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Tanzania Rural Roads Feasibility Study

Final Report
Volume II
Training Requirements

Prepared for
U.S. Agency
for International Development

LYON associates, inc.
in association with
James R. Snitzler Associates, Inc.

TANZANIA RURAL ROADS

FEASIBILITY STUDY

FINAL REPORT

VOLUME II

TRAINING REQUIREMENTS

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I. PURPOSE

The purpose of the training program will be twofold:

- To provide Tanzanian personnel in sufficient numbers and skills to effect an initial rehabilitation of the road system.
- To develop a Tanzanian work force of sufficient numbers and skills to maintain the road system after its rehabilitation.

II. GENERAL TRAINING SITUATION

The general situation in Tanzania parallels that of many other African countries as regards road rehabilitation and maintenance. This was defined at the Pan African Conference on Highway Maintenance and Rehabilitation, which took place in Ghana in 1977 under the auspices of the United Nations Economic Commission for Africa. The following observations resulting from that conference are applicable to Tanzania:

- Road maintenance has been neglected and skilled local staffs have not been trained.
- There is a need for extensive retraining of existing road maintenance staffs and recruitment and training of new members.
- Management must plan for the use of newly-trained staff members and, if necessary, adapt the organization to employ their skills fully.
- Management should be closely involved in designing job specifications and planning the training required to meet those specifications.
- Senior staff members, both managers and supervisors, should be included in any training program.
- The training should be designed to equip the trainee for a particular job; this limitation should be accepted and explained to the trainees.
- Retraining of the existing staff should be given priority; limitations of the existing staff should be recognized and new staff members recruited where necessary.
- Recruited staff members should be carefully selected in accordance with the job specifications and the training program requirements.

- Newly-trained staff members should be posted to staff positions in order to avoid frustration and low morale.
- It is essential that competent technical personnel be selected as counterparts to expatriate instructors at an early stage in the training program.
- An effective manpower survey is a necessary first stage, to precede any training program.
- Mechanical maintenance is often a critical problem: where a central organization exists, consideration should be given to decentralizing the system, such as providing a Roads Department with a separate mechanical maintenance capability
- Where it seems appropriate, consideration should be given to labor-intensive methods of construction and maintenance to avoid reliance on equipment.

III. SPECIAL TRAINING SITUATION

Accepting the observations and suggestions resulting from the Pan African Conference, their application to the training situation in Tanzania must take into consideration the specific circumstances in that country. The following conditions are pertinent to the proposed training program.

A. Current Road Conditions

There has been a nearly complete collapse of the rural road system, a condition accumulated over the past 20 years.

B. Personnel Shortages

1. General Manpower Situation: See Tables II-1, II-2, and II-3.

2. Engineers: There is a critical shortage of engineers. This is a country-wide condition, aggravated in the Roads Division by commitment of engineers to other programs by the Ministry of Works. Of the total engineer positions in the Roads Division, 58 remain unfilled, most of them in the Maintenance Section.

3. Technicians: For rehabilitation, the most critical technical shortage is in the Road Foreman category, with a maximum availability of only

TABLE II - 1

AVAILABLE PERSONNEL AND REHABILITATION PROGRAM REQUIREMENTS

Position	Available Personnel in Region Dodoma	Singida	Kilimanjaro 1/	Total 1/	Total Required Rehabilitation Project
Engineer	5	4	3	12	7
Road Technician	6	2	3	11	
Road Foreman	7	3	3	13	36
Operator	30	18	4	52	36
Driver	52	29	9	90	85
Mechanic	95	76	21	192	56
Carpenter	15	10	8	33	8
Mason	15	9	8	32	16
Storekeeper	22	12	8	42	4
Office Personnel	25	26	11	62	48

1/ From personal interview during site visits.

2/ Not all of the personnel in the Regions are available for the Rehabilitation Program since some are required for other COMWORKS responsibilities and others are needed for the planned World Bank Trunk Road Maintenance Program.

TABLE II - 2

PERSONNEL REQUIREMENTS, REHABILITATION PROGRAM

PERSONNEL	PROJECT COORD.	SINGIDA TEAM (1)	DODOMA TEAMS(2)	KILIMANJARO (SAME/MWANGA) TEAM(1)	TOTAL
Executive Engr.	1				1
Sr. Hwy. Engr.	2	1	2	1	6
Sr. Adminis. (Office Mgr.)	1				1
Supt. Stores	1				1
Office Manager		1	2	1	4
Storekeeper		1	2	1	4
Timekeeper		1	2	1	4
Dispatcher		1	2	1	4
Clerk	2	1	2	1	6
Typist	2	1	2	1	6
Messenger	2				2
Driver	5	20	40	20	85
Driver Trainee		12	24	12	48
Warden	8	4	8	4	24
Foremen		9	18	9	36
Chief Operator		1	2	1	4
Operator		8	16	8	32
Operator Trainee		8	16	8	32
Mason		4	8	4	16
Carpenter		2	4	2	8
Mech. Supt.		1	2	1	4
Mechanic		8	16	8	32
Mechanic Trainee		9	18	9	36
Tire Repairman		2	4	2	8
Tire Repair Trainee		2	4	2	8
Welder		2	4	2	8
Welder Trainee		2	4	2	8
Mech./Lube Man		1	2	1	4
Labor		68	136	68	272

TABLE II - 3

ADDITIONAL SKILLED AND UNSKILLED PERSONNEL REQUIREMENTS FOR THE PHASED-IN MAINTENANCE PROGRAM

PERSONNEL	SINGIDA TEAM	DODOMA TEAMS	KILIMANJARO (SAME/MWANGA) TEAM	TOTAL	PERSONNEL REHABILITATION PROGRAM TOTAL	ADDITIONAL PERSONNEL REQUIRED
Operators	19	34	11	64	32	32
Oper. Trainees	19	34	11	64	32	32
Drivers	28	57	19	104	85	19
Driver Trainees	28	57	19	104	85	19
Foremen	11	20	6	37	36	1
Mason	8	16	4	28	16	12
Carpenter	8	16	4	28	8	20
Mason, Carp. Trainees	16	32	8	56	24	32
Mechanic	8	16	8	32	32	0
Mechanic Trainee	8	16	8	32	32	0
Storekeeper	1	2	1	4	4	0
Tire Repair Man	2	4	2	8	8	0
Welder	2	4	2	8	8	0
Tire/Welder Trainee	4	8	4	16	16	0
Mech./Lube Man	1	2	1	4	4	0
Mech./Lube Trainee	1	2	1	4	4	0
Dispatcher	1	2	1	4	4	0
Labor	30	60	15	105	272	0
Roads Inspector	5	9	2	16	0	16
Recording Clerk	5	9	2	16	0	16
Maintenance Contr. (1½ km/man)	1400	2530	630	4560	0	4560

13 of the required 36 positions, for a deficit of 23. In addition, a substantial number of trainees in several categories are needed for build-up of the work force to meet its commitments:

Driver trainees	48
Operator trainees	32
Mechanic trainees	36

In maintenance, a very large number of Maintenance Contract personnel estimated at 4,560 are required. These are the 1-1/2 km maintenance men. None of these are presently in the operating force. In addition, the following shortages will exist in the categories shown:

Operators	32
Operator trainees	32
Drivers	19
Driver trainees	19
Foremen	1
Masons	12
Carpenters	20
Mason/Carpenter trainees	32
Roads Inspectors	16
Recording Clerks	16

C. Material Deficiencies

There is a general shortage of operating machines and equipment. The current material deficiencies are attributed to: transportation and equipment management practices; the age of existing equipment; lack of qualified mechanics; and lack of funds for spare parts and replacements. These deficiencies, however, will be mainly resolved by the equipment put into country through the road development program. Training will coincide with the receipt of this new equipment and the preparation of it for operations.

D. Ongoing Training and Support Programs

1. Morogoro Training School: The Tanzanian Government constructed the Morogoro Training School in 1974. It provides formal training for

field crew personnel, with a capacity of 120 students. In 1977-78, the following personnel received training at the School:

Road Foremen	58
Plant Operators and Drivers	59
Auto-Electrical Technicians	19
Foremen Mechanics	32

The School has been operated at less than full capacity. This is attributed to insufficient planning for trainee recruitment and selection.

2. World Bank Assistance: The World Bank provided five instructors plus training aids to the Morogoro School at its inception. Training courses were planned until 1980 under the World Bank project; however, due to the pressing need for trained personnel, the effort will have to be continued until 1982. Anticipated World Bank follow-on assistance is intended to provide:

- Four instructors, for a total of 90 man months. These are to provide training for plant and vehicle mechanics, operators, drivers, road foremen, and supervisors; and
- Additional training aids for the foregoing training.

The World Bank plans also to participate in the training of about 120 Tanzanian engineers at Roorkee University, India, and provide 498 man-months of technical assistance for on-the-job training and advice to the Ministry of Works staff and field personnel in the Trunk Road Maintenance Program.

3. Indian Expatriates: In 1974, the Tanzanian Government engaged 35 Indian engineers to fill Ministry of Works positions for from two to three years. Local counterparts were not appointed for these assignments.

An additional 62 Indian engineers were scheduled to join the Ministry of Works in 1978-79. 15 of these engineers were to be allocated to the Roads Division. The effect of this program has been slight. Only five of the 15 to be assigned to road operations were acquired during the first year (1978).

E. Policies Affecting Training

1. Decentralization: The Tanzanian Government is pressing for greater decentralization of the roads organization, which will be reflected in the training situation.

2. On-the-job Training: The critical need for rehabilitation of the road system dictates maximum use of on-the-job (OJT) training in order not to weaken the available work force for training purposes.

3. Engineer Training: It is the concensus that technical training of professional engineers be accomplished by existing programs within the Tanzanian Government.

IV. TRAINING APPROACH

There are two primary considerations which must be served by the training program in all of its aspects:

- The urgent requirement for rehabilitation of the present road system. The training program must contribute to this effort in every way possible, and avoid preempting personnel or equipment needed in the rehabilitation effort for training purposes. This means a maximum emphasis on OJT and a maximum decentralization of the training effort to the operating level.

- The development of a Tanzanian capability to construct, maintain, and rehabilitate as required its own road system. A primary purpose of the training program is to reduce the need for expatriate personnel to zero. This includes the training function, in which each expatriate must have a Tanzanian counterpart to absorb and continue the required training without outside assistance.

It is proposed that the overall training program be based on centralized planning and control, and decentralized execution. Centralized planning and control will serve to create a Tanzanian training management capability, provide an equitable distribution of resources, ensure consistent quality, and offer support to field training activities. In addition, centralized management can identify overall needs and obtain exterior support when required. Decentralized execution will permit integration of the training effort with on-site rehabilitation and maintenance of the road system, supply, equipment

maintenance and repair, and equipment operation, at the District level or below.

Within this general framework, the training program must address the conditions under which it will operate and the needs of the rural road development program.

A. Engineers: The basic professional training of engineers will be effected outside the training program. The system of counterparts for expatriate personnel, however, will provide an exchange of knowledge and experience at the engineer level. This will be supplemented by required self-study to improve and expand professional knowledge. A primary vehicle for this self-study will be the series Transportation Technology Support for Developing Countries, produced by the Transportation Research Board, National Academy of Sciences. Selections from this series will be recommended by the expatriate to his counterpart, based on the needs of the individual and the demands of the rehabilitation and subsequent maintenance program. Through this system of expatriate-counterpart exchange and guided self-study by the counterpart, it is anticipated that a Tanzanian engineer will have the opportunity to become fully qualified in road rehabilitation within the 3-year period of effort in country, and be capable of advancing into the maintenance program through this prior training and experience.

It is proposed that the training program include a system for upgrading technical personnel to the performance of selected engineer functions where possible, thereby freeing fully qualified engineers for a broader exercise of their abilities.

B. Managers and Supervisors

Senior staff personnel, at the management and supervisor levels, should be included in the training program. Particularly, they should be made aware of new methods, procedures, or equipment introduced at the technician or workman levels in order to incorporate them into their management or supervisory functions.

C. Technicians and Workmen

All personnel should be screened and selected for training compatible with their abilities or potential.

Technicians and workmen should be trained for specific jobs directly contributing to the road rehabilitation and maintenance program.

The training program should be used to upgrade personnel to the maximum extent.

D. Training Facilities

The necessary equipment, tools, shops, and instructors for training at any skill or level must be preplanned and positioned prior to commencement of the training. No formal training facilities will be required. Training will be integrated with operations and conducted primarily in the field.

E. Training Publications

It is proposed that the primary method of OJT be supplemented with self-study by the use of instructional publications provided to personnel under training. The sources for such publications exist in U.S. Government documents and are easily adaptable to Tanzanian requirements. They cover all the necessary functions and various skill levels. Specifically, they include training and other publications of the following agencies:

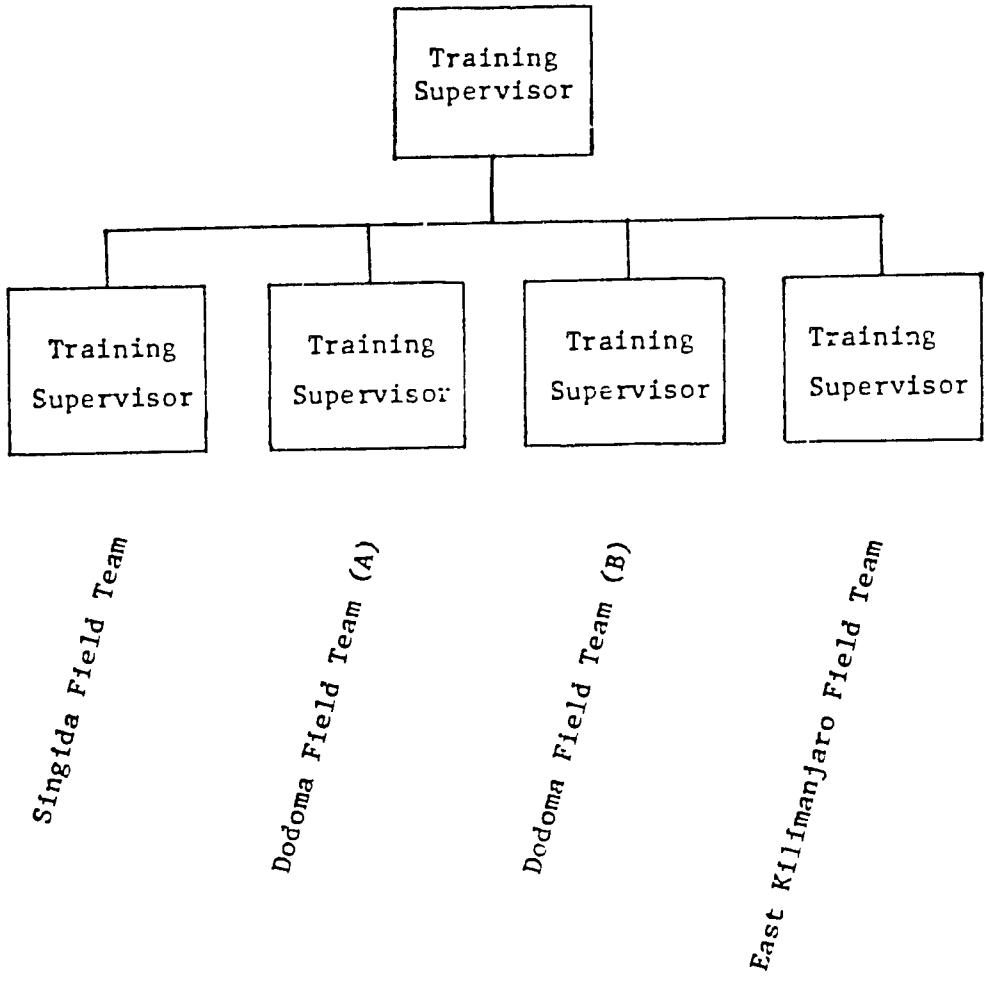
- Transportation Research Board, National Academy of Sciences.
- Naval Facilities Engineering Command.
- Bureau of Naval Personnel.
- Naval Education and Training Command.
- Department of the Army (Field Manuals and Technical Manuals).
- Forest Service, U.S. Department of Agriculture.

Because the number of trainees in each skill will not be large, the quantities of publications for each category will be limited. It is anticipated that in many cases the field requirements can be met by local reproduction of pertinent parts of a single publication, and distributed as needed to trainees.

V. ORGANIZATION FOR TRAINING

The general organization for training is based on the functional organization, centralized at the Project Coordination Team and decentralized for execution at the Field Team Level. Control and coordination will be exercised by designated training supervisors as shown in the following diagram:

PROJECT COORDINATION TEAM



All key personnel functions would be fulfilled by a designated expatriate and his Tanzanian counterpart. A total of 17 such dual positions will be established as follows:

Level	Expatriates	Counterparts
Project Coordination Team	Project Coordinator	Executive Engineer
	Chief Highway Engineer	Senior Engineer
	Highway Engineer/ Training Supervisor	Senior Engineer
	Office Manager	Senior Administrator
	Parts/Supply Manager	Superintendent of Stores

Level	Expatriates	Counterparts
Field Team (4)	Highway Engineer/ Training Supervisor/ Team Leader (4)	Senior Engineer (4)
	Mechanical Superintendent (4)	Senior Mechanical Inspector (4)
	Equipment Operator Superintendent (4)	Chief Operator (4)

For training purposes, each of these key personnel is an instructor. The expatriate is an instructor to his counterpart, and they both are instructors to their subordinates. It is anticipated that on demobilization of the program, the counterpart will be sufficiently trained and experienced to assume the function of the former expatriate, and that a Tanzanian assistant would replace the counterpart to continue the training system established.

A. Screening and Selection of Trainees

The trainees for all positions would be selected on the basis of their immediate usefulness in operations, and their potential for the acquisition of skills required in the job for which they will be trained. Screening and selection would thereby contribute to the rehabilitation and maintenance program at once by adding a productive man to the work force, while ensuring that an increased capability will be obtained from that individual through OJT.

Screening and selection will be accomplished on a broad basis, coordinated at the Project Coordination Team level. Assistance of the Tanzanian Government through Regional officials will be required; similarly, Field Team Leaders, in their Training Supervisory capacity, will coordinate screening and selection of trainees with Tanzanian Districts in their assigned areas. The selection of trainees will initially be accomplished simultaneously with the acquisition of trained workers. It is anticipated that subsequent screening and selection of trainees will be more internal, with screening through observation on the job and selection as part of the upward mobility opportunities offered to members of the work force.

The methods and techniques of screening and selection can be developed from existing procedures and documentation available from U.S. Government resources, such as the following:

1. Naval Facilities Engineering Command
   - Interviewers Guides for selections of engineering aides and equipment operators.
   - Testing and licensing of construction equipment operators.
   - Basic requirements for motor vehicle operators.

2. Forest Service, U.S. Department of Agriculture

   Job performance requirements for specialist skills in road and bridge construction and other civil engineering skills.

3. Department of the Army

   Basic skill requirements for the following functions:
   - Automotive Repairman
   - Bridge Specialist
   - Construction Equipment Repairer
   - Wheeled Vehicle Driver
   - Material Supplyman
   - Mechanical Maintenance Supervisor
   - Motor Transport Operator
   - Senior Supplyman
   - Stock Control Supplyman
   - Storage Supplyman
   - Transportation Supervisor
   - Wheel Vehicle Mechanic

VI. FACILITIES AND EQUIPMENT REQUIRED FOR TRAINING

The selected OJT character of the training program allows it to be carried out with no single-purpose facilities or equipment. Operational material will serve the training function throughout the program. Neither formal classrooms nor sophisticated training aids will be required. The only training-peculiar material needed will be the selected training documents and the capability for their local reproduction.

VII. CONDUCT OF TRAINING

The basic training method will be OJT, under supervision. This will be supplemented by required self-study, using publications provided by the training organization. These may be self-study courses, manuals, and handbooks taken from or adapted from existing U.S. Government publications.

In general, OJT will be carried out in coordination with the actual operation in progress, in a field or shop environment, with the trainee performing his assigned work and learning additional skills under supervision of the assigned instructor. Self-study materials will be provided for the increased skill being learned.

Basic training programs and supporting training documents will be developed and prepared for distribution at the Project Coordination Team level. At the same level, training schedules for each of the field teams will be prepared and issued.

Instructors will be provided with the basic skills or job performance requirements needed by the trainee and convert these to a teaching outline appropriate to the field or shop situation. The outline subjects will be covered in sequence, testing and evaluating the trainee for each subject before passing to the next. Methods of test and evaluation in the field or shop will have to be adapted to the situation. When the trainee has completed the instruction, as set forth in the teaching outline, to the satisfaction of the instructor, he may be required to undergo more formal certification or licensing examination before being accepted into the higher skill. This particularly relates to equipment or vehicle operators, repairmen, and civil engineering specialists.

The training program will be assessed each quarter through on-site visits by the Training Supervisor of the Project Coordination Team, and the results reported quarterly to the Project Coordinator. This assessment will be supported by trainee ratings from instructors and supervisors.

A. Training Load

The training load will be greatest at the beginning of the rehabilitation phase, with about 270 Tanzanian personnel in all categories under some kind of expatriate supervision or instruction. Of these, an estimated 132 will be trainees requiring the greatest amount of direct supervision and training. The overall ratio of expatriate to counterpart or trainee will be about 1:16.

Since the bulk of the direct training will be at the field team level, the ratio at that level will be closer to 1:20, and that of instructor to trainee only about 1:10. In an OJT situation, even the highest ratio (1:20) is considered acceptable, permitting a high degree of personal attention to each learner.

B. Training Concepts

1. General Concept

The basic thrust of the training program is to get the individual into a productive situation at his own skill level as rapidly as possible and build on that base for an increasing contribution to the overall effort with an escalating opportunity for personal reward and satisfaction. For professionals, there will be an emphasis on decision-making by the individual rather than by his instructor. For technicians, emphasis will be on the development of confidence in skills learned and pride in the correct and efficient application of those skills. The following represent the initial program concept.

2. Road Engineer

Number:	Singida	— 1
	Dodoma (2 teams)	— 2
	Kilimanjaro	— 1

The road engineer will be required to do OJT on road survey and produce engineering survey reports showing culvert, bridges, drifts, scouring, and other repairs necessary. He will be required to locate and mark on a map all roadside materials available. He will measure and record the haul distances for planning purposes. Planning information will include requirements for grouting riprap, building headwalls, and the construction of sidewalls, abutments, and drains.

He will determine road locations and alignments; crowns; and bridge, drift, or culvert requirements, identifying the location, size, and length of all culverts.

Horizontal and vertical alignments will be part of the road engineer's instructional program. He will be required to gather all the information on bridge and drift situations needed for engineering design. He will be trained to mark side drains and to eliminate mitre drains from the system. Management techniques and the directing of a road maintenance unit will be included in his instruction.

3. Road Foreman

Number: Singida — 9

Dodoma (2 teams) — 18

Kilimanjaro — 9

A major portion of foreman training will be devoted to the technique of leadership and supervision.

The road foreman will be included in road survey team and participate in the determination of required work. He will be shown how to determine, from stakes and markers, the quantity and type of work to be performed; interpreting the elevations from the markers; and estimating how much compaction and fill is needed.

Instruction for the road foreman will include the placement, length, and size of culverts, and the selection of borrow pits. He will be shown how to determine the size of work force needed, approve time and attendance records, and record the amount of work accomplished.

4. Equipment Operator

Number: Singida — 8

Dodoma (2 teams) — 16

Kilimanjaro — 8

Initial training of equipment operators will consist of instruction on operation of the equipment, using operator manuals, handbooks, or technical manuals, and practicing correct procedures under supervision without starting the equipment. This will be followed by supervised instruction on checking, starting, operating, and stopping the equipment and its attachment.

The operator will be taught the basic operating techniques for all types of tasks, developing skills and techniques under instruction. Safety procedures and preventive maintenance will be emphasized throughout. The operator will be considered responsible for his equipment in all operations.

Equipment reports will be required daily from the trainee and used to determine the hours of use and maintenance requirements.

5. Equipment Mechanic

Number: Singada — 9

Dodoma (2 teams) — 18

Kilimanjaro — 9

The equipment mechanic will be taught how to test, troubleshoot and diagnose equipment problems, effect repairs, replace faulty parts or components, and retest the equipment after correction of the fault.

In the training received, the mechanic will be taught how to use the proper tools and test equipment, and the safe and correct methods of making repairs and maintaining the equipment in working order.

Theory, as to how the equipment operates, will be taught by manual or handbook and supervised instruction. Repair orders, rather than lesson plans, will be used for realistic situations, and the mechanic will sign off on repair work done as a record of his accomplishment.

Concomitant with the instruction the mechanic will be required to keep an orderly and clean work place in order to form proper work habits.

6. Storekeeper

Number:	Project Coordination Team	— 1
	Singada	— 1
	Dodoma (2 teams)	— 2
	Kilimanjaro	— 1

Storekeepers will be trained to be responsive to the needs of the facility served. Government (Tanzanian) as well as functional requirements will be addressed.

Training will include item identification and stocking to maintain inventories in proper ratio. The storekeeper will be trained in inventory control and responsibility for supplies. He will be taught how to set up and maintain inventory and use records, to include fuel, oil, lubrication, repair costs, labor, parts, and supplies; and an inventory and locator system for parts and supplies to ensure that a minumum stock is on hand and that all stock is properly documented and costed.

Motivational training, to ensure that the storekeeper is aware of his essential part in the rural roads rehabilitation and maintenance system, will be included in the instruction.

7. Tire Repair and Welder Trainees

Number:	Singida	— 2
	Dodoma (2 teams)	— 4
	Kilimanjaro	— 2

Welder Trainee

Number: Singida — 2

Dodoma (2 teams) — 4

Kilimanjaro — 2

Tire repair and welder trainees will receive instruction similar to that described for Equipment Mechanic, with specialist training in their specific functions.

8. Driver Trainee

Number: Singida — 12

Dodoma (2 teams) — 24

Kilimanjaro — 12

All driver trainees will begin instruction with operator manuals or handbooks and supervised instruction on operating the vehicle without starting the motor. This will be followed by supervised instruction on checking, starting, operating, and stopping the vehicle. Preventive maintenance and safety precausions will be integral to all instruction.

The trainee will be required to know all Tanzanian motor vehicle requirements, laws, and regulations concerning the vehicle and its operation. OJT training in operating the vehicle under circumstances anticipated in the work to be performed in the rehabilitation and maintenance program will be provided. Special training will be given on the operation of any vehicle attachments, including trailer operations, on the basic vehicle.

Operational requirements, such as driver's checklist, trip tickets, manifests, or log, will be duplicated in the instruction and used as training aids for indoctrination of the trainees. Actual mileage and maintenance records will be kept for vehicle record purposes on any training operation.

9. Motor Vehicle Mechanic

Although current manpower assessments do not indicate a shortage of motor vehicle mechanics, the input of new equipment may require training or retraining in this skill, with a presently undetermined number. Training concept for this will follow that of Equipment Mechanic, adapted to the motor vehicle requirements.

C. Training Schedule

Training schedules will depend on the results of screening and

selection in country, with training courses tailored to the determined requirements. Preliminary work on the amount of training required, in terms of hours of OJT by skill, has been done to form a basis for schedule development. The numbers of hours in the following list indicate the estimated training effort to obtain desired levels of competence.

Function	Hours OJT		
	Phase I 1/	Phase II 2/	Total
Road Foreman	480	960	1,440
Equipment Operator	280	560	840
Equipment Mechanic	516	1,032	1,548
Driver	280	560	840
Motor Vehicle Mechanic	516	1,032	1,548
Tire Repairman	180	360	540
Welder	280	560	840
Storekeeper	140	280	420

1/ Trained for performing useful tasks without direct supervision. Equivalent to apprentice training for construction trades.

2/ Fully trained in specialty, capable of supervising trainees.

Sample lesson plans for one course segment (Motor Vehicle Mechanic: Lubrication) are provided in Appendix A.

D. Certification and Licensing of Trainees

Testing of trainees for certification or licensing will follow standardized procedures established by the training organization. These may be internal requirements for the training program, or follow the requirements of the Tanzanian Government. For internal purposes, certification and licensing requirements contained in U.S. Government publications may be used. Certification and licensing serve a dual purpose, in that they add to the price of achievement of the trainees and are a motivating factor for application and learning.

VIII. TRAINING COSTS

All training will be conducted by personnel in functional positions in the rehabilitation and maintenance program; the costs of their training activities are incorporated into their several rates of pay. Similarly, counterparts and other Tanzanian personnel are in functional as well as instructional roles. Trainees are in an OJT capacity, working while training and being paid at their work rate. All equipment and facilities used in training also are functional as well as instructional. There are no costs directly attributable to training except the minor cost of manuals or other documents purchased for training purposes. With an estimated maximum of 270 trainees in eight definable categories, this publications cost is considered negligible.

For evaluation purposes, it is suggested that the cost of the expatriate team on the project be apportioned equally between the training and operations disciplines, thereby reducing the overhead costs of the rehabilitation and maintenance programs as follows:

A. Overhead & Mobilization Costs

1. Rehabilitation Program (3 years)

		T/shs	
Expatriate salaries	$4,930,000		
Int'l travel, etc.	224,705		
Mobilization	1,941,000	1,780,000	
Subtotal	$7,115,705	1,780,000	
Pro rate	3,557,852	890,000	
T/shs Equiv.		28,462,800	
Subtotal			T/shs 29,352,800

2. Maintenance Program (3 years)

Expatriate salaries	$4,312,000		
Int'l travel	222,750		
Mobilization		1,147,200	
Subtotal	$4,534,750		
Pro rate	2,267,375	573,600	
T/shs Equiv.		18,139,000	
Subtotal			T/shs 18,712,600
Total Reduction to Operations Cost			T/shs 48,065,400

B. To the above should be added the annual remuneration of the trainees included in both the Rehabilitation and Maintenance Programs.

It is estimated that the average annual income for trainees such as operators and mechanics is about T/shs 8,000/year, and for trainees such as drivers, etc., the average annual income is about T/shs 4,800/year.

			Per Year
1. Rehabilitation Program (3 years)			
Operators, etc., Trainees:	68 @ 8,000 =	T/shs	544,000
Driver, etc., Trainees:	64 @ 4,800 =		307,200
Subtotal/year	=		851,200
x 3 years	=	T/shs	2,553,600
2. Maintenance Program (3 years)			
Operators, etc., Trainees:	140 @ 8,000 =	T/shs	1,120,000
Driver, etc., Trainees:	174 @ 4,800 =		835,200
Subtotal/year	=	T/shs	1,955,200
x 3 years	=	T/shs	3,865,600
Total Trainee Salaries		T/shs	8,419,200

APPENDIX A

Sample Lesson Plans

Motor Vehicle Mechanic Course
(Lubrication)

Lesson 1 — Changing the Motor Oil

Lesson 2 — Replacing the Oil Filter

Lesson 3 — Servicing the Undercarriage

Lesson 4 — Lubricating Wheel Bearings

I. INFORMATION SHEET #1 LUBRICATION: CHANGING THE MOTOR OIL

A. Selecting the Right Oil

The American Petroleum Institute (API) classification system uses the symbols SE, SD, and SC to designate oil suitable for gasoline engined vehicle use. Symbols signify the ability of the oil to protect engines of designated model years against rust, wear, corrosion, sludge and other detrimental factors caused by normal use. SE engine oil provides maximum protection between manufacturer-recommended oil changes for 1980 and all prior models. SD engine oil is suggested for 1970 and older models. SC engine oil is the suggested choice for 1967 engines and all older models.

See that the can of oil you select bears the symbol of the type of oil that you desire. The symbol may be used by itself (SD, for example) or in conjunction with others, such as SE, SD, SC. This means the oil is intended for SE use, but, obviously, also fulfills the needs of SD and SC use.

Consult the vehicle owners manual for the oil viscosity to use. This is based on the ambient temperature of the area.

Viscosity, or weight, is the numerical rating system established by the Society of Automotive Engineers (SAE) that designates the resistance of the oil to flow. Thick, slow-flowing oils have high numbers; thin, free-flowing oils have low numbers. The W following the number means the viscosity was determined a 0° F. and the oil is intended for use in cold weather. If there is no W, viscosity was determined at 210 ° F., and the oil is intended for use in warm weather.

Oils with two numbers, such as SAE 20W-40 have the ability to change viscosity as the temperature changes, being light enough to allow easy engine starting in cold weather, yet heavy enough to provide proper protection at high temperatures.

B. Caution

The wrench used to loosen the drain plug must fit exactly to avoid damage, making plug removal very difficult.

Remove the drain plug completely and allow the oil to drain completely from the engine; this insures that all contaminants are drained with the oil.

II. LESSON PLAN #1 - LUBRICATION: CHANGING THE MOTOR OIL

— To have the student learn the correct methods to use in changing the motor oil, and

— To determine the proper oil to use for the greatest operational economy.

Oil is the life blood of the engine. By changing it regularly you can extend engine life and avoid major repairs. This operation is very simple and is perhaps one of the easiest maintenance tasks.

A. Warm up the engine so that the full load of dirty oil will drain from the engine. Heat thins the oil permitting it to flow readily.

B. Lift the front of the vehicle or leave all four wheels on the ground. If you do lift the vehicle, support its weight on safety stands. Do not work beneath a vehicle that is supported only by a jack; this is how accidents happen. Engage the parking brake and put the automatic transmission in parking and a manual transmission in gear. If you raise the front end of the vehicle, place chocks behind the rear wheels of the vehicle.

C. Place a drain pan (large enough capacity) under the drain plug and loosen the plug with an adjustable wrench. Whichever wrench you use, be sure that it fits the plug snugly to avoid damage to the plug.

D. Remove the loosened plug by hand. To avoid burning your fingers, be ready to draw your hand back quickly as oil begins flowing. Allow the oil to drain completely. This will take a couple of minutes.

E. Wipe the drain plug clean and check to see if it has a gasket. If the plug has a gasket, the gasket must be kept and used to prevent an oil leak. However, to be effective, the gasket must be in good condition; if it isn't, replace it.

F. Thread the drain plug into the oil pan (don't cross threads) and tighten by hand. Then, using a wrench, tighten the plug snugly. Do not overtighten or you will distort the oil pan.

G. Add fresh oil of the correct API classification and SAE viscosity through the oil filter on the engine until the proper amount shows on the dip stick. Do not overfill.

H. Check around the oil drain plug for leaks. Tighten the plug if there is a leak.

III. LESSON PLAN #2 - LUBRICATION: REPLACING THE OIL FILTER

— To have the student learn the correct system to employ in changing the oil filter.

— To determine why the oil filter is a very important part of long engine life.

In the past, manufacturers have warned not to tighten the filter with a wrench, because the filter may be difficult to remove the next time it has to be replaced. Some now say use a wrench to assure a tight, leakproof seal. Take the moderate approach. Tighten the filter by hand. After you have filled the crankcase with oil, start the engine and check around the oil filter for leaks. If you find one, tighten the oil filter with a wrench until the leak stops.

A. Place a drain pan under the oil filter before adding fresh oil to the engine. This will catch any of the fresh oil that is spilled while you work.

B. The filter may be reached from inside the engine compartment, depending on its location on the engine. If it is not accessible, you may have to get beneath the vehicle. Be careful and don't grab the filter with your bare hands as it can be very hot.

C. Place an oil filter wrench around the filter. Be sure that you have the right size wrench to do the job because not all wrenches fit all filters. Be ready to tell the parts department the year, make and model of the vehicle and the cubic inch displacement of the engine to get the right filter for the job.

D. Turn the wrench counterclockwise to remove the filter. If the filter is frozen to the engine, remove the wrench and drive a chisel through the filter canister, but watch out for the hot oil that may splatter. Then hit the chisel with a happer to loosen the filter.

E. If the old gasket material sticks to the filter seat on the engine after you have removed and discarded the filter, scrape the seat clean and wipe it with a dry cloth.

F. Wash your hands, and then dip a finger into some clean engine oil and lubricate the gasket of the new filter. Also lubricate the filter seat on the engine. Lubrication assures that you will have a secure fit between the two.

G. Thread the filter by hand onto the engine. Be careful not to cross or strip the threads on the filter. When the gasket touches the filter seat on the engine, hand turn the filter another half to three-quarter turn to secure it.

H. Check for leaks after starting the engine.

IV. INFORMATION SHEET #2 - LUBRICATION: REPLACING THE OIL FILTER

The oil filter on your vehicle is probably the full flow filter. This means that the oil pump delivers oil through the filter before the oil is distributed to the engine.

However, in the event of extremely cold weather causing the filter to clog or the oil to become too thick to flow through the filter, a bypass valve will route the oil around the filter element to the engine. This way, your engine will never starve for oil. Oil delivered to the engine through the bypass will, of course, contain abrasives and sludge elements that will accelerate engine wear.

Filters get clogged with sediment and particles if they are kept in use too long. Therefore, it is important that you replace an oil filter at the time indicated by the manufacturer. In many cases, this requires that a filter be renewed the first time the oil is changed in a new engine, and every other time thereafter. If you use the vehicle under severe conditions, such as pulling a trailer, extensive short-trip driving, idling for long periods, or driving in dusty areas, replace the filter each time that you change the oil.

V. INFORMATION SHEET #3 - LUBRICATION: SERVICING THE UNDERCARRIABE

Undercarriage maintenance refers to lubricating the suspension ball joints and steering linkage fittings and, if called for, universal joints and the clutch cross shaft. Consult the lubrication chart for the particular model that you are working on.

Some manufacturers print such a diagram in the vehicle service manual while others provide it as a separate service manual. The diagram pinpoints lubrication fittings. If such a chart is not available you will have to search for the fittings.

How often should a vehicle have a grease job? Consult the maintenance guide in your vehicle owners manual. However, keep in mind that the interval given is the minimum requirement and assume ideal driving conditions. If the vehicle is driven in cold, snow, rain, extreme heat, or dusty areas, the vehicle will benefit from more frequent lubrication.

You need a hand operated grease gun, which should come with an extension adapter to permit easy access to lubricating fittings. Newer grease guns accept cartridges of grease so that you don't have to pack the gun with grease from a bulk container.

Generally, manufacturers recommend grease containing molybdenum disulphide so-called moly grease) for its long lasting qualities. To provide even greater protection, the grease should be water resistant.

VI. LESSON PLAN #3 - LUBRICATION: SERVICING THE UNDERCARRIAGE

— To have the student learn the correct procedures for lubrication of the vital moving parts of the undercarriage.

— To determine and learn the important points to check for excessive wear or damage.

Body lubrication is usually done when the undercarriage is greased. Be very sure to follow the chart for the particular vehicle and lubricate all the points with the recommended lubricant.

A. Ball Joints, Steering Linkage: To properly lubricate ball joints and steering linkage, do the following —

1. Raise and securely support the front end of the vehicle.

2. Find all the grease fittings and wipe them clean. Some ball joints may have metal or rubber plugs rather than grease fittings. Remove these plugs and insert fittings. After greasing all the components, you can either leave fittings in place or reinstall plugs.

3. Engage each grease fitting, in turn, with the grease gun. Pump the handle slowly to apply grease. Stop lubricating when the ball joint is full; follow these tips:

a. Ball joints of American Motors and Ford vehicles should be lubricated until the rubber boot of the ball joint begins to swell, or you can place your hand on the boot and stop lubricating when you feel the boot starting to swell.

b. Ball joints of Chrysler and General Motors vehicles expel grease through bleed holes at the base of the ball joint when the component has received ample grease.

c. If grease begins oozing between the tip of the grease gun and grease fitting as you start to lubricate a joint, stop pumping the gun. The fitting is probably blocked and should be replaced. Trying to force grease into a blocked fitting will only make a mess.

B. Lubrication of Universal Joints

Many U-joints, as they are called, are sealed and can't be greased. If the joints on the driveshaft of the vehicle on which you are working need to be greased, raise all four wheels and support properly. Turn the driveshaft by

hand and find the grease fittings. Wipe the fittings; attach the grease gun, and apply grease until the lubricant flows from the joint. Then wipe off the excess lubricant.

VII. LESSON PLAN #4 - LUBRICATING: LUBRICATING WHEEL BEARINGS

— To have the student learn the proper methods to service and lubricate wheel bearings.

— To illustrate to the student the safety factors involved in working with vehicles.

A. Jack up the vehicle and support the end that you are working on with jack stands. Remove the wheel covers.

B. Use a chalk to scribe a line from the wheel onto the hub, if the wheel has disc brakes. These marks will allow you to put the wheel back in place so balance is maintained.

C. Loosen caliper retaining bolts, if the wheel has disc brakes, and remove the caliper from the disc; support the caliper on a suspension member to keep the stress off the brake hose.

D. Remove the grease cap; if a castellated locknut is on the spindle, take it off.

E. Straighten the cotter pin, pull it out and throw it away. Remove the wheel bearing adjusting nut and washer.

F. Grasp the disc or the tire of a wheel equipped with drum brakes. Free the outer wheel bearing by pulling disc, or wheel and tire assembly, towards you, and pushing back the wheel bearing will pop clear so that you can remove it.

G. Remove the disc or wheel and tire assembly and lay it face up on clean paper. Insert a brass drift or softwood dowel into the hub so that it contacts the race of the inner wheel bearing. The race is the metal part that surrounds the rollers. Tap the inner bearing out of the disc or wheel. The grease retainer (seal) will also fall free. Throw it away. Remember which is the inner and outer bearing so that they can be replaced correctly.

H. Wash bearings in a grease cutting solvent, working solvent between rollers with a clean, soft bristle paint brush. Handle the bearing by the race to avoid dirtying it.

I. Replace the bearing if it is damaged (cracked, chipped or blackened). If it looks O.K., spin it slowly to see if it rotates smoothly. Discard the bearing if the rollers feel gritty or bind as they are rotated. Don't worry

since you cannot overlubricate a bearing. If a wheel bearing packing tool is not available, scoop wheel bearing grease into the palm of your hand and knead bearing into the grease, coating all the surfaces.

J. Clean the inside of the disc or wheel hub with solvent after the bearings are greased. Allow hub to dry, coat surfaces with a thin layer of bearing grease.

K. Turn the disc or wheel assembly face down and put inner bearing inside the hob. Place a new seal over the bearing. Using a grease-seal installing tool or a soft brass drift, tap the seal into its seat.

L. Clean the wheel spindle and lubricate it with grease. Put on the disc, or wheel and tire assembly, back onto the spindle.

M. Place the outer wheel bearing in the hub, and install the washer and wheel bearing adjusting nut.

N. Tighten the wheel bearing adjusting nut to factory specifications with a torque wrench as you spin the wheel. When the correct torque measurement is obtained, remove the wrench and see if the wheel revolves freely. If it does not, back off the nut about a half turn. Test spin the wheel again.

O. Replace the castellated locknut, if there is one; install a new cotter pin.

P. Reinstall the caliper of a disc brake unit, and reinstall the wheel (line up wheel and hub chalk marks).