.3	NA	NA	NA
Dec. 1986	31.1	69.1	51.3	67.2	83.2	88.0
Jan. 1987	33.2	56.0	61.0	61.4	76.3	84.9
Feb. 1987	29.7	60.2	59.8	56.3	75.0	87.9
Mar. 1987	37.8	60.9	63.8	NA	NA	NA
Period Average	33.5	61.6	60.0	61.6	78.2	86.9

Source: TAZARA Regional Monthly Performance Reports

LOCOMOTIVE USEAGE

<u>TYPE</u>	<u>KM/DAY</u>	<u>PER LOCOMOTIVE</u>	<u>RUNNING</u>
		<u>KM/MONTH</u>	<u>HOURS/MONTH</u>
DFH1	20	440	50
DFH2	520	11,440	276
DFH1 MTU	160	4,300	410
DFH2 MTU	460	10,120	400
KRUPP U30C	340	7,480	240

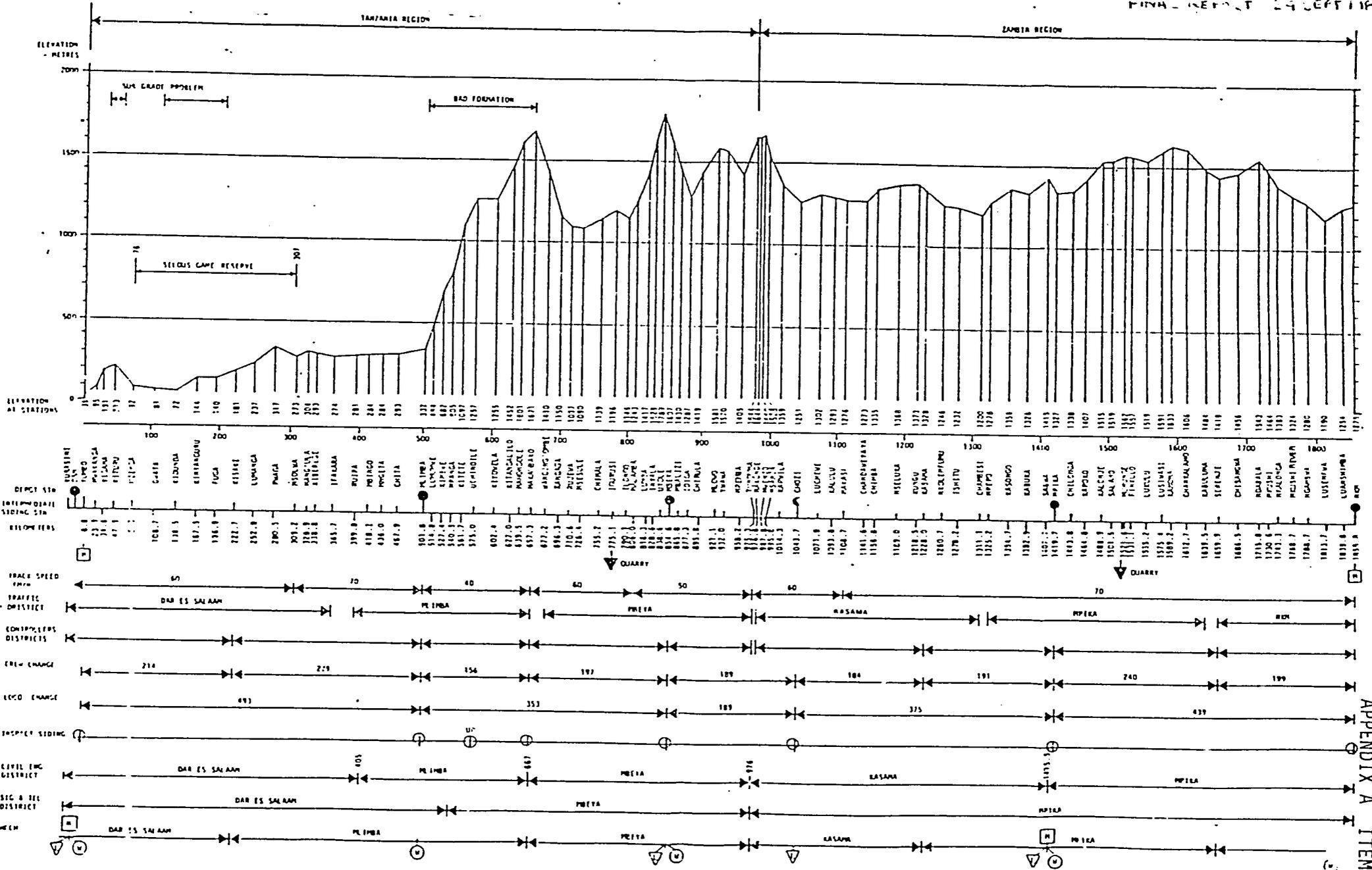
28

Alternative Diesel Engines

- Detroit Diesel Allison (DDA)  
  
Distributor - Tanzania, Equipment and Engineers Services Ltd.  
A. Alves - Zone Representative/Lisbon Portugal Indicates TAZARA locomotive replacement engine within range of DDA products but would require a new transmission.
  
- Cummins Engine Company, Inc. (c)  
  
Regional Office Harare, Zimbabwe  
I. Spark - Cummins Regional Manager identified the Cummins KTA-38L, 2300 c.i.d., 1200 HP engine as a potential TAZARA locomotive replacement engine.
  
- Electro-Motive Division General Motors Corp. (EMD).  
  
The La Grange, Illinois USA office.  
A. Da Costa - International Sales Manager Selected the EMD 645E, 1000 HP as a replacement engine for installation in DHF2 TAZARA locomotives.
  
- Caterpillar Tractor Company (CAT)  
  
Distributor U.A.C. of Tanzania, Limited  
V. Kimesera Marketing Manager qualifies the Caterpillar 3512 series diesel engine as a repowering replacement unit for TAZARA's DFH2 main line locomotives.
  
- Motoren - und Turbinen - Union (MTU)  
  
Distributed directly from MTU Friederichshafen Germany.  
H. Meinhardy - Director MTU office Africa has totally qualified the MTU 12V 396 diesel engine as installed and fully prototype tested in four DFH2 locomotives and operationally tested in a total of 26 DFH2 main line locomotives and one DFH1 shunting locomotive. Three additional locomotive installations are in process as of mid April 1987. The accumulated total running hours to-date on the 27 locomotives is 290,000.

NOTE: Letters from representatives of above suppliers of diesel engines are on file in the U.S.A.I.D. office in DAR ES SALAAM. Also on file are catalog sheets, brochures, dimensional data, installation mounting information and certain commercial pricing, terms and conditions.

Figure  
 CONDENSED RAILWAY DIAGRAM  
 EXPANDED FROM 1950  
 FINAL REPORT 24 OCT 1960



APPENDIX A ITEM 5

TAZARA LOCOMOTIVES  
 (Extracted from TAZARA 1986/87 Quarterly Performance Report 1)

<u>Type</u>	<u>Description</u>	<u>Total Purchased</u>	<u>RPWD (Re-Engined)</u>	<u>Scrapped</u>	<u>Operational or Repairable</u>
DFH2	Main-line China	97	(26)	31	40
DFH1	Shunting China	17	(1)	3	13
DFH2/MTU	Mainline RPWD	-	26	-	26
DFH1/MTU	Shunting RPWD	-	1	-	1
KRUPP	Diesel Electric	14	-	1	13

Notes: Total MTU Engines 58

- DFH1 - Original Chinese Shunting locomotive
- DFH2 - Original Chinese Main-Line locomotive
- DFH1/MTU - Repowered (Re-engined) DFH1
- DFH2/MTU - Repowered (Re-engined) DFH2
- KRUPP - U30C locomotive manufactured under GE license

Above information from TAZARA Quarterly Report and ME:l Project Coordination Unit (PCU) Report TME-001. The information was updated by TAZARA PME (Mr. Mkamba) as of April 13, 1987.

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### MANAGEMENT CONTROL SYSTEMS

Tazara workshop activities of material control, production control, work planning and measurement, and quality control need improved Management Control and Operational Control. Organization and operation of railway workshops and depots is not significantly different than industrial types of manufacturing or business organizations. The results of the operation are usually only as effective as the management of operational planning and controls.

The Tazara organization was designed originally from experiences of the Chinese who funded (loaned) and built the railroad, workshops, depots, locomotives and rolling stock. Since start-up, there have been inputs from many sources including equipment manufacturers, study groups, consultants and other railway/railroad organizations. As a results, the existing management and operational control systems were developed without a strong, totally coordinated effort that would have assured a more effective system.

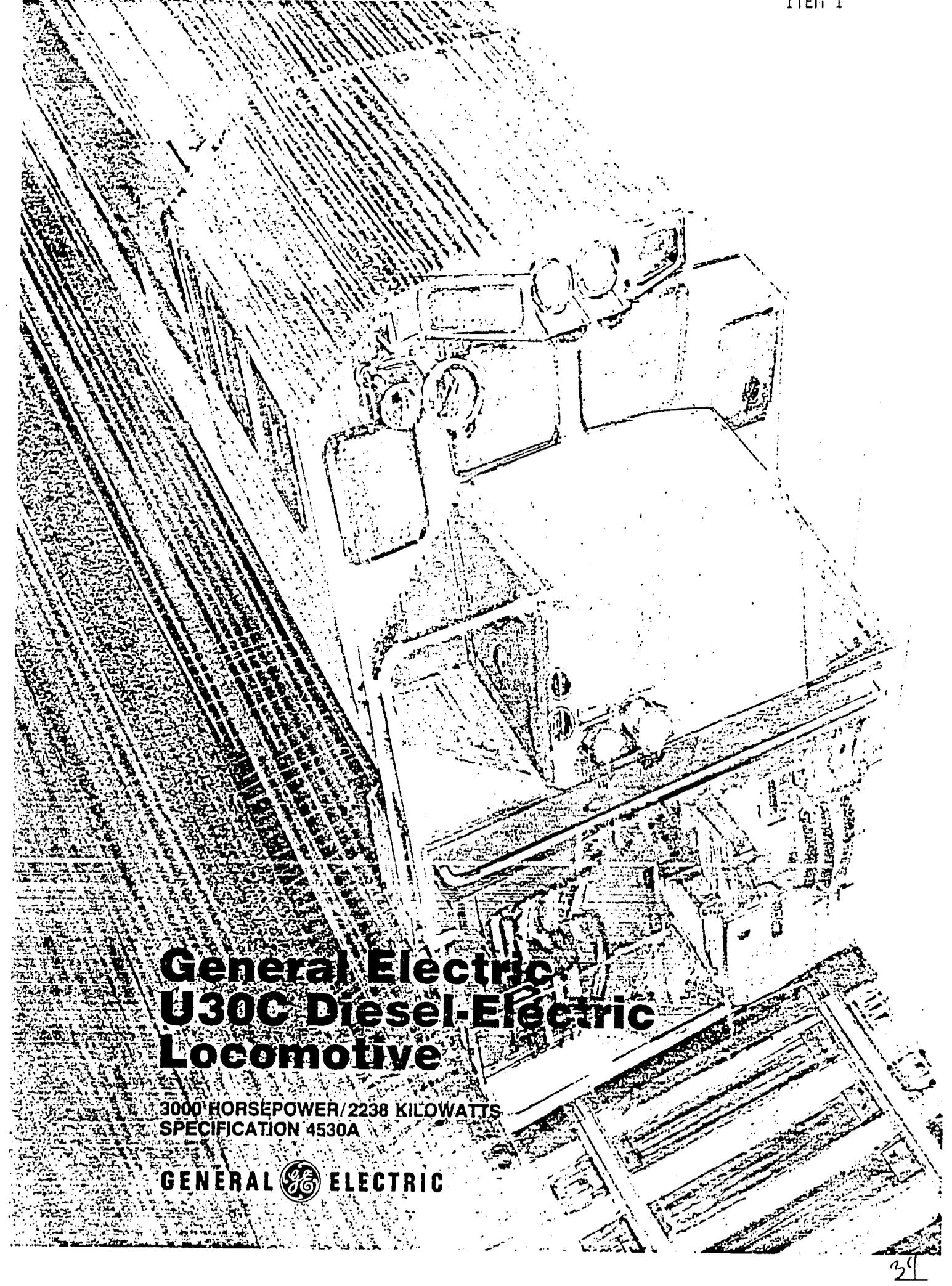
Attention is vitally needed to establish operational controls for:

- o controlling availability of material
- o controlling inventory
- o scheduling production
- o controlling production
- o controlling work force levels
- o controlling work force performance
- o controlling quality as shop/depot output

According to TAZARA management, various efforts have been made periodically to develop segments of control systems. For example, a materials control system was developed some time ago -- the system was defined, procedures documented and manuals issued. The system was not implemented and present management does not know why follow through was not completed. The stock record system was established at start-up of shops. Inputs from companies such as General Electric and MTU have been made on a very limited basis and consequently have not resulted in effective improvements.

A totally coordinated approach is needed to review existing controls, determine type and depth of controls required, document procedures, issue manuals, conduct training and implement. Evaluation and monitoring of Control effectiveness as well as adherence by TAZARA employees to procedures will be required until the system becomes a habit.

Management control and operational control activities are vital to the success of projects dedicated to improving availability of locomotives for TAZARA.



**General Electric  
U30C Diesel-Electric  
Locomotive**

3000 HORSEPOWER / 2238 KILOWATTS  
SPECIFICATION 4530A

GENERAL  ELECTRIC

## Introduction

**DESIGN** - The U30C is designed for service in freight, passenger and switching traffic. The universal design permits adaptability to railways worldwide; any track gage from 39-3/8 (1000 mm) to 66 inches (1676 mm). The operating cab, located between the power plant hood and front (low) equipment hood, provides visibility in either direction. The control station is at the right side with the front hood leading.

**POWER** - A diesel engine is the primary power source. A traction alternator is connected to the engine and furnishes power through rectifiers to the axle-mounted traction motors. The electric transmission per-

mits high utilization of the horsepower output throughout the locomotive speed range. Speed is controlled by a throttle lever that regulates engine output and controls the proper application of power to the traction motors. The direction of motion is controlled by a reverse lever. The throttle and reverse levers are interlocked to prevent reversal under power.

**MATERIALS** - All materials are in accordance with standard material specifications of General Electric. High standards of quality control are maintained. Materials and specifications are subject to change without notice.

U30C  
LOCOMOTIVE



**TESTING** - All component parts are given standard commercial tests before assembly on the locomotive. Each complete locomotive is tested as follows:

1. Control wiring is checked by observing sequence of contactor and relay operation and testing continuity of circuit between terminals.
2. High-potential tests of traction and control circuits are made in accordance with current U.S.A. standards.
3. Air brake tests provide satisfactory operation of the system and check the piping.

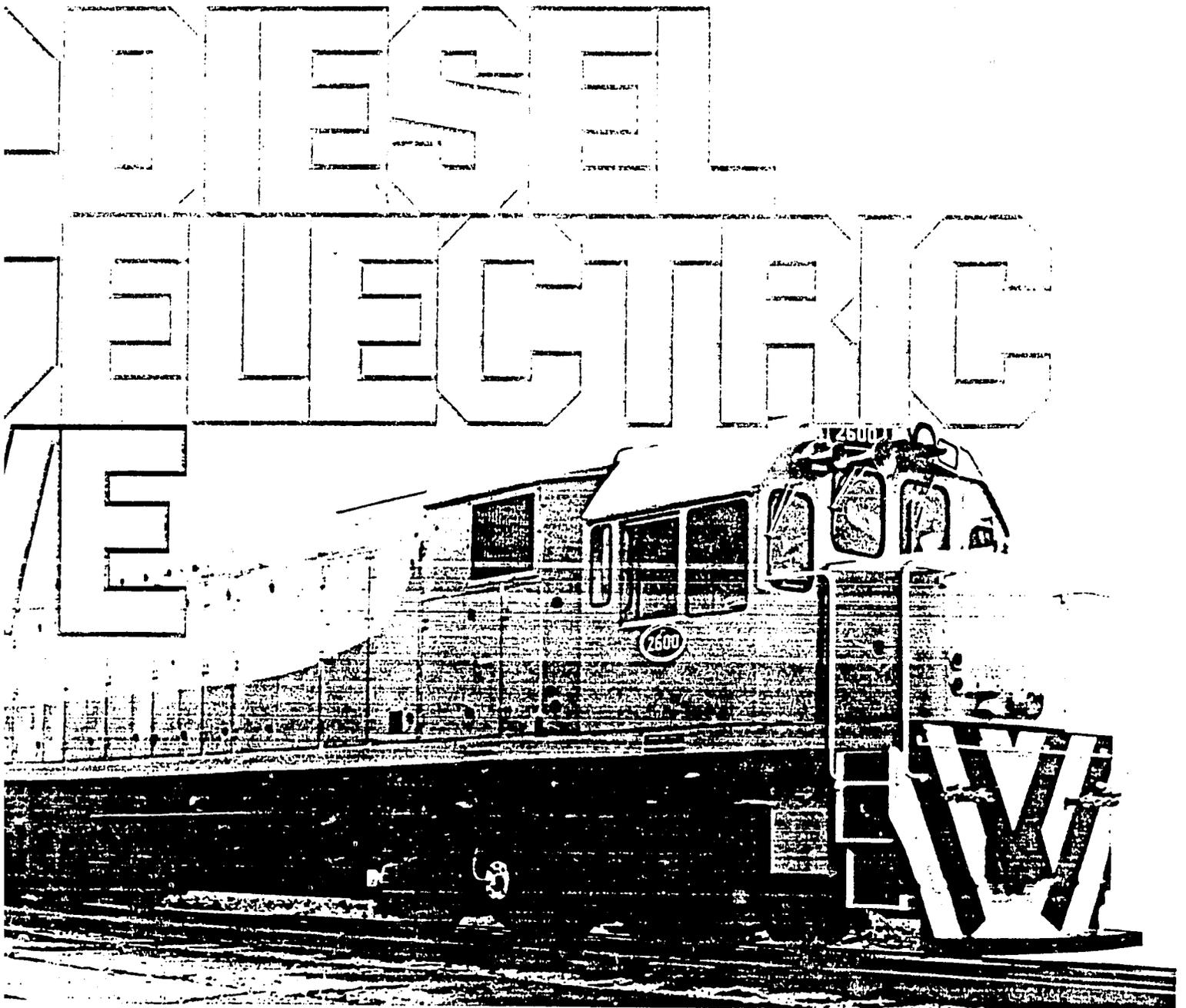
4. The power plant is tested at full load to check and adjust alternator characteristics and engine performance, including power and speed.

**PAINTING** - Interior: gray. Underframe and running gear: black. Interior of battery compartment: special acid resisting paint. Exterior: finish painted in customer's color choice. A Color Selector is furnished to suggest painting schemes.

**EXPORT SHIPMENT** - For overseas delivery, superstructure is protected for on-deck ocean shipment. Running gear is packed for below-deck shipment.

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Modifications .....	10-11



**Summary Model  
U30C AC/DC  
Diesel-Electric  
Locomotive**

**RATINGS**

	<b>ENGLISH</b>	<b>METRIC (S.I.)</b>
Diesel engine brake horsepower (useful service output under U.I.C. standard conditions) .....	3250 hp	2434 kw
Continuous horsepower to alternator for traction .....	3000 hp	2238 kw
Tractive effort at 30% adhesion (nominal weight) .....	79,200 lbs	35,925 kg
Continuous tractive effort (93:18 gear ratio) .....	59,790 lbs	27,120 kg
Maximum locomotive speed with new or worn wheels 36 inch (914 mm) (93:18 gear ratio) .....	64 mph	103 KM/H
Locomotive speed-tractive effort curve .....	(see next page)	

**WEIGHTS**

Nominal locomotive (fully loaded) .....	210,000 lbs	95,256 kg
Per driving axle (fully loaded) .....	35,000 lbs	15,876 kg
Locomotive weight subject to manufacturing tolerance of $\pm 2\%$ . Modifications and gages above 42 inches (1067 mm) may increase weight.		

**WHEEL ARRANGEMENT** .....

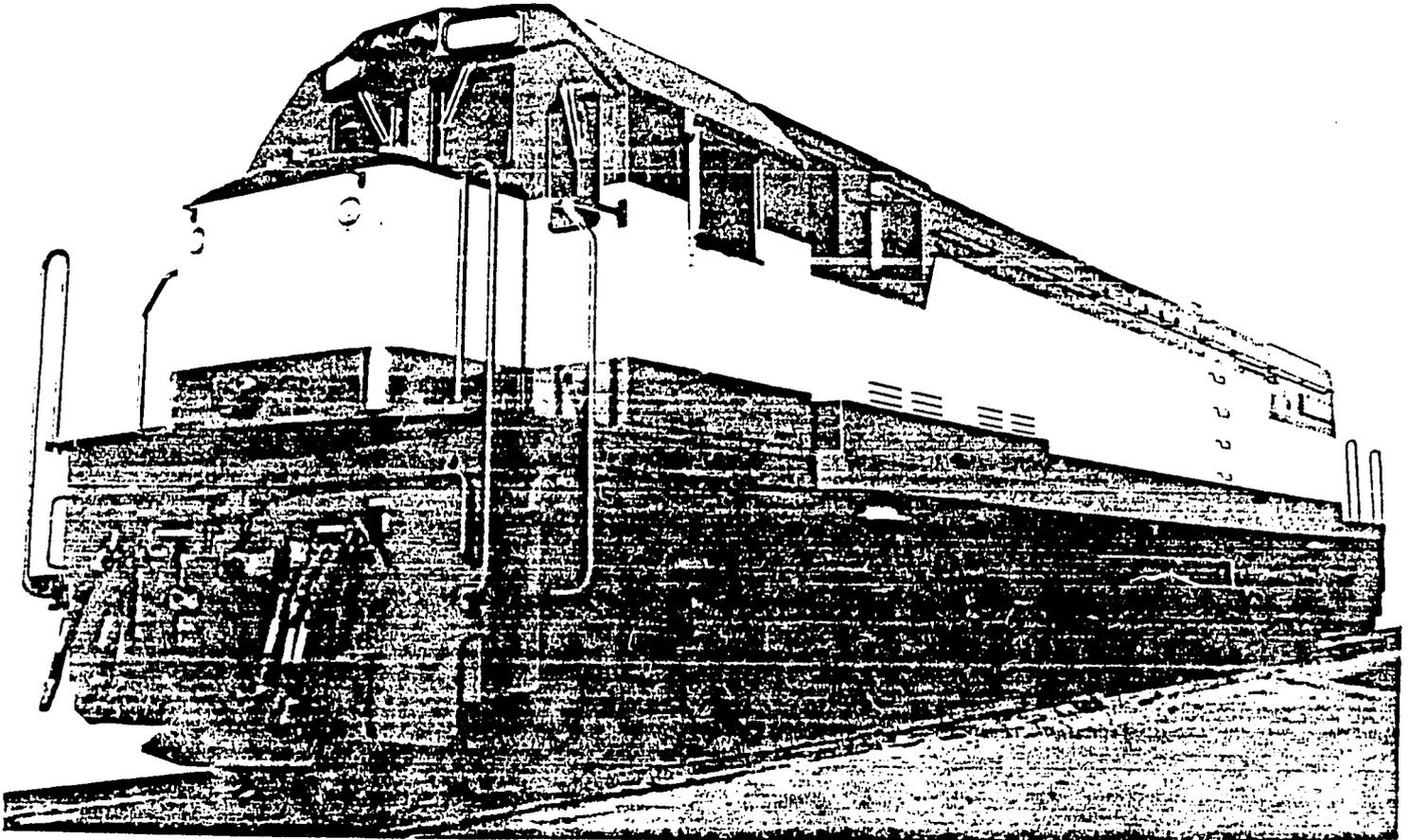
C-C

**MAJOR DIMENSIONS**

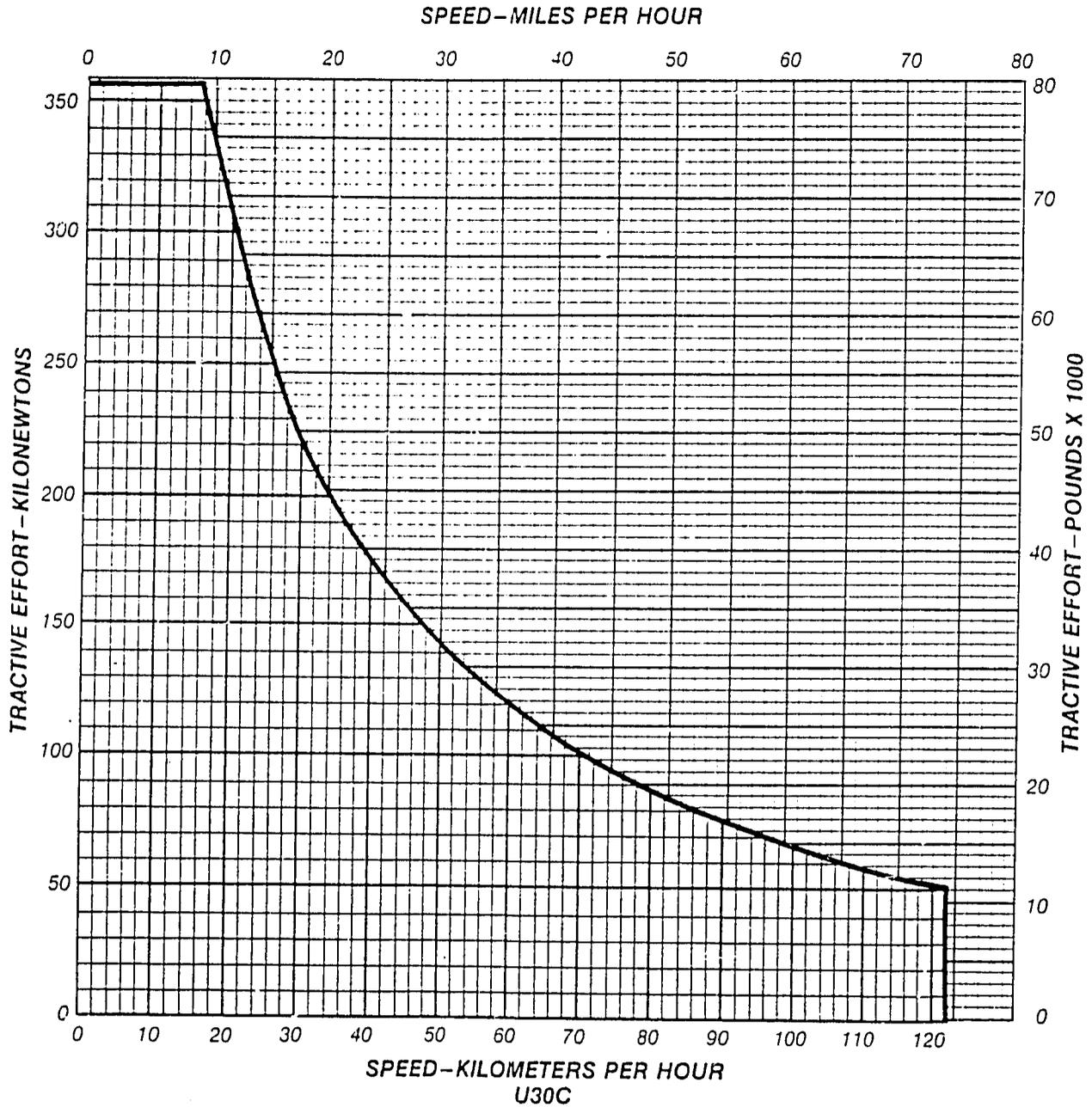
Length over end frames .....	55 ft, 6 in	16,916 mm
Height over operator's cab .....	12 ft, 1-1/2 in	3,697 mm
Width over cab .....	8 ft, 11 in	2,718 mm
Width over platform .....	9 ft, 0 in	2,743 mm
Clearance under gear case (with 36-inch wheels) .....	4-1/4 in	108 mm
Locomotive outline drawing .....	(see pages 6-7)	
Minimum radius of curvature .....	186 ft	56.7 m

**CAPACITIES**

Fuel .....	1200 U.S. gal	4542 liters
Lubricating oil .....	320 U.S. gal	1211 liters
Engine water .....	210 U.S. gal	795 liters
Sand .....	18 cu ft	510 liters



# Locomotive Performance



## Optional Gearing WITH GE-761 MOTORS

Wheel Diameter Inches	Gear Ratio	Maximum Locomotive Speed With New Or Worn Wheels		Tractive Effort At Continuous Motor Rating		
		MPH	KM/H	LB	KN	Kg
36	93:18	64	103	59,790	265	27,120
36	92:19	68	109	56,060	249	25,429
38	93:18	67	108	56,650	252	25,696
38	92:19	72	116	53,080	235	24,077
40	93:18	71	114	53,810	239	24,408
40	92:19	76	122	50,440	224	22,979

Note: Alternate gear ratios are available for special applications.

## Superstructure

The superstructure, of welded steel construction, consists of a low front hood, an operator's cab, engine hood, and a radiator hood. All hoods are bolted to the underframe and are removable.

**UNDERFRAME** - Consists of two steel main sills with end plates, deck plates and transverse steel bolsters, securely welded in place. The center and side bearing plates are of wear-resistant steel.

**FRONT HOOD** - Contains air brake equipment and sand boxes. Doors provide access to this equipment.

**OPERATOR'S CAB** - Sides and roofs are insulated against heat and sound. The floor, raised above the platform, is covered with heavy-duty composition material. The cab has safety glass windows in the front, rear and each side for visibility in all directions. Center windows on each side have sliding sash, equipped with latches. All other windows are fixed and mounted in

rubber self-sealing sash. One door at each end of the operator's cab provides access to walkways along the hoods. The doors have windows, weather stripping and provision for locking.

**CONTROL COMPARTMENT** - Located behind the operator's cab and encloses control devices and main power switching equipment.

**BATTERY BOX** - The batteries are located on the left side walkway, just behind the operator's cab.

**ENGINE HOOD** - Encloses the diesel engine, traction alternator set, and equipment blower. Side doors and roof hatches provide access to the equipment. Equipment cooling air is filtered by self-cleaning inertial air filters. Engine combustion air is taken from outside the hood and cleaned by inertial (primary) and paper (secondary) filters.

**RADIATOR HOOD** - Contains radiator, fan, air compressor, and sand boxes. Doors for access are provided.

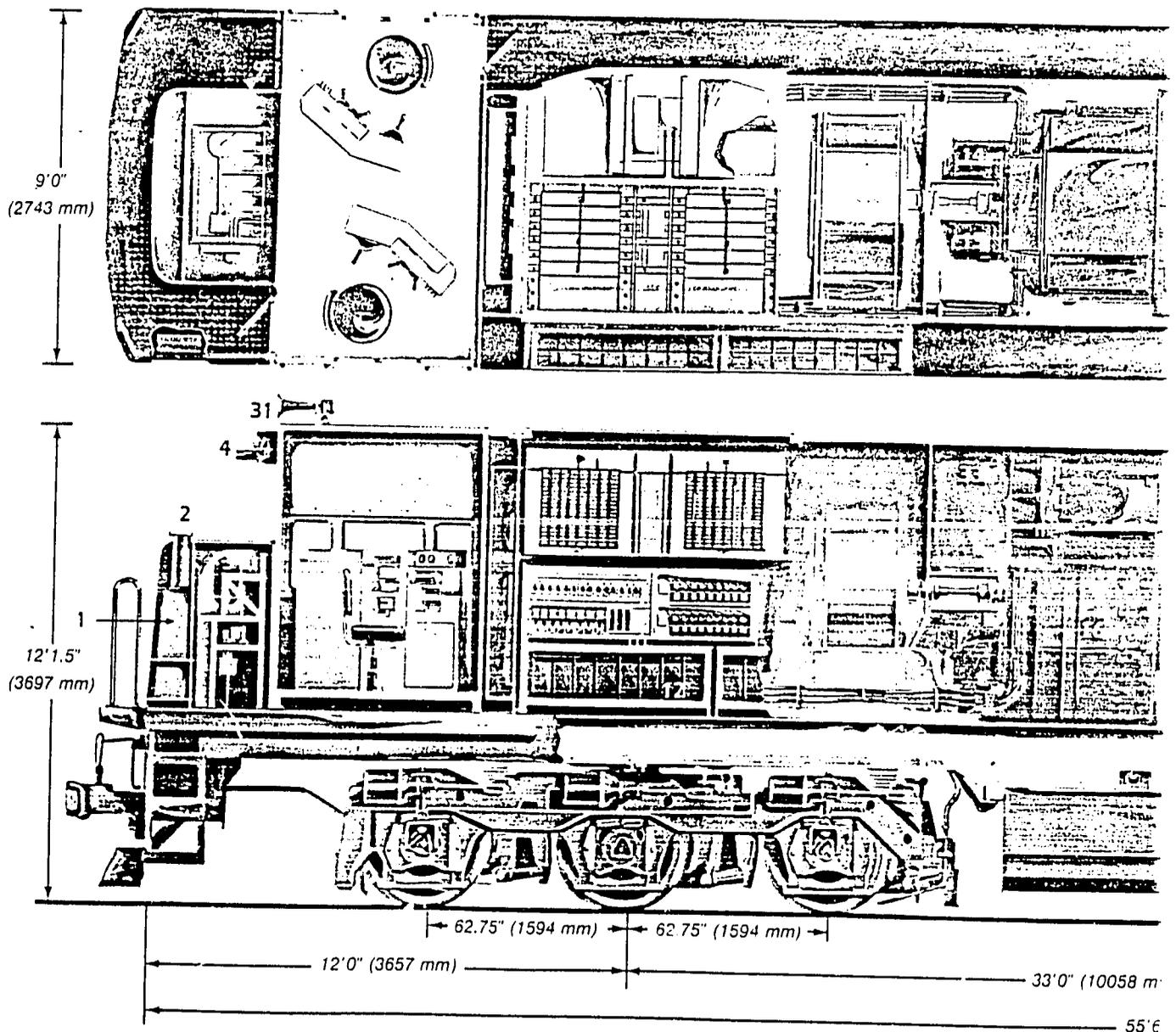
**WALKWAYS** - Provided at each end of the locomotive and along the hoods. Sidesteps are located at each corner for boarding. Walkways and steps have handrails and non-skid treads.

**PILOTS** - Bolted to each end plate.

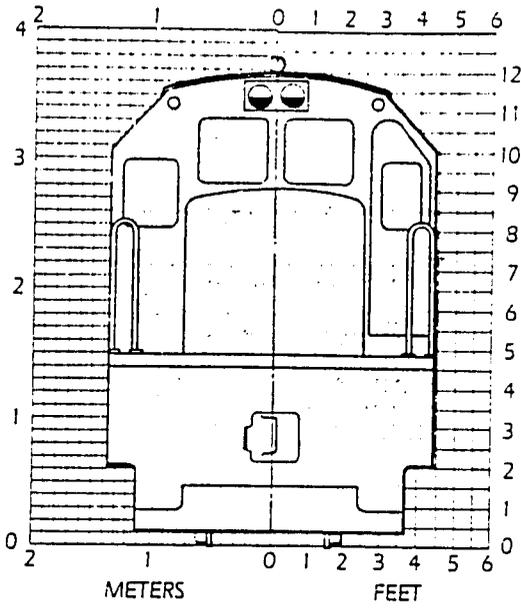
**COUPLERS** - AAR Type E top-operated couplers with rubber-cushioned draft gear are provided when center couplers are required.

**LIFTING AND JACKING** - Four combination jacking pads and lifting lugs are provided on the underframe.

**FUEL TANK** - Fabricated of heavy gage steel, well baffled, vented and bolted to the underframe. Provision is made for draining and cleaning. Filler connections and fuel level gages are furnished on each side of the locomotive.



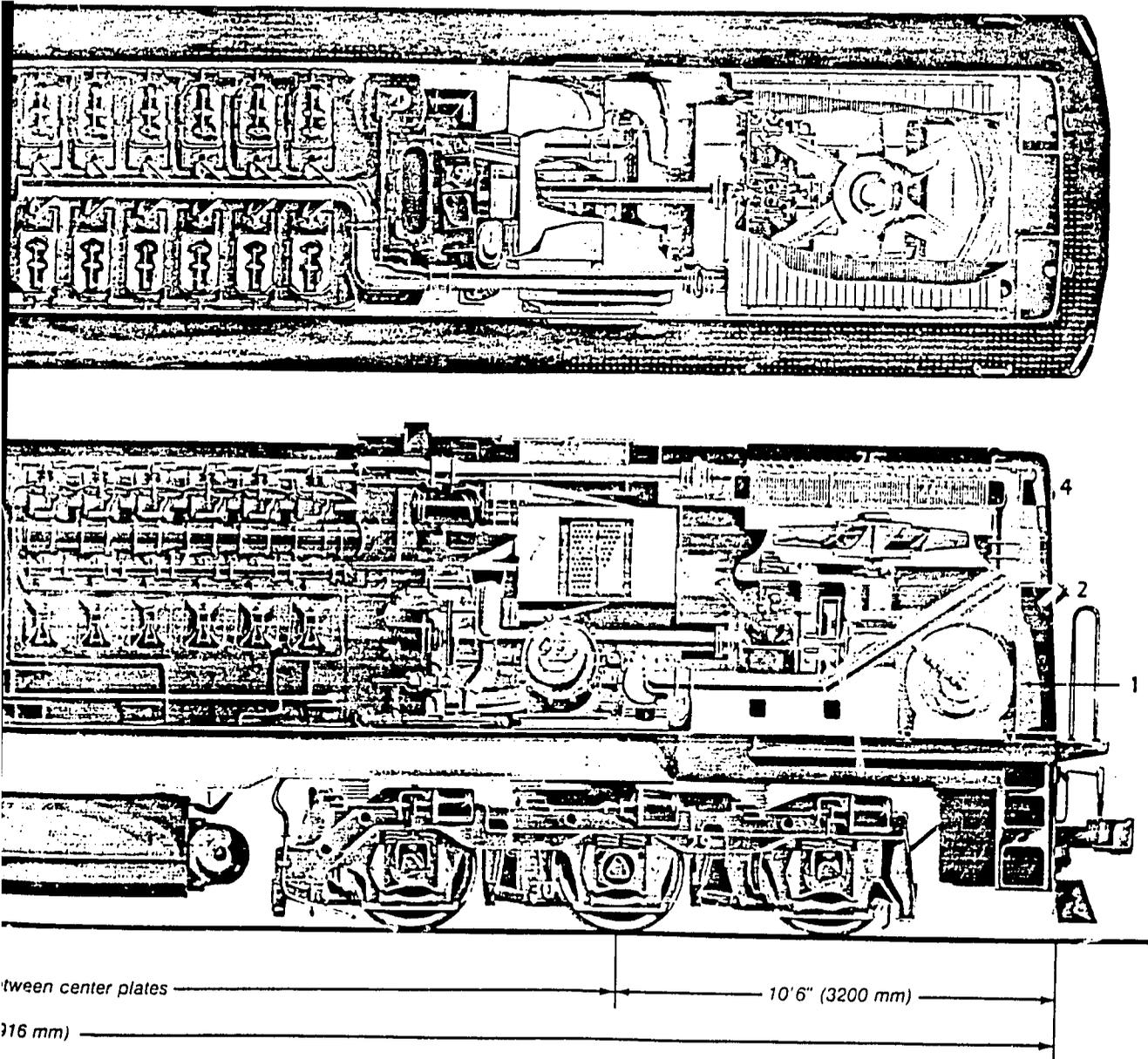
**Maximum Equipment Diagram  
with 36 inch (914 mm) wheels**



**Location of Major Systems**

- |                                |                              |
|--------------------------------|------------------------------|
| 1. Sand Box                    | 18. Fuel Tank                |
| 2. Sand Box Fill               | 19. Turbocharger             |
| 3. Air Brake Equipment         | 20. Engine Water Tank        |
| 4. Headlight                   | 21. Engine Inlet Air Filters |
| 5. Cab Heater (optional)       | 22. Lubricating Oil Filter   |
| 6. Cab Seat                    | 23. Lubricating Oil Cooler   |
| 7. Controiler                  | 24. Air Compressor           |
| 8. Brake Stand                 | 25. Radiator Shutter         |
| 9. Hand Brake                  | 26. Radiator                 |
| 10. Control Compartment        | 27. Radiator Fan             |
| 11. Dynamic Brake (optional)   | 28. Air Reservoir            |
| 12. Battery                    | 29. Floating Bolster Truck   |
| 13. Exciter                    | 30. Traction Motor           |
| 14. Battery Charging Generator | 31. Horn                     |
| 15. Equipment Blower           | 32. Equipment Air Filters    |
| 16. Traction Alternator        | 33. Rectifiers               |
| 17. Engine                     | 34. Lifting And Jacking Pads |

Note: Second control stand is optional.



## Performance Features

**LOW FUEL RATE** - Low auxiliary load with eddy current clutch drive to radiator fan assures that the fan only requires power when the radiator water must be cooled.

Turbocharged, 4-stroke-cycle diesel engine provides highly-efficient operation.

**HIGHER ADHESION** - Floating bolster trucks with traction motors mounted in tandem minimize weight shift and wheel slippage. The GTA-11 alternator has adequate capacity so that all motors are connected in parallel across the alternator field at all times—from start to maximum speeds. The connection assures that, when one wheel slips, the power is inherently transferred to the remaining five motors equally. Sentry wheelslip detection and correction system furnishes the speed and accuracy of action to correct any wheelslip that occurs.

**CLEAN AIR** - Ambient air for the traction motors and alternator is first drawn through self-cleaning inertial air filters which purge the air of a high portion of impurities. Engine intake air is further filtered through paper filters, thus maintaining a supply of clean air to the diesel engine.

**ELECTRICAL ADVANCES** - Constant Horsepower Excitation Control (CHEC) is a modern static power train control system. It sets and controls horsepower at the maximum level consistent with the requirements of all subsystems. Flashovers are virtually eliminated since all traction motor operation is in the full field mode. Shunt field operation is not necessary due to the higher voltage capability of the GTA-11 CHEC Excitation System.

## Power Plant

### DIESEL ENGINE -

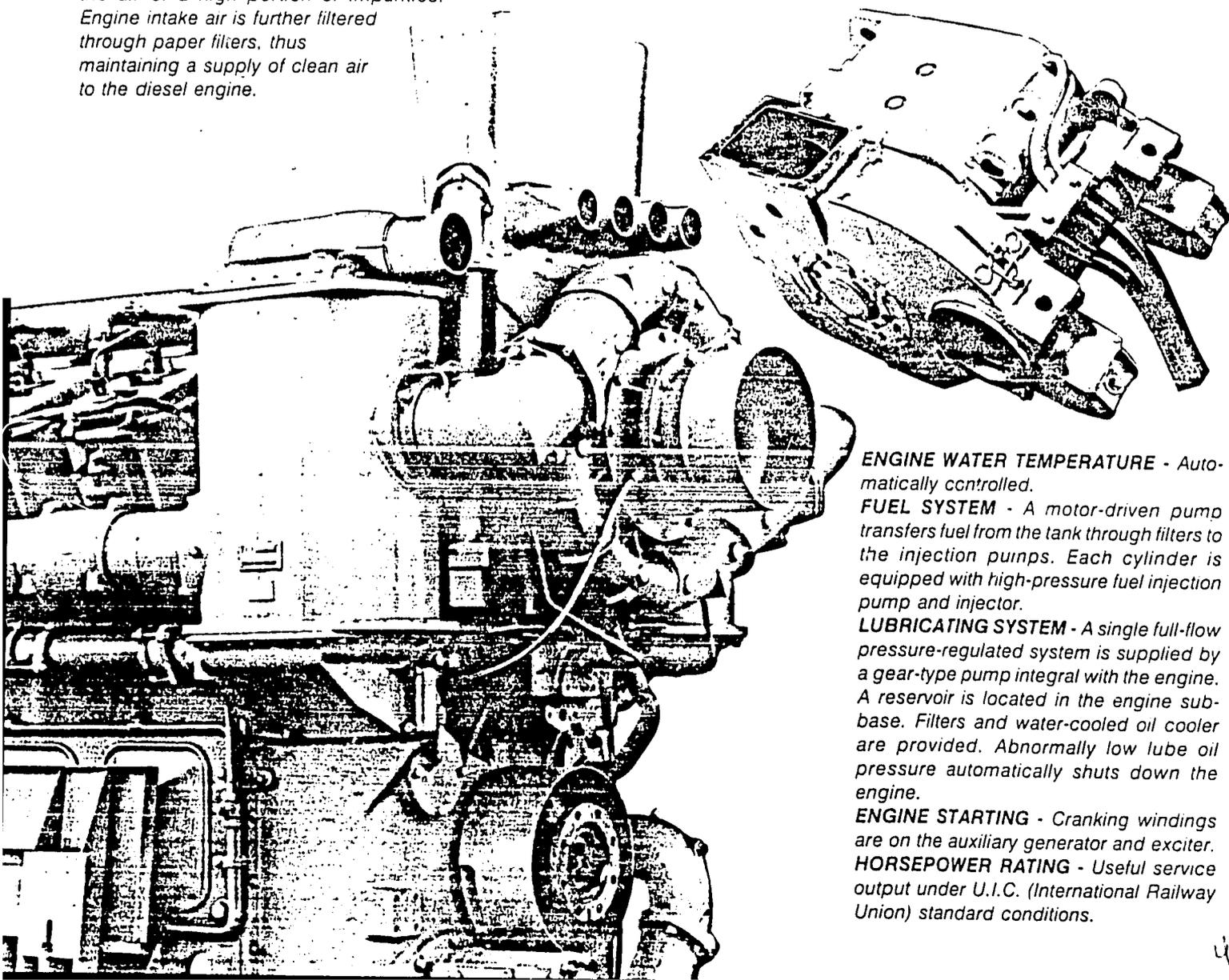
Type .....	One GE FDL-12
Brake horsepower .....	3300
Number of cylinders .....	12
Cylinder arrangement .....	45°V
Stroke cycle .....	4
Bore and stroke ...	9 inches (228.6 mm) x 10-1/2 inches (266.7 mm)
Full load speed .....	1050 rpm
Turbocharger .....	One

**GOVERNOR** - Self-contained, electro-hydraulic modulating engine governor automatically regulates horsepower output at each throttle setting. With low oil or water pressure, the governor reduces engine load to match available pressure until it returns to normal. With loss of oil or water pressure, the engine is shut down.

**OVERSPEED PROTECTION** - Engine is automatically shut down if speed exceeds maximum rated rpm by 10 percent.

**ENGINE AIR FILTER** - The engine air intake is equipped with self-cleaning inertial primary and secondary paper filters.

**COOLING SYSTEM** - Water is circulated through the engine, turbocharger, inter-cooler, radiator, and lube oil cooler by a gear-driven centrifugal pump integral with the engine. An expansion tank with sight gage indicates water level. The water fill is located on roof. Abnormally low water pressure automatically shuts down the engine.



**ENGINE WATER TEMPERATURE** - Automatically controlled.

**FUEL SYSTEM** - A motor-driven pump transfers fuel from the tank through filters to the injection pumps. Each cylinder is equipped with high-pressure fuel injection pump and injector.

**LUBRICATING SYSTEM** - A single full-flow pressure-regulated system is supplied by a gear-type pump integral with the engine. A reservoir is located in the engine sub-base. Filters and water-cooled oil cooler are provided. Abnormally low lube oil pressure automatically shuts down the engine.

**ENGINE STARTING** - Cranking windings are on the auxiliary generator and exciter.

**HORSEPOWER RATING** - Useful service output under U.I.C. (International Railway Union) standard conditions.

## Electric Transmission

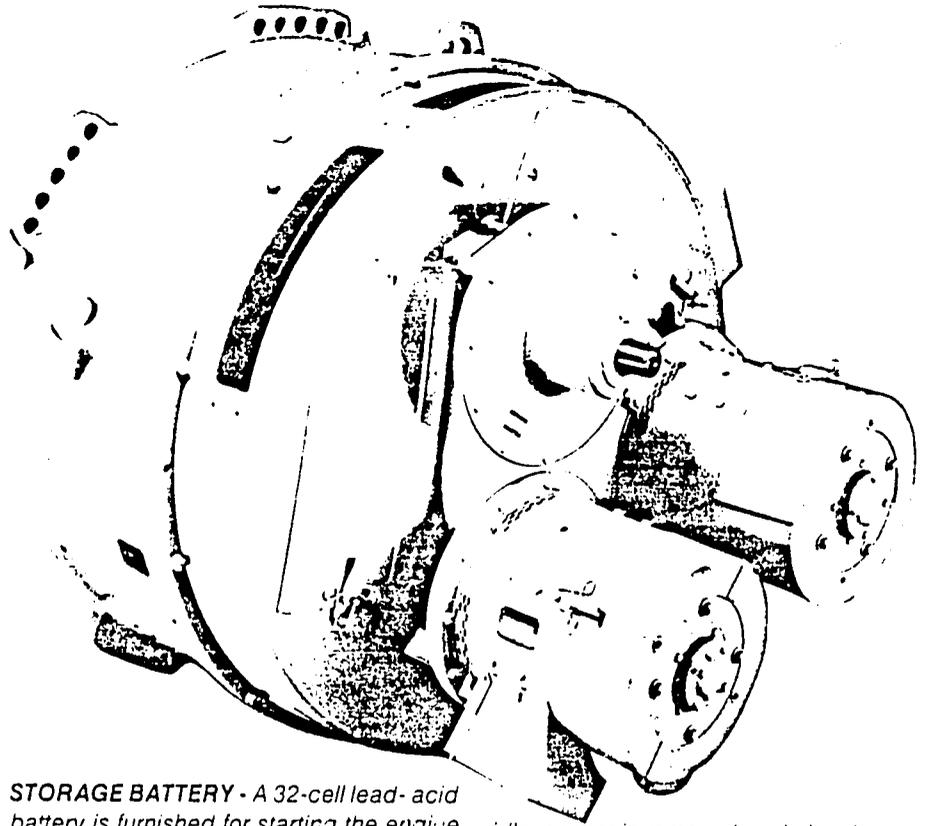
**TRACTION MOTORS** - Six GE-761 traction motors are furnished. They are direct current, series wound, separately ventilated. Armatures are mounted in anti-friction bearings. Motors drive through single-reduction spur gearing. They are supported by the axles to which they are geared and by resilient nose suspensions on truck transoms.

**TRACTION ALTERNATOR** - One GTA-11 traction alternator is engine mounted. It is an AC, single anti-friction bearing, separately excited machine. Output is rectified by a full-wave rectifier.

**CONTROL** - Railway-type single-station single-unit control is basic equipment. Control devices are grouped in dust and water tight steel compartments, fitted with access doors. Reverser and braking switch are electro-pneumatically operated. Contactors are magnetically operated. Circuit breaker-type switches are used in control circuits where overload protection is required. Transition and field shunting are not used.

**EXCITER** - One GY-27 is gear-driven from the traction alternator and provides controlled excitation of the alternator field.

**BATTERY CHARGING GENERATOR** - One Type GY-27 generator is gear-driven from the alternator and furnishes power at regulated potential for battery charging, lighting and control.



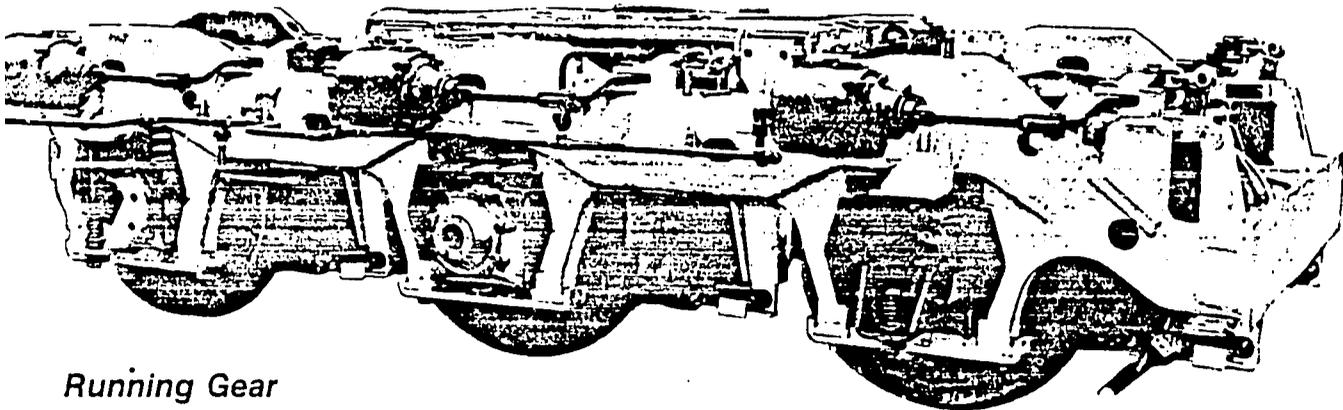
**STORAGE BATTERY** - A 32-cell lead-acid battery is furnished for starting the engine and supplying power for lights and other auxiliaries when the engine is shut down.

**EQUIPMENT BLOWER** - Direct-driven blower supplies ventilating air to the alternator, rectifier, auxiliary generator, exciter, and traction motors through platform ducting and flexible connections.

**GROUND RELAY PROTECTION** - If a ground occurs, engine speed returns to

idle, power is removed and visual as well as audible indication is given.

**SENTRY WHEELSLIP CORRECTION** - Wheel-slip is automatically detected by comparison of output signals from speed sensors located in each traction motor. Slip is corrected by automatic application of sand and reduction of power.



## Running Gear

Consists of two, three-axle lateral motion swivel trucks. A tandem motor arrangement provides low weight transfer and excellent adhesion. Centerplate load is distributed by the "floating bolster" to four rubber mounts which rest on the truck frame and provide controlled lateral motion. Truck frame consists of cast-steel side frames joined integrally with structural steel shapes by electric welding. It is supported by alloy steel coil springs over

the journal boxes. Friction-type snubbers damp vertical and lateral oscillation.

**WHEELS** - Solid multiple wear, rolled-steel of 36-inch (914 mm) diameter, 2-1/2 (63.5 mm) thick rims. The wheels have AAR standard tread and flange contour.

**AXLES** - Forged carbon steel to AAR material specifications.

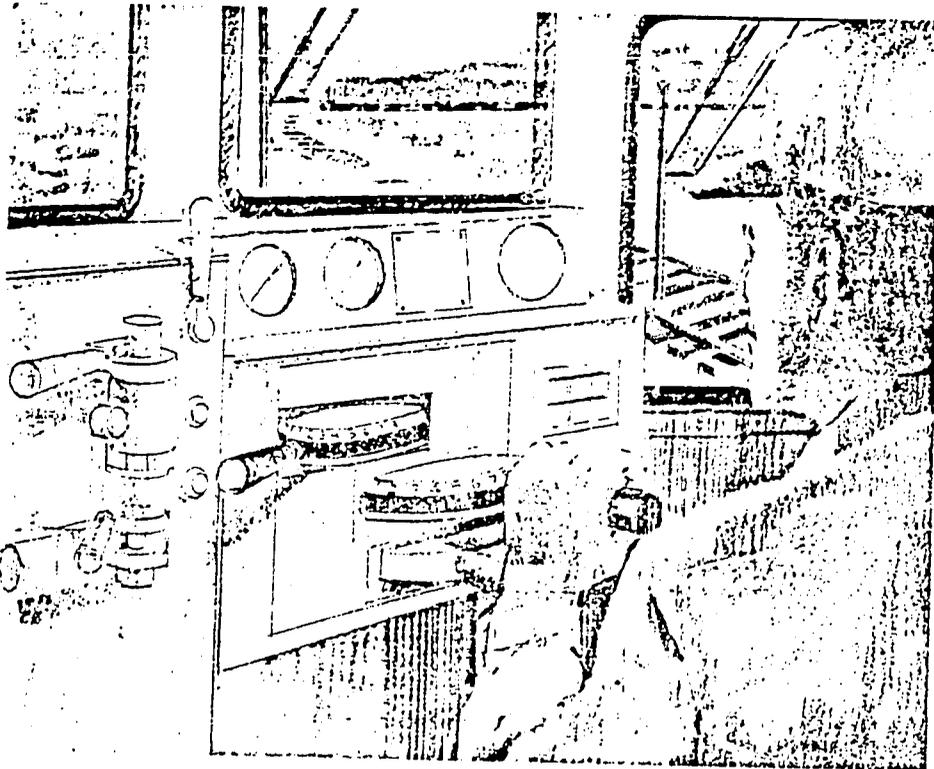
**JOURNALS** - Equipped with sealed, grease-lubricated roller bearings. Guides are lined with renewable wear-resistant plates.

**PEDESTAL GUIDES** - Renewable wear-resistant liners are bolted to pedestal guides.

**CENTER PLATES** - Equipped with renewable wear-resistant liners and arranged for lubrication.

**SIDE BEARINGS** - Provided with renewable wear-resistant wear plates.

**SAFETY BRACKETS** - Prevent slewing and permit the trucks to be lifted with the superstructure.



## Operating Controls

Controls and instruments are grouped at the operator's station and switch panel and gage panel in the operator's cab.

### OPERATING CONTROLS:

Master controller with throttle, reverser, and dynamic braking selector levers

Engine control switch

Brake valves

Sander valve

Bell ringer valve

Air horn valve

Window wiper valves

Circuit breakers and switches

Emergency fuel shutoff

Emergency engine stop switch

### INSTRUMENTS:

Brake gages

Fuel oil pressure gage

Engine intake manifold pressure gage

Lube oil pressure gage

### WARNING INDICATORS:

Low engine lubrication oil pressure—alarm bell and green light

Low engine water pressure—alarm bell and yellow light

Crankcase overpressure—alarm bell and red light

High engine water temperature—alarm bell and red light

Wheelslip—buzzer and white light

Engine shutdown—alarm bell and no charge light

Ground relay—alarm bell and white light

Battery not charging—alarm bell and blue light

Alternator overload—alarm bell and yellow light

Rectifier overtemperature—alarm bell and red light

Power reduction—yellow light

## Accessories

**AIR FILTER (BRAKE SYSTEM)** - Centrifugal, with replaceable element and automatic drain valve.

**AIR FILTER (AUXILIARY AIR DEVICES)** - Centrifugal, with replaceable element and automatic drain valve.

**ARM RESTS** - Two, window mounted.

**AUTOMATIC DRAIN VALVES** - One at each main reservoir.

**BELL** - One, stationary, with air-operated ringer and operating valve.

**EMERGENCY BRAKE VALVE** - At helper's station.

**EMERGENCY FUEL SHUTOFF** - Three, one on each side of the underframe and one on the engine control panel.

**EXTENSION LAMP RECEPTACLES** - Two, in control compartment and engine hood, with one lamp and 35-foot cable.

**FIRE EXTINGUISHER** - Two, five-pound dry chemical.

**FUEL GAGES** - One on each side of locomotive near fill pipe.

**HEADLIGHTS** - Electric, at each end of the locomotive. Each consists of two 200-watt, 30-volt, sealed-beam lamps. Dimming control is provided.

**HORN** - One, air-operated, single-tone.  
**INTERIOR LIGHTS** - Electric, for operating cab, hoods and instruments.

**MARKER LIGHTS** - Four, red, single-aspect electric lights, two at each end of the locomotive.

**SANDERS** - Eight, pneumatically operated, arranged to sand ahead of the lead wheels in each direction.

**SEATS** - Two, swivel type, with back rests, adjustable for height and located to enable operation in either direction.

**SUN VISORS** - Two, adjustable-type.

**WATER TEMPERATURE GAGE** - Located in engine cab.

**WINDOW WIPERS** - Six, air-operated, mounted on front and rear windows of operating cab.

## Locomotive Brakes

**AIR BRAKES** - Schedule 26L with 26F control valve combined independent and automatic is basic equipment. Compressed air locomotive brakes may be operated either independently or with train brakes. Connections for furnishing compressed air to the train brakes are provided at each end of the locomotive.

**COMPRESSOR** - One three-cylinder, two-stage, water cooled engine-driven air compressor furnishes air for the locomotive and train braking systems.

Compressed air displacement:

Idle engine speed ..... 101 cfm  
(2860 liters/min)

Full engine speed ..... 236 cfm  
(6690 liters/min)

**RESERVOIRS** - 40,000 cubic inch (655 liters) capacity for storing and cooling air for the brake system.

**BRAKE EQUIPMENT** - Brake cylinders are mounted on the running gear and operate equalized brake rigging, which applies braking to each driving wheel. Adjustment is provided to compensate for wheel and shoe wear. There is one brake shoe per wheel.

**HAND BRAKE** - Located in the operator's cab for holding the locomotive at standstill.

## Modifications

**ADDITIONAL FIRE EXTINGUISHERS** - To meet requirements.

**ADDITIONAL FUEL** - Total capacity can be increased to 2000 gallons (7570 liters).

**ADDITIONAL RESERVOIR CAPACITY** - Total capacity can be increased to 50,000 cubic inches.

**ADDITIONAL SEAT** - A third seat in the operating cab.

**AIR CONDITIONING** - For operator's cab.

**ALKALINE-TYPE BATTERY** - Instead of the lead-acid battery.

**BRAKE CHARGING AMMETER** - One, on back wall of operator's cab.

**BATTERY CHARGING RECEPTACLE** - Can be mounted on one or both sides of the locomotive for battery charging from a wayside source.

**CAB HEATERS WITH DEFROSTERS** - One or two can be installed in the operating cab.

**CAB ROOF VENTILATORS** - Adjustable for either direction of operation.

**CAB VENTILATING FANS** - Mounted in operator's cab.

**CAB WINDOW AWNINGS** - On each side of operating cab if maximum equipment diagram permits installation.

**COLOR CODING** - Applied to pipe connections according to requirements.

**COUPLER ARRANGEMENT** - To meet requirements.

**COUPLER HEIGHT** - To meet customer requirements.

**CREW LOCKER** - In operator's cab.

**DYNAMIC BRAKING** - Equipment for braking electrically, using traction motors as generators and dissipating the electric power in forced-ventilated resistors. Interlocking prevents application of locomotive air brakes during dynamic braking. Dynamic braking is overridden during emergency brake applications.

**EMERGENCY SANDING** - In addition to manually operated valve, sanding can be automatically initiated by an emergency brake application.

**FLANGE LUBRICATORS** - Four or eight, attached to running gear. (Availability is dependent on truck configuration.)

**HEAD-END POWER** - Up to 15 kilowatts at 75 volts for caboose. Up to 400 kilowatts at 1500 volts for air conditioning and train heat.

**HORN** - Customer's choice instead of single-tone horn.

**HOT PLATE** - Electric, in operator's cab.

**HUBODOMETER** - Axle-drive, for distance recording.

**ILLUMINATED NUMBER BOXES** - Front and rear.

**INCREASED LOCOMOTIVE WEIGHT** - Heavier axle loadings for higher adhesive weight.

**LEFT SIDE CONTROL STATION** - Control station at left side of operating cab with front (low) hood leading, instead of right side. Controls can also be located on either side with long hood leading.

**LOADMETER** - To indicate order of magnitude of the tractive effort being maintained.

**LOCOMOTIVE OVERSPEED PROTECTION** - Returns engine to idle, automatic brake application.

**LOW WATER LEVEL ALARM.**

**MARKER LIGHTS** - Multicolor available, two or three color.

**MOTOR CUT-OUT SWITCH** - Any traction motor may be cut out individually.

**MULTIPLE-UNIT CONTROL** - To enable the operation of two or more locomotive units from one operator's station.

**SAFETY AND/OR VIGILANCE CONTROL** - Foot-suppression or other safety and/or vigilance controls to give a service train-brake application and return engine to idle, after short warning period.

**SPEEDOMETER** - Electric, with provision to compensate for wheel wear.

**SPEED RECORDER** - One combination speedometer, speed recorder and odometer.

**SUN VISORS** - Additional, fully adjustable sun visors for the operator's cab.

**SWITCHMEN'S END STEPS** - At each end of the locomotive.

**TOOL BOX** - Containing emergency hand tools.

**TWO-STATION CONTROL** - Two control stations for operating from either of two diagonally opposite positions.

**WATER-COOLED AIR COMPRESSOR** - Three cylinder available.

**WATER COOLER** - Either an electric cooler or an insulated water tank.

**WAYSIDE LIGHTING** - Receptacle on one or both sides of locomotive for lighting from wayside a-c source.

**WHEELS** - Diameter—to meet requirements, from 36 inches (914 mm) to a maximum of 40 inches (1016 mm). Type—Steel-tired wheels with locking rings or extra thick rims for later application of steel tires by the customer.

**Vacuum Brakes:**

(A) Vacuum or Compressed Air Train Brakes—Schedule 28L-AV1 independent and automatic locomotive compressed air brakes. Six-cylinder compressor-exhausters are recommended for locomotives which will also haul compressed air brake trains.

(B) Vacuum Train Brakes—Schedule 28L-V1 independent and automatic locomotive compressed air brakes and vacuum train brakes.

**Alternate Air Brake** - Schedule 26LA instead of 26L.

**Compressor-Exhausters Available**

**6-Cylinder**

Compressed Air (two cylinders)  
Vacuum (four cylinders)

	Idle/Full Engine Speed	Idle/Full Engine Speed
	Cfm	Liters per Min
	69/161	1950/4500
	276/644	7820/18240

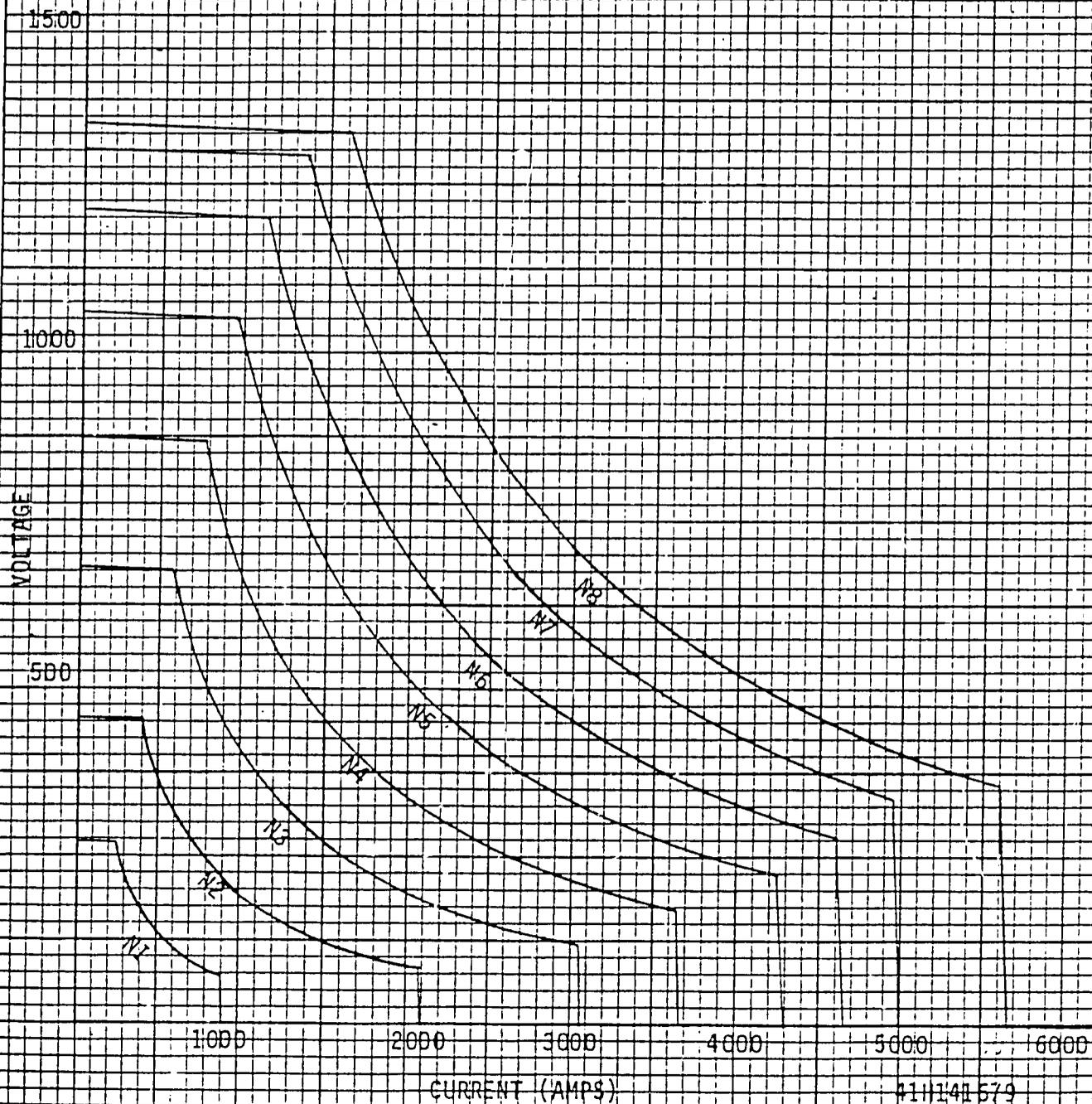
CHARACTERISTICS  
GIA II

HP INPUT FOR TRACTION

NOTCH	HP	RPM
1	100	450
2	275	535
3	575	620
4	960	705
5	1440	795
6	1930	875
7	2500	955
8	3000	1050

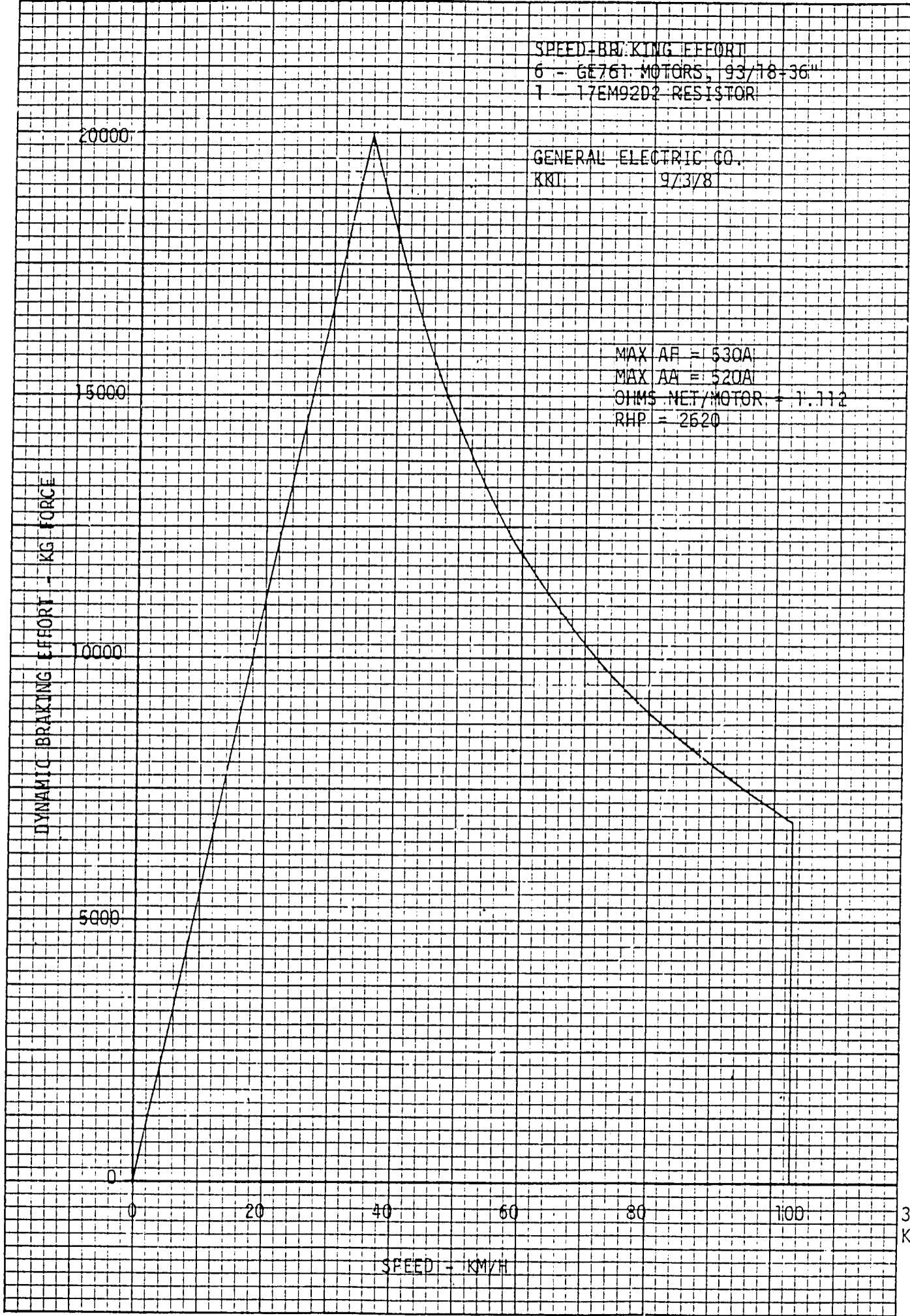
GENERAL ELECTRIC CO. (RY)  
DANIEL ANDERSON

411141579



Revision 0 9/3/81

411141579



SPEED-BR. KING EFFORT  
6 - GE761 MOTORS, 93/78-36"  
1 - 17EM92D2 RESISTOR

GENERAL ELECTRIC CO.  
KIT: 97/3/8

MAX AF = 530A  
MAX AA = 520A  
OHMS NET/MOTOR = 1.112  
RHP = 2620

41H106077

301  
KRUF

41H106077

TE CURRENT  
 GE-761A18  
 93/18 GEAR RATIO  
 36" WHEEL DIA.  
 GTA-II (41H141679)  
 GENERAL ELECTRIC CO. (RY)  
 DANIEL ANDERSON

41H141681

TE-KG(KK,000)/MOTOR

KPH

100

80

60

40

20

6

5

4

3

2

1

SPEED

TE

EFF

EFFICIENCY %

100

90

80

200

400

600

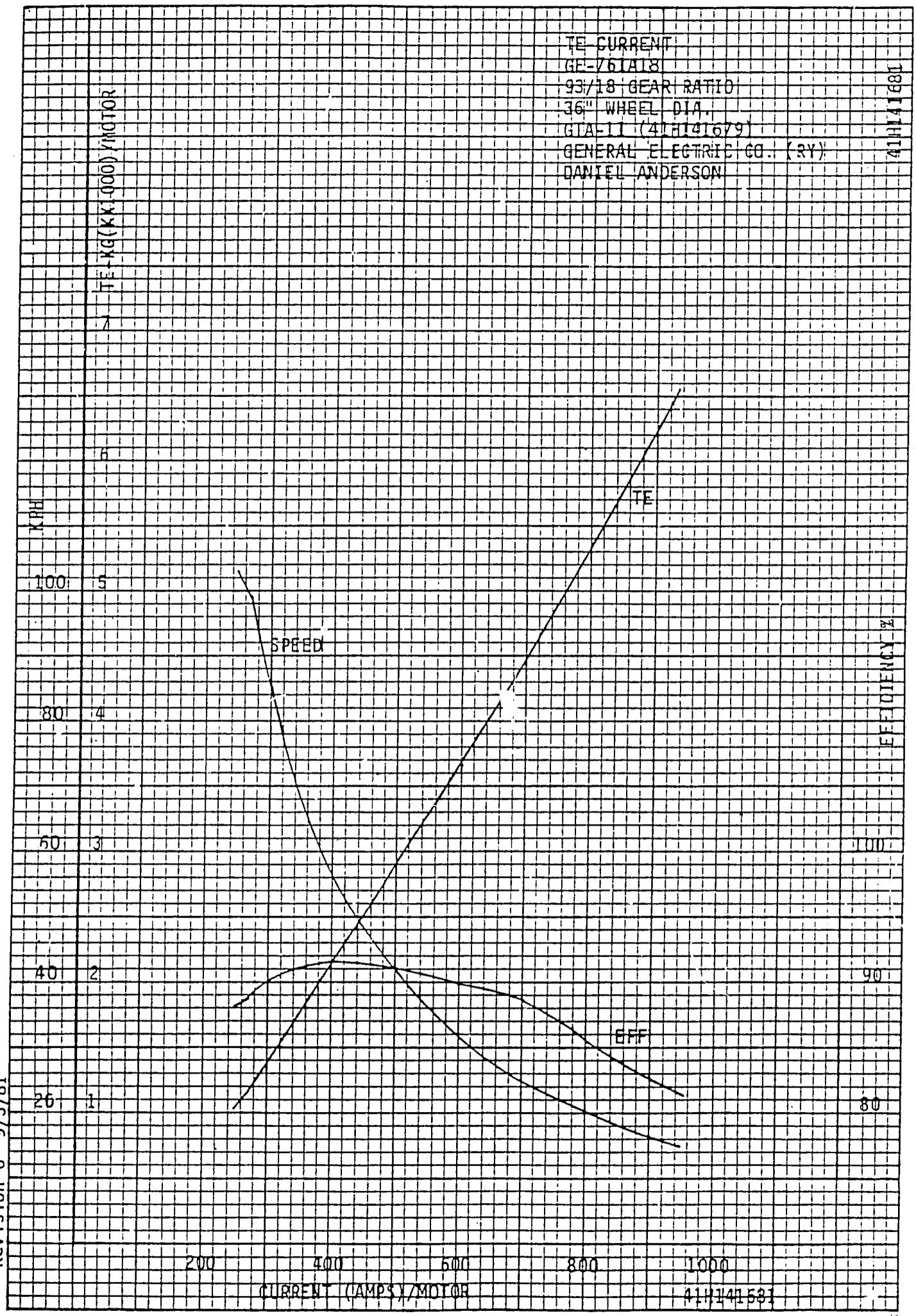
800

1000

CURRENT (AMPS)/MOTOR

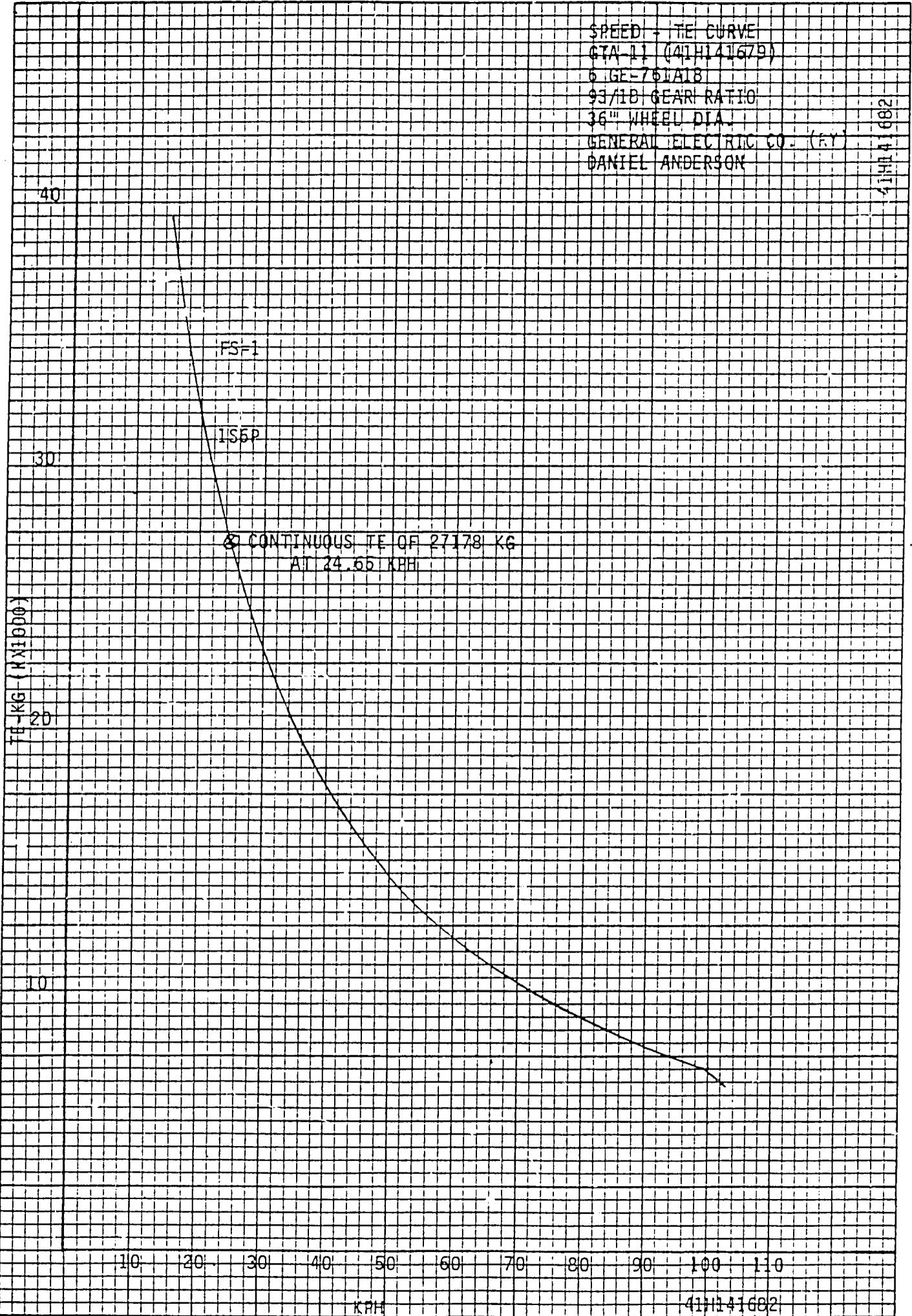
41H141581

Revision J 9/3/81



SPEED - T<sub>E</sub> CURVE  
GTA 11 (41H141679)  
6 GE-761A18  
93/18 GEAR RATIO  
36" WHEEL DIA.  
GENERAL ELECTRIC CO. (F.Y.)  
DANIEL ANDERSON

41H141682



9/3/81

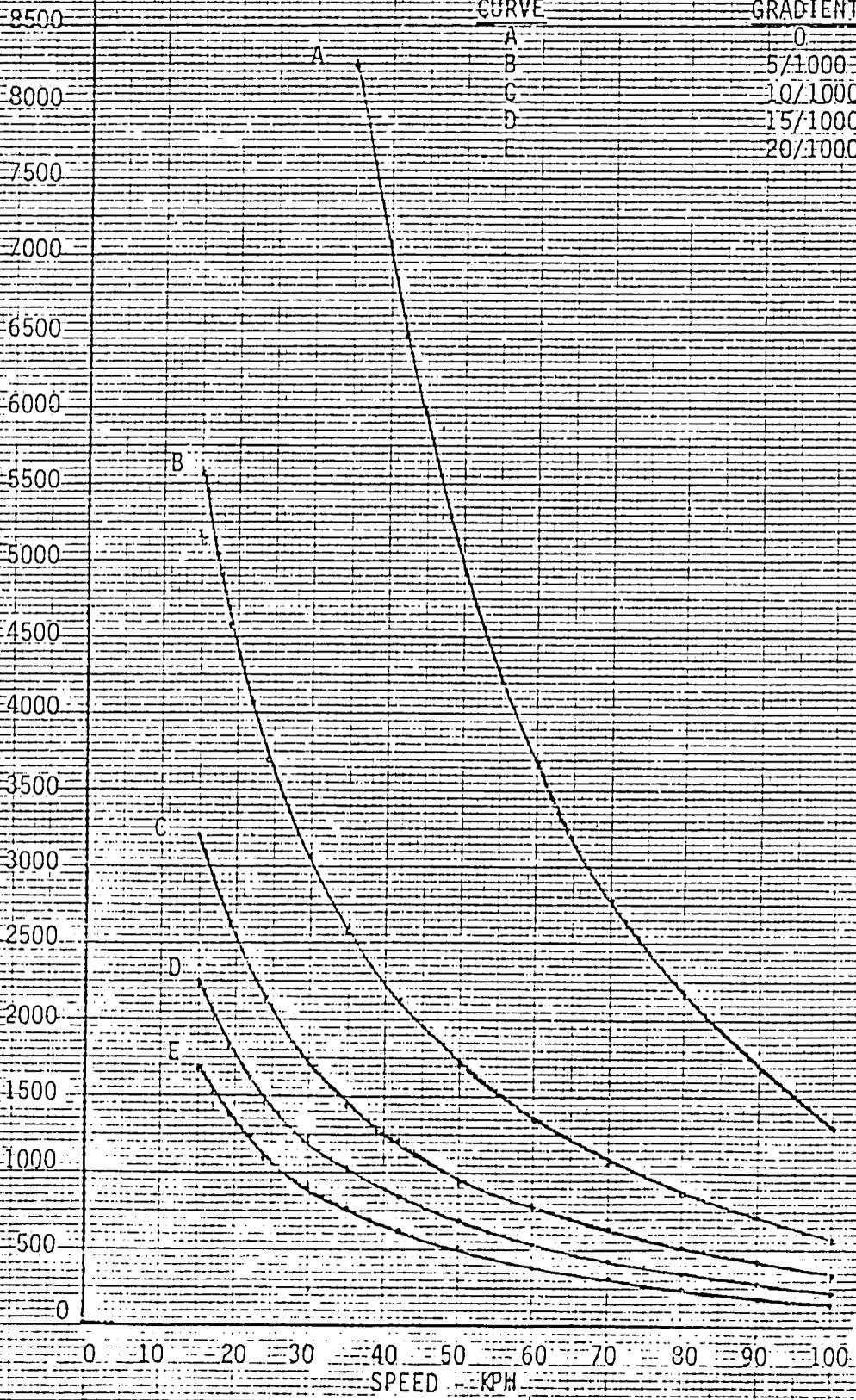
Revision 0

41H141682

TAZARA  
 U30C  
 93:18 Gear Ratio  
 36" Wheel Dia  
 3000 HP for Traction  
 (CVG-9/14/81)

CURVE	GRADIENT
A	0
B	5/1000
C	10/1000
D	15/1000
E	20/1000

TRAILING LOAD - METRIC TONS



SUMMARY OF LOCOMOTIVE FAILURES FOR DFH-REPOWERED LOCOMOTIVE FOR THE YEAR 1985/86

See notes on Sheet 4 attached

Month	Total Kilometrage	Locomotive Failure Components									Total Failures	Rate of Failure per 10 <sup>5</sup> km
		D/engine	Transmission	Electrical	Brakes	Cooling System	Bogies	Compressor & Exhauster	Wheel Slipping	Others		
July	125,157	1	4	4	-	4	1	1	-	-	15	12.5
August	111,227	-	3	1	-	2	-	4	-	1	11	10.0
September	120,823	2	2	2	-	1	-	7	-	-	14	11.7
Quarterly Totals	357,209	3	9	7	-	7	1	12	-	1	40	11.2
October	154,798	3	5	1	-	1	1	1	1	1	14	9
November	108,190	1	1	3	-	2	-	-	1	2	10	9
December	145,470	5	4	6	-	2	-	-	-	2	19	13
Quarterly Totals	408,458	9	10	10	-	5	1	1	2	5	43	10.5
Half Year Totals	765,667	12	19	17	-	12	2	13	2	6	83	10.8
January	105,137	7	3	1	-	-	-	3	-	1	15	14.3
February	126,621	1	-	2	-	1	-	1	-	-	5	4.2
March	114,176	7	1	2	-	-	-	-	-	-	10	8.8
Quarterly Totals	345,934	15	4	5	-	1	-	4	-	1	30	8.7
April	141,395	1	-	1	-	-	-	1	-	-	3	2
May	131,920	1	4	5	-	1	1	1	-	-	13	9.8
June	123,050	2	2	5	1	-	1	-	-	1	12	9.8
Quarterly Totals	396,365	4	6	11	1	1	2	2	-	1	28	7
Half Year Totals	742,299	19	10	16	1	2	2	6	-	2	58	7.8
Yearly Totals	1,507,966	31	29	33	1	14	4	19	2	6	141	9.4

SUMMARY OF LOCOMOTIVE FAILURES FOR DFH CONVENTIONAL LOCOMOTIVE FOR THE YEAR 1985/86

See notes on Sheet 4 attached

Month	Total Kilometrage	Locomotive Failure Components									Total Failures	Rate of Failure per 10 <sup>5</sup> km
		D/engine	Transmission	Electrical	Brakes	Cooling System	Bogies	Compressor & Exhauster	Wheel Slipping	Others		
July	186,651	17	3	3	-	5	1	2	-	3	34	18
August	206,637	6	1	2	2	2	1	3	-	1	18	9
September	202,786	14	1	4	-	1	-	3	-	-	23	11
Quarterly Totals	596,074	37	5	9	2	8	2	8	-	4	75	12.6
October	215,698	20	3	4	-	2	-	1	-	2	32	14.9
November	211,247	17	5	6	-	2	-	-	-	2	32	15.2
December	146,272	20	7	4	3	1	-	3	-	-	38	26
Quarterly Totals	573,217	57	15	14	3	5	-	4	-	4	102	17.9
Half Year Totals	1,169,291	94	20	23	5	13	2	12	-	8	177	15
January	184,755	9	-	1	-	3	2	-	-	-	15	8
February	185,897	12	1	5	-	2	-	1	-	-	21	11.3
March	178,238	25	3	5	3	3	-	1	-	-	40	22.1
Quarterly Totals	548,890	46	4	11	3	8	2	2	-	-	76	13.8
April	176,285	10	1	3	2	-	1	-	-	1	20	11.4
May	142,582	8	1	3	-	3	-	-	-	3	18	12.9
June	174,676	13	-	3	-	4	-	2	-	-	22	12.6
Quarterly Totals	493,543	31	2	9	2	7	1	2	-	4	60	12.2
Half Year Totals	1,042,433	77	6	20	5	15	3	4	-	4	136	13
Yearly Totals	2,211,724	171	26	43	10	28	5	16	-	12	313	14.2

SUMMARY OF LOCOMOTIVE FAILURES FOR U30C LOCOMOTIVES FOR THE YEAR 1985/86

See notes on Sheet 4 attached

Month	Total Kilometrage	Locomotive Failure Components							Total Failures	Rate of Failure per 10 <sup>5</sup> km
		D/engine	Electrical	Brakes	Cooling System	Traction Motors	Wheel Slipping	Others		
July	80,498	-	-	-	-	-	1	-	1	1.25
August	78,754	-	-	1	2	-	2	-	5	6.4
September	73,071	1	1	-	1	-	3	1	7	9.6
Quarterly Totals	232,323	1	1	1	3	-	6	1	13	5.7
October	65,303	-	1	-	1	-	1	2	5	7.7
November	80,376	1	-	-	-	-	3	-	4	5
December	73,990	1	2	-	-	-	4	4	11	15
Quarterly Totals	219,669	2	3	-	1	-	8	6	20	9
Half Year Totals	451,992	3	4	1	4	-	14	7	33	7.3
January	57,427	-	1	2	-	-	6	1	10	16.7
February	65,433	-	-	-	-	-	2	2	4	6
March	70,546	1	1	-	-	-	12	1	15	21
Quarterly Totals	193,406	1	2	2	-	-	20	4	29	11
April	70,487	-	1	-	-	-	2	-	3	4.3
May	78,329	-	1	-	1	-	9	-	11	14
June	67,273	1	1	1	-	1	3	-	7	10
Quarterly Totals	216,089	1	3	1	1	1	14	-	21	9.5
Half Year Totals	409,495	2	5	3	1	1	34	4	50	12
Yearly Totals	861,487	5	9	4	5	1	48	11	83	9.6

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NOTES ON LOCOMOTIVE FAILURE SUMMARY

1. Failures on Chinese engines include leakages (water and oil), cracking of pipes, damages to crankcases, cylinder heads, turbochargers, etc.
2. All failures on MTU engines are due to airlock.
3. Failure rates on conventional locomotives and repowered locomotives (excluding engine failures) take the same pattern.
4. All, but one, engine failure on U30C locomotives have been due to crankcase over-pressure (COP).
5. The majority of failures on U30C locomotives are due to wheel slipping. These locomotives are equipped with a motor speed panel which detects wheel slips and subsequently reduces engine load so as to protect the locomotive wheels and rails. Such equipment is not installed in the other locomotives hence wheelslips don't feature as failures though the locomotives also do slip.
6. The majority of wheelslips are due to wet rails (oily or when covered with dew) lack of sand (finished) or blocked sanding system.
7. Other failures includes:
  - (i) Insufficient fuel.
  - (ii) Failures of other auxiliary systems like heat exchangers, leakages of preheating boilers, etc.

TANZANIA ZAMBIA RAILWAY AUTHORITY

HEAD OFFICE

MECHANICAL ENGINEERING DEPARTMENT

Ref. No. TZR/C/84/1

Date: 23rd June 1986

ANNUAL MAINTENANCE AND REPAIR PLAN FOR LOCOMOTIVES,  
ROLLING STOCK, EQUIPMENT, POWER SUPPLY AND AUXILIARY  
PRODUCTION FOR THE YEAR 1986 - 87

1.0 INTRODUCTION

- 1.1 The production plan for the Mechanical Engineering department for the 1986/87 financial year is as laid down herebelow. This plan has been worked out taking into consideration past experiences and existing problems in production, the state of locomotives, rolling stock and equipment, and development projects in hand.
- 1.2 The targets that have been worked out are in accordance with the demand of the traffic plan. If the traffic plan is to be successfully implemented, it is most important that the targets as set herein are achieved. It is the duty of every supervisor to ensure that these targets are met.
- 1.3 All monthly production plans for the workshops and other units shall be based on targets set out in this plan. Detailed month to month plans may be varied according to undulations in monthly traffic levels. However, the overall quarterly and half yearly plans must agree with the targets set out in this plan.
- 1.4 On the fulfilment of production plans in previous years, it was observed that some of the bottlenecks to production were within the capability of the various units to overcome. Examples are supply of timber or paint for repairs, items which are available in the local market. It is hereby re-emphasized that timely measures have to be instituted to ensure that such bottlenecks are overcome in time.

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- 1.5 The fleet of conventional DFH locomotives is now over ten years old. Regulations governing repairs on these locomotives requires that heavy repairs be undertaken every 4½ years. This has not been done in the past. If these locomotives are to continue running, all the scheduled heavy and medium repairs have to be fulfilled without fail.
- 1.6 To speed up repairs of locomotives, the interchangeable component pool has to be brought into full play. Each workshop shall draw up a special programme for the consolidation of the interchangeable component pool. All repair detention times as provided for in this plan assume existence of this pool, and these have to be strictly adhered to.
- 1.7 Repairs on coaches and wagons has been lagging behind. Most coaches are overdue for heavy repairs and a large number of wagons are overdue for heavy and medium repairs. Safety in operations demands that these repairs be undertaken timely. Each workshop will ensure that the targets for repairs of coaches and wagons are fulfilled without fail.
- 1.8 Modification work of fitting container retainers on all DSO wagons and replacement of clamps will continue to be undertaken as part of medium and heavy repairs. This will continue until all DSO's and flats are fitted with the retainers.
- 1.9 An interchangeable component pool for wagons, in particular bogies, must be consolidated to speed up repairs. Repairs on boggies shall receive special attention as this has been a bottleneck in wagon repairs.
- 1.10 Repairs on refrigerated wagons was not undertaken as required in last year's production plan. The condition of these wagons has thus continued to deteriorate. It is emphasized that the provisions as per this plan must be fulfilled.
- 1.11 Repairs of accident wagons is intended to regain this important asset. In the past, this activity has been afforded secondary attention. It should be given the attention it deserves.

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1.12 The working efficiency of workshops depends on the quality of various working equipment, and to keep equipment constantly in good condition, they must be maintained well. Repairs as envisaged in the plan must be fulfilled.

1.13 Workshop buildings are also in a bad state. Roofs are leaking, gutters are worn out and chimneys need replacement. Work on these must be carried out during the planned period.

1.14 Auxilliary production and power supply have in the past been fulfilled satisfactorily. This trend should be enhanced.

1.15 Detailed provisions and explanations of the plan are as follows:

#### 2.0.0 LOCOMOTIVES

The various parameters of the 1986/87 production plan for locomotives are as follows:

#### 2.1.0 Conventional DFH locomotives and motor trolleys

#### 2.1.1 Maintenance and Repair:

Description	Repair Class	NUMBER OF LOCOMOTIVES		
		TANZANIA REGION	ZAMBIA REGION	TOTAL
Intermediate Inspection	A	110	64	174
Light repair B	B	26	15	41
Light repair A	C	14	11	25
Medium repair	D	10	5	15
Heavy repair	E	2	2	4
Accident repair	G	2	1	3
160 HP trolley repairs	T	4	4	8

B.N. The 160 HP motor trolleys belong to the Civil Engineering Department. Each PME will liaise with the PCE in the Region on the withdrawal of these trolleys for repair.

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2.1.2. Detention time for locomotive repairs.

These are limited as follows:

Description	Repair Class	Allowable detention time in days (maximum)
Inter period inspection	A	3
Light Repair B	B	6
Light repair A	C	35
Medium repair	D	60
Heavy repair	E	90

It should be noted here that detention time exceeding any of the above provisions will have to be accounted for:

2.1.3 Locomotive availability:

The locomotive availability for conventional DFH locomotives shall be 40%.

2.2.0 Repowering and repowered locomotives:

2.2.1 Phase III of the repowering project has extended to the current plan. Locomotives no. DFH2 80 and DFH2 93 will be repowered in the Tanzania Region. The repowering work on the above locomotives should be completed and put into operation by end of November 1986 at the latest. The locomotive body for repowering, including the hydraulic transmission units, running gear, compressors and exhausters, electrical wiring and so on will be worked on in accordance with the requirements of heavy repairs for DFH locomotives.

2.2.2 The targets for the servicing, maintenance and repair of repowered locomotives will be as follows:

Engine Hours	Repair Class	Tanzania Region	Zambia Region	Total
500	W <sub>1</sub> /A	42	40	82
1000	W <sub>1</sub> /B	21	20	41
2000	W <sub>4</sub> /C	17	16	33
8000	W <sub>5</sub> /DorC	2	2	4

2.2.3 Detention times for locomotive servicing, maintenance and repair will be as follows:

Engine hours	Repair Class	Allowable detention time in days (maximum)
500	W <sub>1</sub> /A	2
1000	W <sub>2</sub> /B	5
2000	W <sub>4</sub> /C	15
8000	W <sub>5</sub> /D	60

2.2.4 Locomotive availability:

The minimum locomotive availability for repowered locomotives shall be 65%.

2.3.0 Diesel Electric locomotives

Maintenance and repair of diesel electric locomotives will be in accordance with the following targets.

2.3.1 Maintenance and Repair

Repair Definition	Repair Class	Tanzania Region	Zambia Region	Total
Monthly	G2	37	34	71
3-monthly	G3	10	8	18
6-monthly	G4	5	4	9
Annual	G5	0	0	0
2-yearly	G6	4	3	7
4-yearly	G7	3	2	5
Accident	G	1	1	2

All repairs i.e. G2 through G7 will be carried out at the Mbeya repair shop. Accident repairs for the Zambia based locomotive, DE 1008 will be carried out in Mpika, and those for DE 1006 will be partly carried out in Mbeya and partly in Mpika or Dar es Salaam.

2.3.2 Detention time for the servicing, maintenance and repair of diesel electric locomotives:

These will be in accordance with the following:

Repair definition	Repair Class	Allowable time (days)
Monthly	G2	1
3-monthly	G3	1
6-monthly	G4	2
Annual	G5	4
Two yearly	G6	6

In the previous year, long detention times were recorded for casual repairs, particularly related to the re-profiling of wheelsets. With the now available set of spare boggies, this phenomenon should now be a thing of the past.

2.3.3 Locomotive availability:

The minimum locomotive availability for DE locomotives shall be 65%.

3.0.0 ROLLING STOCKS

3.0.1 As already pointed out in 1.7 above, repairs on rolling stock have been lagging behind plan in the last years, and this situation is not conducive to safety operations. Most of the materials required for the fulfilment of the planned tasks are now available ex-stock. Only commitment is now required to ensure fulfilment of the set targets as follows:

3.1.0 Repair of Coaches:

Repair Class Unit	Heavy Repair	Medium Repair	Light Repair
Tanzania Region	4	36	60
Zambia Region	4	36	54
System Total	8	72	114

3.2.0 Repair of Goods Wagons:

Repair Class Unit	Heavy Repair	Medium Repair	Light Repair	Accident Repair
Tanzania Region	149	446	1190	30
Zambia Region	149	446	1190	30
System Total	298	892	2380	60

NB. All DSO and flat wagons under medium and heavy repair, which are either fitted with container clamps or unmodified will be remodified/modified by fitting in the retractible container retainers as part of the scope of work for medium and heavy repairs.

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3.3.0 Repair of Refrigerated wagons - to be read with notes 1.10:

	Wagon No.	Body	Engine, generator and compressor	Running Parts
Tanzania Region	R004	Heavy Repair	Medium repair	Medium repair
	R008	Heavy Repair	"	"
	R012	Heavy Repair	"	"
	R013	Heavy Repair	"	"
Zambia Region	R003	Medium Repair	"	"
	R007	Medium Repair	"	"
	R010	Medium Repair	"	"
	R019	Medium Repair	"	"

After repairs, the wagons will be stored. These in Tanzania Region in Mbeya, and those in Zambia in Mpika.

3.4.0 Rate of defective wagons:

The rate of defective wagons shall be maximum 160 vehicles a day.

3.5.0 Detention time for the repair of coaches and wagons (in days) shall be as follows:

Vehicle Type	Repair Class			
	Heavy Repair	Medium Repair	Light Repair	Casual Repair
Coach	60	12	1	1
Wagon	9	2	.5	.5

4.0.0 WHEEL SETS

4.1.0 Machining of wheel sets for both locomotives, rolling stock and motor trolleys will be programmed individually by each Region so as to meet the demand for the repair plan as outlined above as well as demand for wheelsets from various depots.

4.1.2 The monoblock wheels on diesel electric locomotives are falling due for fitting new tyres. Instructions in this regard have already been issued by this office. Machining of wheelsets for DE locomotive should always be given adequate priority so as to cut down on downtime on these locomotives awaiting wheelset machining.

**5.0.0 POWER SUPPLY AND POWER SUPPLY EQUIPMENT REPAIR**

5.1.0 The levels of power generation will be determined and planned for by each Region compatible with the varying demand of various stations.

5.2.0 Targets for the repair of power supply equipment (diesel generators and control equipment) are as follows:

Repair Type	Unit	Engine Type	Tanzania Region	Zambia Region	System Total
Heavy repair	set	6160A	1	2	3
Repair Class 3	set	6160A	2	1	3
Repair Class 2	set	6160A	5	5	10
Repair Class 1	set	6160A	28	28	56

**6.0.0 EQUIPMENT MAINTENANCE AND REPAIR**

6.1.0 The repairs of workshop equipment in the two workshops and depots under the Mechanical Engineering Department will be as follows. Casual repairs will be undertaken as per demand:

Repair Class	Tanzania Region	Zambia Region	System Total
Heavy Repair	7	8	15
Medium repair	12	18	30
Light repair	240	240	480

6.1.1 This plan does not however include repairs to equipment whose complex coefficient is less than 3. Repairs to such equipment will be programmed individually and separately by each Region.

6.2.0 The repairs to equipment belonging to and used by other departments/units - the Civil Engineering department, quarries, Construction Units etc. will be carried out in accordance with requests/applications for this service by the user units. Such requests should then be incorporated in the month to month working plan of each workshop.

6.3.0 Modification Works: The MTU engines used in our repowering

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- Details of the modification work required will be issued by this office later in the course of the year. Similarly modification work on the injector pump testing machine.

#### 7.0.0. WORKSHOP AUXILLIARY PRODUCTION

7.1.0 The targets for auxiliary production are as set out hereunder. These are basically the same as the previous year as the overall production task has not changed extensively.

	Unit	Tanzania Region	Zambia Region	System Region
Forging	Tons	40	38	78
Castings	Cast iron	Tons	520	500
	Cast steel	"	4	20
	Non ferrous	"	14	8
Locomotive spares	Pcs	42,000	42000	84000
Wagon spares	"	4,500	4,500	9,000
Coach spares	"	1380	1380	2760
Wagon brake blocks	"	38400	27600	66000
Locomotive brake blocks	"	3000	3000	3000
Oxygen	Cylinders		1200	1200

#### 7.2.0 Contracting of outside works:

As and when the repairs of locomotives and rolling stock are not to be affected, each workshop can contract to carry out works for other customers including government departments, parastatal organisations, private companies and individuals. Every such customer shall undertake to provide his own raw-materials for such works. The works will be costed in accordance with accounting standards of the Authority and paid for before such completed jobs are delivered to the customer.

#### 8.0.0 MAINTENANCE OF WORKSHOP BUILDINGS AND FACILITIES

The state of workshop buildings and chimneys was already mentioned under item 1.13 in the introduction. Water seepage for machine pits is another problem in hand. This situation puts equipment, particularly electrical systems and control equipment to exposure of destruction.

Each PME shall liaise with the PCE to ensure that leaking roofs are repaired before the onset of the next rains. Each PME shall also be responsible for ensuring that broken down chimneys are restored during the plan-year. The programming of this work will be done individually in accordance with the actual state of the facilities.

9.0.0 CONCLUSION

9.1.0 The production plan has been worked out based on the demand of railway operations foreseen during the plan-year. It is therefore most essential that the plan is implemented to the better. It is the responsibility of every unit head/supervisor to ensure that individual targets set for their units are fulfilled.

9.2.0 As a means of keeping track of fulfillment of the set tasks, each workshop shall submit copies of their monthly production plans to this office for noting and review. At the end of each month, each mechanical engineering district and each workshop shall compile a performance report for the month completed. The performance reports shall reach the Head Office not later than the 25th of the month following. Failure to abide by this time table will result in the officer responsible for the respective unit to be dealt with accordingly based on existing codes on work performance.

9.3.0 Successful implementation of the plan means success for the Railway. Let all responsible be dedicated to their work and implement the laid down plan as drawn.

Yours faithfully,

  
L. B. J. Choggo

for General Manager

Copy to: General Manager

Deputy General Manager

All Heads of Department - Head Office

All Functional Heads - Regional Offices

PME (T)

## TANZANIA ZAMBIA RAILWAY AUTHORITY

APPENDIX C  
ITEM 4  
TANZANIA REGION  
PERFORMANCE REPORTTANZANIA REGION  
MECHANICAL ENGINEERING DEPARTMENT

## MONTHLY PERFORMANCE REPORT FOR THE MONTH OF MARCH 1987

## 1.0. OPERATION

## 1.1. LOCOMOTIVE AVAILABILITY

Type of Loco	Traffic Dept Monthly Plan Daily Requirement		MONTHLY PERFORMANCE AVERAGE DAILY SUPPLY								
	Yombo	Mbeya	Yombo			Mbeya			Tanzania Region		
	Daily Supply	Daily Supply	Average Daily Supply	Compared to previous m.	Availability %	Average Daily Supply	Compared to previous m.	Availability %	Average Daily Supply	Compared to previous m.	Availability %
DFH <sub>1</sub>	4	1	4.59	-0.39	65.6	0.92	+0.21	45.8	5.5	-0.19	61.0
DFH <sub>1</sub> Repowered (MTU)	Daily		0.99	+0.1	99%				0.99	+0.1	99%
DFH <sub>2</sub> Conventional	8		9.43	+2	37.8				9.43	+2	37.8
2 Repowered (MTU)		6	2.75	+0.93	91.8	5.16	-0.24	51.6	7.9	+0.69	60.8
DE	4	4				4.47	+0.29	63.8	4.47	+0.29	63.8
Total Mainline & Shunting Locos	12	11	17.78	+2.34	49.4	10.55	+0.25	55.5	28.3	+2.57	51.5
Mainline Locos			12.9	+2.34	43.5	9.6	+0.02	56.7	21.8	+2.05	48.5
Shunting Locos			5.59	-0.29	67.87	0.92	-0.21	45.8	6.5	-0.09	65%

For Tanzania Region, in total the daily supply of locomotives was higher by 2.57 compared to the previous month and higher by 5.3 compared to the Traffic Plan requirement.

- (i) According to the Traffic Plan Requirement the daily supply for D.E. Locomotives in Mbeya was higher by 0.47. However the daily supply was higher by 0.29 compared to the previous month.
- (ii) The repowered mainline locomotives based at Mbeya were less by 0.24 on daily supply basis compared to the previous month but higher by 1.9 compared to the Traffic Plan requirement (considering also those MTU locos which are operating in Yombo)
- (iii) The daily supply of conventional DFH 2 locomotives based at Yombo were higher by 2 compared to the previous month and higher by 1.43 compared to the Traffic Plan requirement.
- (iv) The shunting locomotives based at Yombo were more by 0.59 compared to the Traffic Plan requirement on daily supply basis but less by 0.39 compared to the previous month.
- (v) The introduction of a repair team for locomotives under casual repair at Yombo has resulted to an improvement of locomotive availability. During this month the repair team also attended the technical inspection, one for W3 and three for W2.

## 2.0. MAINTENANCE AND REPAIRS

### 2.1. LOCOMOTIVES

#### 2.1.1. PLANNED REPAIRS OF LOCOMOTIVES

2.0. MAINTENANCE AND REPAIRS

2.1 LOCOMOTIVES

2.1.1. PLANNED REPAIRS OF LOCOMOTIVES

Repair Point	Rep.	DFH-Locos					DFH-Repowered (MTU)				DE-Locos						Total	
		HR	MR	LRA	LRB	TI	W5	W4	W3	W2	G7	G6	G5	G4	G3	G2	No	%
D'Salaam w/Shop	Plan		1	1	3	2	1		0	0							8	
	Act.		1	1	4	2	0		1	3							12	150%
Mbeya	Plan								2	6				2	4	14		
	Act.								0	3				2	3	8	57.1%	
Tanzania Region	Plan		1	1	3	2	1		2	6				2	4	22		
	Act.		1	1	4	2	0		1	6				2	3	20	90.9%	

- (i) The fulfillment of planned repairs in Dar es Salaam Workshops was 150% due to the transfer of casual repairs to Yombo Depot hence providing enough time for periodical repairs. The repairs were affected due to shortages of spares and materials as listed.
- (ii) The fulfillment of planned repairs at Mbeya was 57.1% only. Among the contributing factors are:
- Higher casual repairs - 24 locos were attended under casual during March at Mbeya, while 8 locos only were attended under casual during the previous month.
  - Due to the demand of Traffic operation some locos supposed to undergo Technical Inspection could not enter Mbeya Workshop.
  - Untimely supply of spares and materials from Dar es Salaam
  - Some components had to be repaired at DSM Workshops causing higher detention times.

2.1.2. CASUAL REPAIR

Locomotive Depot	YOMBO	MBEYA	TANZANIA REGION	
			Total	Compared to previous Month
Locomotive Attended	19	24	43	+16
Total Detention (Time (Days))	117.5	112.8	230.3	+52.1
Average Detention (Time Days)	6.18	4.7	5.36	-1.24

(a) The number of locomotives under casual repair in Tanzania Region was higher by 16 due to an increase of Traffic Tonnages (copper from Zambia) conveyed during March compared to the previous month, hence some locos due for periodical repairs could not enter Workshops.

(b) The average detention time for each locomotive attended for casual repair was reduced by 1.24 days compared to the previous month.

The long average detention time in Mbeya was contributed by DE locomotives due to the complex fault finding also was contributed by shortages of spares and materials including awaiting of some components from Dar es Salaam Workshops (wheelsets for DE locos, valves, power assemblies and motors which are normally repaired at DSM Workshops).

2.1.3. DAILY PLANNED AND CASUAL REPAIRS OF LOCOMOTIVE UNDERFRAME

Locomotive Depot	Planned Repairs		Casual Repairs	
	Number of Locos	%	Number of Locos	%
Yombo	6.2	17.3%	12	33.3%
Mbeya	4.25	22.4%	4.19	22.1%
Tanzania Region	10.47	19.0%	16.2	29.4%

2.2. ROLLING STOCK REPAIR SUMMARY

Repair Point		Coach	Coach	Coach	Wagon	Wagon	Wagon	Wagon
		L/R	M/R	H/R	L/R	M/R	H/R	CC/R
DSM W/Shop	Pln.	3	2	1	10	15	-	4
	Act.	1	2	-	18	5	-	4
Yombo	Pln.						100	
	Act.						95	

(i) Most of coaches are overdue for Medium and Heavy Repairs such that only one coach was attended for Light Repair while much effort was put on Medium repair and the fulfillment for Medium repairs was accomplished.

The fulfillment of coach repairs was affected due to shortages of materials and spares as listed in the chart.

(ii) The fulfillment of wagon repairs was satisfactory though for Medium repairs was poor because much effort was put on heavy and accident repairs where for heavy they overfulfilled and

for accident they accomplished according to the plan. The wagon repairs were affected due to the shortage of materials and spares as listed in the chart.

(iii) The Yombo Rolling Stock repair point fulfilled 95 wagons under Light Repair out of 100 wagons as per plan. The repairs were affected due to the awaiting of materials and spares being repaired at DSM Workshop.

### 3.0. PROGRAMME FOR MONTH OF APRIL 1987

The tasks conducted in the previous month (February 1987) will continue in the month of April 1987.

3. NINE ...

SER NO	NAME OF PLANT	PLANT	REMARKS
1	Chamoe seed	A	11-16, 115, 0-90
2	Cash	1.0.1	11-16, 115, 0-90
3	Emm-c	4	11-16, 115, 0-90
4	Tender	2	11-16, 115, 0-90
5	Justiciary	1	11-16, 115, 0-90
6	Emm-c	1	11-16, 115, 0-90
7	Chamoe seed	1	11-16, 115, 0-90
8	Cash	1.0.1	11-16, 115, 0-90
9	Chamoe seed	1.0.1	11-16, 115, 0-90
10	Emm-c	1	11-16, 115, 0-90
11	Chamoe seed	1.0.1	11-16, 115, 0-90
12	Chamoe seed	1.0.1	11-16, 115, 0-90

TANZANIA ZAMBIA RAILWAY AUTHORITY

MECHANICAL ENGINEERING DEPARTMENT

- XC- FEBRUARY 1987 PERFORMANCE REPORT

MPIKA WORKSHOPS PRODUCTION AND -  
OPERATIONS

DATE: 02.03.87

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/vcc

1.1.0 LOCOMOTIVE MAIN ENLANCE REPORT1.1.1 CONSERVATIONAL LOCOMOTIVES

REPAIR CLASS	PLAN	ACTUAL	AVERAGE DETENTION TIME	3-MONTH CUM TOTAL	8-MONTH % FULFILMENT	H2 FULFILMENT	REMARKS
A	8	4	10.5	26	50%	60.5%	
B	1	0	-	14	87.5%	93.3%	
C	2	1	-	3	33.3%	27.5%	
D	0	0	-	2	66.3%	40.0%	
E	2	0	-	1	50%	50%	
ACC.	1	0	-	0	0		Still in process
CASUAL	-	2	4.5	97	-	-	

1.1.2 REPOWERED LOCOMOTIVE

W <sub>2</sub>	5	5	4.8	30		75%	
W <sub>3</sub>	2	1	4	13	65%	65%	
W <sub>5</sub>	0	0	-	3	150%	160%	
ACC.	-	1	9	2	-	-	
CASUAL		9	19	46	-	-	

1.1.3 DIESEL ELECTRIC LOCOMOTIVE

G2	2	2	9	17	-	50%	Figures are
G3	2	2	9	7			not accurate
G4	-	-	-	-		0%	enough due
G5	-	-	-	-		0%	to statistics
G6	2	0	0	3		100%	not being
G7	-	-	-	-		0%	received
							regularly from Mbeya

1.1.4 MOTOR TROLLEYS

Heavy	1	0	0	0	0	0	
Casual	1	0	-	0	2	2	

1.1.5 PLANNED REPAIR SCHEDULE

S/N	LOCC NO. AND TYPE	REP. IR CLASS	ACTUAL REPAIR	DATE IN	DATE OUT	REMARKS
1.	DFH <sub>2</sub> 064	E	E	2/1/87	-	
2.	" 073	E	E/Reh	9/12/86	-	
3.	" 087	C	C	19/2/87	-	
4.	DFH <sub>1</sub> 011	C	C	29/1/87	-	
5.	DFH <sub>2</sub> 028	W <sub>4</sub>	W <sub>4</sub>	28-1.87	12/2"87	
6.	" 039	W <sub>4</sub>	W <sub>4</sub>	9/2/87	-	
7.	" 053	B E	B	24/2/87	-	
8.	" 020	W <sub>3</sub>	W <sub>2</sub>	26/1/87	4/2/87	
9.	" 068	W <sub>3</sub>	W <sub>3</sub>	3/2/87	-	
10.	DFH <sub>1</sub> 016	A	A	22/2/87	-	
11.	" 012	A	A	21/2/87	27/2/87	Low n/Metres
12.	" 015	A	-	-	-	Low K/Metres
13.	DFH <sub>2</sub> 026	A	A	5/2/87	11/2/87	
14.	" 041	A	A	15/2/87	17/2/87	
15.	" 084	A	B	24/2/87	-	
16.	" 095	A	-	-	-	Low K/Metres
17.	" 096	A	-	-	-	" "
18.	" 013	W <sub>2</sub>	W <sub>2</sub>	21/2/87	-	
19.	" 029	W <sub>2</sub>	-	-	-	Low hours
20.	" 033	W <sub>2</sub> W <sub>2</sub>	W <sub>2</sub> /2/87	26/2/87	21/2/87	
21.	" 067	W <sub>2</sub>	W <sub>2</sub>	23/2/87	25/2/87	
22.	" 094	W <sub>2</sub>	W <sub>2</sub>	11/2/87	13/2/87	
23.	DE 1003	Y <sub>3</sub>	-	-	-	
24.	1007	Y <sub>3</sub>	Y <sub>3</sub>	15/2/87	-	
25.	1010	-	G <sub>2</sub>	15/1/87	1/2/87	
26.	1012	G <sub>3</sub>	-	-	-	
27.	1013	G <sub>3</sub>	G <sub>2</sub>	17/2/87	18/2/87	

S/N	LOCO NO.	DATE IN	DATE OUT	DEFERRED TIME	REMARKS
1.	DFH <sub>2</sub> 072	29/1/87	4/2/87	6	
2.	" 030	31/1/87	5/2/87	5	
3.	" 015	2/2/87	3/2/87	1	
4.	" 051	3/2/87	3/2/87	-	
5.	" 030	5/2/87	5/2/87	-	
6.	" 068	10/2/87	10/2/87	-	
7.	DFH <sub>2</sub> 072	15/2/87	15/2/87	2	Accident Repair
8.	DFH <sub>2</sub> 084	13/2/87	24/2/87	11	" "
9.	" 030	16/2/87	25/2/87	9	" "
10.	" 053	16/2/87	24/2/87	8	" "
11.	" 028	16/2/87	17/2/87	1	
12.	" 051	17/2/87	24/2/87	7	
13.	" 004	17/2/87	17/2/87	-	
14.	" 005	17/2/87	17/2/87	5	
15.	" 074	18/2/87	21/2/87	3	
16.	" 020	23/2/87	25/2/87	2	

PROJECTED LOCOMOTIVE REPAIR SCHEDULE FOR MARCH 1987

S/N	LOCOMOTIVE NO.	TOTAL KM UP TO MONTH OF JANUARY 1987	CUMULATIVE KM LAST REPAIR/ENGINE TOTAL HOURS (E. DI - II)		LAST TWO REPAIR	REPAIR PLAN FOR MARCH
			KM	HOURS		
1.	DFH <sub>1</sub> 011	491,557	-		A-A	C
2.	" 012	363,500	-		A-B	A
3.	" 015	380,271	14,521		A-D	A
4.	" 016	389,400	-		B-B-	A
5.	" 017	492,650	3,300		B-A	A
6.	DFE <sub>2</sub> 015	600,430	-		W3-W2	-
7.	" 020	770,292	6599	7316-7804	W2-W2	W5
8.	" 022	778,928	5829	9701-9814	W1-W2	W4
9.	" 026	581,057	3724		B-A	A
10.	" 028	951,996	4245	12118-12145	W2-W4	W2

11.	"	029	893,499	2066	15105-14415	W2-W4	W3
12.	"	030	923,952	3190		W2-W3	W2
13.	"	037	820,051	754	-	W4-W2	-
14.	"	034	699,888	3794		-E	A
15.	"	039	652,158	-	11827-11995	W3-W2	W4
16.	"	041	729,547	1917		B-A	C
17.	"	051	758,965	5945		W4-W2	W3
18.	"	053	572,154	7016		A-A	B
19.	"	064	594845	-		A-A	E
20.	"	067	943633	10,866	11667-11601	W3-W2	-
21.	"	068	692,439	7042	1287-1272	W2-W3	W2
22.	"	072	676,181	10,309		A-B	A
23.	"	073	472-664	472,664		ACC,	E
24.	"	083	540,073	10904		B-A	D
25.	"	084	660,042	5284		B-A	B
26.	"	086	275,829	8295	947-252	E-W2	W2
27.	"	087	468,076	2506		A-A	C
28.	"	094	565,060	3794	10718-10752	W4-W2	W3
29.	"	095	400,247	11315		B-A	A
30.	"	096	429,024	13,874		C-A	A
31.	DE	1003	294,859	-	-	-	Y3
32.	"	1007	31,77710	-	-	-	G2
33.	"	1010	245,660	-	-	-	G6
34.	"	1012	242,533	-	-	-	G2
35.	"	1013	202,345	-	-	-	G2

1.1.7

PRODUCTION CONSTRAINTS AFFECTING LOCOMOTIVE  
REPAIRS

Lack of following materials and services affected production during the month of February 1987.

1. Erratic supply of oils and fuel
2. Lack of araldite for Engine water pump repairs
3. Partex - for transmission and bogie axle boxes overhauls
4. Emery cloth
5. No cotton waste
6. No Locomotive Batteries
7. No sanding hoses for locomotive sanding system
8. Erratic water supply affected steam
9. Power failure also affected production
10. Safety Boots - workers in wheelshops are not able to fit last shoes due to lack of boots

11. Locomotive engine cylinder head valves block has been exhausted. Engine overhauls may be affected.
12. During the month several locomotives have been involved in accidents thereby overloading the shop. All together 60 Locomotives have been involved in accidents.

1.2.0 ROLLING STOCK REPAIR AND MAINTENANCE

1.2.1 WAGONS

REPAIR CLASS	PLAN	ACTUAL	AVERAGE DET TIME(DAYS)	8-MONTH CUMULATIVE TOTAL	% FULFILMENT OF WKP PLAN	% FULFILMENT OF HQ PLAN
Heavy	13	1	42	24	23.3%	24%
Medium	38	19	16.4	151	49.7%	50.5%
Accident	4	7	26.1	28	140%	140
Modification	10	3	-	-	-	-

1.2.2 COACHES

Heavy	-					No Materials
Medium	3	1	180	15	62.5	62.5

1.2.3 REFRIDGERATED WAGONS

Medium	0	-	-	-	-	No Manuals
Casual	1	0	-	-	-	" "

1.2.4 CABOOSE

Heavy	-	-	-	-	-	Nothing available
Medium	-	-	-	-	-	Planned next month

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S/N	VEHICLE NO	DATE REP IR STARTED	DATE REPAIR COMPLETED	CLASS OF REPAIR	REMARKS
1	FT 021	16.2.87	19/2/87	M/R	
2.	" 089	" " "	18/2/87	"	
3.	" 009	14/2/87	13/2/87	"	
4.	" 099	16/2/87	" " "	"	
5.	" 045	11/2/87	13/2/87	"	
6.	" 019	12/2/87	" "	ACC+MR	
7.	" 113	12/2/87	" "	MR	
8.	" 120	11/2/87	12/2/87	"	
9.	" 029	8/2/87	11/2/87	"	
10.	" 118	8/2/87	11/2/87	"	
11.	" 001	8/2/87	14/2/87	"	
12.	" 070	8/2/87	10/2/87	"	
13.	" 077	18/2/87	26/2/87	MR	
14.	FO11	3/12/86	19/2/87	MR	
15.	CO448	23/1/87	23/2/87	ACC+MR	
16.	DS0553	22/1/87	9/2/87	MR	
17.	DS0 316	16/2/87	21/2/87	ACC+MR	
18.	FF 585	17/2/87	20/2/87	MR	
19.	" 441	8/2/87	18/2/87	HR	
20.	" 537	21/1/87	13/2/87	ACC+MR	
21.	" 402	19/2/87	16/2/87	" "	
22.	" 380	21/1/87	13/2/87	MR	
23.	HSO 324	3/12/87	19/2/87	MR	
24.	" 075	5/2/87	13/2/87	M/R	
25.	" 374	2/2/87	11/2/87	ACC+MR	
26.	" 122	15/1/87	13/2/87	" "	
27.	" 145	26/11/86	13/2/87	MR	
28.	Coach 2032	19/8/86	20/2/87	MR	

1.2.6 PRODUCTION CONSTRAINTS

1. Very few wagons from Operations were available for Scheduled repairs in the workshors
2. Breakdown of equipments ie Ultrasonic flaw detector and the shot blasting machine affected production.
3. Shortage spares 50T Bolster Springs coupler Knuckles and various coach spares (list already with Principal Supplies Officer) has contributed to non fulfilment of plans.
4. Erratic supply of steam due to shortage of Diesel and sometimes low water pressure affected production.
5. Heavy repair of wagons may come to a halt if shot blasting pellets are not available.
6. Livestock wagons are pending for Hardwood.
7. In the first week of February production was affected by lack of bearing grease.

1.3.0 AUX SHOP PERFORMANCE REPORT FOR FEBRUARY 1987

REPAIR CLASS	PLAN	ACT	8-MONTH CUMULATIVE TOTAL	8-MONTH % FULFILMENT WORKS	% FULFILMENT PLAN	REMARKS
HEAVY	1	0	4	80%	80%	Work in process
MEDIUM	2	0	12	80%	114.3%	" " "
LIGHT	21	21	156	98.7	97.5%	
CASUAL (MECH)	-	25	247	-	-	
CASUAL (ELECT)	-	22	121	-	-	

1.3.1 PRODUCTION CONSTRAINTS

1. Lack of waste Cotton/emery cloth has affected work on repair of equipments/Testing of Motors
2. Electro-plating plant is still closed awaiting chemicals to neutralize the waste solution in the reservoirs.
3. Silicon varnish for furnaces is required for the furnace No. 3 which is planned in the month of March.
4. Lack of blanks delayed the manufacturing of spares of equipments under medium and Heavy repairs.

DESCRIPTION	UNIT	PLAN	ACTUAL	8-MONTH CUMULATIVE TOTAL	8-MONTH PERCENT AGE FULFIL MENT	PERCENTAGE FULFILMENT OF HQ
Steel castings	Ton	1.70	-	1.284		
Forgings	Ton	3.16	3.70	41.93	110.0%	110%
C.I. Castings	"	41.70	13.26	140.99	28%	28%
NON-Ferrous casts	"	0.70	0.09	2.34	29.3%	29.2%
R/Stock B/Blocks	Each	2300	1774	12,209	44.19%	44.19%
Loco B/Blocks	"	250	-	1046	59.9%	59.9%
Wagon Spares	"	1135	868	85.96	191%	191.0%
Loco Spares	"	1826	1743	6884	16.4%	16.4%
Coach Spares	"	130	80	539	39%	39%
Aux Spares	"	360	266	1,777	-	-
30T Wheelsets	SET	30	15	138	-	-
30T Wheelsets	"	20	21 new 533	54	-	-
Loco Wheelsets	"	18	18	50	-	-
Bolster Springs		400	-	1746	72.5%	-

## 1.4.0

SPARES PRODUCTION CONSTRAINTS

1. Equipment breakdown affected spares production. ie moulding M/C furnaces and power failure.
2. Shortage of diesel affected forging work in F/F system
3. Shortage of water affected steam production
4. Lack of Bentonite powder/Water glass affected casting work in Foundry shop.

OUTSIDE JOB REPORT

PAGE 2

S/N _6	NAME OF CUSTOMER	JOB REQUIRED	AMOUNT PAID	RECEIPT NO.
1	T. Tembo	Manufacture of Basin stand	K19.97	11543
2.	M. Sata	Manufacture of rings (2)	K30.34	11541
3.	Mpika Dist. Council	Panel beading spray Painting	K316.46	11520
4.	Z.B.S. (Kasana)	Rewinding of Motors (2)	K628.99	
5.	S.M. Kalolo	Buying Oxygen Bottles	K172.00	11527
6.	Trent farms	Manufacture of shaft	K191.90	11509
7.	Z.N.C.B(MPIKA)	Charging Battery	K6.50	11503
		TOTAL	K1366=16	

MPIKA LOCOMOTIVE AND ROLLING STOCK SHOPS  
PLANNED PRODUCTION SUMMARY MARCH 1987

I	LOCOMOTIVES	SET	QTY	SHOP RESPONSIBLE	REMARKS
1.	Accident	"	1	Loco	73
2.	Heavy repair(E)	"	1	"	64
3.	Repair D/W5	"	2	"	
4.	Repair C/W4	"	4	"	
5.	Repair B/W3	"	6	"	
6.	Repair A/W2	"	12	"	
7.	M1-Inspection	"			
8.	M3 - Inspection	"			
9.	Y2-Inspection	"			
II.	TROLLEYS	SET	QTY		
1	Heavy repair	"	1		Kasana Trolley
2.	Casual Repair	"	2		1-Brought for wars from last month
III	WAGONS	SET	QTY	R/S	
1	Heavy repair	"	13	"	
2	Medium repair	"	38	"	
3.	Accident repair	"	4	"	
4.	Modification	"	10	"	
IV	COACHES	SET	QTY	"	
1	Medium repair	"	7		

"	Heavy repair	3ev	0	R/S	No Materials
V	CABOOSE	SET	QTY	"	
1	Heavy repair	"	0	"	Nothing available
2	Medium repair	"	1	"	
VI	REFRIGIDGERATED CAR				
	Medium repair	"	1	"	But no manuals
VII	WHEELSETS	EACH	QTY	SHOP	REMARK
1	50T Reprofile	"	40/30	R/S - spec	20 for operations
2	30T "	"	20	"	12 for operations
3	30T New Assembly	"	20	"	
4	Loco wheelsets	"	18	"	
VIII	EQUIPMENT	EACH			
1	Heavy repair	"	3	Aux	1-bought forward from last month
2	Medium repair	"	2	"	
3	Light repair	"	22	"	
IX	FORGINS/CASTINGS				
	Forging	T	3.16	F/F	
	C.I Castings	"	41.70	"	
	Non-ferrous casts	"	0.70	"	
	Steel castings	"	1.70	"	
	R/Stock B/Blocks	Each	2300	"	
	Loco C/Blocks	"	250	"	
	30T Bostersprings	"	400	"	

- 2.0.0 LOCOMOTIVE OPERATIONAL INDICES FOR FEBRUARY, 1987  
LOCOMOTIVE RUNNING AND RELATED PARAMETERS
- 2.0.1 Locomotive Availability: The high percentage of repairs caused the availability to fall to 67.9% in the month of February, 1987, from 70.3% experienced in January, 1987.
- 2.0.2 Locomotive Utility: Utility for February, 1987 was 64.7% this being slightly higher than January's 64.3%
- 2.0.3 Percentage of Reserving: 3.2%. This was lower than January's reserve of 6.0%, and the fall was of course due to increased flow of traffic.
- 2.0.4 Total Locomotive Running kilometers: Although availability fell in February, 1987, the slight rise in utility affected a rise in kilometers to 180892km, from 175497km achieved in January, 1987.
- 2.0.5 Passenger Loco Running Kilometers: 21123km. This was a drop from 22256km experienced in January 1987.
- 2.0.6 Shunting Loco Kilometers: The kilometerage dropped to 18480km, from 22380km experienced in January, 1987. The drop was caused by non availability of shunting loco in W/Shops.
- 2.0.7 Goods Loco Running Kilometers Along the Line: Goods kilometerage rose to 140369km, from 129725km experienced in January, 1987. This increase was caused by a rise in Utility.
- 2.0.8 Actual Running Time of Goods Main Loco: - 3062 hours. This was lower than 3604 hours experienced in January, 1987, and hence showing improved running time.
- 2.0.9 Total Ton-km of Goods Traffic: The ton-km for February, 1987 rose to 12059.5 Ton-km, from January's 10714.6 Ton-km. The rise was caused by increased average gross weight per train.
- 2.0.10 Locomotive Running Kilometers per Day: The month of February, 1987 experienced a rise in kilometers to 391km, from 389km realised in January, 1987. This slight increase was caused by a slight rise in Utility.
- 2.0.11 Technical Speed: The speed for February rose to 41.7km/hr, from 34.4km/hr experienced in January, 1987.

- 2.0.12 Average Gross Weight per Train: Average tonnage per train rose to 944 tons in February, 1987, from 864 tons achieved in January, 1987. The rise was due to increased number of full load trains.
- 2.0.13 Daily Output of Locomotives: 33.6 Ton-km/loco. This was higher than January's 32.1 Ton-km/Loco, and the rise was caused by an increased total tonnage.
- 2.0.14 Total Turnround time of Goods Loco: February, 1987 experienced a higher turnround time. It rose to 8628 hours, from 8032hrs experienced in January, 1987.
- 2.0.15 Kilometers Covered by Light Locomotives:- The kilometerage for February, 1987 rose to 12714km, from 5644km realised in January, 1987. This was caused by an increased number of locomotives running light.
- 2.0.16 Percentage of Locomotive Repairs:- February, 1987 experienced a rise in percentage of repairs to 32.1%, from 29.7% seen in January, 1987. The rise was caused by an increased number of locomotives admitted for both periodical and casual repair, the former affecting the more.
- 2.0.17 Percentage of Locomotives under Periodical Repairs:- February, 1987 had seen a rise in percentage of periodical repairs to 19.5%, from 16.8% experienced in January, 1987. The rise was caused by an increased number of Locomotives admitted for periodical repairs.
- 2.0.18 Percentage of Locomotives Under Casual Repairs:-The percentage of casual repairs for February, 1987 slightly fell to 12.6%, from 12.9% experienced in January, 1987. This slight fall was affected by a slight reduction in the number of - Locomotives admitted for casual repairs.
- 2.0.19 Number of Repairs: The number of repairs slightly fell to 315.0 in February, 1987, from 322.1 experienced in January, 1987.
- 2.0.20 Number of Locomotive Live failures: The number of failures in February, 1987 rose to 27, from 24 experienced in January 1987.

2.1.0 LOCOMOTIVE RUNNING AND OTHER PARAMETERS AS PER FLEET

	KMP LOCO	MTU LOCO	CONV. LOCO
1. Locomotive Availability	87.9%	75.0%	56.3%
2. Locomotive Utility	87.9%	71.4%	52.5%
3. Percentage of Reserving	%	3.6%	3.8%
4. Total Loco Running Kilometers	25255km	84493km	71147km
5. Passenger Loco Running kilometers	2835km	12004km	6096km
6. Shunting Loco kilometers	-	-	18480km
7. Goods Loco Running kilometers along the Line	22420km	72009km	46131km
8. Actual running time of goods Main Loco	569hrs	1518hrs	1309hrs
9. Total Ton-km of goods Traffic	1378.3Ton-km	6300.7Ton-km	3746.8ton-km
10. Loco Running Kilometers per day	258km	449km	417km
11. Technical Speed	36.1km/hr	44.4km/hr	30.6km/hr
12. Average Gross Weight per train	964Tons	936Tons	937Tons
13. Daily Output of Loco	22.7Ton-km/ Loco	39.3Ton-km/ Loco	33.9Ton-km/ Loco
14. Total turnround time of goods Loco	2115hrs	3862hrs	2658hrs
15. Kilometers Covered by light loco	1890	4684km	6140km
16. Number of trips	10	14	17
17. Percentage of locomotive Repairs	12.1%	25.0%	43.7%
18. Percentage of Locomotive Under periodical repairs	-	14.3%	29.2%
19. Percentage of Locomotive under Casual repairs	12.1%	10.7%	14.5%
20. Number of Repairs	17.0	91.0	208.0
21. Number of line failures	3	11	13

2.2.0

ACCIDENTS

February, 1987 experienced eleven train accidents against ten accidents experienced in January, 1987, as recorded on our locomotive operational indices, and viz:-

1. 2/2/87 New Kapiri: Shunting loco No, 016 and wagon No. H30 50677687 both derailed on point Nos. 17 and 19 during shunting work.
2. 3/2/87 Nkamba: Points No. 2 were split by train No. 0751 loco No. 83, as it was departing for Mkushi river.
3. 11/2/87 Chisanwa: Trains 0720 locos 84/72 and 777 locos 30/34 had a side on collision as they were being admitted into the station.
4. 11/2/87 New Kapiri: Loco No. 017 hit into standing wagons during shunting work, resulting into radiators shifting.
5. 12/2/87 Kapiri/Kapiri Section: Driver J. Kawaza of train No. 0720 locos 84/72 hit his head against a home signal post and sustained a cut, as train was in motion.
6. 15/2/87 Mkushi Boma: Train No. 0243<sup>c</sup> loco No. 94 passed through station with starting signal at normal position.
7. 15/2/87 Old Kapiri: Loco No. DFH<sub>2</sub> 96 hit into a pile of rails during shunting work, and this resulted into end II Cow catcher bending.
8. 19/2/87 Cheil: Loco No. 012 hit into standing wagons during shunting work, resulting into radiators shifting, and cooling fan shaft bending.
9. 20/2/87 Mkushi Boma: Train No. 778 loco No. 95 during shunting work, hit into vehicle bumper resulting into wagon No. C328 to jump over bumper.
10. 20/2/87 Makasa/Kapiri: 1113kn+425M: A Motor vehicle hit into running train No. 233 locos 15/012 on a level crossing. Driver of the motor vehicle failed to stop.
11. 24/2/87 Mpika: During shunting work with loco No. 015 wagon No. H30 50671120 uncoupled accidentally and went to split points No. 33.

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2.3.0

LOCOMOTIVE LINE FAILURES:

The performancy of our locomotives has gone down in the month of February, 1987. The number of failures rose to 27 against 24 experienced in January, 1987. The summary is here under given:-

1. Total number of Loco failures: 27

<u>Conventional Loco</u>	<u>MTU Loco</u>	<u>Krupp Loco</u>
13	11	3

2. Component failures:

Conventional Loco:

Diesel Engine	3	E/Box	3	Electrical	3
Bogie	-	Fuel System	1	E/Charger	1
Braking	-	Comp+Exhauster	1	Aux.System	4

MTU Loco

Diesel Engine	2	E/Box	5	Electrical	2
Bogie	-	Fuel system	1	E/Charger	-
Braking	1	Comp+Exhauster	-	Aux.System	-

Krupp Loco

Diesel Engine	-	Electrical System	-	3
Bogie	-	Compressor + Exhauster	-	-
Braking	-	Auxiliary System	-	-
Fuel system	-	Turbo charger	-	-

2.4.0

TRAIN DELAYS CAUSED BY MECHANICAL ENGINEERING DEPT

The month of February, 1987 experienced forty seven (47) cases of train delays caused by Mechanical Engineering department, against fifty six (56) cases of same realised in January, 1987, and Viz:-

1. Technical Examination - 7
2. Locomotive undergoing repairs - 13
3. Locomotive Servicing - 3
4. Wagon undergoing repairs - 5
5. Fitting brak blocks or hose pipes/clips on wagons 4
6. Locomotive driver either reporting late or absent 10
7. Others - 5

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2.5.0 TRAIN DELAYS SUMMARY

The Summary of train delays is compiled as per individual district, as given below:-

1. MPIKA DISTRICT

Total number of trains dispatched - 152  
 Trains dispatched as per planned time - 96  
 Percentage of efficiency - 63.2%  
 Trains dispatched late - 56

Total number of trains received - 144  
 Trains received as per planned time - 83  
 Percentage of efficiency - 57.6%  
 Trains received late - 61

2. CHOZI DISTRICT

Total number of trains dispatched - 154  
 Trains dispatched as per planned time - 124  
 Percentage of efficiency 80.5%  
 Train dispatched late - 30

Total number of trains received - 141  
 Trains received as per planned time - 88  
 Percentage of efficiency 62.4%  
 Trains received late - 53

3. KAPIRI DISTRICT

Total number of trains dispatched - 94  
 Trains dispatched as per planned time - 64  
 Percentage of efficiency 68.1%  
 Trains dispatched late - 30

Total number of trains received - 74  
 Trains received as per planned time - 35  
 Percentage of efficiency 47.3%  
 Trains received late - 39

4. MBEYA DISTRICT

Total number of trains dispatched - 74  
 Trains dispatched as per planned time - 63  
 Percentage of efficiency 85.1%  
 Trains dispatched late - 11

MBLYA DELTRIC

Total number of trains received - 73

Trains received as per planned time - 32

Percentage of efficiency 43.9%

Trains received late -41

2.6.0 FUEL AND LUBRICANTS USED IN FEBRUARY, 1987

NO.	LOCO NO.	KILOMETER COVERED	GAS OIL	ENGINE OIL	TURBO OIL
1.	011	660 KM	797LTS	NIL LTS.	NIL LTS
2.	012	4180	2257	60	60
3.	015	5940	7062	160	40
4.	016	220	1448	40	60
5.	017	4180	4503	105	NIL
6.	15	4776	26170	180	140
7.	20	7353	18267	90	100
8.	22	10055	26305	100	100
9.	26	5500	20814	460	240
10.	28	5256	10733	100	NIL
11.	29	9027	35851	300	140
12.	30	3557	10538	40	100
13.	33	7034	20038	100	220
14.	34	3268	9575	160	140
15.	39	754	4360	20	NIL
16.	41	3677	8274	770	60
17.	51	5491	27338	95	80
18.	53	4628	21868	430	100
19.	64	NIL	NIL	NIL	NIL E
20.	67	6844	29910	145	210
21.	68	8696	18037	120	220
22.	72	7290	27458	753	140
23.	73	NIL	NIL	NIL	NIL E
24.	83	6756	20235	580	120
25.	84	1760	13244	100	20
26.	86	8736	70151	80	NIL
27.	87	4336	19361	470	80
28.	94	7102	11923	80	NIL
29.	95	8924	21172	645	160
30.	96	9450	27827	630	460

2.6.0

31.	1003	4914	21308	270	-
32.	1007	2457	12955	290	-
33.	1010	6613	12955	1190	-
34.	1012	7740	34471	320	-
35.	1013	4914	14166	185	-

2.7.0

FUEL AND LUBRICANTS USED AS FOR FLEET

LOCO TYPE	GAS OIL	ENGINE OIL	TURBO OIL
DFH <sub>2</sub> Loco	226101	4498	1460
M.U Loco	269032	1530	1310
KRUPP Loco	96094	335	Nil
TOTAL	591227	8353	2770

DFH <sub>1</sub> Loco	13879	305	100
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DFH <sub>2</sub> Loco	PASSENGER	9880	180	80
	GOODS	216221	4318	1380

M.U Loco	PASSENGER	22632	230	149
	GOODS	246400	1300	1170

KRUPP Loco	PASSENGER	6404	110	-
	GOODS	89690	2215	-

	KAFIRI		MPIKA		CHOZI	
	FEB	JAN	FEB	JAN	FEB	JAN
1. Replacement of brake-blocks	1012	932	261	413	198	476
2. Adjustment of piston travel	136	52	205	284	701	424
3. Replacement of brake-beams	18	26	30	37	Nil	Nil
4. Replacement of bolster-springs	35	199	103	147	9	18
5. Replacement of ventilation hoses	124	146	101	275	7	16
6. Changing of wheel-sets	4	12	5	5	Nil	1
7. Replacement of damper springs	24	45	Nil	Nil	Nil	Nil
8. Replacement of other spares	729	474	159	169	30	51
9. Testing of vacuum brake-cylinders	208	229	122	Nil	Nil	Nil

REPAIRS THAT WERE CARRIED AT MPIKA CASUAL REPAIR POINT, MPIKA WORKSHOPS AND KAFIRI

3.5.0 WAGONS

Heavy Repairs  
 Medium Repairs  
 Light Repairs  
 Casual Repairs  
 Accident Repairs

	MPIKA WORKSHOPS		MPIKA C/R POINT		KAFIRI	
	FEB	JAN	FEB	JAN	FEB	JAN
Heavy Repairs	1	2	Nil	Nil	Nil	Nil
Medium Repairs	26	2	Nil	Nil	Nil	Nil
Light Repairs	Nil	Nil	Nil	Nil	114	87
Casual Repairs	Nil	Nil	203	260	220	348
Accident Repairs	Nil	Nil	Nil	Nil	Nil	Nil

3.6.0 COACHES

Heavy Repairs  
 Medium Repairs  
 Light Repairs  
 Casual Repairs  
 Accident Repairs

Heavy Repairs	Nil	Nil	Nil	Nil	Nil	Nil
Medium Repairs	1	2	Nil	Nil	Nil	Nil
Light Repairs	Nil	Nil	Nil	Nil	4	9
Casual Repairs	Nil	Nil	Nil	Nil	Nil	Nil
Accident Repairs	Nil	Nil	Nil	Nil	Nil	Nil

3.7.0 DETENTION TIME (HRS)

	FEB	JAN
Average detention time for light wagons -	2.58	3.26 hrs
" " " " Casual repair wagons	2.55	3.14 hrs
" " " " Light " Coaches	3.30	4.00 hrs
" " " " Casual " "	Nil	Nil

## III

**3.0.0** ROLLINGSOCK OPERATIONS - FEBRUARY, 1987

During the month of February a total number of 818 trains consisting of 15648 vehicles were inspected at the three inspection points. Comparing with the previous month's 782 trains, here has been an upward trend in the running of trains during the month under-review. Out of these 818 trains, 49 trains with a total of 674 cars were for passenger traffic. For details a statistical summary is attached.

**3.1.0** RUNNING MAINTENANCE AND CASUAL REPAIRS

423 Casual repair cases were attended to. Comparing with the previous month's 348 cases, there were more cases of Casual repairs.

**3.2.0** LIGHT REPAIRS

114 wagons were repaired and 4 coaches underwent light repairs.

**3.3.0** TRAINS INSPECTED AND DEFECTS ATTENDED TO:

	KAFIPI		MPIKA		CHOZI	
	FEB.	JAN	FEB.	JAN	FEB	JAN
<b>3.3.1</b> No. of trains inspected on arrival	102	109	145	131	135	127
<b>3.3.2</b> No. of Vehicles inspected on arrival	2338	1936	2647	2198	2510	2036
<b>3.3.3</b> No. of trains inspected before dispatch	128	105	129	136	130	124
<b>3.3.4</b> No. of Vehicles inspected before dispatch	2594	2002	2646	2255	2239	2044
<b>3.3.5</b> No. of trains inspected en-route	Nil	Nil	25	24	24	26
<b>3.3.6</b> No. of vehicles inspected en-route	Nil	Nil	342	336	332	374
<b>3.3.7</b> Total No. of trains inspected	230	214	299	291	289	277
<b>3.3.8</b> Total No. of vehicles inspected	4932	3998	5655	4789	5081	4445

3.8.0

LIGHT REPAIRS

	PLANNED	ACTUAL
WAGONS	103	114
COACHES	4	4

9/17

PERIOD:.....

REGION:.....

4.0.0 POWER CHART FOR MPIKA POWER DISTRIBUTION

ITEM	PLANNED	ACTUAL	REMARKS
Time of Supply	744 hrs	738hrs 5min	
Time off	N11	5hrs 9min	
Rate of Supply		99.2%	
Maximum Load		1384KW	
Average Load		208	
Loading Rate		15%	
Kvarh Consumption		901561	
KWH Received		155012	
KWH Distributed		148322	
KWH Self Use		6990	
Power Factor	95%	87%	
Transformer Capacity		5760KVA	
Utilisation Factor		4.2%	
Substation Capacity		3806KVA	

REMARKS:

The longest period of lights going off occurred on Tuesday 13-01-87, time off 2 hours 42 minutes. Annual maintenance work continued as planned.

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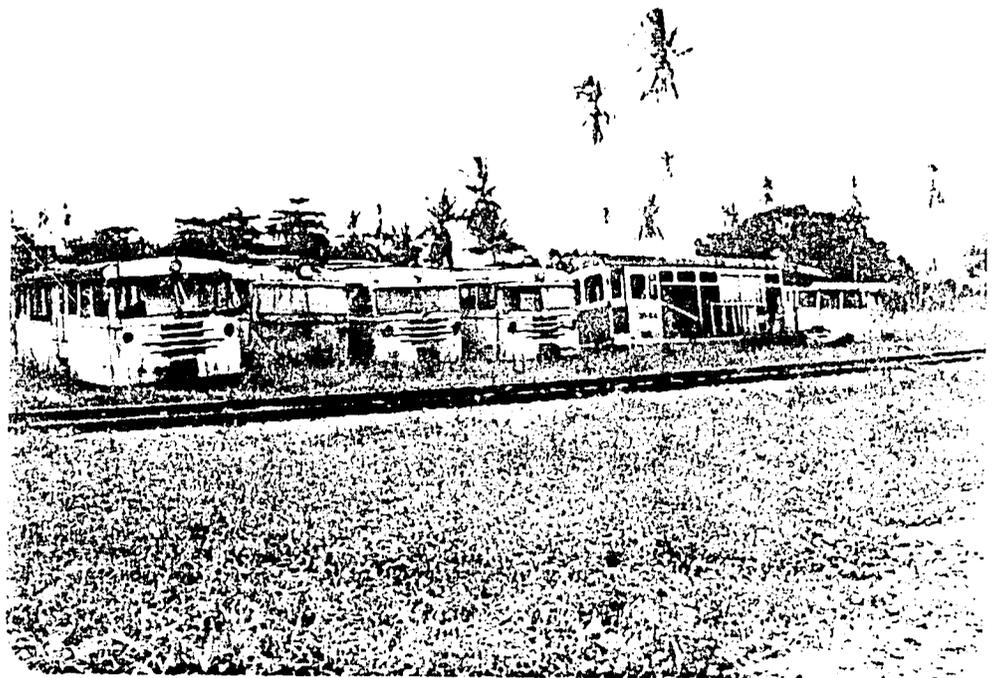
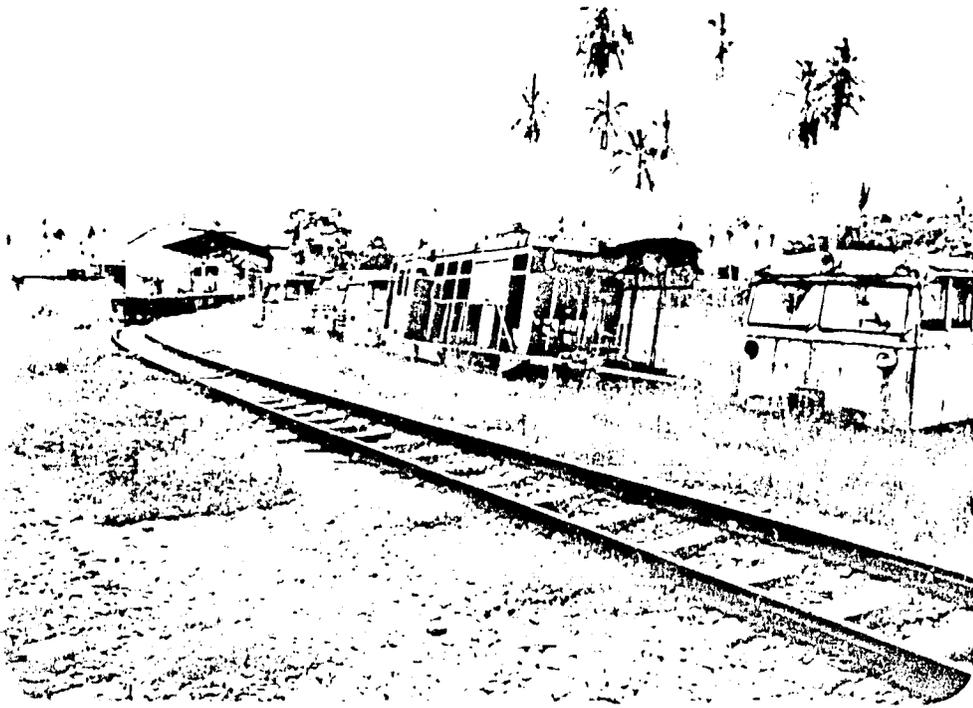
MONTH : JANUARY, 1987.

VALUE ITEM	UNIT	QUANTITY	
TOTAL POWER GENERATED	KWH	44644	
GENERATING TIME	TOTAL	HRS	742.01
	ENGINE No. 1	HRS	267.21
	ENGINE No. 2	HRS	NIL
	ENGINE No. 3	HRS	NIL
	ENGINE No. 4	HRS	474.40
LOAD FACTOR	MAXIMUM LOAD	KW	138
	AVERAGE LOAD	KW	60
	LOAD FACTOR	%	43.5
UTILISATION FACTOR	TRANSFORMER CAPACITY	KVA	230
	POWER FACTOR	%	69
	UTILISATION FACTOR	%	37.8

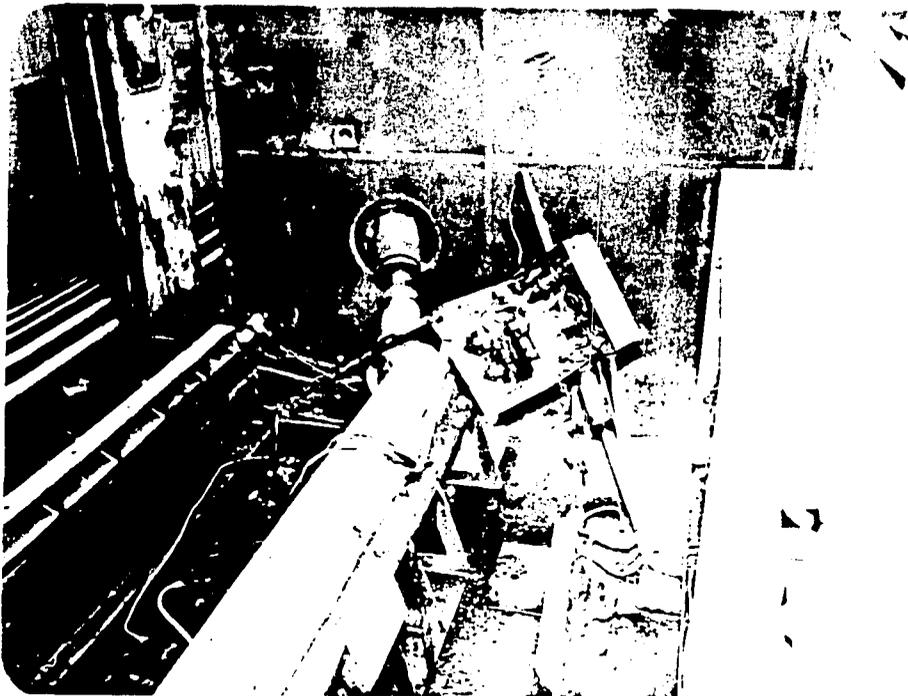
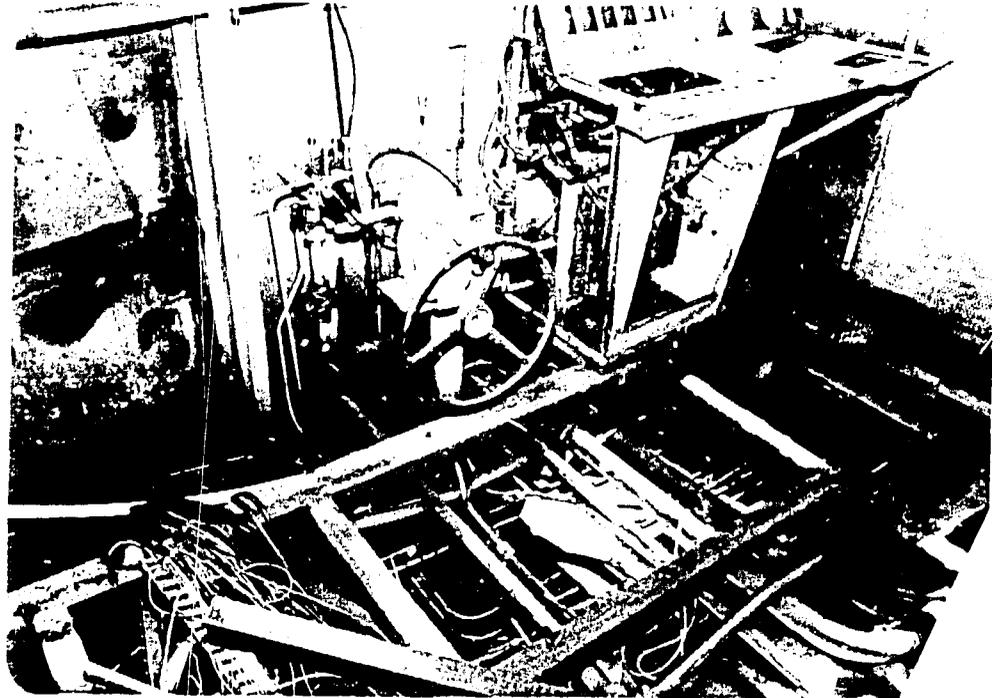
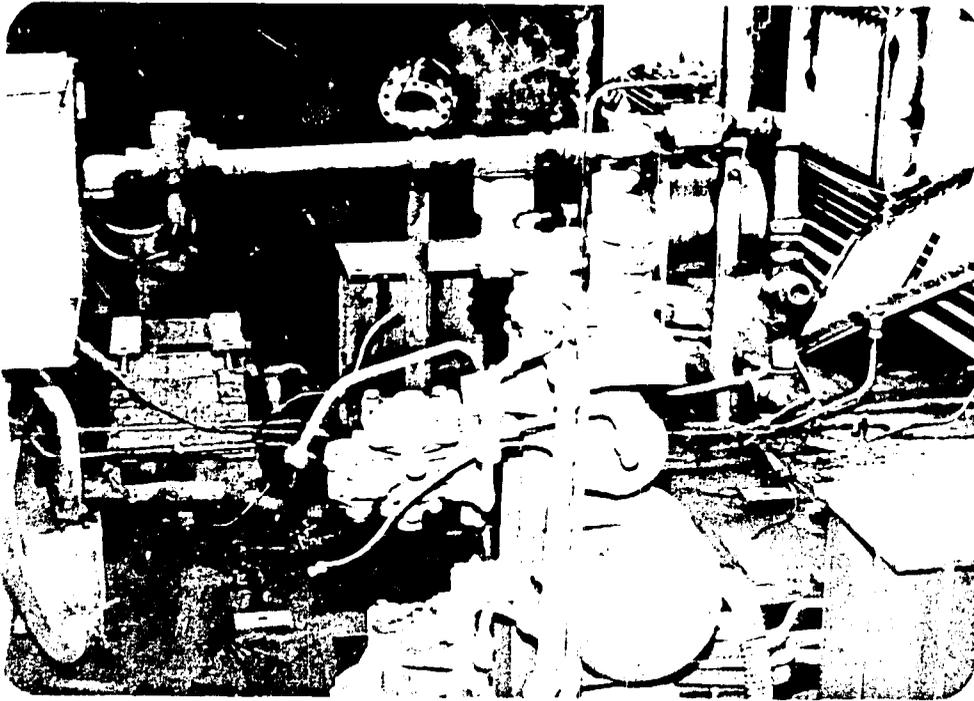
REMARKS

Power Generation rate stood at 99.7%. The shortfall is due to power cut off caused by pistons which seized on engine No. 4 due to insufficient supply of water on 5 th January, 1987. The accident is due to carelessness of the Engine Operator who is being dealt with by the Chozi District Mechanical Engineer.

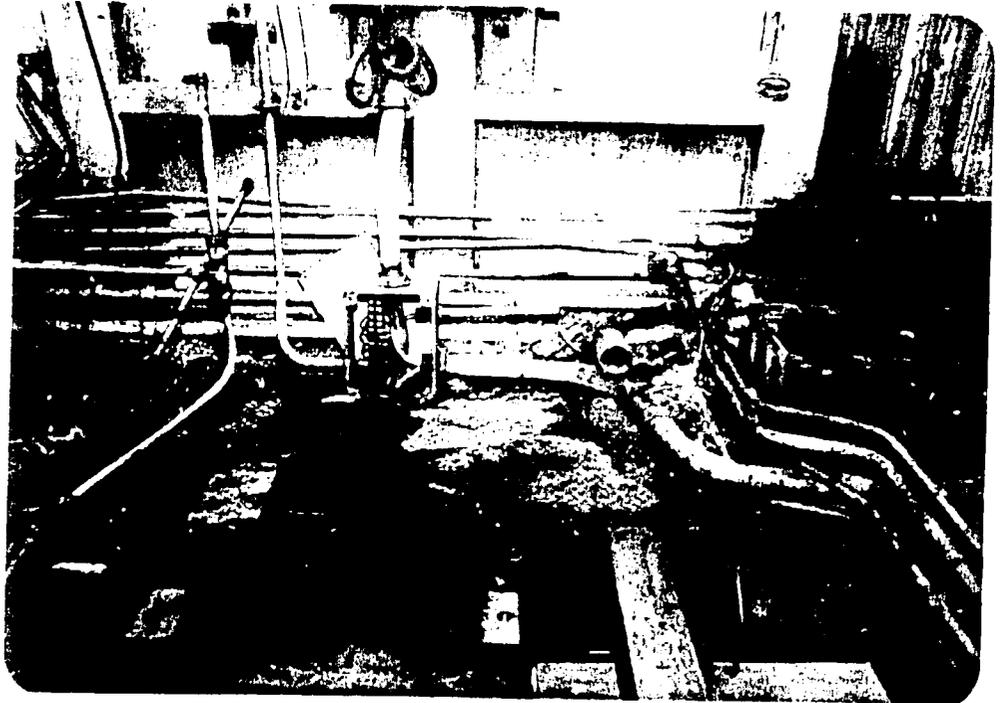
APPENDIX C  
ITEM E  
EQUIPMENT CONDITIONS  
PAGE 10



APPENDIX C  
ITEM 5  
EQUIPMENT CONDITIONS  
SHEET 2



APPENDIX C  
ITEM 5  
EQUIPMENT CONDITIONS  
SHEET 3



APPENDIX C  
ITEM 6  
EQUIPMENT CONDITIONS  
SHEET 4



APPENDIX C  
ITEM 5  
EQUIPMENT CONDITIONS  
SHEET 3



TANZANIA ZAMBIA RAILWAY AUTHORITY

SPECIFIC FUEL CONSUMPTIONS FOR LOCOMOTIVE FLEETS OWNED BY TAZARA

Source of Data: Traction Test Results conducted in 1985

1. U30C Locomotives (on 2% grad. only)

Direction of Travel	Rate (Lts) per 10 <sup>4</sup> ton Km
Mbeya - Mlimba	55 - 64
Mlimba - Mbeya	80 - 89

2. MTU (On 2%)

Direction of Travel	Rate (Lts) per 10,000 ton Km
Mbeya - Mlimba	73 - 75
Mlimba - Mbeya	107 - 125

3. MTU (On 1%)

Direction of Travel	Rate (Lts) per 10,000 ton Km
Chozi - New Kapir Mposhi	60 - 66
New Kapir Mposhi - Chozi	60 - 65

4. DFH - Conventional (ie. with Chinese Engines) on 1% grad. only

Direction of Travel	Rate (Lts) per 10,000 ton Km
Dar es Salaam - Mlimba	57 - 62
Mlimba - Dar es Salaam	65 - 68

1986/87 FUEL/OIL CONSUMPTION FOR TANZANIA REGION LOCOMOTIVE FLEETS

Month	Loco Type	10 <sup>4</sup>			Goods Traffic Consumption			Passenger Traffic Consumption			10 <sup>3</sup> Km Run	Engine Oil Consumed	Rate per 10 <sup>3</sup> Km	Trans. Oil Consumed	Rate per 10 <sup>3</sup> KM
		Ton Km Output	Fuel Consumed Litres	Rate per 10 <sup>4</sup> Ton Km	10 <sup>4</sup> Ton Km	Fuel	Rate	10 <sup>4</sup> Ton Km	Fuel	Rate					
July '86	DFH	6,403.5	425,496	66.4	5,176.5	272,538	49.8	661.8	36,330	64.9	115.0	14,639	127.3	4,051	35.2
	MTU	3,169.9	205,765	64.9	2,903.5	185,202	63.8	264.8	19,820	74.8	60.6	897	14.8	1,697	28.0
	DE	3,845.7	190,245	49.5	3,359.5	157,988	47.0	486.2	32,258	66.3	47.0	2,751	58.5		
August	DFH	7,025.5	461,322	65.6	6,163.7	317,499	51.5	718.4	56,393	78.5	119.0	14,578	122.5	5,228	43.9
	MTU	3,946.5	246,939	62.6	3,612.6	219,969	60.9	329.1	24,247	73.7	80.3	1,494	18.6	3,680	45.8
	DE	2,611.3	133,568	51.1	2,293.6	112,530	49.1	317.7	21,038	66.2	34.0	2,201	64.7		
September	DFH	7,581.0	470,227	62.0	6,829.9	356,515	52.2	324.5	47,595	146.7	119.8	16,099	134.4	5,535	46.2
	MTU	3,412.8	224,118	65.7	3,081.2	196,120	63.7	283.3	23,090	81.5	76.4	1,355	17.7	4,005	52.4
	DE	2,673.3	160,710	56.4	2,611.6	142,973	54.7	235.7	17,738	75.3	35.0	3,015	86.1		
October	DFH	8,385.6	513,173	61.2	7,450.7	372,810	50.0	806.0	51,064	63.4	128.4	18,019	140.3	5,328	41.5
	MTU	2,619.2	179,905	68.7	2,318.4	142,190	61.3	243.2	21,173	87.1	64.6	954	148.0	2,986	46.2
	DE	3,736.5	173,828	46.5	3,449.2	155,595	45.1	287.3	18,233	63.5	44.0	2,916	66.3		
November	DFH	6,882.5	436,516	63.4	6,096.9	306,576	50.3	630.3	41,771	66.3	110.2	15,317	139.0	3,844	34.9
	MTU	3,555.0	254,259	71.5	3,157.9	200,515	63.5	342.8	27,174	79.3	74.6	1,516	20.3	4,905	65.8
	DE	3,809.9	198,660	52.1	3,449.6	176,055	51.0	360.3	22,605	62.7	45.0	3,104	69.0		
December	DFH	6,092.9	396,906	65.1	5,253.0	278,555	53.0	703.6	42,104	59.8	97.5	14,103	144.6	2,847	29.2
	MTU	3,578.9	232,257	64.9	3,096.9	177,715	57.4	350.2	25,421	72.6	68.4	1,558	22.8	4,610	67.4
	DE	3,544.4	153,533	43.3	3,210.3	135,713	42.3	334.1	17,820	53.3	43.0	2,668	62.1		
Half-Year	DFH	42,371.0	2,703,640	63.8	36,970.7	1,904,493	51.5	3,844.6	275,257	71.6	689.9	92,755	134.4	26,833	38.9
Sub-Total	MTU	20,282.3	1,343,243	66.2	18,170.5	1,121,711	61.7	1,813.4	140,925	77.7	424.9	7,774	18.3	21,883	51.5
	DE	20,395.1	1,010,544	49.5	18,373.8	880,854	47.9	2,021.3	129,692	64.2	248.0	16,655	67.2		

101.

TANZANIA ZAMBIA RAILWAY AUTHORITY  
OIL CONSUMPTION RATES FOR JULY - DECEMBER 1985

Month	Fleet Type	Tanzania Region					Zambia Region				
		Total KM	Engine Oil		Turbine Oil		Total KM	Engine Oil		Turbine Oil	
			Total Litres	Rate per 1,000 Km	Total Litres	Rate per 1,000 Km		Total Litres	Rate per 1,000 Km	Total Litres	Rate per 1,000 Km
July	U30C	52,000	4,013	77.2	-	-	28,900	1,750	60.6	-	-
	MTU	31,000	531	17.1	2,454	79.2	87,500	1,442	16.5	2,113	24.1
	DFH	123,000	9,553	77.7	5,029	40.9	67,400	4,635	68.8	1,406	20.9
August	U30C	46,000	1,496	32.5	-	-	32,700	1,515	46.3	-	-
	MTU	29,000	154	5.3	1,744	60.0	79,200	1,610	20.3	2,145	27.1
	DFH	127,000	10,050	79.1	4,066	32	72,100	4,493	62.3	2,395	33.2
September	U30C	47,000	3,125	66.5	-	-	26,400	1,580	59.8	-	-
	MTU	32,000	1,048	32.8	3,163	98.8	82,100	2,030	24.7	3,640	44
	DFH	132,000	13,402	101.5	5,365	40.6	76,800	6,500	84.6	1,900	24.7
October	U30C	40,000	599	15.0	-	-	26,000	1,670	64.2	-	-
	MTU	58,000	568	9.8	3,359	57.9	96,000	1,750	18.2	3,260	34
	DFH	148,400	14,981	101.2	4,744	32.0	71,000	7,340	103.4	5,560	78.3
November	U30C	51,000	2,013	39.5	-	-	30,000	1,630	54.3	-	-
	MTU	29,000	404	13.9	1,235	42.5	75,100	1,620	21.6	1,460	19.4
	DFH	126,800	13,090	103.2	2,690	21.2	92,100	11,895	129.2	3,530	38.3
December	U30C	45,000	1,250	27.8	-	-	24,600	1,650	67.1	-	-
	MTU	35,000	1,350	38.6	1,235	35.3	91,900	1,797	19.6	2,202	24
	DFH	108,000	6,095	56.4	2,260	21.0	71,900	8,160	113.0	2,340	32.5

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Appendix D  
Items 1a, b & c  
DFH Parts Required  
Except MTU Eng. Parts

TANZANIA ZAMBIA RAILWAY AUTHORITY  
HEAD OFFICE  
DEPARTMENT OF MECHANICAL ENGINEERING  
SPARE PARTS REQUIREMENT FOR DFH-LOCOMOTIVES  
INCLUDING DFH1, DFH2, AND DFH2/MTU

1. 12V180ZL Diesel Engine

<u>S/No.</u>	<u>Description</u>	<u>Part No.</u>	<u>Unit</u>	<u>Quantity</u>
1	Crankcase	SFF9-01-00-001	PC	16
2	Crankshaft	SFF9-06-00-016	PC	10
3	Cylinder Head Assembly	SFF9-03-06-001	PC	240
4	Precombustion Chamber	SFF9-03-00-017A	PC	480
5	Cylinder Liner	SFF9-01-00-004	PC	576
6	Fuel Injection Pump	NPT20-00-00A	PC	24
7	Water Sealing Ring	SFF1-01-00-016	PC	1728
8	Exhaust Valve	SFF9-03-00-003	PC	576
9	Inlet Valve	SFF9-03-00-005B	PC	576
10	Chrome-plated Compression Ring	SFF9-05-00-008	PC	1152
11	Compression Ring	SFF9-05-00-007	PC	2304
12	Oil Scrapper Ringer	SFF9-05-00-005	PC	2304
13	Connecting Rod Bearing (Lower)	SFF9-05-01-005	PC	1152
14	Connecting Rod Bearing (Upper)	SFF9-05-01-006	PC	1152
15	Gasket Exhaust Pipe	SFF9-11-00-004	PC	1152
16	Sealing Ring	SFF1-10-00-006	PC	1152
17	Radial Bearing	TPZY31-2-2	PC	96
18	Filter Element (Fuel)	C-1018	PC	192
19	Injector Nozzle	NPT14-01 000	PC	1152
20	Coarse Filter Assembly	TPJF1-20-20-00	Assy	48
21	High Pressure Pipe	SFF9-14-01-001	PC	240
22	Sealing Ring 50x5.2	SFJ3-17-01-105	PC	336
23	Filter Assembly	TPJF1-20-40-100	PC	768
24	Gasket	TPJF1-19-00-005	PC	96
25	Gasket	TPJF1-19-01-005	PC	96
26	O-Ring	SFF9-34-00-003	PC	96
27	O-Ring	SFF9-34-00-004	PC	96
28	Front Cover	SFF9-34-00-001	PC	96
29	Rear Cover	SFF9-34-00-002	PC	96
30	Spring Washer	10GB93-66	PC	3650
31	Gasket	SFF9-37-04-002A	PC	1152
32	O-Ring	SFF9-37-08-002A	PC	192
33	Oil Seal	SFF9-01-00-124	PC	1000
34	Rubber Ring	SFF9-01-00-122	PC	1200
35	Sealing Ring	SFF9-01-00-064	PC	2400
36	Sealing Ring	SFF9-01-00-127	PC	2400
37	Union Screw M8x1	SF73-104.1		600

Appendix D  
Items la, b & c  
DFH Parts Required  
Except MTU Eng. Parts

TANZANIA ZAMBIA RAILWAY AUTHORITY  
HEAD OFFICE  
DEPARTMENT OF MECHANICAL ENGINEERING  
SPARE PARTS REQUIREMENT FOR DFH-LOCOMOTIVES  
INCLUDING DFH1, DFH2, AND DFH2/MTU

2. Hydraulic Transmission Gearbox

<u>S/No.</u>	<u>Description</u>	<u>Part No.</u>	<u>Unit</u>	<u>Quantity</u>
38	Four Point Bearing	3D176224	PC	240
39	Roller Bearing	7D32224	PC	240
40	Roller Bearing	7D32222	PC	100
41	Four Point Bearing	176307	PC	100
42	Ball Bearing	3E306	PC	100
43	Roller Bearing	E32306	PC	100
44	Roller Bearing	7E32206	PC	100
45	Ball Bearing	3E205	PC	100
46	Roller Bearing	7E32205	PC	100
47	Ball Bearing	3E313	PC	100
48	Roller Bearing	7E32313	PC	50
49	Roller Bearing	7E32312	PC	100
50	Roller Bearing	7E32210	PC	120
51	Roller Bearing	7210	PC	120
52	Roller Bearing	7E32320	PC	100
53	Roller Bearing	7E32220	PC	100
54	Roller Bearing	7E42620	PC	100
55	Roller Bearing	7E32226	PC	100
56	Roller Bearing	7E32224	PC	100
57	Roller Bearing	7D32315	PC	100
58	Ball Bearing	3E114 (176114)	PC	200
59	Ball Bearing	3E1000908	PC	200
60	Ball Bearing	46202	PC	100
61	Ball Bearing	102	PC	190
62	Four Point Bearing	E176220	PC	100
63	Four Point Bearing	E176224	PC	100
64	Needle Bearing	941/15	PC	300
65	O-Ring	55x3.5	PC	480
66	O-Ring	19x2.5	PC	1000
67	O-Ring	36x3.5	PC	200
68	O-Ring	30x3.5	PC	100
69	O-Ring	45x3.5	PC	500
70	O-Ring	80x5.7	PC	100
71	O-Ring	10x1.9F	PC	100
72	O-Ring	55x3.5F	PC	500
73	O-Ring	19x2.4E	PC	500
74	O-Ring	80x5.7F	PC	100

Appendix D  
Items la, b & c  
DFH Parts Required  
Except MTU Eng. Parts

TANZANIA ZAMBIA RAILWAY AUTHORITY  
HEAD OFFICE  
DEPARTMENT OF MECHANICAL ENGINEERING  
SPARE PARTS REQUIREMENT FOR DFH-LOCOMOTIVES  
INCLUDING DFH1, DFH2, AND DFH2/MTU

2. Hydraulic Transmission Gearbox (continued)

<u>S/No.</u>	<u>Description</u>	<u>Part No.</u>	<u>Unit</u>	<u>Quantity</u>
75	Rubber Component	DFH1-38-00-100	PC	24
76	B8-III Turbine Wheel	DFH1-31-02-410	PC	24
77	B10-III Turbine Wheel	DFH1-31-02-450	PC	24
78	B8-III Turbine Sealing Ring	DFH1-31-02-314	PC	24
79	B8-III Core Ring	DFH1-31-02-315	PC	24
80	B10-III Core Ring	DFH1-31-02-333	PC	24
81	First Cardan Shaft	DFH1-31-01-000C	PC	20
82	Second Cardan Shaft	DFH1-35-02-000B	PC	20
83	Third Cardan Shaft	DFH1-35-03-000C	PC	20
84	Cardan Shaft, Dynasaster	DFH1-35-10-000	PC	20
85	Cardan Shaft, Fan	DFH1-35-11-000	PC	20

3. Loco-Electrical System

86	Wire	2.5 mm <sup>2</sup>	M	4000
87	Wire	50 mm <sup>2</sup>	M	4000
88	Wire	1.5 mm <sup>2</sup>	M	72000
89	Dynastarter	ZQF-23	Set	10
90	Motor, Compressor	BKW/110V DC	Set	30
91	Contractor	DC110V-CZ0-150/20th	Set	30
92	Contractor	110V DC-CZO-150/10th	Set	30
93	Contractor	110V DC-CZO-4020th	Set	30
94	Electromagnetic Valve	NVD5	Set	300
95	No-Load Start Valve	WQF	Set	40
96	Master Controller	KZ1	Assy	12
97	Master Controller	KZ2	Assy	12
98	Reversing Interlock Switch	HLQ	PC	10

4. BOGIE

99	Roller Bearing	7E3226	PC	160
100	Roller Bearing	2G3615	PC	80
101	Roller Bearing	7D32224	PC	80
102	Roller Bearing	7E32144	PC	160
103	Four Point Bearing	E176224	PC	160
104	Four Point Bearing	D176224	PC	160

Appendix D  
Items 1a, b & c  
DFH Parts Required  
Except MTU Eng. Parts

TANZANIA ZAMBIA RAILWAY AUTHORITY  
HEAD OFFICE  
DEPARTMENT OF MECHANICAL ENGINEERING  
SPARE PARTS REQUIREMENT FOR DFH-LOCOMOTIVES  
INCLUDING DFH1, DFH2, AND DFH2/MTU

4. BOGIE continued

<u>S/No.</u>	<u>Description</u>	<u>Part No.</u>	<u>Unit</u>	<u>Quantity</u>
105	Gear	DFH2-36-03-001	PC	60
106	Spiral Bevel Gear	DFH2-37-01-001	PC	36
107	Gear	DFG2-36-04-001	PC	60
108	Axlebox Lube Oil Pump	DFH1-57-06-00	PC	24
109	Filter	DFH2-36-04-200B	PC	24
110	Gear	DFH2-36-02-001A	PC	60
111	Spiral Bevel Gear	DFH2-36-02-002	PC	48
112	First Shaft	DFH2-57-01-003	PC	24
113	Gear	DFH2-36-01-001A	PC	60
114	Link	SFJ1-52-00-015	PC	200
115	Shaft cover	SFJ1-52-00-016	PC	200
116	Buffer Pad	SFJ1-52-07-000	PC	200
117	Spring, Axlebox (outer)	DFH1-52-03-000	PC	196
118	Spring, Axlebox (inner)	DFH1-52-03-000	PC	196
119	Rubber sleeve	DFH1-52-06-006	PC	200
120	Vibration Damper	DFH1-52-06-000A	PC	200
121	Rubber Sealing Ring	SFJ1-52-06-003	PC	200
122	Thrust Plate	DFH1-57-04-100	PC	200
123	Buffer Pad	DFH1-57-04-000	PC	600

5. GENERAL ASSEMBLY AND AUXILIARY COMPONENTS

124	Cut out cock Dg 15	SF73-105A	PC	40
125	Cut out cock A Dg 20	TB65-68	PC	40
126	Cut out cock A Dg 15	TB65-68	PC	40
127	Cock, Three Way	DFH1-61-31-000	PC	40
128	Cock, Three Way	DFH1-61-42-000	PC	40
129	Cock, A Dg 6	TB 314-61	PC	40
130	Cock, A Dg 6	TB 313-61	PC	40
131	Hose, Brake Cylinder	DFH1-61-17-000	PC	200
132	Hose, Ø 83	DFH1-29-000-009C	M	500
133	Hose, Ø 60	DFH1-29-000-008C	M	500
134	Hose, Ø 100	DFH1-29-000-0013C	M	500

TANZANIA SAMBIA RAILWAY AUTHORITY  
DEPARTMENT OF MECHINCAL ENGINEERING

Re: 2-YEAR SPARE PARTS REQUIREMENTS FOR MTU  
ENGINES, TYPE 12V396 TC 12

<u>S/No.</u>	<u>Class of Repair</u>	<u>Description of Service Parts Required</u>	<u>Quantity Required</u>
1	W2	W2 - Set	700
2	W3	W3 - Set	350
3	W3	M - Set	350
4	W4	W4 - Set	200
5	W5	W5 - Set	40
	W5R	R5 - Set	10
6	W6	W6 - Set	20
	W6R	R6 - Set	4
7		NCzzles (Set)	150

4TH ANNUAL INSPECTIONS OF D.E LOCOMOTIVES U30C

APPENDIX D  
ITEM 1d  
KRUPP U30C  
PARTS REQUIREMENTS

SPARE PARTS REQUIREMENTS

S/No.	Description	Part No.	Quantity	Remarks
	<u>TURBOCHARGER</u>	Type 7S1612C1		To be overhauled
1.	Turbo Gasket kit	150 x 1083-1	12	
2.	Bearings (Blower End)	126 x 1223-1	12	Depending on physical condition
3.	Bearing (Turbine End)	126 x 1222-1	12	Depending on physical condition
4.	Magnetic pick up	126 x 1389-1	6	Depending on physical condition
5.	Seaknt RTV 106	41B562849P156	20	
6.	Turbo End Seal	126 x 1562-1	12	Depending on physical condition
7.	Blower End Seal	126 x 1563	12	Depending on physical condition
8.	Seal	126 x 1461	48	Depending on physical condition
9.	Seal	115 x 2245	12	Depending on physical condition
10.	Balancing machine		1	For balancing rotors impellers etc
11.	Turbocharger Unit	751612C1	1	For interchanging
	<u>ENGINE CONTROL SPEED GOVERNOR TYPE</u>			
1.	Repair Kit	150 x 1112-2	12	Depending on physical condition
2.	Modulator Kit	150 x 1079	12	
3.	Governor Cnv Kit	150 x 1123	12	
	<u>DIESEL ENGINE</u>			
1.	Cylinder head Ass to main frame gasket kit	150 x 1024-1	12	
2.	Cylinder head and liner installation gasket kit	150 x 1023-6	12	
3.	Water Seal	125 x 1015-3	12	
4.	Water pump overhaul kit	150 x 1069	12	

S/No.	Description	Part No.	Quantity	Remarks
5.	OS link ring seal	132 x 1491	12	For overspeed link
6.	OS link ring seal	132 x 1492	12	
7.	Mechanical Seal	125 x 1015-8	12	For water pump
8.	Umbrella	123 x 1001	288	
9.	Nozzle Kit	150 x 1095	144	
10.	Pump and nozzle Kit	150 x 1087	144	
11.	Bearing	132 x 1093-1	20	
12.	Ring Kit	150 x 1044	144	
13.	Fuel hose	140 x 2283	168	
14.	Conrod bearings	117 x 1042-2	72	Depending on physical
15.	Conrod bearings	117 x 1050	72	condition
16.	Plates	123 x 1058	100	Depending on physical
		123 x 1044	100	condition
		123 x 1059	100	"
		123 x 1086	100	"
		123 x 1060	100	"
		123 x 1061	100	"
		123 x 1062	100	"
		123 x 1063	100	"
17.	Shims	123 x 1046	100	
		123 x 1047	100	
		123 x 1048	100	
		123 x 1049	100	
		123 x 1050	100	
18.	Loctite	147 x 1898-1	10	
19.	Shims	132 x 1022	100	
		132 x 1023	100	
		132 y 1024	100	
		132 x 1025	100	
20.	Cam bearings	116 x 1070-1	160	Depending on physical condition
21.	Crankshaft deflection gage	147 x 1227	1	To measure deflection of the crankshaft
22.	Water pump overhaul kit	150 x 1069	12	
23.	Water pump installation kit	150 x 1070	12	
24.	Bearings	125 x 1075	12	
	Bearings	125 x 1026	12	

S/No.	Description	Part No.	Quantity	Remarks
25.	Lub oil pump overhaul kit	150 x 1145	12	
26.	Lube oil pump installation kit	150 x 1139	12	
27.	Water inlet header kit	150 x 1116	144	
28.	'O'ring	115 x 1268	216	
		115 x 1902-1	72	
		115 x 1865	24	
29.	Ring	128 x 1447	24	
30.	Gasket	128 x 1413	12	
31.		128 x 1357	72	
32.	Seal	128 x 1358	144	
33.	Gasket	128 x 1006	144	
34.	Compount	147 x 1640	10	
35.	Bushing	115 x 1876-1	24	
36.	Spring	146 x 1059-1	24	
37.	Seal	132 x 1491	12	Overspeed link
		132 x 1492	12	Overspeed link
38.	Ring	132 x 1491	12	Overspeed link
		N901P412	12	Overspeed link
39.	'O'Ring	115 x 1902-1	144	Engine
40.	Lub oil filters	2 x 4223	96	Engine
41.	Fuel filters	132 x 1250	12	
42.	Air filters	41A216508P4	264	
43.	Sealant	RTV/10.3	40	
		497A806P60		
44.	Sealant	41A212051P5	40	
45.	CHEC III Electronic Cards	Electronic	3 panels	
46.	Motor Speed Panel	(Sentry Syst)	3 panels	

S/NO.	Description	Part No.	Quantity	Remarks
	<u>Exciter/Aux. Generator</u>	GY27M1		
1.	Commutator Grinder Kit	P3843613G1	1	
2.	Carbon brushes	8828400Pa	238	
3.	Puller Set	41B532339G1	1	
4.	Bearings (roller)	3864951P29	24	
	(ball)	8864950P81	24	
	<u>Fuel Booster Pump Motor</u>	41C610401G2		
1.	Carbon Brushes	2 x 4072	48	
2.	Bearings	626A259ABP1	24	
	<u>Dynamic Braking Blower Motor</u>	GA57		
1.	Bearings	Not obtained	2	
2.	Carbon brushes	Not obtained	48	
	<u>Head Lights</u>			
1.	Lamp 200PAR 30V	41A210446P1	48	
	<u>Generators</u>	GTA11C1		
1.	Carbon brushes	41A235676P4	72	
2.	Brush holder with pressure arm	41B531649G2	72	
	<u>Traction Motors</u>	GE 761		
1.	Carbon brushes	41A235897P4	576	
	Bearings (roller)	8864951P1148	72	
	(ball)	8864950P169	72	
2.	Connecting Sleeves	41A232340P3	576	
3.	Speed Sensor	41B537105G1	72	
4.	Brush Holder	41C633996G2	72	
5.	Dust Guard	994918294	72	
6.	Mega Insulation Tester	0-500 megohms 0-1000 Volts	1	
7.	Set of puller tools	8843578G1	1	
8.	Commutator Grinder	9949075G1	1	
9.	Pinion Puller Kit Cable Clamps	994918294	1	

S/No.	Description	Part No.	Quantity	Remarks
	<u>Compressor/Exhauster</u>	6 CD x 44C		
1.	Part No.	41A203648P5		
1.	Safety Valve	10526-0060	12	
2.	Gasket	514650	36	
3.	Gasket	516274	12	
4.	Gasket	514644	12	
5.	"	514627	12	
6.	"	553399	12	
7.	"	514644	24	
8.	"	514638	24	
9.	"	514637	24	
10.	"	514644	24	
11.	"	514651	12	
12.	"	514627	12	
13.	"	514626	12	
14.	"	514644	48	
15.	"	514651	48	
16.	"	514027	48	
17.	"	514626	48	
18.	Chain	584006	12	
19.	Mechanical Seal	585165	12	
20.	'O'Ring	585166	12	
21.	Bearings	585168	12	
22.	Gasket	552658	24	
23.	Gasket	573554	12	
24.	Gasket	584525	12	
25.	"	572403	12	
26.	"	563411	12	
27.	Ring	514624	24	
28.	Ring	520128	24	
29.	"	523429	24	
30.	"	523430	24	
31.	"	520130	24	
32.	"	523432	24	
33.	"	523427	24	
34.	Bearings	540589	72	
35.	"	541079	72	
36.	"	540590	72	
37.	Ring	520123	120	
38.	"	523401	120	
39.	"	523402	120	
40.	"	520133	120	
41.	"	523404	120	
42.	"	523405	120	

S/No.	Description	Part No.	Quantity	Remarks
43.	Ring	566271	24	
44.	O'Ring	575929	24	
45.	Gasket	552660	12	
46.	Bearing	549326	24	
47.	Spring	567379	12	
48.	Shims	567309	60	
49.	"	567810	24	
50.	"	567811	24	
51.	Gasket	522758	12	
	<u>SKF/FAG BEARINGS</u>	<u>6 1/2" x 12"</u>		
1.	Bearings	6 1/2" x 12"	6	
2.	Mobile Unit for mounting and dismantling of bearings		1	
3.	Mounting and dismantling of seals	Fag 157317/1-F	1	
4.	Ram	Fag 157317/2-F	1	
5.	Seal Case jaws	Fag 157317/3-F	1	
6.	Counter rent	Fag 157317/4-F	1	
7.	Adaptor ring bearings	Fag 157317/6-F	2	
8.	Support ring	Fag 157317/5-F	1	
9.	Press for mounting and dismantling of seals	Order No. 50209 OTC owaton tool company Minnesota		Height 328 <sup>mm</sup> Stroke 150 <sup>mm</sup>
	<u>Misc.</u>			
1.7*	Complete assembled bogies		2	For easy interchangeable of bogies
2.	<u>Tool Kits</u>			
	- Mechanical Eng. tool kits		8	For easy repair work
	- Electricians' tool kits		4	

\* NOT NECESSARY PER TAZARA ACME

ADD: Turbochargers

4

Crank case

1

Spares/components for rebuilding one engine

Rebuilding DE 1006

113

LOCOMOTIVE PARTS REQUIREMENTS FOR U30C  
NEW GE LOCOMOTIVES

Parts lists are included in Appendix E, Item 1 as follows:

1. Consumable parts, which include such items as filters, brushes, contact tips, light bulbs, brake shoes and wear plates.
2. Protective parts recommended to adequately protect the fleet in the event of failures or accidents; and for overhaul at the four year service date.
3. Capital spares recommended due to limited capability of railway. These spares include such items as alternators, generators, rectifiers and radiators.

DAR ES SALAAM WORKSHOP EQUIPMENT REQUIREMENTS

When reallocation of work to the three major workshops as recommended herein is completed, dar workshop will be the designated wagon maintenance shop for TAZARA.

Equipment additions are required for present allocation of work and will be necessary when the wagon maintenance becomes the major DAR assignment these additions are:

Wheel Truing Equipment

- Two underfloor wheel lathes have been identified and included in project ME:6. One is designated for DAR and the second for MPIKA.

Brake Component Testing Equipment

- A Davis and Metcalf (or equivalent) brake test equipment is required for testing components of wagon brake systems.  
Estimated Price \$112,000 US.

Fire Fighting Equipment (On-board) for locomotives to help reduce the damage from fires. Cleanliness of locomotive interiors would also help. This problem should be investigated to determine corrective action.

EQUIPMENTS URGENTLY REQUIRED AT MBEYA LIGHT REPAIR SHOP

S/No.	Name	Quantity	Specification	Remarks
1.	Governor Test Stand	1	230V 50/60 HZ single phase	GE Part No. 147 x 2117 Presently no facilities for testing governors except with the Tanzania Railways Corp.
2.	Cylinder Liner Tester	1		GE Part No. 147 x 1646
3.	Cylinder Inlet part cleaner	1	230V 50/60 HZ Single phase or 380V 50/60 HZ 3 phase	GE Part No. 147 x 1612. Inlet puts become heavily clogged with carbon deposits. Hence effect the performance of our engines, and makes maintenance work very difficult and time consuming.
.	Valve checking fixture	1		GE Part No. 147 x 1679 GE Part No. 147 x 2219 GE Part No. 147 x 2221 A great number of valves are machined in D`Salaam W/Shop but no checks are done on tolerances.
.	Valve seat grinding set	1		GE Part No. 147 x 1902 Valve seats are now being grounded using improper tools
.	Ultrasonic test equipment	1	230V 50/60 HZ Single phase or 230V 50/60 HZ 3 phase	GE Part No. 147 x 1906-1
.	Scraper	6		GE Part No. 147 x 1098 for removing carbon deposits on the piston grooves.
.	Crankshaft deflection	1		GE Part No. 147 x 1227 147 x 1228 Six monthly inspection requires measurement of crankshaft deflection but is not done because there is no tool.
.	Turbo Servicing Fixture	1		GE Part No. 147 x 2255
.	Turbo assembly and disassembly tools	1	Bearing installation tool	GE Part No. 147 x 1197 147 x 1197

S/No.	Name	Quantity	Specification	Remarks
		1	Compressor wheel puller	147 x 2075
		1	Bearing puller	147 x 2072
11	Governor tool Kit	1		GE Part No. 147 x 2013
12	Front drive Hub puller	1		GE Part No. 147 x 1914-1
13	Pinion Puller	1		GE Part No. 994918294
14	Commutator Grinder	1		994907591 for GE 761
		4	Stone	3828492P8
			Stone	8828492P11
15	Megger Insulation tester	1	0-500 megohms 1000 Volts	Electronic
16	Fork Lift	1	5 Tons	For lifting wheel set assemblies. Traction motors from one area to the other.
17	Screw Type lifting jacks	4	Capacity 25 Toms	For lifting locomotives
18	Drop table	1	Capacity 5 Tons	The existing one has frequent breakdowns.
19	A.C arc Welding Machines	1	Current range 45 - 375A Welding voltage 25 - 35V	
20	D.C Welding Machine	1	Current range 45 - 375A Welding voltage up to 100V	For trial run of traction motors.
21	Electrical Oven	1	Capacity 4KW Max Temp. 1000°C	Dimensions 550 x 550 x 550mm - Backing of traction motors - Heating of bearings
22	Steam Cleaner	1		For cleaning of locomotives engine parts bogies etc.
23	Hydraulic Bearing removal pressure 40 - 60tons			Removal of Fag Tar of SKF bearings

S/No.	Name	Quantity	Specification	Remarks
24.	Field Coil Braking	1	Portable resistance brasing machine	GE Part No. 41D780746G1
		1	Foot switch	41D780746P11
		1	Brasing Tangs	41D780746P12
		1	Carbon Electrodes	41D780746P14
		1	Water cooled power cables	41D780746P15
		Motor cycles	3	
	Motor vehicles	2		Landrovers. To help maintenance personnel reach loco failure sections to give technical assistance so that the loco does not get back to the W/Shop for unnecessary repairs.
	Deepfreezer	1		For freezing components which need to be below freezing point during assembly work.

Spectrophotometre

Electronic card trouble shooter and servicing equipment.

\* NOT NECESSARY PER TAZARA ACME

#### MPIKA Workshop Equipment Requirements

The diesel engine test stands currently in use at DAR workshop has capacity capabilities for testing the DFH1 and DFH2 engines. No capabilities exist for testing MTU engines after overhaul except for testing after reinstallation in locomotive. MTU has proposed a dynamometer for testing of MTU diesel engines. An equivalent dynamometer could be identified from a USA source and funded by AID.

A Davis and Metcalf (or equivalent) brake system component testing equipment is needed at MPIKA.

An underfloor wheel truing machine is required at MPIKA with the reallocation of locomotive maintenance work. Present wheel truing equipment at MPIKA is worn beyond rehabilitation. Project ME:6 is underway and funded to provide a quantity of two wheel lathes (overfloor), one for MPIKA and one for DAR.

The decision for ordering overfloor instead of underfloor equipment should be reviewed to assure acquisition of correct equipment to fit the need. Underfloor type will eliminate need to remove wheel and axle assemblies from locomotives and/or wagons.

SCHEDULED MAINTENANCE  
DFH<sub>1</sub> and DFH<sub>2</sub> LOCOMOTIVES

Period (or cycle)	Running Kilometrage KM.	Period of Running	Duration Repair
Class of Repair			
Interperiod (A) inspection	10,000	1 month	1 day
Light Repair (B) B	30,000	3 months	2 days
Light Repair (C) A	60,000	6 months	3½ days
Medium Repair (D)	180,000	1.5 years	12 days
Heavy Repair (E)	540,000	4.5 years	25 days

\* The above extracted from the "Rules and Regulations" for maintenance of DFH Diesel Hydraulic Locomotives issued by the working team of the People's Republic of China - April 1975

MAINTENANCE SCHEDULE OF DFH LOCOMOTIVES WITH MTU ENGINES

Low operating and maintenance costs as well as operational reliability and availability depend on maintenance and servicing in compliance with specifications and instructions.

Moreover it is important that:-

- Maintenance services be performed by trained personnel;
- Suitable tools be employed;
- Genuine spare parts as well as fluids and lubricants as per our Fluids and Lubricants Specification No. 1061 be used.

Time intervals and services given are based on operational experience and are intended to serve as a guide. Particular operating conditions may require the Maintenance Schedule to be altered to compensate.

Preventive Maintenance Instructions

- Special care should be exercised to keep the power plant in a clean and serviceable condition at all times to facilitate discovery of possible leaks and prevent subsequent damage.
- Never treat rubber or synthetic parts with chemicals. Wipe with dry cloth only.

MTU Maintenance Concept for Diesel Engine Type 12V396 TC 12

- MTU's maintenance concept features various maintenance schelons (W1 through W6) as outlined below.

Maintenance Echelon W1

- Daily checks.

Maintenance Echelons W2, W3 and W4

- Periodic maintenance services to be performed during out-of-service periods without the need for engine disassembly.

Maintenance Echelon W5

- Intermediate overhaul. Component repairs. The W5 echelon requires partial engine disassembly.

Maintenance Echelon W6

- Major overhaul. The W6 echelon requires complete engine disassembly.

The maintenance frequency pertinent to the W2 - W6 echelons will be determined so as to ensure efficient engine operation in each particular application.

# MAINTENANCE SCHEDULE OF DFH LOCOS WITH MTU ENGINES

Application Group:

2A Rail traction

3A Train electricity supply

Maintenance Frequency Chart

2A

W1	Every operating day	x
W2	Operating hours Limit (months)	500 6
W3	Operating hours Limit (years)	1000 1
W4	Operating hours	2000 2
W5	Operating hours Limit (Years)	8000 6
W6	Operating hours Limit (years)	24000 12

## One Time Additional Services

- On a new engine or after W5 or W6 maintenance the following services are to be performed after the first 50 operating hours:

<u>Code No.</u>	<u>Task Description</u>
00.11 Attachments:	Check tightness of fastening bolts and nuts
06.02 Valve gear:	Check valve clearance, readjust as necessary
10.16 Air System:	Check tightness of fastening bolts and nuts
10.17 Exhaust system:	Check tightness of fastening bolts and nuts
12.04 Main fuel filter:	Drain, replace paper elements
12.05 Fuel prefilter:	Clean
13.08 Engine coolant pump:	Check telltale bore for obstruction
16.03 Engine Oil:	Take sample and analyze
19.01 Engine mounting:	Check tightness of fastening bolts and nuts.

MAINTENANCE SCHEDULE ON DPH LOCOMOTIVES WITH MTU ENGINES

LOCO NO:..... End I: Engine No.... Running Hours.....  
 End II: Engine No.... Running Hours.....

MAINTENANCE ECHELON VI: OPERATIONAL CHECKS

<u>Code No.</u>	<u>Task Description</u>
00.01	Engine operation: Listen for alien running noise.....
00.02	Engine operation: Check exhaust fumes color .....
00.03	Engine operation: Inspect engine and external pipework for evidence of leaks.....
00.04	Engine operation: Check engine revolutions, temperatures and pressures .....
10.01	Air system: Check condensate bleed line of intercooler inlet cover for water leak .....
10.27	Air Filter: Check filter restriction indicator .....
12.02	Fuels: Check supply .....
14.01	Engine coolants: Check level .....
16.01	Engine oils: Check level .....

NB: Tick after accomplishing each task.

Signature of Fitter: (1).....  
 (2).....  
 (3).....  
 (4).....

Signature of Supervisor:.....

Signature of Quantity Controller:.....

MAINTENANCE SCHEDULE OF DFH LOCOMOTIVES WITH MTU ENGINES

Low operating and maintenance costs as well as reliability and availability depend on maintenance and servicing in compliance with specifications and instructions.

Moreover it is important that:-

- Maintenance services be performed by trained personnel;
- Suitable tools be employed;
- Genuine spare parts as well as fluids and lubricants as per our Fluids and Lubricants Specification No. 1061 be used.

Time intervals and services given are based on operational experience and are intended to serve as a guide. Particular operating conditions may require the Maintenance Schedule to be altered to compensate.

**Preventive Maintenance Instructions**

- Special care should be exercised to keep the power plant in a clean and serviceable condition at all times to facilitate discovery of possible leaks and prevent subsequent damage.
- Never treat rubber or synthetic parts with chemicals. Wipe with dry cloth only.

**MTU Maintenance Concept for Diesel Engine Type 12V396 TC 12**

- MTU's maintenance concept features various maintenance echelons (W1 through W6) as outlined below.

**Maintenance Echelon W1**

- Daily checks.

**Maintenance Echelons W2, W3 and W4**

- Periodic maintenance services to be performed during out-of-service periods without the need for engine disassembly.

**Maintenance Echelon W5**

- Intermediate overhaul. Component repairs. The W5 echelon requires partial engine disassembly.

**Maintenance Echelon W6**

- Major overhaul. The W6 echelon requires complete engine disassembly.

The maintenance frequency pertinent to the W2 - W6 echelons will be determined so as to ensure efficient engine operation in each particular application.

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MAINTENANCE SCHEDULE OF DFH LOCOS WITH MTU ENGINES

Application Group:

- 2A Rail traction
- 3A Train electricity supply

Maintenance Frequency Chart 2A

W1	Every operating day	x
W2	Operating hours Limit (months)	500 6
W3	Operating hours Limit (years)	1000 1
W4	Operating hours	2000 2
W5	Operating hours Limit (Years)	8000 6
W6	Operating hours Limit (years)	24000 12

One Time Additional Services

- On a new engine or after W5 or W6 maintenance the following services are to be performed after the first 50 operating hours:

<u>Code No.</u>	<u>Task Description</u>
00.11 Attachements:	Check tightness of fastening bolts and nuts
06.02 Valve gear:	Check valve clearance, readjust as necessary
10.15 Air System:	Check tightness of fastening bolts and nuts
10.17 Exhaust system:	Check tightness of fastening bolts and nuts
12.04 Main fuel filter:	Drain, replace paper elements
12.05 Fuel prefilter:	Clean
13.08 Engine coolant pump:	Check telltale bore for obstruction
16.03 Engine Oil:	Take sample and analyze
19.01 Engine mounting:	Check tightness of fastening bolts and nuts.

MAINTENANCE SCHEDULE OF DPH LOCOMOTIVES WITH MTU ENGINES

Loco No..... End I: Engine No..... Running Hours.....  
 EndII: Engine No..... Running Hours.....

MAINTENANCE ECHELON

<u>Code No</u>	<u>Task Description</u>	<u>W2</u>
00.01	Engine operation: Listen for alien running noise	.....
00.02	Engine operation: Check exhaust fumes color	.....
00.03	Engine operation: Inspect engine and external pipework for evidence of leaks	.....
00.04	Engine operation: Check engine revolutions, temperatures and pressures	.....
10.01	Air system: Check condensate bleed line of intercooler inlet cover for water leak	.....
10.27	Air filter: Check filter restriction indicator	.....
12.02	Fuel: Check supply	.....
14.01	Engine coolant: Check level	.....
16.01	Engine oil: Check level	.....
10.02	Air filter: Clean and empty dust box	.....
10.05	Fuel Prefilter: Clean	.....
10.23	Air System: Check intake ducts for leaks or damage	.....
12.04	Fuel Filter: Drain, replace paper elements	.....
14.03	Engine coolant: Take sample and analyze	.....
16.03	Engine oil: Take sample and analyze	.....
16.04	Free-jet centrifugal oil filters: Check thickness of deposited oil sludge, clean filter	.....
16.05	Engine oil filter: Drain oil sludge and examine for metallic residue	.....

Signature of Fitter:(1).....  
 (2).....  
 (3).....  
 (4).....

Signature of Supervisor:.....  
 Signature of Quantity Controller.....

NB: Tick after accomplishing each task

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MAINTENANCE SCHEDULE OF DFH LOCOMOTIVES WITH MTU ENGINES

Low operating and maintenance costs as well as operational reliability and availability depend on maintenance and servicing in compliance with specifications and instructions.

Moreover it is important that:-

- Maintenance services be performed by trained personnel;
- Suitable tools be employed;
- Genuine spare parts as well as fluids and lubricants as per our Fluids and Lubricants Specification No. 1061 be used.

Time intervals and services given are based on operational experience and are intended to serve as a guide. Particular operating conditions may require the Maintenance Schedule to be altered to compensate.

**Preventive Maintenance Instructions**

- Special care should be exercised to keep the power plant in a clean and serviceable condition at all times to facilitate discovery of possible leaks and prevent subsequent damage.
- Never treat rubber or synthetic parts with chemicals. Wipe with dry cloth only.

**MTU Maintenance Concept for Diesel Engine Type 12V396 TC 12**

- MTU's maintenance concept features various maintenance echelons (W1 through W6) as outlined below.

**Maintenance Echelon W1**

- Daily checks.

**Maintenance Echelons W2, W3 and W4**

- Periodic maintenance services to be performed during out-of-service periods without the need for engine disassembly.

**Maintenance Echelon W5**

- Intermediate overhaul. Component repairs. The W5 echelon requires partial engine disassembly.

**Maintenance Echelon W6**

- Major overhaul. The W6 echelon requires complete engine disassembly.

The maintenance frequency pertinent to the W2 - W6 echelons will be determined so as to ensure efficient engine operation in each particular application.

MAINTENANCE SCHEDULE OF DFR LOCOS WITH MTU ENGINES

Application Group:

2A Rail traction

3A Train electricity supply

Maintenance Frequency Chart

2A

W1	Every operating day	x
W2	Operating hours Limit (months)	500 6
W3	Operating hours Limit (years)	1000 1
W4	Operating hours	2000 2
W5	Operating hours Limit (Years)	8000 6
W6	Operating hours Limit (years)	24000 12

One Time Additional Services

- On a new engine or after W5 or W6 maintenance the following services are to be performed after the first 50 operating hours:

<u>Code No.</u>	<u>Task Description</u>
00.11 Attachements:	Check tightness of fastening bolts and nuts
06.02 Valve gear:	Check valve clearance, readjust as necessary
10.16 Air System:	Check tightness of fastening bolts and nuts
10.17 Exhaust system:	Check tightness of fastening bolts and nuts
12.04 Main fuel filter:	Drain, replace paper elements
12.05 Fuel prefilter:	Clean
13.08 Engine coolant pump:	Check telltale bore for obstruction
16.03 Engine Oil:	Take sample and analyze
19.01 Engine mounting:	Check tightness of fastening bolts and nuts.

MAINTENANCE SCHEDULE OF DEH LOCOMOTIVE WITH MTU ENGINES

MAINTENANCE SECTION

Loco No:.....End I: Engine No..... Running Hours.....  
 EndII: Engine No..... Running Hours.....

<u>Code No.</u>	<u>Task Description</u>	<u>W3</u>
00.01	Engine operation: Listen for alien running noise	.....
00.02	Engine operation: Check exhaust fumes color	.....
00.03	Engine operation: Inspect engine and external pipe-work for evidence of leaks	.....
00.04	Engine operation: Check engine revolutions, temperatures and pressures	.....
10.01	Air system: Check condensate bleed line of intercooler inlet cover for water leak	.....
10.27	Air filter: Check filter restriction indicator	.....
12.02	Fuel: Check supply	.....
14.01	Engine coolant: Check level	.....
16.01	Engine oil: Check level	.....
10.02	Air filter: Clean and empty dust box	.....
10.04	Fuel prefilter: Clean	.....
10.20	Air system: Check intake ducts for leaks or damage	.....
12.04	Fuel filter: Drain replace paper elements	.....
14.03	Engine coolant: Take sample and analyze	.....
16.03	Engine oil: Take sample and analyze	.....
16.04	Free-jet centrifugal oil filter: Check thickness of deposited oil sludge, clean filter	.....
16.05	Engine filters: Drain oil sludge and examine for metallic residue (accomplish when changing oil)	.....
00.07	Lubrication points: Lubricate	.....
06.01	Valve gear: Inspect for proper lube oil supply	.....
06.02	Valve gear: Check valve clearance and readjust	.....
06.18	Valve gear: Check cylinder head cap gasket, replace if necessary	.....
08.02	Governor linkage: Check that linkage does not bind, and lubricate	.....

- 10.06 Air System: Check function of emergency air flaps .....
- 10.21 Exhaust system: Inspect system, and check drains for obstruction .....
- 13.08 Engine coolant pump: Check telltale bore for obstruction .....
- 14.16 Engine coolant: Check for external contamination, if necessary .....
- 16.06 Engine oil: Change filter oil change interval is 1000 hours .....
- 16.15 Engine oil filter: Replace paper elements and seal-rings (accomplish when changing oil) .....
- 88.02 Torsionally resilient coupling: Inspect for proper condition .....

NB: Tick after accomplishing each task.

Signature of fitters(1).....  
 (2).....  
 (3).....  
 (4).....

Signature of Supervisor:.....

Signature of Quantity Controller:.....

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MAINTENANCE SCHEDULE OF DFH LOCOMOTIVES WITH MTU ENGINES

APPENDIX D  
ITEM 3  
MAINTENANCE  
SCHEDULE W4

Low operating and maintenance costs as well as operational reliability and availability depend on maintenance and servicing in compliance with specifications and instructions.

Moreover it is important that:-

- Maintenance services be performed by trained personnel;
- Suitable tools be employed;
- Genuine spare parts as well as fluids and lubricants as per our Fluids and Lubricants Specification No. 1061 be used.

Time intervals and services given are based on operational experience and are intended to serve as a guide. Particular operating conditions may require the Maintenance Schedule to be altered to compensate.

Preventive Maintenance Instructions

- Special care should be exercised to keep the power plant in a clean and serviceable condition at all times to facilitate discovery of possible leaks and prevent subsequent damage.
- Never treat rubber or synthetic parts with chemicals. Wipe with dry cloth only.

MTU Maintenance Concept for Diesel Engine Type 12V396 TC 12

- MTU's maintenance concept features various maintenance echelons (W1 through W6) as outlined below.

Maintenance Echelon W1

- Daily checks.

Maintenance Echelons W2, W3 and W4

- Periodic maintenance services to be performed during out-of-service periods without the need for engine disassembly.

Maintenance Echelon W5

- Intermediate overhaul. Component repairs. The W5 echelon requires partial engine disassembly.

Maintenance Echelon W6

- Major overhaul. The W6 echelon requires complete engine disassembly.

The maintenance frequency pertinent to the W2 - W6 echelons will be determined so as to ensure efficient engine operation in each particular application.

MAINTENANCE SCHEDULE OF DFH LOCOS WITH MTU ENGINES

Application Group:

2A Rail traction

3A Train electricity supply

Maintenance Frequency Chart

2A

W1	Every operating day	x
W2	Operating hours Limit (months)	500 6
W3	Operating hours Limit (years)	1000 1
W4	Operating hours	2000 2
W5	Operating hours Limit (Years)	8000 6
W6	Operating hours Limit (years)	24000 12

One Time Additional Services

- On a new engine or after W5 or W6 maintenance the following services are to be performed after the first 50 operating hours:

<u>Code No.</u>	<u>Task Description</u>
00.11 Attachements	Check tightness of fastening bolts and nuts
06.02 Valve gear:	Check valve clearance, readjust as necessary
10.16 Air System:	Check tightness of fastening bolts and nuts
10.17 Exhaust system:	Check tightness of fastening bolts and nuts
12.04 Main fuel filter:	Drain, replace paper elements
12.05 Fuel prefilter:	Clean
13.08 Engine coolant pump:	Check telltale bore for obstruction
16.03 Engine Oil:	Take sample and analyze
19.01 Engine mounting:	Check tightness of fastening bolts and nuts.

MAINTENANCE SCHEDULE OF DEH LOCOMOTIVES WITH MTU ENGINES

MAINTENANCE SCHEDULE

<u>Code No</u>	<u>Task Description</u>	<u>W4</u>
00.01	Engine operation: Listen for alien running noise	.....
00.02	Engine operation: Check exhaust fumes color	.....
00.03	Engine operation: Inspect engine and external pipe-work for evidence of leaks	.....
00.04	Engine operation: Check engine revolutions, temperatures and pressures	.....
10.01	Air system: Check condensate bleed line of intercooler inlet cover for water leak	.....
10.27	Air filter: Check filter restriction indicator	.....
12.02	Fuel: Check supply	.....
14.01	Engine coolant: Check level	.....
16.01	Engine oil: Check level	.....
10.02	Air filter: Clean and empty dust box	.....
10.05	Fuel prefilter: Clean	.....
10.20	Air system: Check intake ducts for leaks or damage	.....
12.04	Fuel filter: Drain replace paper elements	.....
14.03	Engine coolant: Take sample and analyze	.....
16.03	Engine oil: Take sample and analyze	.....
16.04	Free-jet centrifugal oil filter: Check thickness of deposited oil sludge, clean filter	.....
16.05	Engine oil filter: Drain oil sludge and examine for metallic residue (accomplish when changing oil)	.....
00.07	Lubricating points: Lubricate	.....
06.01	Valve gear: Inspect for proper lube oil supply	.....
06.02	Valve gear: Check valve clearance and readjust	.....

06.18	Valve gear:	Check cylinder head cap gasket replace if necessary	.....
08.02	Governor linkage	Check that linkage does not bind, and lubricate	.....
10.06	Air systems:	Check function of emergency air flaps	.....
10.21	Exhaust system:	Inspect system, and check drains for obstruction	.....
13.08	Engine coolant pump:	Check telltale bore for obstruc- tion	.....
14.16	Engine coolant:	Check function of level monitor	.....
14.17	Engine coolant coolers:	Check for external contamination, clean if necessary	.....
16.06	Engine oil	Change filter oil change interval is 1000 hours	.....
16.15	Engine oil filter	Replace paper elements & sealing rings (accomplish when changing oil)	.....
85.02	Torsionally resilient coupling	Inspect for proper condition	.....
06.12	Valve gear:	Make visual inspection	.....
10.05	Air systems:	Clean condensate bleed line of intercooler inlet cover	.....
10.07	Air system:	Check charge pressure	.....
10.19	Air filter:	Replace paper element (every 4000 hours)	.....
11.01	Fuel injection nozzles:	Remove and test, replace sealing rings, replace nozzles after 3000 - 4000 operating hours	.....
14.04	Engine coolant:	Change coolant, flush cooling system	.....
19.01	Engine mounting:	Check tightness of fastening bolts	.....
19.02	Engine mounting:	Make visual inspection of each mount	.....
84.02	Monitoring system	Check function of monitoring instruments	.....
87.01	Engine controls:	Check function	.....

**NB: Tick after accomplishing each task.**

Signature of fitter:(1).....

(2).....

(3).....

(4).....

Signature of Supervisor:.....

Signature of Quantity Controller:.....

MAINTENANCE SCHEDULE OF DFH LOCOMOTIVES WITH MTU ENGINES

Low operating and maintenance costs as well as operational reliability and availability depend on maintenance and servicing in compliance with specifications and instructions.

Moreover it is important that:-

- Maintenance services be performed by trained personnel;
- Suitable tools be employed;
- Genuine spare parts as well as fluids and lubricants as per our Fluids and Lubricants Specification No. 1061 be used.

Time intervals and services given are based on operational experience and are intended to serve as a guide. Particular operating conditions may require the Maintenance Schedule to be altered to compensate.

Preventive Maintenance Instructions

- Special care should be exercised to keep the power plant in a clean and serviceable condition at all times to facilitate discovery of possible leaks and prevent subsequent damage.
- Never treat rubber or synthetic parts with chemicals. Wipe with dry cloth only.

MTU Maintenance Concept for Diesel Engine Type 12V396 TC 12

- MTU's maintenance concept features various maintenance schelons (W1 through W6) as outlined below.

Maintenance Echelon W1

- Daily checks.

Maintenance Echelons W2, W3 and W4

- Periodic maintenance services to be performed during out-of-service periods without the need for engine disassembly.

Maintenance Echelon W5

- Intermediate overhaul. Component repairs. The W5 echelon requires partial engine disassembly.

Maintenance Echelon W6

- Major overhaul. The W6 echelon requires complete engine disassembly.

The maintenance frequency pertinent to the W2 - W6 echelons will be determined so as to ensure efficient engine operation in each particular application.

MAINTENANCE SCHEDULE OF DFH LOCOS WITH MTU ENGINES

Application Group:

2A Rail traction

3A Train electricity supply

Maintenance Frequency Chart

2A

W1	Every operating day	x
W2	Operating hours Limit (months)	500 6
W3	Operating hours Limit (years)	1000 1
W4	Operating hours	2000 2
W5	Operating hours Limit (Years)	8000 6
W6	Operating hours Limit (years)	24000 12

One Time Additional Services

- On a new engine or after W5 or W6 maintenance the following services are to be performed after the first 50 operating hours:

<u>Code No.</u>	<u>Task Description</u>
00.11 Attachements:	Check tightness of fastening bolts and nuts
06.02 Valve gear:	Check valve clearance, readjust as necessary
10.16 Air System:	Check tightness of fastening bolts and nuts
10.17 Exhaust system:	Check tightness of fastening bolts and nuts
12.04 Main fuel filter:	Drain, replace paper elements
12.05 Fuel prefilter:	Clean
13.08 Engine coolant pump:	Check telltale bore for obstruction
16.03 Engine Oil:	Take sample and analyze
19.01 Engine mounting:	Check tightness of fastening bolts and nuts.

### Maintenance Schedule

Maintenance Echelon W5: The W1 - W4 maintenance echelons can be accomplished without the need for engine disassembly whereas the W5 echelon requires partial disassembly. The following is a list of W5 services and checks to be made in addition to those given for the W1 - W4 echelons.

<u>Code No</u>	<u>Task Description</u>
02.01 Gear train:	Make visual inspection (do not disassemble)
03.02 Running gear:	Check appearance of cylinder liners
03.03 Running gear:	Check condition of piston crown, and clean
05.03 Cylinder heads:	Remove cylinder heads, recondition valve seat insert, reface valves
05.04 Cylinder heads:	Replace cylinder head gasket and water & oil seals
05.10 Cylinder heads:	Replace "O" ring on protective sleeve
06.03 Valve gear:	Remove cylinder heads, recondition valve seat inserts, reface valves
05.04 Cylinder heads:	Replace cylinder head gaskets and water & oil seals
05.10 Cylinder heads:	Replace "O" ring on protective sleeve
06.03 Valve gear:	Remove rocker arms and inspect
06.04 Valve gear:	Check wear on valve tappets
07.02 Governor:	Replace diaphragm
07.08 Governor:	Replace rubber buffer in governor drive
09.06 Exhaust turbocharger	Remove, disassemble, clean, check bearing clearance.
10.08 Air manifolds:	Remove, clean, replace gaskets
10.10 Exhaust manifolds:	Remove, clean, replace gaskets
10.11 Exhaust silencer:	Remove, clean, replace gaskets
10.12 Intercooler:	Remove, clean, leak-test
11.02 Fuel injection nozzle	Replace
11.03 Fuel injection pump:	Remove and check (pump flow, evidence of leaks)
11.09 Fuel injection timer:	Check function

11.13	Fuel injection pump:	Check start-of-supply point
12.08	Fuel:	Clean tank, inspect fuel pipes and seals
13.06	Engine coolant pump:	Disassemble, inspect, replace seals
14.13	Engine coolant cooler:	Clean cooler (radiator) fins
14.21	Engine coolant:	Clean strainers in coolant return line
14.25	Coolant thermostat:	Replace pellet case
16.09	Engine oil heat exchanger:	Remove, clean, leak-test
16.18	Engine oil filter:	Remove, clean, replace paper elements and gaskets
16.24	Free-jet centrifugal oil filter:	Remove, disassemble, replace bearing if necessary
16.29	Engine oil heat exchanger:	Check unloader valve and bypass valves
87.02	Engine controls:	Check, readjust as necessary
<p>X Maintenance Echelon 76: The W6 echelon requires engine removal and complete disassembly</p>		

FB: Tick after accomplishing each task.

Signature of fitter:(1).....  
                          (2).....  
                          (3).....  
                          (4).....

Signature of Supervisor:.....

Signature of Quantity Controller:.....

U30C Locomotive Maintenance Schedule

Periods:

Daily Inspection

One Month

Three Months

Six Months

One Year

Two Years

Four Years - Heavy Repair (Overhaul)

Eight Years - Heavy Repair (Overhaul)

Note: Detail maintenance tasks for each of the above periods are listed in Locomotive Maintenance Manual.

**GENERAL  ELECTRIC**

TRANSPORTATION SYSTEMS BUSINESS OPERATIONS  
GENERAL ELECTRIC COMPANY • 2901 EAST LAKE ROAD • ERIE, PENNSYLVANIA 16531

May 5, 1987

Mr. J. Forman  
Assistant Vice President  
Parsons, Brinckerhoff, Quade & Douglas, Inc.  
1136 Glen Meadow  
Schenectady, NY 12309

RE: TAZARA

Dear Mr. Forman:

Confirming our telex of April 7, 1987, and based upon our discussions with you in Dar Es Salaam the week of March 30, 1987, we are pleased to provide the following quotation for our Model U30C diesel electric locomotives for Tazara. This quotation modifies our April 7 telex in that the quantities of locomotives involved and the spare parts recommendations are based on quantities up to 15. This change is based upon our phone conversation on May 4, 1987.

Locomotive

General Electric Model U30C diesel electric locomotives similar in configuration to those previously supplied to Tazara and equipped with General Electric bogies including clasp brakes and derailment beams in accordance with Tazara requirements. Prices quoted are estimated for locomotives delivered F.O.B. factory within 10 months from receipt of order, complete with all technical and financial details, subject to prior sale of our manufacturing capacity.

Quantity 10 locomotives ..... US \$1,395,000 each  
Quantity 11-15 locomotives ..... US \$1,350,000 each

Estimated ocean freight and insurance charges per locomotive are \$75,000 from U.S. East Coast/Gulf Port to Dar Es Salaam. Ocean freight and insurance costs would be billed at actuals.

Service Engineering

At the request of Tazara, we have checked into the possibility of extending the services of Mr. H. Anton, who is currently in Tanzania. Based upon the exchange rate of 1.8 DM per U.S. dollars, the price for extended engineering service cover - up to three years - is as follows:

Year 1 ..... \$230,000  
Year 2 ..... \$240,000  
Year 3 ..... \$250,000

*ML*

Spare Parts

General Electric's spare parts recommendation to support the U30C fleet is presented in the following categories:

1. Consumable parts, which include such items as filters, brushes, contact tips, light bulbs, brake shoes and wear plates. This list is compiled on the basis of five years of operation. However, it is recommended that filters be ordered in quantities adequate for 2 years of operation.
2. Protective parts recommended to have on hand to adequately protect the fleet in the event of failure, accident, etc. This lot of parts also contains the parts required to perform the first overhaul at four years. The overhaul parts were included in this section because they have protective value as well. Said overhaul parts would total approximately \$30,000 per locomotive.
  - A. Diesel Engine Arrangement
  - B. Mechanical and Electrical Equipment
  - C. Governor
3. Capital Spares - Recommended estimates for the different categories of parts quoted in US \$000 are as follows:

Locomotive Fleet Size	5	10	15
Consumables	154.3	308.6	462.8
Protective			
A - Engine	550.9	738.2	907.3
B - Elec. & Mech.	359.5	478.0	547.1
C - Governor	1.8	3.6	5.5
Capital	<u>380.3</u>	<u>380.3</u>	<u>431.8</u>
Total	1446.8	1908.7	2354.5
Est. Freight & Insurance (3%)	<u>43.4</u>	<u>57.3</u>	<u>70.6</u>
Total CIF	1490.2	1966.0	2425.1

Lists of materials recommended, equaling the above dollar amounts are enclosed for your information.

Material prices quoted are valid for acceptance for four months, i.e. until August 31, 1987. As indicated earlier, the ocean freight and insurance costs are estimates. We will bill ocean freight and insurance charges at actual cost. The service engineering charges are subject to adjustment based upon the fluctuations of the DM vs. US dollar.

This quotation is subject to our standard Conditions of Sale, form GE 43H, copy attached for your ready reference.

In specific response to questions raised during our discussions in Dar Es Salaam, I wish to advise as follows:

1. Shelf life of spares in a heavy moisture environment: Except for paper filter elements we would not have any special concern for the life of the parts being shortened due to high humidity provided adequate protection is taken in handling and storing the goods. Materials susceptible to moisture damage are packed in special moisture resistant paper and, where necessary, materials are sprayed with rust inhibitors.

Paper filter elements should preferably be ordered in quantities equaling two years normal service because: A) the space required to properly store is quite large; and, B) the paper may begin to deteriorate after 3 years or so with resultant shortened life in service.

2. Source of gasketing material for Chinese locomotives: We do not cut many gaskets ourselves. When the occasion does arise that we want to cut our own gaskets, we would have to purchase the material from a gasket cutter because the quantity we would require would not be of interest to the material manufacturers. Names of manufacturers of gasketing material that we use are: Armstrong, Chicago Rawhide, Clinger, Garlock, Parker and Precision. We do not deal directly with any of the above companies as explained earlier. Mailing addresses and phone numbers for any of the above should be available from your Thomas' Register.
3. Incorrect placement of an electronic card from "old" wheelslip system into "new" wheelslip panel or vice versa: The system is designed so that if any card is placed in this wrong slot, or if the wrong cards are put into a panel:
  - A. A wheelslip light would energize on the driver's console.
  - B. The locomotive will not load.
  - C. Corrective action would be required before this locomotive could move under its own power.
  - D. No damage would be inflicted on the card as a result of it being placed in the wrong slot or the wrong panel.
4. Varnish applied by GE Service Shops during a "clean bake and varnish" is or is not VPI'd? I checked with our Cleveland Service Shop and was advised the current practice for a basic overhaul is to VPI the armature and frame on any GE traction motor. Similar work done by the GE Service Shop on Electro-Motive Division of General Motors traction motors, the policy is to VPI armature only, unless a customer asks for and agrees to pay extra for the frame.

This has not always been the policy. However, it is strongly recommended that anytime varnish is applied to a motor frame or armature it be VPI'd. This is the only way to assure proper penetration of the varnish. Applying varnish without VPI might tend to give a false sense of security.

As promised during our phone conversation of May 4, 1987 we will provide quotation for materials required by Tazara for the existing Krupp fleet as well as special tools as soon as possible after we receive the list from you.

We appreciate this opportunity to provide information on General Electric locomotives and spare parts. In the event I have overlooked any questions raised or have not provided a complete answer, please advise and I will attempt to rectify the situation as quickly as possible.

Very truly yours,



T.E. Nelson

CEWP:1063F

# GENERAL ELECTRIC COMPANY

## CONDITIONS OF EXPORT SALE

**NOTICE: THE OFFER, ORDER ACKNOWLEDGEMENT, ORDER ACCEPTANCE OR SALE OF ANY PRODUCTS COVERED HEREIN IS CONDITIONED UPON THE TERMS CONTAINED IN THIS INSTRUMENT. ANY ADDITIONAL OR DIFFERENT TERMS PROPOSED BY BUYER ARE OBJECTED TO AND WILL NOT BE BINDING UPON SELLER UNLESS SPECIFICALLY ASSENTED TO IN WRITING BY SELLER.**

### ARTICLE I - PRICES

Prices include the cost of (i) Seller's usual inspection and factory tests, (ii) Seller's usual packing (or containerizing, if applicable) for export, and (iii) freight by Seller's usual means to alongside vessel at the point of export designated by Seller (but not the cost of insurance, or charges for pier handling, marshaling, lighterage and heavy lifts). Insurance to cover the inland shipment shall be arranged by Seller at Buyer's expense if Seller is arranging for the export shipment pursuant to Article III.

### ARTICLE II - DELIVERY, TITLE AND RISK OF LOSS

A. Except as stated in Paragraph B below, Seller shall deliver the Products to Buyer F.O.B. factory. Partial deliveries shall be permitted. Upon delivery, title to the Products and all risk of loss or damage shall pass to Buyer. Delivery times are approximate and are dependent upon prompt receipt by Seller of all material and information necessary to proceed with work without interruption.

B. If any part of the Products cannot be shipped from the point of inland shipment to alongside vessel when ready due to any cause referred to in Article V, Seller may place such Products in storage (which may be at the place of manufacture). In such event, (i) Seller shall notify Buyer of the placement of any Product in storage, (ii) Seller's delivery obligations shall be deemed fulfilled and title and all risk of loss or damage shall thereupon pass to Buyer, (iii) any amounts otherwise payable to Seller upon delivery shall be payable upon presentation of Seller's invoices therefor and its certification as to such cause, (iv) promptly upon submission of Seller's invoices, Buyer shall reimburse Seller for all expenses incurred by Seller, such as preparation for and placement into storage, handling, storage, inspection, preservation and insurance, and (v) when conditions permit and upon payment of all amounts due hereunder, Seller shall assist and cooperate with Buyer in any reasonable manner with respect to the removal of any Product which has been placed in storage.

### ARTICLE III - EXPORT SHIPMENT

A. In the event Buyer wishes to arrange for export shipment, Buyer shall inform Seller by so indicating on the order. In the absence of such indication, or if Seller exercises its rights under Paragraph B of Article VI, Seller shall arrange for (i) export shipment to Buyer's country and (ii) marine warehouse-to-warehouse insurance (including war risk, if available). Buyer shall pay Seller for all fees and expenses, including, but not limited to, those covering preparation of consular documents, consular fees, ocean freight, storage, insurance and Seller's then current fee for such services. Notwithstanding any extension of credit to Buyer, all such charges shall be promptly reimbursed by Buyer in U.S. Dollars upon submission of Seller's invoices therefor.

B. In performing any of the foregoing services, Seller shall comply with any reasonable instructions of Buyer or, in the absence thereof, shall act according to its best judgment. In so acting on Buyer's behalf, neither Seller nor its agents shall be liable for negligence or for any special, consequential, incidental, indirect or exemplary damages to Buyer resulting therefrom.

### ARTICLE IV - GOVERNMENTAL AUTHORIZATIONS

A. The party that arranges for export shipment (or Buyer's designated export agent) shall be responsible for the timely application in its own name for any required U.S.A. export license. Buyer shall be responsible for timely obtaining and maintaining any required import license, exchange permit or any other governmental authorization. Buyer and Seller shall assist each other when such help is reasonably possible. Seller shall not be liable if any authorization of any government is delayed, denied, revoked, restricted or not renewed, and Buyer shall not be relieved thereby of its obligations to pay Seller for its Products or any other charges which are the obligation of the Buyer hereunder.

B. All shipments hereunder shall at all times be subject to the export control laws and regulations of the U.S.A. and any amendments thereof. Buyer agrees that it shall not make any disposition of U.S.A.-origin Products purchased from Seller, by way of trans-shipment, re-export, diversion or otherwise, other than in and to the ultimate country of destination specified on Buyer's order or declared as the country of ultimate destination on Seller's invoices, except as said laws and regulations may expressly permit.

### ARTICLE V - EXCUSABLE DELAYS

A. Seller shall not be liable for delays in delivery or failure to perform due directly or indirectly to (i) causes beyond Seller's reasonable control, (ii) acts of God, acts (including failure to act) of any governmental authority (de jure or de facto), wars (declared or undeclared), governmental priorities, port congestion, riots, revolutions, strikes or other labor disputes, fires, floods, sabotage, nuclear incidents, earthquakes, storms, epidemics, or (iii) inability due to causes beyond Seller's reason-

able control timely to obtain either necessary and proper labor, materials, components, facilities, energy, fuel, transportation, governmental authorizations or instructions, material or information required from the Buyer. The foregoing shall apply even though any of such causes exists at the time of the order or occurs after Seller's performance of its obligations is delayed for other causes.

B. Seller shall notify Buyer of any delay or failure excused by this Article and shall specify the revised delivery date as soon as practicable. In the event of such delay, subject to Paragraph C of this Article, there shall be no termination and the time of delivery or of performance shall be extended for a period equal to the time lost by Seller by reason of the delay.

C. If delay excused by this Article extends for more than 60 days and the parties have not agreed upon a revised basis for continuing the work at the end of the delay, including adjustment of the price, then either party (except where delay is caused by Buyer, in which event only Seller), upon 30 days' written notice, may terminate the order with respect to the unexecuted portion of the work, whereupon Buyer shall promptly pay Seller its termination charges determined in accordance with Seller's standard accounting practices upon submission of Seller's invoices therefor.

### ARTICLE VI - PAYMENT

A. Payment shall be made in U.S. Dollars in New York as follows:

(i) On an order of fifteen thousand U.S. Dollars (U.S. \$15,000) or under, payment shall be made simultaneously with the placing of the order where the laws of the Buyer's country permit.

(ii) On an order over fifteen thousand U.S. Dollars (U.S. \$15,000), or if the laws of the Buyer's country forbid compliance with Paragraph (i) above, payment shall be made through a letter of credit to be established by Buyer at its expense. All costs, including any bank confirmation charges, relating to such letter of credit are for the account of the Buyer. All letters of credit shall be in favor of and acceptable to Seller, shall be consistent with the terms of this instrument, shall be maintained in sufficient amounts and for the period necessary to meet all payment obligations, shall be irrevocable and issued by, or confirmed by, a bank in New York acceptable to Seller within 15 days after acceptance of the order, shall permit partial deliveries and shall provide for pro rata payments upon presentation of Seller's invoices therefor and either Seller's certificate of delivery FOB factory or of delivery into storage with certification of cause therefor and for the payment of any charges for storage, export shipment, price adjustments, and cancellation or termination.

B. In the event that Seller agrees to any deviation from the cash or the letter of credit requirements set forth above, Seller reserves the right to arrange for export shipment of the Products.

C. If Buyer fails to fulfill any condition of its payment obligations, Seller may (i) withhold deliveries and suspend performance, or (ii) continue performance if Seller deems it reasonable to do so, or (iii) place the Products in storage pursuant to the provisions of Article II hereof. In any event, the costs incurred by Seller as a result of Buyer's non-fulfillment shall be payable by Buyer upon submission of Seller's invoices therefor. Seller shall be entitled to an extension of time for performance of its obligations equaling the period of Buyer's non-fulfillment whether or not Seller elects to suspend performance. If such non-fulfillment is not rectified by Buyer promptly upon notice thereof, Seller may cancel the agreement and Buyer shall pay Seller its charges for cancellation upon submission of Seller's invoices therefor.

### ARTICLE VII - TAXES AND DUTIES

A. All U.S.A. taxes are included in the price except sales, use, excise, value-added and similar taxes which have been excluded based on the assumption that the transaction involves exportation. All rights to drawback of U.S.A. customs duties paid by Seller with respect to Products (or material or components thereof) belong to and shall remain in Seller. If Buyer arranges for export shipment, Buyer agrees to furnish without charge evidence of exportation or other evidence of tax or duty exemption acceptable to the taxing or customs authorities when requested by Seller, failing which, the amount of any U.S.A. taxes or duties imposed on Seller in connection with the transaction shall be promptly reimbursed in U.S. Dollars by Buyer to Seller upon submission of Seller's invoices therefor.

B. Any taxes (including income, stamp and turnover or value-added taxes), duties, fees, charges or assessments of any nature levied by any governmental authority other than of the U.S.A. in connection with this transaction, whether levied against Buyer, against Seller or its employees or against any of Seller's subcontractors or their employees, shall be the responsibility of the Buyer and shall be paid directly by Buyer to the governmental authority concerned. If Seller or its subcontractors, or the employees of either, are required to pay any such levies and/or fines, penalties, or assessments in the first instance, or as a result of Buyer's failure to comply with any applicable laws or regulations governing the payment of such levies by Buyer, the amount of any payments so made, plus the expense of currency conversion, shall be promptly reimbursed in U.S. Dollars by Buyer upon submission of Seller's invoices therefor.

## ARTICLE VIII - WARRANTIES

A. Seller warrants that Products manufactured by Seller shall be free from defects in material, workmanship and true, and shall be of the kind and quality specified or designated by Seller. Seller's obligations, set forth below, shall apply only to failures to meet the foregoing warranties (except as to title) occurring within fifteen (15) months from date of delivery pursuant to Article II of which Seller is given written notice within thirty (30) days of such occurrence and provided the Product or part thereof is made available to Seller as specified by Seller.

B. If any Product or part thereof fails to meet the foregoing warranties (except as to title), Seller shall repair same or, at its option, replace same, in either case F.O.B. factory, on the same basis as described in Article I. Any such failure shall not be cause for the extension of the duration of the warranty specified in this Article VIII. If such failure or defect cannot be corrected by Seller's reasonable efforts, the parties shall negotiate an equitable adjustment.

C. Seller's obligations under Paragraph B above shall not apply to any Product or part thereof which (i) is normally consumed in operation, or (ii) has a normal life inherently shorter than the warranty period specified in Paragraph A, or (iii) is not properly stored, installed, used, maintained or repaired or is modified other than pursuant to Seller's instructions or approval, or (iv) has been subjected to any other kind of misuse or detrimental exposure, or has been involved in an accident.

D. With respect to any Products not manufactured by Seller (except for integral parts of Seller's Products to which the warranties set forth above shall apply), Seller gives no warranty, and only the warranty, if any, given by the manufacturer shall apply.

E. Subject to Article X, this Article sets forth the exclusive remedies for claims based upon defects in or nonconformity of the Products, whether the claim is in contract, warranty, tort (including negligence) or otherwise. Except as set forth in Article IX, the foregoing warranties are in lieu of all other warranties, whether oral, written, express, implied or statutory. **NO IMPLIED OR STATUTORY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE SHALL APPLY.**

## ARTICLE IX - PATENTS

A. Seller warrants that any Product (or part thereof) manufactured by Seller and furnished hereunder shall be free of any rightful claim of any third party for infringement of any U.S.A. patent. If Buyer notifies Seller promptly of the receipt of any claim that such Product infringes a U.S.A. patent and gives Seller information, assistance and exclusive authority to settle and defend such claim, Seller shall, at its own expense and option, either (i) settle or defend such claim or any suit or proceeding arising therefrom and pay all damages and costs awarded therein against Buyer, or (ii) procure for Buyer the right to continue using such Product, or (iii) modify the Product so that it becomes non-infringing, or (iv) replace the Product with a non-infringing product, or (v) remove the Product and refund the purchase price (less reasonable depreciation) and any transportation or installation costs which have been separately paid by Buyer. If, in any such suit arising from such claim, the continued use of the Product for the purpose intended is enjoined by any court of competent jurisdiction, Seller shall, at its option, take one or more of the actions under (ii), (iii), (iv) or (v) above. The foregoing states the entire liability of Seller for patent infringement of any Product and is subject to the limitation of total liability set forth in Article X.

B. The preceding paragraph shall not apply (i) to any Product (or part thereof) which is manufactured to Buyer's design or (ii) to the use of any Product (or any part thereof) furnished hereunder in conjunction with any other apparatus or material. As to any Product, part or use described in the preceding sentence, Seller assumes no liability whatsoever for patent infringement.

C. With respect to any Product (or part thereof) furnished hereunder which is not manufactured by Seller, only the patent indemnity of the manufacturer, if any, shall apply.

D. The patent warranty and indemnity obligations recited above are in lieu of all other patent warranties and indemnities whatsoever, whether oral, written, express, implied or statutory.

## ARTICLE X - LIMITATIONS OF LIABILITY

A. The total liability of Seller, including its subcontractors or suppliers, on any and all claims, whether in contract, warranty, tort (including negligence or patent infringement) or otherwise, arising out of, connected with, or resulting from the performance or non-performance of any agreement resulting herefrom or from the manufacture, sale, delivery, resale, repair, replacement or use of any Product or the furnishing of any service, shall not exceed the price allocable to the Product or

service which gives rise to the claim. Except as to title, any such liability shall terminate upon the expiration of the warranty period specified in Article VIII.

B. In no event, whether as a result of breach of contract, warranty, tort (including negligence or patent infringement) or otherwise, shall Seller, or its subcontractors or suppliers, be liable for any special, consequential, incidental, indirect or exemplary damages, including, but not limited to, loss of profit or revenues, loss of use of the Products or any associated equipment, cost of capital, cost of substitute goods, facilities, services or replacement power, downtime costs or claims of Buyer's customers for such damages. If Buyer transfers title to, or leases the Products sold hereunder to, or otherwise permits or suffers use by, any third party, Buyer shall obtain from such third party a provision affording Seller and its subcontractors and suppliers the protection of the preceding sentence.

C. If Seller furnishes Buyer with advice or other assistance which concerns any Product supplied hereunder or any system or equipment in which any such Product may be installed and which is not required by the terms of this instrument or pursuant to any agreement resulting herefrom, the furnishing of such advice or assistance shall not subject Seller to any liability, whether in contract, warranty, tort (including negligence or patent infringement) or otherwise.

## ARTICLE XI - NUCLEAR USE

A. Products and services sold hereunder are not intended for application (and shall not be used) in connection with the use or handling of nuclear material, or the construction or operation of a nuclear installation. Buyer warrants that it shall not use such Products or services for such purposes, or permit others to use such Products or services for such purposes, unless such use is agreed to in writing by Seller.

B. If, in breach of the foregoing, any such use occurs, Seller disclaims all liability for any nuclear or other damages, injury or contamination, and Buyer shall indemnify Seller against any such liability, whether as a result of breach of contract, warranty, tort (including negligence) or otherwise.

## ARTICLE XII - GENERAL

A. Any Products furnished by Seller hereunder shall comply with federal, state and local laws and regulations of the U.S.A. applicable to the manufacture, packing, sale and shipment of such Products as of the date of Seller's quotation and shall comply with any amendments thereto which may have come into effect prior to the time such Products are furnished, provided that the price and, if necessary, delivery shall be equitably adjusted to compensate Seller for the effect of compliance with any such amendments. Seller shall not comply with any law, regulation or requirement which would subject Seller to criminal or civil penalties or loss of tax benefits under any federal, state or local law or regulation of the U.S.A., and the furnishing of any quotation or acknowledgement of any order does not constitute the furnishing of an agreement to furnish any information which would subject Seller to any of the above mentioned penalties or loss of tax benefits. Seller shall not comply with any other law, regulation or requirement which would increase Seller's costs, unless there is an appropriate adjustment in price.

B. The delegation or assignment by Buyer of any or all of its duties or rights hereunder without Seller's prior written consent shall be void.

C. Any representation, understanding, proposal, agreement, warranty, course of dealing or trade usage not contained or referenced herein shall not be binding on Seller. No modification, amendment, rescission, waiver or other change shall be binding on Seller unless assented to in writing by Seller.

D. The validity, performance and all matters relating to the interpretation and effect of any agreement resulting herefrom and any amendment thereto shall be governed by the internal substantive law of the State of New York, U.S.A.

E. The provisions of any agreement resulting herefrom are for the benefit of the parties hereto and not for any other person except as specifically provided herein.

F. Unless otherwise specified by Seller, any quotation of Seller shall expire 30 days from the date of issuance and may be modified or withdrawn at any time prior to the date of Buyer's order.

G. Buyer may terminate an order only upon paying Seller its termination charges determined in accordance with Seller's standard accounting practices upon submission of Seller's invoices therefor. Termination of an order shall not relieve either party of any obligation arising out of work performed prior to termination.

H. As used throughout this instrument, (i) the term Product (or Products) is defined to include all equipment, materials, supplies, components, services, engineering, design and data, or other work which Seller has contracted to supply and (ii) the term Seller is defined to mean General Electric Company, U.S.A.

I. The invalidity, in whole or in part, of any Article or Paragraph thereof shall not affect the validity of the remainder of such Article or Paragraph or of any agreement resulting herefrom.

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APPENDIX E  
ITEM 1  
CONSUMABLE PARTS

CONSUMABLE SPARE PARTS - 5 YRS  
QUANTITY INDICATED IS PER LOCOMOTIVE

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
FILTERS					
1	480	2X4222-E	OIL FILTER	13.75	6,600.00
2	30	41A216508P4	ELEMENT	50.40	1,512.00
3	20	132X1570	FUEL FILTER	48.60	972.00
4	23	41A216205P1	ELEMENT	15.10	347.30
5	1	41B510720G2	STRAINER	374.00	374.00
6	13	41A211851P1	FILTER	37.10	482.30
SUB-TOTAL					10,287.60
-----					
BRUSHES					
7	125	6727520P1	BRUSH	3.25	406.25
8	40	8104789AAG1	BRUSHHOLDER	30.50	1,220.00
9	500	41A235897P4	BRUSH - T900	9.03	4,515.00
10	250	41A235676P5	BRUSH	9.09	2,272.50
11	125	8828400P1	BRUSH	5.70	712.50
12	12	2X4460	BRUSH/SET	13.40	160.80
13	25	149X1011	BRUSH ASM	16.90	422.50
14	63	998X90	BRUSH	2.10	132.30
SUB-TOTAL					9,841.85
-----					
CONTACTOR TIPS					
15	10	8867977P1	CONTACT	4.96	49.60
16	35	9960190G2	CONTACT	17.90	626.50
17	8	9960190G7	CONTACT TIP	37.50	300.00
SUB-TOTAL					976.10
-----					
TRUCKS					
18	30	41A201604P3	PLATE	120.00	3,600.00
19	240	41A200305P1	BRAKE SHOE	23.10	5,544.00
SUB-TOTAL					9,144.00
-----					
LAMPS					
20	40	200PAR 30V	LAMP	10.10	404.00
21	40	25A17/RS	LAMP	2.81	112.40
22	60	41A210382P6	LAMP GE 44	1.51	90.60
SUB-TOTAL					607.00
TOTAL CONSUMABLE SPARES - 5 YEARS/LOCO					30,856.55
-----					

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APPENDIX E  
 ITEM 1  
 CAPITAL SPARES

CAPITAL SPARES

11 TO 15 LOCOMOTIVES

<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
1 -	5GTA11C1	ALTERNATOR	\$97,660.00	\$ 97,660.00
1 -	5GY27L2	GENERATOR	10,910.00	10,910.00
1 -	5GY27M2	GENERATOR	10,910.00	10,910.00
3 -	17FM307A6	RECTIFIER	7,500.00	22,500.00
1 -	41C618369P6	EQUIP. BLOWER	14,550.00	14,550.00
4 -	4TD704572P1	RADIATOR	22,040.00	88,160.00
2 -	5GY19A5	BLOWER MOTOR	13,530.00	27,060.00
7	41C617473AAP1	AXLE	5,546.00	38,822.00
3	LATER	MTR/W/PIN	23,563.00	70,689.00
180	41C633819G1	MTR SP BRG	281.00	<u>50,580.00</u>
				\$431,841.00

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APPENDIX E  
ITEM 1  
PROTECTIVE SPARES DIESEL ENGINE

LOCOMOTIVE PROTECTIVE/MAINT. SPARES - 5 YRS - 15 LOCOMOTIVES  
DIESEL ENGINE ARRANGEMENT

<u>ITEM</u>	<u>QTY</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
MAIN FRAME - TAB 91000					
CRANKSHAFT, GEAR & VIBRATION DAMPER					
1	1-	119X1096	Crank - V12	34880.00	34880.00
2	1-	135X1045-3	Gear-Crank	2290.00	2290.00
3	2-	119X1058	Key	17.50	35.00
4	2-	119X1062-1	Clamp Ring	350.00	700.00
5	2-	119X1006-3	Damper	2580.00	5160.00
			Sub Total		43065.00
MAIN FRAME & OIL PAN ASSEMBLY					
6	280	115X1905	O Ring	.19	53.20
7	20-	115X2050	O Ring	.18	3.60
8	20-	115X2611	D Seal 4.0	3.71	74.20
9	20-	115X1895-4	Gasket, Gov D	5.50	110.00
10	20-	115X2187	Gasket	.53	10.60
			Sub Total		251.60
MAIN BEARINGS					
11	105	114X1103-1	Main Bearing	125.37	13163.85
12	105	114X1150	Main Bearing-L	124.09	13029.45
13	30	114X1111-4	Lg Thrust	218.00	6540.00
			Sub Total		32733.30
CAMSHAFT, CROSSHEADS, GEAR & BEARINGS					
14	15-	116X1122-1	CAM-R-LF12	564.00	8460.00
15	15-	116X1123-1	CAM-L-LF12	564.00	8460.00
16	4-	116X1085-2	Shaft Stub	180.00	720.00
17	96-	116X1141	Cam Stud	3.64	349.44
18	192-	115X2393	Nut	.83	159.36
19	1-	135X1067	Cam Gear	2140.00	2140.00
20	4-	116X1047	Thrust Bearing	146.00	584.00
21	4-	116X1086	Ring	110.00	440.00
22	28-	116X1070-1	Cam Bearing	153.00	4284.00
23	28-	N22P29032B	Screw Cap	.41	11.48
24	28-	N402P15B	Washer Flat	.34	9.52
25	140-	115X1140	Stato-SL	.54	75.60
26	24-	124X1068	Crosshead	134.00	3216.00
27	24-	124X1072	Bearing	11.20	268.80
28	24-	124X1076-1	Roller	65.90	1581.60
29	24-	124X1077	Roller Pin	48.80	1171.20
30	36-	N509[1918B	Pin Roll	.19	6.84
31	12-	124X1058-1	Xhead-Lgfu	135.00	1620.00
32	12-	124X1062	Bearing	6.29	75.48
33	12-	124X1063-1	Roller	60.50	726.00

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<u>ITEM</u>	<u>QTY</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
34	12-	124X1064	Pin/Dowel	48.80	585.60
35	12-	146X1083	Spring-Hd	12.30	147.60
36	12-	124X1061	Retain-Spr	16.10	193.20
37	396-	115X1045-3	O Ring	2.19	867.24
38	36-	115X1046	Dowel	.49	17.64
			Sub Total		36130.60

## CRANKCASE PRESSURE SWITCH

39	1-	41D713511P1	Switch	1240.00	1240.00
40	15-	1X6849	Diaph Assm	149.00	2235.00
41	120-	1X6860	Brush	5.74	688.80
42	15-	6S6DC-75V	Bulb	3.04	45.60
43	15-	1X6862	Spring	4.76	71.40
44	2-	1X6853	Connector	42.30	84.60
45	2-	1X6854	Gasket	1.44	2.88
46	2-	1X6855	Recept Asy	63.40	126.80
47	2-	1X6858	Plug & Cap	5.44	10.88
48	2-	1X6859	Socket	4.39	8.78
49	2-	140X1760	Ftg	15.00	30.00
			Sub Total		4544.74

## GENERATOR END COVER

50	15-	115X1843	Gasket	28.26	423.90
51	15-	115X1844	Gasket	13.86	207.90
52	390-	N405P75B	Washer Lock	.21	81.90
53	195	115X1021-1	Washer-Seal	.28	54.60
54	165	115X2393	Nut	.83	136.95
55	30	N170P29028B	Screw Sock	.41	12.30
			Sub Total		917.55

## CRANKCASE INSPECTION COVER

56	18	131X1005-4	Door-CC	125.00	2250.00
57	180	115X2363-1	O-Rg-CC Dr	2.45	441.00
58	180	115X1133-1	Seal-CC Dr	6.81	1225.80
59	180	115X2172	Roll Pin	.10	18.00
60	30	146X1002	Spring	15.00	450.00
61	30	115X1143	Washer-Spr	10.20	306.00
62	75	N22P23026B	Screw Cap	.71	53.25
63	75	41B560008P14	Locknut	.40	30.00
64	75	115X2174	Washer	1.04	78.00
			Sub Total		4852.05

FORWARD END COVER & AUX - TAB 92000  
COVER/W LUBE OIL & WTR DRIVE

65	15-	41A219499P138	O Ring	1.13	16.95
66	15-	115X2246-1	O Ring	2.14	32.10
67	15-	115X2075	Gask-Sd Cv	.94	14.10
68	15-	115X2420	O Ring	.50	7.50

<u>ITEM</u>	<u>QTY</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
69	15-	115X1925-1	Gasket-FEC	38.94	584.10
70	1-	135X1059-2	Gear	1100.00	1100.00
71	1-	119X1079-1	Hub	405.00	405.00
72	15-	114X1105-4	FE Coupling	509.00	7635.00
73	15-	115X1929	O Ring	1.84	27.60
74	15-	115X1930-3	Seal-Oil	26.60	399.00
75	15-	115X1931-1	Gask-Bearing	3.16	47.40
76	15-	115X1209	Gask-Mtg	2.98	44.70
77	15-	115X1208	Gaskt-Dsgh	1.44	21.60
78	15-	115X1857	Gask-Elbow	1.06	15.90
79	1-	135X1048-1	Idler Gear	885.00	885.00
80	15-	115X1936	Gasket-Idler	1.41	21.15
81	15-	115X1917-1	Gasket	7.30	109.50
82	15-	131X1052	Seal-Cap	7.34	110.10
			Sub Total		11476.70
WATER PUMP & CONNECTION					
84	20	150X1070	Water Pump I	6.20	124.00
85	20	150X1069-1	Water Pump RB	236.00	4720.00
86	1-	125X1075-1	Impeller	460.00	460.00
87	1-	125X1078-2	Shaft W/Sp	543.00	543.00
88	1-	135X1039-1	Gear	406.00	406.00
			Sub Total		6253.00
LUBE OIL PUMP & MOUNTING					
90	12-	150X1139-1	LOP Install	23.80	285.60
91	6-	150X1143	Lub PM Reb	555.00	3330.00
92	1-	135X1046-1	Gear-Oil P	600.00	600.00
93	1-	139X1230	Dr Shaft	1700.00	1700.00
94	1-	130X1106	Key	8.89	8.89
95	1-	139X1231	Idler Shaft	1310.00	1310.00
96	110	139X1113	Nut	3.34	367.40
			Sub Total		7601.89
LUBE OIL RELIEF VALVE					
97	2-	139X1280	Valve-Rel	1050.00	2100.00
98	18-	115X1937	Gask-O Drn	2.06	37.08
99	15-	115X2246-1	O Ring	2.14	32.10
100	3-	146X1116	Spring	61.30	183.90
101	3-	146X1117	Spring	128.00	384.00
102	6-	123X1039	Keeper	.61	3.66
103	3-	139X1279	Retainer	56.90	170.70
104	3-	139X1278	Shim	4.10	12.30
105	15-	115X1021-1	Washer-Seal	.28	4.20
			Sub Total		2979.94
CRANKCASE BREATHER					
106	30-	115X1871	Gasket Housing	5.35	160.50
107	3-	140X1504	Filter	80.30	240.90

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<u>ITEM</u>	<u>QTY</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
108	15-	115X1872-1	Gask-Filter	3.68	55.20
109	15-	115X1915	O Ring	.45	6.75
110	75-	N405P75B	Washer Lock	.21	15.75
111	75-	N22P29028	Screw Cap	.43	32.25
112	15-	115X1914-1	Gasket-Breather	.98	14.70
			Sub Total		526.05

## POWER ASSEMBLY EQUIPMENT - TAB 93000

113	7-	190X1034	Mast Pow A	9630.00	67410.00
114	7-	190X1035	Art Pow As	7830.00	54810.00
115	30-	121X1240	Weld As-Tf	2190.00	65700.00
116	120-	121X1126-3	Valve Guide	8.03	963.68
117	120-	123X1037-4	Valve Exh	120.00	14400.00
118	120-	123X1090	Valve-15 In	53.80	6456.00
119	120-	146X1082-1	Spring	21.30	2556.00
120	120-	123X1079-1	Spring Seat	1.35	162.00
121	600-	123X1001	Umbrella	1.98	1188.00
122	600-	123X1085	Rotator-Ex	14.30	8580.00
123	1200-	123X1039	Keeper	.61	732.00
124	15-	121X1120-1	Bushing	27.40	411.00
125	75-	121X1167-1	Retainer	2.46	184.50
126	30-	121X1177	O Ring-Grn	20.60	618.00
127	60-	121X1164-1	Seal .200	13.10	786.00
128	60-	121X1165-1	Seal .150	13.10	786.00
129	60-	121X1166-1	Seal .100	13.10	786.00
130	60-	121X1178	Seal	13.10	786.00
131	60-	121X1179	Seal	13.10	786.00
132	60-	121X1174	O Ring-Blk	9.88	592.80
133	3-	147X2226	Glycerine	185.00	555.00
134	180-	121X1077-1	Bolt	2.99	538.20
135	3-	147X1613	7.5 Lb Can	111.00	333.00
136	3-	121X1169	Plug Handle	19.70	59.10
137	3-	121X1163	Adapter	14.10	42.30
138	7-	147X1898-1	50 CC Botl	30.30	212.10
139	15-	115X1948	Copper Washer	.19	2.85
140	15-	115X2147-1	O Ring	.13	1.95
141	15-	121X1109	Stud-Nozzle	3.90	58.50
142	60-	N405P40B	Washer Lock	.20	12.00
143	7-	121X1127-1	Fuel Clamp	13.40	93.80
144	60-	N203P29B	Nut Hex	.14	8.40
145	450-	115X1021-1	Washer-Seal	.28	126.00
146	300-	121X1191-1	Wash-Locat	3.74	1683.00
147	300-	115X2460	Seal Washer	2.26	678.00
148	7-	121X1156-3	Cover W/Ga	155.00	1085.00
149	150-	121X1203	Seal-Cover	9.30	1395.00
150	7-	497A806P60	RTV/10.30Z	8.00	56.00
151	7	121X1036-1	Handle-Cov	12.80	89.60
152	7	121X1037-5	Clamp-Cov	8.93	62.51
153	7-	115X2170	Stud-Cy Cv	1.09	7.63
154	60-	121X1045-3	Bolt Kit	34.60	2076.00
155	60-	115X1033-1	Gasket	.18	10.80

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<u>ITEM</u>	<u>QTY</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
156	120-	N22P25012B13	Screw Cap	.15	18.00
157	120-	N405P113	Washer Lock	.25	30.00
158	30-	140X1826	HP Fuel Ln	68.80	2064.00
159	150-	150X1023-6	Cyl Am Kit	39.40	5910.00
160	15-	150X122	Cyl Asm-Eb	35.00	525.00
161	150-	150X1024-2	Cyl Install	33.30	4995.00
			Sub Total		251422.64

## FUEL PUMP MOUNTING &amp; LINKAGE

162	250-	115X2530-1	Bolt-12 Pt	2.50	625.00
163	45-	N22P29024B	Screw Cap	.46	20.70
165	8-	132X1320-1	Lever-Fuel	111.00	888.00
166	8-	132X1321	Shft	35.00	280.00
167	8-	132X1093-2	Brg-Rd End	24.60	196.80
168	8-	132X1261	Brg-Rod End	9.81	78.48
169	8-	132X1323	Bushing	2.88	23.04
170	65-	247X16	Fitting	1.70	110.50
171	8-	146X1101	Spring	.66	5.28
172	16-	132X1493-1	Adj Nut	5.56	88.96
173	16-	140X2293-4	Banjo Ftg	50.00	800.00
174	300-	115X2445-1	O Ring	.66	198.00
175	16-	115X2444-1	Bolt-Fuel	26.80	428.80
176	150-	150X1096-1	Inj Pump-K	2.91	436.50
			Sub Total		4180.06

## ROCKERS &amp; PUSH RODS

177	12-	124X1070-2	Rocker-Exh	151.00	1812.00
178	12-	124X1075-3	Rocker-Inl	143.00	1716.00
179	12-	124X1080-2	Rocker B/C	100.00	1200.00
180	6-	124X1006	Spacer	7.54	45.24
181	6-	124X1007	Spacer	2.54	15.24
182	48-	124X1010-8	Tappet Screw	13.80	662.40
183	48-	115X2440	Nut-Jam	.54	25.92
184	12-	124X1030-7	Push Rod-X	19.90	238.80
185	18-	124X1031-7	Push Rod-L	25.60	460.80
186	12-	124X1013	P Rod-FP	21.30	255.60
187	12-	124X1014	T Rod-FP	23.60	283.20
188	12-	124X1032	Pin	5.08	60.96
189	12-	124X1015-3	Umbrella	8.00	96.00
190	12-	124X1025	Nut-Tappet	8.44	101.28
191	12-	124X1061	Retain-Spring	16.10	193.20
			Sub Total		7166.64

## FUEL INJECTION NOZZLE

192	90-	123X1110	Inj-Lo Sac	238.75	21487.50
193	180-	123X1091	Dowel	2.97	534.60
194	90-	123X1092	Tran Block	21.29	1916.10
195	90-	123X1093	Thrust Cap	8.22	739.80
196	150-	123X1094	Shim .30mm	.90	135.00

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<u>ITEM</u>	<u>QTY</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
197	150-	123X1101	Shim .41mm	.90	135.00
198	150-	123X1102	Shim .44mm	.90	135.00
199	150-	123X1103	Shim .47mm	.90	135.00
200	150-	123X1104	Shim .50mm	.90	135.00
201	150-	123X1105	Shim .53mm	.90	135.00
202	150-	123X1106	Shim .56mm	.90	135.00
203	150-	123X1107	Shim .59mm	.90	135.00
204	150-	123X1108	Shim .62mm	.80	120.00
205	150-	123X1109	Shim .65mm	.90	135.00
206	150-	123X1111	Shim .68mm	.90	135.00
207	150-	123X1112	Shim .98mm	.90	135.00
208	150-	123X1113	Shim .28mm	.90	135.00
209	150-	123X1114	Shim .58mm	.90	135.00
210	90-	123X1096	Spring-Ins	16.90	1521.00
211	37-	123X1097	Nozzle Nut	22.59	835.83
212	180-	123X1098	Tip/Del Valve	70.94	12769.20
213	180-	123X1052	Valve Assm	75.74	13633.20
			Sub Total		55312.23

## FUEL INJECTION PUMP

214	60	132X1535	Pump-Bx-Db	729.00	43740.00
215	150	132X1291	Dowel	1.20	180.00
216	30-	132X1279	Holder	49.22	1476.60
217	150-	132X1538	Packang-Vl	3.92	588.00
218	150-	132X1539	Packing-Nt	5.00	750.00
219	60-	132X1283	Valve	101.55	6093.00
220	150-	146X1086	Spring-Val	5.91	886.50
221	30-	132X1284	Sleeve	28.30	849.00
222	60-	132X1540	Dl Vl Stop	19.44	1166.40
223	45-	132X1286	Rack Assem	44.47	2001.15
224	60-	132X1290	Screw	1.63	97.80
225	150-	132X1022	Shim	.38	57.00
226	150-	132X1023	Shim .016	.38	57.00
227	150-	132X1024	Shim	.34	51.00
228	150-	132X1025	Shim	.35	52.50
229	60-	132X1292	Screw	.34	20.40
230	60-	132X1541	Br/Plinger	250.22	15013.20
231	30-	132X1294	Sleeve	46.39	1391.70
232	30-	132X1295	Follower	55.43	1662.90
233	60-	146X1087-2	Pump Spring	31.58	1894.80
234	30-	132X1498	L Spring Pl	32.63	978.90
235	30-	132X1297	Pilot	30.40	912.00
236	30-	132X1298	Spring Plate	5.51	165.30
237	30-	132X1200	Plug Assem	28.69	860.70
238	60-	115X1964	Screw	.42	25.20
239	60-	115X1965	Washer	.38	22.80
			Sub Total		80993.85

## PISTONS &amp; RINGS

241	36-	142X1050	Piston-Brg	703.00	25308.00
242	36-	142X1043-3	Stl Crown	285.00	10260.00

<u>ITEM</u>	<u>QTY</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
243	72-	142X1034-1	Bolt-Stcwn	7.48	538.56
244	72-	115X2337	Washer	.89	64.08
245	18-	142X1035-1	Piston X-Hd	539.00	9702.00
246	3-	147X1143-1	17.6 Oz GN	34.50	103.50
247	180-	150X1190-1	Ring Kt-TF	65.20	11736.00
			Sub Total		57712.14

## CONNECTING RODS

248	12-	117X1060-1	Grvl Mas R	2080.00	24960.00
249	24-	117X1038	Bolt-R Cap	26.30	631.20
250	24-	117X1042	Washer	2.38	57.12
251	12-	117X1028-1	Bushing	568.00	6816.00
252	24-	N22P25016B	Screw Cap	.23	5.52
253	12-	117X1012-4	Art Rod	464.00	5568.00
254	12-	117X1029-4	Pin Art Rod	314.00	3768.00
255	24-	142X1052	Pin-Piston	328.00	7872.00
256	24-	117X1040	Bolt-P Pin	18.80	451.20
257	12-	117X1039	Bolt-A Pin	26.30	315.60
258	72-	117X1041-1	Spacer-Bolt	6.38	459.36
259	144-	117X1045-2	Bearing	166.38	23958.72
260	105-	117X1050-1	Bearing-Grooveless	164.34	17255.70
			Sub Total		92118.42

## TURBOCHARGER &amp; INTERCOOLERS - TAB 9400

261	1-	126X1712	Turbo 1612	38625.00	38625.00
262	1-	126X1722	Rotor 1612	21380.00	21380.00
263					
264	36-	115X2376	Gasket-Cover	1.41	50.76
265	300-	N405P113	Washer Lock	.25	75.00
266	180-	N405P17	Washer Lock	.23	34.50
267	15-	126X1222-1	TE Bearing	233.00	3495.00
268	15-	126X1562-1	Seal-TE	431.00	6465.00
269	15-	126X1223-1	BE Bearing	174.00	2610.00
270	15-	126X1563	Seal-BE	168.00	2520.00
271	75-	126X1642	Bolt-T1A	15.10	1132.50
272	300-	N405P75B	Washer Lock	.21	63.00
273	6-	497A806P33	Seal 30Z	6.75	40.50
274	6-	147X1640	H Tm Comp	12.30	73.80
275	3	147X2197	Lubricant	47.90	143.70
276	75-	126X1468	Bolt Seal	.69	51.75
277	3-	126X1613	Diffuser	1380.00	4140.00
278	1-	126X1649	Turb Inlet	9310.00	9310.00
279	7-	126X1389-1	Mag Pickup	735.00	5145.00
280	15-	150X1083-1	Turb Gasket	115.00	1725.00
			Sub Total		97080.51

## INTERCOOLER &amp; MOUNTING

281	1-	128X1360-4	Intercooler-SM	5950.00	5950.00
282	1-	128X1361-4	Intercooler-LE	5950.00	5950.00

<u>ITEM</u>	<u>QTY</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
283	10-	150X1127	Intercooler	30.00	300.00
284	100-	N22P29020B13	Screw Cap	.43	43.00
285	100-	N402P45B	Washer Flat	.20	20.00
286	20-	150X1049-2	K-Intercooler	9.99	199.80
			Sub Total		12462.80

## WATER DISCHARGE HEADER

287	36-	150X1116-1	Cyl Dresser	17.50	630.00
288	15-	115X2612	D Seal 5.0	6.24	93.60
289	15-	41A212792P1	Connection	175.00	2625.00
290	9-	41A212761P1	Ring	19.80	178.20
291	18-	499A910AGP14	Clamp	12.80	230.40
292	30-	N22P33048B13	Screw Cap	1.13	33.90
293	45-	N22P29020B13	Screw Cap	.43	19.35
294	30-	N22P29016B	Screw Cap	.25	7.50
295	45-	N405P75B	Washer Lock	.21	9.45
			Sub Total		3827.40

MANIFOLD EQUIPMENT - TAB 95000  
AIR INTAKE MANIFOLD

296	6-	128X1020-1	Body	81.50	489.00
297	50-	115X2093	Insert	1.58	79.00
298	5-	128X1021	Tube	27.40	137.00
299	6-	128X1023-1	Ring	11.90	71.40
300	50-	N22P29020B13	Screw Cap	.43	21.50
301	50-	N402P15B	Washer Flat	.34	17.00
302	50-	115X2025-1	Bolt-Nylok	.61	30.50
303	10-	115X2186	Stud	.99	9.90
304	25-	N258P29B	Nut Hex	.33	8.25
305	2-	128X1417-4	Air Elbow	641.00	1282.00
306	20-	N22P33028	Screw Cap	.41	8.20
307	20-	N405P17	Washer Lock	.23	4.60
			Sub Total		2158.35

## EXHAUST MANIFOLD

308	3-	128X1443-7	Trans Sect	2310.00	6930.00
309	3-	128X1447	Ring-Ex Mf	141.00	423.00
310	75-	115X2168-1	Bolt-Turbo	3.75	281.25
311	150-	N406P45	Washer Lock	.20	30.00
312	6-	128X1353-4	Main Sect	1290.00	7740.00
313	36-	128X1357	Gasket-Main	2.99	107.64
314	36-	115X2164	Bolt-Clamp	14.50	522.00
315	150-	115X2167	Nut-Exh Mf	7.36	1104.00
316	9-	128X1354-1	Right Elbow	288.00	2592.00
317	9-	128X1355-1	Elbow	288.00	2592.00
318	36-	128X1358	Elbow Seal	55.00	1980.00
319	75-	115X2165-1	Bolt-Clamp	5.46	409.50
320	150-	115X2166	Nut-Exh Mf	1.94	291.00
321	75-	N22P33024B13	Bolt	.76	57.00

<u>ITEM</u>	<u>QTY</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
322	150-	N405P17	Washer Lock	.23	34.50
323	3-	147X1640	H Tm Comp	12.30	36.90
			Sub Total		25130.79

FUEL LINKAGE & GOV DRIVE - TAB 96000  
GOVERNOR DRIVE

324	1-	114X1210-1	Gov Drive	4610.00	4610.00
325	30-	115X1877	Seal-Shaft	2.14	64.20
326	15-	136X1338	Gasket	.25	3.75
327	15-	115X2327	Gasket	.98	14.70
328	15-	115X1444	Oil Seal	5.59	83.85
329	30-	115X2322-2	O Ring	5.29	158.70
330	30-	N3400P406	Key	1.34	40.20
331	15-	146X1102	Spring	.66	9.90
332	2-	135X1044-3	Gear	228.00	456.00
333	2-	114X1131-1	Gear/Pinion	499.00	998.00
334	2-	115X2341	Nut	3.06	6.12
335	2-	N402P20B	Washer Flat	.20	.40
336	2-	114X1132-1	Shaft-Horz	61.40	122.80
337	2-	135X1061-1	Gear-OS Dr	195.00	390.00
338	2-	114X1152-1	Gear	451.00	902.00
339	15-	114X1149-5	Shear Pin	10.80	162.00
340	15-	115X2378	Gasket Cover	.61	9.15
341	15-	115X2381	Gasket Cap	1.21	18.15
342	2-	114X1153	Switch-Crk	13.60	27.20
343	2-	114X1156	Receptacle	136.00	272.00
344	15-	115X2382	Gasket-Recpt	.54	8.10
345	15-	115X2472	Fuel PM OR	3.00	45.00
346	15-	115X1896-4	Gasket, Gov D	5.50	82.50
347	15-	115X1245	Gasket Mtg	.75	11.25
348	30-	115X1232	Gasket Mtg	.30	9.00
349	15-	115X2323-1	Shim .003	.79	11.85
350	15-	115X2324-1	Shim .005	.79	11.85
351	15-	115X2325-1	Shim .0075	.79	11.85
352	15-	115X2326-1	Shim .020	.98	14.70
			Sub Total		8555.22

FUEL CONTROL LINKAGE

353	30-	115X1876-1	Bushing	1.84	55.20
354	30-	247X16	Fitting	1.70	51.00
355	60-	115X2432	Seal-Bush	1.75	105.00
356	30-	132X1093-2	Bearing-Rd End	23.80	714.00
357	150-	115X2393	Nut	.83	124.50
358	3-	146X1059-1	Spring-Rak	8.88	26.64
359	6-	136X1283	Collar	6.60	39.60
360	6	N177P2305	Screw Set	.68	4.08
361	6	N509P1924B	Pin Roll	.55	3.30
			Sub Total		1123.32

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<u>ITEM</u>	<u>QTY</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
OVERSPEED EXTENSION LINK					
362	1-	132X1620	Ext Link	265.00	265.00
363	15-	132X1308	Bushing	42.30	634.50
364	2-	132X1546	Spring	40.00	80.00
365	15	132X1093-2	Brg-Rd End	23.80	357.00
366	2-	150X1202	K-OS Link	1070.00	2140.00
			Sub Total		3476.50
OVERSPEED TRIP DEVICE					
367	2-	132X1530-3	Trip Device	690.00	1380.00
368	1-	132X1554-3	Actuator	431.00	431.00
369	15-	115X2436	O Ring	1.00	15.00
370	30-	132X1561	U Seal	10.00	300.00
371	45-	115X2434	O Ring	.75	33.75
			Sub Total		2159.75
OVERSPEED GOVERNOR					
372	2-	136X2254-2	OS Gov-Aut	1350.00	2700.00
373	20-	115X1413	Gasket	1.19	23.80
374	10-	136X1236	Thrust Brg	54.60	546.00
375	5-	136X2222	Ballhead A	164.00	820.00
376	20-	136X2067	Gasket	.41	8.20
377	5-	136X2223	Gear-Drive	107.00	535.00
378	5-	136X2322	Idler Gear	51.50	257.50
379	20-	115X1427	Gasket	2.88	57.60
380	5-	115X1232	Gask-Mtg	.30	1.50
381	20-	N22P23020B	Screw Cap	.26	5.20
382	20	N405P72B13	Washer Lock	.28	5.60
			Sub Total		4960.40
ENGINE CONTROL GOVERNOR - TAB 97000					
383	2	136X2165-2	Governor	13890.00	27780.00
384	15	150X1136-1	Gov Basic	144.00	2160.00
385	7-	115X1245	Gasket-Mtg	.75	5.25
			Sub Total		29945.25
FUEL & LUBE OIL PIPING - TAB 98000					
FUEL - LUBE OIL, WATER PIPING					
386	180	115X2420	O Ring	.51	91.80
387	42-	140X2289	Hose-Lg	21.00	882.00
388	3-	132X1595	Flow Indtr	150.00	450.00
389	6-	140X2386-1	Reg Valve	203.00	1218.00
390	15-	41B511684P13	Cartridge	91.30	1369.50
391	30-	2X6095	O Ring P13	2.08	62.40
392	30-	2X6183	O Ring P13	3.71	111.30
			Sub Total		4185.00

<u>ITEM</u>	<u>QTY</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
FUEL BOOSTER PUMP & MOTOR					
393	1-	132X1420	Coupling	2260.00	2260.00
394	2-	41C610401G2	Coupling	72.90	145.80
395	2-	N3400P204	Key Woodrf	.55	1.10
396	12-	N22P25018B	Screw Cap	.33	3.96
397	12-	N405P113	Washer Lock	.25	3.00
398	6-	N22P27016B13	Screw Cap	.40	2.40
399	6-	N405P44B	Washer Lock	.20	1.20
400	1-	132X1415-1	Rotor	136.00	136.00
401	15-	132X1408	O Ring	2.71	40.65
402	15-	132X1407	Seal Assem	29.50	442.50
403	18	1X7804	Bolt	1.24	22.32
404	6	N44P16175B	Screw Mach	26.00	156.00
405	12	149X1017	Washer	2.09	25.08
406	150-	149X1011	Brush Asm	16.90	2535.00
407	15-	149X1022	Brush Hold	61.30	919.50
408	15	149X1023	Wash-Br Hl	1.48	22.20
409	7-	149X1024	Brusk Pl K	18.00	126.00
410	15-	149X1029	Ball Bearing	12.00	180.00
411	15-	149X1043	Seal Shaft	14.90	223.50
412	15-	149X1044	Spring Washer	1.13	16.95
413	15-	149X1045	Key	1.71	25.65
414	2-	149X1047	Armature	1240.00	2480.00
415	2-	132X1410-3	Fuel Trs P	215.00	430.00
416	1-	149X1014	Motor	1880.00	1880.00
			Sub Total		12078.81
			TOTAL THIS SECTION		907382.10

1062F

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APPENDIX E  
 ITEM 1  
 PROTECTIVE SPARES  
 MECH. & ELECT.EQUIP.

LOCOMOTIVE PROTECTIVE/MAINT. SPARES - 5 YRS  
 15 LOCOMOTIVES  
 MECHANICAL & ELECTRICAL EQUIPMENT

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
NOSE CAB - TAB 10000					
1	4 -	41A282012P4	HINGE	11.40	45.60
2	4	425C226G1	LATCH	34.55	138.20
3	4	41A200120P11	SHIM	1.15	4.60
4	18 -	N22P25016B	SCREW CAP	.23	4.14
5	10	41A201925P1	SEAL	2.18	21.80
6	10	188V782P1	SPRING	7.14	71.40
7	20	8829217P2	GASKET	3.56	71.20

SUB-TOTAL 356.94

CLASSIFICATION LIGHT

8	6	41A205337P1	MARKER LITE	40.50	243.00
9	6	41A205337P2	MARK LIGHT	40.50	243.00
10	9	1X7845	SOCKET	11.30	101.70
11	15	1X7763	LENS RED	14.90	233.50
12	15	1X7844	WHITE LENS	14.50	217.50
13	30	1X7843	GASKET	3.24	97.20
14	60	GE30S11/DC-75V	LAMP	3.79	227.40

SUB-TOTAL 1,353.30

OPERATOR CAB - TAB 11000

15	6 -	41A304161P2	DOOR GLASS	240.00	1440.00
16	4	41A244111AAG4	GLASS	430.00	1720.00
17	2	41A244111AAG5	GLASS	424.00	848.00
18	4 -	41B542891P1	STRIP	44.90	179.60
19	4	491A281P11	STRIP	33.00	132.00
20	10 -	41A212909P1	SEAL/921N	19.00	190.00
21	80 -	41A212909P2	STRIP/FT	1.24	99.20
22	2	499A386P1	CATCH	73.40	146.80
23	4	156B1888AEP44	GASKET	1.15	4.60
24	4	156B1888AEP98	GASKET	1.15	4.60

SUB-TOTAL 4764.80

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
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OPERATORS CAB ACCESSORIES

25	4	41B503675G3	ARM REST	35.40	141.60
26	1	41A204929P1	HORN	2550.00	2550.00
27	2	8836572P23	GASKET	3.25	6.50
28	4	8861307ACP4	SUN VISOR	65.30	261.20
29	4	41C610665G1	LOUVER	34.80	139.20

SUB-TOTAL 3098.50

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DOME LIGHT

30	6	1X7784	BODY	29.80	178.80
31	9	1X7845	SOCKET	11.30	101.70
32	15	1X7844	WHITE LENS	14.50	217.50
33	30	1X7843	GASKET	3.24	97.20
34	30 -	GE20S11/DC-75V	LAMP	3.79	113.70
35	6	497A911G1	SWITCH	12.80	76.80

SUB-TOTAL 785.70

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HEADLIGHT ARRANGEMENT

36	180	200PAR 30V	LAMP	10.10	1818.00
37	10-	41D700038G3	INSERT RING	26.80	268.00
38	6	41D700038G2	MOUNTING	36.80	220.80
39	30	6720098P1	SPRING	1.55	46.50
40	75	N402P11B	WASHER FLT	.19	14.25
41	75	41A260076P1	LOCK NUT	.46	34.50

SUB-TOTAL 2,402.05

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DOOR LATCH

42	4 -	425C226G2	DOOR LATCH	23.10	92.40
43	4 -	335B572G2	CUP	10.10	40.40
44	12 -	41B560008P9	LOCKNUT	.68	8.16
45	4	41C604640G3	LATCH	122.00	488.00

SUB-TOTAL 628.96

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FOOT SWITCH ARRANGEMENT

46	4	499A936AAP3	SWITCH	80.00	320.00
47	10	N70P1514B	SCREW SET	.28	2.80
48	10 -	N210P15B	NUT HEX	.21	2.10
49	20 -	975X5	SWITCH	22.30	446.00
50	4	499A132P104	HOSE	9.10	36.40
51	16	41A211883P3	CLAMP	2.23	35.68

SUB-TOTAL 842.98

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LOCO PROTECTIVE/MAINT. SPARES - 5 YRS.  
 15 LOCOMOTIVES - MECHANICAL & ELECTRICAL EQUIPMENT

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
CREW LOCKER & HOT PLATE ARRGT.					
52	6 -	41A203971P1	HOT PLATE	606.00	3636.00
53	9	41C623354G1	SWITCH ASM	136.00	1224.00
54	3 -	41A212414P1	CRK BREAKER	47.50	142.50
SUB-TOTAL					5002.50

SLIDING WINDOW ARRGT.

55	6 -	2X3948	LATCH	30.50	183.00
56	6 -	2X3949	CATCH	36.30	217.80
SUB-TOTAL					400.80

WINDOW WIPER ARRGT.

57	4	41A203148P6	MOTOR	130.00	520.00
58	3	41A203148P4	MOTOR	123.00	369.00
59	3	41A203148P2	MOTOR	135.00	405.00
60	15	41A204660P3	ARM	89.90	1348.50
61	24	41A204660P4	ARM	89.90	2157.60
62	180	41A203147P5	BLADE	10.60	1908.00
63	15	497A803P9	HOSE	5.33	79.95
SUB-TOTAL					6788.05

SWITCH PANEL ARRGT.

64	4	497A911P1	SWITCH	9.81	39.24
65	3	41A203655P2	SWITCH	118.00	354.00
66	3	CR2940UA203B	SWITCH	72.30	216.90
67	4	41A212197P1	SWITCH	213.00	852.00
68	6	41B515348P2	CIR BRKR	136.00	816.00
69	6	41A218841P5	BREAKER	68.10	408.60
70	3	41A218842P4	BREAKER	284.00	852.00
71	6	41A218841P4	BREAKER	145.00	870.00
72	4	41A218841P6	BREAKER	91.80	367.20
73	6	41B517782ABP31	CIR BREAKER	69.80	418.80
74	6	41A218842P7	CIR BREAKER	528.00	3168.00
75	6	41A218841P8	CIR BREAKER	85.50	513.00
76	18	41A216941P1	IND LIGHT	.55	9.90
77	18	41A216940P1	LOCK RING	.98	17.64
78	30	41A304446P1	HOLDER	1.13	33.90
79	90	41A210382P6	LAMP GE 44	1.51	135.90
80	6	A700DM	AMMETER	170.00	1020.00
SUB-TOTAL					10,093.08

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LOCO PROTECTIVE/MAINT. SPARES - 5 YRS.  
 15 LOCOMOTIVES - MECHANICAL & ELECTRICAL EQUIPMENT

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
CONTROL CONSOLE ARRGT.					
81	3	A707EF	AMMETER	226.00	678.00
82	3	497A364P1	BUZZER	159.00	477.00
83	3	41A304311P3	BELL	113.00	339.00
84	3	497A365P10	BELL	200.00	600.00
85	3	41B517782AAP4	BREAKER	17.60	52.80
86	12	41B564808G1	DIODE ASM	20.00	240.00
87	6	41A281017P25	DIODE	15.90	95.40
88	30	41A216737P1	LAMPHOLDER	1.63	48.90
89	3	341B189G13	PANEL	136.00	408.00
90	3	341B189G12	PANEL	143.00	429.00
91	3	41B563171G19	TIMING MOD	65.00	195.00
92	3	41B563171G30	TIMING MOD	65.00	195.00
93	6	41B560270P4	RELAY	72.40	434.40
94	3	48&A353ADP8	RHEOSTAT	46.30	138.90
95	3	CR2940UB203B	SWITCH	78.30	224.90
96	7	497A911P1	SWITCH	9.81	68.67
97	3	41A267319P2	SIGNAL	55.10	165.30
98	3	41A245459ABP1	GAGE	40.50	121.50
99	3	41A245459AAP1	GAGE	40.50	121.50
100	3	41A245457P1	GAGE	40.50	121.50
101	3	41B511153P1	VALVE	211.00	633.00

SUB-TOTAL 5797.77

CONTROLLER

102	3	41B557247G1	HANDLE	11.70	35.10
103	3	41C656037P1	INDICATOR	41.10	123.30
104	15	41A264757G2	SCREW	1.36	20.40
105	15	41A264757G3	SCREW	1.64	24.60
106	3	41C656037P3	INDICATOR	5.38	16.14
107	45	482A768G1	CONTACT	4.85	218.25
108	45	41A264589G1	FINGER	43.60	1962.00
109	45	N44P16020B	SCREW MACH	.14	6.30
110	45	N44P16012B	SCREW MACH	.25	11.25
111	3	482A444APP20	RESISTOR	5.00	15.00
112	21	6700549G1	CONTACT	9.56	200.76
113	3	41B557209P1	RHEOSTAT	350.00	1050.00
114	12	278A888G1	BRUSH	18.60	223.20
115	3	2418870P1	SPRING	6.53	19.59

SUB-TOTAL 3940.23

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<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
ENGINE CAB - TAB 15000 BRAKING RESISTOR					
116	27	17EA20A131	RES/GRID	710.00	19,170.00
117	27	17EA20A19	RES/GRID	710.00	19,170.00
118	36	41A218054P1	INSULATOR	15.80	568.80
SUB--TOTAL					38,908.80

BLOWER MTR

121	12	41A231381G1	MOUNTING	59.80	717.60
122	6	302702P2	BUSHING	2.31	13.86
123	3	8828752P1	CAP	84.40	253.20
124	15	N51P16010B	SCREW MACH	.25	3.75
125	3	6727190P1	PLATE	34.40	103.20
126	3	8828748P2	CAP	90.80	272.40
127	15	6717749P1	GASKET	.86	12.90
128	21	N22P23016B	SCREW CAP	.25	5.25
129	21	N405P42P	WASHER LOCK	.56	11.76
130	15	8864950P81	BALL BRG	29.40	441.00
131	15	6704604P1	FLINGER	27.50	412.50
132	15	4701852P1	NUT	14.00	210.00
133	15	6704451P1	WASHER	1.14	17.10
134	24	41B530658G1	BRUSHHOLDER	36.06	865.44
135	12	6727544G1	STRAP	4.50	54.00
136	6	8820297P10	SUPPORT	25.80	154.80
137	24	481A899P1	BOLT/WASHER	.44	10.56
138	12	41A232345P9	LOCK NUT	1.35	16.20
139	60	6727520P1	BRUSH	3.25	195.00
140	1	41D730436G1	FAN	451.00	451.00
141	3	6717753P1	NUT	18.60	55.80
142	3	N503P1240B	PIN COTTER	.21	.63
SUB-TOTAL					4,277.95

ENGINE CAB

143	8	41C604640G3	LATCH	122.00	976.00
144	10	425C226G1	LATCH	34.55	345.50
145	20	41A282012P2	HINGE	10.60	212.00
146	5	41A282012P4	HINGE	11.40	57.00
147	50	N22P29024B	SCREW CAP	.46	23.00
148	50	N258P29B	NUT HEX	.33	16.50
149	50	N405P45B	WASHER LOCK	.21	10.50
150	50	N22P25016B13	SCREW -8	.25	12.50
151	50	N405P43P	WASHER LOCK	.05	2.50
152	6	425C226G13	LATCH	56.10	336.60
153	6	41A210596P2	HINGE	8.15	48.90
154	2	41B515714G4	SHAFT	3090.00	6180.00
SUB-TOTAL					8,221.00

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
BLOWER & DRIVE ARRGT.					
156	6	N22P35032	SCREW CAP	1.29	7.74
157	6	N402P18B13	WASHER FLT	.19	1.14
158	6	N405P48B	WASHER LCK	.20	1.20
159	1 -	147X1143-1	17.6 OZ GN	34.50	34.50
160	3	9962133P3	DOWEL PIN	17.60	52.80
161	3	156B1888FTP190	SEAL	3.50	10.50
162	3	156B1888ETP304	SEAL	6.31	18.93
163	1 -	499A411P2	SEALR/120Z	3.20	3.20
164	1	41B519676P2	DRIVE SHFT	2560.00	2560.00
165	2	41C618604P	HUB	453.00	906.00
166	2	41C618604P1	HUB	463.00	926.00
167	9	41E901373G2	AIR CLEANER	93.80	844.20
168	25	156B1888DTP131	GASKET	1.50	37.50
169	12	156B1888DGP400	GASKET	1.50	18.00
170	6	156B1888DGP325	GASKET	1.39	8.34
171	15	1X9935	FELT	4.95	74.25
172	15	1X9936	WASHER	.75	11.25
173	24	2X4277	BOLT	3.83	91.92
174	60	2X4278	NUTS/16-18	6.48	388.80
175	30	2X4279	WASHER	9.65	289.50

SUB-TOTAL 6,285.77

PILLOW BLOCK

176	2 -	41A288380P2	PILLOW BLK	443.00	886.00
177	2 -	41A288380P3	PILLOW BLK	609.00	1218.00
178	2	41A288380P12	CARRIER	68.10	136.20
179	2	41A288380P14	ADAPTER	16.30	32.60
180	2	41A288380P13	CARRIER	96.10	192.20
181	2	41A288380P15	ADAPTER	45.40	90.80
182	4 -	41A288380P7	BEARING	211.00	844.00

SUB-TOTAL 3,399.80

RECTIFIER PANEL ARRGT.

183	3 -	17FM498A1	PANEL	10,250.00	30,750.00
184	36 -	41A296321AAP1	FUSE	230.00	8,280.00
185	12 -	41A296304AMP1	DIODE	180.00	2,160.00
186	12 -	41A296304AMP2	DIODE	270.00	3,240.00
187	8	41A271200P2	CATCH	2.95	23.60

SUB-TOTAL 44,453.60

RESISTOR PANEL

188	2	41B561936G1	PANEL	526.00	1,052.00
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SUB-TOTAL 1,052.00

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<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
LUBE OIL & WATER PIPING					
189	18	499A912AEP5	GASKET	3.38	60.84
190	30	491A317P11	GASKET	3.88	116.40
191	15	491A318P25	GASKET	4.41	66.15
192	15	491A318P14	GASKET	2.93	43.95
193	4	499A924AEP7	VALVE	73.80	295.20
194	30	499A912AEP10	GASKET	6.93	207.90
195	15	41A212792P1	CONNECTION	175.00	2625.00
196	6	41A212761P1	RING	19.80	118.80
197	12	499A910AGP14	CLAMP	12.80	153.60
198	60	499A912AEP13	GASKET	11.30	678.00
199	15	499A912AEP12	GASKET	11.20	168.00
200	30	499A912ADP5	GASKET	9.84	295.20
201	15	499A912ADP4	GASKET	5.20	78.00
202	15	491A316P1	GASKET	4.08	61.20
203	30	499A477P1	HOSE	27.60	828.00
204	3	41A205302P1	THERMOMETER	81.00	243.00
205	15	339B949P22	SWITCH/170	228.00	3,420.00
206	15	339B949P214	SWITCH	177.50	2,662.50

SUB-TOTAL 12,121.74

LUBE COOLER

207	1	41D723215G1	CORE 161N	2,440.00	2,440.00
208	30	41A212065P1	PACK RING	12.90	387.00
209	15	41B510831P1	RING	161.00	2,415.00
210	30	41A212125P1	GASKET	7.11	213.30
212	1	41D718899G1	LO COOLER	15,530.00	15,530.00
213	1	41D718873G3	OIL FILTER	7,980.00	7,980.00

SUB-TOTAL 28,965.30

LUBE OIL FILTER

214	30	41A211048P7	GASKET	18.50	555.00
215	1	497A806P57	CEMENT/GAL	61.60	61.60

SUB-TOTAL 616.60

RADIATOR CAB

216	5	425C226G1	LATCH	34.55	172.75
217	1	497A806P57	CEMENT/GAL	61.60	61.60
218	4	188V782P1	SPRING	7.14	28.56
219	4	41A201925P1	SEAL	2.18	8.72
220	2	499A452P2	GAUGE	48.60	97.20

SUB-TOTAL 368.83

161

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
RADIATOR CAB ACCESSORIES					
221	12 -	41A212504P1	CAP	66.50	798.00
222	2 -	499A452P2	GAUGE	48.60	97.20
232	2 -	41A216586P1	VALVE	145.00	290.00
224	7	41B564808G1	DIODE ASM	20.00	140.00
SUB-TOTAL					1,325.20

RADIATOR & SHUTTER ARRGT.

225	4	2X1130	CORE	4,700.00	18,800.00
226	20 -	1X5118	GASKET	31.00	620.00
227	12 -	497A803P1	HOSE	12.20	146.40
228	2 -	189V113P1	BREATHER	29.50	59.00
SUB-TOTAL					19,625.40

ENGINE AIR INTAKE ARRGT.

229	12	41A244997P1	V BELT	39.00	468.00
230	4	41A243793P2	DUCT	35.50	142.00
231	9	41A301309P33	CLAMP	11.30	101.70
232	2	41A241257P5	HOSE	40.50	81.00
233	10 -	41A202118P1	AIR DUCT	98.60	986.00
234	20 -	41A210603P9	CLAMP	24.40	488.00
235	10 -	41A213495P1	GASK-AIRIN	7.64	76.40
236	2 -	41B512741P1	SWITCH	191.00	382.00
SUB-TOTAL					2,725.10

EXHAUSTER

237	1	41B519090P2	EXHAUSTER	1,990.00	1,990.00
238	1	2X3853	WHEEL	708.00	708.00
239	4 -	2X3855	BEARING	411.00	1,644.00
SUB-TOTAL					4,342.00

CLUTCH GEAR UNIT

240	15	9961008G1	BRUSHHOLDER	55.00	825.00
241	60	998X90	BRUSH	2.10	126.00
242	2 -	8864951P82	ROLLER BRG	128.00	256.00
243	4 -	8864950P102	BALL BRG	264.00	1,056.00
244	3	2387506P1	GASKET	.45	1.35
245	3	497A706P18	GREASE FIT	2.35	7.05
246	15	8805484P1	GASKET	.86	12.90
247	15	497A806P60	RTV/10.3OZ	8.00	120.00
248	2 -	8864952P87	BALL BRG	280.00	560.00
249	3	41A235580P1	WASHER	3.43	10.29

ITEM	QTY.	PART NO.	PART NAME	UNIT PRICE	EXT. PRICE
250	3	41A235578P1	COLLAR	54.00	162.00
251	3	41A235577P1	FLINGER	33.30	99.90
252	2	41B535761P1	CARRIER	958.00	1,916.00
253	3	41C632208P1	CARRIER	340.00	1,020.00
254	3	8864951P63	ROLLER BRG	340.00	1,020.00
255	3	8864953P87	ROLLER BRG	87.10	261.30
256	2 -	1X7281	GR/PINION	1,010.00	2,020.00
257	1 -	41C635716P1	SHAFT	791.00	791.00
258	1	41B532610P1	SHAFT	404.00	404.00
259	3 -	8864953P51	ROLLER BRG	82.10	246.30
SUB-TOTAL					10,915.09

A/C & RADIATOR FAN ARRGT.

260	1	41B504585P4	COUPLING	1,280.00	1,280.00
261	3	41B505278P2	COUPLING	1,380.00	4,140.00
262	3	41B532612G2	COUPLING	1,500.00	4,500.00
263	150	41A302690G1	COUPLING	35.60	5,340.00
SUB-TOTAL					15,260.00

MAGNET VALVE ARRGT.

264	2 -	41A212361P5	VALVE	255.00	510.00
265	2 -	17ME1A24	VALVE EQP	708.00	1,416.00
266	2 -	17ME1A20	VALVE EQP	619.00	1,238.00
267	2 -	41B5100557P15	SWITCH	278.00	556.00
SUB-TOTAL					3,720.00

PLATFORM PARTS - TAB 17000  
 PLATFORM

268	6	41A303938ABP54	HOSE	38.80	232.80
269	6	41A303938ABP62	HOSE	44.20	265.20
270	12	41A303938ABP15	HOSE	14.30	171.60
271	12	41A303938ABP33	HOSE	11.30	135.60
272	72	499A910AAP3	HOSE CLAMP	1.56	112.32
273	3	8866488AGP8	HOSE	18.00	54.00
274	12	499A910ABP10	CLAMP	5.66	67.92
275	6	CR2940UA202B	SWITCH	35.10	210.60
276	6	41A211570P1	DUST CAP	11.90	71.40
SUB-TOTAL					1,321.44

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
FUEL TANK ARRGT.					
277	4	41A210336G1	FUEL GAGE	133.00	532.00
278	2 -	41A211045G1	FUEL GAGE	173.00	346.00
SUB-TOTAL					878.00
-----					
AIR DUCT END MOTOR					
279	18	41B500680P1	FLEX CONN	100.00	1,800.00
SUB-TOTAL					1,800.00
-----					
AIR DUCT MID MOTOR					
280	9	8836855P1	CONNECTION	51.00	459.00
281	9	339B783P1	CONNECTION	51.90	467.10
SUB-TOTAL					926.10
-----					
CAB HEATER					
282	2	2X4458	HEATER	72.60	145.20
283	2 -	2X4459	MOTOR	510.00	1,020.00
284	60	2X4460	BRUSH/SET	13.40	804.00
285	2 -	2X4473	SWITCH	260.00	520.00
286	1	2X4464	TEMP CNTRL	61.90	61.90
287	1	2X4465	TEMP CNTRL	27.00	27.00
288	4	2X4467	DIODE ASM	78.90	315.60
289	2 -	2X4468	CIRC BRKER	304.00	608.00
SUB-TOTAL					3,501.70
-----					
AIR BRAKE - TAB 20000 AIR BRAKE EQUIPMENT					
290	4	41A205210P1	HOSE/FTGS	37.10	148.40
SUB-TOTAL					148.40
-----					
FILTER, 41A215087P4/MAIN RES.					
291	30	1X6383	FILTER	19.80	594.00
292	30	1X6385	SEAL	9.83	294.90
SUB-TOTAL					888.90
-----					

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
SAND TRAP					
293	8	41A201465P1	SAND TRAP	55.00	440.00
SUB-TOTAL					440.00
-----					
VENT VALVE					
294	2	566403	VENT VALVE	273.00	546.00
295	15	578886	KIT	7.35	110.25
SUB-TOTAL					656.25
-----					
RELAY VALVE					
296	2	499A924BEP1	VALVE	740.00	1,480.00
297	15	560728	GSKT KIT	22.75	341.25
SUB-TOTAL					1,821.25
-----					
DRAIN VALVE - 41A201966P1					
296	2	551116	VALVE	245.00	490.00
SUB-TOTAL					490.00
-----					
SAFETY VALVE - 499A924CCP7					
299	2	542790-0150	VALVE	375.00	750.00
SUB-TOTAL					750.00
-----					
BRAKE CYLINDERS					
300	8 -	93841	FTG GASKET	.27	2.16
SUB-TOTAL					2.16
-----					
PRESSURE SWITCHES					
301	3 -	41B510557P15	SWITCH	278.00	834.00
302	6	41B510557P1	SWITCH	296.00	1,776.00
303	3 -	41B510557P4	SWITCH	278.00	834.00
SUB-TOTAL					3,444.00
-----					

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
AIR COMPRESSOR PARTS LIST LATER EST. PRICE					
	1	LATER	ESTIMATE	41,800.00	41,800.00
SUB-TOTAL					41,800.00
-----					
305	2 -	17MM24AF1	AXLE ALT	1,060.00	2,120.00
SUB-TOTAL					2,120.00
-----					
BOLSTER AND FRAME					
306	36	41B515393P3	WEAR PLATE	23.00	828.00
307	72	41A201604P3	PLATE	120.00	8,640.00
308	72	N22P35128	SCREW CAP	14.10	1,015.20
309	72	41B560008P23	LOCKNUT	1.68	120.96
310	54	499A913AAP5	BUSHING	2.70	145.80
311	54	499A913AAP6	BUSHING	3.53	190.62
312	18	41A204772P1	BAR TIE	119.00	2,142.00
313	36	495A599G4	BOLT	19.40	698.40
314	18	41A244359P1	WEAR PLATE	22.60	406.80
315	6	156B1001AEP12	PIN	1.13	6.78
316	12	339B911G1	STOP	23.00	276.00
317	18	339B911G2	STOP	26.00	468.00
318	12	41A210384P125	FELT SEAL	2.28	27.36
319	6	339B785P2	LINER	448.00	2,688.00
320	6	339B785P3	PLATE	32.00	192.00
321	3	41A244371ABP1	WEAR PLATE	26.10	78.30
322	12	499A114P2	OIL CUP	28.10	337.20
SUB-TOTAL					18,261.42
-----					
BRAKE RIGGING					
323	18	1805318P4	PIN	22.00	396.00
324	9	495A746P6	PIN	25.60	230.40
325	4	495A746P1	PIN	17.40	69.60
326	9	41A241271P2	PIN	9.64	86.76
327	9	41A241271P3	PIN	9.64	86.76
328	36	497A738P5	WASHER	1.43	51.48
329	9	495A806P11	PIN	49.00	441.00
330	9	41A240557P1	BOLT	15.80	142.20
331	9	495A737P8	PIN	20.40	183.60
332	9	495A737P9	BOLT	38.30	344.70
333	36	41C614885G1	HD W/BUSH	323.00	11,628.00
334	360	8821026P1	KEY	7.40	2,664.00
SUB-TOTAL					16,325.50
-----					

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<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
GEAR CASE					
335	3 -	41D730230G3	GEAR CAST	1,230.00	3,690.00
336	10	8855703P14	SEAL	1.64	29.52
337	18	8843557P8	RING	14.90	268.20
338	36	9961547G2	SEAL	6.39	230.04
339	9	8843557P1	RING	144.00	1,296.00
340	9	8843557P2	RING	88.00	792.00
341	9	8843557P7	RING	105.00	945.00
342	9	8843557P10	RING	69.00	621.00
343	36	N509P914B	PIN ROLL	.21	7.56
344	18	41B535376P2	GASKET	1.24	22.32
345	36	6704771P1	BOLT	9.80	352.80
346	36	N402P52B	WASHER FLT	.20	7.20
347	36	N203P45B13	NUT HEX	2.36	84.96
348	36	186V285	BOLT	12.80	460.80
349	36	189V673P1	WASHER	1.34	48.24
SUB-TOTAL					8,855.64
-----					
JRNL. BRG.					
350	6	41A204095G4	BEARING	838.00	5,028.00
351	3	41B510216G2	SUSPENSION	605.00	1,815.00
352	9	479A325G2	SUPPORT	164.00	1,476.00
353	9	41B510214P1	MOUNT	115.00	1,035.00
354	12	8815946	PIN	62.40	748.80
SUB-TOTAL					10,102.80
-----					
SNUBBERS					
355	8 -	41A244100AAP6	SNUBBER	275.00	2,200.00
356	8 -	41A244100AAP2	SNUBBER	359.00	2,872.00
SUB-TOTAL					5,072.00
-----					
SPRING RIGGING					
357	24	41B504932G1	SPRING	293.00	7,032.00
358	8 -	388D240P5	RBR MOUNT	458.00	3,664.00
359	8 -	388D240P2	MOUNT	1,430.00	11,440.00
SUB-TOTAL					22,136.00
-----					

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<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
WHL/AXLE/GEAR					
360	2 --	8837756P1	GEAR	3,218.75	6,437.50
SUB-TOTAL					6,437.50

TRACTION MTR, 5GF761A19

361	10	8864951P148	ROLLER BRG	343.75	3,437.50
363	10	8864950P169	BALL BRG	85.00	850.00
364	10	8819143	GASKET	2.53	25.30
365	54	41A235897P4	BRUSH-T900	17.23	930.42
366	14	9961549P2	GASKET	1.14	15.96
367	14	9961549P3	GASKET	.98	13.72
368	1 -	497A806P57	CEMENT/GAL	61.60	61.60
369	3	9961549G1	COVER	7.28	21.84
370	3	8843545G5	COVER	25.10	75.30
371	7	6726816G1	LEVER	4.63	32.41
372	30	1X9888	GASKET SET	6.79	203.70
373	14	9949062P3	GASKET	.38	5.32
374	14	9949062P4	GASKET	.38	5.32
375	2 -	41A238864G1	PUTTY 1 QT.	11.10	22.20
376	54 -	41C633996G2	B HOLDER	165.00	8,910.00
377	30 -	41A238534P1	OIL FILLER	4.88	146.40
SUB-TOTAL					14,756.99

TRACTION MOTOR ACCESSORIES

378	18	41B535723G1	DUST GUARD	18.50	333.00
379	18	41C630516G1	LUBRICATOR	59.75	1,075.50
380	180	494A549P1	WICK	39.00	7,020.00
381	16 -	41C630516G2	CARRIER	20.80	374.40
382	180 -	41A230387P1	GASKET	1.43	257.40
383	9 -	41C635677P1	PINION	663.00	5,967.00
384	36 -	41C633819G1	MTR SP BRG	281.00	10,116.00
385	9 -	41B537105G1	SPEED SENS	840.00	7,560.00
386	9 -	41A219499P16	C RING	.48	4.32
SUB-TOTAL					32,707.62

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<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
ALTERNATOR & AUX. EQUIP. - TAB 40000					
ALTERNATOR - 5GTA11C1					
387	6	1X8670	GASKET KIT	4.08	24.48
388	40	115X1146	O RING	.23	9.20
389	40	41A237943P1	GASKET	.65	26.00
390	2 -	8805493P1	GASKET	11.70	23.40
391	24	8805499P1	SCREW	1.79	48.33
392	1 -	41C633061P1	GEAR-102T	1,187.50	1,187.50
393	4 -	41C632663P1	PINION	302.50	1,210.00
394	2 -	41C635625P1	PINION	304.00	608.00
395	2 -	41C635232G3	IDLER GEAR	343.75	687.50
396	2 -	8864952P48	BALL BRG	29.90	59.80
397	2	41A231192P1	RETAIN RNG	45.80	91.60
398	8	41A230912P3	BOLT	1.70	13.60
399	6 -	41A231050P4	BOLT	.75	4.50
400	6 -	41A231050P2	BOLT	.75	4.50
401	15 -	41B537660P1	WASHER	.29	4.35
402	2	41A219499P332	O RING	1.01	2.02
403	30	8805492P1	GASKET	4.69	140.70
404	2 -	8864951P166	BEARING, PE	475.00	950.00
405	2 -	41A231141P1	RET RING	79.80	159.60
406	18	8805478P1	SCREW	1.79	32.22
407	2 -	41A233800P1	SEAL RING	225.00	450.00
408	4 -	41A233819P2	SEAL	4.44	17.76
409	4 -	41A235260P1	INSULATOR	6.41	25.64
410	24 -	41B531649G2	BRUSH HLDR	42.40	1,144.80
SUB-TOTAL					6,925.50

GEAR UNIT - 7GA29C1

411	1 -	7GA29C1	GEAR UNIT	1,940.00	1,940.00
412	1 -	493A998P1	BRG-CAP	65.90	65.90
413	2 -	8864950P135	BALL BRG	76.10	152.20
414	2 -	8864951P63	ROLLER BRG	340.00	680.00
415	2 -	494A201P1	SPACER	118.00	236.00
416	15	41A237287P3	PACKING	3.55	53.25
417	15	189V405P1	SLEEVE	11.80	177.00
SUB-TOTAL					3,304.35

AUX. GENERATOR - 5GY27L1/M1

418	4 -	8864951P29	ROLLER BRG	70.00	280.00
419	4 -	8864950P81	BALL BRG	29.40	117.60
420	25	8804066P1	GASKET	.64	16.00
421	27	41B530658G1	BRUSH HLDR	36.06	973.62
422	15	8820297P1	STUD	26.40	396.00
SUB-TOTAL					1,783.22

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
LOWER CONTROL COMPT - 60000 CONTROL GROUP					
423	9	GE5645-1	SOCKET	2.55	22.95
424	15	41A264834G1	MODULE	27.60	414.00
425	1 -	17ET13F1	REACTOR	2,250.00	2,250.00
426	6	17ET34A1	REACTOR	603.00	3,618.00
427	9	41A244928P2	REACTOR	169.00	1,521.00
428	3	41A218054P1	INSULATOR	15.80	47.40
429	3	41A210624P1	INSULATOR	6.71	20.13
430	6	17LE117B1	PANEL	624.00	3,744.00
SUB-TOTAL					11,637.48
-----					
AIR HOSE ARRANGEMENT					
431	4	41C600937P48	HOSE	4.38	17.52
432	4	41C600937P30	HOSE	11.60	46.40
SUB-TOTAL					63.92
-----					
CONTACTOR - 17CM53E10A					
433	2 -	17CM53E10A	CONTACTOR	806.00	1,612.00
434	2 -	4739382G2	COIL	115.00	230.00
435	30	8867977P1	CONTACT	4.96	148.80
SUB-TOTAL					1,990.80
-----					
CONTACTOR - 17CM55N3					
436	2 -	17CM55N3	CONTACTOR	1,190.00	2,380.00
437	4 -	4739356G1	COIL	238.00	952.00
438	25	9960190G6	CONT TIP	37.50	937.50
439	2 -	41D750063G1	ARC CHUTE	77.30	154.60
SUB-TOTAL					4,424.10
-----					
CONTACTOR - 17CM55Y3					
440	2	17CM55Y3	CONTACTOR	963.00	1,926.00
441	6 -	4739356G1	COIL	238.00	1,428.00
442	36 -	9960190G2	CONTACT	17.90	644.40
443	4	2744700G2	ARC CHUTE	42.10	168.40
SUB-TOTAL					4,166.80
-----					

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
REVERSER - 17DP22A1					
444	4 -	17MV38A6	VALVE	256.00	1,024.00
445	4 -	6714650P1	GASKET	.83	3.32
446	6 -	41C600937P10	CONNECTION	6.75	40.50
447	15	426C379G1	FINGER ASM	72.80	1,092.00
448	15	41A321867P1	SPRING	3.39	50.85
449	2	6735511G1	INTERLOCK	284.00	568.00
450	4 -	492A201G1	FINGER ASM	20.10	80.40
451	8 -	9963477G12	CONTACT	1.88	15.04
452	2 -	6715974P1	SUPPORT	15.60	31.20
SUB-TOTAL					2,905.31
-----					
INTERLOCK - 17AF41C1					
453	3	17AF41M1	INTERLOCK	149.00	447.00
454	7	336B737G1	FINGER	5.95	41.65
455	15	8807882G1	CONTACT	2.84	42.60
456	15	487A605G1	CONTACT	3.80	57.00
SUB-TOTAL					588.25
-----					
INTERLOCK - 17AF20B25S					
457	9	17AF20B25S	INTERLOCK	375.00	3,375.00
458	15	6700391G1	FINGER	10.80	162.00
459	30	6700398G1	FINGER	11.60	348.00
460	30	6700890G1	CONTACT	4.61	138.30
461	15	6700392G1	CONTACT	7.61	114.15
SUB-TOTAL					4,137.45
-----					
MAG VALVES					
462	2 -	17MV36B2	VALVE	533.00	1,066.00
463	2 -	2738573G2	COIL	90.50	181.00
464	2 -	17MV39C2	VALVE	413.00	826.00
SUB-TOTAL					2,073.00
-----					

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<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
BRAKING SWITCH - 17GP26B1					
465	4 -	17MV38A6	VALVE	256.00	1,024.00
466	2 -	41C600937P10	CONNECTION	6.75	13.50
467	21	426C380G1	FINGER ASM	72.80	1,528.80
468	24	496A427G1	CONTACT	33.10	794.40
469	24	492A199G1	FINGER	11.20	268.80
470	15	8801839G1	BAR	9.69	145.35
471	24	9963477G12	CONTACT	1.88	45.12
472	24	9963477G8	CONTACT	1.88	45.12
473	1	17GP26B1	SWITCH	9,790.00	9,790.00
SUB-TOTAL					13,655.09
-----					
UPPER CONTROL COMPT. - TAB 70000					
474	3	17AF14H7	INTERLOCK	259.00	777.00
475	5	41A281451P27	CAPACITOR	30.30	151.50
476	30	41B564808G1	DIODE ASM	20.00	600.00
477	3	41A281049P11	DIODE	125.00	375.00
478	6	41B563171G101	MODULE	65.00	390.00
479	6	41B563171G19	TIMING MOD	65.00	390.00
480	3	41B563171G600	MODULE	65.00	195.00
481	24	41A278054G1	MODULE	14.00	336.00
482	3	41A278017G1	MODULE	80.40	241.20
483	3	41A278043G1	MODULE	13.50	40.50
484	4	41B566633G1	VARIATOR	52.10	208.40
485	1	482A614G1	PANEL	293.00	293.00
486	1	41A264231G1	PANEL	313.00	313.00
487	1	41A271329G2	PANEL	95.30	95.30
488	3	488A142G3	RES PANEL	505.00	1515.00
489	3	41B555393P1	RELAY	206.00	618.00
490	3	2X3756	COIL	12.10	36.30
491	3	41A245406P1	SWITCH	195.00	585.00
492	3	497A911P1	SWITCH	9.81	29.43
493	6	502A140P1	SWITCH	47.00	282.00
494	1 -	41A271471P1	PLUG	6.91	6.91
495	1	41A271471P3	CLAMP	2.98	2.98
496	7	41A271471P7	SOCKET PIN	.98	6.86
SUB-TOTAL					7,488.38
-----					

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<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
VOLTAGE REGULATOR					
497	2 -	17FH23DE	REGULATOR	2,000.00	4,000.00
498	3	41A281530P4	CAPACITOR	32.50	97.50
499	3	41B581374P1	TRANSISTOR	78.90	236.70
500	3	41A281496P2	DIODE	62.30	186.90
501	3	41A281496P1	DIODE	52.80	158.40
502	3	41A281044P4	DIODE	14.80	44.40
503	3	41A271102G1	MODULE	333.00	999.00
504	3	41A278597G1	MODULE	178.00	534.00
505	6	41A267871P10	BREAKER	29.30	175.80
506	15	41A281668P2	LED	4.40	66.00
507	3	41A281092P4	POTENTIOMTR	25.60	76.80

SUB-TOTAL 6,575.50

WHEEL SLIP PANEL

508	1	17FL281F2	PANEL	9,960.00	9,960.00
509	3	17FD1347A1	CARD	465.00	1,395.00
510	3	17FD1198B1	CARD	680.00	2,040.00
511	3	17FD1291A1	CARD	355.00	1,065.00
512	3	17FD1317A1	CARD	538.00	1,614.00
513	3	17FD1285A1	CARD	415.00	1,245.00
514	3	17FD1286A1	CARD	529.00	1,587.00
515	3	17FD1295A1	CARD	481.00	1,443.00
516	3	17FD1229A1	CARD	540.00	1,620.00
517	3	17FD1316A1	CARD	404.00	1,212.00
518	3	17FD1318A1	CARD	321.00	963.00
519	3	17FD1331A1	CARD	373.00	1,119.00
520	3	17FD1197A1	CARD	510.00	1,530.00

SUB-TOTAL 26,793.00

EXC. PANEL - 17FL237L1

521	3	17FD732A2	CARD	138.00	414.00
522	3	17FD733B3	CARD	678.00	2,034.00
523	6	17FD1409A1	CARD	298.00	1,788.00
524	3	17FD1322B1	CARD	493.00	1,479.00
525	3	17FD1321A1	CARD	251.00	753.00
526	3	17FD1310A1	CARD	410.00	1,230.00
527	3	17FD739C1	CARD	508.00	1,524.00
528	3	17FD1375A1	CARD	941.00	2,823.00
529	3	17FD1297A1	CARD	400.00	1,200.00
530	3	17FD1284A1	CARD	495.00	1,485.00
531	3	17FD1320A2	CARD	289.00	867.00

SUB-TOTAL 15,597.00

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
RECT. PANEL - 17FM203D1					
531	2 -	41A281049P8	DIODE	166.00	332.00
533	2 -	41A255036G1	CAPACITOR	23.80	47.60
534	2	41B551412P2	HEAT SINK	144.00	288.00
535	8	N22P21044B	SCREW CAP	.13	1.04
SUB-TOTAL					668.64

PANEL - 17LE117B1					
536	4 -	41B560270P4	RELAY	72.40	289.60
537	2 -	41A262156P1	SOCKET	15.60	31.20
538	2 -	41A262157P1	CLIP	3.54	7.08
539	1	41A278269G1	MODULE	168.00	168.00
SUB-TOTAL					495.88

RELAYS

540	6	17LV66J10	RELAY	325.00	1,950.00
541	6	8860474G1	COIL	108.00	648.00
542	3	8860802G1	ARMATURE	20.50	61.50
543	12	8823875P1	SPRING	.80	9.60
544	3	8860803G3	BASE	7.13	21.39
545	18	8860749G1	FINGER	6.88	123.84
546	18	8823868P1	SPRING	.94	16.92
547	18	8807883G1	CONTACT	2.89	52.02
548	3	17LV67F9	RELAY	688.00	2,064.00
549	6	8860832G1	BASE	14.90	89.40
550	3	41B566575P1	COIL	148.00	444.00
551	3	41B566108P1	COIL	100.00	300.00
SUB-TOTAL					5,780.67

ANNUNCIATOR PANEL

552	1	17FM369A6	PANEL	1,236.00	1,236.00
SUB-TOTAL					1,236.00
TOTAL THIS SECTION					547,103.05

CEWP:1069F

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PRICE AND DELIVERY - MTU ENGINES

This quotation for quantities of two engines per locomotive (12 V396 engines) to repower additional Chinese manufactured DHF2 locomotives was submitted April 3, 1987 by:

Heinz W. Meinhardt

Director MTU - Office Africa

Quantity of two engines - 413,200 DM

Delivery - 3 months from time of order.

Subsequent sets of two engines delivered as required.

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TAZARA SPARE PARTS REQUIREMENTS

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
<u>TURBOCHARGER TYPE 7S1612C1</u>					
1	12	150X1083-1	TURBO GASKET KIT	115.00	1,380.00
2	12	126X1223-1	BEARINGS (BLOWER END)	174.00	2,088.00
3	12	126X1222-1	BEARING (TURBINE END)	233.00	2,796.00
4	6	126X1389-1	MAGNETIC PICK UP	735.00	4,410.00
5	20	41B562849P156	SEALANT RTV 106	34.60	692.00
6	12	126X1562-1	TURBO END SEAL	431.00	5,172.00
7	12	126X1563	BLOWER END SEAL	168.00	2,016.00
8	48	126X1461	SEAL	2.25	108.00
9	12	115X2245	SEAL	.64	7.68
10	1	H2B/5	BALANCING MACHINE	32,000.00	32,000.00
11	1	126X1630-1	TURBOCHARGER UNIT	40,880.00	40,880.00
<u>ENGINE CONTROL SPEED GOVERNOR TYPE</u>					
1	12	150X1112-2	REPAIR KIT	888.00	10,656.00
2	12	150X1079	MODULATOR KIT	196.00	2,352.00
3	12	150X1123	GOVERNOR CONV. KIT	854.00	10,248.00
<u>DIESEL ENGINE</u>					
1	12	150X1024-1	CYLINDER HEAD ASSY. TO MAIN FRAME GASKET KIT	33.30	399.60
2	12	150X1023-6	CYLINDER HEAD AND LINER INSTALLATION GASKET KIT	39.40	472.80
3	12	125X1015-9	WATER SEAL	97.50	1,170.00
4	12	150X1069	WATER PUMP OVERHAUL KIT	236.00	2,832.00
5	12	132X1491	OS LINK RING SEAL	1.89	22.68
6	12	132X1492	OS LINK RING SEAL	2.00	24.00
7	12	125X1015-9	MECHANICAL SEAL	97.50	1,170.00
8	288	123X1001	UMBRELLA	1.98	570.24
9	144	150X1095	NOZZLE KIT	.39	56.16
10	144	150X1087-1	PUMP AND NOZZLE KIT	6.98	1,005.12
11	20	132X1093-2	BEARING	23.80	476.00
12	144	150X1193-1	RING KIT	51.06	7,352.64
13	168	140X2283	NUT	1.43	240.24
14	72	117X1045-2	CONROD BEARINGS	166.38	11,979.36
15	72	117X1050-1	CONROD BEARINGS	164.38	11,932.48
16	100	123X1058	PLATES	5.12	512.00
	100	123X1086		5.60	560.00
	100	123X1059		6.43	643.00
	100	123X1086		5.60	560.00
	100	123X1060		5.45	545.00
	100	123X1061		6.41	641.00
	100	123X1062		5.70	570.00
	100	123X1063		7.16	716.00

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
17	100	123X1046	SHIMS	.66	66.00
	100	123X1047		.66	66.00
	100	123X1048		.61	61.00
	100	123X1049		.66	66.00
	100	123X1050		.86	86.00
18	10	147X1898-1	LOCTITE	30.30	303.00
19	100	132X1022	SHIMS	.38	38.00
	100	132X1023		.38	38.00
	100	132X1024		.34	34.00
	100	132X1025		.35	35.00
20	160	116X1070-1	CAM BEARINGS	153.00	24,480.00
21	1	147X1227	CRANKSHAFT DEFL. GAGE	401.00	401.00
22	12	150X1069	WATER PUMP OH KIT	236.00	2,832.00
23	12	150X1070	WATER PUMP INST. KIT	6.20	74.40
24	12	125X1075-1	IMPELLER	460.00	5,520.00
	12	125X1026	BEARINGS	48.80	585.60
25	12	150X1145	LUBE OIL PUMP OH KIT	555.00	6,660.00
26	12	150X1139-1	LUBE OIL PUMP INSTAL. KIT	23.80	285.60
27	144	150X1116-1	WATER INLET HEADER KIT	13.50	1,944.00
28	216	115X1268	O RING	2.49	537.84
	72	115X1902-2		12.31	886.32
	24	115X1865		.74	17.76
29	24	128X1447	RING	141.00	3,384.00
30	12	128X1413-1	GASKET	6.51	78.12
31	72	128X1357-1	GASKET	3.60	259.20
32	144	128X1358	SEAL	55.00	7,920.00
33	144	128X1006-1	GASKET	2.26	325.44
34	10	147X1640	COMPOUND	12.30	123.00
35	24	115X1876-1	BUSHING	1.84	44.16
36	24	146X1059-1	SPRING	8.88	213.12
37	12	132X1491	SEAL	1.89	22.68
	12	132X1492		2.00	24.00
38	12	132X1491	SEAL	1.89	22.68
	12	N901P412		4.55	54.60
39	144	115X1902-1	O RING	12.31	1,772.64
40	96	2X4223	LUBE OIL FILTERS	21.48	2,062.08
41	12	132X1250	FUEL FILTERS	12.50	150.00
42	264	41A216508P4	AIR FILTERS	50.40	13,305.60
43	40	RTV/10.3	SEALANT	8.00	320.00
		497A806P60			
44	40	41A212051P5	SEALANT	9.38	375.20
45	3 pns	17FL237L1	CHEC III ELECT. CARDS	4,750.00	14,250.00
		ELECTRONIC			
46	3 pns	17FL281F2	MOTOR SPEED PANEL	9,960.00	29,880.00

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
<u>EXCITER/AUX. GENERATOR - GY27M1</u>					
1	1	8843613G1	COMMUTATOR GRINDER KIT	1,380.00	1,380.00
2	238	8828400P1	CARBON BRUSHES	5.70	1,356.60
3	1	41B532339G1	PULLER SET	775.00	775.00
4	24	8864951P29	BEARINGS (ROLLER)	70.00	1,680.00
	24	8864950P81	(BALL)	29.40	705.60
<u>FUEL BOOSTER PUMP MOTOR - 41C610401G2</u>					
1	48	149X1011-1	CARBON BRUSHES	16.90	811.20
2	24	149X1029	BEARINGS	12.00	288.00
<u>DYNAMIC BRAKING BLOWER MOTOR - GA57</u>					
1	2	8864950P81	BEARINGS, BALL	29.40	58.80
2	48	6727520P1	CARBON BRUSHES	3.25	156.00
<u>HEAD LIGHTS</u>					
1	48	41A210446P1	LAMP 200 PAR 30V	10.10	484.80
<u>GENERATORS - GTA11C1</u>					
1	72	41A235676P5	CARBON BRUSHES	9.09	654.48
2	72	41B531649G2	BRUSHHOLDER/PRESSURE ARM	42.40	3,052.80
<u>TRACTION MOTORS - GE-761</u>					
1	576	41A235897P4	CARBON BRUSHES	9.03	5,201.28
	72	8864951P148	BEARINGS (ROLLER)	343.75	24,750.00
	72	8864950P169	(BALL)	85.00	6,120.00
2	576	41A232340P3	CONNECTING SLEEVES	13.00	7,488.00
3	72	41B537105G1	SPEED SENSOR	840.00	60,480.00
4	72	41C633996G2	BRUSHHOLDER	165.00	11,880.00
5	72	9949062G1	DUST GUARD	10.60	763.20
6	1	101X910	MEGA INSUL. TESTER	1,880.00	1,880.00
		0-500 MEGAOHMS			
		0-1000 VOLTS			
7	1	8843578G1	SET OF PULLER TOOLS	1,030.00	1,030.00
8	1	9949075G1	COMMUTATOR GRINDER	1,630.00	1,630.00
9	1	9949182G4	PINION PULLER KIT	1,200.00	1,200.00
			CABLE CLAMPS		
<u>TYPICAL</u>				<u>UNIT PRICING</u>	
		41A216236P6		7.08	
		41A216237P6		5.79	
		41C614789P3		2.61	
		41C614789P22		5.38	

Refer to parts bulletins PB 17104-004 and 17550A to identify type and quantity req'd.

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<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
<u>COMPRESSOR/EXHAUSTER - 6CDX44C - PART NO. 41A203643P5</u>					
1	12	10526-0060	SAFETY VALVE	259.00	3,108.00
2	36	514650	GASKET	.38	13.68
3	12	516274	GASKET	.52	6.24
4	12	514644	GASKET	.98	11.76
5	12	514627	GASKET	.91	10.92
6	12	553399	CYLINDER	895.00	10,740.00
7	24	514644	GASKET	.98	23.52
8	24	514638	VALVE	6.79	162.96
9	24	514637	VALVE	4.41	105.84
10	24	514644	GASKET	.98	23.52
11	12	514651	GASKET	.94	11.28
12	12	514627	GASKET	.91	10.92
13	12	514626	LP CYLINDER	559.50	6,714.00
14	48	514644	GASKET	.98	47.04
15	48	514651	GASKET	.94	45.12
16	48	514627	GASKET	.91	43.68
17	48	514626	LP CYLINDER	559.50	26,856.00
18	12	584006	CHAIN	24.90	298.80
19	12	585165	MECHANICAL SEAL	36.40	436.80
20	12	585166	O RING	2.52	30.24
21	12	585168	BEARINGS	40.60	487.20
22	24	552658	GASKET	10.50	252.00
23	12	573554	GASKET	2.02	24.24
24	12	584525	GASKET	4.48	53.76
25	12	572403	GASKET	.49	5.88
26	12	563411	GASKET	.64	7.68
27	24	514624	RING	5.25	126.00
28	24	520128	RING	3.15	75.60
29	24	523429	RING	3.57	85.68
30	24	523430	RING	3.78	90.72
31	24	520130	RING	7.56	181.44
32	24	523432	RING	3.43	82.32
33	24	523427	RING	3.00	72.00
34	72	540589	BEARINGS	16.38	1,179.36
35	72	541078	BEARINGS	88.00	6,336.00
36	72	540590	BEARINGS	67.47	4,857.84
37	120	520123	RING	5.67	680.40
38	120	523401	RING	11.55	1,386.00
39	120	523402	RING	14.35	1,722.00
40	120	520133	RING	11.20	1,344.00
41	120	523404	RING	8.75	1,050.00
42	120	523405	RING	28.00	3,360.00
43	24	566271	SEAL	111.70	2,680.80
44	24	566272	RING ASSY.	111.70	2,680.80
45	12	552660	GASKET	30.24	362.88
46	24	549826	BEARING	385.00	9,240.00
47	12	567379	SPRING	9.45	113.40
48	60	567809	SHIMS	2.00	120.00

<u>ITEM</u>	<u>QTY.</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>UNIT PRICE</u>	<u>EXT. PRICE</u>
49	24	567810	SHIMS	1.91	45.84
50	24	567811	SHIMS	1.90	45.60
51	12	522758	GASKET	3.78	45.36

SKF/FAG BEARINGS - 6-1/2" x 12"

1	6	6-1/2" x 12"	BEARINGS	ESTIMATE	WAITING INPUT FROM FAG STAMPING CO. WHO IN TURN WAITING INPUT FROM CUSTOMER 14,200.00
2	1		MOBILE UNIT FOR MOUNTING & DISMANTLING OF BEARINGS	ESTIMATE	
3	1	FAG 157317/1-F	MOUNTING & DISMANTLING OF SEALS	ESTIMATE	
4	1	FAG 157317/2-F	RAM	ESTIMATE	
5	1	FAG 157317/3-F	SEAL CASE JAWS	ESTIMATE	
6	1	FAG 157317/4-F	COUNTER NUT	ESTIMATE	
7	1	FAG 157317/6-F	ADAPTOR RING BEARINGS	ESTIMATE	
8	1	FAG 157317/5-F	SUPPORT RING	ESTIMATE	
9	1	ORDER PR 3100-J OTC OWATOONA TOOL CO., MN	PRESS FOR MOUNTING & DISMOUNTING OF SEALS	ESTIMATE	

TOOL KITS

1	8	147X1927-1	MECH. ENC. TOOL KITS	1,500.00	12,000.00
2	4	170X1047	ELECT. TOOL KITS	1,114.00	4,456.00

ADDITIONAL ITEMS

1	4	126X1633	TURBOCASINGS	7,260.00	29,040.00
2	1	119X1112	CRANK SHAFT	24,100.00	24,100.00

TOTAL \$583,976.92

CEWP:1080F

ANNUAL MAINTENANCE COST PER LOCOMOTIVE (ESTIMATED)

<u>Type</u>	<u>Number</u>	<u>Average Annual per Locomotive</u>		
		<u>US \$ Parts</u>	<u>Man Hours/ Equiv. US\$</u>	<u>US \$ Technical Assistance</u>
DFH <sub>1</sub> , DFH <sub>2</sub>	42	\$10,000	4,000/\$1,280	China
MTU H <sub>1</sub> , H <sub>2</sub>	30	\$12,000	4,000/\$1,280	\$ 8,000
U30C	13	\$17,500	4,000/\$1,280	\$ 13,500
(U30C with additional	<u>Total</u> 25	\$17,500	4,000/\$1,280	\$ 9,600)

Not including collision, fire damage, capsizing repairs.

COST SUMMARY - FLEET

TOTAL ANNUAL MAINTENANCE COST \$US

<u>No. Loco</u>	<u>Type</u>	<u>Per Loco</u>	<u>Total</u>
42	Chinese	20,000	840,000
30	MTU	22,000	660,000
13	U30	37,280	<u>500,000</u>
Not Incl. TZR <u>OVERHEAD</u>			<u>\$2,000,000</u>

WORK REALLOCATION BY WORKSHOP

MPIKA - All locomotive maintenance work with exception of work on U30Cs will be performed in MPIKA workshops. This includes DFH<sub>1</sub>, DFH<sub>2</sub>, DFH<sub>1</sub>/MTU and DFH<sub>2</sub>/MTU units.

MBEYA - All U30C locomotive maintenance work will be performed in MBEYA workshops. The addition of workshop area and equipment for heavy repair work on KRUPP or GE U30CS will permit this work to be concentrated in this facility.

DAR ES SALAAM - All wagon maintenance work will be performed in DAR workshops.

The schedule for transition of work from present shop assignments to the above reallocation must be established.

Workshop Layouts

DAR ES SALAM - Copy of Layout attached

Comments - current layout basically unchanged from original as per attached. One wagon shop now designated as wheel shop is approximately 60 percent occupied with wheels, axles and wheel sets.

MBEYA - Copy of layout attached

Comments - sufficient land area (unused) adjacent to north wall of building No. 7 - light repair shop is available for an addition of a new heavy repair shop and a parts/material storage building. The new Heavy Repair shop would be 27M x 54M, with a 30 ton moveable bridge crane. Also adjacent to north wall of new heavy repair shop, an additional building for parts and material storage would be constructed. Storage would be for KRUPP/GE U30C locomotive parts and material only. The building would be 24M x 54M.

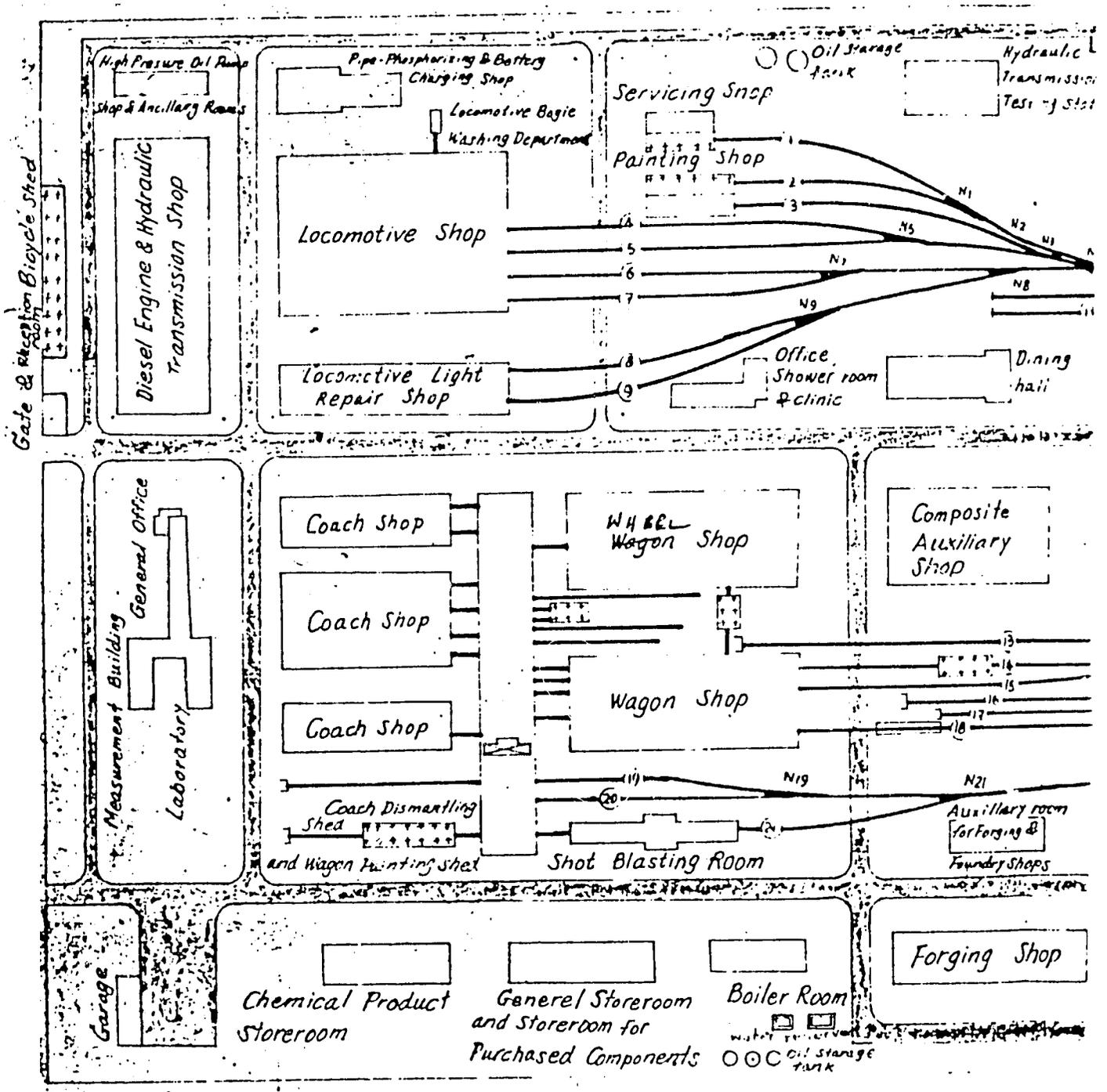
MPIKA - TAZARA unable to furnish copy of layout. However, buildings and area similar to DAR ES SALAAM workshops.

Comments - During interviews with Chief Mechanical Engineer, Assistant Chief Mechanical Engineer and MPIKA workshops manager, Described the MPIKA workshops as a mirror image of DAR ES SALAAM workshops with the

APPEL

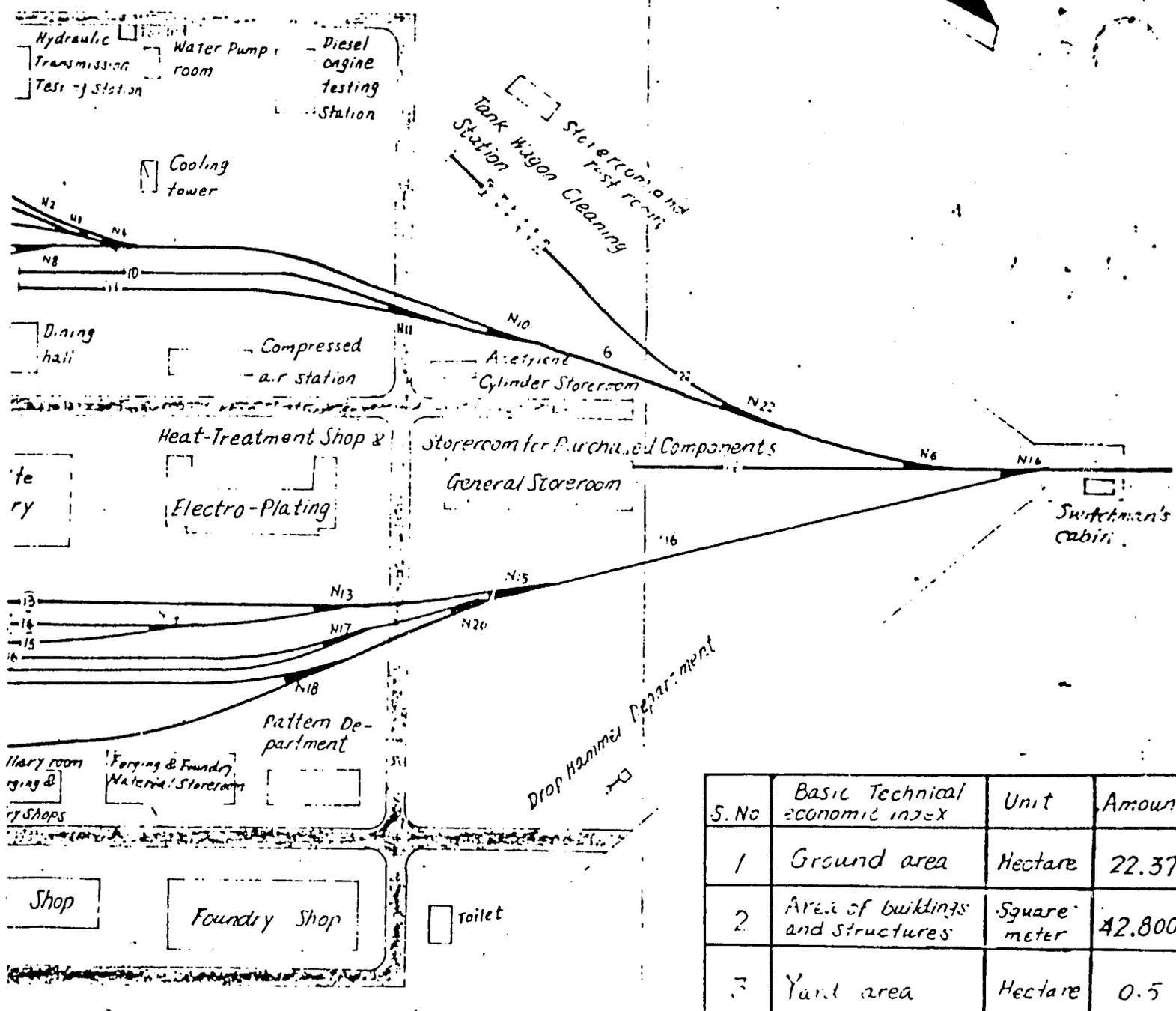
addition of an oxygen producing facility and a different alignment of shop buildings/administration buildings and laboratories. MPIKA does contain a Cupola Furnace. Also, the coach shop and wagon shop are more spacious than those at DAR (estimated 20 percent more area).

# PLAN OF DAR ES SALAAM LOCOMOTIVE



APPENDIX F  
 ITEM 2  
 DAR ES SALAAM  
 WORKSHOPS  
 LAYOUT & PLAN

MOTIVE & ROLLING STOCK REPAIR WORKS



S. No	Basic Technical economic index	Unit	Amount
1	Ground area	Hectare	22.37
2	Area of buildings and structures	Square meter	42.800
3	Yard area	Hectare	0.5
4	Paved area of road and yard	Hectare	1.74
5	Track kilometer	Kilometer	4.53

**REFER TO  
FICHE**

4 OF 4

**FOR**

**FIGURE(S):**

MBEVA  
LOCOMOTIVE  
LAYOUT PLAN

TANZANIA ZAMBIA RAILWAY AUTHORITY  
ORGANISATION STRUCTURE AND LABOUR SKILLS MBEYA LOCOMOTIVE DEPOT

S/No.	Post	Qualification	Other Training	Remarks
1.	District Mechanical Engineer	BSc (Mechanical Eng.)	Short courses (study tours) in railway equipment, maintenance techniques:- France ( 3 months), U.K (11 weeks), India ( 2 weeks).	Crash programme (2 week course) in Diesel Electric locomotive construction, operation and maintenance conducted by G.E. Service Engineer at Mbeya Locomotive Depot.
2.	Maintenance Engineer	Diploma in Railway Engineering (China); BSc (Engineering)	2 week ESAMI Management Course	Has worked as Senior Technician, Auxiliary Equipment Repairs in Dar es Salaam Workshop, and Locomotive Maintenance Engineer at Mbeya. 2 week crash programme course in Diesel Electric Locomotives.
3.	Senior Technician (Electrical Systems)	Full Technicians Certificate; Higher Diploma in Electrical Engineering		Has attended 2 week course in Diesel Electric Locomotives.
4.	Senior Technician (Mechanical Systems)	Diploma in Railway Engineering (China)	Seven week short course in Diesel Electric Locomotives at Erie (USA) and Essen (KRUPP Industries)	
5.	Running Master (Technician - Operations)	Diploma in Railway Engineering (China)	-	Attended and coordinated Locomotive drivers course for D.E. locos.
6.	Technician IV (Diesel Engine, Electrical, Brake, Injection Pumps, Operations)	Full Technician's Certificate	-	2week course in Diesel Electric Locomotives.
7.	Technician IV Quality Control	Full Technicians Certificate (TAZARA Training School); Locomotive Driver IV License		2 week course in D.E. Locomotives. Worked as licensed Locomotive driver for a number of years before joining Technician Course.

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TANZANIA ZAMBIA RAILWAY AUTHORITY  
ORGANISATION STRUCTURE AND LABOUR SKILLS MBEYA LOCOMOTIVE DEPOT  
(Continued)

S/No.	Post	Qualification	Other Training	Remarks
8.	Artisan I (Bogies & Transmission)			Attended full Technician Certificate course but failed in one subject in his final examination. Attended 2 week course in D.E. Locomotives.
9.	Artisan II (L/Man) (Diesel Engine, Brake, Electrical, Transmission)	Trade Test III Certificate (TAZARA)	Attended 3 month Trade test courses in their respective fields at the TAZARA Training School.	Were absorbed into TAZARA from the Chinese Railway Railway Construction Team. Promoted to supervisor/ levels (Leadingmen) due to their good performance (technically and administratively) compare to their workmates. Attended 2 week course in D.E. Locomotives.
10.	Artisan III	TAZARA Trade Test Certificate	Attended 3 months courses in respective field at the TAZARA training School.	i) One group were absorbed from the Chinese Railway Construction Team. ii) The other group were employed after completion of their Secondary School education and underwent apprenticeship in TAZARA Workshops for two years. 3 engine fitters, 2 brake fitters, 2 electrical fitters and one transmission fitter have attended the two week course in D.E. Locomotives.
11.	Locomotive Inspector	Locomotive Driver IV License		Former competent locomotive locomotive drivers selected to perform inspectorate duties under on-the-job training basis.
12.	Locomotive Line Inspector	Locomotive Driver IV Licence		Selected from fellow drivers to undergo a Diesel Electric drivers course conducted by an Expert from KRUPP.

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**TANZANIA ZAMBIA RAILWAY AUTHORITY**  
**ORGANISATION STRUCTURE AND LABOUR SKILLS MBEYA LOCOMOTIVE DEPOT**  
(Continued)

S/No..	Post	Qualification	Other Training	Remarks
13.	Locomotive Controller	Locomotive Driver IV Licence		Former competent locomotive drivers selected to perform locomotive running control duties under on-the-job training basis.
14.	Licensed Locomotive Driver IV	Locomotive Driver IV Licence	-	<p>i) One group absorbed from the Chinese Railway Construction Team after being trained on-the-job.</p> <p>ii) The other group underwent a two year training at the TAZARA training school and minimum 1½ years practical training in the field.</p> <p>Both groups had to sit a Driver IV qualifying examination.</p> <p>23 locomotive drivers have attended and passed a Diesel Electric driver course.</p>
15.	Assistant Locomotive Driver	-	-	i) and ii) as in 14 above. Both groups have failed to pass Driver IV qualifying examinations.
16.	Locomotive	-	-	Absorbed from the Chinese Railway Construction Team and given on-the-job training in servicing of various types of locomotives.

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CODE NO.	<u>EXPLANATORY NOTES</u>	AMOUNT TSHS.
6017	<p><u>LOCOMOTIVES:</u></p> <p>1. Provision for rehabilitation of locomotive DE: 1006:</p> <p>(a) Foreign purchase costs provided for in 1986/87 revised budget.</p> <p>(b) Local costs for undertaking the work estimated to cost shs. 2,000,000/=</p> <p>2. Provision for the rehabilitation of DE 1008. part of work done in 86/87. Overflow of work estimated to cost shs. 1,500,000/=</p> <p>3. Provision for administering of project ME: 1 - Locomotives as follows:-</p> <p>(a) Air fares estimated at two return trips to the USA. Basic fare estimated at shs. 130,000/= Air travel levy = 25,000/= Total cost = 156,000 x 2 = 312,000/=</p> <p>(b) Subsistence allowance estimated at 36-mandays at USD 170 per day. = 36 x 170 x 60 = 367,200/=</p> <p>(c) Local costs relating to results of project ME: 1, e.g. part charges and other clearing costs amongst others under this project Estimated at shs. 3,000,000/=</p> <p>(d) Construction of building extensions for Mbeya as per project ME 1</p> <p>(i) Workshop building extension 61m x 20m = 1220 m<sup>2</sup></p> <p>(ii) Parts store 50m x 20m = 100 m<sup>2</sup></p> <p>(iii) Demonstration-room 10m x 20m = 200 m<sup>2</sup></p> <p>Total built area 2,420 sq m. Estimated construction cost is shs. 24,000 per sq m Total construction cost 2420 x 2400 = 58,080,000</p> <p>Design consultancy cost estimated at 10% of construction cost i.e 5.808 m.</p> <p>In current year, provision is made for Design costs 5,808,000 50% of building costs = 29,040,000</p> <p>Total 34,848,000</p>	<p>42,027,200</p>

TOOLS - TAZARA

<u>S/NO.</u>	<u>NAME</u>	<u>QTY.</u>	<u>SPECIFICATION</u>	<u>REMARKS</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
1	GOV. TEST STAND	1	230V 50/60 HZ SINGLE PHASE	GE PART NO. 147X2422 PRESENTLY NO FACILITIES TESTING GOVERNORS EXCEPT WITH THE TANZANIA RAILWAYS CORP.	60,000.00	60,000.00
2	CYLINDER LINER TESTER	1		GE PART NO. 147X1646	738.00	738.00
3	CYLINDER INLET PORT CLEANER	1	230V 50/60 HZ SINGLE PHASE OR  380V 50/60 HZ 3 PHASE	GE PART NO. 147X1612, INLET PORTS BECOME HEAVILY CLOGGED WITH CARBON DEPOSITS. HENCE EFFECT THE PERFORMANCE OF OUR ENGINES, AND MAKES MAINTENANCE WORK VERY DIFFICULT AND TIME CONSUMING	8,730.00	8,730.00
4	VALVE CHECKING FIXTURE	1		GE PART NO. 147X1679 GE PART NO. 147X2219 GE PART NO. 147X2221  A GREAT NUMBER OF VALVES MACHINED IN D'SALAAM w/SHOP BUT NO CHECKS ARE DONE ON TOLERANCES.	2,440.00 538.00 538.00	2,440.00 538.00 538.00
5	VALVE SEAT GRINDING SET	1		GE PART NO. 147X1902 VALVE SEATS ARE NOW BEING GROUNDED USING IMPROPER TOOLS.	7,680.00	7,680.00

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TOOLS - TAZARA

<u>S/NO.</u>	<u>NAME</u>	<u>QTY.</u>	<u>SPECIFICATION</u>	<u>REMARKS</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
6	ULTRASONIC TEST EQUIPMENT	1	230V 50/60 HZ SINGLE PHASE OR 230V 50/60 HZ 3 PHASE	GE PART NO. 147X1906-1	OBSOLETE	-
7	SCRAPER	6		GE PART NO. 147X1098 FOR REMOVING CARBON DEPOSITS ON THE PISTON GROOVES.	135.00	810.00
8	CRANKSHAFT DEFLECTION	1		GE PART NO. 147X1227 147X1228 SIX MONTHLY INSPECTION REQUIRES MEASUREMENT OF CRANKSHAFT DEFLECTION BUT IS NOT DONE BECAUSE THERE IS NO TOOL.	401.00 37.10	401.00 37.10
9	TURBO SERVICING FIXTURE	1		GE PART NO. 147X2255	11,000.00	11,000.00
10	TURBO ASSEMBLY AND DISASSEMBLY TOOLS	1	BEARING INSTALLATION TOOL	GE PART NO. 147X1197-1	603.00	603.00
		1	COMPRESSOR WHEEL PULLER	147X2075	238.00	238.00
		1	BEARING PULLER	147X2072	186.00	186.00
11	GOVERNOR TOOL KIT	1		GE PART NO. 147X2013-1	624.00	624.00
12	FRONT DRIVE HUB PULLER	1		GE PART NO. 147X1914-1	6,740.00	6,740.00

<u>S/NO.</u>	<u>NAME</u>	<u>QTY.</u>	<u>SPECIFICATION</u>	<u>REMARKS</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
13	PINION PULLER	1		GE PART NO. 9949182G4	1,200.00	1,200.00
14	COMMUTATOR GRINDER	1	FOR GE761	9949075G1	1,630.00	1,630.00
		4	STONE	8828492P8	14.38	57.52
		4	STONE	8828492P11	16.30	65.20
15	MEGGER INSULATION TESTER	1	0-500 MEGOHMS 1000 VOLTS	101X910	1,880.00	1,880.00
++16	FORK LIFT	1	5 TONS	FOR LIFTING WHEEL SET ASSEMBLIES. TRACTION MOTORS FROM ONE AREA TO THE OTHER.	ESTIMATE	19,000.00
++17	SCREW TYPE LIFTING JACKS	4	CAPACITY 25 TONS	FOR LIFTING LOCOMOTIVES	ESTIMATE	85,000.00
++21	ELECTRICAL OVEN	1	CAPACITY 120 KW MAX TEMP. 700°F	DIMENSIONS 6' x 10' x 6' BAKING OF TRACTION MTRS. HEATING OF BEARINGS	ESTIMATE	35,000
++22	STEAM CLEANER	1		FOR CLEANING OF LOCOMOTIVE ENGINE PARTS, BOGIES, ETC.	ESTIMATE	8,000.00
++23	HYDRAULIC BEARING REMOVAL PRESSURE 40-60 TONS			REMOVAL OF FAG OR SKF BEARINGS	LATER	
24	FIELD COIL BRAZING	1	PORTABLE RESISTANCE BRAZING MACHINE	GE PART NO. 6CM-001	19,560.00	19,560.00
		x 1	FOOT SWITCH	41D780746P11	132.66	132.66
		x 1	BRAZING TANGS	41D730746P12	1,290.00	1,290.00
		x 1	CARBON ELECTRODES	41D780746P14	18.30	18.30
		x 1	WATER COOLED POWER CABLES	41D780746P15	1,035.00	1,035.00

x - INCLUDED IN GE PART NO. 6CM-001

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TOOLS - TAZARA

<u>S/NO.</u>	<u>NAME</u>	<u>QTY.</u>	<u>SPECIFICATION</u>	<u>REMARKS</u>	<u>UNIT PRICE</u>	<u>EXTENDED PRICE</u>
++28	SPECTOPHOTOMETER	1	BAIRD FAŞ-2C		ESTIMATE	120,000.00
28A	IBM PCXT	1	FOR AUTO READOUT		ESTIMATE	18,500.00
28B	MISC. SUPPLIES	1 LOT			ESTIMATE	11,300.00
29	ELECTRONIC CARD TROUBLESHOOTER AND SERVICING EQUIPMENT		OTP 1200-4		26,775.00	26,775.00
30	TEST BLOCKS	APPROX. 20			2,000.00	40,000.00
						<u>\$491,746.78</u>

++- PRICES ARE APPROXIMATES AND PROVIDED FOR ESTIMATING PURPOSES. WE WOULD BE HAPPY TO ADVISE MODEL NUMBER, MANUFACTURER, ETC. FOR USE IN PROCURING DIRECTLY.

CEWP:1082F

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TAZARA Key Personnel Interviewed for Background Information

S.C.I. Mapara	General Manager
M.J. Kachumi	Chief Mechanical Engineer
L.B.J. Choga	Assistant Chief Mechanical Engineer
H.A. Mawona	Chief Civil Engineer
M.A. Kashonda	Finance Manager
L.Z. Mutakyahwa	Supplies Manager
S. Chisamu	Personnel Manager
A.S. Mweeba	Corporate Planning Manager
N. Ngonyani	Principal Planning Manager
A.G.I. Shayo	Deputy General Manager
N. Magotti	Workshops Manager - DAR
C.D. Phiri	Workshops Manager - MPIKA
A.O. Mkamba	Principal Mechanical Engineer
A. Kilufi	Electrical Engineer - MBEYA
E. Simbo	Technical Service Engineer - DAR
A. Sato	Foreman Locomotive Assembly - DAR
M. Mnkabenga	District Engineer - MBEYA
I. Chache	Senior Mechanical Engineer - DAR HDQ

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Personnel interviewed from U.S.A.I.D. and Equipment Manufacturers'

Representatives

C. Campbell	U.S.A.I.D. Projects Officer, DAR
D. Light	U.S.A.I.D. Regional Engineer, HARARE
P. Brahmbhatt	U.S.A.I.D. Engineer, NAIROBI
J. Schulman	U.S.A.I.D. Project Engineer, HARARE
B. Mutiti	U.S.A.I.D. Transport Economist
R. Bruce Stader	U.S.A.I.D. Reg. Econ. Dev. Support Officer
H. Anton	KRUPP Service Engineer
H. Meinhardt	Director MTU Office Africa
S. Schluszas	MTU Service Representative
T. Shui GA Tshof	Chief Mechanical Engineer, China
Lioobin Heng	Engineer - Interpreter, China
R. Rinamo	Mechanical Engineer, PCU TAZARA
M.L. Clancy	Manager Rail Traction Mktg - Cummins
T.F. Nelson	Manager Export Locomotives G.E.
J. Davies	SIDA Chartered Engr. Consultant

List Of Information Source Documents

Tanzania Transport Sector Study -- Final Report to U.S.A.I.D. submitted by Louis Berger International Incorporated March 1987

Canadian Pacific Consulting Services Ltd. Final Report of the Operational and Staffing Study for Tanzania Zambia Railway Authority September 1984

Tanzania Railways Corporation, Donor Conference Background Information DAR ES SALAAM 1983

Tanzania -- Zambia Railway - (TAZARA) Donor Coordination Conference Notes, February 13 and 14, 1987 -- Tazara Headquarters, DAR ES SALAAM.

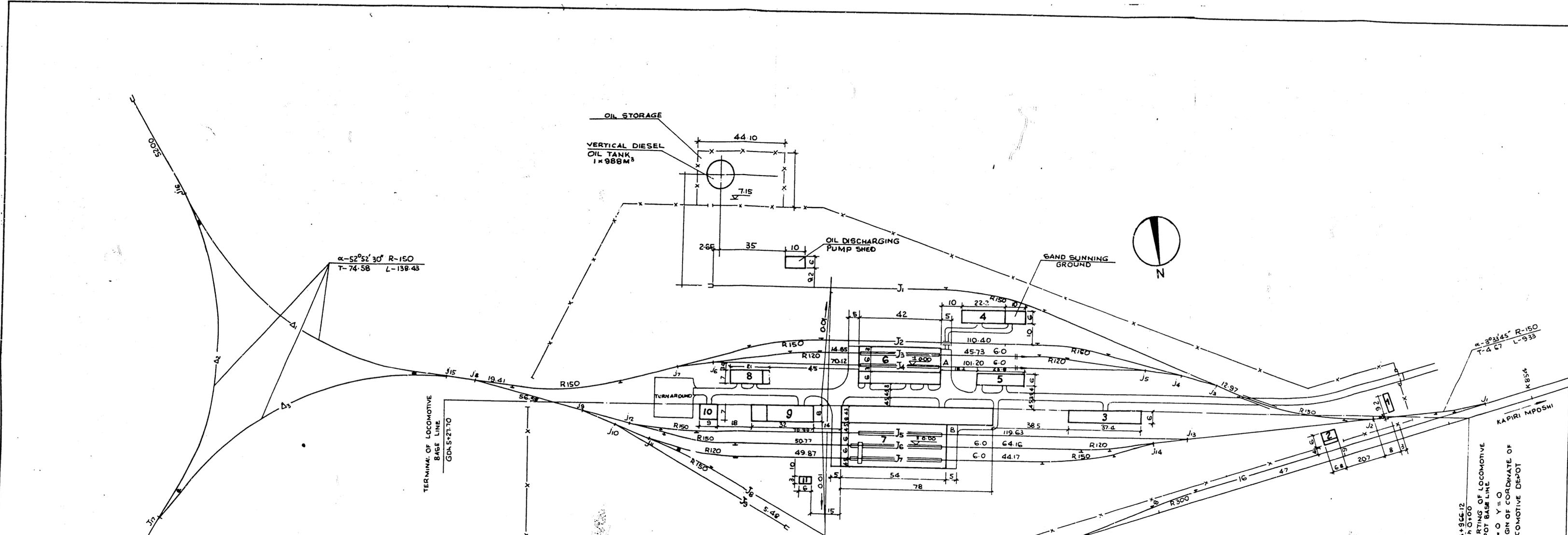
Tanzania -- Zambia Railway Authority, "Ten Years of Tazara Operations Review and Perspective, DAR ES SALAAM August 1986

U.S.A.I.D./Tanzania, A Conceptual Framework for Resumption of AID assistance to Tanzania, DAR ES SALAAM January 1987

TAZARA Locomotive Repair Record Book Register covering period of 1985, 1986 and 1987 to-date.

Programme of training and related measures to strengthen the mechanical engineering department of the Tanzania-Zambia Railway Authority (Final Report) submitted to Kreditanstalt fur Wiederaufbau November 1986

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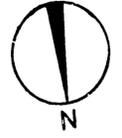
$\alpha - 52^{\circ} 52' 30''$  R-150  
 T-74.58 L-138.43

TERMINA: OF LOCOMOTIVE  
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 LOCOMOTIVE DEPOT

$\alpha - 30^{\circ} 34' 45''$  R-150  
 T-4.67 L-9.33

KAPIRI MPOSHI



OIL STORAGE

VERTICAL DIESEL  
 OIL TANK  
 1 x 988M<sup>3</sup>

OIL DISCHARGING  
 PUMP SHED

SAND SUNNING  
 GROUND

TURNAROUND

5200  
 J16

J15

J14 19.41

J13 56.58

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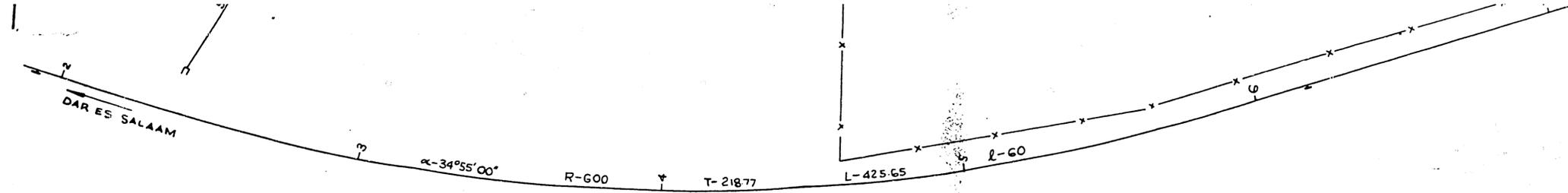
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- NOTES--
1. ALL DIMENSIONS ARE IN M.
  2. THE DIMENSIONS BETWEEN BUILDINGS ARE AXIS TO AXIS DIMENSIONS
  3. COORDINATE A ON THE SERVICING SHED AXIS: X = 273.11 Y = 21.11  
COORDINATE B ON THE SERVICING SHED AXIS: X = 269.10 Y = 12.89
  4. OIL STORAGE AND OIL DISCHARGING PUMP SHEDS ARE PROVIDED BY SHELL TANZANIA LIMITED.
  5. TRACK LENGTHS IN FRONT AND REAR OF LIGHT REPAIR SHOP OR SERVICING SHED EXCLUDE THE GRADING 5 METERS EACH IN FRONT AND AT REAR OF THE SHOP OR SHED.
  6. THE GROUND ELEVATION OF OIL STORAGE IS RELATIVE TO ±0.00 WHICH IS THE INDOOR GROUND LEVEL OF SERVICING SHED.
  7. ROAD SURFACE WITHIN DEPOT ARE OF CONCRETE. THE TURNAROUND IS OF GRAVEL SURFACE.

TRACKS

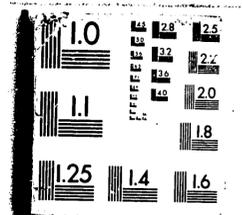
SER No.	NAME	CLEARANCE LENGTH (M)	TANGENT LENGTH (M)	REMARKS
J1	OIL DISCHARGING SIDING	238	120	
J2	LOCOMOTIVE RUNNING LINE	202		
J3	LOCOMOTIVE SERVICING TRACK	162		
J4	LOCOMOTIVE SERVICING TRACK	162		
J5	LIGHT REPAIR SHOP TRACK	224		
J6	LIGHT REPAIR SHOP TRACK	203		
J7	LIGHT REPAIR SHOP TRACK	198		
J8	STAND BY LOCOMOTIVE TRACK	78		
J9	STAND BY LOCOMOTIVE TRACK	70		
A1 43	Y - TRACK	—		
16	RESCUE TRAIN PARKING TRACK	149		

BUILDINGS

SER No.	NAME	QTY	UNIT	BUILDING AREA (M <sup>2</sup> )	DRG. No.	REMARKS
1	LADGE & DEPOT GATE CABIN	1		30.3	VII-4-3-33/43-34/43	
2	RESCUE TRAIN OFFICE	1	EACH	43	VI-4-3-20/43-21/43	
3	OFFICE	1	EACH	234	VII-4-3-17/43-19/43	INCLUDING CHEMICAL LAB.
4	SAND DRYING ROOM	1	EACH	140.5	VI-4-3-29/43-30/43	
5	SHOWER ROOM & WELDING	1	EACH	160	VI-4-3-31/43-32/43	
6	SERVICING SHED & AUXILIARY ROOMS	1	EACH	771.1	VI-4-3-35/43-43/43	
7	LIGHT REPAIR SHOP & AUXILIARY ROOMS	1	EACH	1874.3	VI-4-4	
8	FORGING & AIR COMPRESSOR ROOM	1	EACH	154	VII-4-3-24/43-25/43	
9	PARTS & MATERIAL STORE	1	EACH	260	VI-4-3-22/43-23/43	
10	BATTERY ROOM	1	EACH	67	VI-4-3-29/43-28/43	
11	TOILET	1	EACH	18.6	VII-13	

4 of 4  
PDAAW-779

DESIGNED	TANZANIA ZAMBIA RAILWAY AUTHORITY
DRAWN	MECHANICAL ENGINEER'S DEPT. DAR-ES-SALAAM
TRACED	TITLE
CHECKED	MBEYA LOCOMOTIVE DEPOT
PASSED	LAYOUT PLAN
APPROVED	DIMENSIONS
SCALE: 1:1000	DRG. No. 3L310-00-000
ORIG. No. XJ-3-1-1/17	ISSUE A



24 X