SOUTHERN AFRICA REGIONAL TRANSPORT DEVELOPMENT (ZAMBIA RAILWAYS) WORKSHOP EVALUATION

March 17, 1989

TABLE OF CONTENTS

Item No.	Description	Page
1.00	The storage, accessibility, checkout and availability of locomotive parts.	1-2
2.00	The overall setup of workshop operations for major components of workshop operations and the inter-relationship of such components.	2-4
3.00	The availability and efficiency of appropriate machinery, benches, tooling and crane operations.	4-6
4.00	The setup by labor and materials by man-hours, quantities and costs for all fixed operations.	6-7
5.00	The assessment of skills available for such operations.	7-8
6.00	The background and training required and presently available for the operations.	8
7.00	The quality control and interrelationship to operations.	9
8.00	The critique of planned operations versus actual operations and reasons why certain operations have not occurred or are delayed.	9-10
9.00	The testing and trials of locomotives at each major stage. Are there recognized trends in failures and how can these be minimized ? Are there failures due to specific lack of G.E. locomotive experience ?	10-11
10.00	The assessment of the current use of computers for inventory control, locomotive maintenance schedules, locomotive rehabilitation schedules and spare parts procurement in comparison with recommendations made by Price Waterhouse.	11-12
11.00	An overall assessment of the locomotive rehabilitation operation and how it could be improved. Is the current rehabilitation program progressing too slow, too fast or at the right pace ?	12
12.00	An overall assessment in terms of the above for normal maintenance and repair operations. Are the maintenance repair operations adequate for the rehabilitation program ? Can they be improved ? If so, how ?	12-13
12.A	The results of quality control tests conducted with Zambia Railways personnel on master and articulated conn rods supplied by Arbaco Engineering Company under A.I.D. funded Purchase Order No. ZR/UD00005/86 issued by Zambia Railways.	14-16

SUMMARY OF ATTACHMENTS

Attachment No.	
1	Railway Workshops Layout
2	Material Requisition Form
3	Material Request Form
4	Material Draw Card Form
5	Organization Chart (Motive Power)
6	Q.C. Pre-Annual Test
7	Q.C. Defect List
8	Q.C. Turbocharger
9	Q.C. P.O.M. Inspection - Electrical (only Sheet 1 of 11)
10	Q.C. Component Rejection Certificate
11	Q.C. Quality Assurance Certificate
12	Training Program for 1989-1990 - Mechanical
13	Training Program for 1989-1990 - Electrical
14	Utilization of Manpower - December 1988
15	Analysis of Idle Time - December 1988
16	Projected Targets for Assemblies - Mechanical
17	Projected Targets for Assemblies - Electrical
18	Stage Inspection Report
19	Connecting Rod Checking Fixture
20	Supplier Problems (Rejected Materials)
21	Listing of Emergency Spare Requirements
22	Listing of Locomotive & Machine Shop Machinery
23	Chart of Locomotive Overhaul Program

Date: March 17, 1989

To: J. Harmon, CMO, USAID/Zambia

From: R. Frees

Subject: Southern Africa Regional Transport Development (Zambia Railways) Workshop Evaluation
Contract No. OTR-0000-I-00-7208, Delivery Order No. 03 - Effective 02-20-89

ARTICLE I - Evaluation of Regional Transport Development (Zambia Railways)

ARTICLE II - The objective is to examine the locomotive rehabilitation work in terms of overall and specific workshop operations, task preparations and interconnection of tasks, efficiency of operations and quality control. The interrelation of workshop operations with stores and supplies, plus the set-up for future maintenance and repair operations.

ARTICLE III - The contractor shall conduct an evaluation which addresses the following areas:

1.00 "The storage, accessibility, checkout and availability of locomotive parts".

1.01 FINDINGS

(a) The facilities for storage of all AID material and issuance or check out of spare parts are located in a warehouse called Ward 315 (see Attachment No. 1, a layout of the motive power shops). These facilities are adjacent to the locomotive power shops, under the daily direct supervision of the Senior Engineer of Spares and Reconditioning - Mr. R.S. Chugh. (b) No material can be released without Mr. Chugh or his assistant, a superintendent, signing the material requisition (see Attachment No. 2)*. (c) In addition to the material requisition, the employee requiring the material for the job must fill out a material request form (see Attachment No. 3)*. This form is signed by the foreman, who completes the material draw card (see Attachment No. 4)*. (d) The material draw card form is then given to the material planner who makes up the material requisition. (e) Upon presentation of the material requisition to the storekeeper the material is then issued. (f) In the store there are records maintained for every piece of material both incoming and outgoing by part number and name. (g) There is also a monthly computer inventory status report run out on A.I.D. material. (h) In addition to the warehouse, there are 13 locked containers (8'x 8' x 20' type) within a fenced area adjacent to the AID warehouse. These containers are dedicated also only to AID material. (i) The efficiency of the employees observed

within the material area is excellent, but overall efficiency could be improved by switching from a manual to a computerized material requisition system. While the current manual system is sufficient for control purposes, it is a bit too slow. (j) Each piece of material, when signed out is charged to the respective locomotive it will be used on. (k) The availability of locomotive parts is good, however there are some critical parts not available - this issue is addressed in the following Item No. 11 of this report. This list of critically needed spares is attached as Attachment No. 21 and should be procured on an emergency basis from the manufacturer to avert a potential serious delay in project implementation. These materials could not have been procured under the main batch of spares procured earlier, due to a recent design change in certain assemblies. These design changes require approximately $25,000 C.I.F. Lusaka in miscellaneous small parts such as gaskets, O-rings, seals, etc. It would not be practical to carry out a competitive procurement of this wide range of items due to quality assurance problems in dealing with jobbers. The potential delays in sorting out incorrect parts delivered to ZR could continue indefinitely. Further, it would not be commercially viable to approach all the G.E. vendors of these items because the required quantities are too small.

1.02 RECOMMENDATIONS

Install a computerized card system for:

A. Increased efficiency

B. Better overall control of materials.

1.03 LESSONS LEARNED

A better material control system should be instituted. This would:

A. Reduce production costs

B. Increase the reliability of the records of materials needed or on hand.

* Note: Attachments 2, 3 and 4 are standard acceptable industry forms.

2.00 "The overall set up of workshop operations for major components of workshop operations and the interrelationship of such components".

2.01 FINDINGS

(a) See Attachment No. 1 for a general concept of the workshop and components repair area, which is adequate for the work being performed. (b) The entire main motive power (MP) workshop area is approximately 525'x 225', not including the blacksmith and foundry which is another building 75'x 525' located 50' north from the main MP workshop area. (c) As you will notice there are 3 tracks (24, 25 and 26) into the workshop that run the entire length of the shops. (d) The A.I.D. Program locomotives are dismantled on the west end of track 24 and reassembled on track 25 or 26. The major components are indeed repaired within a few hundred feet of the dismantle and assembly area. (e) All major components are removed and taken to their respective component (i.e., mechanical or electrical) areas for overhaul, by crane and/or fork lift truck. (f) After the locomotive has been dismantled the locomotive chassis is then thoroughly cleaned and inspected for any damages or cracks and repaired as necessary. (g) The components are then cleaned and inspected and tested. Those components which are within allowable tolerances and in good condition are retained, the bad ones are replaced by new components, if available (see item No. 11 of this report). (h) The locomotive is then rebuilt with all components reconditioned. (i) Stage checks are carried out during the reassembly process (see item No. 7 of this report - Quality Control). (j) There are stored inside and outside the shops over 100 traction motor stators, basically with mismatched axle bearing caps and grounded fields. An equal number of traction motor armatures are in need of rewinding. (k) There is an historical file maintained by Zambia Railways of each locomotive, from the time it is purchased to the present. Each time the locomotive goes into the shops for repairs, or a major event occurs, it is recorded and put into that locomotive's history record. This is a requirement in the U.S.A. by the Federal Railway Administration (FRA). It is a factual way of determining future programs for any locomotive fleet. Through these records, Zambia Railways determined the necessity of the present A.I.D.-financed program. Zambia Railways should keep up the good work in maintaining these most vital records of their locomotives.

2.02 RECOMMENDATIONS

A. Purchase a vacuum impregnation (VIP) tank so rewinding of stators and armatures can start immediately. The initial cost would be made up quickly by getting all these much needed motors back into service, and by doing contract work for Tazara, etc.

B. Re-bore the traction motor mismatched caps.

C. Utilize unit exchange, (possibly through G.E.) for used traction motor frames and caps.*

D. Procure Tungsten Insert Gas Welding (TIG) Machine. Offset initial cost by doing contract work for other Railways in Southern Africa.

2.03 LESSONS LEARNED

A. Not to mix traction motor bearing caps. They are matched pairs for the life of the motor.

B. Stage checks carried out during the reassembly process are very effective and adequate for the program.

C. Have not seen stage checks carried out in Tazara Railroad shops in Dar-es-Salaam or Mbeya, Tanzania, thus transfer of certain Zambia Railways technology and procedures may be beneficial to Tazara and other regional railroads.

*Note: FYI

-"Unit Exchange" - G.E. provides a rebuild component in exchange for a damaged component with a salvage credit in the billing.
-"Repair & Return" - Original builder rebuilds component and returns with billing for new parts and labor.
-"Rebuild Trade-in" - Similar to "Unit Exchange", except they are handled in truck or carload lots rather than single components.

3.00 "The availability and efficiency of appropriate machinery, benches, tooling and crane operations".

3.01 FINDINGS

(a) All necessary machinery is available, as are work benches, tooling and there are two fifty ton cranes over the locomotive work area. (See illustrative combined Locomotive and machine shop equipment listing included as Attachment No. 22). (b) There is one ten ton crane over the bogie, traction motor and electrical component sections, and one ten ton crane over the machine shop and mechanical component areas. (c) In addition to the aforementioned cranes there are at least eight jib cranes (1 to 3 ton) in various sections to facilitate component repair activities. (d) In the machine shop there are many (15-20) lathes and general purpose milling machines. (e) The fabricating shop has all the necessary shears, bending and profile cutting equipment needed for this type of operation. (f) In addition there is also a complete blacksmith and foundry capable of producing

all necessary casting required in the program. (g) There is a new hand sand blasting machine (purchased by A.I.D.) for cleaning all valves, piston rings etc. (h) There is a room with machines and tools for testing the governors, fuel pumps, injectors and all related equipment. There is another room for electrical instrumentation testing i.e., voltage regulator cards and panels, transition cards and panels, load meters, speedometers, battery ammeters, vacuum and pressure gauges, lubricating fuel oil gauges, etc. (i) There is antiquated Westinghouse Air Brake Co., (AB) air valve test rack presently being used to test only 4 of the 15 or more valves which must be tested on each annual overhaul. These are A9, SA9, N1 and HS4. The valves not tested after rework are 26C, 5A26, H5, F1, P2A, J1, 28VB, MU2B, A1, VA1B, VA1, etc. These valves are put on the locomotives and then tested when the locomotive has built up sufficient air pressure (approximately 125 psi). If any of these valves leak, the air must be cut off, and the leaking valve returned to the bench for further repair. This is an expensive and time consuming procedure. (j) Hand tools are drawn by each man from the common tool room. There are not enough tools to do an efficient job. Several instances of one man standing and waiting patiently for another man to complete his task with a 3/4" socket were observed. Therefore much time of production and money is lost in non producing situations. (k) Other specific larger hand tools, i.e., large (1" and up) open end wrenches, box wrenches and socket sets with torque handles should be specifically assigned to the A.I.D. program. (l) A few other small tools that are needed are an auxiliary generator gear gauge, an axle gear gauge, and a wheel tape gauge. All of these gauges are essential to good running and alignment of the locomotive. (m) A brush holder spring tension tester with a range of 0 to 50 pounds is needed. The present tester only has a 25 pound range. Springs with a tension (as required by the O.E.M.) beyond 25 pounds are not tested presently. (n) In the blacksmith shop is a Henry Berry Spring Testing Machine that has been out of service since 1971; consequently none of the springs for the bogies (trucks) are presently tested. According to AAR regulations and the O.E.M., these springs must be tested each time the bogies (trucks) are rebuilt. (o) When a traction motor or any motor with brushes is rebuilt and gets new brushes, the brushes must be seated, this is done to prevent a flashover of the motor. If a flashover occurs the motor has to be removed, dismantled and the commutator put in a lathe to be trued and undercut again. This is another time consuming and costly situation. None of the motors rehabilitated under the A.I.D. project have had their brushes seated due to the lack of brush seater.

3.02 RECOMMENDATIONS

A. Add a flow meter to the Air brake (AB) test rack.

B. Purchase a number of personal hand tool boxes with socket sets included. Have them checked out and returned each day to the tool room with the employee financially responsible for his tools.

C. Purchase wheel gauges and tapes.

D. Purchase 25 pound spring tester.

E. The spring testing machine to be repaired and placed in service or a new one purchased.

F. Procure an air compressor for the AB test rack.

G. We would recommend the immediate purchase of brush seaters for all motors.

Note: Some of the aforementioned small value items should be procured from the limited residual funds in the A.I.D. Project Grant

3.03 LESSONS LEARNED

A closer look must be taken to ensure that the day to day operations equipment is sufficient for a program of this magnitude.

4.00 "The set-up by labor and materials by man-hours, quantities and costs for all fixed operations".

4.01 FINDINGS

(a) For the set-up of labor by man-hours see Attachment No. 14, Utilization of Manpower, a recently instituted management control system. (b) For information on the utilization of the materials by man-hours, quantities and costs of fixed operations, see Attachments 14 (Utilization of Manpower), 16 (Projected Targets for Assemblies - Mechanical), and 17 (Projected Target Assemblies - Electrical). (c) Attachment 14 gives an overview of the utilization of manpower in a key assembly operation as follows. The fuel equipment planned for two locomotives a month requires 491 man-hours at an average of K15 per hour = K7,365.00 to produce the projected total (Attachment No. 16) of 7 governors, the 96 fuel injection pumps (F.I.P.) and the 236 injectors. (d) An

analysis of the set of facts in point (c) above indicates the use of too much overtime and its effect on overall efficiency. You will notice in column 13, they were only 82% efficient, because column 7 shows 72 hours of overtime. Without the overtime they would have been 94% efficient. (e) Note in Attachment No. 14 the column 10 "Idle Time" which is about equivalent to the overtime (column 7). The explanation of this idle time is contained in Attachment No. 15 (Analysis of Idle Time). In the opinion of this evaluator Zambia Railways is incorrect in not deducting this idle time from their total hours (column 9 of Attachment No. 14), even though it is non productive.

4.02 RECOMMENDATIONS

A. That Zambia Railways re-evaluate their manpower utilization chart to take into account idle hours that are lost. The current procedures are not adequate to compare with a budget for manpower utilization or to evaluate the efficient utilization of manpower.

4.03 LESSONS LEARNED

The recently instituted Utilization of Manpower System has assisted Zambia Railways greatly as a management tool and should be further refined as time goes on.

5.00 "The assessment of skills available for such operations".

5.01 FINDINGS

(a) There are 247 employees available to perform all the necessary work on this project. They include; managers, engineers, superintendents, quality controllers, foremen, diesel fitters (machinists, pipe fitters, air men, sheet metal men, etc.,) diesel electricians, instrument technicians, crane operators, fork truck operators, general workers (laborers), painters, clerks and typists. (b) 36 or 15% of the above people were observed doing various phases of their respective jobs. This sampling represented a thorough cross section of the total range of skills in the workshop. (c) They were found to be very competent in the performance of their duties. However, there is also room for improvement, such as additional training (see point 6). d) Presently there are 15 job vacancies in various crafts due to retirements. None of these vacancies are constraints.

5.02 RECOMMENDATIONS

Zambia Railways should continue the periodic refresher courses for their employees within their training center and reinstitute their previously successful apprenticeship program.

5.03 LESSONS LEARNED

The training under the A.I.D. project appears to have been beneficial as the individuals evaluated in the various positions appeared to be very knowledgeable in their respective fields of endeavor. Their skills are adequate to complete the AID Project.

6.00 "The background and training required and presently available for the operations".

6.01 FINDINGS

(a) The training center for Zambia Railways was set up in 1970. Theoretical and practical training in various fields of locomotive maintenance is taught. (b) A.I.D. financed outside experts have been brought in from various companies i.e., WABCO (Westinghouse Air Brake Co.,), G.E. (General Electric Co.,), Woodward Governor Co., etc., to instruct on their respective components. In addition, G.E. provides periodic shop floor assistance from a qualified equipment service engineer. (c) The workers are very knowledgeable in their respective fields, however, many of them expressed the need and desire for additional training on the latest technological advances. (d) Many of the workers have expressed the desire to attend schools put on periodically by various suppliers outside Zambia, for instance on turbochargers, governors, airbrakes etc. This may be costly, however, it could be used as an incentive for the outstanding employee(s) in their craft sent to the schools. The suppliers also pick up some of the costs. The results of this type of program would be immeasurable because the employee would work harder and better to be the chosen one to go to the school. His attitude and the quality and production of his work would improve. This type of motivation is utilized in many railroads in the U.S.A. (e) The Zambia Railways training center has set up a schedule for training in mechanical (see Attachment No. 12) and electrical (see Attachment No. 13) subjects.

6.02 RECOMMENDATIONS

Institute additional training recommended by various manufacturers, both in-country and funds permitting, abroad.

6.03 LESSONS LEARNED

Zambia Railways is indeed doing their utmost to train their mechanics, however there is always room for improvement.

7.00 "The quality control and interrelationship to operations".

7.01 FINDINGS

(a) There are 4 quality controllers equivalent to superintendents working on this project. (b) They do not report to the motive power manager but report to the technical manager of production, planning and control (see Attachment No. 5, Organization Chart). (c) The 4 quality controllers are as follows: mechanical overhaul, mechanical components, electrical overhaul and electrical components. (d) A sampling of a few quality control check lists as pertains to the interrelation of operations are attached as Nos. 6,7,8,9,10 and 11. These are only 6 of the many forms completed. (e) The men who have these quality control jobs are very knowledgeable, aggressive and conscientious. They are a credit to their craft. (f) However, there is a need to establish a quality control system with adequately trained personnel for pre-inspection of all incoming materials on arrival.

7.02 RECOMMENDATIONS

Add a quality control person to monitor and check all incoming materials.

7.03 LESSONS LEARNED

It is apparent that the present quality control team is well staffed and knowledgeable. If properly maintained, this present level of performance will pay dividends regarding the reliability of rehabilitated locomotives.

8.00 "The critique of planned operations versus actual operations and reasons why certain operations have not occurred or are delayed".

8.01 FINDINGS

(a) Planned operations are detailed in Attachment No. 23, and further outlined in Attachment No. 14, column No. 3 (Utilization of Manpower), and Attachments No. 16 and 17 (Material Component Assemblies). This schedule has been set up for 2 locomotives a month. (b) This is a very good, scheduled program Zambia Railways has planned. However, the plan has not materialized and it has been delayed. (c) Delays in the plan are not because of lack of knowledge of personnel, but due mainly to lack of materials listed in Attachment 21, and also wrongly supplied and rejected materials. (See item 12A). (d) Consequently, they are

producing only one locomotive per month. (e) Additional hand tools have been ordered and many have already arrived in the storehouse. (f) Mr. Singh advised me that complete tool boxes will be given to the employees before the end of March (or sooner if the balance of the tools arrive). (g) Some of the critical materials urgently needed are all types of gaskets, seals, O rings, special nuts and bolts, special connectors for the governor, special flexible hoses to the governor, manganese wear plates for the trucks, standard size traction motor armatures, step size traction motor bearings, suspension bearings and test cocks. (h) In addition to the above item (g), there have been other supplier problems, see Attachment No. 20 and item 12A of this report.

8.02 RECOMMENDATIONS

A. Purchase critically needed materials. (Approximately $45,000 - see Attachment 21).

B. Supply the hand tools needed.

C. Extend the Project Assistance Completion Date to December 31, 1990 to be consistent with the current schedule to complete locomotive rehabilitation.

8.03 LESSONS LEARNED

Two locomotives a month (the present program) cannot be produced as long as these critical materials and hand tools are not on the job.

9.00 "The testing and trials of locomotives at each major stage. Are there recognized trends in failures and how can these be minimized ? Are there failures due to specific lack of G.E. locomotive experience ?"

9.01 FINDINGS

(a) The Quality Control Department does the testing of the locomotive from the time it arrives in the shops to when it is released for service, including testing of all components before re-applying to the locomotive. (b) When the locomotive is released for service a Q.C. rider goes with it for its first roundtrip. (c) A stage or trial inspection report (see Attachment No. 18) is issued to the superintendent for his edification and action as may be required. (d) There have been no specific trends in failures of the 5 locomotives released to date. (e) A nut or bolt may not have been tight enough or a wire may have vibrated loose during its first round trip. (f) There have been no failures due to specific lack of G.E. locomotive experience.

9.02 RECOMMENDATIONS

Zambia Railways is very efficient in their testing of locomotives. Keep up the good work.

9.03 LESSONS LEARNED

Zambia Railways Quality Control Department has instituted procedures under the A.I.D. rehabilitation program which has resulted in a marked increased reliability of locomotives.

10.00 "The assessment of the current use of computers for inventory control, locomotive maintenance schedules, locomotive rehabilitation schedules and spare parts procurement in comparison with recommendations made by Price Waterhouse."

10.01 FINDINGS

(a) The only reference observed to a computer was a run out of material which was termed "Stores Depot Ledger 16-10-01". This run out, the storekeeper claims, is received monthly from the data processing department (DP). (b) As one can see in item No. 1 of this report, their procedures are antiquated, time consuming and many items are lost thru the shuffle of paper. (c) I concur with the recommendations of the Price Waterhouse review and evaluation of January 1988 to improve regular prompt monitoring of the status of orders, improve communications with suppliers and between various departments at Zambia Railways and strict adherence to the control system already in place. (d) No computers are being used by the mechanical or stores departments in Kabwe for inventory control, locomotive maintenance schedules or locomotive rehabilitation schedules. A system for spare parts procurement tracking exists, but has not yet been utilized effectively as a management tool.

10.02 RECOMMENDATIONS

A. The computerized procurement tracking system should be more effectively utilized. The investment of time and energy would greatly enhance the control of ordering, purchasing, delivery etc., of all parts needed.

B. Immediately establish a computer system for locomotive maintenance schedules, locomotive rehabilitation and spare parts utilization within the mechanical department.

C. Hire a consulting engineering firm to evaluate the current situation in point B and install a computerized system. The costs would be minimal and offset through a more efficient, less time consuming operation.

10.03 LESSONS LEARNED

Efficiency in control of costs could be greatly improved if there was an efficient computer system utilized within the mechanical department.

11.00 "Make an overall assessment of the locomotive rehabilitation operation and how it could be improved. Is the current rehabilitation program progressing too slow, too fast or at the right pace ?"

11.01 FINDINGS

(a) The program is progressing too slowly for the number of people working on the project and the amount of overtime expended. (b) See Attachment No. 14 (Utilization of Manpower) for hours and No. 15 for analysis of idle time. (c) Nowhere did we see an analysis of overtime performance. (d) Most of the overtime is spent on Saturdays and Sundays searching for and trying to reclaim old used parts for the program. (e) This situation again comes back to the lack of much needed critical materials, as outlined in item No. 8 of this report. Neither skills of personnel nor adequate facilities appears to be a major constraint. (f) Mr. Singh advised that as of March 1 he has had an assistant; this will give Mr. Singh more time to personally pursue this problem.

11.02 RECOMMENDATIONS

A. The program will be greatly improved when Mr. Singh organizes these every day critical materials (see Attachment 21), and gets them to the workshops.

B. These critical consumable materials must be kept flowing to the shops in order to keep up with the planned projection of two locomotives per month.

11.03 LESSONS LEARNED

Overtime is currently related more to searching for acceptable used materials in the shop than to more productive work such as actual assembly of components, etc.

12.00 "Make an overall assessment in terms of the above for normal maintenance and repair operations. Are the maintenance repair operations adequate for the rehabilitation program ? Can they be improved ? If so, how ?"

12.01 FINDINGS

(a) Systems for normal maintenance exist and are adequate in most cases. However, a shortage of spare parts has led to a deferred and inadequate routine maintenance program in the past. (b) Under the present circumstances the rehabilitation operations (components or unit exchange system) are adequate but not efficient enough to support the rehabilitation program set up for two locomotives a month. (c) They are only completely rehabilitating one locomotive a month with the same manpower projected for two locomotives a month. (d) Rehabilitation production has decreased 50% while labor has increased by as much as 22%, see Attachment No. 14 column 3 - booked hours and column 7 - overtime. (e) If this trend is allowed to continue they will over expend on budgeted labor funds long before the last locomotives are even placed in the shops for the A.I.D. rehabilitation program. (f) Another point that can be improved is the employee's "Gate Attendance Card" or time card.

12.02 RECOMMENDATIONS

A. Provisions should be made for adequate funding of spares for routine maintenance.*

B. Get the much needed critical material (as previously outlined in No.(8) and hand tools to the shops.**

C. Eliminate the necessity to work overtime on Saturdays and Sundays to reclaim usable parts.***

D. Zambia Railways should continue to keep a record of these usable (seals, bolts, nuts, gaskets, etc.) parts being applied to A.I.D. locomotives. Records of this should be kept for future reference in case of locomotive failures.**

E. A more efficient time keeping method must be set up.***

F. Do not use old reclaimed parts in component rebuilds, i.e., gaskets, seals, O rings, nuts, bolts, small fittings, etc.***

Notes:
* routine maintenance
** rehabilitation
*** both routine maintenance and rehabilitation

12.03 LESSONS LEARNED

Records of employee time charges must be improved and maintained so the true total costs of a locomotive rehabilitation can be established.

12.A "Supervise and document the results of quality control tests conducted with Zambia Railway personnel on master and articulated conn rods supplied by Arbaco Engineering Company under A.I.D. Funded Purchase Order No. ZR/UD00005/86 issued by Zambia Railways".

On Friday March 3, 1989 Mr. Jackson C. Mubuka (Foreman Components II) and the writer took a master conn rod and an articulated conn rod from the above Purchase Order of Arbaco Engineering Company.

Equipment used for testing:

We used the standard acceptable alignment checking fixture with the standard acceptable mandrels. See Attachment No. 19 (Connecting Rod Checking Fixture). Fixture has the two normal dial indicators (one positive (+) and one negative (-). Also a set of normal small feeler gauges (0.001 to 0.010)

Procedure for testing:

Lift with a 1 ton jib crane the rod (main or articulated) with its proper mandrels attached into the alignment checking fixture on the work bench. Release the crane hook once the rod is in place. Set each dial indicator (+ & -) to zero on the upper mandrel. Use the feeler gauge to be sure the mandrels are not twisted away from the alignment fixture.

If twisted, this figure must again be checked after the following 180° rotation - if not the same, the results are included in the total twist. Once this reading is taken and the dials are set at zero (0), hook up the jib crane to the rod and pull it away from the alignment fixture, turn the rod 180° and reinstall in the attachment fixture, releasing the jib crane. Now read the + and - dial indicators. The sum of these two indicators gives you the total twist of the rod plus or minus any feeler gauge deviation.

FINDINGS:

(a) Master connecting rod dial readings were 0.004 + and 0.006 - for a total of 0.010 twist. Maximum acceptable deviation, by the manufacturer, from zero (0) for this rod is 0.004. Consequently the rod is twisted by 0.006 more than the maximum allowable and is therefore tagged rejected.

(b) Articulated connecting rod dial readings were 0.0035 + and 0.0035 - for a total of 0.007 twist. Maximum acceptable deviation, by the manufacturer, from zero (0) for this rod is 0.0027, consequently this rod is twisted by 0.0043 more than the maximum allowable and is therefore tagged rejected.

(c) Other (8) master and (16) articulated rods were checked and all found twisted beyond the manufacturers allowable deviations and all are tagged rejected.

(d) In addition to (a) above, the master rods were found to have their brass pin bushing windows too narrow on the inside, causing them to bind when installed. These bushings are installed cooled - 130° F and the master rod is heated to 250° to 275° F the bushing is then installed with a bushing inserting tool. Once this bushing is installed and the rod and bushing return to room temperature it cannot be removed without cutting it out. If the windows are too small nothing can be done except replace the bushing. All the master conn rods inspected here have the windows too small and are therefore rejected. In addition, the bearing surfaces appear worn and scuffed, indicating used rods. Given that the observed test results proved that these master and articulated conn rods were found to be in excess of the deviation allowed by G.E. quality assurance limits, one has to conclude that they were originally rejected by G.E. quality control personnel and therefore not sold by G.E. as new parts. The only logical conclusion is that these parts were rejected by G.E. and resold by the vendor who originally manufactured the rods for G.E.

(e) Camshaft bearings (80) of this order were also checked and found with no matching numbers (they are assembled in 2 halves), the outside diameter is too large to fit in the engine block and the inside surface had some previous holes welded and ground down. They are all tagged rejected.

RECOMMENDATIONS

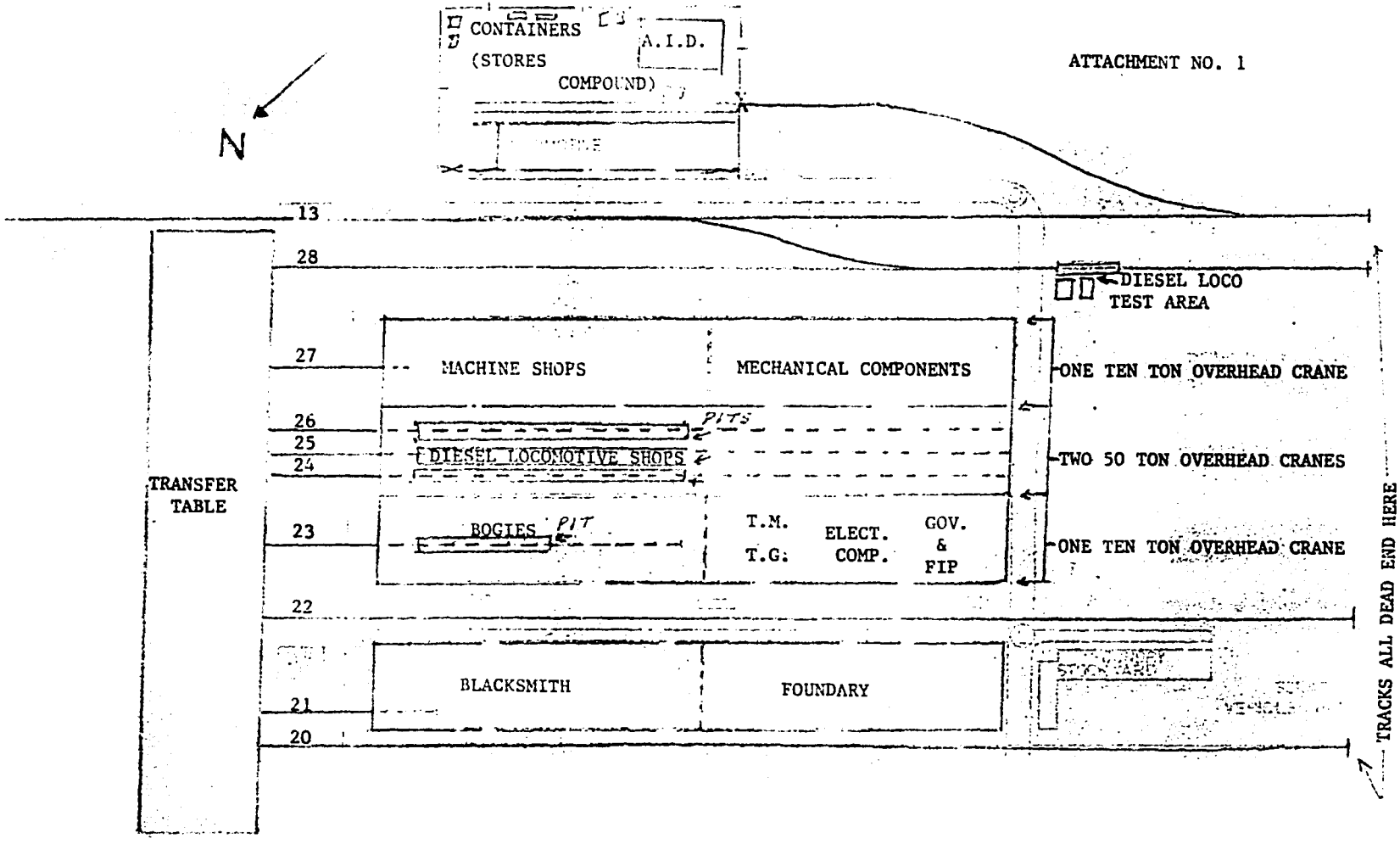
This is a serious situation. Zambia Railways has spent a considerable amount of time and money just checking this order. A reputable firm would have replaced the entire order upon notification by the railroad, let alone an official U.S. Mission cable. Replace the entire order. Production has been severely delayed.

LESSONS LEARNED

In this developing country it may be prudent to stay with the original equipment manufacturers (OEM) to the greatest extent practicable, without sacrificing the ability to negotiate fair prices. The rationale is mainly because of warranty,

quality assurances and expediency of replacement parts. This is particularly true on major rehabilitation exercises where thousands of line items are procured in one exercise because the logistics related to procuring from multiple suppliers can be an unreasonable management burden.

ATTACHMENT NO. 1



ZAMBIA RAILWAYS
MATERIAL REQUISITION

FORM No. 83-29-5241-2

TO THE STORES DEPOT AT ..... WARD No. .....

PLEASE SUPPLY THE FOLLOWING MATERIALS TO: .....

REQUISITION No.	REQUISITION DATE	ALLOCATION TO BE CHARGED

II ONLY ONE ITEM SHOULD BE ENTERED ON EACH LINE

SR. No.	NOMENCLATURE	CATALOGUE	UNIT	QUANTITY REQUIRED

III PURPOSE FOR WHICH REQUIRED

.....

DESPATCH INSTRUCTIONS

.....

DATE BY WHICH REQUIRED	FOR FURTHER INFORMATION
	PLEASE CONTACT TEL: No. .....
DATE STAMP	DATE STAMP
REQUISITIONED BY:	APPROVED BY: .....

DISTRIBUTION:
Pink — Supplies ACCEPTANCE (Bill Payable)
Blue — Stores after acknowledgement
Green — Indentor/Supplier
Yellow — Stores
White — Stock Control
White — Buyer Indentor

MATKA PRINTERS - NDOLA

ATTACHMENT NO. 2

24

ATTACHMENT NO. 3

ZAMBIA RAILWAYS LIMITED
W O R K S H O P S
PLANNING AND MATERIALS ACQUISITION MECHANICAL

MATERIAL REQUEST FORM

ITEM DESCRIPTION OR NOMENCLATURE	ITEM CODE NO. OR PART NO/SPECIFICATION NUMBER	QUANTITY REQUIRED	QUANTITY NEEDED PER LOCO, COACH WAGON, OTHER EQUIP.	WHERE ELSE IS THE SAME ITEM/S USED	APPROX AVERAGE YEARLY USAGE	STOCK ON HAND

REQUESTED BY: _____

DATE REQUESTED: _____

APPROVED BY: _____

DATE: _____

SHOP NO. OR SECTION: _____

FOR MANAGER (PMA) USE ONLY

REQUEST APPROVED: _____

DATE: _____

ACTION TAKEN: _____

_____

ATTACHMENT NO. 4

PLANNING AND MATERIAL ACQUISITION MECHANICAL
MATERIAL DRAW CARD FORM (PETTY STORE)

DEPOT..... DATE:.....

DRAWER'S FULL NAME.....

SIGNATURE.....

ITEM	MATERIAL DESCRIPTION	CODE NO.	QUANTITY REQUIRED	REQUISITION NUMBER(S)	QUANTITY ISSUED	END USE

WITHDRAW APPROVED BY:-
(FOREMAN'S FULL NAME).....

SIGNATURE.....

DATE.....

MATERIAL COLLECTED BY:-
FULL NAME.....

SIGNATURE.....

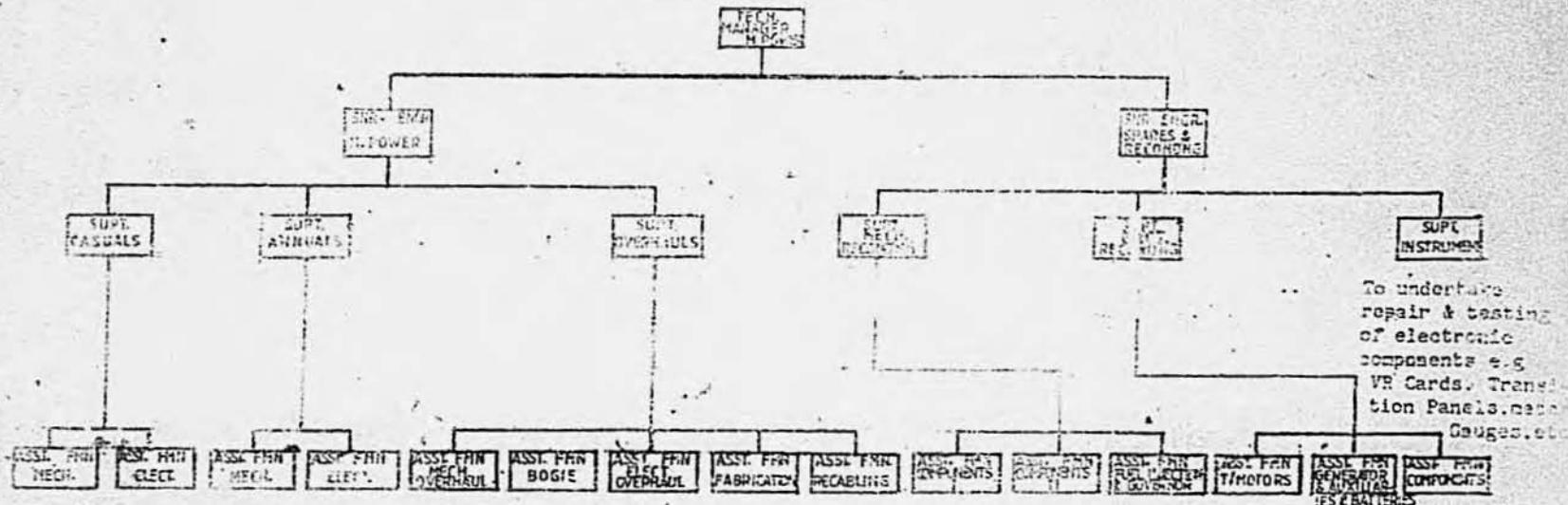
DATE.....

MATERIAL ISSUED BY:..... SIGNATURE..... DATE.....
(FULL NAME)

ATTACHMENT NO. 5

ORGANISATION CHART

MOTIVE POWER SHOP



ZAMBIA RAILWAYS LIMITED

TECHNICAL SERVICES DEPARTMENT
WORK SHOPS

PRE-ARRIVAL TEST
QUALITY CONTROL

LOCOMOTIVE NUMBER:- _____ DATE:- _____
TYPE OF INSPECTION:- _____

1. Check and record for leaks in the

		LOCATION
(i)	Fuel oil system	
(ii)	Cooling system	
(iii)	Engine Air System	
(iv)	Lubricating oil system	
(v)	Brake system	

2. Listen to any abnormal noise for the following and record.

(i)	Engine	
(ii)	Compressor Exhauster	
(iii)	Fan clutch unit	
(iv)	Traction motor Blower	
(v)	Any other Location	

3. (i) Check and record the deficiencies and breakages observed visually
   (ii) Inspect the super structure and record for repairs

4. Check operation of the following and record obervations:-

(i)	Vigilance
(ii)	Sanding system
(iii)	Brake system

5. Check compressor-exhauster oil and crankcase vacuum

Oil pressure _____ P.S.I. AT IDLE

Crankcase vacuum _____ Inches

6. Check repair book or contact running shed and record nature of repairs booked repeatedly

Name & Signature of Quality Controller:- _____

ATTACHMENT NO. 6

ZAMBIA RAILWAYS LIMITED

NEW WORKSHOPS

QUALITY CONTROLLER DEFECT LIST

TO: _____ LOCO NUMBER: _____

DATE: _____

REPORTED REPAIRS: _____

_____

DEFECTS FOUND:- _____

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QUALITY CONTROLLER (MP) _____

cc: Technical Manager (MP)
cc: Senior Engineer (PP & C)
cc: Senior Engineer (MP)
/bc

ATTACHMENT NO. 7

89

ITEM	ACTIVITIES AND QUALITY STANDARDS

ON THE DAY OF ARRIVAL

1. Quality controller to inspect the locomotive

(a) Check the deficiencies of locomotive.

(b) Basic Setting Checks:-

(i)	Engine speed	Idle - 8th notch	) Refer
(ii)	Aux. generator voltage	Idle - 8th notch	) Standards
(iii)	No load voltage	1st - 8th notch	) Electrical
(iv)	1st notch current		) Values

- Record the reading of load ammeters.
- Record the difference of reading in both load ammeters.

(v) Take first notch current position and check millivolt drop across WSR1, 2,3 operating coils.
- Refer standard Electrical values.

(vi) Manual operation of Ground Relay:
- Raise engine speed with reverser handle in neutral position and then operate ground relay manually (i.e., operate armature by hand)
  (a) Engine speed comes to idle.
  (b) Ground Relay indication light glows "bright".
  (c) Buzzer sounds.
- Take first notch current and operate ground relay manually.
  - The reading in both load ammeters drops in addition to : ground relay indication light glows "BRIGHT" and Buzzer sounds.

CAUTION: Loco Air brake must be in application condition.

(vii) Manual operation of Wheel Slip Relays:

Take first notch current and operate WSR manually (i.e., operate armature manually).

(a) The reading in load ammeter drops.
(b) Wheel Slip indication light glows "Bright."
(c) Alarm bell sounds.

CAUTION: Loco Air Brake must be in application condition.

ATTACHMENT NO. 9

TURBO CHARGER (ELLIOTT MODELS).

CHECK SHEET.

SERIAL NO. _____ FITTED ON LOCO _____

REMOVED FROM LOCO _____ DATE OF INSPECTION. _____

DATE REMOVED. _____ INSPECTED BY. _____

TYPE OF INSPECTION _____

NO.	ITEM DESCRIPTION	SPECIFICATIONS	READING TAKEN	ASST. FMN INSPECTION
1.	INSIDE DIAMETER BOTH BEARINGS	1.8740-1.8755"		
2.	SHAFT O.D. BOTH BEARINGS SURFACES	1.8695-1.8700"		
3.	TURBINE SEAL-INSIDE DIAMETER	2.694 -2.697"		
4.	BLOWER SEAL- INSIDE DIAMETER	2.694 -2.697"		
5.	ROTOR ASSEMBLY-END PLAY	0.007-0.020"		
6.	DIAMETER CLEARANCE (RADIAL)	0.007-0.012"		
7.	MATCHING THRUST COLLAR O.D	2.686-2.687"		
8.	MATCHING SHAFT OUTSIDE DIAMETER	2.686-2.687"		
9.	IMPELLER - BODY OUTER FACE TO INTERMEDIATE CASING AXIAL DIMENSION	0.009-0.027"		
10.	RADIAL CLEARANCE-INDUCER BLADES, INLET SIDE TO BLOWER CASING	0.045-0.050"		
11.	TURBINE DISK BLADES TO TURBINE INLET CASING RADIAL CLEARANCE WITH MAGNETIC MATERIAL SHROUD WITH NON MAGNETIC	0.020-0.040"		
12.	NOZZLE RING BLADES TO TURBINE INLET CASING RADIAL CLEARANCE	0.000-0.035"		

1. NAME THE COMPONENTS REPLACED WITH BRIEF REASONS: _____

2. BALANCING OF ROTOR ASSEMBLY: BALANCED/NOT BALANCED

3. REMARKS: _____

NAME AND SIGNATURE OF ASSISTANT FOREMAN: _____

SIGNATURE AND NAME OF SUPERINTENDENT: _____

SIGNATURE AND NAME OF QUALITY CONTROLLER: _____

ATTACHMENT NO. 8

ZAMBIA RAILWAYS WORKSHOPS

QUALITY CONTROL REPORT

COMPONENT REJECTION CERTIFICATE

(ELECTRICAL)

COMPONENT _____

SERIAL NO. _____

REPAIRS UNDERTAKEN _____

DATE INSPECTED _____

REASONS FOR REJECTION _____

RECOMMENDATION: _____

QUALITY CONTROLLER'S NAME _____

SIGNATURE _____

SENIOR ENGINEER (S&R) _____

cc SENIOR ENGINEER (PP&C)
cc FILE

/en.

ATTACHMENT NO. 10

ZAMBIA RAILWAYS LIMITED

NEW WORKSHOPS

KABWE

QUALITY CONTROLL REPORT

QUALITY ASSURANCE CERTIFICATE

(ELECTRICAL)

COMPONENT _____

SERIAL NO. _____ FITTED ON LOCO NO. _____

DATE INSPECTED _____

REPAIRS UNDERTAKEN _____

CHECKS CARRIED OUT BY QUALITY CONTROLLER AND THE RESULTS

_____

_____

_____

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_____

QUALITY CONTROLLER'S NAME _____

SIGNATURE _____

SENIOR ENGINEER (E&R) _____

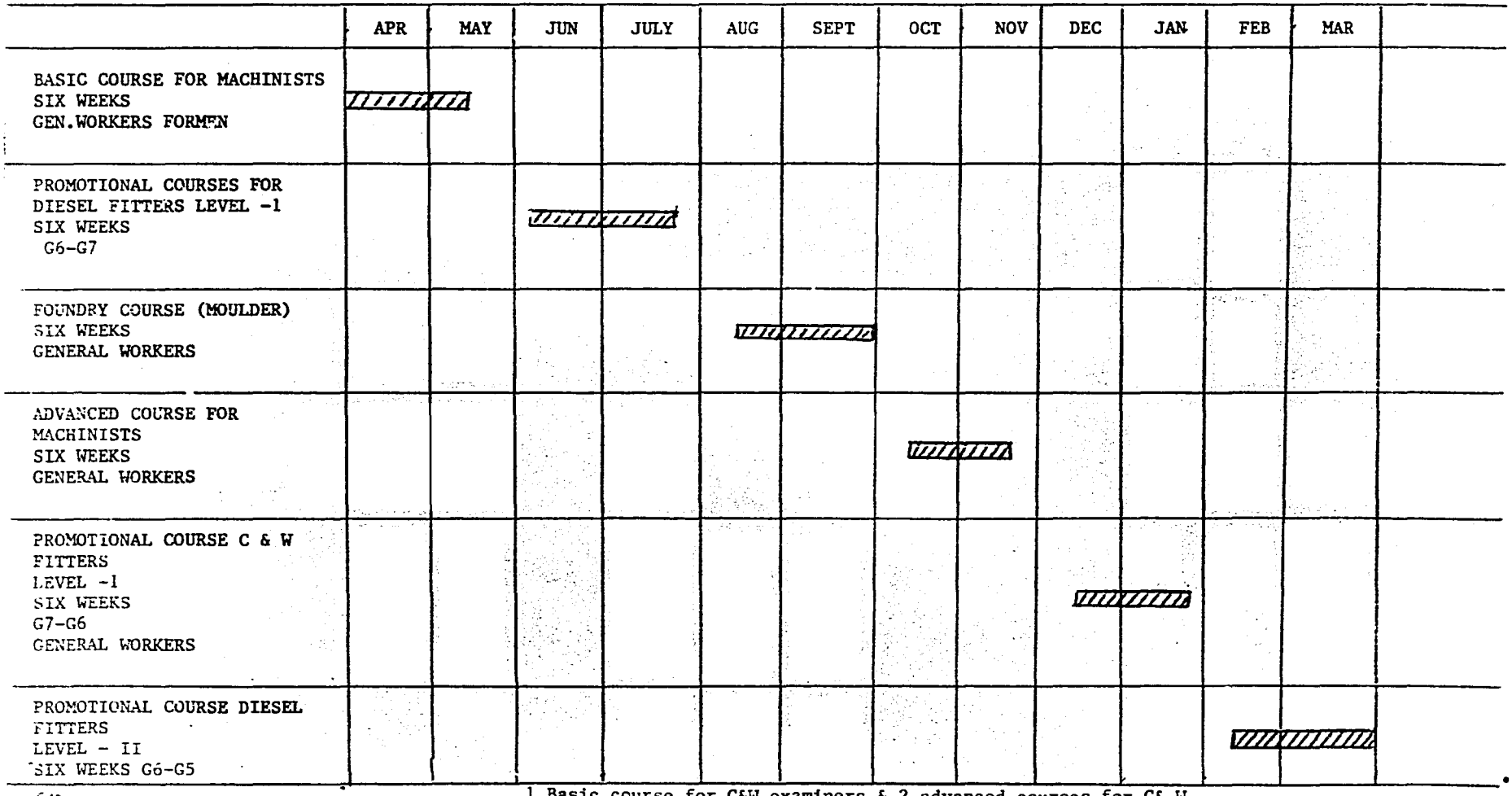
cc SENIOR ENGINEER (PP&C)
cc FILE

/en.

ATTACHMENT NO

ATTACHMENT NO. 12

SUBJECT TO AVAILABILITY OF LECTURERS
TRAINING PROGRAM FOR 1989-1990
TECHNICAL



1 Basic course for C&W examiners & 2 advanced courses for C& W examiners not included

ATTACHMENT NO. 13

TRAINING PROGRAM FOR ELECTRICAL COURSE FOR 1989-1990

DESCRIPTION AND DURATION OF COURSE	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR
1. PROMOTIONAL COURSE FOR D.T.E.S. (SIX WEEKS) G6-G5												
2. COACH ELECTRICAL SYSTEMS (ELECTRICIANS) TWO WEEKS												
3. COACH ELECTRICAL SYSTEMS (SUPERVISORS) ONE WEEK												
4. WOODWARD GOVERNOR COURSE (REFRESHER) ONE WEEK												
5. PROMOTIONAL COURSE FOR ELECTRICIANS ASSISTANTS (GENERAL) SIX WEEKS												
6. PROMOTIONAL COURSE FOR D.T.E.S. G5-G4												
7. TRACTION MOTOR SEMINAR												

UTILISATION OF MAN POWER MONTH DECEMBER 1988

22 WORK DAYS

ATTACHMENT NO. 14

S/NO	SHOP AND SECTION PROJECTED TARGET ITEMS	BOOKED HOURS (2 LOCOS. PER. MO. PLANNED)	HOURS CLOCKED						IDLE TIME		OUTPUT IN STANDARD HOURS (FOR PROJECTED TARGETS)	EFFICIENCY OF UTILISATION OF MAN POWER (%) COL 12 x 100 / COL 9
			SICK LEAVE ABSENT		NORMAL HOURS COL3-COL4	OVERTIME		TOTAL	HRS	%AGE		
			HRS	%AGE		HRS	%AGE					
1	2	3	4	5	6	7	8	9	10	11	12	13
1	MOTIVE POWER (MECHANICAL)											
(a)	Fuel Equipment *	491	NIL	-	491	72	15	563	75	13	460	82
(b)	Components I *	1474	108	7	1366	224	16	1590	265	17	1288	81
(c)	Components II *	1638	16	1	1622	398	25	2020	271	13	1436	71
(d)	Annual	819	131	16	688	105	15	793	137	17	306	39
(e)	Rebuild (PROJ. O/HAUL)	1147	56	5	1091	688	63	1779	188	11	1184	67
(f)	Casual	1966	104	5	1862	480	26	2342	290	12	1931	82
(g)	Bogie *	2457	168	7	2289	488	21	2777	356	13	2095	75
(h)	Air brake *	655	128	20	527	89	17	616	116	19	338	55
(i)	Fabrication	1966	136	7	1830	536	29	2366	522	22	1686	71
2	MOTIVE POWER (ELECTRICAL)											
(a)	Generator *	819	56	7	723	112	15	875	120	14	596	71
(b)	Traction Motor*	2293	96	4	2197	480	22	2677	605	23	1722	64
(c)	Components *	819	168	21	651	32	5	683	153	22	502	73
(d)	Annual	655	40	6	615	32	5	647	96	15	236	36
(e)	Rebuild (PROJ. O/HAUL)	1147	16	1	1131	264	23	1395	313	22	963	69
(f)	Casual	983	80	8	903	272	30	1175	144	12	977	83
(g)	Instrumentation *	491	56	11	435	NIL	-	435	71	16	323	74
	Total for M/P Shop	19820	1354	7	18417	4272	23	22693	3722	16	16043	71

ANALYSIS OF IDLE TIME MONTH DECEMBER 1988

ATTACHMENT NO. 15

SNO	SHOP/SECTION	TOTAL HOURS	CAUSE WISE ANALYSIS OF IDLE TIME BOOKING															
			MACHINE BREAK DOWN		AWAITING CRANE		PERMISSION		FUNERALS		MEETINGS		PAY DAY		NO GAS MATERIAL POWER		OTHER		TOTAL	
			HRS	%AGE	HRS	%AGE	HRS	%AGE	HRS	%AGE	HRS	%AGE	HRS	%AGE	HRS	%AGE	HRS	%AGE	HRS	%AGE
1.	MOTIVE POWER (MECHANICAL)																			
(a)	Fuel Room	563	NIL	-	NIL	-	NIL	-	6	1	33	6	36	6	NIL	-	NIL	-	75	13
b)	Component I	1590	NIL	-	NIL	-	4	0.3	33	2	120	8	108	7	NIL	-	NIL	-	265	17
c)	Component II	2020	NIL	-	NIL	-	6	0.3	43	2	104	5	108	5	10	0.5	NIL	-	271	13
d)	Air Brake	616	NIL	-	NIL	-	16	3	NIL	-	52	8	48	8	NIL	-	NIL	-	116	19
e)	Annual	793	NIL	-	2	0.3	NIL	-	NIL	-	87	11	48	6	NIL	-	NIL	-	137	17
f)	Rebuild	1779	NIL	-	4	0.2	2	0.1	17	1	93	5	72	4	NIL	-	NIL	-	188	11
g)	Casual	2342	NIL	-	12	1	NIL	-	4	0.2	132	6	138	6	4	0.2	NIL	-	290	12
h)	Bogie	2777	NIL	-	NIL	-	NIL	-	24	1	164	6	168	6	NIL	-	NIL	-	356	13
i)	Fabrication	2366	NIL	-	NIL	-	6	0.3	40	2	332	14	144	6	NIL	-	NIL	-	522	22
	ELECTRICAL																			
a)	Generator	835	NIL	-	NIL	-	13	2	4	0.5	49	6	54	6	NIL	-	NIL	-	120	14
B)	Traction Motor	2677	NIL	-	NIL	-	61	2	27	1	349	13	168	6	NIL	-	NIL	-	605	23
c)	Components	683	NIL	-	NIL	-	18	3	6	1	87	13	42	6	NIL	-	NIL	-	153	22
d)	Annual	647	NIL	-	NIL	-	NIL	-	4	1	44	7	48	7	NIL	-	NIL	-	96	15
e)	Rebuild	1395	NIL	-	NIL	-	36	3	4	0.3	189	14	84	6	NIL	-	NIL	-	313	22
f)	Casual	1175	NIL	-	13	1	NIL	-	NIL	-	60	5	66	6	5	0.4	NIL	-	144	12
g)	Instrumentation	435	NIL	-	NIL	-	NIL	-	NIL	-	33	8	28	6	10	2	NIL	-	71	16
	TOTAL	22693	NIL	-	31	0.1	162	1	212	1	1928	8	1360	6	29	0.1	NIL	-	3722	16

PROJECTED TARGETS FOR ASSEMBLIES (MECHANICAL)			2LOCOS/MO	3LOCOS/MO		
			POH AID PROJECT	AOH	CASUALITY SHED	TOTAL
1.	CYLINDERS	COMPT.II (c)	24	6	35	65
2.	CONRODS/PISTONS		24	4	2	30
3.	WATER PUMP		2	3	3	8
4.	LUBE OIL PUMP		2	1	1	4
5.	INTERCOOLERS		4	6	2	12
6.	GOVERNORS	(a) FUEL EQUIP.	2	3	2	7
7.	FUEL INJECTION PUMP (FIP)		24	36	36	96
8.	INJECTORS		24	36	176	236
9.	OVERSPEED GOVERNOR		2	3	4	9
10.	COMPRESSOR		2	3	3	8
11.	TURBO CHARGER	(b) COMPT.I	2	3	9	14
12.	TRACTION MOTOR BLOWER		2	3	4	9
13.	RADIATOR FAN		2	3	2	7
14.	RADIATOR	(c) COMPT.II	2	3	7	12
15.	LUBE OIL COOLER		2	3	4	9
16.	DRIVE SHAFT		2	3	4	9
17.	BRAKE VALVES & HORNS	AIR BRAKE (h)	2 SETS	3 SETS	5 SETS	10 SETS
18.	SANDER		2 SETS	3 SETS	3 SETS	8 SETS
19.	WIPERS		2 SETS	3 SETS	3 SETS	8 SETS
20.	VIGILANCE		2 SETS	3 SETS	-	5 SETS
	BOGIE ITEMS (g)					
1.	WHEEL SETS (WITH EQUALIZER)		12	16	15	45
2.	BOGIE FRAMES W/HANGERS ETC.		4	6	2	12
3.	GEAR CASES		12	18	30	60
4.	BRAKE CYLINDERS		16	-	4	20
5.	SNUBBERS		20	30	30	80
6.	BRAKE SHOES		24	36	30	90
7.	AXLE BOXES		24	36	60	120

ATTACHMENT NO. 16

	PROJECTED TARGETS FOR ASSEMBLIES (ELECTRICAL)	2 LOCOS/MO	3 LOCOS/MO		
		POH (AID PROJECT)	AOH	CASUALITY SHED	TOTAL
1.	TRACTION MOTORS (b)	12 RECOND.)	18 (O/H)	20 (SERV)	50
2.	MAIN GEN.	2	-	2	4
3.	EXCITER — GEN. (a)	2	-	1	3
4.	AUX.GEN.	2	-	1	3
5.	EDDY CURRENT CLUTCH	2	-	1	3
6.	FUEL PUMP W/MOTOR	2	3	4	9
7.	AXLE ALTERNATOR	2	3	4	9
8.	MASTER CONTROLLERS	2	-	-	ONE SPARE ALWAYS AVAILABLE
9.	REVERSER	2	-	2	4
10.	ELECTRO.PNEUM.CONTACT.	15	2	-	17
11.	FIELD SHUNT CONTACTOR	28	10	-	38
12.	GEN. FIELD CONTACTOR — ELECT COMPT	2	1	3	6
13.	CRANKING CONTACTOR (2) (c)	4	1	-	5
14.	RADIATOR FAN CONTACTOR	4	1	-	5
15.	GROUND RELAY	2	1	-	3
16.	WHEEL SLIP RELAY (1,2,3)	6	2	-	8
17.	WHEEL SLIP RELAY (4,5)	4	-	-	4
18.	GENERAL PURPOSE RELAY (10)	20	6	-	26
19.	SIGNAL RELAY	2	1	-	3
20.	TRANSITION PANEL W/CARDS (SETS)	3	3	7	12
21.	VOLTAGE REGULATOR & CARDS (SETS)	2	3	16	21
22.	AIR BRAKE GAUGES (g) INST	2 SETS	-	-	2 SETS
23.	SPEEDOMETER	4	6	-	10
24.	LOAD AMMETERS	4	6	-	10
25.	CRANKCASE OVER PRESSURE SWITCH (c)	2	3	1	6

ATTACHMENT NO. 17

ZAMBIA RAILWAYS LIMITED

DATE _____

TO SUPERINTENDENT

_____ SHOP

RE: STAGE INSPECTION REPORT

A Report on the Stage Inspection carried out by the undersigned is given below. You are requested to take a note of the observations and recommendations for necessary action.

1. LOCO NO./COACH NO./WAGON NO./COMPONENT DESCRIPTION AND S.NO.

_____

2. TYPE OF REPAIRS BEING EXECUTED _____

3. DATE INSPECTED _____

4. NATURE OF CHECKS CARRIED OUT, OBSERVATIONS AND RECOMMENDATIONS

_____

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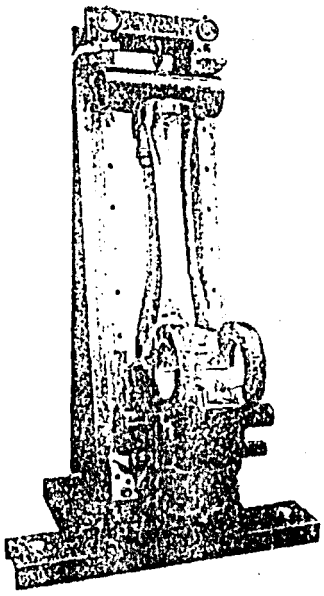
QUALITY CONTROLLER ( )

CC: SEs (_____, _____), EM ( ), _____.

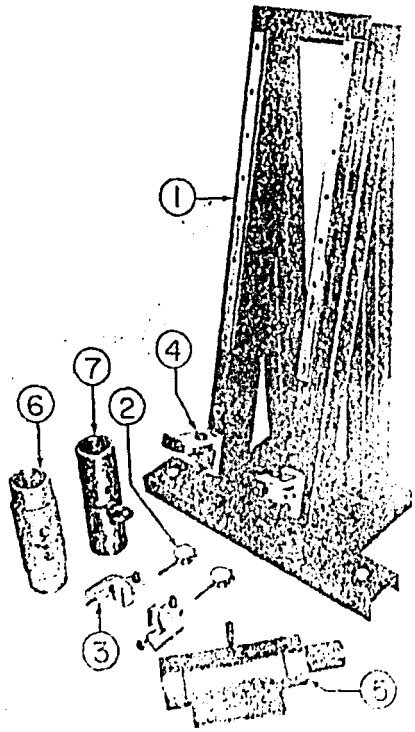
ATTACHMENT NO 18

CONNECTING ROD



ROD CHECKING FIXTURE

This rod checking fixture is designed to check connecting rods for sidewise bending, twist and bore parallelism. An expandable crank mandrel is furnished to fit in the master connecting rod bearing bore after the cap has been torqued. A piston pin and an articulated pin mandrel are also supplied to complete the set. Two dial indicators and brackets mount at the top of the fixture to give an easy and precise reading.



All mandrels except the expanding mandrel must be torqued to the rods so no erroneous readings are obtained when checking the connecting rods. Also the rod checking fixture should be mounted in a relatively clean area to avoid getting dirt between the mandrel and rod.

NOTE: Ensure the fixture is mounted securely so it will not give false readings. Refer to instructions furnished with the fixture.

All connecting rods should be checked on this precision fixture during overhaul to ensure long engine life.

Ref. No.	GE Part No.	Tool	Application
	147X2229	Rod Checking Kit (includes Items 1 thru 8)	8, 12 & 16 Cylinder 7FDL Engines
1	147X1502	Fixture, Rod Checking	
2	147X1503	Dial Indicator (2 req'd.)	
3	147X1504	Bracket, Dial Indicator (2 req'd.)	
4	147X1913	Feet, Button (4 req'd.)	
5	147X1506	Mandrel Expanding Crank	
6	147X1507	Mandrel Articulated Pin 3-1/2 in. O.D.	
7	147X1508	Mandrel Piston Pin 3-1/8 in. O.D.	
8	147X1509	Eyebolt	

SUPPLIER PROBLEMS (REJECTED MATERIALS)

DESCRIPTION	PART NO.	QTY. ORD.	QTY. REJ.	SUPPLIER	REASON REJECTED
CIRCUIT BREAKER 25AMP.	994864G2	21	21	KESSLER	SUPPLIED 50 AMPERE
CRANKSHAFT	556608	24	06	WABCO	RUSTED - PACKING NOT
CYLINDER LINERS	553399	30	03	"	SEAWORTHY
CAMSHAFT BEARINGS	116X1070-1	80	80	ARBACO	OD TOO LARGE & NO MATCHING NOS. ALSO, WELDED INSIDE.
MASTER CONNECTING RODS	117X1060	65	65	"	TWISTED FROM 0.005 TO 0.010+ OUT OF LINE & BUSHING WINDOWS TOO SMALL CAUSING BINDING.
ARTICULATED CONN.RODS (SEE ALSO ITEM 12 OF THIS REPORT MORE INFO)	117X1012	78	16	"	TWISTED OUT OF ALLOWABLE TOLERANCE (0.0027) TO 0.007+
ROTOR W/COL. RING	8855769G2	09	09	MYRON SNYDER	SUPPLIED WRONG MODEL
RING AND LINER	493A772P3	04	04	"	SUPPLIED WRONG MODEL
BOLT GEAR CASE HALVES	6704771P1	96	96	"	SUPPLIED WRONG MODEL
BOLTS COMMUTATING POLE	41A238308P1	23	23	"	SUPPLIED WRONG MODEL
ARTICULATED CONN.RODS	117X1012	66	31	"	TWISTED OUT OF LINE - 0.005 to 0.018 (MAX. DEVIATION 0.004)

ATTACHMENT NO. 2

LISTING OF EMERGENCY SPARE REQUIREMENTS

ITEM 9776026 89/03/02 13:36
FROM: B59DV
TO: 96581230
CC: 96545050
B59DV

ATTN PURCHASING STORES MGR, ZAMBIA RWYS, KABWE ZAMBIA
WIRE COPY D BARKER, IND SPEC SUPPLY, LUSAKA ZAMBIA

3/2/89

RUSH

REF OUR 247-FJK60145 YOUR ZR/02798/88-ZR/02838/88
CONFIRM ITEM 6 TO READ (10) PCS

FOLLOWING PRICES APPLY ITEMS 42 THRU 46

IT	QTY	PART NBR	DESCRIPTION	UNIT PRICE	EXTD PRICE
42	15	41A203032P2	BREAKER	532.14	7982.10
43	45	41B544907P2	BREAKER	64.40	2898.00
44	20	41B544907P4	BREAKER	64.38	1287.60
45	15	41B544907P1	BREAKER	64.38	965.70
46	200	497A911P1	SWITCH	7.74	1548.00

TOTAL FOB VALUE 27123.20
ESTD GR WT - 625 POUNDS
ESTD CIF (2) SHIPMENTS VIA AIR NEW YORK TO LUSAKA 2455.00 LOT

REGARDS

F KALETA, GENERAL ELECTRIC CO ERIE PA. USA TLX 703531
-END-

IN ADDITION TO THE ABOVE 5 ITEMS (42 THRU 46) A QUOTATION FOR 41 OTHER CRITICAL ITEMS (1 THRU 41) HAS PREVIOUSLY BEEN RECEIVED FROM GENERAL ELECTRIC COMPANY IN THE AMOUNT OF $12,442. PLUS $2,500. THIS TOTAL IS $14,942.

THE BOTTOM LINE FIGURE FOR THE ENTIRE ORDER WILL BE APPROXIMATELY $45.000.

ATTACHMENT NO. 21

LISTING OF LOCOMOTIVE (LO)

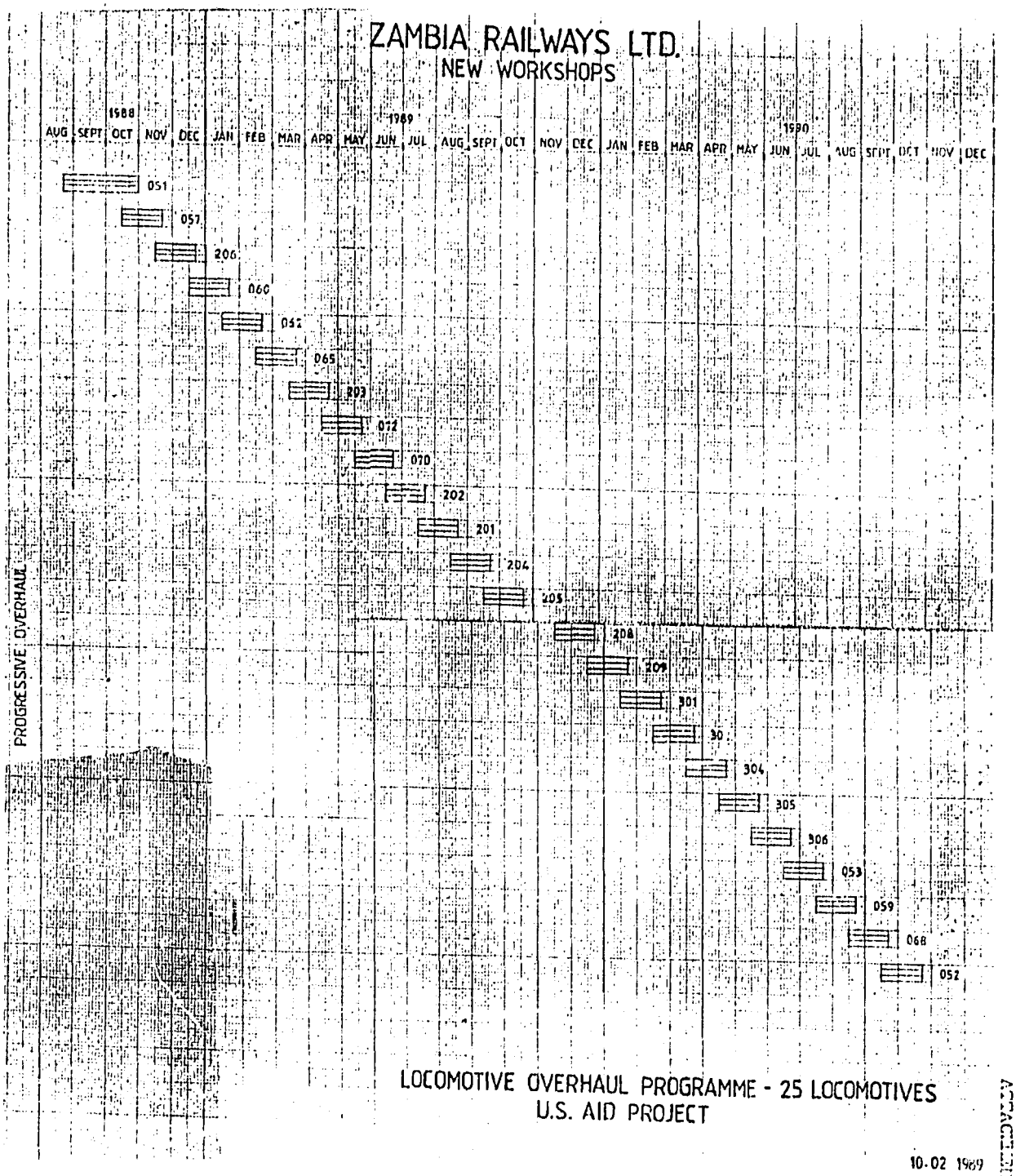
AND

MACHINE SHOP MACHINERY (MS)

VERT. BORING MACHINE	LO 1
TYRE TURNING LATHE	LO 2
84" D.E. FLOOR GRINDER	LO 3
200T WHEEL PRESS	LO 4
TYRE LIP ROLLING MACH.	LO 5
ELECTRIC TYRE HEATER	LO 6
18" D.E. FLOOR GRINDER	LO 7
BALANCING MACHINE	LO 8
VALVE GRINDER	LO 9
VERTICAL BORING MILL	LO 10
DSE CENTRE LATHE	LO 11
OVEN	LO 12
GOVERNOR TEST STAND	LO 13
BRAZING MACHINE	LO 14
COIL WINDING MACHINE	LO 15
KASENT OVEN	LO 16
AIR BRAKE TESTING EQUIP.	LO 17
"GRACO" WASHING MACHINE	LO 18
WELDING RECTIFIER	LO 19
WELDING RECTIFIER	LO 19A
WELDING RECTIFIER	LO 19B
WELDING RECTIFIER	LO 19C
WELDING RECTIFIER	LO 19D
WELDING RECTIFIER	LO 19E
MAGNA FLUX EQUIPMENT	LO 20
NOZZLE TESTING MACHINE	LO 21
NOZZLE TESTING MACHINE	LO 21A
NOZZLE TESTING MACHINE	LO 21B
NOZZLE LAPPING MACHINE	LO 22
NOZZLE LAPPING MACHINE	LO 22A
10 TON OVERHEAD CRANE	LO 23
50 TON OVERHEAD CRANE	LO 24
50 TON OVERHEAD CRANE	LO 25
10 TON OVERHEAD CRANE	LO 26
INJ.PUMP CALIBRATOR	LO 27
LOADING RESISTOR	LO 28
TURNTABLES	LO 29
AIR HOIST	LO 30
10" BENCH GRINDER	LO 31
PILLAR JIB CRANE	LO 32
CRACK DETECTOR	LO 33
DYNAMIC BALANCING MACH.	LO 34
ARMARTURE U/CUTTING MACH.	LO 35
PORTABLE VAC. DUST COLLECTOR	LO 36
HIGH FREQ. SURGE TESTER	LO 37
PORTABLE BRAZER	LO 38
LOW RESISTANCE OHMMETER	LO 39
BAYCO CURING OVEN	LO 40
ULTRASONIC CLEANING EQUIP.	LO 41
KASENIT OVEN	LO 42
1000 KG COLUMN JIB CRANE	LO 43
500 KG COLUMN JIB CRANE	LO 44
3000 KG COLUMN JIB CRANE	LO 45
500 KG PILLAR JIB CRANE	LO 46
3000 KG PILLAR JIB CRANE	LO 47
KG PILLAR JIB CRANE	LO 48
3000 KG PILLAR JIB CRANE	LO 49
1000 KG PILLAR JIB CRANE	LO 50
INJECTOR PUMP TESTER	LO 51
NOZZLE RECONDITIONER	LO 52
WICK WASHING MACHINE	LO 53
SAND BLASTING MACHINE	LO 54

UNIVERSAL TOOL/CUTTER GRINDER	MS 1
8"WET & DRY TOOL GRINDER	MS 2
TWIST DRILL GRINDER	MS 3
DO-ALL-BAND SAW	MS 4
5"X20" CHIP MASTER LATHE	MS 5
10" MAJAR SHAPER	MS 6
30" UNIVERSAL MILLING MACH.	MS 7
30" UNIVERSAL MILLING MACH.	MS 8
3/4"SENSITIVE PEDESTAL DRILL	MS 9
2"-4" SCREWING MACHINE	MS 10
3" PIN GRINDING MACHINE	MS 11
36"SINGLE COL.VERT.BORING	MS 12
HEAVY DUTY MILLING MACHINE	MS 13
30"UNIVERSAL MILLING MACHINE	MS 14
10,1/2" CAP BED LATHE	MS 15
ARBOR PRESS	MS 16
19,1/2 SWING COMD.TURRET LATHE	MS 17
16" SWING COMB.TURRET LATHE	MS 18
16" SWING COMB.TURRET LATHE	MS 19
16,1/4"CAPSTAN LATHE	MS 20
POLISHING MACH/DUST CONTROL	MS 21
100T VERT.BUSHING PRESS	MS 22
SALT BATH FURNACE	MS 23
1,1/2" PILLAR DRILL	MS 24
3/4"SENSITIVE PEDESTAL DRILL	MS 25
18" D.E. FLOOR GRINDER	MS 26
10" POWER SAW	MS 27
1,1/4"DRILLING MACHINE	MS 28
8"X3"X2" PLANER	MS 29
HAND PRESS	MS 30
20" CAP BED LATHE	MS 31
15" CAP BED LATHE	MS 32
12,1/2" CAP BED LATHE	MS 33
30" SWING SURF.BORING LATHE	MS 34
30" SHAPER	MS 35
48" RADIAL DRILL	MS 36
18" SHAPE	MS 37
10,1/2" CAP BED LATH	MS 38
COLCHESTER MASCOT C.LATHE	MS 39
COLCHESTER MASCOT C.LATHE	MS 40
8,1/2 SLOTTER	MS 41
COLCHESTER MASCOT 1800 C.LATHE	MS 42
8" WET AND DRY TOOL GRINDER	MS 43
8" BRASS FINISHER LATHE	MS 44
1" PILLAR DRILL	MS 45
RADIAL DRILLING MACHINE	MS 46
KEY SETTING/SLOTTING MACHINE	MS 47
16" SWING COMB.TURRET LATHE	MS 48
19,1/2"SWING COMB.TURRET LATHE	MS 49
48"X10" CYL.CAL.GRINDER	MS 50
VERTICAL SPINDLE SURFACE M/C	MS 51
16,1/2" CAPSTAN LATHE	MS 52
HORIZONTAL BORING MACH.	MS 53
WATER COOLER	MS 54
8,1/2" SLOTTING MACH.	MS 55
36" RADIAL DRILLING MACH.	MS 56
PORTABLE SCREWING MACH.	MS 57
12" SLOTING MACHINE	MS 58
SAW SHARPENER	MS 59
UNIVEERSAL MILLING MACHINE	MS 60
HIGH SPEED ENGINE LATHE	MS 61
HIGH SPEED ENGINE LATHE	MS 62
HIGH SPEED LATHE	MS 63
500 KG PILLAR JIB CRANE	MS 64
500 KG PILLAR JIB CRANE	MS 65
500 KG PILLAR JIB CRANE	MS 66
500 KG PILLAR JIB CRANE	MS 67
DIE SINKING MACHINE	MS 68
NUT TAPPING MACHINE	MS 69
CRANKSHAFT GRINDER	MS 70

ATTACHMENT NO. 22



ATTACHMENT NO. 23