Sida Evaluation 96/16

Swedish Support to Botswana Railways

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Department for
Infrastructure and
Economic Cooperation

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THE EVALUATION OF SWEDISH SUPPORT TO BOTSWANA RAILWAYS

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ABBREVIATIONS USED

BTC	Botswana Telecommunication Corporation
BR	Botswana Railways
CSTE	Chief Signal and Telecommunications Engineer
CTC	Centralised Train Control
EMX	
GEC	General Electric Company
GM	General Manager
GSI	General Signal International Ltd
MSEK	Million Swedish Kroner
NRZ	National Railways of Zimbabwe
RETBS	Radio Electronic Token Block System
SADCC	Southern Africa Development Coordination Conferences
SIDA	Swedish International Development Cooperation Agency
VECTA	

1. EXECUTIVE SUMMARY

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The Project

Botswana Railways (B.R) was created in 1986, taking over from the National Railway of Zimbabwe (NRZ).

The railway take-over and rehabilitation was seen in both a national and a regional (SADCC) context. In the national context the railway was and still is needed as a cost-effective alternative to road-transport of heavy bulk goods through Botswana. In a regional perspective the railway was a means of transport of goods between the land-locked countries in the region, and also a link to the South African ocean ports at a time when Mozambique's three international ports as well as the port of Dar es Salaam were not able to operate effectively.

SIDA identified three key areas where Swedish Aid would greatly assist the new railway administration, these were:

(i) Provide signalling and telecommunications engineering expertise to establish the foundations of a new S&T department.

(ii) Train Botswana citizens to take over the management, operation and maintenance of the signalling and telecommunications equipment.

(iii) Purchase and install a new signalling and telecommunications system in place of the life-expired equipment inherited from the NRZ.

In January 1986 Swedish support to BR was agreed up to a ceiling of 56 MSEK for:

(i) Supply and installation of new telecommunications equipment.

(ii) Supply and installation of a new Radio Electronic Token Block System (RETBS) for train working.

(iii) Supply and installation of a local signalling system at the sidings and workshop in Mahalapye.

(iv) Consulting Services for procurement and installation of the systems.

(v) Technical Assistance to establish a signal and telecommunications division within Botswana Railways' central administration, staffed by Botswana citizens.

(vi) Training of local staff to operate and maintain the equipment supplied.

In April 1989 a new agreement was entered into between Sweden and Botswana for a three-year extension of the Technical Assistance support to BR at a cost of MSEK 12.0.

In May 1992 a third agreement was signed between Sweden and Botswana for an 18 month extension to the Technical Assistance at a cost of MSEK 9.6. In April 1993 the ceiling was raised by MSEK 1.5 to MSEK 11.1 to cover a final period of Technical Assistance by the Signal Engineer up to the end of February 1994.

Swedish aid therefore supported the project for over seven years from January 1986 to February 1994 at a total cost of MSEK 79.1.

The Evaluation

The evaluation exercise has focused on the Swedish support given to provide train working and telecommunications equipment and to establish a sustainable staff unit within the Botswana Railways' administration to operate and maintain the equipment provided.

The main issues studied, analysed and commented upon are the following:

(i) Were the procedure as well as the equipment chosen appropriate for Botswana Railways? (The question is particularly relevant for the train working equipment since the RETBS was fairly new and untested in a track system as large as BR's).

(ii) The procurement procedures, supplier, installation supervision and the performance reliability aspects of the project.

(iii) The Consultant's assistance to train local staff to administer, operate and maintain the new equipment and to create a sustainable Signal and Telecommunications Department within BR.

(iv) Were the objectives for the Consultants services precise and clear.

(v) Should the Human Resource Development have followed a slower or perhaps quicker path with a more concentrated assistance input? Is the organisation and staffing of the S & T Department sustainable in a longer time perspective?

(vi) Did the Government of Botswana fulfil its contractual commitments according to the Specific Project Agreements with Sweden?

Issues of second priority looked into were:

(i) Did NRZ provide good advice to the project as consultants for installation and commissioning of the train working equipment and did NRZ supply appropriate equipment for the local signalling system in Mahalapye?

(ii) Has there been any notable environmental impact (positive or negative) of the Swedish project.

Finally, the economic relevance of the railway take-over from NRZ was briefly considered with regard to the economic development in the country.

The evaluation team visited SIDA offices in Stockholm on 15 & 16 November 1995 and carried out a field mission in the period 22 November - 9 December 1995. the field mission incorporated a visit to the Swedish Embassy & SIDA office in Gaborone, B.R headquarters in Mahalapye, Francistown training school, NRZ headquarters in Bulawayo and Spoornet headquarters in Johannesburg. Meetings were held with relevant people in all of the offices visited.

A draft summary of the teams findings was presented to the Managing Director of B.R and the SIDA representative in Botswana prior to departure.

Summary of findings

1. System

   (i) Choice of system

   The RETB system chosen for BR was identified by two preliminary studies as being the most suitable, cost-effective system for BR. This was subsequently

confirmed by an independent study after the installation of the equipment. It did however put BR in the vanguard of radio train control - which is now becoming common-place on many railways.

The choice was correct and the system is functioning adequately but the equipment installed has resulted in a system which has too many failures.

(ii) Procurement and installation
Cost-cutting measures have proved detrimental to BR. The choice of a stand-alone telecommunications and signalling system has resulted in BR being reliant on the Botswana Telecommunication Corporation (BTC) for its long distance telecommunication links. BTC give no guarantees of service. During installation BR decided that several of the installation tasks would be carried out by their own staff; this invalidated some of the manufacturers guarantees.

It is also unfortunate that the equipment selected for installation on the railway used an unproven transponder, which has caused many on-going problems.

There was some overlap of responsibilities between the NRZ staff nominated as The Engineer for the installation and the newly appointed SwedeRail staff who were responsible for the operation and maintenance of the equipment.

(iii) Reliability
The contract for the supply and installation of the RETBS did not contain any clauses relating to reliability. the manufacturer cannot therefore be challenged over the poor reliability that was achieved. It is regrettable that the supplier has now virtually abandoned the system and is totally uncooperative.

The S&T staff are overcoming the unreliability problem but this involves them in a lot of repair work and searching for alternative suppliers of spare parts.

2. Establishment of S&T Department

(i) Objectives
The objective, of establishing a new S&T Department, was clearly impossible in the initial two year time-scale. The Department had to be built up over a period of time and it was necessary to institute a major training scheme. The lack of time was acknowledged by SIDA and the contracts for the technical assistance and training staff were duly extended.

(ii) Achievements
At the commencement of the project it was stated that a minimum period of 8 to 10 years would be required before the S&T Department would be fully localised.

That estimate was proved correct but on 1 January 1993 the local engineers adopted their substantive posts and, with the assistance for a further year of the expatriate engineers, took over the management of the Department.

Despite the exception teething problems associated with the RETB installation and the difficulty in attracting and retaining staff, a new signalling system is now in daily operation and a fully localised staff are showing initiative and resourcefulness in maintaining the system.

This must be regarded as a successful outcome to some eight years of

development and training, mainly sponsored by Swedish aid.

3. Economic factors

(i) Regional transport situation
The railway is facing severe competition from both road and alternative rail routes. Rail traffic can now by-pass Botswana on routes to Beira, Maputo and directly from South Africa into Zimbabwe via Beit Bridge. Botswana has invested heavily in building roads and by so doing attracted traffic from the railways onto roads.

The strong Botswana currency means that Zimbabwe and South Africa have a financial incentive to use their own rail networks wherever possible.

(ii) Traffic patterns.
Freight traffic accounts for 80% of BR revenue subdivided as:

Transit traffic which has dropped from 84% to 28% in the period 1986 - 1995;

Internal traffic which has remained relatively constant;

Import traffic grew in the late 1980's but has dropped dramatically since;

Export traffic is very dependent upon the success of the Sua Pan project.

Passenger traffic has dropped sharply in recent years - presumably due to an increase in bus and coach competition but also possibly due to railway unreliability and poor time keeping. A recent initiative has reversed the trend.

2. PROGRAMME CONTEXT

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2.1 Context of the Project

Botswana Railways (BR) was created by the Botswana Railways Act in 1986 and in the following year Botswana took over the administration and operation of the railway from the National Railways of Zimbabwe (NRZ). This involved the acquisition of all the railway assets and the need to train Botswana citizens in the various skills required to operate and maintain the railway.

Locomotives were purchased, a maintenance workshop was built at Mahalapye and track upgrading works were put in hand.

SIDA identified three key areas where Swedish Aid would greatly assist the new railway administration, these were:

(i) Provide signalling and telecommunications engineering expertise to establish the foundations of a new S&T department.

(ii) Train Botswana citizens to take over the management, operation and maintenance of the signalling and telecommunications equipment.

(iii) Purchase and install a new signalling and telecommunications system in place of the life-expired equipment inherited from the NRZ.

This appraisal report traces the history and achievements of the Swedish aid project.

2.2 Project History

The railway take-over and rehabilitation was seen in both a national and a regional (SADCC) context. In the national context the railway was and still is needed as a cost-effective alternative to truck-transport of heavy bulk goods through Botswana.

In a regional perspective the railway was a means of transport of goods between the land-locked countries in the region, and also a link to the South African ocean ports at a time when Mozambique's three international ports as well as the port of Dar es Salaam were not able to operate effectively.

Therefore, based upon a request in 1982 from the Government of Botswana to SIDA, the Swedish Government authorised SIDA to prepare and agree upon Swedish support for the rehabilitation of the train control system and telecommunications system for the railway up to a ceiling amount of MSEK 38. However, in June 1984 a new request was submitted by the Government of Botswana for a signalled block system for train control which, including the telecoms part, was estimated to cost MSEK 80.

After a final appraisal in 1985 an agreement was signed, in January 1986, for Swedish support to Botswana Railways up to a ceiling of MSEK 56 (MSEK 46.0 from the regional SADCC allocation and MSEK 10.0 from the bi-lateral Botswana country allocation) to cover:

(i) Supply and installation of new telecommunications equipment.

(ii) Supply and installation of a new Radio Electronic Token Block System (RETBS) for train working.

(iii) Supply and installation of a local signalling system at the sidings and workshop in Mahalapye.

(iv) Consulting Services for procurement and installation of the systems.

(v) Technical Assistance to establish a signal and telecommunications division within Botswana Railways' central administration, staffed by Botswana citizens.

(vi) Training of local staff to operate and maintain the equipment supplied.

The total agreed amount of MSEK 56.0 included a contingency of MSEK 9.0.

This budget was sub-divided as follows:

Item	MSEK
Telecommunications system	17.70
R.E.T.B. system	29.00
Mahalapye signalling	0.90
NRZ supervision	1.37
Technical Assistance	6.70
Training (in Sweden)	0.33
Total	56.00

In April 1989 a new agreement was entered into between Sweden and Botswana for a three-year extension of the Technical Assistance support to BR at a cost of MSEK 12.0.

In May 1992 a third agreement was signed between Sweden and Botswana for an 18 month extension to the Technical Assistance at a cost of MSEK 9.6. In April 1993 the ceiling was raised by MSEK 1.5 to MSEK 11.1 to cover a final period of Technical Assistance by the Signal Engineer up to the end of February 1994.

Swedish aid therefore supported the project for over seven years from January 1986 to February 1994 at a total cost of MSEK 79.1.

2.3 Description of the Project

The component parts of the project as set out in items (i) to (vi) above are now elaborated in this section and set into a time frame, summarised in Figure 2.1

2.3.1 Telecommunications System

As will be discussed later, an initial appraisal study proposed that the signalling (train working) and telecommunications systems should be considered as an integrated package. Further, that the communications system should have a development capability beyond that available on open wire carrier systems.

In the event, the system choice was based on an open wire carrier system and comprised:

- a selector telephone system for 15 stations;
- 3 + 12 channel open line wire carrier system;
- five electronic PABX telephone exchanges.

The contract was awarded to Ericsson Network Engineering and was taken into service in November 1988, within one month of the planned date. No major problems were encountered at the time of installation or were reported to the evaluation team.

2.3.2 Train Working System (RETBS)

This train working or signalling system is based on the exchange of tokens directly between a central control point and the driver in his locomotive cab. A token represents the authority to proceed into a specified section of running line. The exchange is achieved using radio communications conveying both voice and secure data transmissions. The central control point contains safety electronic interlocking equipment to safeguard against conflicting movement orders and also enables the progress of trains to be monitored. An illustrated description is given in Appendix D1.

For the Botswana application, a further feature was added to the basic RETB system. By using track mounted transponders it is possible to effect an automatic and overriding braking action on the train should the driver attempt to move his train into an unauthorised section of running line.

The supply and instal contract was let, after some delay to the original plans due to specification changes, to General Signal International Ltd (GSI) in April 1987. The main components of the supply comprised:

- central control interlocking equipment and monitoring consoles;
- radio base stations to provide two way communications at all locations where token exchange may be required;
- radio and RETBS equipment in all locomotive cabs;
- transponder interrogator equipment on all locomotives;
- track transponder units, six per site, throughout the route.

NRZ were contracted to act as The Engineer for the project. In order to save some costs BR took on some responsibilities in connection with the installation and transport of equipment. These matters are considered in detail in Section 4 of this report.

2.3.3 Local Signalling at Mahalapye

A local signalling installation was deemed desirable to control and protect movements in the vicinity of the new workshops at Mahalapye. This work was contracted to NRZ with a very limited budget. It was commissioned in July 1987. It was however found necessary to upgrade the installation in 1990.

2.3.4 Consulting Services for Procurement

As mentioned above, NRZ were appointed as consulting engineers to undertake a range of duties associated with the supply and installation of the contracted system. These duties included feasibility studies, preliminary and detailed design and general administration of all aspects during the construction of the Works. The manner in which this was undertaken and issues arising are also discussed in Section 4.

2.3.5 Establishment of the BR S&T Department

SwedeRail were commissioned to undertake this task. To this end three experienced Swedish engineers took up residence in Botswana at the end of 1986 for an initial contract period of two years. They were joined by four other expatriates, from Zambia, Zimbabwe and South Africa, in supporting supervisory positions. The contract for technical support, although not with the same people, was subsequently extended for a further three years, 1989 to 1991

inclusive and then finally for a further period to cover the 'localisation' training.

The localisation programme comprised a period of just over one year when each local engineer designate was attached to an expatriate engineer as a so called 'counterpart'. This programme contained a disengagement plan so that during the year 1992 responsibilities were progressively handed from the expatriate to the counterpart. The expatriate then acted as advisor to the engineering during 1993.

These matters are discussed in Section 5 of this report.

2.3.6 Training of Technical Staff

A recommendation made by SwedeRail in June 1987 identified the need for dedicated training resources, detached from day to day line management duties. This recommendation was adopted and a SwedeRail engineer was appointed in November 1987. During 1987 and through to 1992 the Training Engineer, (and later together with his counterpart) devised and conducted courses for all technicians and engineers covering the new technical equipment which had been installed under the signalling and telecommunications contracts. During 1992 and 1993, these courses were extended to cover general and project management areas.

A new training facility was built at Francistown providing for both classroom and outdoor equipment training.

At the conclusion of the contract for training services, a forward looking Training Strategy Report (ref. M10) was left with BR anticipating individual training needs in the period 1993 to 1997. The status of this document together with the identified training needs must now be in question, see Section 5.

EVENTS TIMETABLE

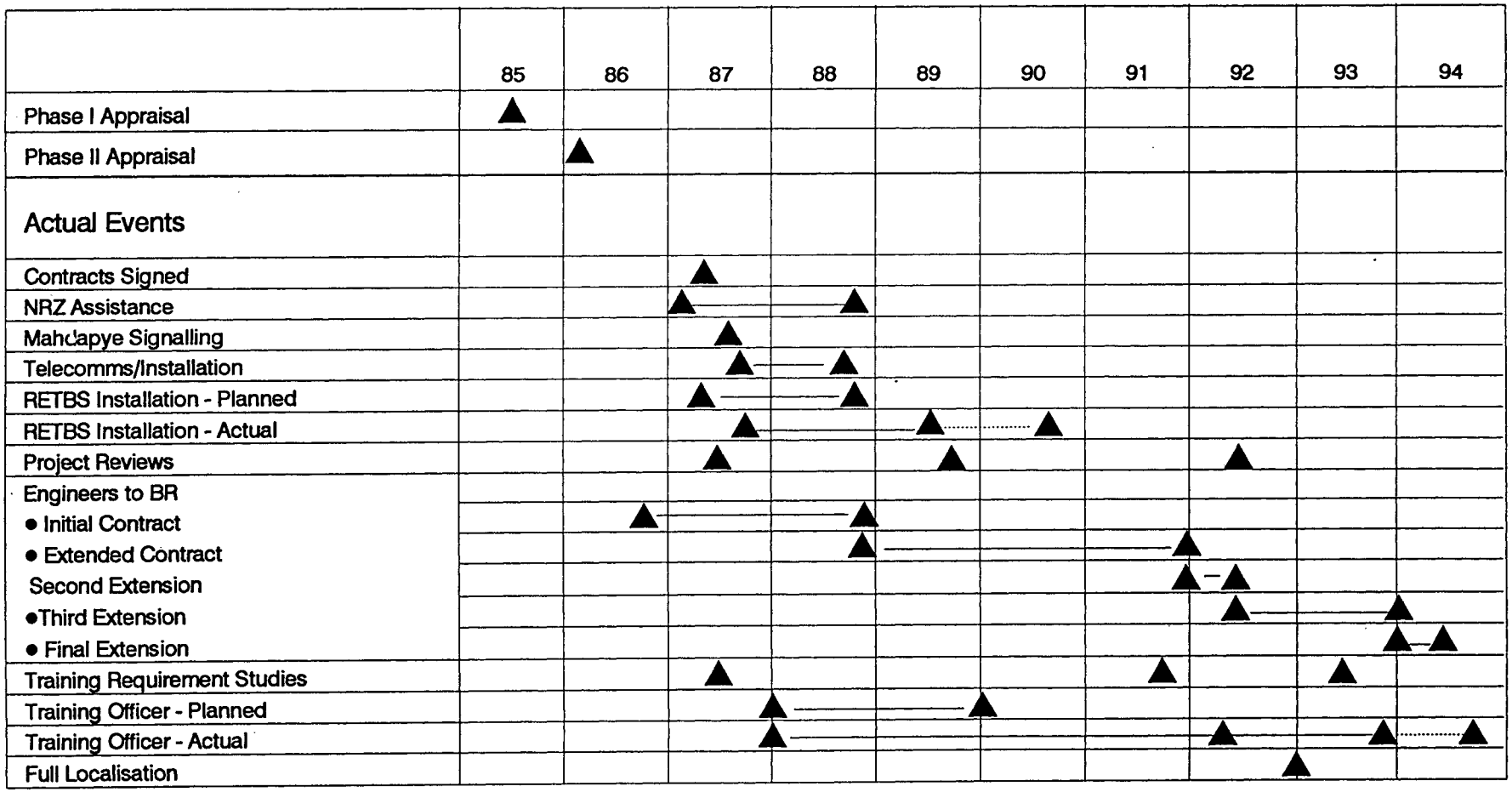

Figure 2.1

3. EVALUATION METHODOLOGY

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3.1 Scope and Focus of the Evaluation

The evaluation exercise has focused on the Swedish support given to provide train working and telecommunications equipment and to establish a sustainable staff unit within the Botswana Railways' administration to operate and maintain the equipment provided.

The main issues studied, analysed and commented upon are the following:

(i) Were the procedures as well as the equipment chosen appropriate for Botswana Railways? (The question is particularly relevant for the train working equipment since the RETBS was fairly new and untested in a track system as large as BR's).

(ii) The procurement procedures, supplier, installation supervision and the performance reliability aspects of the project.

(iii) The Consultant's assistance to train local staff to administer, operate and maintain the new equipment and to create a sustainable Signal and Telecommunications Department within BR.

(iv) Were the objectives for the Consultants services precise and clear.

(v) Should the Human Resource Development have followed a slower or perhaps quicker path with a more concentrated assistance input? Is the organisation and staffing of the S & T Department sustainable in a longer time perspective?

(vi) Did the Government of Botswana fulfil its contractual commitments according to the Specific Project Agreements with Sweden?

Issues of second priority looked into were:

(i) Did NRZ provide good advice to the project as consultants for installation and commissioning of the train working equipment and did NRZ supply appropriate equipment for the local signalling system in Mahalapye?

(ii) Has there been any notable environmental impact (positive or negative) of the Swedish project.

Finally, the economic relevance of the railway take-over from NRZ was briefly considered with regard to the economic development in the country.

3.2 Evaluation Activities

The project team, as listed in our proposal, carried out the evaluation in accordance with the project and manning schedules figures 3.1 and 3.2

Following award of contract on 6 November, it was agreed with SIDA that the project should be carried out before the end of 1995 although this left little time to make the necessary arrangements.

The Team Leader (Brian Green) and Signalling Expert (Peter Law) visited SIDA's offices in Stockholm on 15 & 16 November to clarify administrative matters, review the documentation held in SIDA offices and meet members of SwedeRail staff who participated in the project.

Unfortunately this visit was not wholly successful as the staff and many documents were not available but a useful insight to the project was gained and some documents were collected.

The documents were studied in the UK and arrangements made for the field mission. Peter Law travelled to Botswana on 21/22 November and undertook the following activities:

22 November	Gaborone - SIDA/Embassy office	
		Introduction to Lars-Olov Jansson
		Established office base
		Commenced review of documents
23 November	Gaborone - SIDA/Embassy office	
		Review of documents
	p.m.	to Mahalapye
24 November	Mahalapye - B.R. Headquarters	
		Preliminary discussions with the CSTE
25 - 28 November	Gaborone - Hotel/SIDA/Embassy office	
		Review and indexing of documents
		Preparations for field mission
		Letters and telephone contacts with BTC and Ministry of Works.

Brian Green joined Peter Law in Botswana on 28 November and commenced reviewing the documents. Visits to B.R. headquarters at Mahalapye, Francistown and NRZ headquarters in Bulawayo were arranged and attempts made to secure meetings with representative of Botswana Telecommunications Corporation and the Ministry of Works, Transport and Communications but the officers with knowledge of the project were not available for discussion.

The field mission then followed the programme as outlined below:

29 November	Gaborone - SIDA/Embassy office	
		Review of documents.
30 November	Gaborone - SIDA/Embassy office	
		Review of documents
	p.m. to Mahalapye	
01 December	Mahalapye - B.R. Headquarters	
		Detailed discussions with CSTE
		Meeting with General Manager of B.R.
02 December	Francistown	
		Visit to station and S&T workshop/training school
03 December	Sua Pan	
		View (external) of railway facilities and line to Botswana Ash terminal
	p.m. to Bulawayo	
04 December	Bulawayo - NRZ headquarters	
		Discussions with CSTE of NRZ and members of staff involved in the supply and installation of the RETB system.
	p.m. to Francistown	

05 December	Mahalapye - B.R. headquarters Further discussions with CSTE Visit to S&T workshop On-locomotive(s) inspection of RETB system, travelling from Mahalapye to Lose and back to Mahalapye p.m. to Gaborone
06 December	Gaborone - SIDA/Embassy office Preparation of draft summary of findings Further attempts to arrange meetings with Min. of Works and BTC. Presentation of draft summary of findings to General Manager and Planning Officer of BR.
07 December	Gaborone - SIDA/Embassy office Telephone discussions with BTC and Botswana Ash. Presentation of draft summary of findings to Lars-Olov Jansson at the Swedish Embassy
08 December	a.m. to Johannesburg Meetings with Spoornet regional manager responsible for Business Development and the senior S&T engineer. p.m. depart for London
09 December	arrive London.
11 - 29 December	Review of documents Briefing transport economist (Richard Snell) Preparation of draft report

The evaluation team acknowledge with thanks the assistance that was provided to them by the persons listed in Appendix B during the course of the assignment.

3.3 Limitations of the Study

As described above, the team were able to follow the programme as presented in the original proposal, apart from the visit to Botswana by the transport economist which was discussed with SIDA and agreed to be an unnecessary expense.

Due to the length of the project and the time that has elapsed since the completion of the work, most of the expatriate team members were not available for discussion and the SIDA staff in the Gaborone Embassy have changed. This may be a good thing as the team were able to make their own judgements of the work carried out without any pressure from participants. It did however leave some gaps in the evaluation. For instance:

(i) The documents relating to the decision to award the contract to the GSI group.

(ii) The reasons for not pursuing an integrated signalling and communications package as suggested on the Phase 1 Appraisal Study (see 4.1.1).

The absence of documents in SIDA offices in Stockholm (due to the office move) meant that there was not a lot of background to review before the team went to Botswana. However, the large number of documents available in the Swedish Embassy in Gaborone provided most of the details required.

Discussions were held in Botswana, Zimbabwe and South Africa with relevant staff in the railway organisations, but it proved impossible to meet representatives of the Botswana Ministry of Works, Transport and Communications or of the Botswana Telecommunications Corporation, despite writing letters and numerous telephone calls as the relevant officials of the organisations were on leave, about to retire or out of Gaborone on the days when the evaluation team were in Gaborone.

EVALUATION OF SWEDISH SUPPORT TO BOTSWANA RAILWAYS

PROJECT PROGRAMME

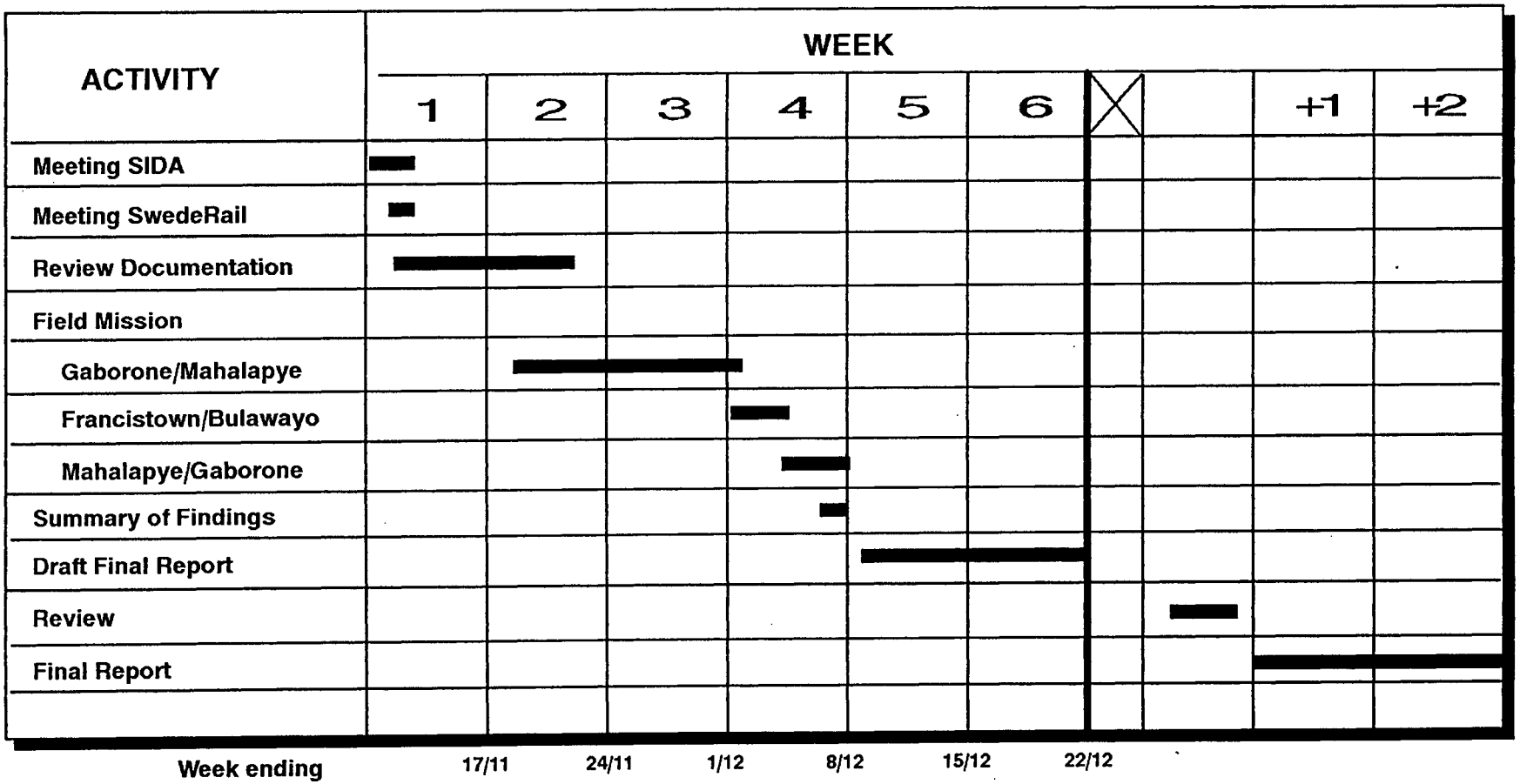


Figure 3.1

MANNING SCHEDULE

NAME	POSITION	WEEK 1	2	3	4	5	6					TOTAL UK	O.S.	
B.M. GREEN	Team Leader and Railway Management/ Training Specialist											2.0		4.5
		SW		Southern Africa									2.5	
P. LAW	Railway Signalling Specialist											2.0		5.5
		SW	Southern Africa										3.5	
R. SNELL	Transport Economist											1.5		1.5
													0.0	
Week ending		17/11	24/11	1/12	8/12	15/12	22/12							

Evaluation of the Swedish Support to Botswana Railways

Figure 3.2

4. TRAIN WORKING SYSTEM

4. TRAIN WORKING SYSTEM

4.1 Appropriateness of Equipment

Prior to the choice of the system of train control for installation on BR, two completely independent studies were carried out which reviewed the systems then available.

4.1.1 Systems Appraisal Study (Phase 1)

An initial Appraisal Study carried out in 1985 by Henderson, Hughes & Busby (ref. R10) reviewed the various methods that were established at that time for train control on single line railways to determine their relevance and suitability for BR.

These established methods included:

- a replacement of the existing Facsimile system;
- token instrument systems;
- tokenless block;
- full CTC;
- simplified CTC providing loop signalling but no power operation of points and only limited overall control capabilities.

To this list was added the recently developed technique for utilising radio communications to exchange electronic tokens between a central control point and the cab of the locomotive. Radio Electronic Token Block (RETB) was by then a proven system and had been installed on several lightly used lines in the U.K. Demonstration equipment was made available for BR/NRZ inspection.

In the subsequent evaluation, the Facsimile system, despite being the cheapest, was dismissed on grounds of no improvement of safety or line capacity or betterment for the expenditure involved. Token or tokenless systems were found to be poorly suited to the Botswana application where the prospective block sections would contain many unmanned crossing loops. Of the remaining options, full CTC implying centralised control and power operation of all points and signals along the route could not be justified financially when set against the amount of traffic anticipated on Botswana Railways.

On grounds of cost and suitability the study concluded that the simplified CTC and RETB would be the most appropriate systems to go forward for consideration in the next phase of the study. Preliminary estimates suggested that RETB could be about 50% lower in first cost than the nearest contender, simplified CTC. Further, it could provide operational benefits through the two way communication facilities inherent in the system and traffic supervision from a central point on the network.

The initial Systems Appraisal Study was also required to consider the options for rehabilitating the telecommunications system. To meet the minimum requirements established for communications by BR, a 3+12 channel carrier system was envisaged operating on the existing open wire pole route. The study however strongly recommended that consideration should be given to a more modern approach utilising radio-borne multi-channel transmissions. This would have the advantage of increased capability for expansion, it would be less affected by electrical storms, it would be independent of vulnerable open wire routes and would be a natural counterpart if the choice of signalling system favoured RETB. The study

recommended that in this event it could be advantageous to consider the train control and telecommunications systems as one integrated package and not treat these as two separate systems. Some savings in capital cost were envisaged.

4.1.2 Appraisal Study (Phase 2)

In 1985/6 a further Appraisal Study (ref. R11) was carried out by SwedeRail. This had a broader remit but was required to make recommendations regarding train working systems. Specifically the three options for consideration were: rehabilitation of the facsimile system, a simplified CTC system and a RETB system. The rehabilitation of the telecommunications system was also to be considered.

At the request of Botswana Railways, and as advised by NRZ, an additional safety feature was to be added to the basic RETB specification. This was to be an automatic braking of the train should the driver attempt to proceed into an unauthorised block section. Conceptually this was to be achieved through the addition of track mounted transponders situated at each loop or station exit. The use of transponders for track to train data communication was already an established technology although they had not been used up to this time in conjunction with the RETB system.

The study concluded in favour of the enhanced RETB system. It was regarded as 'by far the most suitable system'. Contributing to this recommendation were:

- estimated investment of only MSEK 19 compared with MSEK 60 for the simplified CTC system;
- considerable reduction in staff numbers;
- facilities for overall traffic supervision;
- maintenance costs and problems 'within limited frame'.

The avoidance of all active signalling equipment such as track circuits and colour light signals at the lineside is the major contributor to reducing such costs.

With regard to the possible integration of RETB and telecommunications as proposed in the Phase I Study, the Phase II Study does not choose to pursue this possible course of action. Instead, the telecommunications and signalling systems are treated as stand-alone systems. Telecommunications is to be based on the 3+12 carrier system on the open wire pole route as described above. For RETB it is proposed that this shall be provided with its own independent radio distribution system with long haul links provided by rented BTC channels in their new (1984) microwave transmission system.

It seems likely from remarks in the Phase II Report (Section 1.5.3) that this course of action was influenced by the then positive marketing by BTC to renting lines in their new system and the offer of, and prospective use of, some BTC towers for mounting RETB antennae. Additionally, if a decision had already been made concerning the retention of the open wire route, then the proposal to integrate the respective RETB and telecommunications systems would no longer present such a strong argument.

4.1.3 Signalling Feasibility Study

A subsequent study by De Leuw Cather (ref. R17) conducted in July 1992, addressed a remit to review the status of the existing signalling and consider the possible future directions for BR having regard to economic, market and technical issues.

Despite the problems arising with the engineering realisation of the RETB system (see 4.5.1), the study broadly reinforced the earlier decision that radio based signalling was the appropriate solution for BR. With a view to future competitiveness, the study went on to recommend the introduction of full local signalling at main stations together with facing point improvements at other loops to enable faster running and reduced overall transit time. These recommendations have been implemented in part, to the extent of signalling main stations, but other improvements are presently in abeyance as a result of financial constraints.

4.2 Procurement

4.2.1 Specification

Given the decision to proceed, a Functional and Technical Specification was prepared in 1986 (ref. M1). As there was only one Radio Electronic Token Block System in operation at that time the Specification had to relate directly to the system as used on lightly used lines on British Railways, but with modifications to suit the additional feature of transponders activating train brakes.

In recent discussions, NRZ confirmed their involvement in the preliminary framing of this specification and acknowledged the contribution of Westinghouse in providing specific detail of the RETB system. The specification was then developed into its final form by SwedeRail.

Tenders were invited from the two contractors who had previously supplied and installed RETB equipment, namely Westinghouse Signals Limited and General Signal International Limited (GSI).

Westinghouse responded (ref. M.6) with a proposal which included linking with Ericssons. Westinghouse would supply the basic and proven RETB equipment. Ericsson would provide their established transponder equipment and also be responsible for all communications.

GSI responded with a proposal to resource the entire system from within the Group but significantly, in view of subsequent events (see 4.5), stated that their preferred option was also to link with Ericssons for the supply of transponders and radio equipment. They noted however that this course of action had been denied to them, presumably this was on account of the prior agreed liaison between Westinghouse and Ericsson. The GSI transponders therefore had to be obtained from EMX.

4.2.2 SwedeRail Appointment

At the end of 1986 SIDA awarded a contract to SwedeRail (ref. A.14) for technical assistance to the newly established Botswana Railways. Initially this was for three experienced Swedish engineers to take up post for a period of two years to form the embryo Signal and Telecommunications Department.

4.2.3 NRZ Appointment

In early January 1987 a Memorandum of Agreement was signed between BR and NRZ (ref A15) for consultancy services to supervise the design and construction of the Works. This activity embraces all those items normally associated with **'The Engineer'** of the Works and this term is actually embodied into the Contract with GSI (ref M8). See 4.4.1.

4.2.4 Tender Assessment and GSI Appointment

Assessment of the tenders was conducted, seemingly independently, by SwedeRail (ref M5) and NRZ (ref M7). It should be noted that during this assessment SwedeRail recommended that the use of the tried and tested Ericsson transponder would be preferable but for cost considerations this course of action was not adopted. The evaluation team were not able to study any documentation (if such documentation exists) of the method of tender evaluation that was adopted.

After some delay a contract was signed on 10 April 1987 between BR and GSI for the supply and installation of an enhanced RETB system at a cost of £3,078,208 plus Zim. $ 93,458 equivalent to 32.85 MSEK. Swedish aid financed 29 MSEK of this cost.

4.3 Supplier

A number of observations may be made with respect to the interpretation of the specification by the contractor which could provide pointers for future contracts. In this we are conscious of the benefit of hindsight and the following remarks are intended to be constructive rather than critical.

4.3.1 Onus on contractor

Whilst the specification includes a general coverall clause regarding matters on which it is silent, a more robust clause would be desirable placing the onus firmly on the contractor to satisfy himself on local conditions. Such a reminder may have been helpful in ensuring that the transponders supplied were matched more closely to the BR sleeper configuration. Again, the high level of locomotive power supply unit failures experienced initially, may point to insufficient attention having been given to the electro magnetic interference or traction transients present in the particular type of locomotive used on BR.

4.3.2 Mechanical environment

A marked difference is evident in the engineering of the RETB token exchange unit mounted in the cab and the associated radio and modem unit mounted alongside. The RETB unit is very robust and is equipped with heavy duty 'MIL' type connectors. Conversely, the radio equipment and connections thereto are to normal commercial standards. Such practice for the radios is perhaps acceptable on grounds of cost where the radio is a desirable but not essential adjunct to train operation. However, where it is an essential link in the safety and train working chain then comparable standards of engineering to the RETB unit would be desirable.

4.3.3 System reliability

Perhaps the most significant omission is in the absence of performance targets in respect of the overall system availability, or those of any sub systems.

In making this observation we are conscious that such reliability requirements were only just becoming commonplace at the time of preparation of the specification. Even today it is notoriously difficult to extract meaningful figures or promises from contractors. Nevertheless it is felt that the need for some guarantee of performance should have been recognised.

This single omission has led to the frustration of determining what constitutes acceptable reliability (refs M12, R13, R14).

It is understood from discussions with the BR Chief Signalling and Telecommunications Engineer (CSTE), that similar problems have arisen in current negotiations with The Botswana Telecommunications Company (BTC) in relation to seeking guarantees in the performance of rented radio links.

4.4 Project Management

4.4.1 Project Management Organisation

References are made in several reports and other papers (refs R12, R15, R21, Q1) that in the early stages, the relationship between NRZ and BR representatives was not always harmonious.

Regardless of the extent to which personalities may have been a factor, a matter on which we cannot comment, the formal arrangements and responsibilities of the respective parties seemed destined to lead to contention.

NRZ were given substantial and independent authority as "The Engineer" over the Works (ref M8). This confers a well understood and special status with respect to instructions given to the contractor. Further, the contractor would see The Engineer as the point of contact with the Client (B.R).

The newly appointed SwedeRail CSTE and his team might also, quite reasonably, be expected to have some views on the engineering and operation of a new system for which they would ultimately have the responsibility for its safe operation and maintenance. In addition the scope of works in the Terms of Reference of the SwedeRail contract (ref. A1 and Appendix D2) quotes the requirement for the SwedeRail engineers to 'plan, monitor and advise BR in the procurement, delivery, installation and commissioning of the new equipment for telecommunications, signalling and train working'. The clause then goes on to say 'it is anticipated that NRZ will be engaged on consulting terms to supervise the delivery, installation and commissioning of the new systems for telecommunications and train working'.

This does suggest an overlap of responsibilities and there does not appear to be a formalised machinery for coordination of the respective roles. If disputes did arise, it would not be surprising. It is possible that the contractors may also have received conflicting signals from time to time as to who was in charge of the project, the CSTE or The Engineer (ref R8).

Our discussions with both NRZ and Spoornet leave little doubt that such problems did arise. Whilst in no way excusing the subsequent poor support given by the Contractor, it may have some bearing on the contract as there were obvious good relations and considerable technical support from GSI during the early stages of the work.

The employment of NRZ for their unique experience in Botswana is understandable. Indeed it would be appropriate if the exercise was to be mounted today. However a less potentially contentious structure should have been set up.

A more suitable means of integrating the respective responsibilities is illustrated in the arrangements subsequently accepted for the installation of the new signalling at Gaborone Station (ref Q6). Here, whilst the status of The Engineer is preserved, with reporting lines directly to senior management, he is subject to direction and given expert technical support through a steering group comprising representatives from all concerned departments.

The subsequent production of an Office Handbook for the S&T Department by SwedeRail (ref Q6 & M9), which includes a section on Project Management, indicates that the issue has been recognised and action taken.

4.4.2 Use of Sub-Contractors

In the Project Review of October 1987 (ref. R12) it is recorded that due to an increase in the cost of the RETB equipment presumably as the branch lines to Selebi Pikwe and Morupule were belatedly added, ways had to be found to reduce costs. BR therefore undertook to install the train-borne radio units and track transponders, together with the transport of all equipment.

Whilst the practice of using local labour for some installation work is not unusual, unless properly agreed with the main contractor, who will probably insist on supervising the work, there is a risk that the main contractor will then not be prepared to guarantee his total system or its performance.

Despite obvious technical limitations in the design of the track mounted transponders (refs R13, R14) a situation has clearly arisen where the main contractor, GSI, has absolved himself from responsibility following the decision to install the transponders using local labour. In a letter from the General Manager of BR to SIDA (ref. M11 and Appendix D3), it appears that BR had 'no legal recourse' and the potential cost savings, (the motivation for adopting the course of action) have clearly not been realised. An unfortunate case of saving money in the short term regardless of long term cost.

4.5 System Performance

4.5.1 The System as Installed

No comment was made to the evaluation team that the system concept and operational features of the system were the wrong choice. The serious deficiencies that have occurred have been in the engineering realisation (ref. R13, R14) and in particular, the unreliability of the system as installed and the lack of support from the manufacturers.

The main issues in the realisation have been:

- unreliability of base station radio equipment leading to the inability to exchange tokens;
- the above is compounded by failures of the BTC microwave links used for long haul communications;
- breakages and other failures of the track mounted transponder units;
- failure of cab displays and associated power supply units.

These matters have been fully reported in earlier documents and a brief comment only is appropriate here.

Perhaps the strongest evidence of an unsatisfactory situation is revealed in the period June to September 1989. In June a SwedeRail inspection by Mr Salerius (ref. R13), reported on several technical issues which had been and still were, affecting system performance. This led to a letter from SIDA to GSI couched in the strongest terms (ref. M12). This letter also drew attention to the likely knock-on effect on potential orders in the SADCC region.

A response was obtained from GSI and some remedial action on the base station transmitters was in fact being undertaken by a Marconi engineer at the time of the visit of the Project Review team during September 1989. (ref. R14). It was then too early to report on the

effectiveness of that exercise but subsequent events mentioned in section 4.5.2 below suggest that the remedial action was not successful. Since that time we understand that there has been no further active assistance given by GSI.

For completeness however we note below our findings with regard to issues which are current.

4.5.2 Base Station Radios by Marconi

The long standing failure problem with the power output stage (ref. R13, R14) has never been resolved by the manufacturer. Premature failures are now minimised by reducing the transmitter output from its rated level of 30 watts down to 20 watts.

BR is currently experimenting with a number of new radios purchased from Exicom in order to create a pool of interchangeable spares. This will help avoid periods of communications breakdown whilst the Marconi units are repaired at Mahalapye Workshops.

4.5.3 Transponders

The EMX units supplied by GSI are no longer in production but a special order for 200 new spares has been negotiated directly between BR and EMX.

4.5.4 Supply of Other Spares from GSI

Whilst the letter of the contractual conditions, to maintain spares availability for a period of 15 years, would appear to be being honoured, the actuality is that the option is made very unattractive with deliveries being very protracted, (typically nine to twelve months) and the costs prohibitive, (mark ups of over 500% have been identified). This has forced BR to seek other cheaper substitutes and to make do and mend wherever possible in their own workshop.

It is claimed that spares are not yet at a critical state. It was noted however that cab equipment from locomotives temporarily out of service was being removed to provide working spares whilst other units are being repaired.

Nothing is now being returned to GSI for repair.

4.5.5 GSI Support

Despite encouraging promises from the manufacturer, (references R11 and Q3) it does not appear that any constructive follow-ups have in fact taken place.

4.5.6 Signalling of Stations

A programme, recommended by consultants De Leuw Cather (ref R17). for providing lineside signalling at several more important stations together with crossing loop improvements is only partly completed due to BR funding constraints.

From personal observation the procedures required for crossing trains at unmanned wayside loops, is a major cause of delay on the line. The necessity for manual point changing by train crews is a practice which is totally incompatible with an objective to improve transit times. There are relatively simple mechanical or electronic means of overcoming this delay every time trains cross.

4.5.7 Updating Communications System

The only way that BR can secure their communications links is if they own their own system.

The initial appraisal study, reference R6, recommended that in the event that RETB was the chosen signalling system then the communications system be fully integrated with it. This was not pursued and the specification for tender was framed around the use of both dedicated radio links and rented lines. It is of note however that the specification did invite, as an option, a quotation for a separate BR network of base stations and repeaters to avoid the use of rented circuits altogether. This again was not pursued for reasons which are not evident from the documentation.

Clearly stimulated by the unsatisfactory service provided by the BTC channels, a subsequent proposal in 1992 (refs. Q3 and R23), envisaged a BR owned fibre optic link throughout the railway system to avoid the use of BTC lines. This was estimated to cost 28 million Pula. The proposal remains in abeyance.

A partial solution to the problems of reliable train control was implemented at the initiative of the SwedeRail team in 1992 through the provision of a back-up radio communications system together with some rationalisation of the BTC links. This system provided improved voice communication coverage over the network to assist in the verbal exchange of movement orders when the electronic token exchange had failed.

It is of note that BTC have now installed their own fibre-optic link from north to south of the country adjacent to the main road.

Currently there are negotiations with BTC to improve the reliability of the channels offered, but it seems difficult for BR to secure any guarantees or impose penalties for poor performance.

However, before BR can make any claims on BTC it is essential that BR should differentiate in its failure reports between those communication failures attributable to BTC and those due to the RETB system proper.

Perhaps the best hope for BR in the short term is in the possibility that more competition in communication services will be introduced in Botswana. It is understood that such studies are presently in hand and that proposals are expected to emerge during the coming year. In this event:

- it may be possible to secure the guarantees sought from BTC,
- competitive operators may be prepared to offer dedicated and reliable links,
- BR itself should reconsider the recommendations of earlier studies which proposed BR's own dedicated links, offsetting the cost by entering the competitive situation and offering surplus capacity to others. There are successful precedents in other railway organisations for this type of initiative.

4.6 Sustainability

The fact that a new signalling system is now in place and in daily operation and that full staff localisation has been achieved must be regarded as a successful outcome to some eight years of development.

The question of long term sustainability can only be judged on a number of indicators, some positive, some negative. These indicators concern both technical performance and effective staff performance.

4.6.1 Positive Indicators

(a) In spite of exceptional teething problems with equipment and less than satisfactory support from the signalling contractor, the CSTE department is showing initiative and resourcefulness in maintaining the system to date. For example, spare components are now identified and ordered directly from suppliers (not GSI) and experiments are being conducted with substitute radio equipment (Exicom) in order to create spare units.

(b) Hand-over to a newly trained Chief Signal and Telecommunications Engineer, supporting management team and workforce was accomplished in around five years.

This appears to be functioning adequately but intermediate reorganisations and now a BR-wide retrenchment programme will effectively reduce staff resources by 30% on the original establishment. This could have some negative effects given that the size of the system and amount of equipment in service remains the same.

4.6.2 Negative Indicators

(a) Despite the technical initiatives mentioned above, it is inevitable that some consumable items, including the specialised transponders, will become increasingly difficult to obtain. Again, because of the nature of the system, non-availability of the cab based equipment for token exchange renders the locomotive to which it is fitted unavailable for main line duties.

The first longer term measure is to find alternative equipment of sufficiently similar technical characteristics that it may be substituted for the original. The Exicom transmitter mentioned above is such an example.

This process cannot extend however to the transponder sub system or cab decoding and display equipment which is custom engineered by GSI. For the transponder subsystem, alternative proven equipment is available but would probably require the whole sub system, locomotive and track equipment to be changed and also a new interface designed and procured for use between the train mounted antenna and cab decoding equipment. Clearly the cost would be a major capital expense.

(b) From an examination of recent operational failure statistics, the signalling system is being maintained such that failures attributable to the S&T Department average less than 20% of the whole (Appendix D4). The VECTA reports are based on train minute delays due to a variety of train, signalling and permanent way failures. Whilst the number of signalling failures reported by this mechanism is typically in the range 9 to 15 per month (a seemingly acceptable amount) we were told that failures to exchange tokens, (which results in the need to issue paper orders Forms 3 A/B) still remain at the 1989 level (ref. R13) of between one and two per day.

A post contract attempt to assess likely reliability performance was given in the Project Review of 1989 (ref. R14). This highly tentative exercise indicated that failures per month due to fixed equipment failures might average 3 per month, with locomotive failures adding up to 10 per month (with 30 locomotives in service). It now seems unlikely that these relatively low figures will every be achieved.

5. SIGNALLING AND TELECOMMUNICATIONS DEPARTMENT

5. SIGNALLING AND TELECOMMUNICATIONS DEPARTMENT

5.1 Establishment of the Department

5.1.1 Objectives

Early in 1985 the Botswana Ministry of Works and Communications recognised the urgent need to fill the large number of vacancies at the higher management levels in the newly established Botswana Railways administration. SIDA were asked by the Ministry to provide staff for three senior posts to lead and develop the Signalling and Communications Department of the Railway. These were::

Chief Signal and Communications Engineer
Senior Signal and Communications Engineer
Chief Technical Officer

These three officers were to operate within the new railway organisation for an initial contract period of two years, see Appendix D2 and Organisation Structure in Appendix D5. Their brief was to:

- plan, organise and monitor the BR takeover of operations and maintenance of existing signalling and telecommunications equipment;
- plan, monitor and advise BR in the procurement, delivery, installation and commissioning of new equipment for telecommunications, signalling and train working.
- plan and organise for the proper maintenance and operation of the new equipment;
- elaborate plans and initiate actions for the long term permanent staffing of the BR Signal and Communications Division at the headquarters as well as the workshop and field units;
- assist the BR Departmental Management Division in immediate short term actions to provide sufficient staffing of the Signal and Communications Division;
- advise and assist BR in any other matters required for the proper operation and maintenance of signals, telecommunications and train working systems.

5.1.2 Initial contracts

SwedeRail were commissioned to provide the staff and they nominated the engineers listed below:

Title	Name	Period
Chief Signal and Communications Engineer	Mr Lennart Johansson	23.02 months
Senior Signal and Communications Engineer	Mr Göran Remén	21.25 months
Chief Technical Officer	Mr Reider Alander	21.25 months
Short term technical staff		6.0 months
	Total	71.52 months

The total budget for the provision of the expatriate staff, local support, office equipment, subsistence and travel was SEK 6,105,000 (ref A2).

Mr Johansson took up his appointment at the end of 1986 and the other two engineers followed early in 1987.

The Swedish engineers were assisted by an expatriate technician from Zambia and three senior supervisors with varying experience, but the majority of the other staff in the Department were new graduates with little or no railway experience. It is clear from the various documents studied that there was considerable difficulty in attracting the right type of technician or graduate to the railway despite the offers of training and job security that were being made.

The early years were a difficult period for the engineers, having to deal with the installation of a new S&T system at the same time as establishing the S&T Department. It is noted that the Terms of Reference for the staff did not require that they have any experience outside Sweden. Presumably therefore none of the appointed staff were aware of the standards or conditions that applied when working in Botswana. It would therefore have taken several months for them to 'acclimatise' to their new environment.

In July 1987 SwedeRail staff carried out a Training Requirements Study (ref. R18). This study concluded that a comprehensive manpower development scheme must be launched. (see Section 5.2). As a consequence of the study SIDA authorised the appointment of a Training Officer, which allowed the engineers to continue the task of commissioning the new S&T systems and keeping the railway operating with a very limited staff.

The evaluation team have read criticism of the work being carried out by the SwedeRail engineers during this period but, without knowing any of the personalities involved, it is understandable that their main activities would be associated with the practical side of the running of an S&T Department - simply to keep the railway operating safely in this period of major change.

The fact of the matter is however that this did not assist in the localisation process and therefore when it became obvious that a new Department could not be created in two years a new contract was approved (in May 1989) which extended the expatriate's involvement for a further three years.

Based upon experienced gained in the first three years of the aid programme a plan for a revised organisation of the S&T Department, with a total staff of 63 persons, was prepared and this was subsequently accepted in September 1991.

Appointments were made of local counterpart engineers who were to work closely with the expatriate officers - specifically Mr B Gakelebotse as CSTE, Mr E Maje as Communications Engineer, Mr Mosiny as Signal Engineer and Mr Ramontsho as Workshop Engineer. Two new posts were created - assistant signal engineer and assistant telecommunications engineer in order to provide a graded structure within the Department in readiness for the promotion of the counterpart engineers to their designated position.

Even at this late date there were however 17 vacant technician posts (out of a planned 27) and a further 70 graduate trainees had to be recruited straight from the Polytechnic in late 1991/early 1992.

5.1.3 Change of emphasis

As the new Department began to settle down it was possible to change the emphasis of the expatriate involvement from the practical to the more managerial side of the work. The

SwedeRail team was changed in the late 1991 - early 1992 period to accommodate this change of emphasis; though it is unfortunate that all of the staff should be changed at virtually the same time.

Chief Signalling & Communications Engineer
L. Johansson to S Modig and subsequently K Forss

Senior Signalling & Communications Engineer
G. Remen to C Klangsell

Chief Technical Officer (Signals)
R Alander to J Thulin

At this time concern was once again registered over the very short timetable for the localisation of all posts in the S&T Department and a request was made by the Botswana Ministry of Finance and Development (dated 20/12/91) that the Swedish support should be extended to the end of 1993. An interim extension of the SwedeRail staff contract was then made, to June 1992.

In February 1992 the CSTE (Mr Forss) prepared a Disengagement Plan which proposed full localisation of posts by the end of 1993 and despite the understaffing of the Department this Disengagement Plan was carefully followed, in association with the revised management and training strategy.

It was clear however that to complete the main objective of establishing a competent S&T Department within BR the key expatriate engineers would be required until at least the end of 1993. A further extension of the contract was therefore negotiated.

During 1992 a communication study was carried out by the SwedeRail team and a back up communication system proposed. This was installed (financed by USAID to support the World Food Aid Project) in early 1993. A design for local signalling at Gaborone was also prepared by the team in this period.

Handover (to counterpart) documents were produced and a series of projects were designated for completion during the final year of the SwedeRail involvement (see Appendix D8) and all counterparts were promoted to their substantive posts at 1 January 1993, with the expatriate staff acting as advisors.

BR submitted a request to SIDA that the post of CSTE (Mr K Forss) and a Signal Engineer advisor (Mr J Thulin) should be extended up to February 1994 in order to assist in the installation of the signalling at Gaborone station. In addition, short term consultancies in the fields of radio training, supervisory training and a safety review were carried out during 1993/94.

5.1.4 Summary of appointments

We have attempted to summarise below the SwedeRail staff appointments, but in some cases the actual dates of appointment has not been quoted in the documents read or the dates vary from one document to another, possibly due to last minutes changes in contracts.

Lennart Johansson	CSTE - Team Leader	12/86 - 10/91
Goran Remen	Communications Engineer	03/87 - 03/92
Reider Alander	Signals Engineer	1987 - 1991
Lennart Ekstrom	Training Engineer	1987 - 06/92
Sune Modig	Acting CSTE	1991 - 11/91
Kent Forss	CSTE - Team Leader	10/91 - 09/92

Curt Klangsell	Communications Engineer	03/92 - 06/93
Jan Thulin	Signals Engineer	02/92 - 02/94
Olot Holmberg	Training Engineer	06/92 - 06/93
Bengt Andersson	Signal Training Engineer	02/92 - 11/93

In addition, short term assignments were carried out by the following SwedeRail staff:

Aller Persson	Radio Training
Curt Cederholm	Radio Training
Leif Nordenfas	Signal Training Reviewer
Leif Ivarsson	Management Training

5.1.5 Conclusions

In the early stages of the project warnings were given that it would take 8-10 years to establish all the necessary routines and supporting structures and train the staff for a completely new Department, however at the end of the aid project BR had an established S&T Department with a complement of over fifty staff, all of whom had received training in their particular discipline.

Due to the reduction in traffic there has not been the demand on the new staff that there would have been if traffic levels had been higher, but as there are continuing problems with maintaining the S&T equipment, the staff are still well employed. The requirement for an adequate S&T staff complement is acknowledged by the management and in the recent staff 'retrenchment' the S&T staff were only reduced from 51 to 41, whereas some other departments of BR were reduced by 30%.

There must be some concern over the sustainability of technical competence in the Department as three of the senior engineers - Messrs. Maje, Mosiny and Bosa - have left BR in recent months. The assistant engineers have been promoted to fill the vacant posts in the new establishment, see Appendix D6 and the CSTE is confident that he can run the Department with the new establishment.

5.2 Training Objectives

With the establishment of a new Signal and Telecommunications Department for Botswana Railways it was essential that a comprehensive training scheme should be instituted.

In April/May 1987 SwedeRail carried out a Training Requirements Study which identified the training that would be needed and recommended a series of actions that should be taken, viz:

- employ 6-8 trainee technicians in the fields of Radio, RETB and PABX;
- recruit additional candidates;
- selected trainees to undergo basic training courses at the Swedish State Railways training centre at Angelholm;
- programme for on-the-job training of two Botswana telecommunications engineers should be prepared;
- employ a Training Engineer to work in Mahalapye for 18-24 months;

- equip the S&T workshop in Mahalapye with a facility for training.

The study also identified a lack of ready-trained and experienced persons and stated that it would therefore be necessary to recruit trainees with good technical education background and to slot them into comprehensive development programmes.

Proposed training programmes and courses were identified.

5.3 Training Progress

The proposed departmental organisation, as prepared by Coopers and Lybrand, was developed to allow for a number of employees to be under training at any one time.

A Training Engineer (Mr L Ekstrom) was appointed (in November 1987) and in the period from 1988 to 1992 a very comprehensive training programme was carried through. Full details are recorded in the Appendix to SwedeRail's report of activities in 1992.

Training was carried out at a training centre at Mahalapye and later at a new signalling training centre at Francistown.

Six trainees technicians were sent to Sweden for an 11 week training course and seven were sent to the NRZ signalling training school. This was not entirely successful as several students did not complete their training, or left BR before their training could be of any benefit to the railway.

A counterpart Training Engineer (Mr J Bosa) was appointed to work alongside Mr Ekstrom and 20 new trainees were taken on in September 1991.

In November 1991 SwedeRail produced a further Signalling Training Study whose purpose was :

- to investigate and plan for the conducting of courses in Botswana;
- to recommend training and estimate the cost of training facilities.

This document incorporated a useful set of Course Plans and Teachers Guides, which could be used in future training projects.

During the course of the SwedeRail team reorganisation early in 1992, Mr Ekstrom was replaced by a new Training Engineer, Mr O Holmberg and subsequent training included courses in general management and project management.

A Training Strategy document was prepared in March 1993 for the period 1993-95. This claims that there had not been a training strategy in the past and presented one for the future. This may be true but should not be taken as a criticism when compared with the list of training courses which had been completed.

The evaluation team could not find any evidence of a training handbook for the use of future trainers - with the exception of the aforementioned report which contains section headed 'teachers guides'. There are of course the manufacturers manuals for the various components of the telecommunications and train control systems, but a comprehensive S&T training manual would have been a useful document to leave for future reference.

A 'Maintenance Guide for the Signalling Section' was produced and this is a useful practical guide for use by the maintenance staff. The only other documents that was shown to the team was entitled 'Office Handbook for the S&T Department'. This is a comprehensive guide to the office and management functions.

The overall training scheme has resulted in a well trained staff, though we would support the reservations quoted in several documents with regard to the speed of training and rapid promotion of local staff without the usual period of time to gain on-line experience.

Until recently BR have had the services of Mr J Bosa, the Training Officer but in the recent cut-backs his post has been eliminated. The reasoning for this is that the current S&T staff have completed their training and the Training Officer was carrying out more administration duties rather than actual training. The administration duties will now be covered by the CSTE's clerk and any necessary training will be done by the five engineers.

5.4 Staff Retention

We understand that there is a turn-over of S&T staff - many being attracted to BTC - but to compensate somewhat the quality of the new entrants from the Polytechnic is to a higher standard than previous and they therefore need less training.

5.5 Government of Botswana Commitments

The agreements between the Swedish Aid Administration and the Botswana Government contained the following clauses relating to contributions and obligations of the Botswana Government:

> In order to ensure the efficient and successful implementation of the Project, Botswana shall provide the financial, material and personnel resources necessary for the Project, which are not explicitly referred to as being the obligations of Sweden.
>
> A. Botswana shall designate local personnel with suitable background qualifications as counterparts, for training in operation and maintenance of the equipment or for other tasks to be specified in Terms of Reference, contracts or otherwise agreed upon. Botswana undertakes to make every effort to fill, no later than 30 June 1989, a complete staffing scheme including due reserve capacity for staff at training etc - with suitably qualified local personnel in line positions or on training for such line positions within BR's Signals and Telecommunications Department.
>
> Botswana shall apply a bondage system in order to retain within BR such personnel as has been trained to operate and maintain the equipment.
>
> B. Botswana shall further:
>
> (a) assume legal responsibility for the equipment;
>
> (b) provide the financial resources necessary for the proper operation and maintenance of the equipment according to recognised standards;
>
> (c) provide all data and information related to the Project such as plans, budgets and relevant Government policies;

(d) finance all costs incurred in local currency.

The evaluation team did not find any evidence to suggest that there had been any problem with items under subsection B, but for matters relating to staffing, subsection A, it had obviously proved difficult for the Botswana Government to comply with the obligations.

The SwedeRail Final Report (ref. R25) comments that the staff recruitment process was very slow to start due to a shortage of local graduates and it was not possible to recruit engineers with work experience.

This obviously had an effect on the time that was necessary to carry out the 'localisation' of the Department.

The evaluation team enquired if it was possible under Botswana Law to apply any meaningful bondage system to retain trained staff and learnt that, as in Europe, it is not possible to retain the services of an employee against his will. The Government of Botswana was therefore unable to comply with this condition and, as noted above, trained staff do leave BR.

(c) Maintenance and Repair Workshop

An impromptu visit was paid to this facility at Mahalapye. Four technicians were in attendance at the time together with the supervisor. Making due allowance for expectations of standards for housekeeping and organisation, the impression gained was of herculean attempts to stem a rising tide of equipment failures, some beyond repair.

If, as seems likely, all resources must be focused on the immediacy of repair, there remains little time for maintenance work. Whilst outside the scope of this evaluation, it may be remarked that attention to items such as tidying or replacing wiring and cable harnesses and plug connectors would contribute significantly to reliability. This is particularly relevant to the cabling and connections to the several items of cab equipment and to radio and transponder antenna fitments on the locomotives.

4.7 NRZ Involvement

Through the offices of Mr David Scott, Acting Chief S&T Engineer, the team were fortunate in meeting Mr Hawkins and Mr Martin who were both closely involved in the early studies, the preparation of the contract and the installation phase of the project.

They confirmed that NRZ were closely involved in the preliminary framing of the Functional and Technical Specification (ref. M1) but that this was then developed to its final form by SwedeRail. In this work NRZ were assisted by the contractor Westinghouse and also by Mr R Brown who was working at that time in Zimbabwe. Mr Hawkins expressed the view that he would have preferred at that time to see an alternative approach, a simplified CTC system designed along well established lines, but the perceived advantages of RETB, in particular the inherent train communication feature, prevailed.

With regard to the lack of reliability targets in the specification, it was acknowledged that these should have been included but such clauses had not hitherto been considered as all of the conventional signalling hardware had very well known performance capabilities.

It was again acknowledged that initially the project management structure gave rise to problems in defining personal responsibilities, but it was claimed that these were soon resolved. It does seem clear however from discussions with NRZ and subsequently with Spoornet, that disputes did in fact arise and that the contractor may have received some confusing signals as to who was in charge.

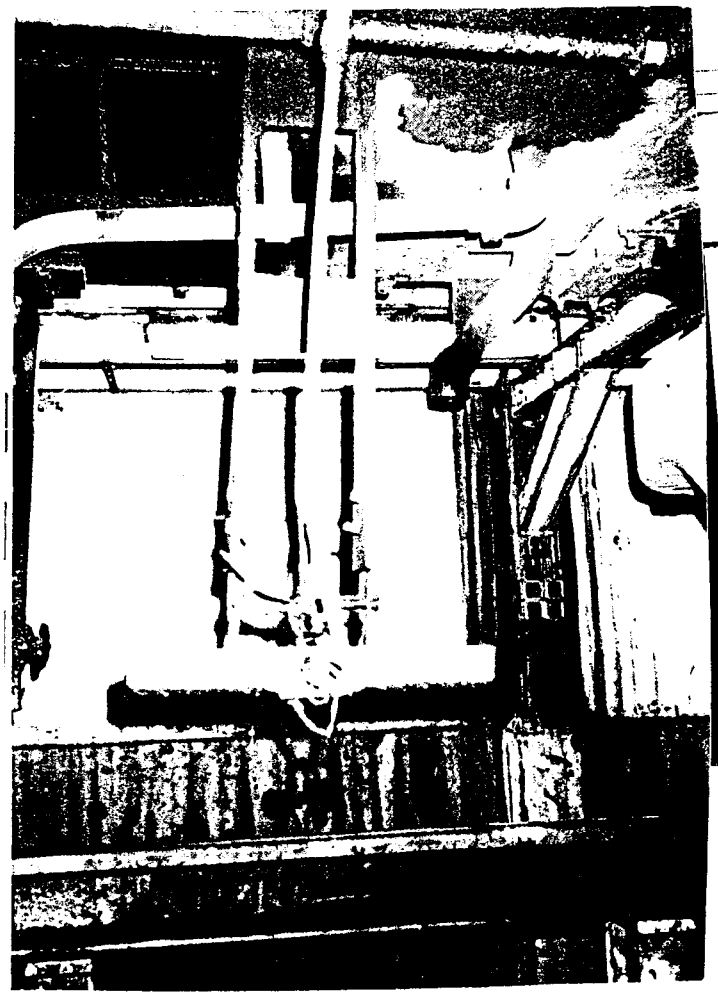
4.8 Mahalapye Installation

With regard to the provision and installation of local signalling at Mahalapye, for which NRZ were responsible, no opinion was offered to us by the CSTE of BR. The contracted cost of this installation was Zim. $300,000 equivalent to 0.9 MSEK. It was learned subsequently however from the SwedeRail Final Report (ref. R.16) that the original installation had received an upgrade in 1990 and was now performing satisfactorily.

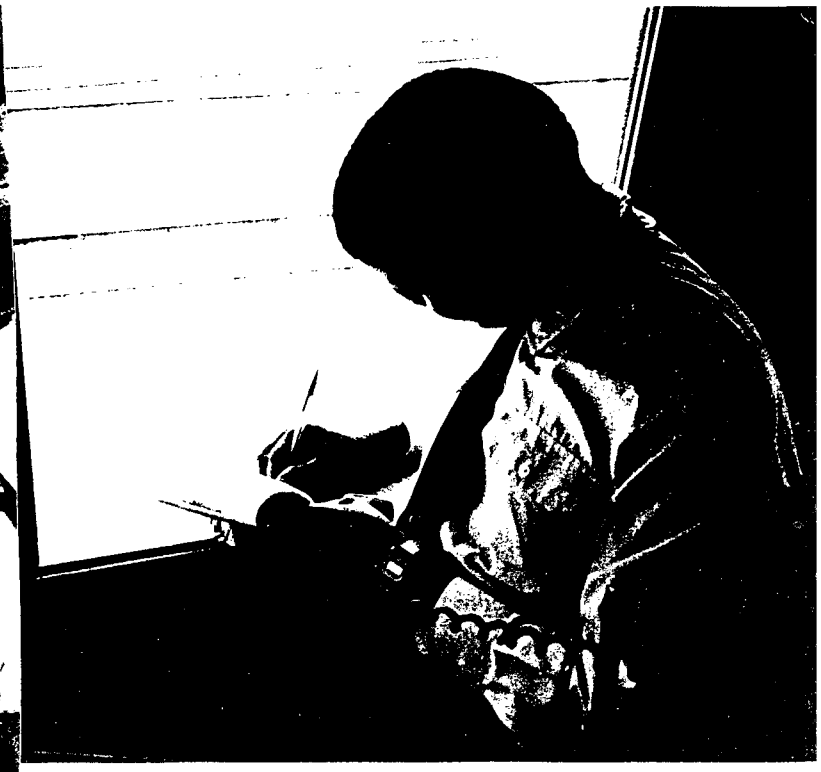
4.9 Environmental Impact

The operating circumstances have so changed since the start of the SIDA support in 1986, that it is not possible to draw any firm conclusions about environmental improvement resulting from greater efficiency, reduced fuel consumption, etc. The changed circumstances include, *inter alia,* the purchase of new rolling stock, the cutback in the number of services and the huge reduction in transit traffic.

The issue of road versus rail traffic is very important, however. It is widely recognised that road vehicles are heavy pollutants and inefficient users of fossil fuels compared with rail. Policies to get more traffic back onto rail, through marketing, "level playing field" legislation, or other strategies or policies, would be desirable both directly to the railways and to the country as a whole in cost benefit terms. Thus this is an area to include as a key item in any transport strategy.

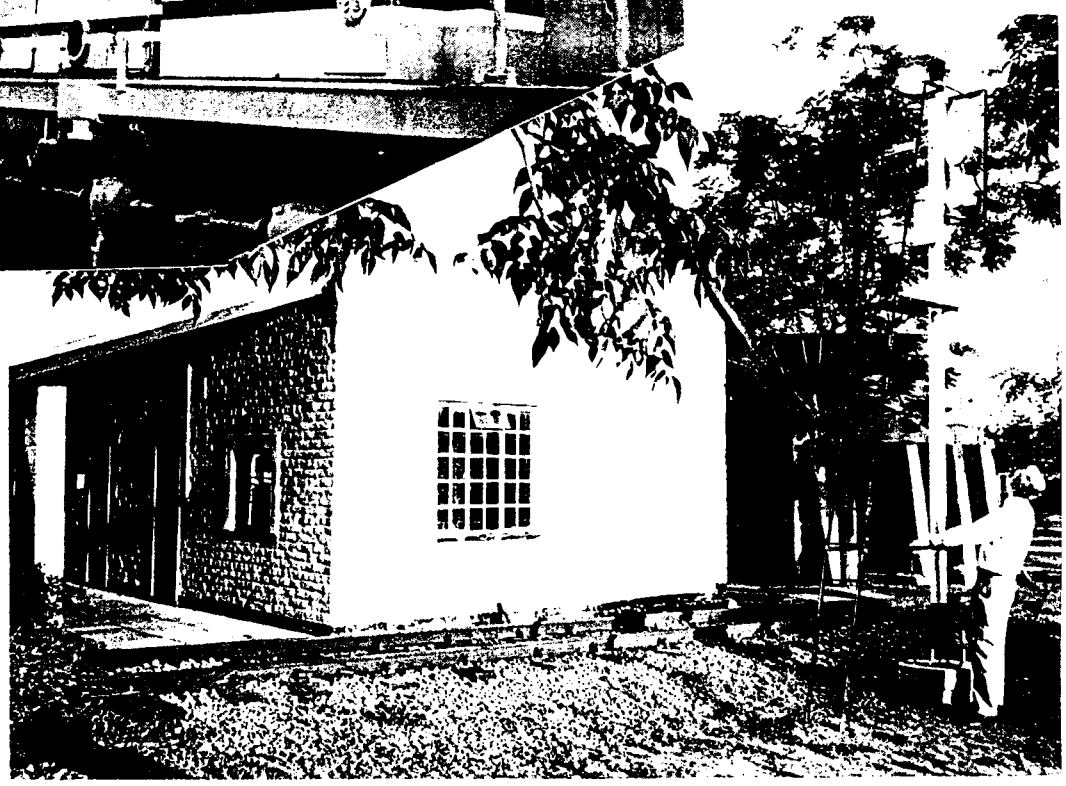


Transponder interrogation unit on locomotive



Driver preparing form 3A, written order

Driver requesting token exchange by radio



Francistown S&T workshop/ training school

6. ECONOMIC FACTORS

6. ECONOMIC FACTORS

6.1 Botswana Railways and the Economic Context

6.1.1 History

Botswana Railways was established in 1987 as part of the process of reducing Botswana's political and economic dependence on neighbouring states. The railway line was originally built through Botswana in the nineteenth century, linking the Cape Colony and British possessions further north, in order to by-pass the Boer Republics. The line was run by SA Railways from 1910 to 1973, and then by NRZ until 1987. The direct Zimbabwean railway link to South Africa at Beit Bridge was only connected in the 1970s under the Rhodesian UDI regime as a means of evading sanctions.

6.1.2 Regional Rail Competition

Thus until the 1970s all rail traffic from South Africa northwards, and v.v. from central Africa southwards, went via Botswana. The opening of the Beit Bridge link and the Tan Zam Railway in the 1970s started to undermine this route, but the closure of many West Coast ports because of hostilities in Mozambique retarded this process, as did the desire by independent states to support each other and minimise their exposure to South Africa.

Now, however, given the political changes in South Africa and Namibia, and the re-opening of lines and ports in Mozambique (upgrading to Beira and re-opening the Maputo line via Chicualacuala), Botswana railway risks finding itself on the geographical margins. In addition, Botswana now has the second highest GNP per capita in the region after South Africa, which means that other countries will offer no favours (whereas at independence 29 years ago Botswana was one of the poorest 25 countries in the world). The consequent potential haemorrhaging of transit traffic means that BR will need to focus more strongly on domestic traffic in future, or be more inventive in marketing its transit route.

6.1.3 Road Competition

Throughout the world, rail has lost market share to road because of the enormous flexibility and diminishing cost of road vehicles. In some cases this has been exacerbated by inefficiency and unreliability of the rail services. In Botswana there are alarming signs that rail may not only be losing market share, but losing absolute volume as well (see table 6.2) both freight import and passenger volumes have dropped over the last five years to their lowest levels ever.

Botswana itself has invested heavily in improving its roads and in building new ones, for instance, the Trans-Kalahari road to connect with Namibia. In so doing some traffic will necessarily be abstracted from rail. In addition, road building in neighbouring countries will encourage road haulage - for instance, the Caprivi road in northern Namibia will filter away traffic from central Africa.

6.1.4 Level playing field between Road and Rail

A further factor favouring roads is that rail usage is required by statute to cover all costs including fixed costs. Road users by contrast may not pay even their full marginal costs - it has been estimated that a heavily loaded lorry can cause up to a hundred times more road damage than an ordinary car. Hearsay evidence suggests that in Botswana axle weight regulations may be negligibly enforced, or in worst cases provide a source of undercover payments to evade the regulations.

With transit road traffic, e.g. Johannesburg - Namibia once the Trans - Kalahari road is finished (a distance reduction of up to 450 km), it is even more important to ensure that road users pay their full contribution. Botswana must enact and enforce "level playing fields" for road and rail traffic, to avoid major disadvantage to rail. The Botswana Government has acknowledged that the road pricing policy needs review.

6.1.5 Domestic Economic Factors

The *diamond wealth* that brought Botswana such growth in the 1980s (25% pa from 1985 - 1990 - Botswana was the world's fastest growing economy at that time) has also been a mixed blessing for BR. Diamonds, unlike coal for instance, do not require freight trains, nor great movements of passengers. In addition, the diamond wealth has bid up the currency (the Pula) in relation to neighbouring states, making the Botswana economy relatively uncompetitive in trading terms, and hence damaging internal industrial growth which might increase demand for rail in the future. The diamond industry has also pushed up salaries throughout the economy for those in employment, further adding to industry costs.

Whilst the geographic and political trends appear broadly unfavourable to BR, the *strong currency* may have directly contributed to the dramatic loss of transit business. For instance, over the six year period 1986 - 1991 the Pula appreciated against the Zimbabwean dollar in real terms by 135% (an average of 19% pa). At the same time, the rail charge to transit traffic remained constant in Pula terms at about 0.06 Pula per tonne-mile (see table 6.2). From the Zimbabwean perspective, therefore, the costs more than doubled over the same period, giving Zimbabwean traffic a strong incentive to use its own rail network where possible, to seek alternative rail outlets, or to transfer to road.

Thus understanding the *competitive position* in terms of charges and exchange rates between all countries in the region is imperative for BR if it is to seek to retain or regain transit traffic. BR's productivity and efficiency may have to improve by a quantum leap to enable it to compete on price. This may be unavoidable, since chronic over-capacity and under-utilisation in the region are likely to force prices down.

Lack of diversification in the Botswana economy means that BR relies on a small number of big companies, with the attendant risks. BR made a major investment in the Sua Pan project in 1988 - 90, with a 175 km link line from Francistown, a marshalling yard at Francistown, and purchase of 284 wagons. One million tonnes pa were expected, but last year the traffic fell below 300,000 tonnes, and the company has recently gone insolvent. BR has posted a provision of 30m Pula in the 1994/95 Accounts to cover for this - more than the total profit in any previous year. A low manufacturing base (6% of GNP compared to Zimbabwe and South Africa at >25%) mean that opportunities for internal development and export trade are limited. Policies to increase diversification over the last ten years appear to have had limited impact.

High levels of import and export mean that Botswana is very dependent on exchange rate and price effects in other countries. Botswana imports and exports roughly the equivalent of the GNP in value (in Zimbabwe and South Africa imports and exports each represent about one third of GNP). Part of the reason for this is that most of the mineral wealth is exported, whereas most food is imported (agriculture is only 3% of GNP, reflecting Botswana's arid climate).

Other factors reflect continuing inequalities in the economy. Diamond mining has created few jobs - unemployment remains about 25%. Rural poverty remains high - 95% of country dwellers cannot earn enough to support themselves. The population growth rate is high - half the population is below 15. Productivity is still relatively low in some sectors, pointing to a continuing skills gap and need for further training.

6.1.6 Conclusion

The balance of the economic backdrop does not appear favourable to rail. On the positive side, however, much of the infrastructure is now in place to reap dramatic efficiency gains, including the signalling improvements supported by SIDA. BR has shown that it can be successful at containing costs or cutting back when required. What it must now demonstrate is an ability to operate its assets more efficiently to improve international competitiveness and internal profitability, as well as a deeper understanding of relative pricing, price elasticities and marketing finesse.

The asset building stage is coming to an end. A major long-term strategic review of transport policy within Botswana and transport developments in other countries needs to be undertaken. Developing the market analysis and business skills within BR should be a key component. Controlling costs is only one element of success - an organisation must grow and develop new markets if it is to survive and flourish.

6.2 Traffic Developments

This section looks in detail at the historical performance of BR since its inception in 1987.

6.2.1 Total Results

The total operating costs and revenues are shown in table 6.1 and Appendix D7, in money (nominal) terms, and also at constant 1994/95 prices to reveal real trends unaffected by inflation. A breakdown of freight and non-freight sources of income is also shown at constant prices.

Table 6.1 - BR Revenue (Pula million)

	NOMINAL PRICES		CONSTANT 1994/95 PRICES				
	Total Operating Revenue	Total Operating Expenditure	Total Operating Revenue	Total Operating Expenditure	Total Freight Revenue	Total Non-freight Revenue	Passenger Revenue
1986/87					112,107		6,568
1987/88	46,170	46,995	95,393	97,097	80,291	15,101	10,136
1988/89	52,894	57,407	99,989	108,520	80,100	19,888	12,478
1989/90	61,394	61,582	106,218	106,543	86,715	19,503	11,644
1990/91	71,041	67,779	110,141	105,084	89,279	20,862	9,705
1991/92	93,176	84,682	129,591	117,777	105,538	24,053	10,292
1992/93	111,281	100,151	138,582	124,721	112,204	26,377	8,045
1993/94	82,293	100,581	91,845	112,256	67,191	24,654	6,306
1994/95	86,848	89,877	86,848	89,877	66,636	20,212	6,230

The results demonstrate:

(i) A steady increase in total revenues, reflecting GDP growth, until the last two years.

(ii) The dramatic loss of 40% of previous transit traffic revenue in 1993/94 (see next section - there was a similar loss in 1986/87, but the total revenues in that year are not known since the line was still run by NRZ).

(iii) The impressive ability of BR to respond by reducing costs in the last two years.

(iv) The decline by half in passenger revenues.

6.2.2 Freight

Freight accounts for over 80% of BR's revenues. This can be divided into four sub-divisions: Transit, Internal, Import, Export. Table 6.2 and Appendix D7 show the changing fortunes of each of the sub-divisions.

Table 6.2 - Freight Traffic Revenues

		1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
Inflation Index		44.0	48.4	52.9	57.8	64.5	71.9	80.3	89.6	100.0
Revenue Pula (m)	Local	7.3	6.8	7.0	7.2	9.3	13.0	13.6	12.4	14.4
	Transit	31.5	17.4	18.0	22.9	22.7	30.4	42.9	13.8	10.9
	Import	8.5	14.5	14.9	17.0	22.1	24.6	23.4	19.8	19.3
	Export	2.0	2.1	2.5	3.0	3.5	7.8	10.2	14.2	22.0
Adjusted Revenue at constant 1994/95 prices Pula (m)	Local	16.6	14.0	13.2	12.5	14.4	18.1	16.9	13.8	14.4
	Transit	71.6	36.0	34.0	39.6	35.2	42.3	53.4	15.4	10.9
	Import	19.3	25.8	28.2	29.4	34.3	34.2	29.1	22.1	19.3
	Export	4.5	4.3	4.7	5.2	5.4	10.8	12.7	15.8	22.0
Total (@ 1994/95 prices)		112.1	80.3	80.1	86.7	89.3	105.5	112.2	67.2	66.6
Tonne - Kms(m)	Local	86.0	82.0	69.0	74.0	76.0	110.0	106.0	58.0	127.0
	Transit	1,162.0	540.0	484.0	608.0	499.0	569.0	847.0	248.0	180.0
	Import	136.0	155.0	181.0	239.0	235.0	213.0	195.0	143.0	127.0
	Export	34.0	23.0	36.0	43.0	42.0	87.0	118.0	137.0	214.0
Total		1,419.0	800.0	771.0	964.0	852.0	979.0	1,266.0	585.0	626.0
Average Revenue per Tonne - Km Pula	Local	0.193	0.171	0.191	0.169	0.189	0.165	0.159	0.238	0.113
	Transit	0.062	0.067	0.070	0.059	0.071	0.074	0.063	0.062	0.061
	Import	0.142	0.166	0.156	0.123	0.146	0.161	0.149	0.155	0.161
	Export	0.132	0.187	0.130	0.121	0.129	0.124	0.108	0.115	0.103

Transit

The biggest change has occurred in *transit* traffic, which accounted for 84% of tonne-miles in 1986/87, the year Swedish aid commenced and now accounts for only 28% of the traffic.

In revenue terms, the drop is from 64% to 16%. Transit revenue is relatively less important than tonne-miles since the average charge per tonne-km is about 0.06 Pula, whereas for the

other three sectors it averages about 0.14 Pula. Nonetheless, the impact on total revenues is highly damaging.

The two major downturns in transit traffic since the inauguration of BR have resulted from:

(i) Re-routing of some traffic to the direct Zimbabwe to South Africa route via Beit Bridge, following the handover of the Botswana line from NRZ to BR.

(ii) Further re-routing of traffic to the Beit Bridge route following the political change in South Africa.

Internal

Internal traffic has remained relatively constant in volume - a disappointing result in view of considerable GDP growth over the period, but reflecting to some extent the lack of new industries as discussed previously. It is not clear whether the change in the perceived charge rate in the last two years (sharply up then sharply down) reflects a change in pricing policy with consequent change in volumes, or whether it reflects a fixed price contract with changing volumes with consequent alteration of the effective charge per unit.

Import

Import volumes and revenues grew in the late 1980s as GDP was growing and the food aid project continued, but have dropped alarmingly since then. If transit traffic does prove transitory, then trade - import and export -traffic is where BR must find its profits. The historically high revenues (0.16 Pula per tonne-mile) suggest that this could be a potentially profitable area if costs can be kept down. However, the reasons for the downward trend of recent years need to be analysed, e.g. is it price effects, road competition, or other factors, and then action taken rapidly to reverse the trend.

Export

Export appears to be the major success story, and should be built on. It is not clear what proportion of this was attributable to the Sua Pan soda ash works, and hence what impact the insolvency will have on revenues in the short term. However, the replacement company Botswana Ash is intending to keep Sua Pan trading, and given the major investment in the branch BR should seek to develop a profitable partnership.

6.2.3 Passenger

As shown in table 6.3 and Appendix D7, the passenger volumes have dropped sharply in recent years, at the same time that average revenue per passenger was also dropping sharply. This suggests that external factors are operating and need to be understood, so that the passenger sector does not wither further. Factors that have been suggested are bus and coach competition and railway unreliability and poor time-keeping (hearsay evidence suggest that buses/coaches have been taking higher volumes than rail even though their fares were marginally more expensive).

A recent initiative has cut rail fares sharply - e.g. from 26 Pula to 15 Pula on the Gaborone - Francistown route, undercutting buses whose fares are about 30 Pula. The resulting overcrowding has surprised BR and train consists have had to be increased from 8 to 10 coaches in some cases to accommodate the increase in demand. This may boost total revenues, but it suggests that a profit optimum could be found at a higher price. Improving the quality of the product, i.e. the reliability and to some extent the speed of the service, should enable even high profitability to be achieved. A better understanding of passenger demand elasticities to such factors as price and reliability and cross elasticities to competing

modes, is essential to BR's marketing strategy in an increasingly exposed and hostile environment.

Table 6.3 - Passenger Traffic

	Passenger revenue (Pula million)	Passenger numbers (thousands)	Revenue per Passenger
1986/87	6,568	289	22.73
1987/88	10,136	491	20.64
1988/89	12,478	425	29.36
1989/90	11,644	445	26.17
1990/91	9,705	394	24.63
1991/92	10,292	431	23.88
1992/93	8,045	355	22.66
1993/94	6,306	331	19.05
1994/95	6,230	N/A	N/A

6.2.4 Other Non-passenger, Non-freight Services

These consist mainly of parcels, mail and demurrage & storage. In total revenues they exceed the passenger sector and they have been growing in most recent years. Any further initiatives are to be encouraged.

6.2.5 Pricing Policy

It is not clear whether any consistent price policy is being followed, though price is clearly recognised as a weapon (compare the passenger price changes discussed above). There is a reference in 1985/86 to the intention to hire a consultant to institute a pricing policy. However the only noticeable change in the following years is a sharp increase in export freight costs in 1987/88 which was reversed the following year. Otherwise all the prices seem to be unchanged from those inherited from NRZ and kept fairly constant in real terms thereafter (see Appendix D7). Pricing and comparative pricing are key marketing weapons and a detailed, comprehensive and consistent policy should be worked out as soon as possible, as part of the transport strategy suggested above.

7. CONCLUSIONS AND OBSERVATIONS

7. CONCLUSIONS AND OBSERVATIONS

It is always easy to criticise with hindsight and obviously with a project of this magnitude, spread over seven years, some things will have gone wrong. The end result however proves that the project was a success. There is now a new train control system in operation which is being maintained by a trained S&T departmental staff.

Economic and political changes have dictated that the local engineers do not have as demanding a task as in previous years as the volume of rail traffic has fallen (this is of course a mixed blessing) but this gives time for the new S&T team to establish themselves and gain that valuable 'railway culture' which only comes with time.

We have summarised below our conclusions relating to each part of the evaluation exercise.

7.1 System and procedures

7.1.1 Choice of system

With regard to the choice of system, the evaluation team believe that even with the passage of some ten years, it is likely that a similar system would be recommended today, although nowadays the range of manufacturers and railway organisations with experience of radio based train control system would be wider (4.1.4).

Clearly Botswana were in the vanguard of the development of the radio technology for train control and both NRZ and Spoornet are now moving towards similar systems. Spoornet, in discussion with SADC will encourage the adoption of a common radio based system throughout the region, but this will not be achieved in the short term. Both Spoornet and NRZ require that their radio links are installed and operated by the railway authority. They would definitely not rely on a third party for their essential control links, which is one of the major reasons why the BR system is not working as well as it should. (4.5.2).

7.1.2 Procurement and installation

The use of unproven transponders (4.2.1 and 4.2.4) was unfortunate and it can only be assumed by the evaluation team that there were major financial benefits to be gained by awarding the contract to the GIS (GEC) consortium rather than the Westinghouse/Ericsson group. Further cost saving by using local labour (4.4.2) invalidated the manufacturers guarantee, which has had a long term detrimental effect. This may also have lead to the fall-off in support from the manufacturer, though his actions leave much to be desired.

There was a conflict of responsibilities between the SwedeRail and NRZ engineers which caused some confusion during the installation phase and resulted in conflicting instructions being given to the contractor.

7.1.3 Reliability

Unfortunately the contract for the RETB system did not contain any clauses relating to reliability, therefore BR have not been able to make any sustained claims against the contractor. The equipment has a poor reliability record and BR staff are spending much of their time in repairing equipment. No real assistance is given by the manufacturers.

7.1.4 N.R.Z. Involvement

NRZ were closely involved with the preparation of the specifications for the RETB system and were appointed as the Engineer for the installation of the equipment. They acknowledge that the project management structure gave rise to problems but believe that most of these were overcome. (4.7).

7.2 Establishment of S&T Department

7.2.1 Objectives

The need to establish an S&T Department for BR was obvious and SIDA's actions in appointing expatriate staff in 1987 was very timely. The objectives were well set out in the terms of reference (5.1.1), but it was clearly not possible to achieve those objectives in the contract time span of two years. It would be difficult for engineers with experience in Africa and in the operation of BR to achieve the objectives. None of the appointed staff had any local experience. In addition, they had to deal with the installation of a new S&T system at the same time as setting up the new Department. (5.1.2).

It is therefore not so much a question of 'were the objectives for the consultants services precise and clear' but more a case of were the objectives achievable in the timescale set? The answer to that question must be no. This was realised by SIDA and the contracts were extended.

After completion of the initial contract the experience gained was used to revise the structure of the department and later to change the emphasis of the SwedeRail engineers assignment. (5.1.3).

New engineers were appointed at a time when the first three engineers would have become conversant with the new equipment and the local environment. The evaluation team are not aware of the personalities involved, but it is unfortunate that all the team had (?) to change at the same time with, apparently, a very short handover period to staff who were new to Botswana.

7.2.2 Timetable

Early warnings that it would take 8 to 10 years to establish a S&T department were correct, but by the time the expatriates left there was a functioning S&T department, totally staffed by local engineers and technicians (5.1.5). We believe this to be a major achievement in such a short timescale.

7.2.3 Training

A comprehensive training scheme was carried through but, as with many railways in Africa, many trained staff have left to find more lucrative positions elsewhere. It is to be hoped that with a larger number of graduates coming from the Polytechnics the supply will soon satisfy the national demand for expertise. (5.3).

7.2.4 Government of Botswana Commitment

The Government of Botswana had a commitment to designate local personnel with suitable background qualifications as counterpart staff. It is not known how much assistance was provided by the Government of Botswana, but counterpart staff were appointed and eventually took over the key posts on 1 January 1993. It was not legally possible to apply a bondage

system to retain staff. (5.5).

7.2.5 Sustainability

The recent 'retrenchment' exercise which has resulted in the total BR staff being reduced from 1900 to 1250 has not severely reduced the S&T department, but unfortunately three of the senior engineers have left in recent months. (5.1.5).

The reduction in traffic obviously makes it easier for the S&T department to cope, but there is cause for concern as the RETB equipment is getting older and it will become more and more difficult to get spare parts.

The evaluation team can do no better than concur with the words of Mr Serema, the Marketing Manager of Botswana Ash, a major user of the railway, when he reported that the aid project went exceedingly well and the new signalling and telecommunications is a major contribution to the well being of the railway, which he believes is being well run and has a good future.

7.3 Economic Factors

7.3.1 Competition

The railway is facing severe competition from both road and alternative rail routes. The end of local conflicts and the political changes in South Africa mean that rail traffic can now by-pass Botswana by using routes to Beira, Maputo or direct from Zimbabwe into South Africa via Beit Bridge.

BR must therefore focus more strongly on domestic traffic. (6.1.2).

Botswana has invested heavily in building roads and by so doing attracted traffic from the railway onto the roads. (6.1.3). As in all countries, road users do not have to pay a fair share of the infrastructure costs, however we understand that the Government of Botswana acknowledges that their road pricing policy needs review.

7.3.2 Economic outlook

The strong Botswana currency must contribute to the loss of transit traffic as Zimbabwe and South Africa have a strong financial incentive to use their own railway networks as much as possible. (6.1.5).

The economic backdrop does not appear positive to rail but as much of the rail infrastructure has been upgraded and BR has a surfeit of locomotives, wagons and coaches, it should be possible to improve its competitiveness. (6.1.6).

7.3.3 Traffic developments

The main traffic developments since the inception of BR in 1987 are:

(i) A steady increase in total revenues, reflecting GDP growth, until the last two years.

(ii) The dramatic loss of 40% of previous transit traffic revenue in 1993/94.

(iii) The impressive ability of BR to respond by reducing costs in the last two years.

(iv) The decline by half in passenger revenues.

Freight traffic accounts for 80% of B.R. revenue (6.2.3), subdividied as:

Transit traffic which has dropped from 84% to 28% in the period 1986 - 1995;

Internal traffic which has remained relatively constant;

Import traffic grew in the late 1980's but has dropped dramatically since;

Export traffic is very dependent upon the success of the Sua Pan project.

Passenger traffic has dropped sharply in recent years - presumably due to an increase in bus and coach competition but also possibly due to railway unreliability and poor time keeping. A recent initiative has reversed the trend. (6.2.3).

7.3.4 Economic policy

Following all the political and economic changes in the region a major long-term strategic review of rail transport policy in Botswana needs to be undertaken. (6.1.5). This should:

- develop a full transport strategy;
- include pricing and business skills training in the strategy;
- examine competitive pricing with other countries; consider damage that over-valued currency is doing to the economy as a whole;
- address lack of manufacturing base - over-dependence on mining (diamonds, soda ash, maybe coal in future);
- alter road pricing system to provide level playing field;
- recognise BR's geographic marginality, which may require ingenuity in marketing;
- address falling import tonnages;
- address passenger diminution (fares and numbers going down), including road competition, especially buses - reduce unreliability
- ensure profits to rail from big mining developments;
- set performance targets for revenues and profits in each sector.

8. LESSONS LEARNED

8. LESSONS LEARNED

8.1 Project Management

There were not clear lines of responsibility and communication at the outset. It is necessary to provide the project manager/engineer with direct access to senior management but at the same time ensure that the views of all other interested or affected parties can be properly integrated. The contractor must have one point of contact with the client, usually The Engineer.

If possible the staff appointed to a project should have some experience of previous work in that country or a similar country and when expatriate staff are replaced an adequate hand-over period should be ensured.

An adequate time-table for the project should have been agreed in discussion with all concerned parties. The intangible railway safety culture requires additional time to mature over and above the immediate needs for training in technical and operational procedures. This culture will only develop in time.

8.2 Training

For the particular case of a new railway, requiring training of the work force at all levels, then consideration should be given to separating the operating activities from the training activities and giving equal status to training and day-to-day line management responsibilities.

8.3 Specifications

The specifications for the RETB system should have included measurable performance targets, e.g. overall system reliability in service. Targets should be discussed and agreed with the Contractor during tender negotiations and then embodied into the contract.

The onus should have been placed firmly on the contractor to satisfy himself on local conditions.

A clause should have been included in the contract giving the client the right to manufacturing drawings and specifications should the contractor cease trading or not be in a position to supply spare parts.

8.4 Self Contained Radio System

With a train control system whose correct functioning depends upon the maintenance of communications or any other essential sub-systems, it is preferable to ensure that these are installed by and under the control of the railway organisation.

8.5 Cost-cutting

The use of sub-contractors or local labour (to save costs) without the express agreement of the main contractor may put at risk the contractors willingness to provide support under warranty.

The choice of the RETB system was appropriate for the application and additionally it offered the prospect of 'half price' signalling. This may have become an end in itself and insufficient attention given at the time to selective redundancy of equipment to improve system availability, or the use of the proven but more costly Swedish transponder equipment.

Since the introduction of the system a back-up communications link has had to be added together with considerable expenditure on transponder replacements. Full life cost evaluation is a vital consideration in railway planning.

APPENDIX A

TERMS OF REFERENCE

partment for Infrastructure and
onomic Cooperation

TERMS OF REFERENCE

EVALUATION OF THE SWEDISH SUPPORT TO BOTSWANA RAILWAYS

Contents

1. BACKGROUND

2. REASONS FOR THE EVALUATION

3. SCOPE AND FOCUS OF THE EVALUATION

4. METHODOLOGY, TEAM COMPOSITION AND TIME SCHEDULE

5. REPORTING

1. BACKGROUND

The railway in Botswana is a single line track of approximately 650 km main line in the eastern part of the country between Ramatlabama at the South African border and Bakaranga at the Zimbabwean border. There are also three major branch lines totalling 250 km along the main line:

- Serule - Selebi Phikwe
- Palapye - Moropule, and
- Francstown - Sua Pan

The railway and its assets was owned and operated by the National Railways of Zimbabwe (NRZ) up to 31 December 1986, after which date it was taken over by the Government of Botswana (GOB).

The intention to take over ownership and operation of the railway in Botswana was announced by GOB already in 1975 with the motivation that the country must exercise national control over the key functions of its transport sector.

As a result of Botswana's announcement in 1975, NRZ ceased to make re-investments in the railway system and carried out only current maintenance and necessary repairs.

To prepare for the take-over GOB had to rehabilitate the track, invest in new rolling stock and fixed assets and recruit and train staff for a completely new administration to operate the railway system.

Based upon a request in 1982 from GOB to SIDA, the Swedish Government authorized SIDA to prepare and agree upon Swedish support to the rehabilitation of the train control system and telecommunications system for the railway up to a ceiling amount of MSEK 38. All technical discussions at that time were held with NRZ officials since Botswana Railways was not yet established.

However, in June 1984 a new request was submitted by GOB for a signalled block system for train control which, including the telecoms part, was calculated at MSEK 80.

As an initial phase of the project appraisal SIDA engaged two consulting firms, Henderson & Busby and SwedeRail to carry out, independently from each other, a desk study to compare alternative solutions for the train control system. Both consultants recommended the, at that time, recently developed (by British Railways) Radio Electronic Token Block System (RETBS) for train control of the railway main track through Botswana.

Botswana's railway rehabilitation project as a whole included not only the requested Swedish support, but also

- building of a new head office
- procurement of 20 locomotives and 450 wagons
- building of a locomotive and wagon workshop
- a three-year staff training programme
- track rehabilitation of the main line as well as branch lines.

The project was included in Botswana's 5-year Development Programme as well as in SADC's Regional Programme of Projects.

The railway take-over and rehabilitation was seen in both a national and a regional (SADC) context. In a national perspective the railway is needed as a cost-effective alternative to truck-transport of heavy bulk goods within Botswana.

In a regional perspective the railway is a means of transport of goods between the land-locked countries in the region, and also a link to the South African ocean ports in a time when Mozambique's three international ports as well as the port of Dar es Salaam were not operational.

The objectives for Botswana to take over and invest in the railway were expressed as to create increased national independence, economic development and regional exchange of goods and trade.

After a final appraisal in 1985 an agreement was signed in January 1986 for Swedish support to Botswana Railways up to MSEK 56 to cover:

i) Supply and installation of new telecommunications equipment.
ii) Supply and installation of a new RETBS for train working.
iii) Supply and installation of a local signalling system at the train workshop in Mahalapye.
iv) Consulting Services for procurement and installations.
v) Technical Assistance to establish an indigenous and sustainable signal and communications division within Botswana Railways' central administration.
vi) Training of local staff to operate and maintain the equipment supplied.

The total agreed amount of MSEK 56.0 included a contingency of MSEK 9.0. Of the total amount, MSEK 46.0 were to be taken from the regional SADC allocation and MSEK 10.0 from the bi-lateral Botswana country allocation.

NRZ was engaged to carry out items iii) and iv) above. On behalf of GOB, SIDA engaged SwedeRail Consulting AB to provide Technical Assistance to the Signal and Telecommunication Department (S & T) and to organize training of local staff, items v) and vi).

In April 1989 a new agreement was entered into between Sweden and Botswana for a three-year extension of the Technical Assistance support to BR at a cost of MSEK 12.0. In May 1989 SIDA made an agreement with the Consultant, SwedeRail, for correspondingly extended Technical Assistance.

In May 1992 a third agreement was signed between Sweden and Botswana for 18 months' continued Technical Assistance at a cost of MSEK 9.6, and SwedeRail's engagement was extended correspondingly. In April 1993 the ceiling was raised by MSEK 1.5 to MSEK 11.1 to cover a final period up to the end of February 1994 for the adviser to the Signal Engineer.

The Consultant's Final Report was submitted in April 1994.

From January 1993 all key positions in the Signal and Telecommunications Department were filled by local staff and the expatriate consultants acted as advisers during 1993.

2. REASONS FOR THE EVALUATION

Sweden has supported the project for 8 years from January 1986 to May 1994. There have been many problems along the route but they seem to have been solved. The preconditions for the original project objectives have changed with regard to the new political situation in southern Africa. Sida and the Government of Botswana are interested in learning lessons from the implementation of the Swedish support and collect the experience made for utilization in similar future projects.

3. SCOPE AND FOCUS OF THE EVALUATION

It would lead too far to evaluate the entire railway take-over project which includes, apart from Sweden, several other donors such as Canada, Denmark and China. Furthermore, when GOB made the decision to implement the investment project of the actual magnitude of regional as well as national importance, it must be presumed that it has committed itself to monitor the overall implementation process very closely.

This evaluation will therefore mainly focus on the Swedish support to provide train working and telecommunications equipment and to establish a sustainable staff unit within the Botswana Railways' administration to operate and maintain the equipment provided.

The relevance of the whole project can be split in two major issues, namely (i) the political relevance for Botswana to have a national railway linking Zimbabwe and South Africa, and (ii) the economic relevance of Botswana's large investments.

The first issue has today a historical interest and shall not be dealt with in this evaluation.

The second issue concerning the economic relevance of the railway take-over project shall be looked into by the Evaluation Team and commented upon with regard to the economic development in the country and forecasted versus actual transport revenues for goods and passengers. Is there for example an appropriate balance between road transport and railway transport?

As regards the specific Swedish support, the main issues to be studied, analyzed and commented upon are the following:

Firstly, were the procedure as well as the equipment chosen appropriate for Botswana Railways? The question is particularly relevant for the train working equipment (RETBS) since the system was fairly new and untested in a track system as large as BR's. Procurement, supplier, installation supervision and the performance reliability shall be looked into.

Secondly, the Consultant's assistance to train local staff to administer, operate and maintain the new equipment and to create a sustainable Signal and Telecommunications Department within BR shall be analyzed and evaluated as regards competence and sustainability. The Consultant has in his Final Report claimed that the objective for his services was not precise and clear. The evaluation should therefore also assess whether the output of the assistance would have improved by a more precise formulation of the objective. Should the Human Resource Development have followed a slower or perhaps quicker path with a more concentrated assistance input? Is the organization and staffing of the S & T Department sustainable in a longer time perspective?

Thirdly, assess if GOB has fulfilled its contractual commitments according to the Specific Project Agreements with Sweden?

Issues of second priority to be looked into are:

Did NRZ provide good advise to the project as consultants for installation and commissioning of the train working equipment and did NRZ supply appropriate equipment for the local signalling system in Mahalapye?

Has there been any notable environmental impact (positive or negative) of the Swedish project (such as shorter idling times at passing loops, fewer train stops resulting in less fuel consumption).

Gender aspects were not included in the original Agreement or its replacements. However, the Evaluation Team shall feel free to give any comments which may be relevant in this respect.

4. METHODOLOGY, TEAM COMPOSITION AND TIME SCHEDULE

4.1 Methodology

The evaluation team shall commence the mission by collecting and studying all available background information from relevant documentation, the majority of which is listed in Appendix 1 to these ToR. This information will mainly be available at Sida in Stockholm and/or at the Swedish Embassy in Gaborone. Some documentation may also be available at Botswana Railways' headquarter in Mahalapye, Botswana.

The team shall thereafter carry out a mission in Botswana and interview relevant officials at the Swedish Embassy in Gaborone as well as at BR's head quarters, particularly the General Manager, the heads of Staff Training Department, Signal & Telecommunications Department and Financial Department. The Permanent Secretary of the Ministry of Works, Transport and Communications is probably also a valuable source of information. BTC, Botswana Telecommunications Corporation has been involved in the radio transmission for the RETBS and may also be of interest for interviews.

A field mission to study the operation and maintenance of the S & T equipment as well as a visit to the Train Control Centre in Mahalapye and training schools in Mahalapye and Francistown should be undertaken.

Interviews with selected users of the railway services should be considered.

Contacts with NRZ and Spoornet South Africa may be considered.

The Consultant SwedeRail Consulting AB have expressed their opinions and experience in a multitude of quarterly and interim reports as well as in their Final Report. Nevertheless is may prove valuable for the Evaluation Team to establish a direct contact with SwedeRail during the evaluation mission.

4.2 Team Composition

It is anticipated that the team will consist of 3 persons namely:

one Transport Economist
one Railway Signalling Specialist conversant in various existing train control systems
one Management/Training Specialist

One of the teammembers shall be appointed Team Leader.

4.3 Time Schedule

The evaluation is anticipated to require 6 weeks from commencement of the study to Draft Final Report.

Week no. 1	will be spent to study available background documentation.
Week no. 2-4	will be spent for a fact finding mission in Botswana.
Week no. 6	after commencement of the evaluation shall be the latest time for submission of a Draft Final Report to Sida and Botswana Railways.

The Final Evaluation Report shall be submitted to Sida and BR within 2 weeks after the reception of Comments on the Draft Report.

5. REPORTING

The Evaluation Report shall be written in English and follow the format in the enclosed Appendix 2, "Sida evaluation reports" - a standardized format.

At the end of the 3-week field mission, the Evaluation Team shall present a Draft Summary of Findings and Conclusions to the Swedish Embassy in Gaborone and to Botswana Railways.

The Draft Final Report shall be delivered to Sida and Botswana Railways in three copies each not later than two weeks after the team has finalised their work in Botswana. The Final report shall be submitted in 3 copies each to Sida and Botswana Railways not later than two weeks after the evaluation team has received comments on the Draft Final Report.

APPENDIX B

LIST OF PERSONS INTERVIEWED

APPENDIX B

LIST OF PERSONS INTERVIEWED

Gosta Werner	SIDA, Stockholm
Leif Holmgren	SIDA, Stockholm
Torkel Danielsson	SIDA, Stockholm
B O Marklund	Senior Vice President, SwedeRail
Kjell Salerius	Senior Consultant, SwedeRail
Curt Klangsell	Telecommunications Engineer, SwedeRail
Lars-Olov Jansson	Councellor - Swedish Embassy
Mr Tumelo	Sec. for Economic Affairs, Ministry of Finance
A Ramji	General Manager, Botswana Railways
B Gakelebotse	Chief S&T Engineer, Botswana Railways
O.S. Molebatsi	Commercial Manager, Botswana Railways
J Ramontsho	Workshop Engineer, Botswana Railways
David Scott	Assistant Chief Signal Engineer, NRZ
J Hawkins	Chief Signal Engineer (Retd), NRZ
R Marten	Telecomms Engineer, NRZ
T K Prinsloo	Assistant Regional Manager, Spoornet
G B Paverd	Senior Engineer (Infrastructure) Spoornet
Mr Serema	Marketing Manager, Botswana Ash
J Williams	Transport Manager, Botswana Ash

APPENDIX C

LIST OF DOCUMENTS AND OTHER REFERENCES

APPENDIX C

LIST OF DOCUMENTS AND OTHER REFERENCES

AGREEMENTS

A1 Specific Agreement regarding Equipment and Services for Botswana Railways 31/1/86

A2 Terms of Reference for Technical Assistance to Botswana Railways 20/5/86

A3 SIDA assistance to Botswana Railways
(Project Review Sept. 1989)

A4 Specific Agreement regarding Equipment and Services for Botswana Railways

A5 Contract on Consulting Services, 24 May 1989

A6 T.O.R. for Continued Technical Assistance to Botswana Railways 1989

A7 Agreed Minutes on Support to Botswana Railways

A8 Agreed Minutes from Programming Discussions on Future Development Cooperation between Botswana and Sweden in Gaborone, 6-7 December 1990

A9 Agreement between the Government of Sweden and the Government of Botswana on Development Cooperation, 1 July 1992 - 30 June 1994

A10 Specific Agreement between the Government of Sweden and the Government of Botswana on technical assistance to Botswana Railways

A11 Agreed Minutes from Programming Discussions on Future Development Cooperation between Botswana and Sweden in Gaborone, 17-18 February 1992

A12 Agreed minutes from discussions held in Gaborone during 24 February to 3 March 1992, regarding Swedish support to Botswana Railways

A13 Specific Agreement between the Government of Sweden and the Government of Botswana on Personnel and Consultancy Fund

A14 Contract for Consulting Services, 19 June 1991

A15 Memorandum of Agreement BR/NRZ - 27 January 1987

MISCELLANEOUS REFERENCES

M1 Functional and Technical Specifications for Radio Electronic Token Block System (RETBS) for the Botswana Railways. (SwedeRail).

M2 Inspection of Telecommunications and signalling Rehabilitation Project for Botswana Railways - 13-27 June 1989. (SwedeRail).

M3 Minutes of Meetings (GEC/BR/SIDA/SWEDERAIL) - February 1987

M4 Maintenance Handbook. Signal Section (SwedeRail)

M5 Assessment of GEC Tender - 27 March 1987 (SwedeRail)

M6 Quotations - GEC - GSI Ltd and Ericssons/Westinghouse

M7 Assessment of Tenders - NRZ 3 December 1986

M8 Contract for Supply & Installation of RETBS - 10 April 1987
(Botswana Railways/GEC)

M9 Office Handbook for the S&T Department (SwedeRail)

M10 Training Strategy 1993 - 1995

M11 Letter 26 March 1991 - General Manager (BR) to SIDA
(Request for financial aid for replacement Transponders - No legal recourse on GEC)

M12 Letter 24 August 1989 - SIDA to GEC
(Strong dissatisfaciton with performance - GEC response 4 September 1989)

QUARTERLY REPORTS

Q1 September 1990 - March 1991 (2 Quarters)

Q2 January - March 1992

Q3 April - June 1992

Q4 July - September 1992

Q5 January - March 1993

Q6 April - June 1993

Q7 July - September 1993

REPORTS

R1 Republic of Botswana
Ministry of Works and Communications
Annual Report for the Period 1 April 1985 to 31 March 1986

R2 Botswana Railways First Annual Report 1987/1988

R3 Botswana Railways Annual Report 1988 - 1989

R4 Botswana Railways Annual Report 1989 - 1990

R5 Botswana Railways Annual Report 1990 - 1991

R6 Botswana Railways Annual Report 1991 - 1992

R7 Botswana Railways Annual Report 1992 - 1993

R8 Botswana Railways Annual Report 1993 - 1994

R9 Botswana Railways Statement of Accounts 1995

R10 Appraisal Study, Phase I - August 1985 (Henderson Busby International Ltd.)

R11 Appraisal Study, Phase II - February 1986 (SwedeRail)

R12 Review of SIDA assistance to B.R. - October 1987 (KM Group)

R13 Inspection of Telecomm and Signalling Rehabilitation Project Botswana Railways June 13-27 1989

R14 Project Review - September 1989 (Kennedy Henderson and K&M)

R15 Botswana Railways Department
SIDA Assistance to Botswana Railways
Project Review in September 1989 - Final Report

R16 Follow-up and Review of SIDA assistance to B.R. - April 1992 (K&M)

R17 Signalling Feasibility Study - 10 July 1992 (De Leuw Cather)

R18 Training Requirements Study - 1987 (SwedeRail)

R19 Signalling Training Study - 1991 (SwedeRail)

R20 Final Report from Training Engineer. April 1988 - June 1992

R21 SwedeRail Report for the Year 1991

R22 SwedeRail Report for the Year 1992

R23 Communications Study (SwedeRail) c. June 1992

R24 Details of RETB Communications Network at 12/93 (SwedeRail)

R25 Creation of a S&T Department Final Report 1994 (SwedeRail)

R26 Gaborone Signalling - Final Report 1994 (SwedeRail)

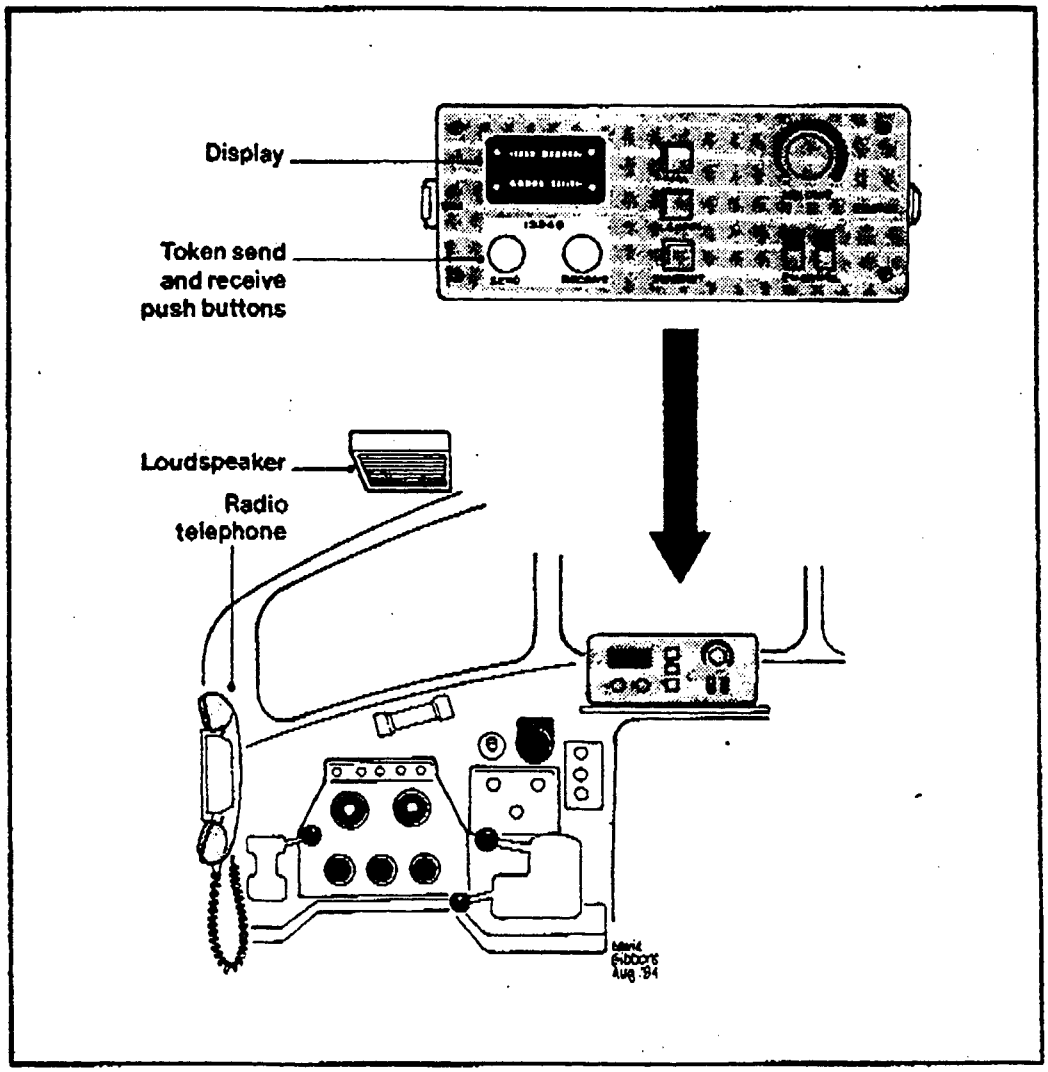
APPENDIX D

REFERENCE TABLES AND DIAGRAMS

D1 Low cost radio signalling

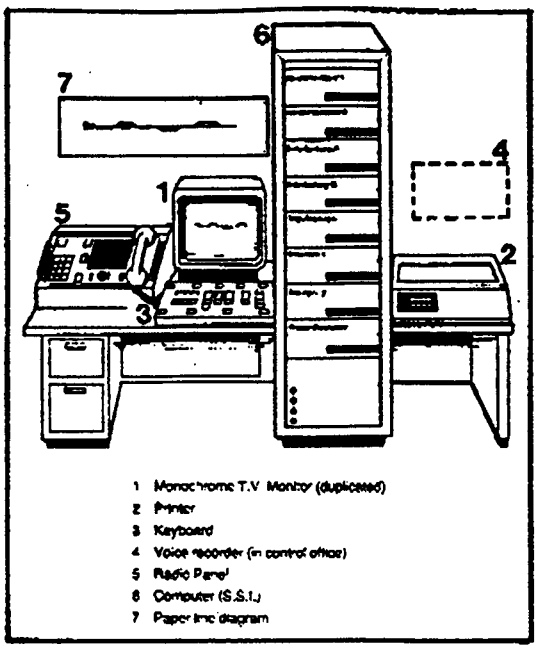
Low Cost Radio Signalling

In response to the need for a low-cost but highly reliable signalling system with the same order of integrity as that provided by existing signalling, British Rail Research, in association with the Signalling and Operating Departments, has developed the concept of the "Radio Electronic Token Block" (R.E.T.B.).



On train equipment and control panel of locomotive.

This system satisfies the requirements for signalling lightly used single or double track railways, making use of two existing developments, radio communication and computer-based interlocking, to create a high technology alternative.



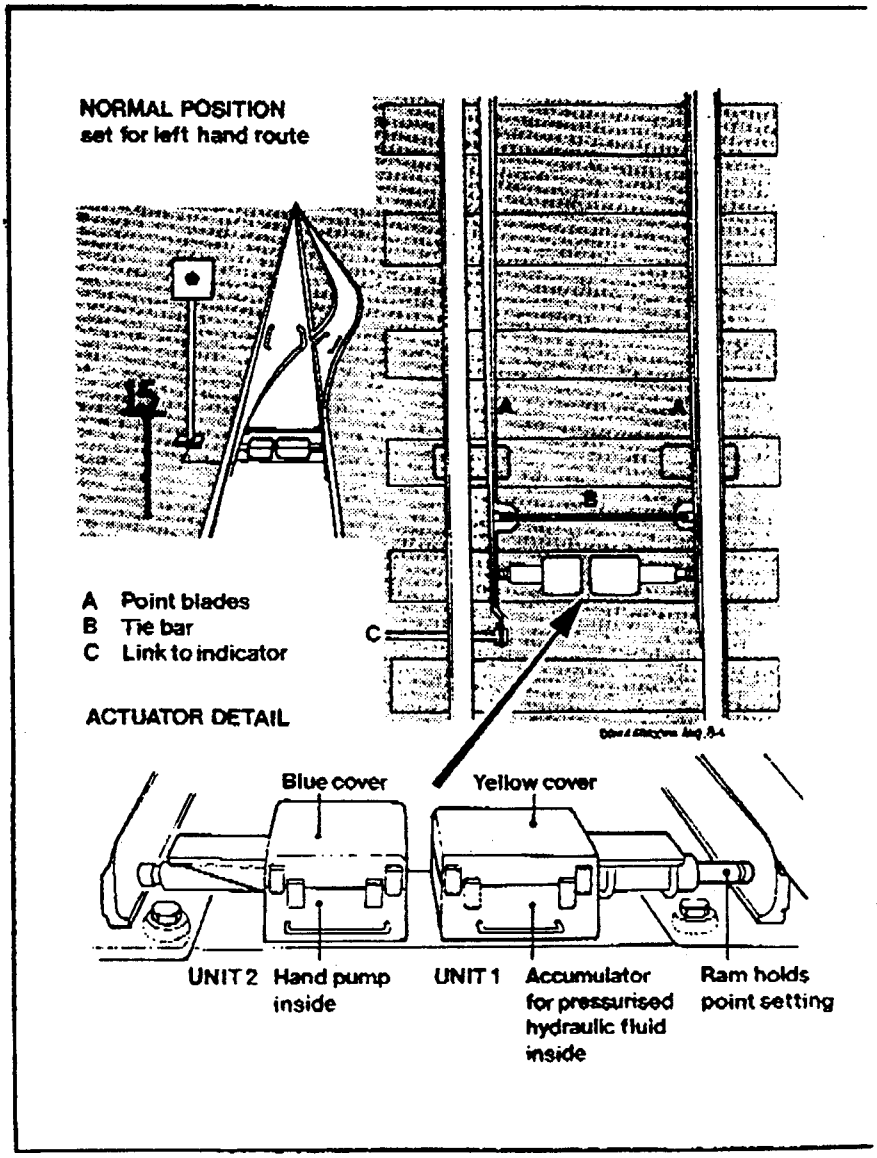
The Signalman's control console.

By concentrating all the interlocking hardware and the control functions in one signalbox it has been possible to achieve dramatic savings in the costs of procurement, train running and maintenance of signalling the lightly used line.

To implement R.E.T.B. it is necessary to fit the locomotive or multiple units which use that line with Radio and special 'Token Display' equipment.

The signalbox must be equipped with a specially adaptec Solid State Interlocking and Radio Interface equipment.

In the case of single line railways with passing loops it is an advantage to fit these loops with a hydraulic, train-operated points mechanism



Train Operated Points

SIDA
Infrastructure Division

TERMS OF REFERENCE FOR TECHNICAL ASSISTANCE TO BOTSWANA RAILWAYS

1. INTRODUCTION

The 651 km long single track railway through Botswana between Plumtree at the Zimbabwe border and Ramatlhabama at the South Africa border is now owned and operated by the National Railways of Zimbabwe (NRZ). From 1st January 1987 the ownership and operations will be taken over by Botswana through its in 1984 established department Botswana Railways (BR) under the Ministry of Works and Communications.

Since Botswana in 1975 announced its intention to take over the railway line, no major investments have been made to improve the permanent way and the fixed installations, but merely a regular maintenance to keep the operations safely running. In 1984 Botswana commenced an intensified planning and preparatory actions for the take over of the railway line, which included requests for financial support in three main areas from the international community, namely

1. Staffing at all levels of the new Botswana Railways organization.

2. Rehabilitation and upgrading of the existing permanent way and its fixed installations for efficient and safe train operations.

3. Investment in new rolling stock (locomotives and wagons) and necessary maintenance- and repair facilities for this.

Sweden was requested to support the acquisition and installation of a new train working system and new telecommunications equipment. In the last quarter of 1985 SIDA, assisted by Swederail Consulting AB carried out an appraisal of different train working systems and the telecommunications system for which the Government of Botswana had requested Swedish financial support. The appraisal revealed that in addition to the new equipment required, the organization structure for the department of Botswana Railways suffered from a large number of vacant positions on higher management levels in the railway administration. The responsible Ministry had recognized this alarming staff situation and added to its request to Sweden the manning of three positions in the Signal and Communications Division namely:

- Chief Signal and Communication Engineer

- Senior Signal and Communication Engineer

- Chief Technical Officer

Further to the assistance requested from Sweden Botswana has reached an agreement with Denmark (who will finance a locomotive workshop in Mahalapye) to provide a Chief Mechanical Engineer, Principal Mechanical Engineer and Senior Mechanical Engineer for the BR Mechanical Engineering Division. An agreement has also been concluded with Transmark (UK) for the manning of five Senior Manager positions from June 1986 and one year ahead. These positions are Chief Civil Engineer, Traffic Manager, Operations Manager, Planning and Development Manager and Manpower Manager.

Subsequent to the project appraisal, SIDA has agreed with Botswana to support the acquisition of

(i) a new Radio Electronic Token Block System (RETBS) for train working along the main line;

(ii) a local signal installation at Mahalapye workshop;

(iii) new telecommunications equipment including a selector system, an open wire line carrier system and electronic PABX telephone exchanges at five railway stations along the main line.

(iv) Consulting Services to be provided by NRZ, for Supervision of delivery and installation of the equipment and

(v) the provision, through a Consulting company, of three experts on signalling and telecommunications to lead and develop the Signal and Communications Division at Botswana Railways Headquarters.

These Terms of Reference describe the objective and Scope of Works for the Consulting Services to provide technical assistance to Botswana Railway's Signal and Communications Division (v).

2. BACKGROUND

The present system for train working along the railway line is based on written train orders transmitted from station to station with facimile machines at 11 different sections on the railway, operating over an open wire line along the track. The facimile machines are close to life expired. The manufacturing of identical or similar machines has ceased and spare parts are no more available.

The agreed new system for train working (RETBS) is based upon radio transmission between the locomotives and a train control centre at Mahalapye which leaves additional capacity for improvement of the telecommunications over the existing 3-pair open wire line on steel poles along the line.

The existing telecommunications equipment, operating over the open wire line, is still functioning although many of the components are worn and out of date, i a the carrier systems and the traffic control telephone. Exchanges at the five biggest stations are fairly modern but without sufficient spare capacity for further required extensions and trunks. The agreed new equipment will use the existing open wire line for;

- a selector system and a 12 channel open wire line carrier system between Bulawayo in Zimbabwe and south to the southern border of Botswana

- a 3 channel open wire line carrier system between Bulawayo and Gaborone with a spur link from Serule to Selebi-Phikwe

- electronic telephone exchanges at five major stations along the railway line

An interim organization structure showing the position of Botswana Railways Department within the Ministry of Works and Communications is given in Annex 1 to these Terms of Reference. The Signals and Communications Division is working under responsibility to the Railway Project Coordinator, and consists of the three technical positions given in order of hierarchy in Section 1 above. The Chief Signal and Communication Engineer is presently an expatriate working under a contract which expires in September 1986. Remaining two positions are presently vacant.

3. OBJECTIVES

The overall objective of the requested Consulting Services is to provide the Botswana Railways with professional assistance to run and develop the BR Signal and Communications Division, including the build-up of a local capacity to take over and continue in a reasonable time the current operations, maintenance and development of the BR Signal and Communications Division.

4. SCOPE OF WORK

4.1 GENERAL

The Consulting Services shall include the manning during a period of two years of the following three positions in the BR, Signal and Communications Division

A Chief Signal and Communications Engineer

B Senior Signal and Communications Engineer

C Chief Technical Officer (Signals).

The professional competence of the personnel appointed for the three long term positions shall be the responsibility of the consulting firm as well as any technical back-up support which may be required in the performance of their duties.

The three persons shall work as normal holders of their respective position in the railway administration with full individual responsibility for the work they are performing and any propositions or decisions they make. The common duties of the Consultants' personnel as civil servants in the BR Signal and Communications Division shall include but not necessarily be limited to

- plan, orginize and monitor the BR take over of operations and maintenance of existing signalling and telecommunications equipment

- plan, monitor and advise BR in the procurement, delivery, installation and commissioning of new equipment for telecommunications, signalling and train working. It is anticipated that NRZ will be engaged on consulting terms to supervise the delivery installation and commissioning of new systems for telecommunications and train working

- plan and organize for the proper maintenance and operation of the new equipment

- elaborate plans and initiate actions for the long term permanent staffing of the BR Signal and Communications Division at the headquarters as well as the workshop and field units

- assist the BR Departmental Management Division in immediate short term actions to provide sufficient staffing of the Signal and Communications Division

- advise and assist BR in any other matters required for the proper operation and maintenance of signals, telecommunications and train working systems.

Essential and desirable qualifications as well as the essential tasks the holders of the positions are required to perform are described in detail under 4.2 below.

Further to the provision of personnel for the manning of the three requested positions the Consulting Services shall include a technical back-up assistance which may be necessary during the contract period. Such technical back-up assistance is described under 4.3 below.

All Headquarter's staff will initially be stationed in Gaborone. At a later stage the BR Headquarter will be transferred to new premises in Mahalapye and the Consultants' personnel will then be required to move to Mahalapye.

The normal duties of the personnel will include a high degree of over-night service travel along the railway line and the Consultants' personnel is required to comply with these duties.

4.2 QUALIFICATIONS AND PROFESSIONAL TASKS

Position A: Chief Signal and Telecommunications Engineer:

It is assumed that the person appointed for this position will have had wide experience in both signalling and telecommunications with a railway administration but that he will have specialized in signalling techniques and will, therefore, be able to handle the majority of the planning and design work in this discipline.

Essential Qualifications:

1. An acceptable degree in electrical engineering or an equivalent qualification (e.g. Corporate Membership of the Institution of Electrical Engineers (London)).

2. Fluency in the English language.

3. A minimum of 15 years experience as an engineer in the railway signalling and telecommunication field.

4. A minimum of three years experience in a managerial post in the railway signalling and communication field.

5. The possession of a valid motor vehicle driving license.

Desirable Qualifications:

6. Have had experience in both the maintenance and development aspects of the signalling and telecommunication functions.

7. Have had experience in single line signalling systems.

8. Communication experience should include experience in the following:

   (a) HF, VHF and UHF radio;
   (b) 12 channel carrier systems;
   (c) Telephone exchange networks;
   (d) Open wire telephone routes.

9. Have had experience in a Workshop in which the overhaul of signal and communication equipment was carried out.

Professional Tasks:

10. To plan, design, test and commission signalling installations.

11. To formulate maintenance instructions and schedules for signalling equipment.

12. To elaborate a plan and initiate the short term and long term staffing and gradual localization of the BR Signal and Communications Division.

13. To formulate training programmes for signalling and telecommunications staff.

Position B: Senior Signal and Telecommunication Engineer.

It is assumed that the person appointed for this position will have had wide experience in the telecommunication field and hence will carry out the majority of the design work etc. in this discipline.

Essential Qualifications:

1. An acceptable degree in electrical engineering or an equivalent qualification (e.g. Corporate Membership of the Institution of Electrical Engineers (London)).

2. Fluency in the English language.

3. A minimum of 8 years experience in the telecommunication field.

4. The possession of a valid motor vehicle license.

5. Experience in the following telecommunication techniques:

   (a) 3 & 12 channel analogue carrier equipment;
   (b) Digital telephone exchange equipment;
   (c) HF, VHF and UHF radio equipment;
   (d) Overhead telephone line equipment and transposition systems.

Desirable Qualifications:

6. Have had experience in both the maintenance and development aspects of the telecommunication functions.

7. Have had some telecommunication experience within the railway environment.

8. Have had some experience in the railway signalling field.

9. Had experience with microprocessor systems.

Professional Tasks:

10. To plan, design, and commission communication systems.

11. To fault find on the communication equipment.

12. To formulate maintenance instructions and schedules for the communication equipment.

13. To instruct staff in the maintenance and fault finding techniques for the equipment.

Position C: Chief technical Officer.

It is assumed that the person appointed for this position, which is essentially a practical one, will not require an academic qualification of a high standard but will have had considerable "hands-on" experience in the maintenance and installation of signal and communication equipment.

Essential Qualifications:

1. Have served a recognised apprenticeship in either signalling or telecommunications.

2. Have had a minimum of 15 years experience in the railway signalling and telecommunication field.

3. Have had a minimum of five years experience as a Foreman in the railway signalling and telecommunication field.

4. Fluency in the English language.

5. The possession of a valid motor vehicle driving license.

Desirable Qualifications:

6. A British Higher National Certificate in Telecommunications or its equivalent.

7. Experience in radio techniques.

Professional Tasks:

8. To maintain and fault find on relay interlocking equipment (including electric point machines).

9. To instruct artisan staff in maintenance techniques with regard to both signalling and communication equipment.

4.3 TECHNICAL BACK-UP

A very urgent task for the Chief Signal and Communications Engineer will be to develop a local capacity in Botswana Railways on all levels of the Signal and Communications field. The planning and preparations for this must start without delay since the implementation is a process extended over several years. No doubt, however, considerable efforts by the permanent staff immediately before and after the railway take over, will have to be devoted to the solution of more immediate technical and operational tasks.

It is therefore anticipated that additional technical back-up assistance may be required within the scope of the Consulting Services to support the long term personnel in their elaboration of a programme for the education and training of local signal and communications staff on all levels within Botswana Railways.

The services for such a programme shall include:

- an organization structure showing the number of staff required at different levels and their required level of education with regard to assigned tasks;

- a detailed inventory of the educational situation for the existing staff;

- a detailed programme for the recruiting, basic and further training of signal and telecommunications staff encompassing time schedule, suitable institutions inside or outside Botswana, costs involved and spare resources.

5. TIME SCHEDULE

With regard to the take over time schedule and the expiry of current staff assignments it is a requirement that the Chief Signal and Communications Engineer will be in position at BR Headquarters in September 1986 at the latest. The remaining two long term expatriates shall be in position as soon as possible but not more than two (2) months after the Chief Engineer.

The time of assignment for each position will thus be

Position A; 26 months

Position B; 24 months

Position C; 24 months

6. ACCOMMODATION OFFICE AND LOCAL TRANSPORT

Botswana Railways will provide, free of charge for the Consultants' staff, furnished accommodation and furnished office premises.

The Consultants may be required to provide stationery, minor equipment and local services for the organization and efficient running of the office. Such expenditure shall be subject to prior approval by SIDA as a condition for reimbursement.

Vehicles for local services transport shall be purchased by the Consultants. SIDA's local procurement regulations shall apply for all purchases.

7. LANGUAGE

The language for all services under these Terms of Reference shall be English.

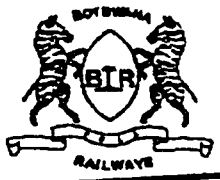
8. BACKGROUND MATERIAL

Further information on the project is available in

- Report from Fact Finding Mission, Swederail Dec. 1982
- Report from Appaisal Study, Swederail March 1986
- Specifications for procurement of telecommunications and train working systems.

APPENDIX D3

4-12 H



TELEPHONE: 373185
TELEGRAMS: RAILWAYS
TELEX: 2960 RAILS BD
FAX: 312305

GENERAL MANAGER
BOTSWANA RAILWAYS
PRIVATE BAG 00125
GABORONE
BOTSWANA

910408
Alm. t. INFRA (AD)
aa/ll

SIDA
BOT-DCO
Reg. no
Date 91 03 26
Filing index no.

OUR REF: BR: March 26, 1991

SIDA
BOT-DCO
Reg. no 225
Date 91 03 26
Filing index no.
1.32.13

Ms Liselott Laurin
S.I.D.A.
Swedish Embassy
GABORONE

Dear Ms Laurin,

ELECTRONIC SENSORS: TRANSPONDERS

The Transponder is a vital part of the electronic equipment which completes the pack of devices that make up the Radio Electronic Tokenless Block System (RETBS) supported and implemented by S.I.D.A. on Botswana Railways.

There are 360 (10 spares) of such devices on the system which are installed at strategic locations between the rails and from interrogation by passing locomotives assure the central computer that safe movement is taking place.

The transponders initially installed were in reinforced concrete. They were manufactured in the U.K.

Our officers visited the U.K. factory and approved the fabrication method. It was not recognised that,

1. they were heavy and could be damaged during handling and certainly on the long rail, ship and rail journey to Botswana;

2. they were made for track gauge 4' - 8½" and were too heavy for Southern African gauge 3' - 6";

3. they were designed for flat sleepers and are subject to vibration and damage through their own weight on more than half of Botswana Railway which is laid in concrete surfaced concrete sleepers;

4. as an economy it was decided they would be fitted by Botswana Railways, not the contractor they, were clearly roughly handled and the guarantee was lost;

5. The transponders were badly fitted.

Some two thirds of the transponders are damaged and mostly not recording - the full couplement will have to be replaced.

Local experiment with a lighter plastic fibre glass design has produced a more satisfactory transponder. It is also ironic that the original supplier is producing transponders in plastic casing.

Botswana Railways have already ordered 15 of the transponders made in Botswana and tested satisfactorily. The railway is not presently funded to obtain the remaining 345 which cost P500.00 each total P172 500.00.

Since there is no legal recourse, assistance would be appreciated.

Yours Sincerely

F.W. MARKHAM
GENERAL MANAGER

APPENDIX D 4

SPECIMEN V.E.C.T.A. OPERATING DIARY STATISTICS

FAULT ANALYSIS FOR NOVEMBER 1995

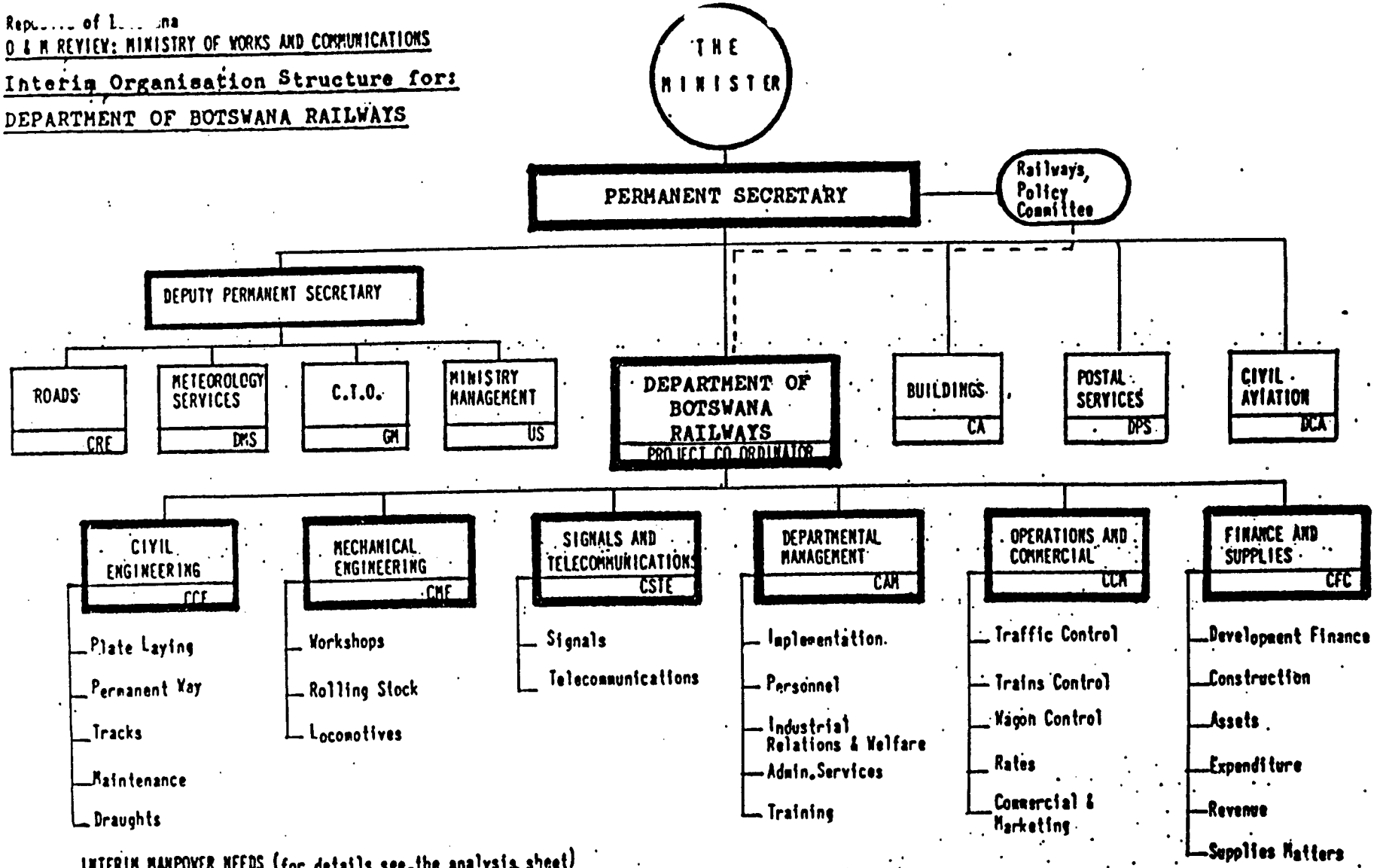
Description faults	Number of faults	%age of all
Auxiliary Motors	0	0%
Body	0	0%
Bogie	0	0%
Brake Hoses	0	0%
Brake Rigging	0	0%
Brake System	5	7%
Couplers	0	0%
Electrical Equipment	6	8%
Engine Fuel System	2	3%
Engine Governor	0	0%
Engine Oil System	0	0%
Engine Water System	1	1%
Exciter	0	0%
Generator - Main	0	0%
Radio Comms Failure	3	4%
Generator - Auxiliary	0	0%
Headlights	2	3%
RETBS Equip Failure	**11**	**15%**
Traction Motors	4	5%
Warning Devices	3	4%
Telecomms. Failure	**2**	**3%**
Wheels/Axles/Bearing	0	0%
Broken Rail	0	0%
Permanent Way	8	11%
Colour Signal Failure	0	0%
Other Faults	27	36%
TOTAL FAULTS	74	

Repu.... of L... na

O & M REVIEW: MINISTRY OF WORKS AND COMMUNICATIONS

Interim Organisation Structure for:

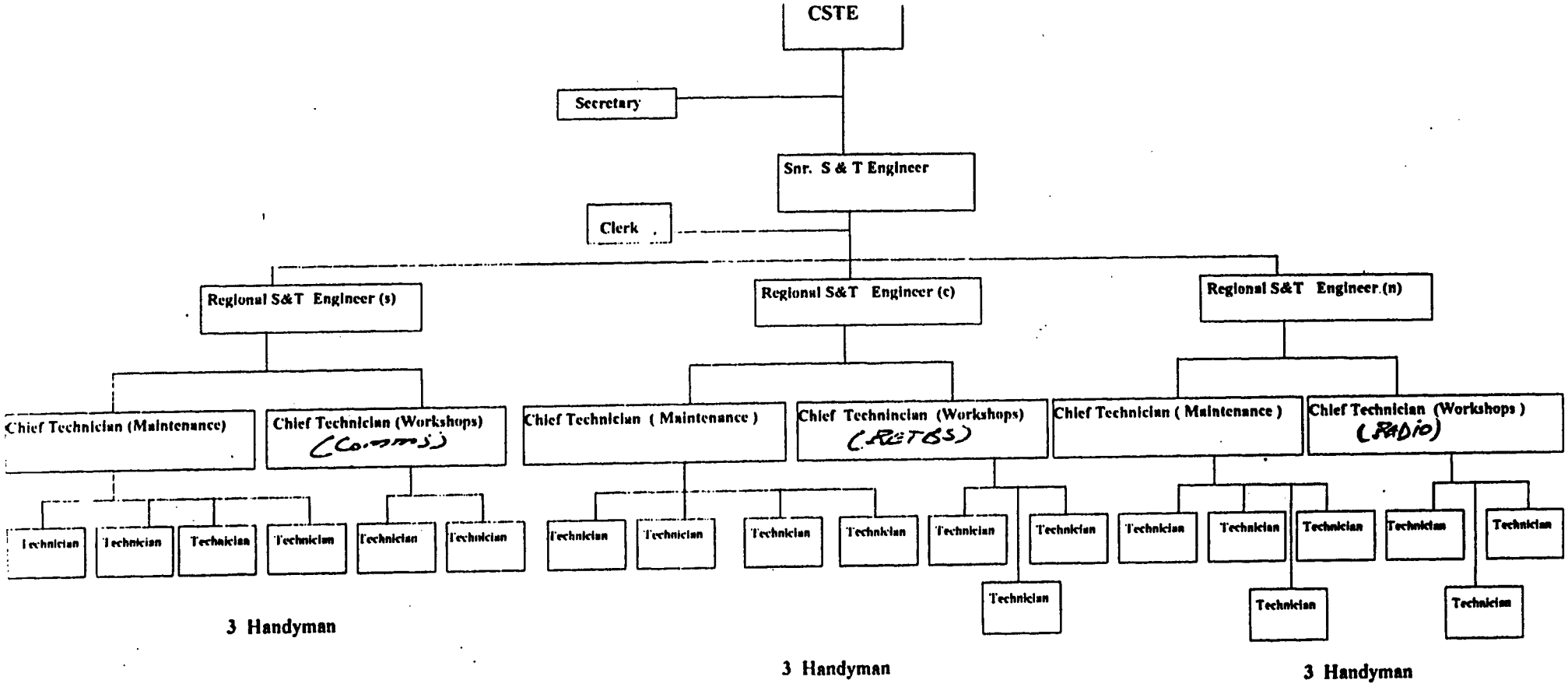
DEPARTMENT OF BOTSWANA RAILWAYS



INTERIM MANPOWER NEEDS (for details see the analysis sheet)

	CIVIL ENGINEERING DIV.	MECHANICAL ENGINNERING	SIGNALS AND TELECOMS	CORPORATE MANAGEMENT	OPERATIONS AND	FINANCE AND SUPPLIES
	1 CCE SV 2 PE PR.1 3 CTO T.1 1 STO T.2 1 IO T.3 1 Eng.PR.3(S)	1 CME SV 1 PME PR.1 1 SME PR.2	1 CSTE SV 1 SSTE PR.2 1 CTO T.1	1 Proj.Co-od. SIV 1 Impl.Officer S.V 1 CAM S.V 3 PPO/PAO/PIR GA.1 1 Tr.Officer BA.2 1 Adm.Off. GA.3 2 AO GA.3/6 1 Per.Sect. S.2 2 Typists S.3/4	1 CCM S.V 3 CTC/CC T.1 6 SC/STI T.2 3 WC/TI T.3 1 SRO GA.2 3 RO GA.3	1 CFC S.V 1 ACSM S.VI 1 SFO PR.2 1 FO PR.3 4 CA/CSO GA.1 1 SA GA.2 1 SO GA.3
TOTAL	9	3	3	TOTAL 13	17	10

APPENDIX D5



Planned (retrenched) organisation of the S & T Department.

December 1995.

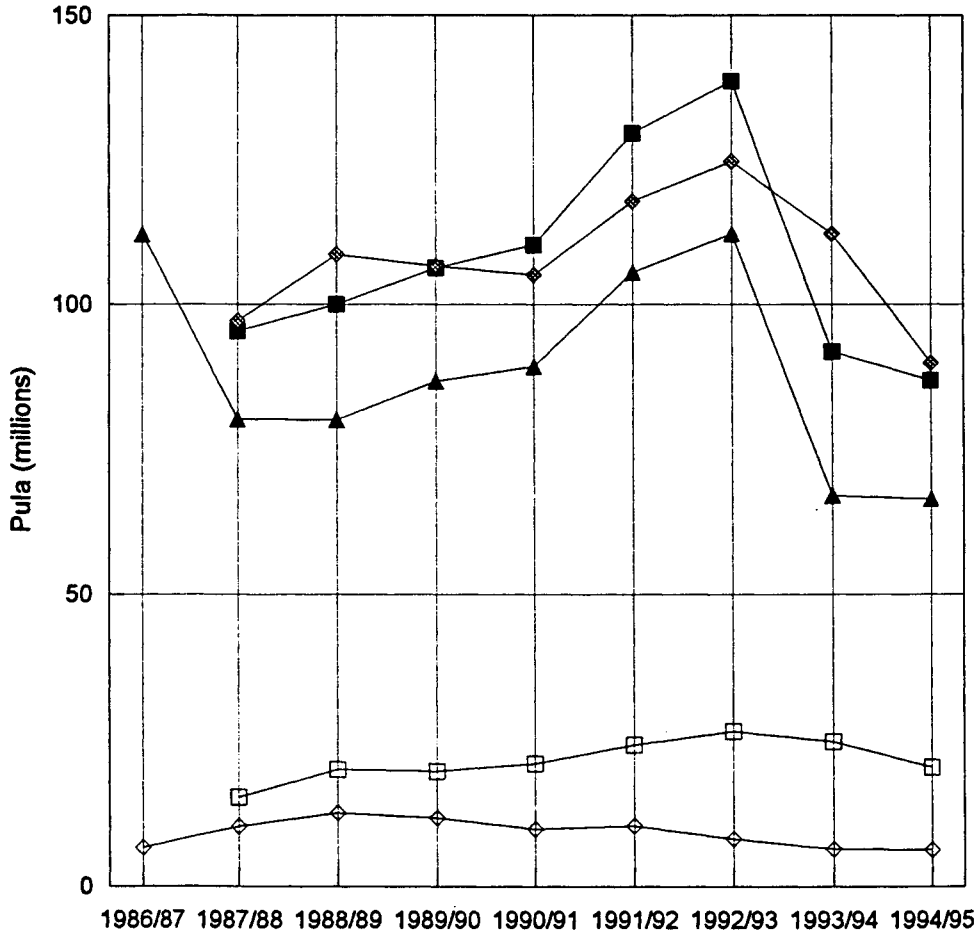
APPENDIX D6

APPENDIX D7

TRAFFIC AND REVENUE GRAPHS

Operating Costs and Revenues

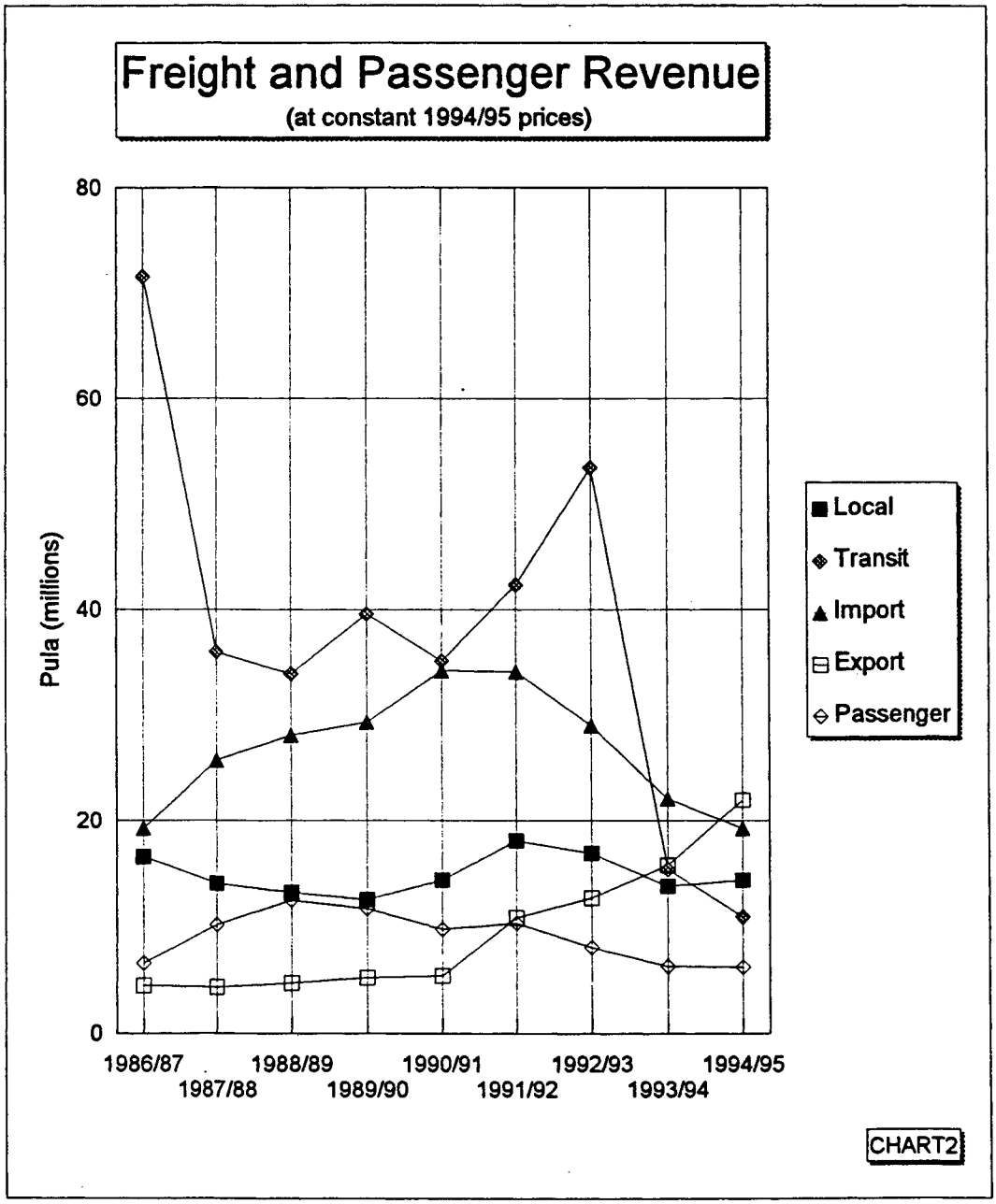
(at constant 1994/95 prices)

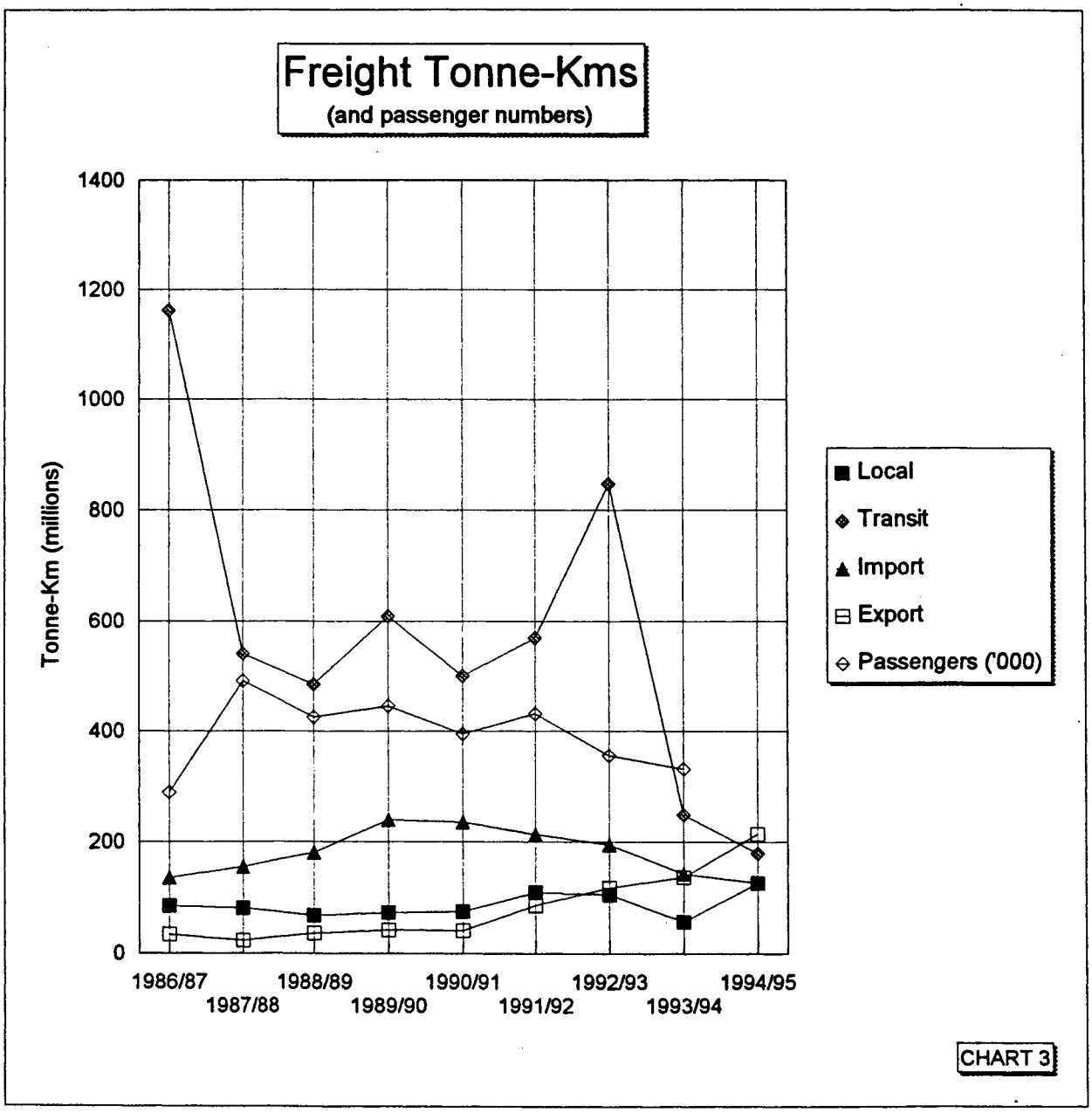


■ Total Operating Revenue ◆ Total Operating Expenditure ▲ Total Freight Revenue

⊟ Total Non-freight Revenue ◇ Passenger Revenue

CHART 1


Freight and Passenger Revenue
(at constant 1994/95 prices)
Pula (millions)
80
60
40
20
0
1986/87
1987/88
1988/89
1989/90
1990/91
1991/92
1992/93
1993/94
1994/95
Local
Transit
Import
Export
Passenger
CHART2


Freight Tonne-Kms
(and passenger numbers)
Tonne-Km (millions)
1400
1200
1000
800
600
400
200
0
1986/87
1987/88
1988/89
1989/90
1990/91
1991/92
1992/93
1993/94
1994/95
Local
Transit
Import
Export
Passengers ('000)
CHART 3

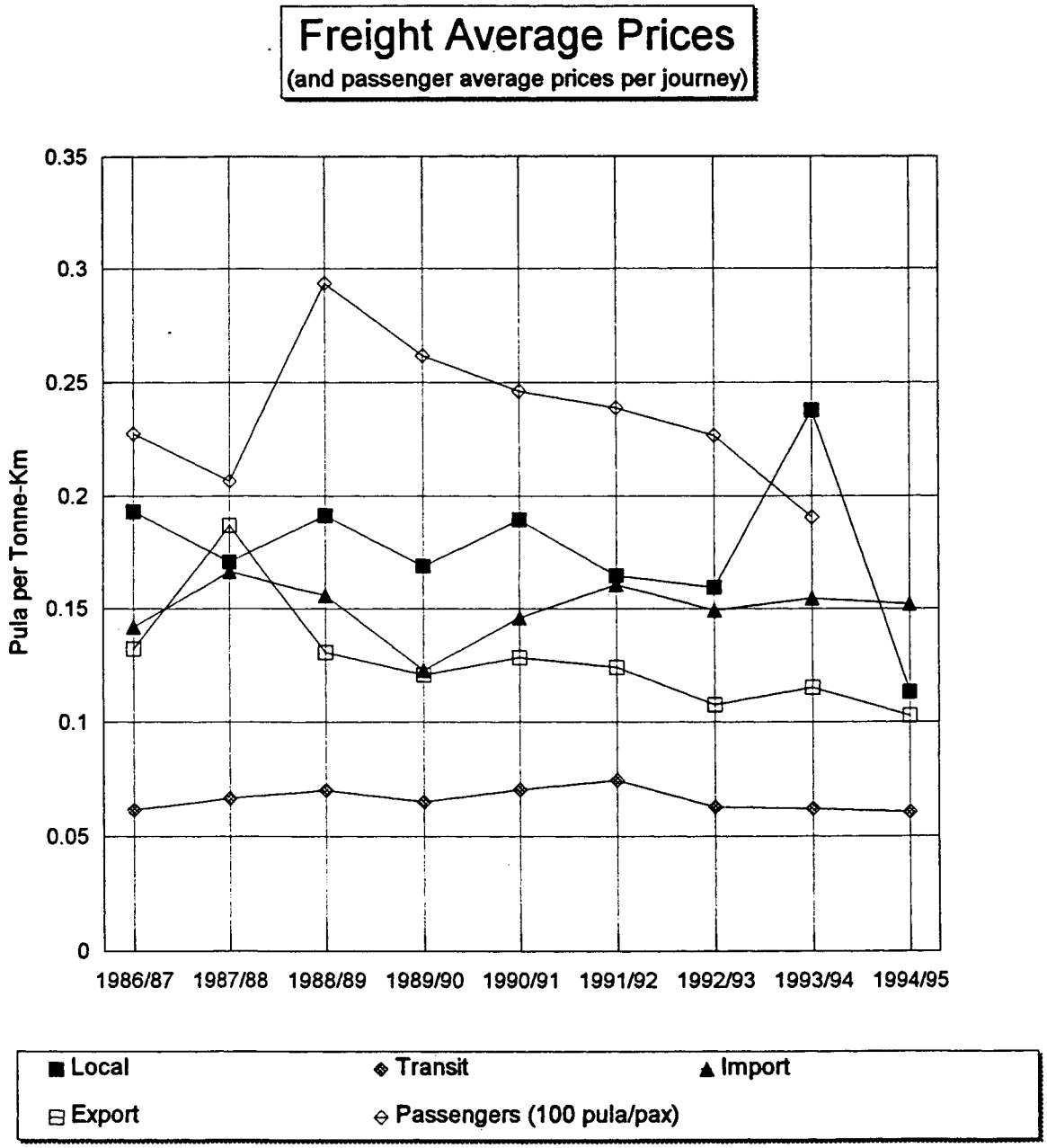

Freight Average Prices
(and passenger average prices per journey)
Pula per Tonne-Km
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1986/87
1987/88
1988/89
1989/90
1990/91
1991/92
1992/93
1993/94
1994/95
Local
Transit
Import
Export
Passengers (100 pula/pax)

CHART 4

PROJECT LIST FOR SWEDERAIL CONSULTANTS 1993

Administrative projects

System for registry within S&T
Fault report system
Drawing system
Budget routines / manual
Introduction for new employees
Info mtrl for S&T systems
Signalling principles
Statistics for S&T
Office handbook for S&T department
Job descriptions

Specifications

Optofibre
Simplified signalling

Routines

Maintenance handbook update
Testroutines/ manual
Store routines

Policy

Grading for S&T staff
Petty cash
Acting allowances
Handheld radios etc
Promotion

Management

Managent by objectives
Maintenance planing
Interface with civils/Personnel/Mechanical
Quality assurance system
Productivity mesauring system
Organisation review
Overtime control
Workshop strategy

Training

Course descriptions
Course plans

Sida Evaluations - 1995/96

95/1 Educação Ambiental em Moçambique. Kajsa Pehrsson
Department for Democracy and Social Development

95/2 Agitators, Incubators, Advisers - What Roles for the EPUs? Joel Samoff
Department for Research Cooperation

95/3 Swedish African Museum Programme (SAMP). Leo Kenny, Beata Kasale
Department for Democracy and Social Development

95/4 Evaluation of the Establishing of the Bank of Namibia 1990-1995. Jon A. Solheim, Peter Winai
Department for Democracy and Social Development

96/1 The Beira-Gothenburg Twinning Programme. Arne Heileman, Lennart Peck
The report is also available in Portuguese
Department for Democracy and Social Development

96/2 Debt Management. (Kenya) Kari Nars
Department for Democracy and Social Development

96/3 Telecommunications - A Swedish Contribution to Development. Lars Rylander, Ulf Rundin et al
Department for Infrastructure and Economic Cooperation

96/4 Biotechnology Project: Applied Biocatalysis. Karl Schügerl
Department for Research Cooperation

96/5 Democratic Development and Human Rights in Ethiopia. Christian Åhlund
Department for East and West Africa

96/6 Estruturação do Sistema Nacional de Gestão de Recursos Humanos. Júlio Nabais, Eva-Marie Skogsberg, Louise Helling
Department for Democracy and Social Development

96/7 Avaliação do Apoio Sueco ao Sector da Educação na Guiné Bissau 1992-1996. Marcella Ballara, Sinesio Bacchetto, Ahmed Dawelbeit, Julieta M Barbosa, Börje Wallberg
Department for Democracy and Social Development

96/8 Konvertering av rysk militärindustri. Maria Lindqvist, Göran Reitberger, Börje Svensson
Department for Central and Eastern Europe

96/9 Building Research Capacity in Ethiopia. E W Thulstrup, M Fekadu, A Negewo
Department for Research Cooperation

96/10 Rural village water supply programme - Botswana. Jan Valdelin, David Browne, Elsie Alexander, Kristina Boman, Marie Grönvall, Imelda Molokomme, Gunnar Settergren
Department for Natural Resources and the Environment

96/11 UNICEF's programme for water and sanitation in central America - Facing new challenges and opportunities. Jan Valdelin, Charlotta Adelstål, Ron Sawyer, Rosa Núnes, Xiomara del Torres, Daniel Gubler
Department for Natural Resources and the Environment

96/12 Cooperative Environment Programme - Asian Institute of Technology/Sida, 1993-1996. Thomas Malmqvist, Börje Wallberg
Department for Democracy and Social Development

96/13 Forest Sector Development Programme - Lithuania-Sweden. Mårten Bendz
Department for Central and Eastern Europe

96/14 Twinning Progammes With Local Authorities in Poland, Estonia, Latvia and Lithuania.
Håkan Falk, Börje Wallberg
Department for Central and Eastern Europe

96/15 Forestry Sector in Latvia. Kurt Boström
Department for Central and Eastern Europe

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