FEASIBILITY REPORT ON A REGIONAL LOCOMOTIVE REHABILITATION FACILITY AND PARTS WAREHOUSE IN EAST AND SOUTHERN AFRICA

Presented To:

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INTRODUCTION

This report is prepared by Transportation and Economic Research Associates, Inc. (TERA) for the Union of African Railways (UAR) pursuant to a feasibility study services contract funded by the United States Trade and Development Agency (USTDA). The report specifically covers issues pertaining to the establishment and operation of a regional locomotive rehabilitation facility and parts warehouse in East and Southern Africa.

The East Africa region included in the scope of this feasibility study is made up of Kenya, Tanzania, and Uganda. Countries in Southern Africa included in the study are Botswana, Malawi, Mozambique, Namibia, South Africa, Zambia, and Zimbabwe.

DEVELOPMENT OF RAILWAYS

During much of the colonial period, railways using steam power were the primary mode of transportation in Africa connecting the resource rich hinterland to the sea ports. The railway lines were built primarily for the purpose of developing the vast mineral and agricultural resources of the region. In order to maximize the region's export potential, the rail lines were built to radiate from the ports to the inland producing centers. They were built inexpensively with narrow gauge, steep gradients, and tight curves. The railways were designed for handling light axle loads. Several factors are important to an understanding of African railway systems today:

Incompatible gauges. In Southern Africa, the British built the railways with a track gauge of 3'6", commonly known as the Cape Gauge. The railways of East Africa were constructed by German companies to a one meter gauge.

Shift to diesel power. During the 1950's and 1960's, most railways throughout the world began shifting from steam to diesel traction power. Since diesel equipment requires much less maintenance, service, and repair, this shift resulted in significant redundancies of staff, equipment, and infrastructure. At the same time, growing competition from trucks and efforts to deregulate rates and operations created additional pressures on railways to become more efficient. Many of the railways in the region have not yet completed this evolutionary process.

Redundant facilities. As individual African countries gained independence, the large private railways of the region were broken up into smaller separate networks and nationalized. Major workshops have subsequently been constructed for each country's railways, largely through foreign donor assistance.

Skilled staff. Financially strapped countries cannot maintain adequate pay levels to attract or retain skilled workers. The railways often find it difficult to increase the pay scale for skilled shop workers without a corresponding increase in overall civil service pay scales.

Disruption of transport services. Cold war, independence movements, and civil strife resulted in the disruption of transportation services and alteration of traditional railway routes. Sabotage destroyed numerous railway bridges and other facilities, tore up track, and closed normal railway export routes to the ports.

Donor priorities. Geopolitical struggles and disruption of traditional transportation routes in the region resulted in considerable financial support from foreign donors. The primary donor concern, at the time, was the possibility of immediate economic failure of landlocked countries and the potential danger of famine if the regional transportation networks were destroyed. Donor projects were often justified on humanitarian and disaster-avoidance considerations, rather than long-term economic and regional development criteria. The donors provided substantial financial support for track replacement, rolling stock, staff training, and institutional development.

CURRENT CONDITIONS

The current railway environment in East and Southern Africa is not simply the consequence of normal business practices and market-based conditions, but it is rather a combination of exogenous non-economic factors. The international donor community has, for the most part, successfully tackled many of the physical and rehabilitation problems associated with track, equipment, and infrastructure of East and Southern African railways. Today, with a few exceptions, the railways of East and Southern Africa have sufficient physical equipment and resources to move current traffic.

Unfortunately, the donor agencies and African governments have been much less successful in dealing with the operating efficiency and productivity problems of the railways. In many cases, the government owned and operated railways require massive annual subsidies to continue operations. There has been, until recently, only limited coordination of donor efforts. The donors have found it difficult to get the African railways to undertake the often painful, frequently difficult, and almost always politically risky task of reducing staff and rationalizing assets and operations. With donor fatigue already affecting many African countries, improving the long-term financial viability and competitiveness of Africa's railways is the next important task for the railways and their governments to undertake.

Despite substantial financial support by regional governments and international donors, most East and Southern African railways are unprofitable, offer poor service, and are losing traffic to trucks. The principal problems are due to poor efficiency and productivity of railway operations rather than a need for new equipment or infrastructure. While there are many reasons for the poor railway performance, poor locomotive availability and reliability has been highlighted as a particularly serious problem in numerous studies over the last few years. Locomotive availability and reliability problems have resulted in increased costs and poor service. These problems also are a contributor to the railways' annual deficits and loss of market share to motor carriers.

EMERGING TRENDS

The railway environment in East and Southern Africa is undergoing rapid change, affecting not only the scope and viability of railway operations, but also the basic operating pattern for railway activities such as locomotive repair, maintenance, and overhaul. For several decades, decisions concerning railway investments and operations have been influenced by central government planning, geopolitical conditions, and relief objectives. In many cases, funding, was supplied by donor agencies and was dominated by immediate humanitarian objectives. Similarly, governments set rates and established staffing and service levels without regard to the impact on railway finances. Little attention was paid by either donors or governments to the institutional structure of the railways. These practices distorted normal market conditions and led to inefficiencies.

Three emerging trends exogenous to, but affecting the viability of the railways, are:

Political Stability. With the end of the cold war, the emergence of majority rule in South Africa, and the termination of armed struggle in much of the rest of the region, the railways in East and Southern Africa now have to concentrate on improving their profitability and productivity. As governments open their economies, normal market incentives and planning become important factors in this drive. Railways face increasing government pressure to reduce or eliminate operating losses.

Loss of Donor Assistance to Railways. Donor assistance to the development of East and Southern African railways has been substantial. With changes in geopolitical priorities and in response to their own increasing budgetary pressures, the donor agencies have begun a reassessment of their priorities for foreign aid. Donor governments are cutting back funding for assistance and railways should expect very little future financial support, particularly for infrastructure projects, or provision for new rolling stock. Whatever donor assistance there is, will be primarily focused on institutional reform and railway restructuring efforts.

Increasing Highway Competition. As new roads are built and existing ones rehabilitated, highway competition is increasing throughout East and Southern Africa. Truckers are reducing transit times and offering improved service. Trucks are able to compete effectively against the railroads and railroads have lost considerable traffic to trucks. In the present regulatory environment, railways are unlikely to get much protection against truck competition from governments.

Highway competition is, and will continue to be, an increasingly significant problem for the region's railways. The governments will continue to improve and expand the road network or at least not actively discourage trucks. In order to survive, the railways must become more efficient, cut costs, improve service and market their services more aggressively.

IMPLICATIONS FOR THE RAILWAYS

The emerging trends of peace and political stability, disappearing donor financial support, and increased highway competition have important implications for the railways. Most of the region's railways have recognized the importance of these trends and are beginning to search for strategic ways to effectively respond to them.

Railway Restructuring. Restructuring is a process of transforming troubled state-owned transport organizations into stand-alone (financially self-sufficient) enterprises operating on commercial principles (even though the government may retain ownership). This activity has been led by the World Bank in collaboration with USAID, Canadian CIDA, and other donor agencies.

Most East and Southern African railways are either undergoing (or have proposed) restructuring and privatization programs. Early efforts in the late 1980's and early 1990's to restructure African railways into becoming commercially viable transportation enterprises met with mixed success. The restructuring initiatives were often too timid and incremental. The Governments found it difficult to act as shareholders and ensure commercially sound behavior. The railways found it either too difficult or impossible to shed excess staff and unprofitable operations. These problems led donors to seek new approaches to railway restructuring. Current World Bank and donor efforts for restructuring and privatizing African railways are now focusing on concessioning.

It is too early to evaluate the impact of future concessioning on the performance of African railways. However, one result which can be anticipated with confidence is that future locomotive overhaul and repair decisions, including those that involve a regional locomotive workshop, will be made by restructured railroads and concessionaires in an open market environment. Therefore, decisions concerning present workshop facilities, as well as the establishment and operation of a regional locomotive workshop by the railways, must take into account the future needs and requirements of restructured railroads and concessionaires.

Increased Regional Cooperation. The establishment of majority rule in South Africa has stimulated renewed regional cooperation in transportation and other areas. South Africa has become a member of the Southern Africa Development Community (SADC) and Spoornet, its railway, is a member of the Southern Africa Transportation and Communications Commission (SATCC). A new institution, Southern Africa Railways Association (SARA) has been established recently for better coordination between the regional railways in promoting railway interests with national governments and international agencies.

The three railways in East Africa recently signed a series of cooperation agreements intended to improve coordination of railway operations and move toward a possible future establishment of some form of a new East African Railway.

Although national boundaries still exist, new cooperative agreements in both East and Southern Africa are beginning to allow the railways to operate in an integrated manner similar to earlier times. These efforts toward closer cooperation considerably enhance the likelihood of coordination among the region's railways for establishment of a regional locomotive workshop.

LOCOMOTIVE AVAILABILITY AND RELIABILITY

The railways of East and Southern Africa are dealing with a number of problems in their efforts to improve operations, reduce costs, and increase market share. These include poor operating practices, limited marketing, excess equipment, and overstaffing. One of the most serious of these problems, however, is low locomotive productivity. Locomotive productivity, in turn, is influenced by several factors including operating procedures, type and volume of traffic, condition of track, etc. Locomotive availability and reliability are two critical factors affecting productivity.[1]

It should be noted that poor locomotive productivity can be caused by factors other than low locomotive availability and reliability, such as track conditions and operational problems. This is true for some railways in the region where the low locomotive productivity, as measured in terms of Traffic Units (TU = passenger km + ton km) per year, can not be entirely attributable to low locomotive availability and reliability.

An important observation must be made concerning the impact of locomotive availability and reliability and their potential effect on customer traffic and perceived railway performance. Since most railways have surplus locomotives, availability problems can be relatively easily handled. Because locomotive reliability is defined by unpredictable events, it can not be easily planned for or handled. Reliability problems affect not only the traffic on board the affected train, but also on all the trains which have to stop while the failed locomotive is being fixed or removed. Increasing locomotive reliability (i.e., reducing the number of failures) has a direct bearing on the railway's performance and quality of service as perceived by shippers, passengers, and consignees. Therefore, improving locomotive reliability is a more critical factor in this region than improving locomotive availability.

SURPLUS LOCOMOTIVE PROBLEM

Almost all the railways currently have surplus locomotive capacity. The surplus is expected to rise substantially over the next decade as railways improve locomotive productivity. Since there is a very limited world demand for Cape Gauge locomotives, most of the surplus locomotives are expected to be scrapped, cannibalized, re-manufactured or sold for parts. In the short run, however, the surplus locomotives will have several effects on the railways. First, they will keep the cost of locomotive power and spare parts low by providing a competitive alternative to new locomotives or OEM parts. Second, they may allow the railways to delay changing their maintenance practices and avoid consolidation of workshops. Third, surplus locomotives will substantially dampen the need for new locomotives and the viability of a regional workshop.

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[1] Locomotive utilization is a third factor which affects productivity. Although these three factors are closely interrelated (increased availability and reliability directly contributes to increased utilization), locomotive utilization is also affected by train size, scheduling and dispatch procedures, bi-directional cargo potential, equipment interchangeability, average speed, line condition, etc.

In so far as the existing core fleet represents the current inefficient operations, any improvement in present levels of locomotive availability, reliability, and utilization will result in additional surplus locomotives unless an increase in traffic causes a corresponding offset. Given that the current locomotive productivity of a typical railway in the region is approximately 25 million TUs/year, the existing core fleet inherently includes a significant number of surplus locomotives. Stated differently, if the average locomotive productivity is not increased (by improving the TUs through aggressive marketing), any increase in locomotive availability will not result in any measurable benefit to the railways. It will just increase the number of available but idle (i.e., surplus) locomotives.

ALTERNATIVE STRATEGIES TO IMPROVE AVAILABILITY AND RELIABILITY

Several alternative options have been suggested for improving locomotive availability and reliability and reducing costs per horsepower. Some of these options can be adopted either in conjunction with, or in place of workshop consolidation. They include leasing locomotives with maintenance, cooperative agreements, pooling locomotives, run through locomotives, a network of private facilities, a bonded spare parts warehouse, and contract maintenance.

Contract maintenance offers an appropriate means to improve locomotive availability and reliability. However, it is difficult to capture the benefits of improved locomotive availability and reliability if the railway has poor locomotive utilization. Given the current locomotive surplus, any such improvement without a matching increase in traffic or rationalization of the locomotive fleet would result in more surplus motive power. It is, therefore, important that the strategy adopted by the railways consider likely improvements in locomotive availability, reliability, and utilization. A good contract maintenance program can be designed to encourage the railway to accomplish this often elusive goal.

FINDINGS AND CONCLUSIONS

- As their economies become more market oriented and open, African countries are facing increased pressure to change the operation and even ownership structure of their transportation providers. This is especially true for railways where the proposed changes range from an internal restructuring of railway services to a call for the complete concessioning of railway operations to the private sector. The Mozambique Railway's citrus terminal in Maputo, for example, is now in private operation, the railway workshop at the Uganda railway is being privatized and Malawi has restructured its railway. Almost all railways in the region either have a restructuring plan or are seriously considering one.

- Most railways have lost and are continuing to lose traffic to trucks. To maintain current levels of traffic and gain lost traffic, the railways must implement a more effective marketing program and improve the level of service.

- While locomotive availability and reliability problems are important components of the railways' poor financial and service performance, they are not the most significant factors. Poor operating practices, high overhead costs, excessive staffing, poor pay, and weak marketing are equally serious problems.

- During the last decade international donors have provided substantial financial assistance for purchasing or rehabilitating locomotives to most of the region's railways. Meanwhile, falling traffic levels continued to reduce locomotive power requirements. At current traffic levels with efficient railway operation, therefore, at least 50% of the region's locomotives must be considered surplus.

- Because of this surplus, locomotive reliability not locomotive availability has become the more critical immediate problem. With about 50% of the locomotive fleet realistically surplus, a railway can have one out of every two locomotives out of service and still meet 100% of its locomotive requirements. Poor locomotive reliability, on the other hand, means frequent breakdowns and delays that have a significant impact on the railway's cost and the service it offers to its customers.

- There is a significant surplus of locomotive workshop capacity in the region. Not only this duplication is wastefully expensive, but it also leads to poor service since most of the workshops do not have sufficient work to realize significant economies of scale or to maintain adequate employee skills.

- Current customs rules impose an impediment to the efficient operation of a consolidated workshop. Custom rules do not provide exemptions for unit exchange (returning old repairable parts for rehabilitated parts). Consequently most international parts repair is done on the basis of repair and return of the old part. Only the value of the repair itself is then taxed. This causes delays or requires a railway to maintain a larger parts inventory which defeats one of the main advantages of a regional workshop.

- Most of the railways recognize that there will be cost savings from workshop consolidation, but they are, for a number of non-economic reasons, unwilling to close their own workshop and send the work to an outside shop. This tendency is supported by the fact that costs for existing workshops are sunk and customs regulations make it difficult to send work to a foreign workshop.

- A regional locomotive workshop, therefore, is not viable at this time because the railways are not ready to cooperate on workshop consolidation. Most government owned railways are focusing instead on implementing national restructuring programs that will provide the railways with more autonomy over their own operations as well as more responsibility for the outcome.

- In the long run, however, given the substantial potential benefits, consolidation of many railway workshops is inevitable. As the railways are restructured and concessioned, the new managers will be looking for additional ways to improve service quality and reduce their costs. Rationalizing locomotive workshop capacity should be high on their list.

- Future locomotive overhaul and repair decisions, including those that involve a regional locomotive workshop, will be made by restructured railroads and concessionaires in an open market environment. Therefore, decisions concerning present workshop facilities, as well as the establishment and operation of a regional locomotive workshop by the railways, must take into account the future needs and requirements of restructured railroads and concessionaires.

- Regional workshops specialize in major parts overhaul and repairs. This only accounts for 30% of the total maintenance process. They do not specialize in depot level locomotive maintenance. Since the most immediate locomotive problem of the railways is reliability, which is primarily a function of proper maintenance, the railways should pursue maintenance contracts or restructuring and concessioning of their maintenance facilities as a solution. Workshop consolidation and regionalization will follow this effort. The ADTranz joint venture project in Uganda is a good example of how such processes may occur.

- Contract maintenance is one alternative that addresses several important aspects of the locomotive availability and reliability problem such as low pay and the retention of skilled mechanical staff. Contract maintenance incorporates incentives for the contractor to train and retain competent staff, use a management information system, and provide an adequate supply of spare parts. Furthermore, it improves locomotive availability and reliability

- General Electric and General Motors locomotives are the principal locomotives used in East and Southern Africa. These companies must adopt new strategies, such as providing contract maintenance, to assist African railways in improving their locomotive availability and reliability.

- The situation is complicated by the current locomotive surplus which limits the market for new locomotives. It also reduces the sales potential of OEM parts because they must complete with recycled parts from surplus locomotives. Until this surplus is worked off, locomotive manufacturers will be cautious about expanding new services in the region. Nevertheless, participation in maintenance contracts may be necessary if the locomotive manufacturers want to protect their market and have more control on sales of new parts and components. This control is not necessarily important for improved sales, but more critical in improving the quality of parts and components used in locomotive maintenance.

- Low parts availability and delivery delays contribute to locomotive availability and reliability problems. Any measure that improves parts availability or shortens delivery time will improve the situation.

- A locomotive maintenance management information system (MIS) at each railway to forecast parts needs and track locomotive component performance is needed. With a MIS the railway has a better ability to control parts usage, determine quality performance, estimate maintenance costs, and accurately project spare parts requirements. A MIS is capable of improving locomotive availability by 2-5 percentage points simply by adjusting scheduled maintenance to balance work loads.

- The creation of a regional parts warehouse (bonded) stocked with hard to get OEM parts and operated in conjunction with licensed manufactures' representatives would be useful. Such a warehouse needs to be supported by manufacturers' service engineers stationed in the region and visiting the railways on a regular basis.

RECOMMENDATIONS

The creation of regional locomotive workshops, although may be economically justified, does not appear to be a practical solution at this time. Because of its limited impact on the locomotive maintenance process, it should not be considered a high priority. The railways are undergoing an evolutionary process as they shift from government owned and operated institutions under managed economies toward autonomous businesses that respond to market-driven signals. Consolidation and perhaps privatization of the locomotive workshops will eventually occur, driven by the need to reduce costs, improve quality, and efficiency. There appears to be no significant role for the UAR, USTDA or locomotive manufacturers in this process at this time.

However, locomotive availability and reliability can be improved through other means such as contract maintenance, which can be implemented with relative ease. This will provide railways with improved service, reduced cost, and increased equipment utilization. TERA, therefore, makes the following recommendations for Phases 2 and 3 of the study:

(1) That the UAR, with the concurrence of USTDA, refocus the remainder of the feasibility study grant from evaluating the creation of a regional workshop to assisting the regional railways in establishing locomotive contract maintenance programs. Since it addresses the entire maintenance process, contract maintenance provides the most effective way to improve locomotive availability and reliability. It would lower railway costs and improve service. It would be consistent with the eventual creation of regional workshops and it would be a step in support of railway restructuring initiatives currently underway with assistance from multinational and bilateral organizations. It will also create a sustained pool of managers and mechanics.

(2) Under Phase 2, TERA proposes to develop the necessary framework for railways to solicit contract maintenance proposals. A report will be prepared which includes a

discussion of the definitions, rules, and concepts implicit in contract maintenance. Draft contract documents will be prepared to provide an acceptable basis for both railways and potential U.S. contractors to negotiate a final agreement. This stage is necessary because many African railways are unfamiliar with all the implications of contract maintenance and do not want to be at a disadvantage in contract negotiations. Especially contract maintenance with power on demand includes a complicated set of rules which establish an acceptable risk-return balance for the contractor, while accomplishing the railways' goal of improved locomotive availability, reliability, and utilization.

Concurrent with the development of the contract maintenance framework described above, TERA will investigate available computerized locomotive maintenance management information systems and evaluate their cost and adaptability to the specific needs of the region's railways. MIS offer great capability to predict locomotive parts needs. This capability will be the first step supporting the establishment of a regional parts warehouse.

(3) Phase 3 will set the stage for a contract maintenance test case. During this stage TERA will assist one railway selected by the UAR in the preparation of specific contract maintenance documents and negotiation of a contract with a U.S. contractor selected by the railway. The procedures, documents and practices developed during this phase will serve as a model for other African railways in developing their own contract maintenance programs. To support this goal, TERA will prepare and deliver a revised Phase 2 report to UAR which outlines the lessons learned during negotiations of the maintenance contract. This report will describe all pertinent issues of contract maintenance for the benefit of other railways in the region.

B - BACKGROUND

OVERVIEW OF REPORT

This report is prepared by Transportation and Economic Research Associates, Inc. (TERA) for the Union of African Railways (UAR) pursuant to a feasibility study services contract funded by the United States Trade and Development Agency (USTDA). The report specifically covers issues pertaining to the establishment and operation of a regional locomotive rehabilitation facility and parts warehouse in East and Southern Africa.

Following a description of feasibility study objectives and TERA's scope of services in this Section, the report continues with a review of emerging trends in the region which affect the viability of railway operations (Section C), their implications for the railroads (Section D), and fundamental issues affecting the need for a regional locomotive repair facility and parts warehouse (Section E). A detailed description of the current railway operations and assets in each country is presented along with a discussion of emerging trends and practices. TERA's findings, conclusions and recommendations are presented in the final two Sections.

OVERVIEW OF THE FEASIBILITY STUDY

Regional Setting

Figure 1: East and Southern Africa Region

This is a digitally created sketch. All locations are approximate.

The East Africa region included in the scope of this feasibility study is made up of Kenya, Tanzania, and Uganda. The Southern Africa region includes Angola, Botswana, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe (Figure 1).

As opposed to the continued violent political change in other parts of Sub-Saharan Africa, the countries in the East and Southern Africa region included in the study are currently experiencing stable and peaceful conditions. The civil wars in Mozambique and Angola are now over and democratic rule is returning in both. The Presidents of Zambia, Malawi, and Uganda have replaced incumbents in open elections. Namibia and Zimbabwe have maintained stable political rule for several years. South Africa is successfully making the difficult transition to democratic majority rule. With the return of political stability, the region is turning its attention toward promoting economic growth and development.

Socio-Economic Characteristics

Many of the nations included in this study are richly endowed with natural resources. Botswana, Namibia, and South Africa, have rich reserves of diamonds, gold, and other precious stones. Abundant copper, zinc, cobalt, nickel, and chromium reserves are located in Botswana, Namibia, South Africa, Zambia, and Zimbabwe. South Africa is one of the world's largest exporters of coal and iron ore. Coal is also exported from Mozambique. Kenya, Malawi, Tanzania, and Uganda are significant exporters of coffee, tea, and tobacco. Despite this abundance of natural resources and political stability, however, one-half of the 12 nations included in the region are ranked at the bottom fifth of the U.N. Human Development Index. Top ranked Botswana is about mid-point among the world's nations and lowest ranked Mozambique is 167th.

1993 Human Development Index, Rank Among 174 Countries

Botswana	71
South Africa	100
Swaziland	110
Namibia	116
Zimbabwe	124
Kenya	128
Zambia	136
Tanzania	144
Uganda	155
Malawi	157
Angola	165
Mozambique	167

Source: UN Development Programme

Table 1: Regional Socio-Economic Data

Country	Population mid-1995 (million)	Area (000 sq.km.)	1994 GNP ($ million)(*)	Per capita GNP 1994 ($)(*)	Per capita GNP Real Growth Rate (%), 1985-1994
Angola	10.07	1,246.70			-0.9
Botswana	1.39	600.37	4,037	2,800	6.6
Kenya	28.82	582.65	6,643	260	0.0
Malawi	9.81	118.48	1,560	140	-2.0
Mozambique	18.12	801.59	1,328	80	3.5
Namibia	1.65	825.42	3,045	2,030	3.4
South Africa	45.10	1,219.91	125,225	3,010	-1.4
Swaziland	0.97	17.36	1,048	1,160	-1.3
Tanzania	28.70	945.09			1.1
Uganda	19.57	236.04	3,718	200	3.0
Zambia	9.45	752.61	3,206	350	-1.3
Zimbabwe	11.14	390.58	5,424	490	-0.6
Region Total	**184.79**	**7,736.80**	**155,234**	**1,070**	**n/a**
Sub-Saharan Africa Total	**486.85**	**18,135.82**	**241,184**	**495**	**n/a**
World	**5,733.69**	**510,072.00**	**30,700,000**	**5,400**	**n/a**

(*) GNP estimates are based on the World Bank's Atlas method. To smooth fluctuations in prices and exchange rates, the World Bank uses a special Atlas method of conversion. This conversion factor averages the exchange rate for a given year and the two preceding years, adjusted for differences in rates in inflation between the country and the G-5 countries (France, Germany, Japan, United Kingdom, and United States). The resulting estimate is divided by the mid-year population estimate to obtain per capita GNP. **Source:** Country data from The World Bank, ***The World Bank Atlas, 1996;*** Washington, D.C.; 1995. World data from U.S. Central Intelligence Agency, ***The World Factbook, 1995;*** Washington, D.C.; undated.

The estimated mid-1995 population of East and Southern Africa is 184.8 million, or nearly 38 percent of the total population of Sub-Saharan Africa and slightly greater than 3.2 percent of the world's population (Table 1). On the other hand, the geographic size of the region is in excess of 7.7 million square kilometers (sq. km.), which represents 42.6 percent of the Sub-Saharan Africa region and 1.5 percent of the world's land mass. Therefore, the region's population density of 23.9 inhabitants per sq. km. is lower than Sub-Saharan Africa (26.8 people per sq. km.). Population density in the region ranges from 2.3 per sq. km. in Botswana to over 82.9 in more densely populated Uganda.

Per capita GNP in the region ($1,070) is one-fifth of the world's average of $5,400 but is more than twice the average for Sub-Saharan Africa. In terms of per capita GNP, South Africa, Botswana, Namibia, and Swaziland are more developed economically than the other nations of East and Southern Africa. With a per capita GNP of $3,010, South Africa leads the nations in the region in terms of the level of economic development.

In half of the countries of the region, the growth rate of real GNP/capita during the ten-year period from 1985 to 1994 has been negative. Botswana, however, with an average annual growth rate of 6.6 percent during this period, has experienced the fourth highest annual growth rate in the world, surpassed only by Thailand (8.2 percent), South Korea (7.8 percent), and China (6.9 percent). Other countries in the region with good annual growth experience in 1985-1994 include Mozambique (3.5 percent, despite a civil war), Namibia (3.4 percent), and Uganda (3 percent).

Historical Development of African Railways

During much of the colonial period, railways using steam power were the primary mode of transportation in Africa connecting the resource rich hinterland to the sea ports. The railway lines were built primarily for the purpose of developing the vast mineral and agricultural resources of the region. In order to maximize the region's export potential, the rail lines were built to radiate from the ports to the inland producing centers. They were built inexpensively with narrow gauge, steep gradients, and tight curves. The railways were designed for handling light axle loads. Several factors are important to an understanding of African railway systems today:

Incompatible gauges. In the Southern Africa region, the British built the railways with a track gauge of 3'6", commonly known as the Cape Gauge. The railways of East Africa were constructed by German companies to a one meter gauge. The difficulty of equipment interchange caused by this incompatibility of gauges limits trade and rail traffic between the countries of East and Southern Africa.

Shift to diesel power. During the 1950's and 1960's, most railways throughout the world began shifting from steam to diesel traction power. Since diesel equipment requires much less maintenance, service, and repair, this shift resulted in significant redundancies of staff, equipment, and infrastructure. At the same time, growing competition from trucks and efforts to deregulate rates and operations created additional pressures on railways to become more efficient. Therefore, in the ensuing years, most railways underwent a long and arduous evolutionary process. Those that could effectively adjust (such as the American freight railways) were able to improve their operations and profitability. Sub-Saharan Africa, however, was involved in political struggle during much of this period. Therefore, many of the railways in the region have not yet completed this evolutionary process.

Redundant facilities. As individual African countries gained independence, the large private railways of the region were broken up into smaller separate networks and nationalized. In many cases (such as in Uganda, Tanzania, Zambia, Botswana, and Namibia), the newly nationalized railways ended up without their own locomotive workshop. In all cases except Botswana, which has contracted out its heavy maintenance, major workshops have subsequently been constructed for each country's railways, largely through foreign donor assistance. In fact, when Zambia and Tanzania could not agree on the location of the mechanical workshop for TAZARA, one was constructed for each country. A third locomotive workshop was later constructed to serve a fleet of new USAID-financed locomotives. The breaking up of former regional railways into smaller national networks and disagreement on the location of a workshop in the only multi-national railway in the region resulted in expensive duplication of workshops throughout East and Southern Africa (Figure 2).

The individual railways operating in the region, with the exception of Spoornet, the South African railroad, do not have enough locomotives to justify their own workshops.

Skilled staff. In many countries, much of the skilled staff left when independence was declared. This resulted in severe shortages of skilled labor able to perform maintenance or rehabilitation of rolling stock, track, and other railway equipment. This problem continues today in some areas because financially strapped countries cannot maintain adequate pay levels to attract or retain skilled workers. The railways often find it difficult to increase the pay scale for skilled shop workers without a corresponding increase in overall civil service pay scales.

Disruption of transport services. Cold war, independence movements, and civil strife resulted in the disruption of transportation services and alteration of traditional railway routes. Sabotage destroyed numerous railway bridges and other facilities, tore up track, and closed normal railway export routes to the ports, particularly in Mozambique and Angola. In some cases, it became necessary to construct new infrastructure. For example, TAZARA is a 1,860 kilometer Cape Gauge railway owned jointly by Tanzania and Zambia, built in 1975 by the Chinese to serve the copper exports of Zambia and Zaire, and to provide access for Botswana's, Malawi's, and Zimbabwe's exports through the Port of Dar es Salaam as opposed to traditional South African ports. With the establishment of majority rule in South Africa, the political necessity which favored use of TAZARA in the past is now over. The economics suggest that many of these exports will return to South African or Mozambique ports.

Donor priorities. Geopolitical struggles and disruption of traditional transportation routes in the region resulted in considerable financial support from foreign donors. The primary donor concern, at the time, was the possibility of immediate economic failure of landlocked countries and the potential danger of famine if the regional transportation networks were destroyed. Donor projects were often justified on humanitarian and disaster-avoidance considerations, rather than long-term economic and regional development criteria. The donors provided substantial financial support for track replacement, rolling stock, staff training, and institutional development.

Figure 2: Location of Locomotive Workshops in East and Southern Africa

This is a digitally created sketch. All locations are approximate.

In summary, the current railway environment in East and Southern Africa is not simply the consequence of normal business practices and market-based conditions, but it is rather a combination of exogenous non-economic factors. The international donor community has, for the most part, successfully tackled many of the physical and rehabilitation problems associated with track, equipment, and infrastructure of East and Southern African railways. Today, with a few exceptions (such as Angola), the railways of East and Southern Africa have sufficient physical equipment and resources to move current traffic.

Unfortunately, the donor agencies and African governments have been much less successful in dealing with the operating efficiency and productivity problems of the railways. In many cases, the government owned and operated railways require massive annual subsidies to continue operations. There has been, until recently, only limited coordination of donor efforts. The donors have found it difficult to get the African railways to undertake the often painful, frequently difficult, and almost always politically risky task of reducing staff and rationalizing assets and operations. TAZARA, for example, had as many as 16 donor agencies assisting it at one time. But it has yet to complete a comprehensive restructuring plan. With donor fatigue already affecting many African countries, improving the long-term financial viability and competitiveness of Africa's railways is the next important task for the railways and their governments to undertake.

Despite the problems of the region's railways today, they still are an important factor in Africa's future transportation and development. Transit distances are long. A large proportion of the region's freight traffic consists of low value, high volume raw materials and minerals. These are conditions favorable to railway transportation. Despite operational constraints caused by narrow gauge and, in some cases, light axle loads, efficiently managed and cost-conscious railways can compete effectively against the trucking industry and provide shippers with good service. Shippers and consumers of the region would benefit from lower freight rates and better transport services resulting from increased competition between truckers and railways. Lower freight rates mean increased competitiveness in world markets for the region's exports. This is especially important for high volume, low value raw materials where price elasticity of demand is significantly higher than for other types of commodities.

NEED FOR THE STUDY

Despite substantial financial support by regional governments and international donors, most East and Southern African railways are unprofitable, offer poor service, and are losing traffic to trucks. The principal problems are due to poor efficiency and productivity of railway operations rather than a need for new equipment or infrastructure. While there are many reasons for the poor railway performance (excess staffing, government interference, and poor training, to name a few), low locomotive productivity (poor availability and reliability) has been highlighted as a particularly serious problem in numerous studies over the last few years.

Low locomotive productivity has been an endemic problem of East and Southern African railways. Despite the fact that all of these railways have their own locomotive workshops and have received substantial donor support, technical assistance, new equipment, and spare parts, most African locomotives (with the possible exception of those in South Africa) break down more frequently and take longer to fix than locomotives in other parts of the world. Locomotive availability and reliability problems have resulted in significantly increased costs and poor service. These problems also are a significant contributor to the railways' annual deficits and loss of market share to motor carriers.

One aspect of this problem is caused by the small size of many East and Southern Africa railways and the number of railway workshops. While the railways provide periodic maintenance services and some repairs (such as traction motor replacement), they do not have enough locomotives, traffic or skilled staff to justify undertaking major repairs, overhauls, and rehabilitation of their locomotives. Outside of South Africa, for example, there are only about 900 locomotives in all of East and Southern Africa. A central locomotive repair and maintenance facility serving several railways would be a more economical way to take advantage of the economies of scale and to maintain staff skills than the multiple workshops that exist today.

As shown in Table 2, Spoornet, the largest of the national railway systems in the region carries about 14 times (176 versus 12.3 million tons) the freight handled by the second largest system, the National Railways of Zimbabwe (NRZ). NRZ, in turn, carries six times the average freight (12.3 versus 2 million tons) of the remaining railroads. In terms of traffic units (combined freight ton kilometers and passenger kilometers), the combined traffic units of Spoornet and NRZ constitute 91 percent of the total regional traffic (Figure 3). Clearly, many of the region's smaller railways cannot justify their own locomotive workshop and would benefit from regional consolidation. While the railways provide periodic maintenance services and some repairs (such as traction motor replacement), they do not have sufficient locomotives, traffic or skilled staff to justify undertaking major repairs, overhauls, and rehabilitation of their locomotives.

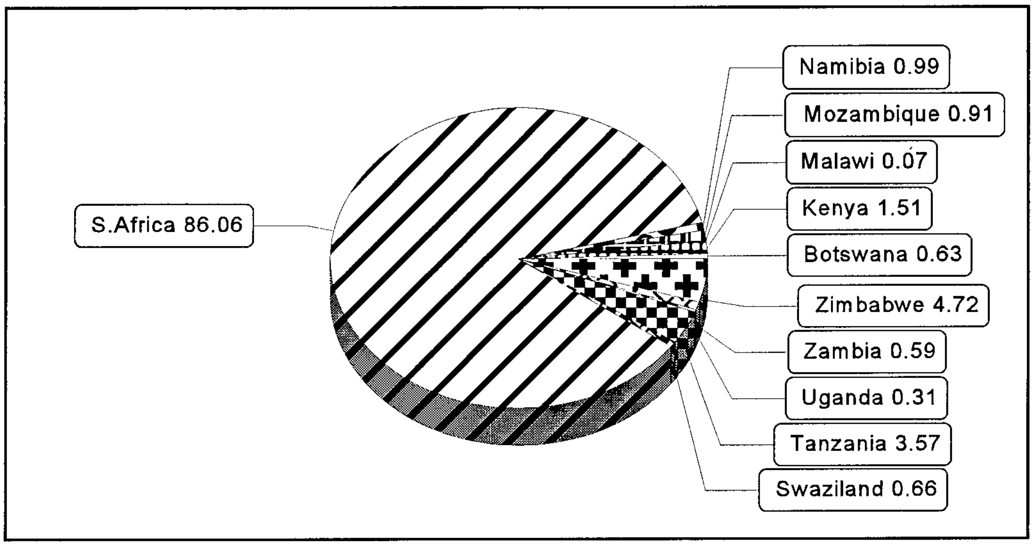
Table 2: Railway Traffic, 1995

Country	Freight Tons (000)	Passenger Trips (000)	Ton-Km (million)	Passenger - Km (million)	Traffic Units (million)
Botswana	1,760	525	603.5	104.5(1)	708.0
Kenya(1)	2,200	1,600	1,282.0	408.0	1,690.0
Malawi	368	431	61.4	16.9	78.3
Mozambique	3,104	4,529	892.2	120.2	1,012.4
Namibia	1,734	110	1,076.5	34.7	1,111.2
S. Africa	175,956	2,202	95,591.2	1,021.0	96,612.2
Swaziland	4,284	-	742.8	-	742.8
Tanzania(1)(2)	1,835	3,024	2,808.6	1,195.2	4,003.8
Uganda	880	368	237.6	99.4	337.0
Zambia	1,881	920	446.3	213.9	660.2
Zimbabwe	12,269	1,871	4,754.0	546.0	5,300.0
Total					**112,255.9**

(1) Data for 1994. (2) Data includes TAZARA and Tanzanian Railways Corporation. **Source:** Southern Africa data from Southern Africa Transport and Communications Commission (SATTC), ***Annual Report 1995-1996;*** Maputo, Mozambique; data for other nations from Jane's Information Group Ltd., ***Jane's World Railways 1995-1996, 37th Ed.;*** Surrey, United Kingdom.

The need for a consolidated locomotive rehabilitation facility and parts warehouse in East and Southern Africa has been expressed and studied before by the UAR, other regional railway entities such as the Southern Africa Transportation and Communications Committee (SATCC) of Maputo, Mozambique, the World Bank and other interested organizations. The World Bank, for example, has held three locomotive maintenance seminars in Sub-Saharan Africa since 1988, the most recent being in Namibia in July 1994. In all cases, speakers and seminar participants have mentioned the advantages of consolidating major locomotive maintenance functions and of creating a centralized locomotive parts warehouse as ways to improve availability and reliability. and to reduce costs.

Figure 3: Share of Traffic Units in East and Southern Africa (%)



In 1993, USTDA hosted an Orientation Visit (O/V) involving railway officials from Botswana, Ghana, Kenya, Mozambique, Tanzania, Tunisia, Uganda, and Zambia. Delegates participating in the O/V expressed a need for a regional locomotive repair facility capable of servicing a wide variety of locomotive types and models, and of stocking spare parts to improve locomotive availability and reliability. In August 1994, USTDA received a request from the UAR for a feasibility study to evaluate the establishment of a regional locomotive rehabilitation facility and parts warehouse in either East and/or Southern Africa. Based on the UAR's request, USTDA funded a Definitional Mission which recommended that such a feasibility study be conducted.[2]

As a result of the Definitional Mission recommendation, USTDA provided a grant to the UAR to contract for the feasibility study services. TERA, in cooperation with the Electro Motive Division of the General Motors Corporation and Transportation Systems Division of the General Electric Company, was selected by the UAR to conduct the study.

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[2] S. Rowitz and Associates, ***Definitional Mission for Africa Regional Locomotive Rehabilitation Facility;*** prepared for USTDA; Buffalo Grove, IL: February 22, 1995.

Study Objectives and Scope of Work

The primary objective of the study is to assess means of improving locomotive availability and reliability through:

- Establishment and operation of a regional locomotive repair facility or facilities and parts warehouse; and
- Evaluation of alternative approaches to locomotive repair and maintenance.

The study originally envisioned the following three Phases:

Phase 1 of the study consists of an evaluation of the viability and sustainability of a regional locomotive rehabilitation facility and parts warehouse. The first phase work concentrates on an analysis of current railway operations and emerging trends in light of the need for a regional facility to achieve improved locomotive availability and reliability. An evaluation of the feasibility of alternative approaches to improving locomotive availability and reliability is also provided.

Phase 2 of the study will use the findings and conclusions of Phase 1 to discuss participation in the organization and operation of the locomotive rehabilitation facility, parts warehouse, and other alternative approaches with potential U.S. suppliers and manufacturers. The purpose of this Phase is to identify potential U.S. participants for the recommended course of action and solicit their commitment to its implementation.

Phase 3 of the study will be concerned with the preparation of organizational documents and operating agreements and assistance in the negotiation of the institutional framework necessary for the implementation of TERA's recommendations. Assistance will also be provided in the preparation of project financing documents, if required, for consideration by bilateral and multilateral financing organizations.

This Report describes TERA's findings and conclusions for the first Phase. The Phase Report is prepared after a field trip by TERA to discuss needs and preferences with officials of individual railways. In addition, extensive discussions were held with GM-EMD and GE, two U.S. locomotive manufacturers supporting TERA in this study.

Based on TERA's findings and conclusions in Phase 1, the nature and scope of services recommended for Phases 2 and 3 are somewhat different from the originally envisioned scope described above. Sections H and I of this Report describes TERA's findings, conclusions, and the recommended courses of action for the remaining phases.

C - EMERGING TRENDS

INTRODUCTION

The railway environment in East and Southern Africa is undergoing rapid change, affecting not only the scope and viability of railway operations, but also the basic operating pattern for railway activities such as locomotive overhaul. For several decades, decisions concerning railway investments and operations have been influenced by central government planning, geopolitical conditions, and relief objectives. In many cases, funding, was supplied by donor agencies and was dominated by immediate humanitarian objectives. Similarly, governments set rates and established staffing and service levels without regard to the impact on railway finances. Little attention was paid by either donors or governments to the institutional structure of the railways. These practices distorted normal market conditions and led to inefficiencies.

Three emerging trends exogenous to, but affecting the viability of the railways, are described in this Section. Implications of these trends to railways' restructuring, profitability, and operations are described in Section D.

POLITICAL STABILITY

With the end of the cold war, the emergence of majority rule in South Africa, and the termination of armed struggle in much of the rest of the region, the railways in East and Southern Africa now have to concentrate on improving their profitability and productivity. As governments open their economies, normal market incentives and planning become important factors in this drive. Railways face increased government pressure to reduce or eliminate operating losses. While peace and a stable political environment provide favorable conditions for growth, they also remove some of the excuses that railways used to explain their losses and poor service.

LOSS OF DONOR ASSISTANCE TO RAILWAYS

Donor assistance to the development of East and Southern African railways has been substantial. The aggregate USAID contribution to the SADC Program of Action from 1981 to 1993, for example, was $415 million, of which $281.5 million or nearly 68% was allocated to the transport sector. A little over $190 million or 67% of the transport sector assistance was for railways, approximately $60 million was for roads, and the balance of $31.5 million for intermodal projects. The World Bank, Canadians, British, French and others donated hundreds of million dollars more.

Table 3 presents a brief listing of donor assistance by individual railways in Southern Africa. It should be emphasized that the table is not intended to present a complete list of assistance. The totals given for each country represent only a part of assistance given. For example, Chinese assistance to the construction of TAZARA and French support for the Nacala corridor are not included. Despite these shortcomings, the projects included depict a broad range of assistance

Table 3: Donor Activity by Railway

Donor	Malawi Railways	TAZARA	Zambia Railways	Zimbabwe Railways	Mozambique Railways[5]	Swaziland Railways	Botswana Railways
USAID	Locomotive. Rehab., car repair, marine depot rehab., Nacala line rehab., floating dock ext. 95-97: restructuring, labor retrenchment	17 locomotives., Mbeya w/shop, training, tech.asst., tools & equip., w/shop artisan training, cargo center	Overhaul of 25 locomotives.	13 locomotives., repowering 43 locomotives., spare parts	W/shop extension, locomotive w/shop & rehab. equip., tools & spares, shunting locomotive., financial system, rehab. 11 locomotives.	Tech. asst., accounting system & track maint. system	Communications equipm.
UK-ODA	Track rehab., concrete sleepers, ballast prod., w/shop imprv.			Telephone exchanges, track repair and wagon maint. equip.	Rolling stock & spares, tools, jacks, forklifts, tech. asst., toxic waste disposal, rehab. of line, w/shop, & locomotives.		
EEC		Crushing plant, TERA/a track maint., wheel lathes, forklifts, tire induction heaters, arc welders, w/hop equip.			Track rehab., tech. training, equip. For school, railway line study	Misc. training asst.	
IBRD			Fourth railway project, infrastructure rehab.	Org. & operational restructuring	Tech. asst. & training, 6 shunters, line revitalization		

Sweden-SIDA		Quarry equip., welding equip.& training, 350 wagons, proj. coord. assistance, commercialization study			Track. rehab.		Train control system, signaling and telecom. system, tech. asst.
Denmark-DANIDA	Tech.Asst.	Telecom. & signaling feasibility study		Locomotive. maint. audit	Wagon rehab., w/shop study	Dry port facility study	Mech. w/shop asst., tech. asst. For inland terminal
Finland-FINNIDA		Rescue crane, rerailing equip., accident prevention equip.		Auto-transformers	Track rehab.		
Germany-KfW		Locomotives., manpower development plan	Coach modification, w/shop equip.	CTC, line rehab., telecom. & signaling upgrade	Rescue crane, track. rehab., signal system, training		
Swiss AID	Radio sets	Track maint. equip., tech. asst., 39 trolleys, rail repairs			Training		
AfDB		Rectification of landslides	Track rehab., CTC, digital microwave radio and multiplex				
Austria		Track welding and maint. equip., spare parts, rectification of landslides		Central elec. w/shop equip.	Track maint. & repair equip., tech. asst.		
Norway-NORAD		Manpower development plan, computerization of personnel data	W/hop & locomotive study, branch line viability		Locomotive. hire asst.		
Canada-CIDA	Nacala Track Rehab., sleepers				Track. rehab., 10 locomotives., line rehab. study		

Belgium	5 shunters		2 shunters, w/shop equip., wagon assy., tech. asst.				
Italy			Quarries, track renewal equip.		Track. rehab., radio-telecom. system, line & track rehab., wagon rehab., tech. asst. & studies		
France	Nacala track rehab.				Track. rehab., 15 locomotives.		
Japan			Overhaul of 12 locomotives, spare parts		5 locomotives.		Wagons, equip. For maint. depot
Kuwait Fund					Wagon control system		
OPEC					Line rehab.		
China		Soft loans for line construction, new locomotives, parts, coaches, scholarships					Track maint., rails and equip., tech. asst.
India	Training asst.						Track studies
Portugal	Nacala track rehab.						
Total ($ Million)	36.6(1)	157.4(2)	28.4(3)	46.4(4)	351.3(6)	6.9(7)	12.3(8)

(1) Includes U.S. and Belgium only; (2) Does not include AfDB and Chinese assistance; (3) Includes U.S., Belgium, and Italy only; (4) Does not include IBRD and Denmark; (5) Includes assistance provided to CFM-N, CFM-C, and CFM-S; (6) Does not include United Kingdom, Norway, and OPEC assistance. Includes only $45.2 million from France for track rehabilitation; (7) Includes U.S. only; (8) Includes U.S. Danish, Japanese, and Chinese assistance only.

activities in infrastructure investments, provision for rolling stock, technical assistance, and training amounting to $639.3 million to the seven railway systems of the Southern Africa region.

With changes in geopolitical priorities and in response to their own increasing budgetary pressures, the donor agencies have begun a reassessment of their priorities for foreign aid. Not only have the conditions that led to substantial donor support for African railways changed, but the donors have developed what one prominent magazine calls "donor fatigue." Donor governments are cutting back funding for assistance and railways should expect very little future financial support, particularly for infrastructure projects, or provision for new rolling stock. Whatever donor assistance there is, will be primarily focused on institutional reform and railway restructuring efforts.

INCREASING HIGHWAY COMPETITION

As new roads are built and existing ones rehabilitated, highway competition is increasing throughout East and Southern Africa. Truckers are reducing transit times and offering improved service. As in much of the rest of the world, there is substantial debate over whether truckers are paying their fair share of highway costs. The railways claim that in many cases, user charges in the form of fuel taxes, annual license fees, and other dues collected from commercial truck operators do not fully cover the cost of road construction and maintenance. Weight limits for highway vehicles have been increased. This allows truckers to carry more cargo[3]. Usually there is no corresponding increase in user fees to reflect the incremental road maintenance costs due to the increased weights. In the railways' view, this is a subsidy of the road user that allows truckers to reduce tariffs and increase competition with the railroads.

The truckers counter that the substantial road taxes that they pay often go directly to the national treasury and frequently are not spent on roads. They also point to the railway deficits financed by government budgets and donor assistance as a much greater subsidy than the truckers receive.

Regardless of the merits of either side, the fact remains that trucks are able to compete effectively against the railroads and that railroads have lost considerable traffic to trucks. In the present regulatory environment railways are unlikely to get much protection against truck competition from governments. If they want to survive, the railways must become more efficient, cut costs, improve service and market their services more aggressively.

These needs are beginning to be recognized in the region. "Many railways of the region are production driven and not market oriented. The railways of the region need to become market driven and reach out to customers and design [develop new] services to meet emerging customer needs. A

[3] For example, South Africa has recently increased the truck gross vehicle weight (GVW) limits to 60 tons, compared to 36 tons in the United States and 40 tons in all Western European countries except Sweden, which also allows a GVW limit of 60 tons.

sustained marketing effort is required not only for retaining existing, but also to attract new customers. Since the markets are changing rapidly, the response has to be dynamic. Today, the customers are more demanding and seek higher levels of service with respect to predictability, [shorter] transit times, integrated door-to-door service, security, tracking of consignments, and speedy settlement of claims."[4]

Highway competition is, and will continue to be, an increasingly significant problem for the region's railways. The governments will continue to improve and expand the road network or at least not actively discourage trucks. Trucks offer flexibility and complete door-to-door service. Railways must offer good service at low cost if they are going to compete effectively.

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[4] E. M. Hachipuka, "Review of Some Key Issues With Regard to SADC Railways Restructuring and the Evaluation of the Desirability of Separating Management of Rail Infrastructure from Operations"; a paper delivered at the ***SADC Railways Policy Options Workshop;*** Pretoria, South Africa: September 9-11, 1996, p.14.

D - IMPLICATIONS FOR THE RAILWAYS

INTRODUCTION

The emerging trends of peace and political stability, disappearing donor financial support, and increased highway competition described in Section C have important implications for the railways. Governments are unwilling to continue financing massive annual railway deficits. They are willing to give the railways greater autonomy to make their own business decisions, but in turn are demanding greater railway responsibility for the outcome. Shippers are demanding better service and are turning to truckers when they do not get it from the railways. The railways must restructure and cooperate more closely on a regional basis or face further substantial loss of business and government support.

Most of the region's railways have recognized the importance of these trends and are beginning to search for strategic ways to effectively respond to them. Two principal responses, restructuring and increased regional cooperation, that have a significant impact on the viability of a regional locomotive rehabilitation facility and a centralized parts warehouse are described in this Section.

RAILWAY RESTRUCTURING

International donors have been assisting African railways since the 1950's in an effort to improve their operations. Until the 1980's, these efforts focused primarily on providing capital investments, including locomotives, track rehabilitation, spare parts, as well as some training. The results were often disappointing. Most African railways continued to lose traffic to road haulers and incur large annual deficits that required government subsidies.

Since the late 1980's and early 1990's, however, the emphasis pursued by multilateral and bilateral donors has shifted toward institutional reform to improving the operational efficiency of the railways. All East and Southern African railways are government owned parastatals. They are generally characterized by poor service, limited tariff flexibility, and surplus staff. The new strategy seeks to lessen the dependency of the railways on state subsidies and establish them as autonomous commercial enterprises through "restructuring".

Restructuring is a process of transforming troubled state-owned transport organizations into stand-alone (financially self-sufficient) enterprises operating on commercial principles (even though the government may retain ownership). This activity has been led by the World Bank in collaboration with USAID, Canadian CIDA, and other donor agencies.

The principle behind restructuring is that the African railways, as other transport enterprises, should be able to operate as commercial entities. They should also be able to finance their operations and replace capital assets without subsidies from their national governments or grants from donors. Subsidies should only be necessary if national governments insist that the railways carry uneconomical traffic (i.e. passenger traffic or government freight).

This concept is supported by international experience and academic research. "Regulation of railways is still a major handicap militating against fair competition between railways and other modes of transport in many countries. Deregulation of rates and service provisions, abandonments, mergers, and a host of other features by [in] the U.S., particularly after the Staggers Act in [of] 1980, has [have] demonstrated the remarkable way in [by] which deregulation can assist vitalization of a dying railway system and restore [its] competitive vigour."[5]

As the traffic levels, financial condition, and operational performance of the railways continued to deteriorate with poor availability and utilization of locomotives and rolling stock, many African governments sough external assistance in order to restructure their railways and reverse the decline. Competition from the mostly private trucking sector in these countries highlights the railways' problems and indicates the importance of market-driven business operations.

Most East and Southern African railways are either undergoing (or have proposed) restructuring and privatization programs. On-going or proposed restructuring and concessioning efforts include the National Railways of Zimbabwe, Swaziland Railways, CFM/South in Mozambique, Zambia Railways, Tanzania Railway Corporation, Malawi Railways, Kenya Railways, and Uganda Railways.[6]

Railway restructuring can take many forms, although all forms of restructuring seek to:

- Rationalize the railway's staff and management structure, and upgrade locomotives, rolling stock, and facilities to bring them in line with projected traffic demand;
- Divest non-core railway assets and ancillary services;
- Promote private sector participation in all aspects of railway operations and ancillary services;
- Introduce efficient rail operations, procedures, and practices through technology transfer and the provision of technical assistance and training; and
- Reorganize the railways such that they are commercially oriented and financially viable.

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[5] S. Kasy Aiar, "International Experience With Railway Restructuring", a paper delivered at the ***SADC Railways Policy Options Workshop;*** Pretoria, South Africa: September 9-11, 1996, p.i.

[6] For a description of restructuring programs in these and other African railways see Transportation and Economic Research Associates, Inc. (TERA); ***Transport Africa: Project Resource Guide***; prepared for U.S. Trade and Development Agency's Conference Linking African Buyers with U.S. Suppliers of Transportation Equipment and Services; Cleveland, OH: September 9-11, 1996; pp. 267-280.

Early efforts in the late 1980's and early 1990's to restructure African railways into becoming commercially viable transportation enterprises met with mixed success. The restructuring initiatives were often too timid and incremental. The Governments found it difficult to act as shareholders and ensure commercially sound behavior. The railways found it either too difficult or impossible to shed excess staff and unprofitable operations. These problems led donors to seek new approaches to railway restructuring. Current World Bank and donor efforts for restructuring and privatizing African railways are now focusing on concessioning.

Concessioning is aimed at reaching an agreement between two contracting parties (the national Government and the private operator or concessionaire) to transfer railway operations to a private operator. The terms of the arrangement are set forth in a concession agreement. Three basic conditions of the concession agreement are:

(1) Ownership of the railways' infrastructure is retained by the government;

(2) Railway operations are performed as commercial activities at the concessionaire's risk; and

(3) The concessionaire has flexibility to change tariffs, staff, or equipment according to market conditions.

Concessioning also has some important advantages to potential investors over other railway restructuring alternatives such as privatization. "One of the features of concessions is that the initial capital cost for taking over the operation of the railway is much reduced as compared to outright purchase. This broadens the market for private sector participation and enhances competition. Furthermore, implementation of the concession option is simpler and takes [a] much shorter time than the sale of a railway."[7]

Typically, concession arrangements are: (a) a mixture of a strict concession in which the required investments are financed by the concessionaire; or (b) a franchise or leasing arrangement in which new investments are financed by the government. Railway concessioning differs from railway privatization in that under a concession arrangement there often is no sale of assets. While provisions of the concession vary in each case, in most cases the concessionaire will have the option of deciding what level, if any, of existing railway equipment and staff it wishes to retain.

It is too early to evaluate the impact of future concessioning on the performance of African railways. Concessioning seems to be working well in other parts of the world where it has been tried, such as Argentina and United Kingdom. However, one result which can be anticipated with confidence is that future locomotive overhaul and repair decisions, including those that involve a

[7] J. Sondhi, "Application of Railway Concessioning to the SADC Region",a paper delivered at the ***SADC Railways Policy Options Workshop;*** Pretoria, South Africa: September 9-11, 1996, p.ii.

regional locomotive workshop, will be made by restructured railroads and concessionaires in an open market environment. Therefore, decisions concerning present workshop facilities, as well as the establishment and operation of a regional locomotive workshop by the railways, must take into account the future needs and requirements of restructured railroads and concessionaires.

INCREASED REGIONAL COOPERATION

The establishment of majority rule in South Africa has stimulated renewed regional cooperation in transportation and other areas. South Africa has become a member of the Southern Africa Development Community (SADC) and Spoornet, its railway, is a member of the Southern Africa Transportation and Communications Commission (SATCC). A new institution, Southern Africa Railways Association (SARA) has been established recently for better coordination between the regional railways in promoting railway interests with national governments and international agencies. Co-chaired by Spoornet and the National Railways of Zimbabwe, SARA is actively involved in countering the competitive advantage gained by road haulers.

The railways of Uganda, Kenya, and Tanzania were, at one time, part of a single railway known as the East African Railway. The railway was split into national entities in 1976, at a time when there were serious political differences between the three countries. Originally, the centrally located workshop in Nairobi was the only locomotive workshop in the region. After separation, bilateral aid agencies provided assistance to Uganda and Tanzania in building their own workshops in Kampala and Morogoro, respectively. The three railways recently signed a series of cooperation agreements intended to improve coordination of railway operations and move toward a possible future reestablishment of some form of a new East African Railway.

Although national boundaries still exist, new cooperative agreements in both East and Southern Africa are beginning to allow the railways to operate in an integrated manner similar to earlier times. These efforts toward closer cooperation considerably enhance the likelihood of coordination among the region's railways for establishment of a regional locomotive workshop.

E - Issues Affecting Locomotive Availability and Reliability

Introduction

The railways of East and Southern Africa are dealing with a number of problems in their efforts to improve operations, reduce costs, and increase market share. These include overstaffing, poor operating practices, limited marketing, and excess equipment. One of the most serious of these problems, however, is low locomotive productivity. Locomotive productivity, in turn, is influenced by several factors including operating procedures, type and volume of traffic, condition of track, etc. Locomotive availability and reliability are two critical factors affecting productivity.[8] When a locomotive is not available to handle traffic, or if it becomes "out of service" while carrying traffic, it cannot earn revenue. The cumulative impact of low locomotive availability and reliability on productivity and profitability can be substantial.

In Africa, locomotive availability and reliability problems are primarily related to the railways' maintenance practices and the ready availability of quality repair parts. The concept of consolidating locomotive workshops is based on the potential to reduce maintenance costs and improve locomotive availability and reliability. With a world-wide emphasis on just-in-time inventories, shippers are increasingly relying on predictable service schedules to plan their operations. They are willing to pay truckers a premium over rail rates to guarantee delivery times when rail service is uncertain. This has frequently happened at African ports where coastal ship schedules are fixed.

The seriousness of the locomotive problem in Africa was noted in the Windhoek, Namibia Locomotive Maintenance Seminar Proceedings: "... the availability and reliability of [locomotives in] most Sub- Saharan railways remain far inferior to those of railways in other parts of the world, owing principally to insufficient and inadequate maintenance combined with a high rate of failures and accidents. Excluding Spoornet and TransNamib, over 26 percent of the locomotive rosters sampled were out-of-service, awaiting accident repairs or major overhauls. A further 14 percent were undergoing casual repairs as a result of line failures or reported defects, while another 16 percent were stopped in shops and depots for programmed maintenance. These statistics show that much remains to be done on many railways in the field of motive power maintenance and operation to keep locomotives efficiently on the road".[9]

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[8] Locomotive utilization is a third factor which affects productivity. Although these three factors are closely interrelated (increased availability and reliability directly contributes to increased utilization), locomotive utilization is also affected by train size, scheduling and dispatch procedures, bi-directional cargo potential, equipment interchangeability, average speed, line condition, etc.

[9] ***Locomotive Maintenance Seminar Proceedings;*** Windhoek, Namibia; July 27-29, 1994; p.6

The principal focus of this Section is on issues which affect locomotive availability and reliability. Following a description of factors affecting locomotive productivity, the Section continues by estimating the cost of an idle locomotive to the typical regional railway, and describing the locomotive maintenance and repair process. This Section also describes the basic problems facing workshops in the region and the benefits of workshop consolidation. The future locomotive demand and the surplus locomotive problem are discussed, as well as locomotive costs and other economic considerations associated with locomotive availability and reliability.

FACTORS AFFECTING LOCOMOTIVE PRODUCTIVITY

Depending on the type of locomotive and terrain, a typical locomotive in the region should be able to haul 600 to 1,200 net tons, with an average speed of 30 kph. At 85 percent availability, with 60 percent utilization, the locomotive is capable of producing 80 to 160 million ton-km/year.[10] Zimbabwe, with 30.6 million Traffic Units (TU = passenger km + ton km) per locomotive, has the highest TUs/year in the region, while some railways are as low as four million TUs. All the railways, therefore, have a substantial opportunity to lower costs by increasing the annual traffic units each locomotive hauls.

It should be noted that poor locomotive productivity can be caused by factors other than low locomotive availability and reliability, such as track conditions and operational problems. This is true for some railways in the region where the low locomotive productivity, as measured in terms of TUs/year, can not be entirely attributable to low locomotive availability and reliability. For example, reducing availability from 85 percent to 40 percent in the above example and keeping the other variables constant, would result in 37.8 million to 75.7 million TUs/year. These figures are still significantly higher than the productivity of all the railways in East and Southern Africa. It is, therefore, evident that when the railways are operating at productivity figures as low as 4 million to 25 million TUs/year, operational factors which directly affect productivity such as average speed, net tons carried, utilization (percent of time loaded), hours of work per day, number of work days per year, etc., must also be considerably lower than the typical values assumed above. Nevertheless, a substantial part of the locomotive productivity problem is caused by low availability and reliability.

Definition of Availability

There is no standard way to define or measure locomotive availability. The general practice is to include those locomotives that are available for freight and/or passenger service at a fixed time every day. Some railways measure this twice a day, others every hour, and still others determine availability based on whether the locomotive will be available within the next hour or even during that day (usually done to avoid including locomotives just being refueled). The method chosen can account for two to five percentage points in average locomotive availability.

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[10] This computation is based on the assumption that the locomotive will work for 365 days per year for 24 hours per day. At 85% availability, the total working hours per year is 7446 (365*24*0.85). At an average speed of 30 kph, the annual locomotive kilometers is 223,380 (7446*30). At a utilization rate of 60%, the annual revenue producing train kilometers is 134,028 (223,380*0.6). At an average trailing weight of 600 and 1,200 tons of cargo, the annual ton-km is 80.4 and 160.8 million, respectively.

Which locomotives are included in the fleet is also important. Are heavily damaged but repairable locomotives included? Mechanical departments argue against inclusion on the grounds that heavy accident damage is not a reflection on the performance of the mechanical department; so these locomotives should not be included in the availability totals. Zambian Railways, for example, recently retired 23 locomotives, retaining only those that fit their fleet rationalization policy. Of the 68 remaining locomotives, 24 are seriously damaged but could be repaired if funds were available and traffic warranted it. Based on the 44 active locomotives, 28 are available on a typical day, for a 63.6 percent availability. However, based on the total fleet size of 68 locomotives, the availability is only 41.2 percent. In this case there are two availability figures, one based on the total fleet on the railway's books, the other being based on the locomotives that are actively being used (active fleet). The choice of availability figures depends on the purpose that it is being used for. The book fleet figure helps to identify potential surplus assets, the active fleet figure is useful for evaluating locomotive productivity. Care must be taken, however, when comparing different railways since locomotive availability may be measured differently.

The following factors affect locomotive availability:

- **Fleet Condition.** This includes age and types of locomotives, and period of time since last overhaul.

- **Availability of spare parts.** This in turn, is a function of good management information, funding, and the problems associated with ordering parts, such as letters of credit, customs delays, proximity of the source of parts, procurement procedures, etc.

- **Workshop and Depot Capacity.** It is a well known phenomena that excess workshop and depot capacity frequently lowers locomotive availability. This is because "work expands to fill the allotted space and time". Basically, it is necessary to have a locomotive waiting outside the facility to encourage workshop employee productivity. Railways should actively find ways to reduce workshop capacity to a minimum.

- **Workshop and Depot Operations.** A modern, well-staffed and equipped facility can perform its work efficiently. It requires, for example, about 525 man-hours to overhaul a 16 cylinder engine, plus about 150 man-hours to remove and re-install the engine, or a total of 84 man-days. In a two man workshop, this would take more than two months during which the locomotive would be out of service. In a large workshop, with 12 men assigned to the work, it would take only 1.5 weeks. Given that the engine overhaul procedure may take place every eight years, then the impact on locomotive availability would be 6.3 days/year or 1.7 percentage points. Some railways can do an eight year mechanical overhaul in three days, while others take three months, a difference of three percentage points in locomotive availability. This can have a substantial on the locomotive's annual revenue producing capacity.

- **Type of Service.** Locomotives in heavy haul service require more maintenance.

Definition of Reliability

There are a number of definitions of locomotive reliability. In principle, it is the number of km between locomotive failures. But the definition of failure varies among railways. Some railways define it as any locomotive failure that delays a train for more than 10 minutes. Others use 60 minutes, while others may indicate a failure only if the railway has to dispatch another locomotive to haul the train. As with locomotive availability, care must be taken when comparing locomotive reliability data between railways.

The following are the principal factors which affect locomotive reliability:

- **Frequency and Quality of Maintenance.** Manufacturers have a general recommended schedule for periodic and major locomotive maintenance. This schedule should be modified to the specific conditions of each railway. Generally, the closer this schedule is followed and the better the quality of the maintenance, the higher the reliability of the locomotive.

- **Parts Quality.** The better the quality and the design of the spare parts used (as measured by the form, function, and fit), the more reliable the locomotive.

- **Driver Skill and Experience.** Poor driver skill can cause failure. On the other hand, a knowledgeable driver can spot and quickly fix problems.

- **Type of Service.** Locomotives in heavy haul service are more prone to failure.

- **Communications.** The reliability figure also can be affected by the availability of radios on the locomotive that allow the driver to radio in for expert advice.

An important observation must be made concerning the impact of locomotive availability and reliability and their potential effect on customer traffic and perceived railway performance. Since most railways have surplus locomotives, availability problems can be relatively easily handled. Because locomotive reliability is defined by unpredictable events, it can not be easily planned or handled. Reliability problems affect not only the traffic on board the affected train, but also on all the trains which have to stop while the failed locomotive is being fixed or removed. Increasing locomotive reliability (i.e., reducing the number of failures) has a direct bearing on the railway's performance and quality of service as perceived by shippers, passengers, and consignees. Therefore, improving locomotive reliability is a more critical factor in this region than improving locomotive availability.

COST CONSIDERATIONS

The cost to the railway of poor locomotive availability and reliability is significant. A new locomotive delivered in Africa costs about $2 million. The annual ownership cost, assuming a capital recovery rate of 10% per year and an economical life of 25 years, is approximately $225,000. In addition, fixed inspection and maintenance costs amount approximately $25,000 annually.

A locomotive only earns revenue when it is moving in service with a revenue paying load or passengers. A detailed discussion of economic factors associated with locomotive ownership and operation, which affect the profitability of the region's railways is presented later in this Section. However, the fixed costs of the typical regional locomotive moving 25 million TUs per year is approximately $0.01 per TU. Therefore, a 50% utilization rate results in a total locomotive power charge of $0.02 per TU. Since the railroad must also cover track maintenance and other operating costs, it is little wonder that many railways in Africa are having a hard time competing with truckers whose cost (depending on type of road, truck, fuel cost, and road user tax) can vary from $0.035 to $0.10 per ton km. The current operating deficits of many African railways would be much worse except for the fact that they had substantial donor assistance in acquiring locomotives.

There are several ways that railways can keep average per ton km motive power costs down. These include: (a) adopting improved scheduling and operating procedures to increase average revenue traffic per train and reduce empty backhaul; (b) rationalizing fleet size to eliminate surplus locomotives; (c) better marketing to increase traffic; and (d) improving locomotive maintenance, repair, and overhaul procedures. This study deals primarily with the impact of improving locomotive maintenance, repair, and overhaul procedures. Other measures to reduce costs or increase profitability, although at least as important as locomotive availability and reliability, are not within the technical scope of the study.

THE MAINTENANCE AND REPAIR PROCESS

Types of Maintenance

A locomotive consists of a number of subassemblies such as the engine, a transmission system (electric or hydraulic), controls, braking system, frame, bogies and body.

The locomotive, when purchased, comes with a schedule of recommended maintenance practice that is based on kilometers or time for a locomotive in normal use. This recommended practice will indicate what inspection, maintenance, overhaul, and replacement should take place, and when. A railway with a computerized locomotive management information system, can track the performance of specific components on an individual locomotive and often improve upon the manufacturer's recommended maintenance schedule, thereby improving locomotive availability and reliability.

The locomotive maintenance process can be divided into the categories shown in Table 4.

Table 4: Maintenance Tasks

Tasks	Approximate % of Total Man Hour Requirement (*)
Daily inspection and fueling	35
Periodic inspections and light maintenance	25
Heavy maintenance (overhaul or replacement)	25
Minor repair, heavy repair, accident repair	15
Total	**100**

(*) Based on North American Railways

These maintenance tasks are performed in three basic types of maintenance facilities:

- **The Fueling Facility.** This is where the locomotive receives its fuel and daily inspection. Usually this consists of checking for leaks. Maintenance may involve the replacement of minor items such as burned out lights. As modern fueling facilities become more expensive with pollution control equipment and powerful pumps (to minimize time required for fueling), railways become more interested in minimizing the number of fueling facilities.

- **The Maintenance Depot.** Periodic inspections and light maintenance along with minor accident repairs are done in maintenance depots. The number of depots needed depends on the fleet size, system geography, and traffic patterns. By planning locomotive and train assignments to position a locomotive at the depot when it is time for an inspection or maintenance, it is possible to reduce the number of depots needed. There are railways where a single depot services a fleet of 500 locomotives, and railways with 20,000 km of track that have only two depots.

- **Locomotive Workshop.** Major maintenance and repairs are done in workshops. This is also where all locomotive subassemblies are sent for overhaul and/or repair. There should be no more than one workshop per railway. Single workshops can serve locomotive fleets of up to 4,000. Table 4 shows that workshops account for about 30% of total locomotive maintenance tasks (25% for heavy maintenance, plus approximately 5% for heavy accident repair). Workshop consolidation could save a substantial portion of the costs associated with these tasks.

Overhaul Frequency and Man-hour Requirements

The major components or subassemblies which are likely to be shipped to a regional workshop for overhaul are listed in Table 5. The man-hour requirements for component overhaul are based on a typical North American railway. The frequency is based on 16,000 km a month average, which is 75 to 100 percent more than the average for the region's locomotives.

Table 5: Locomotive Components subject to Overhaul

Subassembly (No of Units installed/Locomotive)	Typical Overhaul Frequency *	Typical Man-hours per Unit	Man-hours/ Locomotive/yr
Injector (16)	1	1	16
Power Assembly (16)	3	7	37
Water and Fuel Pumps (3)	3	3	3
Governor (1)	4	13	3
Turbo Charger (1)	4	20	5
Engine w/ 16 cylinder (1)	12	525 **	30
Generator/Alternator (1)	12	82	7
Auxiliary Generator (1)	4	10	3
Traction Motor(6)	3	32	70
Cooling Fan (2)	4	4	2
Radiators (Locomotive set) (1)	6	171	30
Blower Motor (2)	4	2	2
Relay Sets	4	2	10
Bogies (Pair-1)	6	175	30
Wheel Sets (6)	3	10	20
Air Brake Valve Set(1)	4	57	14
Air Compressor(1)	6	45	8
Total			**290**

(*) Represents number of years between overhauls
(**) Includes above components

The table shows, for example, that a locomotive's 16 injectors are overhauled each year. It takes one man-hour per injector. Therefore, the annual man-hours needed to maintain 16 injectors are 16 hours. The workshop manpower requirement is 290 hours per locomotive per year for subassembly overhaul. If an additional 60 hours is added for accident repair, the average annual man-power requirement is 350 hours of workshop direct labor per locomotive. Even if direct labor utilization is as low as 50%, each locomotive would require approximately 4 man-months of direct labor in the workshop. Based on this computation, a fleet of 200 locomotives should be efficiently served by 67 workshop employees. Adding another 13 employees for administrative support, overhead, and other indirect tasks would result in a total workshop employment of 80 employees, or 0.4 jobs per locomotive. The workshop employment in the region is considerably above this norm.

BASIC PROBLEMS OF THE WORKSHOP

Steam to Diesel Conversion

Steam locomotives are labor intensive, requiring 10 times as much labor to maintain as diesel locomotives. The demise of the steam locomotive, therefore, created a large surplus of workshop capacity. Because the diesel locomotive is more powerful and can be better utilized, diesel locomotives replaced steam locomotives on a three for one basis. Increased highway competition and traffic loss, further reduced the need for locomotives and thus the need for maintenance facilities and staff.

Unit Exchange

The need for workshops is also effected by the increased use of unit exchange. Under unit exchange a railway replaces an old part for a new or rebuilt part. This increases locomotive availability since the locomotive does not have to wait while the subassembly is overhauled. It also allows the depot to do maintenance (parts exchange) that used to require a workshop for parts overhaul. The unit exchange has resulted in some overlap between the roles of the workshop and maintenance depot.

Unit exchange of subassemblies is generally regarded as the only logical approach for maintenance and repair of locomotives. Its primary advantages are: (i) Increased locomotive availability because the locomotive does not have to wait while the failed subassembly is being overhauled; (ii) Minimum skill requirement because the maintenance depot workers primarily serve as part changers; and (iii) Specialization at the workshop level of skilled workers.

Despite these advantages, customs regulations in the region do not permit widespread practice of unit exchange. This is especially true for subassemblies and components which are marked with a serial number for identification. When such an item is exported to a regional workshop for exchange with a new or rebuilt part, the amount due for the replacement part is established after the workshop completes overhaul on the old part. The replacement part is usually shipped without an invoice since repair of the old part in many cases would not have been completed. The customs regulations usually allow a temporary export and import privilege subject to duty collection at a later date when the price is established. However, because of the difference in the serial numbers between the old and the new part, establishing the value subject to duty becomes a complicated issue.

Railway Size

A brief description of each railway and basic data appears in Section G. A summary of principal size characteristics appears in Table 6. Most of the railways, by international standards are small. In fact, if a direct comparison is made to the railways of the United States, there is essentially one Class 1 railway (Spoornet), one regional railway (Zimbabwe), and a number of short lines. In the United States, the regional railways and, especially branch line railways, depend heavily on Class 1 railways for second hand locomotives, as well as traffic. With respect to traffic, this is already largely the case for Southern Africa, and may also become the case for locomotives.

In terms of total route length, excluding South Africa, the rest of the railways combined in East and Southern Africa are smaller than Poland or Ukraine and about one-half of France. South Africa's route length of 31,733 km is slightly less than France. In terms of Traffic Units, the regional total excluding South Africa, is about equal to Hungary or Slovak Republic or Turkey. South Africa's TUs is about 10 percent less than France or five percent more than Poland.

Table 6: Summary Railway Characteristics, 1995

Railway	Route Length (km)	No of Locomotive-motives	Ton-Km (Million)	Passenger-Km (Million)	TU/Route Km (000)	TU/ Locomotive(Mil)	TU/Employee (000)
Botswana	887	41	603.5	104.5*	798.2	17.3	493.1
Kenya	2,652	156	1,282.0*	408.0*	637.3*	10.8*	92.0
Malawi	789	18	61.4	16.9	99.2	4.4	70.1
Mozambique	1,890	105	892.2	120.2	535.7	9.6	10.3*
Namibia	2,382	71	1,076.5*	34.7*	466.5*	15.7*	576.3*
S.Africa	31,733	3,516	95,591.0	1,021.0	3,044.5	27.5	1,558.3
Tanzania (+)	4,460	191	2,808.6	1,727.6	1,071.1	23.7	254.6
Uganda (*)	1,241	60	208.0	34.8	195.6	4.0	63.0
Zambia	1,273	68	446.3	213.9	518.6	9.7	120.0
Zimbabwe	2,759	173	4,754.0	546.0	1,921.0	30.6	408.5
Total/Avg.	50,066	4399	107,723.5	4,227.6	2,236.1	25.4	843.5

(*) Data for 1994.
(+) Includes TAZARA. Data for 1993.

In short, when South Africa is excluded, the rest of the railways in the region are small in comparison to other railways in the developing world. They cannot all afford individual locomotive workshops and would benefit from regional consolidation.

Surplus Workshop Capacity

At a time when technology suggested a reduction in locomotive workshop capacity (due to conversion from steam to diesel engines), the railways of East and Southern Africa were, largely through foreign assistance, building workshops. Following is a brief description of existing workshops in the region today.[11] The list does not include numerous depots some of which approach the capability of a workshop.

EAST AFRICA

Kenya: Nairobi. This facility was the workshop for the East Africa Railways and serviced the locomotive fleet of what is now the separate railways of Uganda, Tanzania, and Kenya.

Tanzania: Morogoro. This facility was constructed after the disintegration of the East Africa Railways. The workshop does a limited amount of component work for TAZARA's diesel electric fleet.

Uganda: Kampala. This facility was constructed after the disintegration of the East Africa Railways. The facility was specifically designed to service a fleet of diesel hydraulic locomotives.

TAZARA: Mpika and Dar es Salaam. These workshops were constructed in the mid-1970's to service the original fleet of 125 diesel hydraulic locomotives. The facilities also were designed to maintain wagons and passenger coaches. These facilities are identical in every respect, except the Mpika facility has an oxygen generating plant. Each facility has approximately 1,000 machine tools.

TAZARA: Mbeya. The Mbeya facility has been recently constructed and equipped to maintain a relatively new fleet of diesel electric locomotives. A new underfloor wheel lathe is presently being installed. Due to the limited fleet of diesel electric locomotives, equipment to overhaul rotating electrical equipment has not yet been installed. TAZARA is the only railway with workshops in East and Southern Africa region that regularly sends overhaul work to other railways and private companies.

SOUTHERN AFRICA

Botswana: Mahalapye. This shop is actually a "heavy" maintenance depot. The railway contracts out much of its locomotive repair and overhaul work.

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[11] Figure 2 on page 15 presents a map showing the location of workshops in the region.

Malawi: Limbe. Given the size of the railway and locomotive fleet, this workshop is relatively well equipped. To a certain extent, this is a result of being relatively cut off from other railways.

Mozambique: Maputo. This facility was built in the early 1970's to manufacture and maintain a fleet of some 200+ steam engines for all of the Mozambique railways. This facility is far larger than required to maintain the current diesel locomotives assigned to CFM (South). The diesel depot is currently being renovated and modernized to serve as the workshop.

Mozambique: Beira. The maintenance depot in Beira has been, in the last 10 years, upgraded to undertake many of the functions normally performed by a workshop.

Mozambique: Nampula. The depot in Nampula has been, in the last 10 years, upgraded to undertake many of the functions normally performed by a workshop.

Namibia: Windhoek. Namibia Railways was operated by the South African railways until 1988. When the railway became autonomous a workshop was constructed.

South Africa: Bloemfontein, Koedoespoort, Cape Town, Durban, East London, Port Elizabeth, Germiston. Spoornet has seven very large workshops. Given the size of the facilities and virtual monopoly on long distance freight under the previous government, there was little pressure to modernize the workshops. Today, these facilities would be considered to be poorly equipped and in need of rationalization and modernization. Essentially, any one of these facilities could have the capacity for the entire railway.

Zambia: Kabwe. With the disintegration of the Rhodesia Railways, Zambia was left without a locomotive workshop. As a result, in the 1970's a large facility was constructed at Kabwe. The equipment in this facility was recently upgraded under several aid projects.

Zimbabwe: Bulawayo. The Bulawayo workshop was originally constructed as the central facility for the Rhodesia Railways. It is a very large facility due to the fact that it was originally designed to manufacture steam engines. The railway is in the process of rationalizing (reducing the size) and consolidating this facility. This workshop has been assigned the maintenance of the General Electric locomotives of the National Railways of Zimbabwe.

Zimbabwe: Mutare. This workshop was originally built for the locomotives that operated on the most important Rhodesia Railway line between Harare (Salisbury) and the port of Beira. This workshop is in the process of being improved to service the General Motors locomotives that are currently assigned to it.

The 22 locomotive workshops in East and Southern Africa service a total fleet of approximately 4,400 locomotives, an average of 200 per workshop. If the Spoornet fleet and workshops are excluded, the 15 remaining workshops service about 900 locomotives, or an average of 60 per workshop. These averages clearly indicate a significant surplus of workshop capacity in East and Southern Africa.

Training and Pay

There is a lack of trained mechanics and management on many of the African railways although various donors have over the years financed various technical assistance projects specifically aimed at improvements in locomotive maintenance. These programs usually consisted of consultants being retained often for a period of years to train employees and assist the railway management in improving its locomotive maintenance practices. Generally, long term conventional technical assistance is only marginally successful because consultants often serve in an advisory capacity and usually have no line authority. In addition, there is no financial incentive or penalty to the consultant for the project's success or failure.

Low pay also makes it very difficult for the railway to retain skilled mechanical staff or compete with the private sector. It is very difficult for the government-owned railways to raise the pay of one part of their labor force without generating pressure to raise the pay of all workers. As an example of the problem, on the jointly owned TAZARA railway Zambian employees are paid significantly less than the Tanzanian counterparts. Poor pay often results in trained employees working at two jobs or leaving the railway for better paying jobs. In many cases it also results in theft from the railway.

Parts Availability

Availability of locomotive parts and components is frequently cited as a serious problem contributing to the low availability of locomotives. Many railways view this as a recurring problem with OEMs and provide examples of specific instances where the needed part is no longer supported by the OEM and no suitable replacements are recommended. In some cases, the needed part is a small quantity order, which does not qualify for a special production batch run and needs to be consolidated with other orders of the same part to manufacture. Such manufacturing delays can add months to the delivery time.

On the other hand, OEMs frequently cite railways' problems in correctly and timely identifying the needed part, and delays in following international competitive bidding procedures and making satisfactory payment arrangements as major problems causing delays in parts delivery.

Regardless of the cause, the fact remains that some parts take longer to produce and receive. However, as long as the lead time for acquisition is realistically predicted, the part order cycle can be adjusted to accommodate any anticipated delay in delivery. Therefore, the ability to predict future parts needs and acquisition lead times is crucial to improve the availability of parts.

Several of the African railways have fairly effective inventory control management information systems that are used to prepare a parts order. When it comes to tracking parts usage for specific locomotives, however, railways use hand written log books. Checking the usage of specific parts is done manually. A locomotive maintenance management information system can go a long way to solving the problem by essentially computerizing the log book. It also provides extensive additional benefits. With this system, the railway can track part usage patterns, determine quality performance, determine maintenance cost, and more accurately project spare parts requirements. It is also useful in determining the cause(s) of parts failure. Locomotive maintenance management information systems can be run on existing personal computers and are relatively inexpensive. They are also capable of increasing locomotive availability by 2 to 5 percentage points simply by adjusting scheduled maintenance to balance work loads.

BENEFITS OF WORKSHOP CONSOLIDATION

The greater the number of locomotives a workshop handles, the more opportunity there is for specialization of labor and the introduction of sophisticated equipment. This reduces the likelihood of human error and the dependence on a highly skilled mechanical staff. For example, when a railway overhauls only one traction motor a year, it cannot afford $500,000 for motor test equipment. Instead, the motor is installed and "tested" in the locomotive. If, on the other hand, a workshop is overhauling five motors a week, the average cost per locomotive for the test equipment is only $200.[12] The motor is tested before installation and any problems are fixed before they affect locomotive reliability. By specializing in one maintenance task, a mechanic can become an expert. The need for master mechanics is greatly reduced while the quality of the maintenance improves.

A review of the various railway workshops indicates that, while they have most of the equipment to overhaul locomotive components, they largely lack sophisticated test equipment, specialized cleaning equipment, and pollution control and treatment equipment. In the current environment, African railways will not be able to afford this equipment for each workshop and sooner or later this will encourage them to consolidate or out source heavy maintenance work to specialized regional workshops.

There are economies of scale in maintenance, as well as improved quality from having larger locomotive workshops. Since the total number of locomotives in the Southern African region (excluding Spoornet) is about 450, one shop could easily maintain the fleet. Given geographic separation and the political problems, however, many of the benefits could be achieved if the workshop specialized in different major components, such as mechanical and electrical. There might be two or three workshops, which install subassemblies overhauled at another location.

[12] Assuming a ten-year economic life for the test equipment.

Recognizing the need for a privately owned and operated consolidated regional locomotive repair and maintenance facility in Southern Africa, O. Conolly and Co. (PVT) Ltd. of Bulawayo, the GM-EMD authorized contract shop in Zimbabwe, proposed such a facility in early 1994.[13] The proposal was a natural extension of Conolly's work in the repair of accident damaged GM locomotives, which was supported by USAID and Canadian CIDA. As envisioned by Conolly, the proposed facility would be located in Bulawayo at the company's existing premises, would be fully owned and operated by the private sector, and would focus on the following functions:

- Major overhauls ("F" and "G" services for GM locomotives);
- Locomotive re-manufacture, including complete accident damage repair and return of equipment to specification; and re-power, fleet refurbishment, and modification projects;
- Component level overhauls and rebuilds, including traction motors, engines and sub-components, air compressors and exhausts, alternators, generators, fractional hp motors, air brake components, oil and fuel pumps, turbo chargers, water pumps, bogies (trucks), and locomotive system assemblies and sub-assemblies;
- Locomotive manufacturing (construction of local order for NRZ and "short runs" for GM);
- Training (satellite facility for GM trainers to perform classroom and hands-on training for all African railways operating GM locomotives); and
- Regional spare parts supply depot for GM locomotives serving as a regional spare parts facility, including supply of locally manufactured components such as axles, couplers, hoses, etc. and a unit exchange parts facility.

Bulawayo is approximately at the weighted average geographic and motive power center of the railways in Southern Africa excluding Spoornet. Its location is especially convenient for Zimbabwe, Botswana, Zambia, and Mozambique. This private sector initiative, if implemented in a revised format (such as a joint venture that allows use of NRZ's workshop facilities in Bulawayo would accomplish many of the major benefits expected from a regional workshop facility.

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[13] O. Conolly and Co. And W. Graves and Associates, ***Regional GM Locomotive Maintenance and Repair Facility: Proposal for Investment in Private Sector Development;*** Bulawayo, Zimbabwe: January 28, 1994.

It should be emphasized that a regional workshop, while important, would address only 30% of the maintenance tasks associated with locomotives (Table 4). Although a consolidated workshop would contribute to improved locomotive availability and reliability, this contribution would, therefore, affect approximately 30% of any such improvement.

FUTURE LOCOMOTIVE DEMAND

Total demand for transportation services is primarily based on total population, population density, geography, and per capita income. Numerous models and statistical relationships have been used to predict the demand for transportation and derive the need for transport equipment. In a majority of cases, a set of socio-economic and physical (geographic size, terrain, etc.) factors are used as antecedent variables to forecast transportation demand as an intervening variable from which equipment needs are estimated as the dependent variable. Regardless of the predictive technique's format and quantitative rigor, this paradigm generally offers a logical conceptual framework to support equipment planning and acquisition decisions.

In a similar manner, locomotive demand can be forecast based on population, population density, geography, and per capita income. As income grows, a larger percentage of passengers shift from rail to road. Similarly, as income grows, the proportion of high value goods (televisions, furniture, etc.) increases and an increasing share of freight transport shifts from rail to trucks. The use of this technique is much less precise for land-locked countries with a high degree of transit traffic or where most exports are bulk minerals or agricultural commodities. Nevertheless, Table 7, based on a comprehensive study of world locomotive demand[14], provides an interesting perspective on future locomotive needs in the Southern and East Africa region.

It should be emphasized that the model's predictions are not very sensitive to the GDP per capita growth rates assumed. Every 10% change in the GDP growth rate will cause a change of 1% in estimated locomotives. For example, if the annual GDP growth rate for South Africa is changed from 0.8% to 2.5% (a 212.5% increase), the estimated locomotives for 2008 will be increased from 1,482 to 1,792 (20.9% increase).

Table 8 shows the present and estimated fleets for railways in the region. Railways summarize their locomotive fleet in several ways. The fleet on the books includes all locomotives that the railway owns whether or not they will ever be used again. Sometimes government rules will not allow the railway to scrap locomotives. Therefore, the fleet on books usually represents an inflated asset base for the railway. For example, during the civil strife in Mozambique, Malawi Railways carried locomotives on its books that had been destroyed in Mozambique or those that it had not used in several years.

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[14] David Burns, ***A Worldwide Railway Locomotive and Multiple Unit Market Analysis;*** Riverforest, IL: December, 1995.

Core fleet or relevant fleet includes stored locomotives in usable condition, locomotives that could be repaired or put back into service should money and traffic be available. It often includes locomotives that have been damaged through no fault of the mechanical department.

Table 7: Future Locomotive Needs

Railway	Population (Million)	Population Growth (%)	Income/ Capita ($)(2)	Growth/ Capita (%) (3)	# of Core Locomotives 1996(1)	Estimated Locomotives 2008
Southern Africa						
Botswana	1.3	3.5	4,690	9.8	41	87
Malawi	8.8	3.3	800	3.1	18	16
Mozambique	16.1	2.6	600	1.5	92	60
Namibia	1.5	3.1	1,500	1.0	73	51
S. Africa	38.9	2.5	5,500	0.8	3,586	1,482
Zambia	8.3	3.6	1,010	0.8	68	66
Zimbabwe	10.1	3.4	2,160	3.1	167	170
East Africa						
Kenya	25.0	3.8	1,350	4.2	156	174
Tanzania	25.2	3.0	570	2.9	194	121
Uganda	16.9	2.5	1,120	0.1	55	26
TAZARA (4)					60	48

Most data relates to 1992-1994, with the exception of locomotive data which is 1996. (1) The few remaining steam engines have been ignored, all other types of locomotives are considered. (2) The "Purchasing Power Comparison" instead of the conventional rate of exchange has been used. (3) Per capita income growth rate is a historical figure. (4) Data prorated 50-50 between Tanzania and Zambia.

SURPLUS LOCOMOTIVE PROBLEM

As shown in Table 8, almost all the railways currently have surplus locomotive capacity. The surplus rises substantially over the next decade. Since there is a very limited world demand for Cape Gauge locomotives, most of the surplus locomotives are expected to be scrapped, cannibalized, re-manufactured or sold for parts. In the short run, however, the surplus locomotives will have several effects on the railways. First, they will keep the cost of locomotive power and spare parts low by providing a competitive alternative to new locomotives or OEM parts.[15] Second, they may allow the

[15] A similar situation existed in the United States in late 1970's when there was a surplus of 5,000 locomotives. It was possible to buy a locomotive in good running condition for $10,000. Therefore, railways were buying locomotives just for the spare parts. Until the market cleared in mid-1980's, sale of new parts and components was considerably limited.

railways to delay changing their maintenance practices and avoid consolidation of workshops. Third, surplus locomotives will substantially dampen the need for new locomotives and the viability of a regional workshop.

Table 8: Present and Estimated Fleets for East and Southern Africa Railways (Number of Locomotives)

Railway	Fleet on Books	Core Fleet	Estimated 2008 Fleet	Current Surplus	Future Surplus
Southern Africa					
Botswana	41	41	87	-	-
Malawi	37	18	16	19	2
Mozambique	111	92	60	19	32
Namibia	88	73	51	15	22
S. Africa	3,644	3,586	1,482	58	2,104
Zambia	82	68	66	14	2
Zimbabwe	304	167	170	137	-
East Africa					
Kenya	199	156	174	43	-
Tanzania	180	194	121	-	63
Uganda	73	55	26	18	29
TAZARA	-	60	48	-	12
Total				**323**	**2,266**

In the long run, the locomotive surplus will disappear. At that point the railways will have to pay the full capital costs for new locomotives and parts. This could cause significant future financial problems unless the railways improve their maintenance and operating practices.

An important observation to be made from Table 8 relates to the derivation of the current surplus figures. The current surplus is estimated by deducting the core fleet from the fleet on books. In so far as the existing core fleet represents the current inefficient operations, any improvement in present levels of locomotive availability, reliability, and utilization will result in additional surplus locomotives unless an increase in traffic causes a corresponding offset. Given that the current locomotive productivity of a typical railway in the region is approximately 25 million TUs/year, the existing core fleet inherently includes a significant number of surplus locomotives. Stated differently, if the average locomotive productivity is not increased (by improving the TUs through aggressive marketing), any increase in locomotive availability will not result in any measurable benefit to the railways. It will just increase the number of available but idle (i.e., surplus) locomotives.

Because of its relative size compared to the railways in the rest of East and Southern Africa, developments in Spoornet have a significant impact on other railways. Therefore, it is important that any consideration of a change in current locomotive repair and overhaul practices take into account the outlook for surplus locomotives in the region, particularly Spoornet.

During apartheid, particularly in its latter stages, South Africa had very limited access to oil, but a plentiful supply of domestic coal. As a result, there was a concerted effort to emphasize the railway, particularly as a means of freight and commuter passenger transportation. Not only were there restrictions placed on freight movements by road vehicles, there was extensive electrification. The electrification was even undertaken on light traffic lines that, under normal circumstances, would not have been electrified.

There are approximately 8,000 people per equivalent locomotive (one electric locomotive equals 1.25 diesels or eight multiple unit passenger coaches equals one diesel) in South Africa, compared to an average of about 17,000 for the developed countries. However, the per capita GNP is $3,010, about 20 percent of that of the developed countries. Argentina, which has a similar population and almost three times the per capita GNP has about 30,000 people per locomotive. This indicates an overemphasis on railways by a factor of approximately 10 in comparison to countries with similar socio-economic characteristics.

In the aftermath of apartheid, the government has gone from legislation favoring railways to allowing a strong competition by trucks. South Africa now permits 60 ton gross vehicle weight trucks. The United States railways, which are regarded as some of the world's most efficient, are just about able to compete with 36 ton trucks. This would indicate that Spoornet must become very efficient if it is to be a viable railway. This is especially true since the country already has a good road network.

On the other hand, annual TUs per locomotive in South Africa are about 27.5 million, which is about typical for a developing country. However, when compared to similar freight-oriented railways, such as United States (87 million) and Canada (110 million), they are very low.

The above facts alone indicate that there is (or there could be an eventual) surplus of about 2,000 locomotives. Spoornet has indicated that they will have 600 diesel and 370 electric surplus locomotives by the year 2001. Although there is not much demand for electric locomotives in other countries in the region, there is a large number of surplus diesel locomotives in South Africa. The railway has retained a major consulting company to develop a restructuring plan. What this will look like is too early to tell, and the ability of the railway to implement it is also very difficult to forecast.

However, the fact remains that the Southern Africa region has a significant number of surplus locomotives. Based on past experience in other countries, most surplus locomotives will be scrapped for parts. Some will be rehabilitated and sold to other railways as second hand locomotives and some will be leased with or without maintenance. Spoornet is already leasing 10 diesel locomotives to Kenya Railways under a five-year contract which includes maintenance at the lessee's workshops in Nairobi and a guaranteed minimum availability. This lease indicates that the surplus locomotive problem in East Africa is not as pronounced as in Southern Africa, which is one reason why there is more interest in contract maintenance in Uganda and Kenya.

LOCOMOTIVE COST

Most railways in East and Southern Africa have acquired locomotives through foreign aid or government assistance. As a result, the purchase cost of the asset recorded in the railways' accounts may not represent the full cost of acquisition. However, the railways are increasingly expected to fully recover their costs. Therefore, it is important to reflect the true cost of owning and operating a locomotive as if its purchase cost is fully internalized.

A new locomotive delivered in Africa costs about $2 million. Assuming an opportunity cost of capital at 10 percent, the annual fixed capital recovery cost is approximately $225,000. Additional fixed costs must be incurred for inspection, insurance and time-dependent maintenance costs. These fixed costs would be in the range of $25,000 per year. Therefore, the cost of owning the locomotive, i.e. fixed costs would be $250,000 per year.

It is expected that, under assumptions of full cost recovery, the railway's revenues would be sufficient to cover the costs of ownership of a locomotive. The larger the TUs produced by the locomotive, the lower is the fixed cost of ownership per TU. For example, if the locomotive generates one million TUs per year, the average cost of locomotive ownership is $0.25 per TU. Given the current levels of locomotive productivity, the highest cost of locomotive ownership in East and Southern Africa is in Uganda ($0.062 per TU) and Malawi ($0.057 per TU). The lowest is Zimbabwe ($0.008 per TU) and South Africa ($0.009 per TU).

The variable (marginal) costs of operating a locomotive include wear and tear, lubricating oil, distance-related maintenance costs, and other expenses in support of locomotive operations. These costs are generally expressed on a per kilometer basis and are in the range of $0.50 per kilometer. On the average, the total fixed and variable costs of operating a locomotive in the U.S. is about eight percent of total revenues and the average freight revenue is $0.02 per ton-kilometer. Therefore, to recover only the fixed costs of locomotive ownership in the U.S., the total ton-km required is 156 million per year (250,000/(0.02*0.08)). Given that the average locomotive use in the U.S. is 87.5 million ton-km, this means that only locomotives which produce approximately 60 percent more than the average would economically warrant the purchase for business expansion. This, in fact, is the case.

In order to effectively compete with road transport, the railways must maintain a tariff structure which is 10-30 percent less than truck rates. This cost differential is necessary to offset the lower transit time and higher flexibility offered by trucks. The general range of railway tariffs, worldwide, is $0.02 to $0.07 per ton-km. Assuming an average tariff of $0.045 per ton-km in the region, to warrant the purchase of a new locomotive the minimum traffic level required is 69 million ton-km per year (250,000/(0.045*0.08)). This minimum level of locomotive productivity is more than twice the highest performance in East and Southern Africa (Zimbabwe) and 3-17 times the performance of the eight small railroads in the region.

This indicates that the region's railways must significantly increase the productivity of their locomotives to be able to justify the purchase of new ones (this does not include fuel efficiency and tractive effort considerations). In the mean time, they must improve the performance of their existing fleet, through improvements in availability, reliability, and utilization. Furthermore, given the current low TUs/locomotive, low revenue potential per locomotive, and the availability of surplus locomotives in the region, it is expected that there will be a very limited market, if any, for new locomotives or major components in the foreseeable future.

ECONOMIC BENEFITS OF IMPROVING LOCOMOTIVE AVAILABILITY AND RELIABILITY

Economic Benefits

The economic benefits to the nation derived from improvements in locomotive availability and reliability can be quite large if these improvements result in a shift of traffic from road vehicles to railways, or if new traffic is generated by the lower cost rail transport. The latter phenomenon is especially relevant in bulk raw material exports typical of East and Southern Africa with low value to weight ratio where the world markets are sensitive to changes in price. Low railway costs compared to trucks make the country's exports more competitive in world markets and imports less expensive to the consumers.

The societal benefits are estimated by multiplying the cost differential between the average ton-km cost for road vehicles and railways by the additional ton-km made possible through improvements in locomotive availability and reliability. Any additional costs associated with generating these improvements are subtracted. This method assumes that sufficient rail competitive traffic exists to utilize the additional locomotive capacity made available through improvements in availability and reliability and that the railway will use the incremental capacity efficiently.

Estimating the cost differential between rail and road transport is one of the principal difficulties of the method described above. Rail transport cost is inherently lower on a per ton km basis than truck transport. Average freight rates for the regional railways range from $0.01 per ton km (TAZARA) to $0.07 per ton km (Malawi and Uganda). The corresponding figures for South

Africa and Zimbabwe is $0.02, for Kenya $0.04, Tanzania $0.05, and Zambia $0.06.[16] Road transport costs generally range from $0.06 to $0.10 per ton km[17], thereby resulting in a higher cost per ton. However, trucks offer complete and faster service. Therefore, the shipper perceived cost advantages of rail transport is usually more than offset by the ease and convenience associated with trucks.

Assuming a conservative estimate of $0.025 per ton km as rail cost savings over road transport and the average locomotive utilization of 25 million TUs per year in the region, the societal benefit associated with a modal shift to rail is $625,000 per locomotive per year (25 million*0.025). This benefit is based on the current average locomotive utilization rate of approximately 50% in the region. If the locomotive availability is increased by ten percentage points to 60%, the TUs per year would be increased to 30 million per locomotive. At the same cost savings of $0.025 per ton km, the incremental economic benefit to the society would be $125,000 ((30 million TUs*$0.025)-$625,000) per locomotive. Except South Africa, there are 924 locomotives in the core fleet in the region. Therefore, the potential economic benefits of increasing availability by ten percentage points is $115.5 million. This benefit is based on the assumption of available traffic.

It is much harder to quantify the economic benefits expected from improving locomotive reliability. Poor reliability can take many forms ranging from a failed injector that causes a loss of power and increases fuel consumption to complete locomotive failure en route (line of road failure). The latter type of failures result in out-of-service locomotives and wagons, reduced track capacity, additional cost for standby locomotives, possible accident damage, and likely theft of goods.

On some of the region's railways, there is a locomotive failure every 3,000 km or as high as 20-30 failures every year. This compares to about three failures per year for an American locomotive in a developed country. When the failure is longer than one hour, another locomotive is usually sent to haul the train and take the failed locomotive back to the workshop. Some estimates put the typical impact of a line of road failure at one locomotive day per incident plus reduced wagon utilization, track capacity, and increased transit time. The impact can escalate if other trains are also delayed. Locomotive failures also severely impact on schedule predictability, a key factor in shipper satisfaction.

Railway Cost Savings

The potential cost savings to the railway from an improvement in locomotive availability depends on how the annualized locomotive capital costs are estimated and booked. Two methods are described below: The first method assumes the long-run perspective where new replacement is

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[16] Data for 1992 taken from Louis Thompson and Julie Fraser, "Financial Success Hinges on Productivity"; ***Rail Business Report: A Railway Gazette Yearbook for 1995.***

[17] Rodrigo Archondo-Callao and Asif Faiz, ***Estimating Vehicle Operating Costs;*** World Bank Technical Paper No. 234.

necessary. The second method assumes the short-term viewpoint where a locomotive rebuild is assumed. No attempt is made to quantify the benefits to the railways associated with improved locomotive reliability, such as better equipment utilization, faster average delivery time, reduced disruption of train schedules, etc.

Long-run Perspective. In the long-run locomotives must be replaced with new units. Assuming the annualized capital recovery plus fixed maintenance costs at $250,000, the daily cost is $684. An increase of ten percentage points in locomotive availability translates to an additional 36.5 days per year where the locomotive is in productive service and, therefore, the daily fixed cost is incurred to generate revenue rather than booked only as an expense. This translates to a benefit of $25,000 per locomotive per year. The annual benefit to the railways for the 924 locomotives in the region (except South Africa) is $23.1 million.

Short-run perspective. A railway with excess locomotives and stable or falling traffic levels can avoid some locomotive replacement costs by consuming surplus locomotive capital. In the long-run these assets will be used and the railway will have to assume full replacement costs as described above. Although African railways currently have some excess locomotives, many of them need substantial maintenance and repair and should not be counted in the core fleet.

The short-run perspective recognizes the current railway difficulties in the region and assumes that a locomotive will be operated under deferred maintenance to the point of failure, where upon it will be rebuilt. Assuming a rebuilding cost of $1 million, the annualized capital recovery cost is $100,000 and total fixed costs $125,000. This translates to a daily cost of $342 and a benefit of $12,500 per locomotive per year for an increase of ten percentage points in availability. The annual benefit to the railways for the same fleet of 924 locomotives is $11.55 million.

The above estimates are provided only as rough approximations of possible benefits from improving locomotive availability. They do, however, illustrate several important points:

- The economic benefits to the society are much greater than the benefits to the railways.

- Societal benefits from improved availability and reliability are tied in to the assumption that incremental traffic is available for the railways to carry. Given inadequate marketing, stable or decreasing traffic in most railways, this may not be a realistic assumption for the region's railways.

- The benefits to any railway are not so large that they may not be outweighed by the costs associated with improved locomotive availability and reliability necessary to realize the benefits. For example, consolidating workshop facilities is not easily reversible and it may result in substantial staff redundancy costs.

F - Strategies for Improving Locomotive Availability and Reliability

Several alternative options have been suggested for improving locomotive availability and reliability and reducing costs per horsepower. Some of these options can be adopted either in conjunction with, or in place of workshop consolidation. They include leasing locomotives with maintenance, cooperative agreements, pooling locomotives, run through locomotives, a network of private facilities, a bonded spare parts warehouse, and contract maintenance with or without a leased power option. These alternatives and their relative applicability to the railways in the region are described in this Section.

Leased Locomotives with Maintenance

Under this arrangement another railway, a railway cooperative, or a private company provides locomotives for lease usually including major maintenance and repair. South Africa, on occasion, has leased locomotives to Mozambique, Kenya, Zambia, Zimbabwe, and Swaziland. Namibia has also leased locomotive power to Swaziland. Two shunters of Uganda Railways are used by the Kenya Railways at the port of Mombasa. Leased locomotives were also used during the recent drought relief program.

The railway leasing the locomotives obtains the benefit of guaranteed traction power and can concentrate its attention on core railway operations. The cost of a lease depends on many factors, including the age, capital cost, and type of locomotive; tax benefits such as accelerated depreciation, investment tax credits, etc.; eligibility for cross border financing; and commercial and currency risk. Until recently there has not been much competition in the leasing market. With an increasing number of surplus locomotives in the region, this may change and the cost of leasing may fall. A major difficulty concerning leasing, however, concerns the disposition of the railway's existing locomotive fleet. Most leasing companies are not interested in purchasing them.

The success of most leasing arrangements around the world has tended to be based on either tax advantages (a profitable leasing company can take advantage of depreciation and in some cases, investment tax credits to reduce its taxes) or donor assistance. Unfortunately, tax advantages which encourage leasing are not widely available in the region.[18] Furthermore, since most customs regulations in the region treat long-term lease programs as purchases subject to import duty, most leases are for two years or less.

Because of these reasons, locomotive leasing is not expected to be widely practiced in the region. The leasing alternative is likely to continue to be used primarily for special situations such as alleviating peak demand, capturing specialized tax advantages, or supporting donor financed operations.

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[18] The railways in the United States, for example, lease locomotives at very attractive rates. To the extent the U.S. leasing company takes advantage of the special tax treaties with Japan or Ireland, the advantages provided by double depreciation and other tax benefits allow a lease finance rate as low as one percent or less per year.

COOPERATIVE AGREEMENT

Under this arrangement, the region's railways could form a "maintenance cooperative", agreeing to use either a single regional facility or a number of specialized facilities. This would in effect be re-creating what existed before the breakup of the railways. With the recent agreements of cooperation among East African railways and the formation of SARA, there will be increasing interest towards further cooperation. Given the size of individual railways and the need of land-locked countries for transit railway service, cooperation among the region's railways is a necessity. However, many of the reasons which make leasing impractical also apply to the formation of cooperative arrangements. In addition, each railway has at least one well-equipped workshop. It would be difficult to reach an agreement on the location of a cooperative workshop.

POOLING LOCOMOTIVES

Railways involved in regular train movements sometimes establish a pooling arrangement where they supply locomotives to the pool in proportion to the length of the train movement over their track. Depending upon the train routing, the most convenient workshop maintains the locomotives with the locomotive owner responsible for the costs. There is no trackage charge for pooled locomotives. Pooling can increase locomotive scheduling and efficiency. Depending on the routing, it could enhance also the use of specialized maintenance facilities.

This arrangement is somewhat similar to the situation that existed before the break-up of the old regional railway systems. With the cooperation agreements that the East African railways are currently considering, they may be moving in this direction. For the present, however, since most railways are reluctant to even agree on locomotive workshop consolidation, they are not likely to be interested in locomotive pooling arrangements. Special situations exist, such as the Nacala line where pooled locomotives or a cooperative agreement might be applicable, particularly if the line is concessioned.

RUN THROUGH TRAINS

Much of the region's rail traffic crosses national borders and terminates on a different railway than the originating railway. Although rail wagons regularly travel the entire distance, locomotives are typically changed at the border. A number of recent studies have noted the operational advantages of run through trains. There also are locomotive maintenance advantages from the use of run through trains. Workshops and depots on each railway can specialize in different types of maintenance and repair. Opportunities exist for run through trains between Botswana and South Africa; from Francistown, Botswana to Bulawayo, Zimbabwe; between Zambia and TAZARA; in the Beira Corridor; and on the Nacala line.

Even though run through trains provide significant benefits, most regional railways have been reluctant to adopt them. A run through train, however, was used during the drought relief program between South Africa and Zimbabwe.

NETWORK OF PRIVATE FACILITIES

Railways in North America and Europe are beginning to use a network of privately owned facilities for the overhaul of many locomotive components. The private companies can handle work overflow from the railway's workshop, they are often cheaper, and they can provide specialized services that small railways cannot afford to maintain in-house. Use of private facilities also allows the railways to avoid staff adjustments as work levels change.

There is already a network of private businesses in Southern Africa including Union Carriage and Wagon Company, Conolly & Company and Dorbyl that could be more extensively used by the railways. Gailey & Roberts in Kenya also has heavy maintenance capability. It is quite likely that the network of private companies will increase if the railways' surplus locomotives are sold for parts or scrap. Newly concessioned railways are especially likely to take advantage of the cost savings that private workshops offer.

JOINT VENTURE WORKSHOPS

One alternative, where there is a need for new technology, investment, or training is to form a joint venture with several partners that may include both public and private sector entities. A joint venture operation can also be useful when the individual partners are too small to effectively operate alone.

The new joint venture being formed in Uganda provides an interesting example of this concept. Uganda has 47 diesel hydraulic locomotives. The railway and ADTranz are in the process of negotiating a joint venture agreement where the joint venture company would lease the workshop with employees and maintain the locomotives for a period of five to ten years. The joint venture company would be paid for maintenance under a minimum availability contract. ADTranz is providing new investment and training to the joint venture. Kenya Railways and the Tanzania Railway Corporation, which also use diesel hydraulic locomotives, are being given an opportunity to buy-in to the joint venture using their existing locomotive fleet.

BONDED SPARE PARTS WAREHOUSE

Railways frequently blame part of their locomotive availability and reliability problems on their difficulty in obtaining needed locomotive parts in a timely fashion. Given their small size, most railways cannot keep an adequate supply of all needed spare parts. In many cases they are forced to order major locomotive parts directly from the manufactures in the United States. This can take up to several months for some parts according to the railways. It has been suggested that a regional bonded spare parts warehouse would ease this situation.

The spare parts problem is not as serious as it was several years ago when tight foreign currency controls prevented the railways from ordering needed parts. Nevertheless, most regional railways are too small to keep a full supply of all needed replacement parts. There is some merit in a central parts supply facility. Parts and materials account for about fifty percent of all maintenance costs. This amounts to a Southern Africa spare parts market of about $7 to 10 million (excluding

Namibia and South Africa) per year. There are some costs involved, of course, such as inventory carrying, warehousing, and management costs. These costs would be offset by the reduced need for each railway to keep its own large inventory, and the reduced out-of-service locomotive time due to delays in parts delivery.

There are several reasons why the bonded spare parts warehouse has not been implemented despite the fact that both U.S. major locomotive manufactures have licensed representatives in the region. General Electric and General Motors have different sales policies that also vary from country to country. GE, for example, sells directly to Spoornet while GM sells through its licensee. Generally the manufacturers sell directly to railways that own their locomotives, but in the case of Kenya, GE sells through its distributor. The manufactures are unlikely to be willing to use the same spare parts warehouse, particularly if it also carries generic parts.

Some railways do not have a good sense of what their spare needs are going to be. To be profitable, a spare parts warehouse needs to keep its inventory low and its parts turnover high. Unless the railways can predict future needs fairly accurately, the warehouse concept will not be viable. Many regional railways still use a written log book to track parts needs. A modern computer management information system would provide large cost savings in spare parts control and provide a more accurate prediction of future needs.

The current locomotive surplus in the region provides a potential source for cheap used replacement parts that compete with the purchase of new replacement parts.

Although the bonded spare parts facility does provide positive benefits, it is not likely until the railways develop the capability to predict more accurately their parts needs through implementation of computerized locomotive management information systems.

CONTRACT MAINTENANCE

Fixed Maintenance Contract

Under this concept, a contractor agrees to provide locomotive maintenance for a fixed period of time, usually 5-7 years. The fee is usually performance based so the contractor has a direct financial interest in locomotive performance (availability and reliability). The railway may provide its workshop, and the contractor is encouraged to draw the majority of the employees it needs from existing railway workshop staff. Contract maintenance provides significant benefits for both the railway and the contractor over the current situation.

Contract maintenance rationalizes maintenance facilities. While the contractor uses existing railway employees, for the most part he is free to set staffing levels. He can also set pay schedules and increase the pay of skilled workers without interference from the government. Employees also receive managerial and technical training (possibly overseas). Unlike some other alternatives (such as a regional workshop), the process of contract maintenance can be relatively easily reversed if the railway does not believe it is working out. Under contract maintenance the railway still owns the workshops, depots, and locomotives. The trained staff also remains available should the contract be terminated.

Locomotive manufacturers or private locomotive maintenance companies are potential contractors. Also, as regional railways downsize, companies may be formed by skilled ex-employees of railways such as TransNamib and Spoornet that have good maintenance practices. This should provide competition and make contract maintenance cost effective.

Kenya Railways is currently in negotiations with General Electric for the overhaul and maintenance of a fleet of 35 locomotives for an eight year period. The contract calls for the railway to allocate part of their workshop to the contractor. They will also assign some employees to work directly for the contractor. The contractor will initially have expatriate and local managers. Within three years it is expected that the local managers will be solely responsible for maintenance operations. The contract will include incentives and penalties based on the availability and reliability of the locomotives. The contractor will provide the local employees with a bonus based on performance.

The contemplated ADTranz - Uganda Railways joint venture is a variant of contract maintenance in the sense that the railway's locomotives will be maintained by a contractor leasing the railway's workshop and operating under a minimum locomotive availability contract. The only difference between conventional contract maintenance and this model is that the railway is also a partner of the maintenance contractor.

Contract Maintenance With Power on Demand

As mentioned earlier in this report, it is difficult to capture the benefits of improved locomotive availability and reliability if the railway has poor locomotive utilization. Given the current locomotive surplus, any such improvement without a matching increase in traffic would result in more surplus motive power. It is, therefore, important that the strategy adopted by the railways consider likely improvements in locomotive availability, reliability, and utilization. A good contract maintenance program can be designed to encourage the railway to accomplish this often elusive goal.

Under a power on demand maintenance contract the contractor would be given the railway's locomotives for the duration of the maintenance contract and would be guaranteed to receive a small fixed payment annually to cover the fixed maintenance costs. The contractor may also be compensated for any costs to repair, overhaul, or upgrade the locomotives at the beginning of the maintenance contract or as an add on to the daily rate. The contractor would be responsible from maintaining the locomotives and providing the railway with power on demand for an additional fee. This fee could be based on power by the kilometer, by the day or hour, or by kilowatt, or a combination of these. The important factor in this type of arrangement is that the fee is based on the amount of power demanded by the railway.

As the railway starts accumulating charges for locomotive use, it would start to be concerned about locomotive utilization in order to reduce the cost per TU. Idle locomotives in the yard or operating units without revenue traffic would be noticed. There would be incentives for the railway's operating division to be concerned about locomotive utilization. To encourage the development of this "power-conscious" culture within the railway's operating divisions, the railway may even consider a bonus pay system based on performance. Locomotive utilization would be improved drastically.

The contractor, in turn, will begin to mothball excess locomotives, thereby reducing the maintenance costs. If the contractor becomes too aggressive in this direction and can not supply the required locomotives on demand, he would be financially penalized pursuant to the contract's provisions regarding minimum guaranteed availability. The contractor would also have a financial incentive in increasing his profits by consolidating maintenance activities or using private workshops as subcontractors. In order to benefit from economies of scale, the contractor may also market similar contracts with connecting railways. In this manner, maintenance operations for multiple railways will be eventually consolidated.

Economics of Contract Maintenance

The cost of contract maintenance depends on many factors. These include the number of locomotives being maintained, size, type, age and manufacture, and most importantly, the condition of locomotives being turned over to the contractor. The cost also depends heavily on whether or not the contractor will have to pay customs duty on imported spare parts.

Contract maintenance is likely to be relatively expensive, costing between $180 and $250 per available day of the locomotive.[19] Assuming that the annual fixed maintenance costs are computed and paid separately under the contract, the daily cost for fixed maintenance would be about $80 (25,000/365*0.85) for each available day.[20] This would apply to the entire contract fleet, whether the railway chooses to use all or part of the locomotives every day. When this figure is deducted from the total daily rate, the remainder represents an usage-based variable maintenance cost, which would range from $100 to $170 per available day of the locomotive. This represents the additional daily charge for any locomotive the railway uses. Assuming a guaranteed minimum availability of 85% under the maintenance contract, the total maintenance cost, inclusive of fixed and variable costs, at the lower end would be about $56,000 (25,000+(100*365*0.85)) per locomotive per year. At the higher end, it would be about $78,000 (25,000+(170*365*0.85)) per locomotive annually.

A typical locomotive with availability of 85% generating about $1 million of revenue per year would have the following cost structure: Approximately 8% (or $80,000) would cover locomotive maintenance costs (both, fixed and variable); 12% wear and tear of wagons; 6% fuel costs; 20% track related costs (maintenance, repair, and rehabilitation); 34% other operating expenses, including labor; and 20% overhead, general and administrative expenses, and profit. If $25,000 of the $80,000 total maintenance cost covers fixed maintenance costs, then $55,000 is available for variable maintenance costs. This locomotive would carry about 50 million ton km of freight at an average tariff of $0.02 per ton km. It would be used for about 10,000 km per month in revenue traffic to generate the annual revenue of $1 million. Therefore, the variable maintenance cost would be approximately $0.50 (55,000/120,000) per revenue locomotive km.

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[19] These daily rates assume that no customs duty is assessed on imported components. Otherwise, the daily rates may need to be increased by as much as $100.

[20] This computation assumes an average availability of 85%, a likely level of "guaranteed" locomotive availability under a typical maintenance contract in the region.

The above economic analysis represents typical conditions which are not necessarily true for East and Southern Africa railways. To begin with, the locomotive utilization in the region is considerably below 120,000 km per year, ranging from 14,815 in Uganda to 81,600 in Zimbabwe (Table 9). The average for the region is 44,000 km per locomotive per year in revenue generating traffic.[21] At this level of utilization, the locomotive maintenance cost is approximately $47,000 (25,000+(44,000*0.50)) per year. If this cost under a maintenance contract is increased to $56,000 to $78,000 per year, the railways will have to initiate substantial measures to either improve utilization, or allocate considerably more than 8% of their revenue to locomotive maintenance.

Table 9: Locomotive Utilization, 1995

Railway	TU/Locomotive (Million)	Average Length of Haul/TU (Km)	Average Annual Km/Locomotive
Botswana	17.3	310	55,806
Kenya	10.8	445	24,269
Malawi	4.4	98	44,898
Mozambique	9.6	133	72,180
Namibia	15.7	603	26,036
S. Africa	27.5	542	50,738
Tanzania	23.7	824	28,762
Uganda	4.0	270	14,815
Zambia	9.7	236	41,102
Zimbabwe	30.6	375	81,600

Source: Average lengths of haul computed from Table 2. TU/Locomotive data from Table 6.

Because of this reason contract maintenance without a locomotive rationalization program would not be a feasible alternative. Under such a program, the railway's savings from maintaining a smaller fleet of locomotives would more than offset the incremental cost associated with contract maintenance. For example, a railway which increases locomotive availability from 50% to 85% would need 41% less locomotives. Assuming that unneeded locomotives are retired, the savings for an existing railway with a fleet of 100 locomotives would be more than the increased unit costs:

- Current maintenance cost: (25,000+44,000*0.5)*100 = $4.7 million

[21] Considering that this average is computed by use of the core fleet (as opposed to the fleet on books), the figure clearly indicates an excess of locomotives even in the core fleet. Therefore, there is a clear need for further rationalizing the core fleet.

- New fleet size: 59 locomotives

Average km/locomotive = (44,000*100)/59 = 74,600

Maintenance cost under contract = (25,000+74,600*0.50)*59 = $3.7 million

Savings .... $1.0 million

As shown in the above example, contract maintenance with full fleet rationalization would provide a cost savings of $10,000 per year for each locomotive in the current fleet. However, for this benefit to materialize, the existing fleet must be large enough to warrant private contractor interest with the contract maintenance program.

As described in the preceding Section, there are a number of economic and operational advantages to the region's railways from consolidating their workshops into a regional facility. In addition to cost savings, the quality of locomotive maintenance will improve and locomotive down time will be reduced. At this time, however, there are also several constraints that the railways face when considering consolidated workshop proposals. These include the location of the regional facility, the need to close their own workshop and layoff staff, political problems associated with sending maintenance work to a foreign facility, customs difficulties in unit exchange of components, and uncertainties regarding railway restructuring activities currently underway.

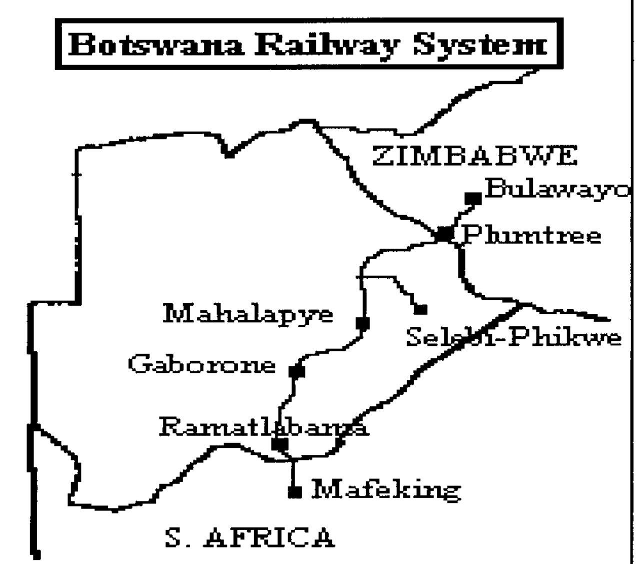
Given that railway workshops only account for 30% of the total maintenance and repair process, the anticipated benefits from consolidation are not sufficient to outweigh these constraints. However, several of the alternative strategies to improve locomotive availability and reliability described above (such as contract maintenance), account for 100% of the maintenance process. The possible improvement in locomotive availability and reliability from contract maintenance, therefore, is significantly greater and may be sufficient to outweigh the constraints.

G - OVERVIEW OF RAILWAYS

The information contained in this section is organized by country based on most recently published data and discussions held with railway officials during a field trip to the region. The Section is not intended to provide an exhaustive reference of recent developments and current operations, but rather an overview of relevant information.

BOTSWANA RAILWAYS (BR)

Botswana Railways has 888 km of cape gauge (1,067 mm) track. The system includes a 640 km mainline running between Ramatlabama, north of Mafikeng, South Africa, and Bakaranga, south of Plumtree, Zimbabwe. Three branch lines serve as feeders to the main line. The railway was managed by National Railways of Zimbabwe until 1986 when Botswana Railways took over. A 175 km branch line from Francistown to serve soda ash deposits at Sua Pan was opened in 1991.



This is a digitally created sketch. All locations are approximate.

Botswana Rail serves as part of one of the main rail corridors linking Zimbabwe, Zambia, and other land-locked parts of Africa to the sea through South Africa. Recent economic and political changes in Southern Africa have reduced the role of Botswana Rail in regional transit traffic. Drought relief food shipments helped the railroad reach a record 2.85 million tons in 1993. By 1994, however, tonnage had dropped to 1.7 million tons. It remained at this level in 1995 (Table 10).

The railway has 41 locomotives, some 1,036 wagons, and 48 coaches. All traction equipment is diesel electric 6-axle units of relatively new vintage. The locomotive fleet includes 11 Krupp UM 20C models with a rated power of 1,500 kw which were built in 1982. These locomotives are equipped with General Electric 7FDL 12 type engines with GE transmissions. An Additional 10 GE U15C model locomotives with a rated power of 1,120 kW are in service, mainly as shunters. These units were built in 1991 and are equipped with GE FDL8 type engines. The fleet also includes 20 GM main line diesel-electrics (GT22LC-2 model) built in 1986 with a rated power of 1,700 kW and equipped with GM645E3B-12 engines.

In response to declining traffic revenue, the railway's staff has been reduced almost 40% from 2,024 in 1993 to 1,224 in 1995. Unfortunately, this has not been enough to make up for the loss of revenue. The operating ratio (% of total expenses to total revenue) went from 78.2% in 1993 to 134.8% in 1995.

Botswana Rail has contracted consultants to consider a reorganized management structure and other options to improve business prospects and viability.

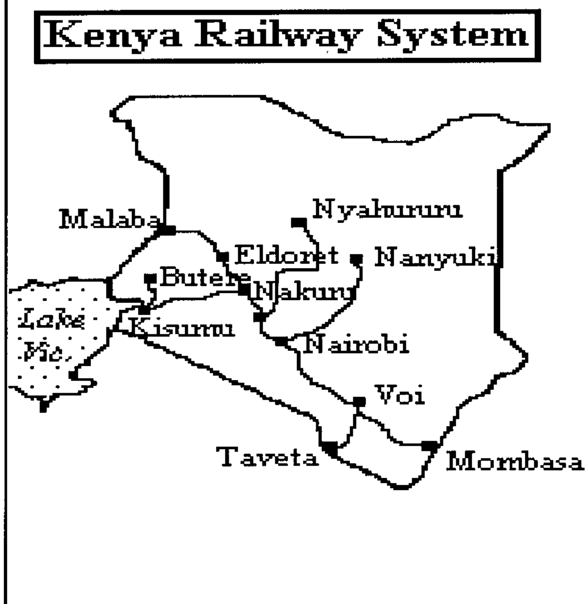
Table 10: Operational Indicators of Botswana Railways

INDICATOR	1991	1992	1993	1994	1995
Route Length (km)	888	888	887	887	887
No. of Locomotives			35	40	41
No. of Wagons			1,055	1,142	1,036
No. of Coaches			43	47	48
Freight Tons (000)	2,220	2,370	2,852	1,713	1,760
Freight Ton-Km (million)	852.0	979.0	1,265.8	585.2	603.5
Passengers (000)	394	431	355	331	525
Passenger-Km (million)			-	104.5	-
Employees (number)			2,024	1,997	1,224
TUs/Line Km (000)			1,427.0	777.7	680.4
TUs/Locomotive (000)			36,164.9	17,244.8	15,087.5
Ton-Km/Wagon (000)			1,199.8	512.5	582.5
Passenger-Km/Coach (000)			-	2,431.4	-
TUs/Employee (000)			625.4	345.4	493.1
Working Ratio (% of operating expenses to total revenues)			78.2	107.3	134.8
Operating Ratio (% of total expenses to total revenue)	75.2	82.3	90.9	123.4	152.0

Source: Data for 1991 and 1992 from Jane's Information Group Ltd., ***Jane's World Railways 1995-96, 37th Edition;*** Surrey, United Kingdom; p.434. Data for 1993-1995 from Southern Africa Transport and Communications Commission (SATCC), ***Annual Report 1995-1996;*** Maputo, Mozambique.

KENYA RAILWAYS (KR)

Kenya Railways (KR) operates on 2,652 km of meter gauge track with a staff of 16,000 (down from 20,696 in 1990). The network consists of a mainline between Mombasa on the Indian Ocean and Malaba at the border with Uganda. The route runs through Nairobi, Nakuru, and Eldoret. A branch line runs from Nakuru to the Lake Victoria town of Kisumu (which is the departure point for the train ferry route to Uganda and Tanzania). There are also branch lines linking Nairobi to Nanyuki near Mt Kenya; Gilgil to Nyahururu; Voi to Taveta; Kisumu to Butere; and Konza to Magadi. The railway also provides lake services within Kenya.



This is a digitally created sketch. All locations are approximate.

Until the early 1970's, the railway dominated long-distance freight transport services. During that period KR operated as part of the East African Railways which served Kenya, Tanzania, and Uganda. The collapse of the East African Community resulted in the breakup of the regional railway into three national railways and caused a further shift in intercity traffic from rail to road. Increased problems associated with locomotive availability and reliability, a new pipeline, and increased road competition have caused a significant reduction in rail traffic during the ensuing years. Between 1980 and 1993 rail tonnage has fallen by 42%, ton-km by 39%, and passenger service by 7.7%. KR's share of the current national freight transport market is only 20 percent.

KR's locomotive fleet consists of a variety of French, German, British, and American built diesel units (Table 12). As of June 1996, the railway had about 109 locomotives in service out of a fleet of 156. Of these in-service units, approximately 60 are available at any one time. With respect to fleet size, the locomotive availability is 38 percent.

Because of poor service due to low locomotive availability, KR entered into a contract with Spoornet in 1994 for lease of a fleet of 10 diesel electric locomotives with maintenance and guaranteed availability. The contract will run through 1998. In order to fulfill repair and maintenance obligations under the contract, Spoornet has established a dedicated section within KR's Nairobi locomotive workshop. The Spoornet locomotive maintenance operation in Nairobi is supported by four South African technicians and about a dozen Kenyans selected from among KR's workshop personnel. KR is currently negotiating with GE for a rehabilitation and long-term maintenance contract covering the 35 U26C mainline units with a contractor guaranteed minimum availability.

Table 11: Operational Indicators of Kenya Railways

INDICATOR	1990	1991	1992	1993	1994	1995
Route Length (km)	2,065	2,065	2,065	2,065	2,740	2,652
No. of Locomotives	218	199			198	156(*)
No. of Wagons	6,476	6,475			6,490	6,490
No. of Coaches	591	587			546	546
Freight Tons (000)	3,461	3,090	2,460	2,230	2,200	
Freight Ton-Km (million)	1,919	1,784	1,444	1,282	1,282	
Passengers (000)	2,989	2,300	2,100	1,600	1,900	
Passenger-Km (million)	715	586	477	408	408	
Employees (number)	20,696	20,374	19,659	18,564	18,500	16,000
TUs/Line Km (000)	1,275	1,148	887	876	617	
TUs/Locomotive (000)	12,082	11,910			8,535	
Ton-Km/Wagon (000)	406	366			260	
Passenger-Km/Coach (000)	1,210	998			747	
TUs/Employee (000)	127	116	93	97	92	

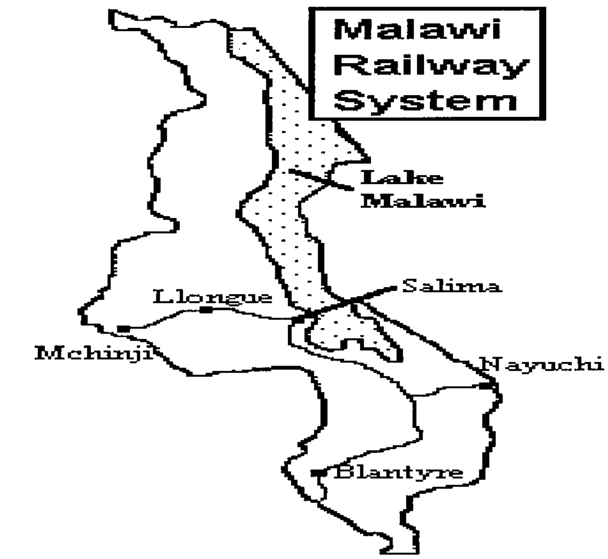
(*) Does not include leased locomotives. **Source:** Data for 1990-1994 from The World Bank, ***Railway Data Base***; and Jane's Information Group Ltd., ***Jane's World Railways 1995-96, 37th Edition;*** Surrey, United Kingdom, p.605; 1995 data from Kenya Railways.

Table 12: KR's Diesel Locomotive Fleet

Class	Trans-mission Type	Rated Power (kW)	Max Speed (km/h)	Year First Built	Model No.	Fleet Size (No)	In Service (No)	Mech-anical Parts	Eng-ine Type	Trans-mission Type
94XX	Electric	2,172	72	1978	U26C	10	10	GE	7FDL12	GE
93XX	Electric	1,947	72	1978	U26C	25	13	GE	7FDL12	GE
92XX	Electric	1,901	72	1971	MX-624	15	12	MLW	Alco 251F	GE
87XX	Electric	1,372	72	1960		16	10	EE	12-CSVT	EE
72XX	Electric	925	72	1972		5	2	GEC	8CSVT	GEC
71XX	Electric	925	72	1967		2	1	EE	8CSVT	EE
62XX	Hyd-raulic	552	72	1977	DHG-1000	36	25	Hens-chel	MTU-493TZ	Voith
47XX	Hyd-raulic	391	28	1977		28	20	Huns-let	RRDV-8TCE	Voith
46XX	Hyd-raulic	514	32	1967		19	16	Barclay	Cummin NT380	Twin Disc CF-11500
Total						156	109			

Source: Jane's Information Group Ltd., ***Jane's World Railways 1995-1996, 37th Edition***, Surrey, United Kingdom; p. 605 and Kenya Railways.

MALAWI RAILWAYS LTD (MR)



This is a digitally created sketch. All locations are approximate.

Following a World Bank sponsored restructuring program, Malawi Railways closed its doors on June 20, 1995 and a new railway company known as Malawi Railways Limited (1994) commenced operations. The new company has fewer staff, debts, and assets. It is market oriented with commercial freedom to set tariffs and service levels. Plans are being explored to concession the operation of Malawi Rail, particularly the Nacala corridor operations, to a private operator.

The 789 km cape gauge railway has a single track line from Mchinji near the Zambian border through Lilongwe to Salima on Lake Malawi and Blantyre to the southern border with Mozambique. A line from Nkaya to Nayuchi on the eastern border with Mozambique connects with the Mozambique Railway CFM (N) which serves the port of Nacala.

Malawi Rail has a staff of 1,117, down from 4,401 in 1990. The restructuring of the railway in 1995 has significantly improved labor productivity from 42,100 TUs per employee in 1990 to 70,100 TUs per employee in 1995 (Table 13). Streamlining of non-core assets, unprofitable operations, and employees also improved the railway's profitability and equipment utilization.

After restructuring, the railway kept a reduced locomotive fleet of 18 units, down from 55. This fleet consists of 13 mainline locomotives and 5 shunters, all diesel electrics. The mainline fleet is made up of 1,500 hp units built in 1980 by Canadian Bombardier, which is now a division of GE. These locomotives were extensively overhauled recently and are equipped with Alco-251-E type engines, which can reach a maximum speed of 72 mph. The shunters were manufactured by Cockerill Mechanical Industries of Belgium in 1993. These units have 510 hp.

Transit time on the Nacala corridor between the port and Blantyre has been cut from 15-20 days in 1990 to the current 30 hours. Freight traffic has risen from 69,226 tons in 1992 to 368,000 tons in 1995. A lake service for passengers and cargo connects with Malawi Rail at Chipoka at the southern end of the lake. Passenger operations do not constitute an important portion of the railway's revenue.

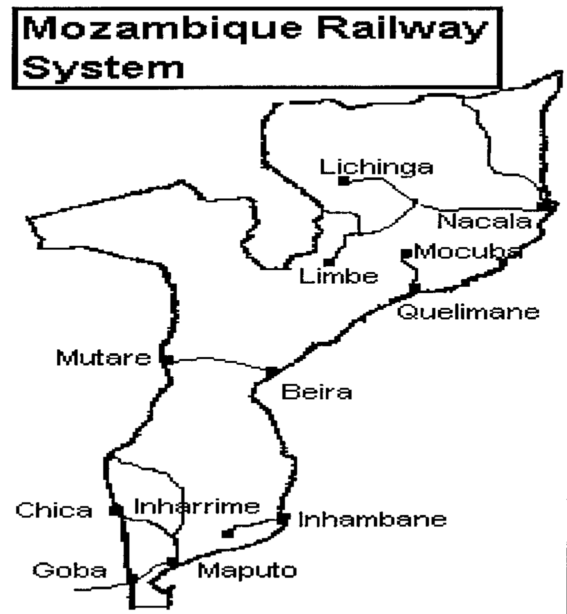
Table 13: Operational Indicators of Malawi Railways

INDICATOR	1990	1991	1992	1993	1994	1995
Route Length (km)	789	789	789	789	789	789
No. of Locomotives	51	51	51	51	55	18
No. of Wagons	814	875	792	778	768	400
No. of Coaches	30	38	32	32	29	27
Freight Tons (000)	420	418	337	340	342	368
Freight Ton-Km (million)	69.7	76.1	56.4	52.3	48.5	61.4
Passengers (000)	1,713	1,501	1,282	859	635	431
Passenger-Km (million)	115.5	101.1	87.7	65.4	40.2	16.9
Employees (number)	4,401	4,456	3,832	3,658	2,573	1,117
TUs/Line Km (000)	234.7	224.6	182.6	149.1	112.7	99.2
TUs/Locomotive (000)	3,631	3,475	2,825	2,306	1,617	4,350
Ton-Km/Wagon (000)	85.6	87.0	71.2	67.2	63.2	153.6
Passenger-Km/Coach (000)	3,850	2,661	2,741	2,043	1,393	624
TUs/Employee (000)	42.1	40.0	37.6	32.2	34.6	70.1
Working Ratio (% of operating expenses to total revenues)	88.1	77.4	105.6	149.0	171.9	134.6
Operating Ratio (% of total expenses to total revenues)	99.7	86.5	105.6	149.0	185.2	148.8

Source: Data for 1990-1992 from the World Bank, ***Railway Data Base***; data for 1993-1995 from Southern Africa Transport and Communications Commission (SATCC), ***Annual Report 1995-1996***, Maputo, Mozambique.

MOZAMBIQUE PORTS AND RAILWAYS (CFM)

In 1990, Mozambique Railways were joined with the country's ports of Maputo, Beira, and Nacala in a new state owned company, Mozambique Ports and Railways (CFM). This reorganization also changed the status of both ports and the railway from government controlled entities to a somewhat more autonomous organization with financial accountability. In 1991, a new law was enacted giving impetus to plans for revitalization of CFM and envisaging, for the first time, the possibility of private sector participation in the operation of separate infrastructure components of CFM such as port terminals and specific railway segments.



This is a digitally created sketch. All locations are approximate.

Since it's reorganization, CFM has undertaken significant improvements in identifying and eliminating non-core operations, streamlining resources, improving the management structure, and decentralizing some of its operations. In a further move aimed at improving the financial viability and institutional effectiveness, CFM became a public company in early 1995. The government's principal objective is to eliminate all subsidies and other financial support for CFM's operations.

Freight traffic performance during the last five years has been strongly affected by the low availability of traction power and poor security at the ports and en route. In an attempt to address the chronic congestion problem at the Port of Maputo, several of the port's terminals have been franchised to private operators. Because of CFM's poor performance, donor governments have been pressing for outright privatization of the railway as a means of strengthening operational control and eliminating the financial drain on public resources. World Bank assistance was obtained in 1993 for the Maputo Corridor Revitalization Technical Assistance Project, designed to review the option for private sector involvement ana assist in its implementation.

CFM's rail network consists of 2,988 km (route length) of 1,067 mm (cape gauge) line and 143 km of narrow gauge (762 mm) line. The system is made up of three major and two minor networks linking the coastal ports to the hinterland. These networks are not connected within Mozambique. The major three serve as transit gateways to land-locked countries in the hinterland. The minor networks are: (I) a 90 km cape gauge line connecting the Port of Inhambane to Inharrime; and (ii) the 145 km cape gauge Zambezia line running from the coastal town of Quelimane to Mocuba. Following is a description of the three major networks:

The Northern System (CFM-N)

CFM(N), commonly referred to as the Nacala Corridor, is a 919 km cape gauge line, which runs from Limbe, Malawi to the deep water port of Nacala. It is the principal route for Malawi's foreign trade. Although traffic was severely restricted during the recent conflict, the line has been, with the exception of 66 km, rebuilt up to the Malawi border. The railway now needs to recapture traffic that had diverted to other routes.

Table 14: Operational Indicators of CFM-N

INDICATOR	1993	1994	1995
Route Length (km)	877	877	877
No. of Locomotives	19	18	-
No. of Wagons	1,067	1,069	-
No. of Coaches	2	15	-
Freight Tons (000)	136	155	215
Freight Ton-Km (million)	67.1	74.9	99.4
Passengers (000)	118	80	589
Passenger-Km (million)	3.5	11.2	30.6
Employees (number)	2,195	2,147	-
TUs/Line Km (000)	80.5	98.2	148.2
TUs/Locomotive (000)	3,717.4	6,386.4	-
Ton-Km/Wagon (000)	62.9	74.9	-
Passenger-Km/Coach (000)	1,765.0	2,323.7	-
TUs/Employee (000)	32.2	53.5	-

Source: Southern Africa Transport and Communications Commission (SATCC), ***Annual Report 1995-1996***, Maputo, Mozambique.

The Central System (CFM-C)

CFM(C), commonly known as the Beira line, is 994 km long (cape gauge). It consists of the Machipanda line which is a primary corridor for northern Botswana and southern Zambia. It also contains the now closed Sena line. If the coal deposits on this line were developed for export, the Sena line would be reopened. This corridor is served by the port at Beira.

Table 15: Operational Indicators of CFM-C

INDICATOR	1993	1994	1995
Route Length (km)	317	317	317
No. of Locomotives	12	19	-
No. of Wagons	3,144	3,141	-
No. of Coaches	42	42	-
Freight Tons (000)	1,026	958	1,063
Freight Ton-Km (million)	311.6	289.8	315.1
Passengers (000)	139	528	1,279
Passenger-Km (million)	2.2	8.1	68.3
Employees (number)	4,978	4,678	-
TUs/Line Km (000)	989.9	939.7	1,209.5
TUs/Locomotive (000)	26,149.5	12,748.3	-
Ton-Km/Wagon (000)	99.1	74.5	-
Passenger-Km/Coach (000)	52.2	195.7	-
TUs/Employee (000)	63.0	51.8	-

Source: Southern Africa Transport and Communications Commission (SATCC), ***Annual Report 1995-1996***, Maputo, Mozambique.

The Southern System (CFM-S)

CFM(S), known as the Maputo Corridor consists of 840 km of cape gauge and 143 km of narrow gauge (762 mm) line. CFM(S) has three international routes. The Goba line (64 km) serves as the main corridor between Maputo and Swaziland. The Ressano Garcia line (88 km) is the primary corridor linking Maputo to South Africa. The Limpopo line (528 km) is a principal route between Maputo and Chicualacuala at the Zimbabwe border. The Limpopo line connects Maputo to Zambia, Botswana, and the south-east Zaire through Zimbabwe.

Table 16: Operational Indicators of CFM-S

INDICATOR	1993	1994	1995
Route Length (km)	696	696	696
No. of Locomotives	44	38	-
No. of Wagons	3,127	2,856	-
No. of Coaches	55	43	-
Freight Tons (000)	1,914	1,504	1,826
Freight Ton-Km (million)	272.1	289.4	477.7
Passengers (000)	1,581	2,057	2,661
Passenger-Km (million)	50.8	103.1	21.3
Employees (number)	2,553	3,602	-
TUs/Line Km (000)	463.9	563.9	717.0
TUs/Locomotive (000)	7,338.3	10,306.5	-
Ton-Km/Wagon (000)	113.1	87.0	-
Passenger-Km/Coach (000)	923.4	1,594.1	-
TUs/Employee (000)	126.5	108.7	-

Source: Southern Africa Transport and Communications Commission (SATCC), ***Annual Report 1995-1996***, Maputo, Mozambique.

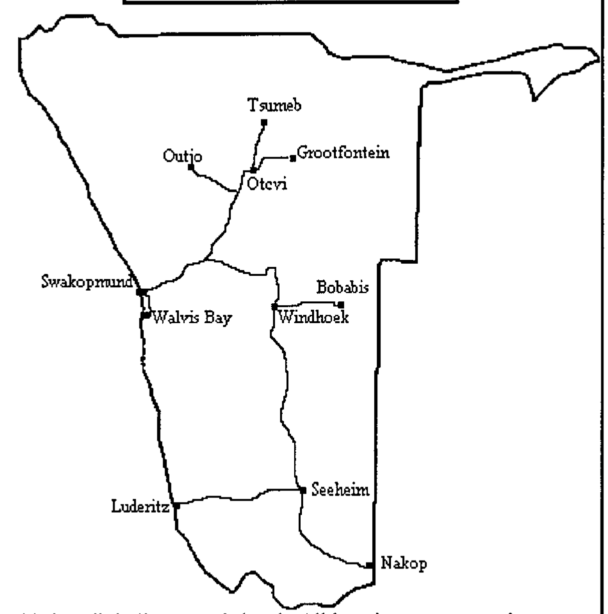
CFM's locomotive fleet consists of 54 steam locomotives, 77 diesel electric line-haul units, 28 diesel hydraulic shunters, and 7 diesel railcars (Table 17). The fleet includes 34 GE locomotives equipped with 7FDL-12 type engines. An additional 28 diesel electrics supplied by GE do Brazil are equipped with the same type engine. Another 6 GE diesel electrics are equipped with the Caterpillar Series 3508 type engine. Continuing maintenance problems lead to poor availability and reliability of locomotives. For example, in 1991-1992, GEC Alsthom supplied 15 type AD26C diesel electrics powered by Caterpillar Series 3606 engines for use in the Limpopo Corridor. Due to the need for highly trained and skilled workers to service these units, the railway could not implement a proper maintenance schedule.

Table 17: CFM's Diesel Locomotive Fleet

Class	Trans-mission Type	Rated Power (kW)	Max Speed (km/h)	Year First Built	Fleet Size (No)	Engine Type	Transmission Type
1a	Electric	2,150/50	103	1966	1	7FDL-12B3	GE USA
2a	Electric	2,150/200	103	1968	5	7FDL-12B7	GE USA
3a	Electric	2,150/200	103	1973	17	7FDL-12D10	GE USA
4a	Electric	2,150/200	108	1979	11	7FDL-12D29	GE do Brazil
5a	Electric	2,150/200	108	1980	17	7FDL-12D29	GE do Brazil
6a	Electric	2,150/200	108	1984	6	7FDL-12	GE USA
7a	Electric	2,150/200	103	1990	5	7FDL-12	GE USA
8a	Electric	1,850	103	1991-92	15	3606	GEC Alsthom
10a	Electric	1,100	70	1991-92	6	3508	GE USA
	Electric	2,200		1993	10	GT22LC2	GM
Total					93		

Source: Jane's Information Group Ltd., ***Jane's World Railways 1995-1996, 37th Edition***, Surrey, United Kingdom; and Tanzanian Railways Corporation.

NAMIBIA, TRANSNABIB RAIL (TNR)



This is a digitally created sketch. All locations are approximate.

TransNamib Rail is part of the government owned, but independently operated, TransNamib Ltd holding corporation that is the national carrier of Namibia. There is no government official on TNR's Board of Directors. The holding company also includes Air Namibia and TransNamib Carriers, the national trucking company, as well as a number of other subsidiaries. Following the transfer of all rail, road, and harbor services in 1988 by the South African Transport Services (which was operating these facilities under contract), the holding company was established in 1989. The railway has operated without outside funding or subsidy since its inception. It makes an operating profit but does not fully cover its long run capital replacement costs.

The 2,382 km cape gauge rail line runs from Tsumeb/Grootfontein in the north to Walvis Bay on the Atlantic ocean, and through Windhoek to the South African border town of Kleinbegin. There are 613 km of branch lines to Outjo, Bobabis, and Luderitz. Prior to independence in 1990, the railway was part of Spoornet and most of its traffic went through South Africa. Though small and subject to changing traffic patterns, TNR is currently perhaps the most efficiently run railway system in Southern Africa.

The railway owns 6 GE U18C1 and 67 GE U20C diesel electric locomotives. Some 45 locomotives are currently in the operating fleet. Their availability rate is 87% and the utilization rate is 60%. The railway recently sold 16 of its locomotives and has also leased some locomotives to Swaziland Rail. The average age of the locomotives is 26 years. In order to spread replacement evenly over a long period, the railway divides its fleet into three parts. One-third of the locomotives receive normal maintenance, one-third are being completely rebuilt, and one-third will be replaced with new locomotives starting in about four years. The railway believes that the new technology and greater fuel efficiency of the new locomotives makes this policy appropriate.

The railway is doing the overhauls in its Windhoek workshop. It has an excellent elector-mechanical apprentice program. Many of its graduates are working throughout the region on railways or in other private sector employment. The railway is reducing staff and may not be able to justify the apprentice program for its own operations. It would like to serve as a training site for other railways or the staff of a regional workshop.

Table 18: Operational Indicators of TNR

Indicator	1991	1992	1993	1994	1995
Route Length (km)	2,382	2,382	2,382	2,382	2,382
No. of Locomotives	82	87	85	75	71
No. of Wagons	1,621	1,632	1,629	1,624	1,329
No. of Coaches	-	-	79	35	19
Freight Tons (000)	1,697	1,681	1,684	1,734	-
Freight Ton-Km (million)	1,225.7	1,108.8	1,074.9	1,076.5	-
Passengers (000)	84.8	88.9	74.9	92	110
Passenger-Km (million)	46.1	34	24.2	34.7	-
Employees (number)	2,344	2,042	2,002	1,928	1,800
TUs/Line Km (000)	533.9	479.8	461.4	466.5	-
TUs/Locomotive (000)	15,509	13,135	12,930	14,816	-
Ton-Km/Wagon (000)	756.1	679.4	659.9	662.9	-
Passenger-Km/Coach (000)	245.2	182.8	136.7	284.4	-
TUs/Employee (000)	542.6	559.6	549.0	576.3	-
Working Ratio (% of operating expenses to total revenues)	-	90.0	88.4	93.2	-
Operating Ratio (% of total expenses to total revenue)	-	91.3	89.9	94.6	-

Source: Data for 1990-1992 from the World Bank, ***Railway Data Base***; data for 1993-1995 from Southern Africa Transport and Communications Commission (SATCC), ***Annual Report 1995-1996***, Maputo, Mozambique and TransNabib Rail.

Although traffic levels have remained relatively constant during the last three years, the railway is facing serious future traffic problems. The end of South Africa's involvement in the Angolan conflict was one of the first causes of traffic pressure on the railway. There has also been a shift away from traffic movement by rail through South Africa to coastal waterway traffic movement through the port of Walvis Bay. This shortens the rail line haul for TNR. A new cement plant, which is schedule to open in Namibia next year will also significantly reduce the length of cement hauls, one of the primary freight commodities for the railway. Finally, the future opening of the Trans Kalahari Road will provide substantial truck competition on a shorter route for the railway's most profitable traffic.

The railway has responded to these competitive pressures in a number of ways. It is providing intermodal service with its corporate trucking firm partner. It is offering a money back guaranteed overnight parcel express service and it has revamped and cut costs on its passenger service, which is now growing at 25% per year. Nevertheless, the three train pairs that the railway currently runs may be reduced to only one train pair within several years.

SOUTH AFRICAN RAILWAYS (SPOORNET)

The bulk of the former South African Transport Services operations were restructured in 1990 by regrouping most functions in a new public and profit-centered company, Transnet Ltd. Transnet has six major divisions, including SAA (air services), Autonet (roads), Portnet (harbors), Petronet (pipelines), and PX (parcel express service). Spoornet is the commercial railway freight and passenger business (excluding the sub-urban passenger services) within the Transnet group and makes up the largest portion of the group. In 1995, it operated 31,733 km of track, much of it electrified throughout South Africa. It has more than 3,500 locomotives, 2,100 of which are diesel electric, mostly GE and GM models built by their South African licensees (Tables 20 and 21).

As shown in Table 19, the railway carried 176 million metric tons of freight in 1995, mostly coal (60 million tons), export ore (22 million tons), and general freight (80 million tons). Like U.S. railroads, Spoornet is predominantly a freight railroad (98% of traffic). The railway has pioneered numerous cost-saving operations in bulk minerals transportation. For example, on the 861 km Cession-Saldanha ore line, operations were initiated in 1989 for a 660-wagon train carrying 71,600 tons of iron ore. This 7.3 km long train, powered by 3 electric locomotives at the head, 4 locomotives in the middle, and 7 diesel locomotives at the rear, could reach speeds of up to 80 km/hour.

Spoornet is expected to announce a loss for 1996. It has a staff of 62,000 down 23% from 1993. There will be further cost cutting to eliminate operating losses. The railway is currently evaluating alternative strategies to streamline operations, improve overall performance, and increase profitability.

As the largest railroad in Southern Africa and linked by rail to all the SADC countries, Spoornet is a very important player in the regional railroad operations. Even during the period of sanctions, rail cooperation between African countries continued. Today, Spoornet leases locomotives and wagons to several other African countries. It also operates some railway track in Zaire, Lesotho, and has trackage rights in Swaziland. With the encouragement of the South African government, the railway is negotiating with CFM of Mozambique on the possible formation of a joint venture on a concession basis to operate the Maputo railway corridor. Spoornet's revenue from traffic destined to/from other African countries represents about 7% of its revenue or about $150 million per year. Additional revenue is derived from equipment leasing operations.

Table 19: Operational Indicators of Spoornet

Indicator	1990	1991	1992	1993	1994	1995
Route Length (km)	21,617	21,635	21,635	20,934	20,934	31,733
No. of Locomotives	4,001	3,978	3,944	3,667	3,540	3,516
No. of Wagons	156,835	155,849	155,320	150,162	147,330	123,780
No. of Coaches	4,271	3,776	3,715	4,186	3,669	6,549
Freight Tons (000)	183,400	173,624	169,086	167,746	169,100	175,956
Freight Ton-Km (million)	100,410	93,767	89,248	91,359	93,487	95,591
Passengers (000)	4,700	3,500	2,300	2,350	2,500	2,202
Passenger-Km (million)	-	1,038.0	895.0	894.7	1,007.0	1,021.0
Employees (number)	114,002	155,882	106,096	81,334	64,682	62,000
TUs/Line Km (000)	-	4,382.0	4,166.5	4,406.9	4,513.9	3,044.5
TUs/Locomotive (000)	-	23,832.3	22,855.7	25,157.8	26,693.2	27,477.9
Ton-Km/Wagon (000)	640.2	601.7	574.6	608.4	634.5	772.3
Passenger-Km/Coach (000)	-	274.9	240.9	213.7	274.5	155.9
TUs/Employee (000)	993	668	925	1,134.3	1,460.9	1,558.3
Working Ratio (% of operating expenses to total revenues)	-	-	-	-	83.6	86.8
Operating Ratio (% of total expenses to total revenue)	-	-	-	-	92.8	95.4

Source: Data for 1990-1992 from the World Bank, ***Railway Data Base***; data for 1993-1995 from Southern Africa Transport and Communications Commission (SATCC), ***Annual Report 1995-1996***, Maputo, Mozambique.

Table 20: Spoornet's Diesel-Electric Locomotive Fleet

Class	Rated Power (kW)	Max Speed (km/h)	Year First Built	Fleet Size (No)	Mechanical Parts	Engine Type	Transmission Type
31-000	985	90	1958	40	GE	Cooper Bessemer FVBL-8	GE BGE-761A4
32-000	1,475	100	1959	13	GE	Cooper Bessemer FVBL-12	GE 5GE76A3
33-000	1,605	100	1965	61	GE	GE 7FDL-12	GE 761A6
33-200	1,640	100	1966	13	GM-EMD	EMD 16645E	EMD D29CC7
33-400	1,605	100	1968	30	GE	GE 7FDL-12	GE 761A6
34-000	2,050	100	1971	125	GE	GE 7FDL-12	GE 761A13
34-200	2,145	100	1971	48	GM-EMD	EMD 16645E	EMD 29B
34-400	2,050	100	1973	126	GE	GE 7FDL12	GE 761A13
34-600	2,245	100	1974	98	GM SA	EMD 16645E	EMD D29B
34-800	2,140	100	1978	58	GM SA	EMD 16645E	EMD 29B
34-900	2,050	100	1979	30	GE	GE 7FDL12	GE 761A13
35-000	1,230	100	1972	69	GE	GE 7FDL8	GE 764C
35-200	1,195	100	1974	150	GM-EMD & GM SA	EMD 8645E	EMD D29CCBT
35-400	1,230	100	1976	100	GE	GE 7FDL8	GE 764C1
35-600	1,195	100	1976	100	GM SA	EMD 8645E	EMD D29CCBT
36-000	875	100	1975	124	GE	GE 7FDL8	GE 764C1
36-200	875	90	1080	101	GM SA	EMD 8645E	EMD D29B
37-000	2,340	100	1981	98	GM SA	EMD 16645E	EMD D31
91-000	520	50	1973	20	GE	CAT D-379	GE 778A1
Total				1,404			

Source: Jane's Information Group Ltd., ***Jane's World Railways 1995-1996, 37th Edition***, Surrey, United Kingdom and Spoornet.

Table 21: Spoornet's Electric Locomotive Fleet

Class	Rated Power (kW)	Max Speed (km/h)	Year First Built	Fleet Size (No)	Line Voltage (kV)	Mechanical Parts	Electrical Equipment
5E	1,508	100	1955	59	3	English Elec.	4EE529
5E1	1,940	100	1959	614	3	Metro Vickers/ Union Car.& Wag.	135/ 4VM281, etc.
6E	2,492	110	1970	72	3	Union Car.& Wag.	4-AEI-283AZ
6E1	2,492	110	1969	749	3	Union Car.& Wag.	4-AEI-283AZ
EXP/AC	2,492	110	1975	1	25	Union Car.& Wag.	4-AEI-283AZ
7E	3,000	100	1978	99	25	Union Car.& Wag.	50-CS
7E1	3,000	100	1979	50	25	Dorman Long	Hitachi HS-1054-GR
7E2-1	3,000	100	1982	25	25	Union Car.& Wag.	Siemens 6-MG-680
7E2-2	3,000	100	1983	40	25	Union Car.& Wag.	Siemens 6-MG-680
7E3-1	3,000	100	1983	60	25	Dorbyl	Hitachi HS-1054-HR
7E3-2	3,000	100	1984	25	25	Dorbyl	Hitachi HS-1054-HR
8E	800	75	1983	100	3	Union Car.& Wag.	Siemens 4-1 KB 2820-OTA-2
9E	4,068	90	1979	25	50	Union Car.& Wag.	GEC Engineers
9E2	3,750	90	1978 1985	6		Union Car.& Wag.	GEC 6-GEC
10E	3,240	90	1985	50	3	Union Car.& Wag.	Toshiba 6-SE-218
11E	4,000	90	1985	45	25	GM SA	Asea 6X LJM 54D-1
12E	2,492	165	1983	5	3	Union Car.& Wag.	4-AEI 283Z
10E1	3,240	90	1987	79	3	Union Car.& Wag.	GEC 6X-G425-A2
10E2	3,240	105	1989	25	3	Union Car.& Wag.	Toshiba 6X SE-218A
14E	4,000	130	1989	3	3/25	Swiss Loco.Works	50 c/s group
Total				2,132			

Source: Jane's Information Group Ltd., ***Jane's World Railways 1995-1996, 37th Edition***, Surrey, United Kingdom and Spoornet.

SWAZILAND RAILWAY (SR)

Swaziland Railway (SR) operates a cape gauge network with a total route length of 301 km. It was originally built by a Japanese mining company in 1964 to carry iron ore to the Mozambican port of Maputo.

Table 22: Operational Indicators of Swaziland Railway

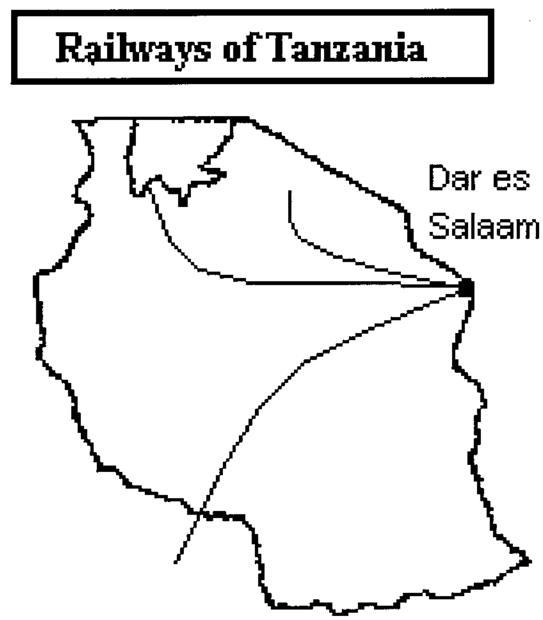
INDICATOR	1993	1994	1995
Route Length (km)	300	300	300
No. of Locomotives			
No. of Wagons	166	389	169
No. of Coaches			
Freight Tons (000)	4,203	3,908	4,284
Freight Ton-Km (million)	723.8	675.2	742.8
Passengers (000)			
Passenger-Km (million)			
Employees (number)	747	728	725
TUs/Line Km (000)	2,412.6	2,250.6	2,476.2
TUs/Locomotive (000)			
Ton-Km/Wagon (000)	4,360.1	1,735.7	4,395.5
Passenger-Km/Coach (000)			
TUs/Employee (000)	968.9	927.4	1,024.6
Working Ratio (% of operating expenses to total revenues)	80.1	82.6	80.7-
Operating Ratio (% of total expenses to total revenue)	82.4	85.8	83.9-

Source: Southern Africa Transport and Communications Commission (SATCC), Annual Report 1995-1996, Maputo, Mozambique.

The main route is from Ka Dake to Goba on the border with Mozambique, with lines from Phuzumoya to Lavumisa/Golela and Mpaka to Komatipoort. The Mpaka-Komatipoort line is 120 km long with 58 km in Swaziland and the remaining 62 km in South Africa. This line was built in 1986 to provide a through north-south rail line to South Africa via the Mpaka-Phuizumoya section. Swaziland allows shortest connection for traffic from Zimbabwe to the port of Richards Bay in South Africa. The railway leases 9 steam locomotives from Spoornet and owns 169 wagons. Approximately 80% of SR's traffic is run-through trains between the northern and southern borders. The railway carried 4.3 million tons of freight in 1995. Improvements in the operation of CFM and the port of Maputo will create competitive pressures on Swaziland Rail.

TANZANIA

Two railway systems, Tanzania Railways Corporation (TRC) and Tanzania-Zambia Railways (TAZARA), form transport corridors to the port of Dar es Salaam carrying transit traffic for the landlocked countries in the region and earning significant foreign exchange for Tanzania. The railways also handle a substantial portion of the domestic movement of bulk goods and passengers.



This is a digitally created sketch. All locations are approximate.

Tanzania Railway Corporation (TRC)

TRC, with 2,600 km of meter gauge track, was established after the breakup of the East Africa Railway Corporation to handle Tanzania's portion of the old system. From inception, it has suffered from declining traffic levels and poor financial performance. The causes include poor availability and utilization of assets, inadequate maintenance, inflexible tariff policies, weak management, and overstaffing. Recent improvements in the operation of the Port of Dar es Salaam and the possible reestablishment of the East Africa Railway Corporation may help TRC improve its efficiency and hold or increase its share of transit traffic to the hinterland.

TRC currently operates 104 diesel locomotives, 100 passenger coaches, and 2,186 freight wagons. The locomotive fleet includes a variety of makes and engines (Table 24), which makes it very expensive for TRC to undertake maintenance.

Tanzania-Zambia Railways Authority (TAZARA)

TAZARA, with 1,860 km of cape gauge (1,067 mm) track, was built by the Chinese during the regional struggles for independence in East Africa. An agreement signed in 1967 the governments of Tanzania, Zambia, and China stipulated the construction of the line from Dar es Salaam to in Tanzania to Kapiri Mposhi in Zambia, together with equipment, two workshops, and other auxiliary facilities. Operations began in 1975.

The railway was designed to serve as a secure outlet for the region when many of the other transportation corridors were closed by hostilities. Since TAZARA's gauge permits through traffic from Central and Southern African region, transit traffic from Botswana, Malawi, Zaire, Zambia, and Zimbabwe seeking to use Dar es Salaam instead of South African ports, traffic increased rapidly during 1980's. At the end of 1987, with the coordination of SATCC, a ten-year $230 million rehabilitation program was launched (this is equivalent to 50% of the original cost of construction).

The program was supported by the World Bank and other donors, including the African Development Bank, Sweden, Denmark, China, and Norway. By 1993, through improvements in management and operations, the transit time between Zambia and Dar es Salaam was reduced from 14 days to 4 days.

Table 23: Operational Indicators of Tanzania Railway Corporation

Indicator	1990	1991	1992	1993
Route Length (km)	2,584	2,600	2,600	2,600
No. of Locomotives	-	82	82	91
No. of Wagons	-	-	-	2,122
No. of Coaches	-	110	100	100
Freight Tons (000)	900	922	924	1,205
Freight Ton-Km (million)	-	961	937	1,263
Passengers (000)	-	1,714	1,442	1,732
Passenger-Km (million)	-	795	661	898
Employees (number)	-	13,123	11,823	11,218
TUs/Line Km (000)	-	675.4	614.6	831.2
TUs/Locomotive (000)	-	21,414.6	19,487.8	23,747.3
Ton-Km/Wagon (000)	-	560.7	649.8	729.2
Passenger-Km/Coach (000)	-	7,227.3	6,610.0	8,980.0
TUs/Employee (000)	-	133.8	135.2	192.6
Working Ratio (% of operating expenses to total revenues)	74.1	77.6	70.7	82.4
Operating Ratio (% of total expenses to total revenue)	75.8	78.7	74.0	85.3

Source: Data for 1990-1992 from the World Bank, ***Railway Data Base***; data for 1993-1995 from Southern Africa Transport and Communications Commission (SATCC), ***Annual Report 1995-1996***, Maputo, Mozambique.

Table 24: TRC's Diesel Locomotive Fleet

Class	Trans-mission Type	Rated Power (kW)	Max Speed (km/h)	Year First Built	Fleet Size (No)	Mechanical Parts	Engine Type	Transmission Type
35	Hydraulic	205	25	1973	4	Andrew Barclay	Paxman 8RPHL-7	Voith L320V
36	Electric	244	25	1979	20	Brush	Ruston-Paxman	Brush
37	Hydraulic	295	25	1985	5	Henschel-Thyssen	MTU 6Y396	Voith TC12
64	Hydraulic	559	72	1979	21	Henschel-Thyssen	MTU EB	Voith L520-UZ
73	Electric	1,003	96	1975	10	Varanasi, India	YDMA4	Varanasi
88	Electric	1,490	72	1972 1980	35	MLW	Alco 251C	GE Canada
	Electric	2,200		1993	9	ABB Henschel	DE 2200	Henschel
Total					104			

Source: Jane's Information Group Ltd., ***Jane's World Railways 1995-1996, 37th Edition***, Surrey, United Kingdom; and Tanzanian Railways Corporation.

With the political change in South Africa, which enabled the land-locked states to resume use of South African ports, the anticipated traffic did not materialize during 1990's. In recent years TAZARA has served mainly Zambian and Malawian markets. It has been plagued by poor locomotive availability and reliability, inadequate coordination with Zambia Railways, organization and management inefficiencies, and weak financial performance. The line which was built for an annual traffic of five million tons, was able to carry only about a million tons.

TAZARA currently operates 100 diesel locomotives (Table 26) of which 29 are GE U30C's and 71 are Chinese makes.

Table 25: Operational Indicators of TAZARA

Indicator	1990	1991	1992	1993	1994
Route Length (km)	1,860	1,860	1,860	1,860	1,860
No. of Locomotives	100	85	100	100	86
No. of Wagons	1,796	1,494	1,782	1,734	2,331
No. of Coaches	98	97	97	97	97
Freight Tons (000)	1,000	1,012	902	1,079	635
Freight Ton-Km (million)	-	1,360.8	1,310.4	1,545.6	-
Passengers (000)	1,600	1,584	1,925	2,220	1,824
Passenger-Km (million)	547.0	560.0	698.1	829.6	720.9
Employees (number)	-	6,926	7,011	6,756	6,600
TUs/Line Km (000)	-	1,032.7	1,079.8	1,277.0	-
TUs/Locomotive (000)	-	22,597.6	20,085.0	23,752.6	-
Ton-Km/Wagon (000)	-	910.8	735.4	891.4	-
Passenger-Km/Coach (000)	-	5,773.2	7,196.9	8,552.7	7,431.5
TUs/Employee (000)	-	277.3	286.5	351.6	-
Working Ratio (% of operating expenses to total revenues)	-	67.5	70.7	67.7	113.9
Operating Ratio (% of total expenses to total revenue)	-	76.3	76.2	71.6	167.5

Source: Data for 1990-1992 from the World Bank, ***Railway Data Base***; data for 1993-1995 from Southern Africa Transport and Communications Commission (SATCC), ***Annual Report 1995-1996***, Maputo, Mozambique.

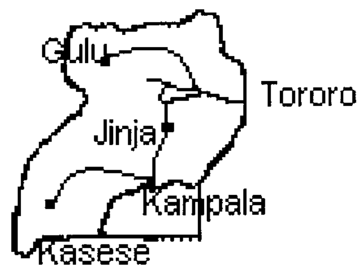
Table 26: TAZARA's Diesel Locomotive Fleet

Class	Trans-mission Type	Rated Power (hp)	Max Speed (km/h)	Year First Built	Fleet Size (No)	Mechanical Parts	Engine Type	Transmission Type
DFH-1	Hydraulic	1,000	50	1971	14	Chintao Locomotive. Works	12V 189ZL	Chintao SF2010
DFH-2	Hydraulic	2,000	100	1971	57	Chintao Locomotive. Works	12V 180ZL or MTU 12V 396TC12	Chintao SE2010
U30C	Electric	3,200	100	1983	12	Krupp	GE 17FDL 12HT	GE
U30C	Electric	3,200	100	1991	17	Krupp	GE 17FDL 12HT	GE
Total					100			

Source: Jane's Information Group Ltd., ***Jane's World Railways 1995-1996, 37th Edition***, Surrey, United Kingdom; and TAZARA.

UGANDA RAILWAYS CORPORATION (URC)

UGANDA RAILWAY SYSTEM



This is a digitally created sketch. All locations are approximate.

Uganda Railways Corporation (URC) was created after the 1977 breakup of the East African Railways. It operates a 1,241 km meter gauge track within Uganda which provides the country with access to its three major international trunk routes:

- A 1,300 km overland rail link through Kenya Railways to the port of Mombasa;
- Ferry connection through Kisumu to Mombasa (1,300 km); and
- Ferry connection through Mwanza to Dar es Salaam by Tanzania Railways Corporation (1,700 km).

The three routes carry 18%, 52%, and 30% of Uganda's international rail traffic, respectively. The railroad carries less than 4% of Uganda's domestic traffic. Passenger traffic which stood at 1.5 million trips in 1990 was down to 368,000 trips in 1993. With the restoration of weekly international passenger service between Nairobi, Kenya and Kampala, the downward trend in passenger service has been somewhat abated.

URC carried 880,000 tons of freight in 1995, a 13% increase from 1994, and 76% increase from 1993. This boost in freight traffic is particularly due to the carriage of emergency aid to neighboring Rwanda. The railway currently has 3,900 employees, down from 8,900 in 1989. The goal is to reduce the staff to between 2,000 and 2,500.

URC currently has 49 main line locomotives, which is made up of eight French diesel electrics (between 1,050 and 1,675 hp), and 41 Henschel diesel hydraulics (between 740 and 1,230 hp). It also has 6 shunter locomotives, all Henschel diesel-hydraulics of 330 hp. German aid had financed the rehabilitation of the Henschel locomotives and construction of a locomotive workshop at Nalukolongo, near Kampala.

In 1993 URC adopted a corporate plan to commercialize the railroad. All non-core activities are being privatized. Consideration is currently being given to privatizing track maintenance. The railway is negotiating a joint venture agreement with the German ADTranz for leasing and operating the locomotive workshop. The new company will be owned jointly by ADTranz (60%) and the URC (40%). Both Kenya and Tanzania will be invited to join the venture which will supply overhaul and maintenance service for all Henschel locomotives in East Africa. If Tanzania and Kenya decide to become a joint venture partner, both URC and ADTranz would reduce their partnership share by 10 percentage points per new partner. The eventual distribution of shares under this scheme would be 40% for ADTranz and 20% each for Uganda, Kenya, and Tanzania.

Table 27: Operational Indicators of Uganda Railways

Indicator	1990	1991	1992	1993	1994
Route Length (km)	1,232	1,241	1,241	1,241	1,241
No. of Locomotives	52	52	60	60	60
No. of Wagons	1,517	1,460	1,469	1,509	1,485
No. of Coaches	57	70	70	65	48
Freight Tons (000)	491	416	363	495	780
Freight Ton-Km (million)	159	138	119	135	208
Passengers (000)	572.0	392.0	391.1	368.1	221.0
Passenger-Km (million)	351.1	59.8	74.0	59.5	34.8
Employees (number)	5,694	5,762	5,815	4,068	3,854
TUs/Line Km (000)	414.0	159.4	155.5	156.7	195.6
TUs/Locomotive (000)	9,809.6	3,803.8	3,216.7	3,241.7	4,046.7
Ton-Km/Wagon (000)	278.0	352.0	304.3	366.7	941.2
Passenger-Km/Coach (000)	6,156.9	854.3	1,057.1	915.4	725.0
TUs/Employee (000)	89.6	34.3	33.2	47.8	63.0
Working Ratio (% of operating expenses to total revenues)	75.3	77.2	71.6	92.0	63.0
Operating Ratio (% of total expenses to total revenue)	75.6	124.2	112.0	116.0	85.0

Source: Data for 1990-1992 from the World Bank, ***Railway Data Base***; data for 1993-1995 from Southern Africa Transport and Communications Commission (SATCC), ***Annual Report 1995-1996***, Maputo, Mozambique.

The joint venture company would lease the locomotive workshop from URC under a long-term lease agreement which would cover a period of 5 to 7 years. The company would also assume the payroll obligations of the workshop with some flexibility in deciding on the staffing level. The company would enter into a locomotive maintenance contract with the URC to rehabilitate and maintain initially the fleet of Henschel locomotives, and eventually other makes in Uganda, Kenya, and Tanzania. The maintenance contract will provide for guaranteed minimum availability and reliability levels for locomotives. The German aid agency, KfW, is considering a DM20 million assistance to Kenya to encourage that country to participate in the contemplated URC-ADTranz joint venture.

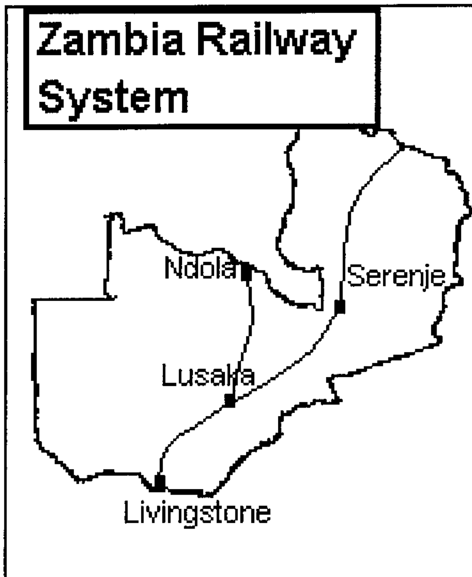
Uganda Railways is interested in two major improvements in its network:

- Emergency Rehabilitation of the Kampala - Kasese Line. This project would open up a valuable route from Mombasa to Zaire. In 1989, the World Bank, with assistance from Italy, had developed a $153 million project for the rehabilitation but the aid package was deferred and the line continues to deteriorate.

- The establishment of a rail container facility/dry port in Uganda. The German Government has offered to fund 50% of this project.

ZAMBIA RAILWAYS LTD (ZR)

The Zambia Railways (ZR) is part of the Southern Africa corridor system that links land-locked Zambia to the ocean ports of Tanzania, Mozambique, and South Africa. Formerly part of Rhodesia Railways, ZR was segregated as an autonomous system in 1976. Zambia Railways operates 1,273 km of cape gauge rail line. In addition, ZR connects to the Tanzania-Zambia Railway Authority's (TAZARA) system 89 km inside Zambia.



This is a digitally created sketch. All locations are approximate.

Since its inception, ZR has been handicapped by the political crises in the region and problems of some neighboring railways, which have adversely affected the land-locked country's access to the sea ports. Rail outlets are of critical importance to Zambia's copper industry, which generates 90 percent of the country's export earnings.

The railway has been experiencing falling freight levels and large losses during the last few years. It carried 1.9 million metric tons in 1995 down 25% from 1994. There were 5,500 employees down 35% from 1993. Its losses are a major burden to the Government. The World Bank is working with Zambia Railways to commercialize, restructure, and possibly even concession the railway.

In 1996, ZR's active fleet consisted of 68 locomotives, including the following units:

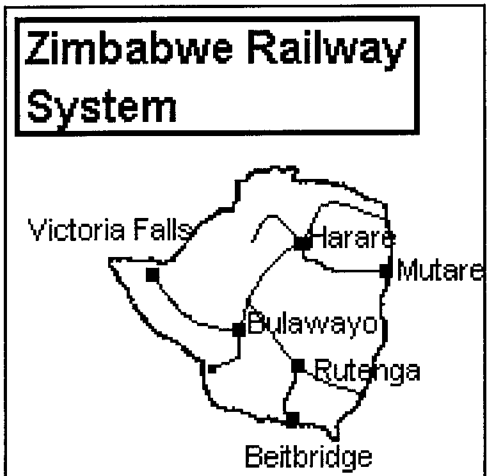
- 39 GE U20C main line diesel-electric units of 2,000 hp delivered in batches from 1967 to 1976. Twenty-five of these were recently overhauled with a $10.23 million grant from USAID.
- 12 GE U15C 1,016 kW diesel shunters delivered from 1967 to 1980.
- 15 GM-EMD GT36 diesel-electrics of 3,600 hp delivered in 1991.
- Two diesel-hydraulic units of 1,050 hp built by Cockerill Mechanical Industries (CMI) of Belgium.

Table 28: Operational Indicators of Zambia Railways

Indicator	1990	1991	1992	1993	1994	1995
Route Length (km)	1,273	1,273	1,273	1,273	1,273	1,273
No. of Locomotives	59	56	56	60	60	80
No. of Wagons	6,846	6,773	6,742	5,492	3,352	3,733
No. of Coaches	84	82	80	75	75	75
Freight Tons (000)	4,087	3,435	3,200	3,453	2,516	1,881
Freight Ton-Km (million)	1,444	1,081	1,025	1,074	653	446.3
Passengers (000)	1,187	788	904	1,181	1,502	920
Passenger-Km (million)	268.8	204.9	240.7	258.9	336.4	213.9
Employees (number)	8,419	8,544	8,025	8,518	7,929	5,500
TUs/Line Km (000)	1,345.5	1,010.1	994.3	1,047.1	777.2	518.6
TUs/Locomotive (000)	29,030.5	22,962.5	22,601.8	22,215.0	16,490.0	8,252.5
Ton-Km/Wagon (000)	210.9	159.6	152.0	195.6	194.8	119.6
Passenger-Km/Coach (000)	3,200.0	2,498.8	3,008.8	3,452.0	4,485.3	2,852.0
TUs/Employee (000)	203.4	150.5	157.7	156.5	124.8	120.0
Working Ratio (% of operating expenses to total revenues)	-	-	-	100.8	114.8	-
Operating Ratio (% of total expenses to total revenue)	77.5	85.1	84.5	93.0	121.8	-

Source: Data for 1990-1992 from the World Bank, ***Railway Data Base***; data for 1993-1995 from Southern Africa Transport and Communications Commission (SATCC), ***Annual Report 1995-1996***, Maputo, Mozambique.

NATIONAL RAILWAYS OF ZIMBABWE (NRZ)



This is a digitally created sketch. All locations are approximate.

National Railways of Zimbabwe (NRZ) is a 2,759 km cape gauge (1,067 mm) railway. Some 313 km are electrified (25 kV 50 Hz AC) and 42 km are doubled tracked. The main line (between the capital in Harare and Bulaweyo and extending to the coal fields in Hwange) was built between 1887 and 1904. It linked, then- Rhodesia to the seaports of Beira (Mozambique) and Cape Town (South Africa). The line was extended into Zambia following the discovery of lead, zinc, and copper deposits. In the 1950's, the line was extended into Chicualacuala to connect to the southern railway network in Mozambique and the Port of Maputo. During this period, NRZ provided transport service for several of the land-locked countries to the sea, mostly through the ports of Mozambique.

In 1974, as security conditions worsened, the mainline was extended from Rutenga to Beitbridge (on the border with South Africa) to provide increased access to the ports of Durban and Port Elizabeth. During the civil struggles in Mozambique, much of the transit traffic that had formerly used ports in Mozambique, was routed over a longer more costly route through ports in South Africa.

Today, as access to Mozambique ports improves, much of this traffic may revert to the shorter, cheaper traditional transit routes through Mozambique. Since Zimbabwe is at the center of key international rail and road routes serving Zambia, Zaire, Malawi, and Botswana, these changes will have a significant impact on the traffic patterns and revenues of NRZ, as well as other regional railways.

NRZ continues to face substantial competition from long-haul truckers for high valued freight. In this environment, NRZ is being forced to restructure and commercialize its operations. In 1995, the railway carried more than 12 million metric tons, a bit less than the freight traffic in 1993. Passenger traffic was down about 20% between 1993 and 1995. The railway has cut its staff size by about 15% since 1993 to a total of 12,975.

In 1991, NRZ's locomotive fleet consisted of 296 diesel-electric, 8 diesel-hydraulic, 30 electric, and 79 steam locomotives. The diesel-electric fleet included numerous manufacturers such as GE-USA, English Electric and Brush Electric of United Kingdom, German Siemens, Austrian SGP Verkehrstechnik, GEC Alsthom of France, and GM-EMD of USA and Canada. By 1995, NRZ has been able to streamline its fleet by eliminating nine classes of locomotives and reducing the fleet to 20 electric-, 147 diesel-, and 6 steam-powered units. By the end of 1996, the railway plans to retire the remaining 6 steam locomotives from its fleet.

Table 29: Operational Indicators of NRZ

Indicator	1990	1991	1992	1993	1994	1995
Route Length (km)	2,759	2,759	2,759	2,759	2,759	2,759
No. of Locomotives	-	392	352	312	155	173
No. of Wagons	-	17,099	12,427	12,427	11,840	12,027
No. of Coaches	-	401	378	378	364	364
Freight Tons (000)	14,300	14,377	13,654	12,496	10,791	12,269
Freight Ton-Km (million)	5,590	5,394	5,644	5,446	4,327	4,754
Passengers (000)	2,862	2,375	2,215	2,349	2,138	1,871
Passenger-Km (million)	781.5	571.4	659.8	588.1	651.4	546.0
Employees (number)	17,158	16,799	16,343	15,362	13,918	12,975
TUs/Line Km (000)	2,309.4	2,162.2	2,284.8	2,187.1	1,804.4	1,921.0
TUs/Locomotive (000)	-	15,217.9	17,908.5	19,340.1	32,118.7	30,635.8
Ton-Km/Wagon (000)	-	315.5	454.2	438.2	365.6	395.3
Passenger-Km/Coach (000)	-	1,424.9	1,745.5	1,555.8	1,789.6	1,500.0
TUs/Employee (000)	371.3	355.21	385.7	392.8	357.7	408.5
Working Ratio (% of operating expenses to total revenues)	109.8	81.9	57.5	75.6	77.2	-
Operating Ratio (% of total expenses to total revenue)	109.8	81.9	73.8	79.4	81.0	-

Source: Data for 1990-1992 from the World Bank, ***Railway Data Base***; data for 1993-1995 from Southern Africa Transport and Communications Commission (SATCC), ***Annual Report 1995-1996***, Maputo, Mozambique.

The 20 electric locomotives has a rated output of 2,400 kW at 34 km/h with a line voltage of 25 kV 50 Hz. These units, first built in 1983 by a joint venture of Austrian SGP Verkehrstechnik and ZECO (Zimbabwe Engineering Ltd) of Bulaweyo, are designed to reach a maximum speed of 100 km/h. The current diesel-electric fleet consists entirely of GE and GM locomotives (Table 30).

Table 30: NRZ's Diesel Locomotive Fleet

Class	Trans-mission Type	Rated Power (kW)	Max Speed (km/h)	Year First Built	Fleet Size (No)	Mechanical Parts	Engine Type	Transmission Type
DE 6	Electric	1,559	116	1966	9	GE U20C	GE FDI	GE-USA
DE 9	Electric	686	103	1972	20	GE U10B	CAT D398B	GE-USA
DE 9A	Electric	895	103	1975	44	GE U11B	CAT D398B	GE-USA
DE 10A	Electric	1,678	107	1982	61	GM-EMD GT22LC-2	GM 645E3B	GM-EMD
	Electric	3,000		1992	13	GM-EMD	GM	GM-EMD
Total					147			

Source: Jane's Information Group Ltd., ***Jane's World Railways 1995-1996, 37th Edition***, Surrey, United Kingdom; and National Railways of Zimbabwe.

H - FINDINGS AND CONCLUSIONS

- As their economies become more market oriented and open, African countries are facing increased pressure to change the operation and even ownership structure of their transportation providers. This is especially true for railways where the proposed changes range from an internal restructuring of railway services to a call for the complete concessioning of railway operations to the private sector. The Mozambique Railway's citrus terminal in Maputo, for example, is now in private operation, the railway workshop at the Uganda railway is being privatized and Malawi has restructured its railway. Almost all railways in the region either have a restructuring plan or are seriously considering one.

- Most railways have lost and are continuing to lose traffic to trucks. To maintain current levels of traffic and gain lost traffic, the railways must implement a more effective marketing program and improve the level of service.

- While locomotive availability and reliability problems are important components of the railways' poor financial and service performance, they are not the most significant factors. Poor operating practices, high overhead costs, excessive staffing, poor pay, and weak marketing are equally serious problems.

- During the last decade international donors have provided substantial financial assistance for purchasing or rehabilitating locomotives to most of the region's railways. Meanwhile, falling traffic levels continued to reduce locomotive power requirements. At current traffic levels with efficient railway operation, therefore, at least 50% of the region's locomotives must be considered surplus.

- Because of this surplus, locomotive reliability not locomotive availability has become the more critical immediate problem. With about 50% of the locomotive fleet realistically surplus, a railway can have one out of every two locomotives out of service and still meet 100% of its locomotive requirements. Poor locomotive reliability, on the other hand, means frequent breakdowns and delays that have a significant impact on the railway's cost and the service it offers to its customers.

- There is a significant surplus of locomotive workshop capacity in the region. Not only this duplication is wastefully expensive, but it also leads to poor service since most of the workshops do not have sufficient work to realize significant economies of scale or to maintain adequate employee skills.

- Current customs rules impose an impediment to the efficient operation of a consolidated workshop. Custom rules do not provide exemptions for unit exchange (returning old repairable parts for rehabilitated parts). Consequently most international parts repair is done on the basis of repair and return of the old part. Only the value of the repair itself is then taxed. This causes delays or requires a railway to maintain a larger parts inventory which defeats one of the main advantages of a regional workshop.

- Most of the railways recognize that there will be cost savings from workshop consolidation, but they are, for a number of non-economic reasons, unwilling to close their own workshop and send the work to an outside shop. This tendency is supported by the fact that costs for existing workshops are sunk and customs regulations make it difficult to send work to a foreign workshop.

- A regional locomotive workshop, therefore, is not viable at this time because the railways are not ready to cooperate on workshop consolidation. Most government owned railways are focusing instead on implementing national restructuring programs that will provide the railways with more autonomy over their own operations, as well as more responsibility for the outcome.

- In the long run, however, given the substantial potential benefits, consolidation of many railway workshops is inevitable. As the railways are restructured and concessioned, the new managers will be looking for additional ways to improve service quality and reduce their costs. Rationalizing locomotive workshop capacity should be high on their list.

- Future locomotive overhaul and repair decisions, including those that involve a regional locomotive workshop, will be made by restructured railroads and concessionaires in an open market environment. Therefore, decisions concerning present workshop facilities, as well as the establishment and operation of a regional locomotive workshop by the railways, must take into account the future needs and requirements of restructured railroads and concessionaires.

- Regional workshops specialize in major parts overhaul and repairs. This only accounts for 30% of the total maintenance process. They do not specialize in depot level locomotive maintenance. Since the most immediate locomotive problem of the railways is reliability, which is primarily a function of proper maintenance, the railways should pursue maintenance contracts or restructuring and concessioning of their maintenance facilities as a solution. Workshop consolidation and regionalization will follow this effort. The ADTranz joint venture project in Uganda is a good example of how such processes may occur.

- Contract maintenance is one alternative that addresses several important aspects of the locomotive availability and reliability problem such as low pay and the retention of skilled mechanical staff. Contract maintenance incorporates incentives for the contractor to train and retain competent staff, use a management information system, and provide an adequate supply of spare parts. Furthermore, it improves locomotive availability and reliability

- General Electric and General Motors locomotives are the principal locomotives used in East and Southern Africa. These companies must adopt new strategies, such as providing contract maintenance, to assist African railways in improving their locomotive availability and reliability.

- The situation is complicated by the current locomotive surplus which limits the market for new locomotives. It also reduces the sales potential of OEM parts because they must complete with recycled parts from surplus locomotives. Until this surplus is worked off, locomotive manufacturers will be cautious about expanding new services in the region. Nevertheless, participation in maintenance contracts may be necessary if the locomotive manufacturers want to protect their market and have more control on sales of new parts and components. This control is not necessarily important for improved sales, but more critical in improving the quality of parts and components used in locomotive maintenance.

- Low parts availability and delivery delays contribute to locomotive availability and reliability problems. Any measure that improves parts availability or shortens delivery time will improve the situation.

- A locomotive maintenance management information system (MIS) at each railway to forecast parts needs and track locomotive component performance is needed. With a MIS the railway has a better ability to control parts usage, determine quality performance, estimate maintenance costs, and accurately project spare parts requirements. A MIS is capable of improving locomotive availability by 2-5 percentage points simply by adjusting scheduled maintenance to balance work loads.

- The creation of a regional parts warehouse (bonded) stocked with hard to get OEM parts and operated in conjunction with licensed manufacturers' representatives would be useful. Such a warehouse needs to be supported by manufacturers' service engineers stationed in the region and visiting the railways on a regular basis.

I - RECOMMENDATIONS

The creation of regional locomotive workshops, although may be economically justified, does not appear to be a practical solution at this time. Because of its limited impact on the locomotive maintenance process, it should not be considered a high priority. The railways are undergoing an evolutionary process as they shift from government owned and operated institutions under managed economies toward autonomous businesses that respond to market-driven signals. Consolidation and perhaps privatization of the locomotive workshops will eventually occur, driven by the need to reduce costs, improve quality, and efficiency. There appears to be no significant role for the UAR, USTDA or locomotive manufacturers in this process at this time.

However, locomotive availability and reliability can be improved through other means such as contract maintenance, which can be implemented with relative ease. This will provide railways with improved service, reduced cost, and increased equipment utilization. TERA, therefore, makes the following recommendations for Phases 2 and 3 of the study:

(1) That the UAR, with the concurrence of USTDA, refocus the remainder of the feasibility study grant from evaluating the creation of a regional workshop to assisting the regional railways in establishing locomotive contract maintenance programs. Since it addresses the entire maintenance process, contract maintenance provides the most effective way to improve locomotive availability and reliability. It would lower railway costs and improve service. It would be consistent with the eventual creation of regional workshops and it would be a step in support of railway restructuring initiatives currently underway with assistance from multinational and bilateral organizations. It will also create a sustained pool of skilled managers and mechanics.

(2) Under Phase 2, TERA proposes to develop the necessary framework for railways to solicit contract maintenance proposals. A report will be prepared which includes a discussion of the definitions, rules, and concepts implicit in contract maintenance. Draft contract documents will be prepared to provide an acceptable basis for both railways and potential U.S. contractors to negotiate a final agreement. This stage is necessary because many African railways are unfamiliar with all the implications of contract maintenance and do not want to be at a disadvantage in contract negotiations. Especially contract maintenance with power on demand includes a complicated set of rules which establish an acceptable risk-return balance for the contractor, while accomplishing the railways' goal of improved locomotive availability, reliability, and utilization.

Concurrent with the development of the contract maintenance framework described above, TERA will investigate available computerized locomotive maintenance management information systems and evaluate their cost and adaptability to the specific needs of the region's railways. MIS offer great capability to predict locomotive parts needs. This capability will be the first step supporting the establishment of a regional parts warehouse.

(3) Phase III will set the stage for a contract maintenance test case. During this stage TERA will assist one railway selected by the UAR in the preparation of specific contract maintenance documents and negotiation of a contract with a U.S. contractor selected by the railway. The procedures, documents and practices developed during this phase will serve as a model for other African railways in developing their own contract maintenance programs. To support this goal, TERA will prepare and deliver a revised Phase 2 report to UAR which outlines the lessons learned during negotiations of the maintenance contract. This report will describe all pertinent issues of contract maintenance for the benefit of other railways in the region.

APPENDIX A - CONTACTS

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