5-5 Telecommunication and Signalling

5-5-1 Telecommunication

(1) Outline

BRC's wire telecommunication consists of block lines between stations, station-to-station telegram lines, control telephone lines from each control office and telephone exchanges at major stations. These lines and exchanges are not sufficient in capacity and almost all of them are overaged and heavily deteriorated. Owned by PTC, loaned bare wires are not well maintained. This often impedes smooth train operations.

Communication between two stations is conducted by means of telegram line, control telephone line, or block line. In case all of these lines are in trouble, the locomotive, uncoupled from the train, will go to the next station and back for clear block confirmation. This practice will necessitate the provision of more stable telecommunication lines. When an accident happens between stations, the train crew has to walk to the nearby station and inform this accident. This also hampers the smooth and regular train operation.

Some 150 sets of medium and high frequency wireless equipment are provided at main points on all lines and also at those points lacking in telecommunication lines. They use many frequencies. UHF wireless system is also provided for the parts of the Mandalay Line to make up for the lack of PTC lines.

(2) Present status

1) Telecommunication line

For performance of BRC services, most communication is conducted by using control telephones or radio. PTC subscriber telephones are also used. Tie lines which connect the exchanges provided at main points are insufficient and this makes it difficult to allow urgent and close contacts.

2) Wire equipment

a) Bare line

Bare lines along the railway track and used by BRC are owned by PTC. These lines often suffer by theft; and many insulators are seriously damaged. After theft, the repair and maintenance by PTC is not sufficient; parts different in type and diameter are used, resulting in malconnection and resistance increase, hampering the flow of current. There are many sections where lines are unusable. Usually, repair is not done immediately after theft, resulting in a change to the paper line-clear ticket system for the block. Thus, safe train operation is not maintained, nor scheduled train speed is kept.

Broken insulators bring about lower line insulation in wet season; and especially, in block and telegram lines using ground circuits, the effect is serious, hampering communication. Bare lines are sometimes broken or cut by falling tree branches.

Fig. 5.5.1 shows sections by line, indicating the lines in fault or unrepaired after theft with the number of sections. As shown in this figure, the block line of the Mandalay Line suffered the greatest impact, 91 percent relying on the paper line-clear ticket system. The control telephone line between Pyinmana and Thazi was left unrepaired and UHF radio owned by BRC was provided for communication among 15 stations.

b) Control telephone line

Divisional Control offices are located at Rangoon, Toungoo, Thazi, Mandalay, Kawlin and Mohnyin, and their areas covered and equipment used are shown in Fig. 5.5.2.

Control telephone lines are mainly used for communication with stations on train operations, passenger and freight services, when not by radio.

Equipment of DC 200V, 17 code calling system is provided over all lines, except for the section of 234.2 km (146.1 miles); but it, installed back in 1950, was overaged and much deteriorated. The bare lines are poorly maintained by PTC; the status of communication is not stable, as shown in Table 5.5.1. As these figures show, the percentage of successful talks against calls is 44 percent as a whole, and only 9 percent on the section between Pegu and Martaban of the Martaban Line.

c) Telegram line

A single telegram line is provided between stations, using Morse code. Almost all station-to-station communications are done by this line, which is playing an important role, especially on the paper line-clear system sections. However, PTC's poor maintenance is greatly affecting the use of these lines.

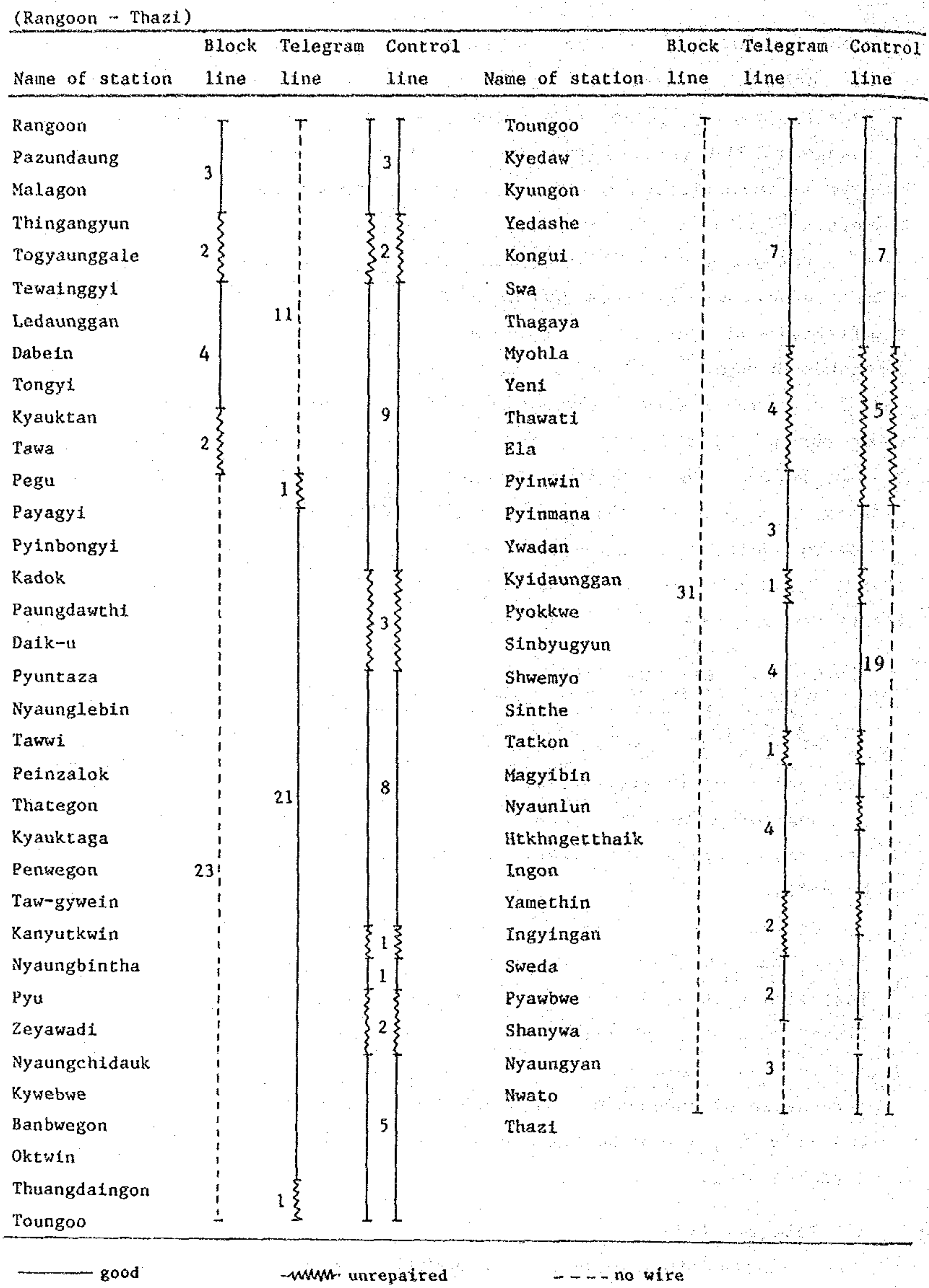


Fig. 5.5.1 Situation of Telecommunication Line

Source: BRC

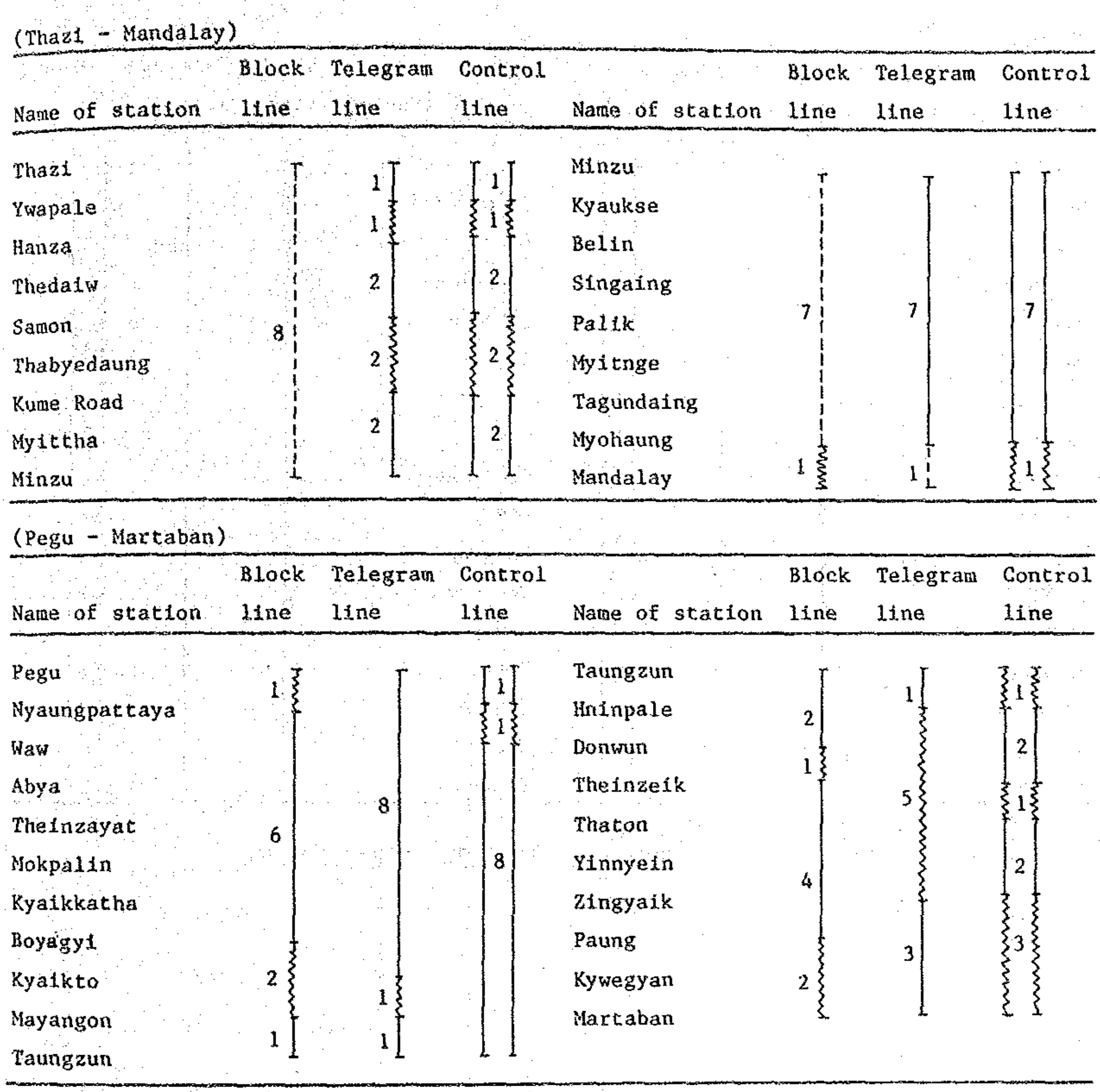


Fig. 5.5.1 Situation of Telecommunication Line

Source: BRC

(Rangoon - Prome)

Name of station	Block line	Telegram line	Control line	Name of station	Block line	Telegram line	Control line
Rangoon				Tonze			
Kemmendine				Tharrawaddy	2		
Kamayut				Inywa			4
Thamaing	6		6	Letpadan	2		
Insein				Sitkwin		16	
Ywama				Minhla			2
Danyingon	1	15	1	Othegon	4		
Hlawga			1	Okpo			2
Hmawbi				Gyobingauk	1		
Wanetchaung	6			Zigon	1		3
Pugya			5	Nattalin	1		
Taikkyi				Paungde			
Thanatchaung				Padigon			
Hpalon	4		4	Thegon	4		5
Okkan				Sinmizwe			
Ngapugle		1		Hmawza	1		
Thonze				Prome			

Fig. 5.5.1 Situation of Telecommunication Line

Source: BRC

(Myohaung - Myitkyina)

Name of station	Block line	Telegram line	Control line	Name of station	Block line	Telegram line	Control line
Myohaung				Gyodaung			1
Amarapura	3		3	Nankan			2
Amarapura-shore				Bonchaung			
Ywataung		6		Meza			
Saye				Seywa			4
Padu				Indan			
Ketka				Naba			
Paukkan				Pinwe			
Wetlet		4		Mawlu			2
Moksogyon				Naunsiaung		17	1
Shwebo			17	Mawhan			1
Myinkatha				Kadu			1
Kinu				Mohnyin			1
Madaunghla				Namma			
Tantabin				Myothitgale			3
Tangon		11		Hopin			
Kanbalu				Namkwin			
Thityabin				Pinbaw			
Pintha				Mingon			6
Kyaikthin				Taungni			
Zawchaung				Sanmaw		5	
Kotaungbo		1	1	Hto-pu			
Kawlin				Mogaung			
Wuntho		3	3	Namti			2
Kin				Mayan		4	
Gyodaung				Pidaung			2
				Myitkyina			

Fig. 5.5.1 Situation of Telecommunication Line

Source: BRC

Comparison List

(Unit, station to station section)

Section	Classification of section		Block line	Telegram line	Control line	Total
Rangoon-Mandalay	Good	A	7	53	45	105
	No wire Unrepaired	B	74	28	36	138
	Total	A+B=C	81	81	81	243
	Ratio	B/C	91%	35%	44%	57%
Pegu-Martaban	Good	A	13	13	13	39
	Unrepaired	B	6	6	6	18
	Total	A+B=C	19	19	19	57
	Ratio	B/C	32%	32%	32%	32%
Rangoon-Prome	Good	A	21	17	22	60
	No wire Unrepaired	A+B	11	15	10	36
	Total	A+B	32	32	32	96
	Ratio	B/C	34%	47%	31%	38%
Myohaung-Myitkyina	Good	A	3	41	35	79
	Unrepaired	B	0	10	16	26
	Total	A+B	3	51	51	105
	Ratio	B/C	0%	20%	31%	25%
Total	Good	A	44	124	115	283
	Unrepaired	B	91	59	68	218
	Total	A+B=C	135	183	183	501
	Ratio	B/C	67%	32%	37%	44%

Fig. 5.5.1 Situation of Telecommunication Line

Source: Study Team

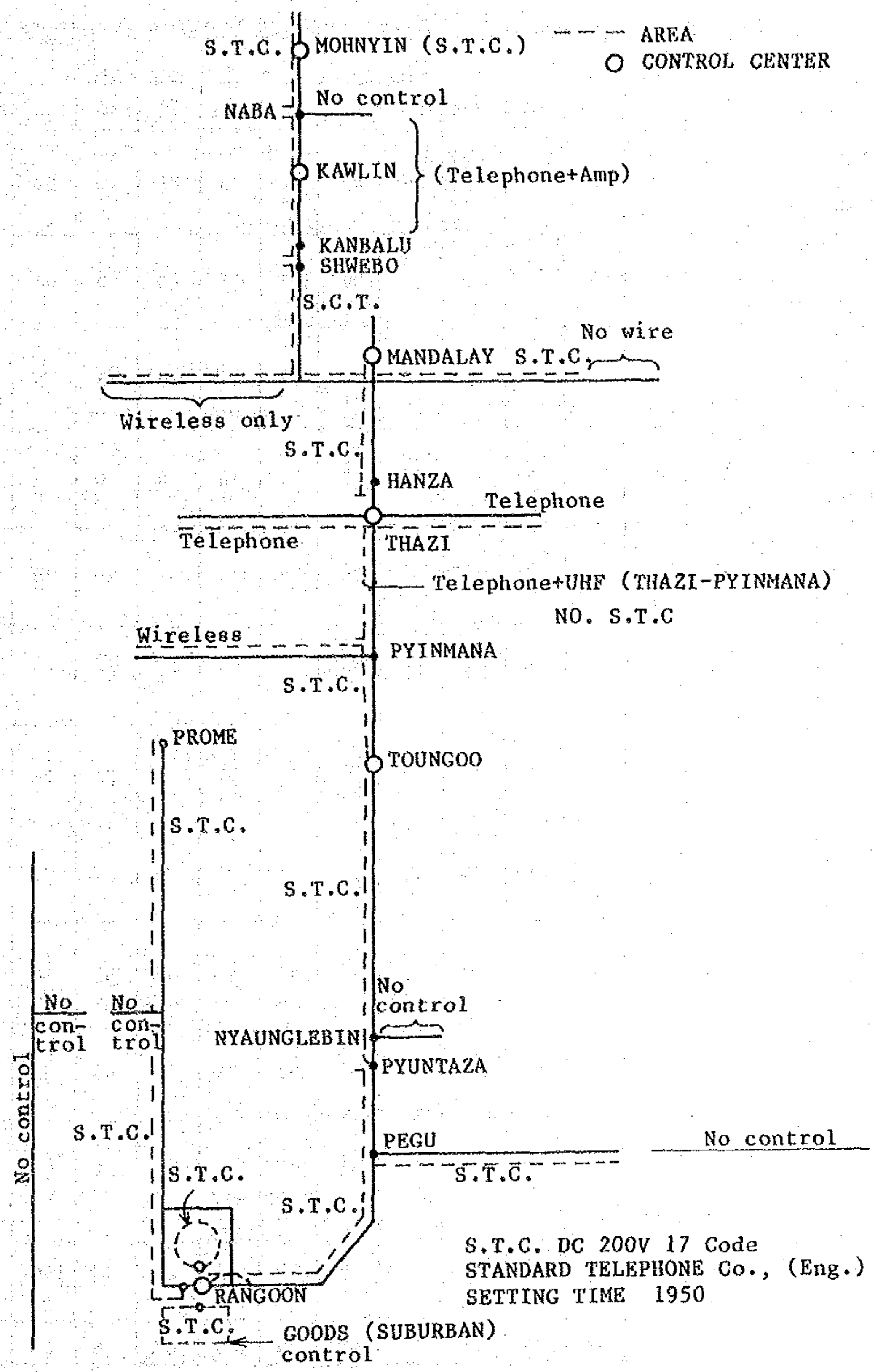


Fig. 5.5.2 BRC Control System

Source: BRC

Table 5.5.1 Percentage of Successful Talks through Control Telephone Line (1985)

Month	1	2	3	4	5	6	7	8	9	10	11	12	Average
Rangoon ~ Pyinmana	14	71	72	77	66	74	60	71	70	81	76	63	66
Rangoon ~ Martaban	44	44	47	44	42	48	48	44	42	45	43	44	46
Pegu ~ Martaban	9	9	14	9	7	15	10	9	7	10	3	5	9
Rangoon ~ Prome	42	44	34	36	36	15	15	15	16	16	16	16	25
Toungoo ~ Pyuntaza	40	41	31	17	27	27	24	24	29	32	29	29	29
Toungoo ~ Pyinmana	56	50	44	39	29	12	39	47	47	58	54	58	44
Mandalay ~ Thazi	44	44	44	44	29	27	27	30	31	31	22	22	37
Mandalay ~ Shwebo	36	36	36	36	36	31	31	21	27	26	27	27	31
Kawlin ~ Shwebo	50	50	50	49	39	25	14	50	47	37	51	50	43
Kawlin ~ Naba	44	44	44	39	50	56	53	52	58	42	46	53	48
Mohyin ~ Naba	83	83	83	73	63	71	61	82	85	83	83	83	78
Mohnyin ~ Myitkyina	64	50	64	75	70	87	92	84	83	100	100	100	81
Average	44	47	47	45	41	41	40	44	45	47	46	46	44

Source: BRC

d) Telephone line

Few stations are provided with telephone line. There are some sections where lines, which have become unusable as control telephone lines because of poor quality, are used as block or magneto telephone lines.

Large stations, workshops and marshalling yards are provided with telephone exchanges. Subscribers use magneto telephone sets and bare lines.

e) Telephone exchange

Telephone exchanges are provided at large yards, workshops and signal cabins. Almost all of them are for communication among their neighboring subscribers; tie lines between exchanges are borrowed from PTC. These exchanges of the magneto type are overaged and deteriorated; some lines often fail because of poor indicators; connection is limited due to poor cords.

The composition of exchange network is as shown in Fig. 5.5.3.

f) Sunshine hours

Data on sunshine hours are collected for possible use of solar cell where a.c. power is not available for the communication and signal equipment. Fig. 5.5.4 shows the results. A particularly short period of sunshine hours is near Rangoon in July 1984; the daily average sunshine hours is 2 for 16 days from 2nd through 17th. It is therefore necessary to provide large battery for equipment with large capacity and this is not economical.

3) Wireless equipment

a) Medium and high frequency wireless equipment

Some 150 sets of MHF wireless equipment are provided over the country for long distance communication, and are used in the areas where no telecommunication lines are installed.

Roughly, there are 3 kinds of equipment: 150w equipment of single side band for telephone, 100w equipment of single side band for telephone, and 50w for telegram. In some places, this telegram is used as telephone. 150w wireless uses 10 waves from 2 to 5 MHz, 100w radio 4 waves from 2 to 6 MHz, and 50w wireless 38 waves from 2 to 8 MHz, grouped in 10.

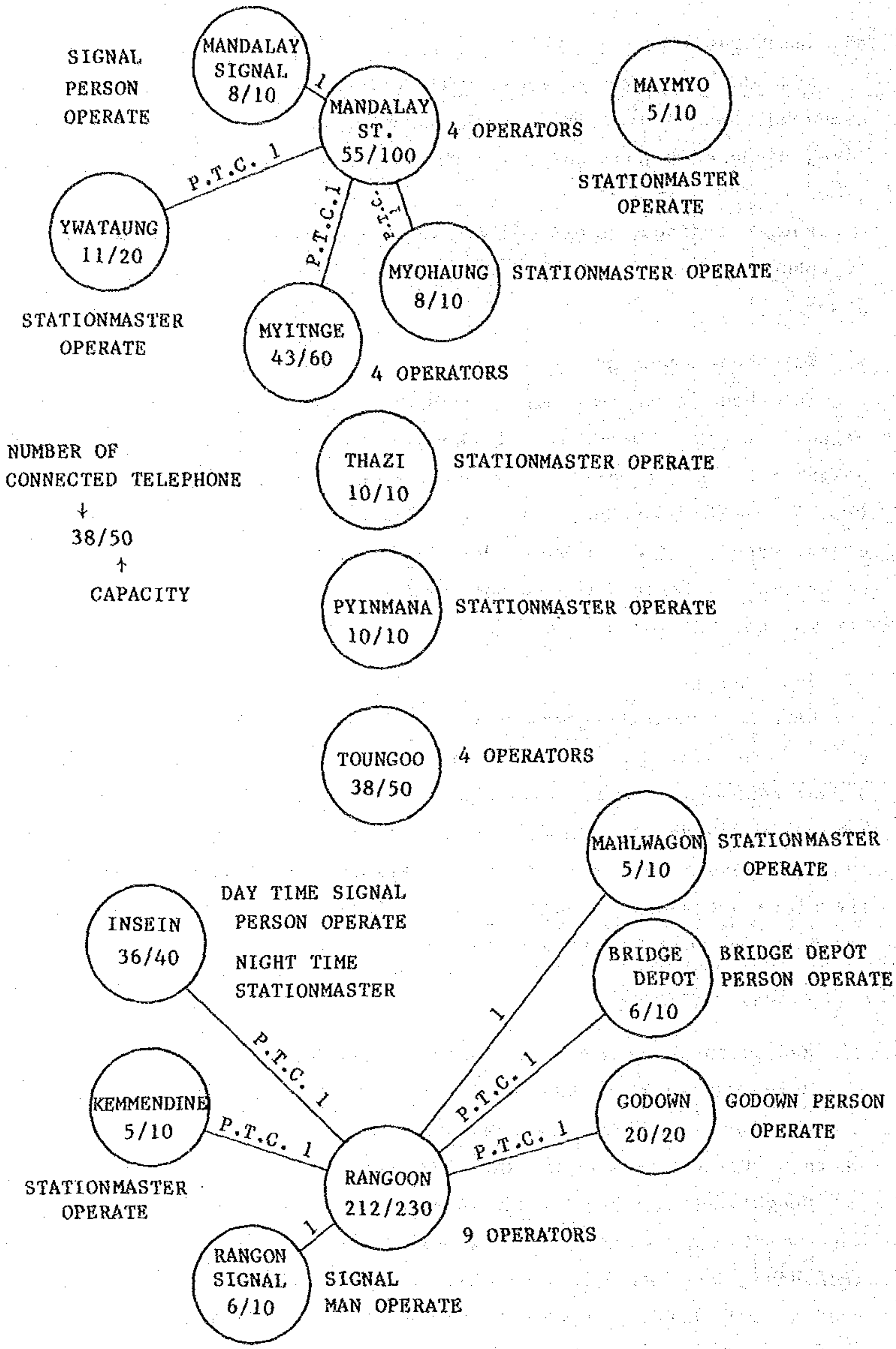


Fig. 5.5.3 BRC Exchange Network

Source: BRC

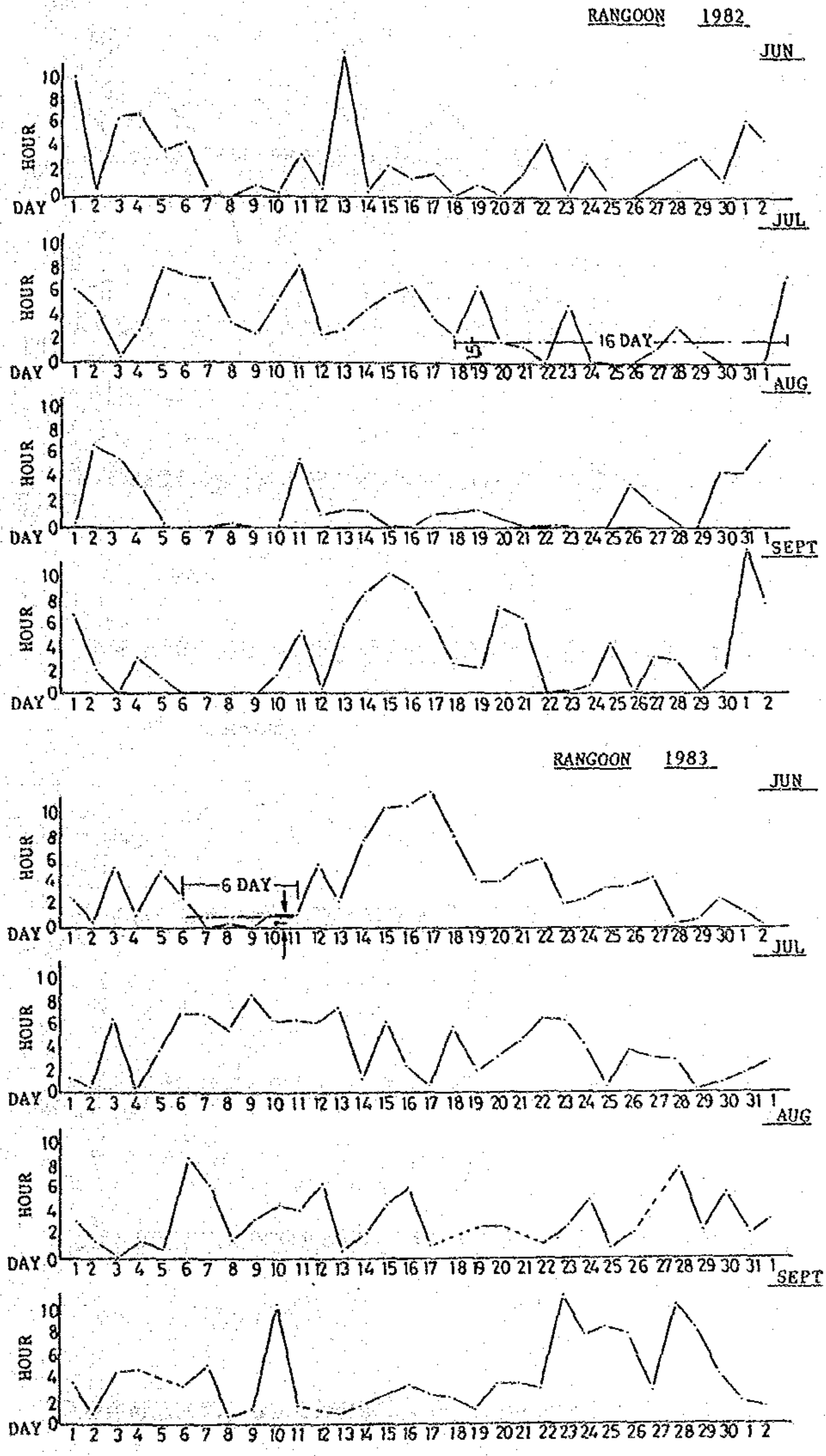


Fig. 5.5.4 Record of Sunshine Hours

Source: BRC

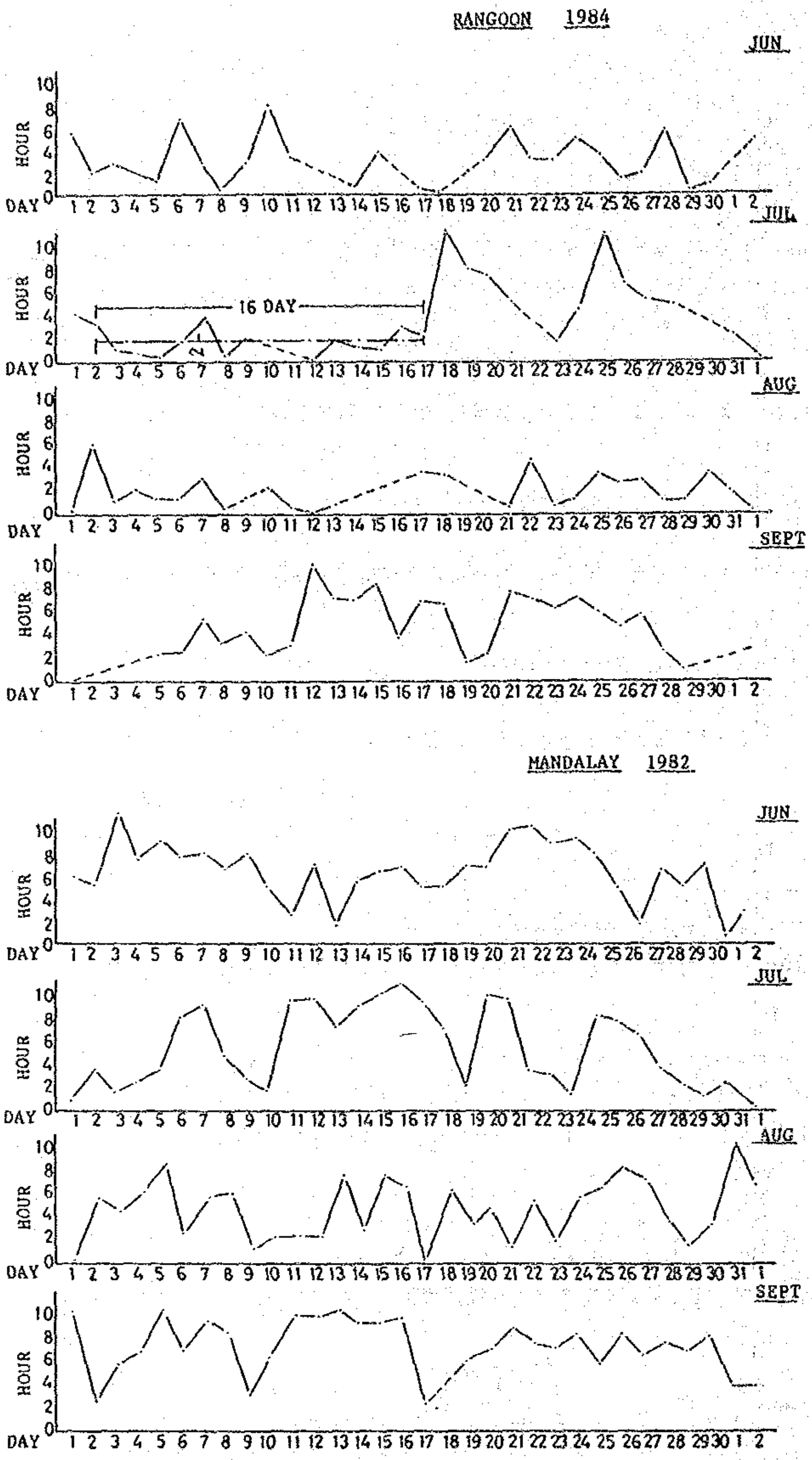
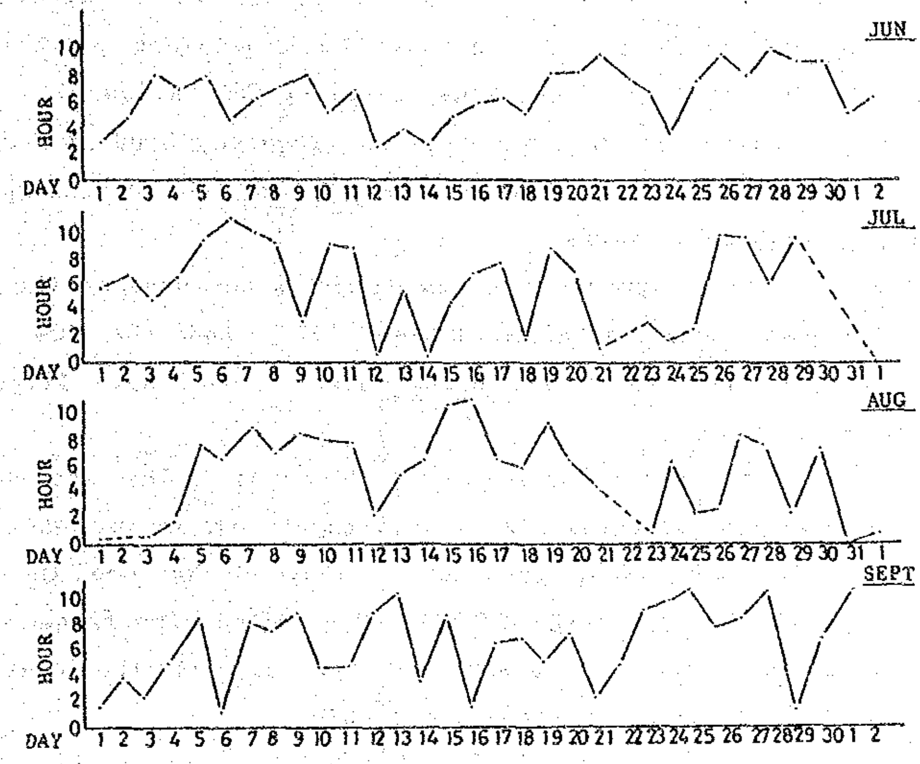


Fig. 5.5.4 Record of Sunshine Hours

Source: BRC

MANDALAY 1983



MANDALAY 1984

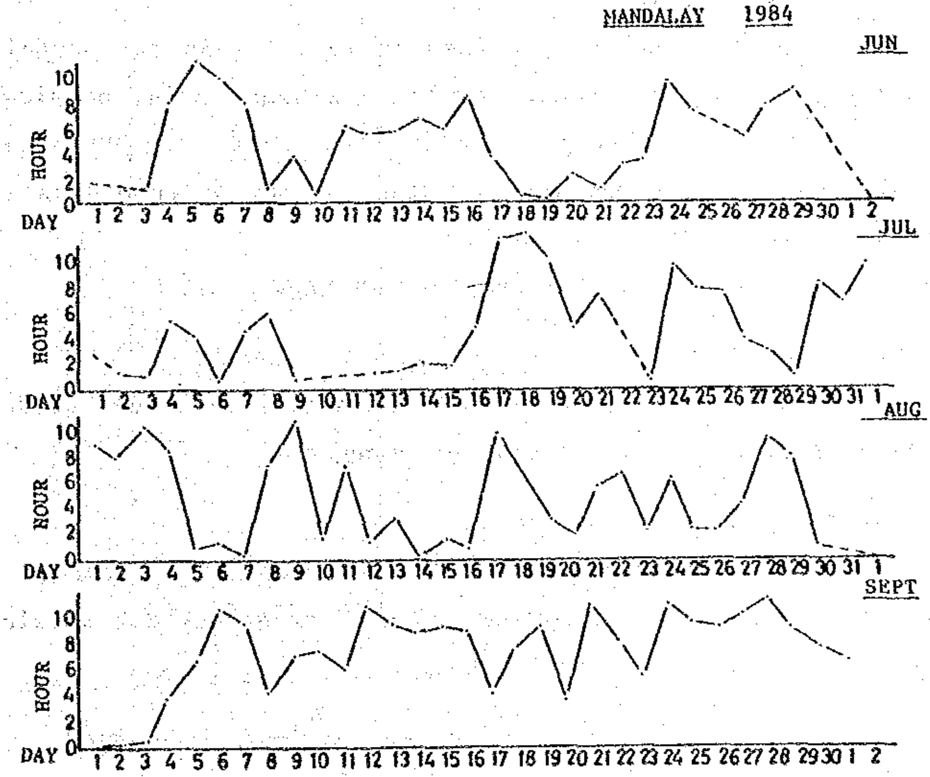


Fig. 5.5.4 Record of Sunshine Hours

Source: BRC

150w equipment is installed at 17 places in 12 stations, 100w equipment 34 places in 33 stations, 50w equipment at 102 places, including reserves, in 59 stations, totaling 68 stations.

Telecommunication in this wireless frequency band is not smooth, for it receives a disturbance from fluctuation of ionosphere and strong foreign radio waves.

Each of the equipment is overaged and deteriorated; the 150w and 100w equipment was installed before 1971, and the 50w equipment between 1957 and 1959. All, using vacuum tubes, have difficulty in replacement.

No records on the number of telephones talks are available. Monthly volume of telegram was: receiving telegrams amounted to 9867, sending telegrams, 9588, totaling 19,455, at Rangoon in December, 1985, with the daily average of 628. This means high frequency of use and it is considered necessary to replace all the overaged and deteriorated equipment as soon as possible.

The composition of the wireless network is shown in Fig. 5.5.5.

b) UHF wireless equipment

UHF wireless sets are provided at 15 stations to communicate with each other on six frequencies of 450 MHz band, using 6 relay stations for up and down railway lines between Thazi and Pyinmana on the Mandalay Line, where one wire for the control telephone is maintained poorly by PTC. The output is 25w.

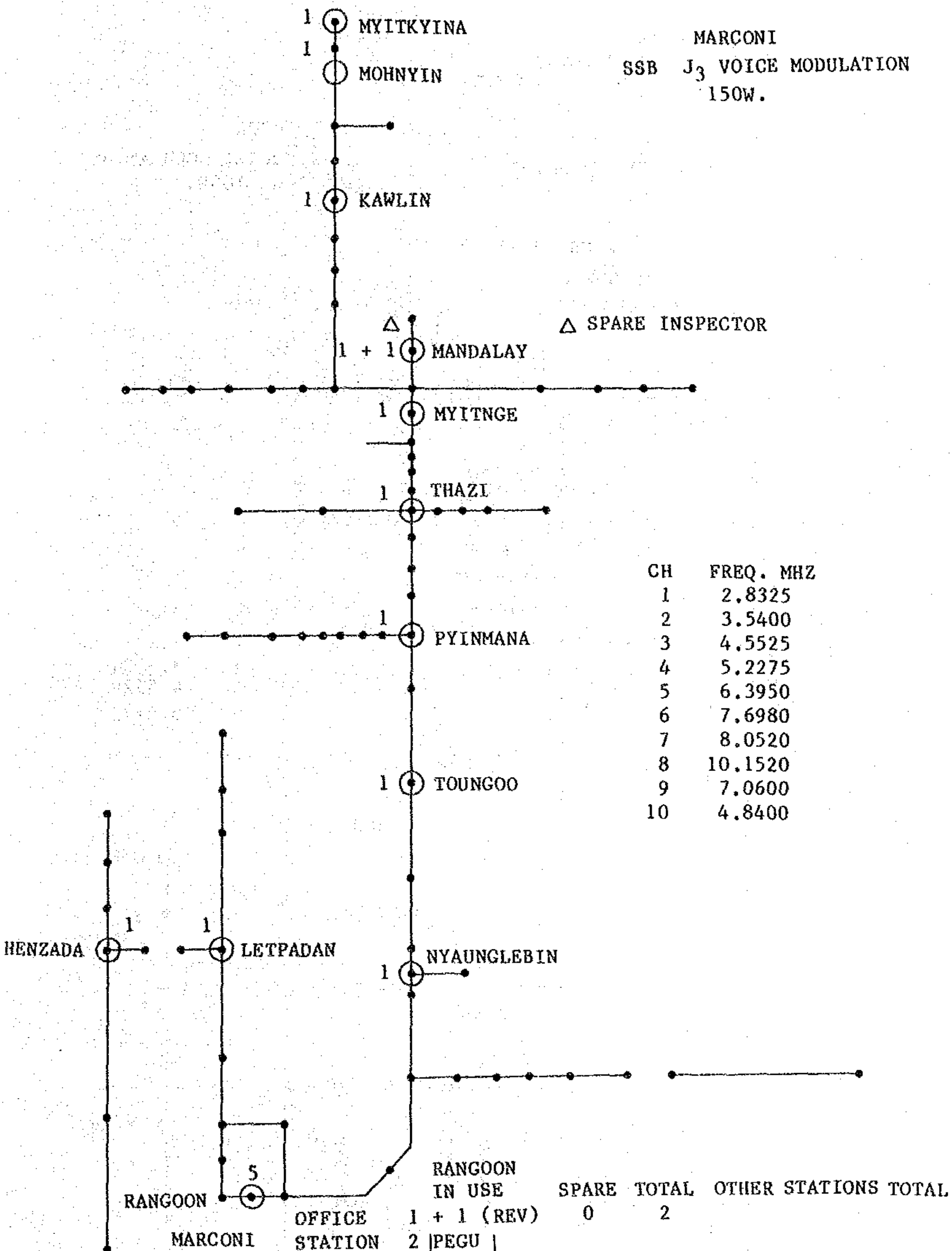
The outline of the link is shown in Fig. 5.5.6.

c) Emergency wireless set

A 2-13 MHz portable set with 6 channels is provided at Rangoon and Mandalay stations respectively for emergency.

d) Power supply for wireless set

Two sets of 10-cell alkaline battery, 12V/35AH, charger type, are used for power supply of medium and high frequency SSB wireless sets.



CH	FREQ. MHZ
1	2.8325
2	3.5400
3	4.5525
4	5.2275
5	6.3950
6	7.6980
7	8.0520
8	10.1520
9	7.0600
10	4.8400

	RANGOON IN USE	SPARE	TOTAL	OTHER STATIONS	TOTAL
OFFICE	1 + 1 (REV)	0	2		
STATION	2 PEGU PROME	1*	3		
TOTAL	4	1	5	12	17

* EMERGENCY

OTHER 2 STANDBY AT INSPECTORS

Fig. 5.5.5 BRC Wireless Network (Marconi 150w)

Source: BRC

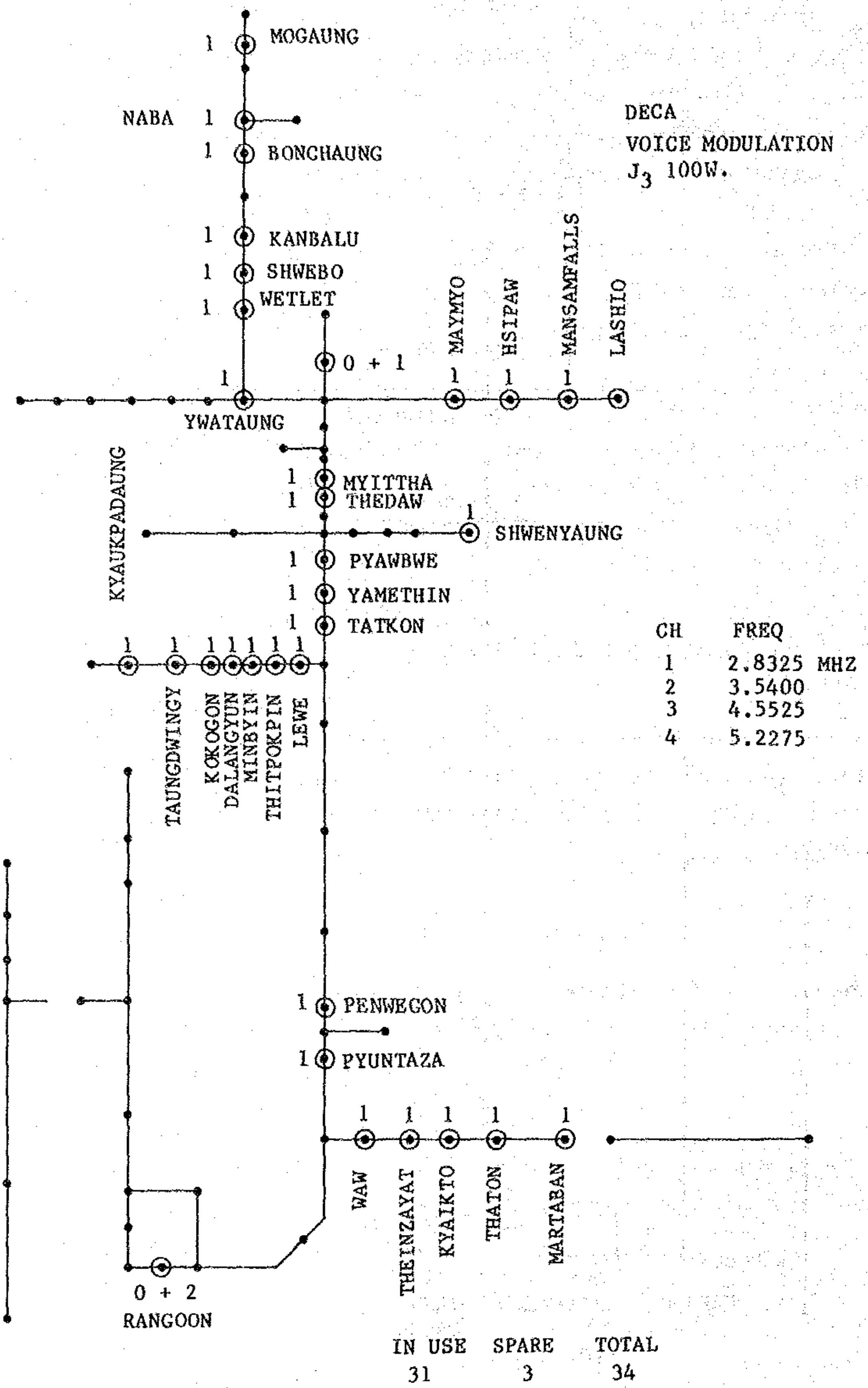


Fig. 5.5.5 BRC Wireless Network (Deca 100w)

Source: BRC

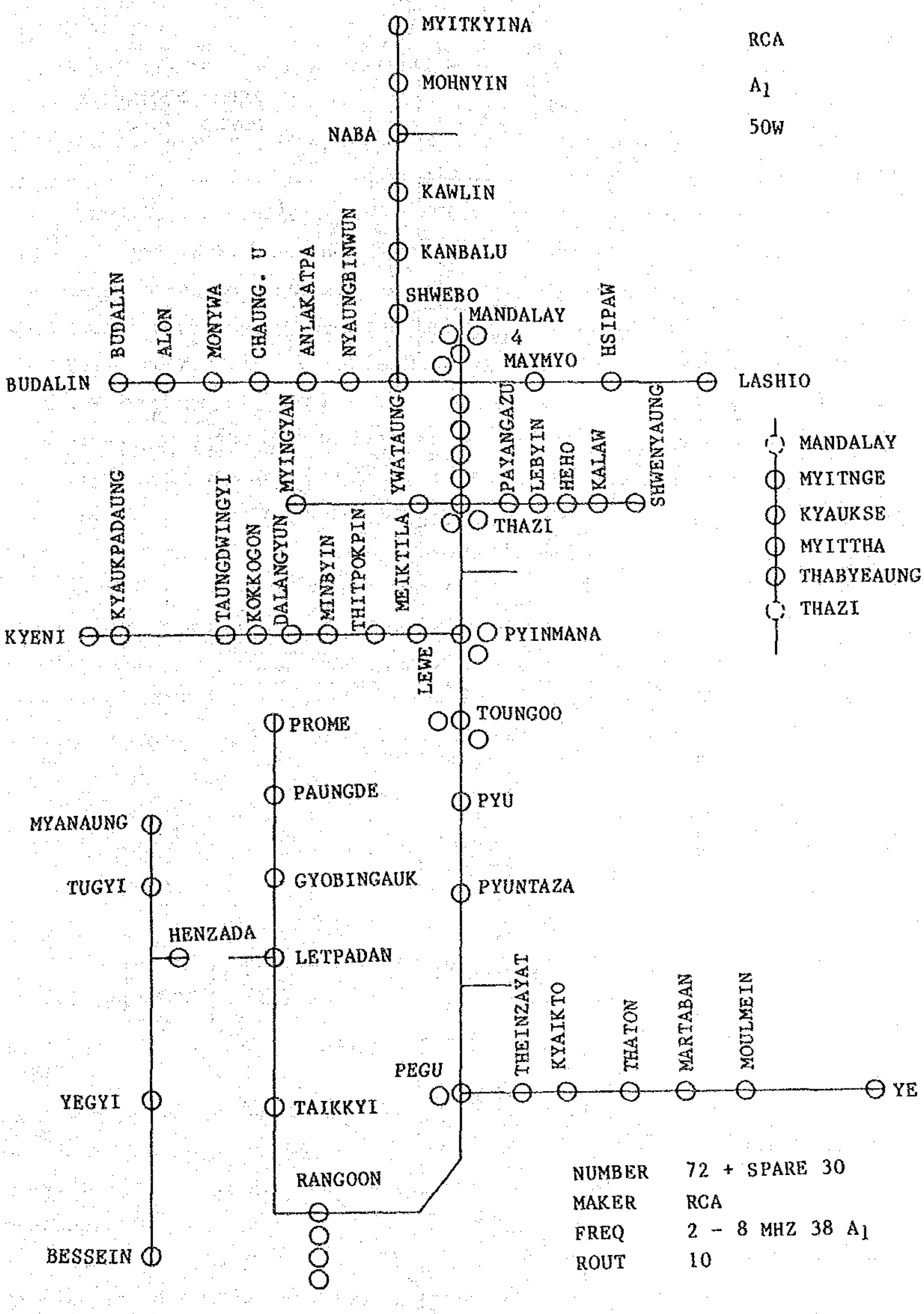


Fig. 5.5.5 BRC Wireless Network (RCA 50w)

Source: BRC

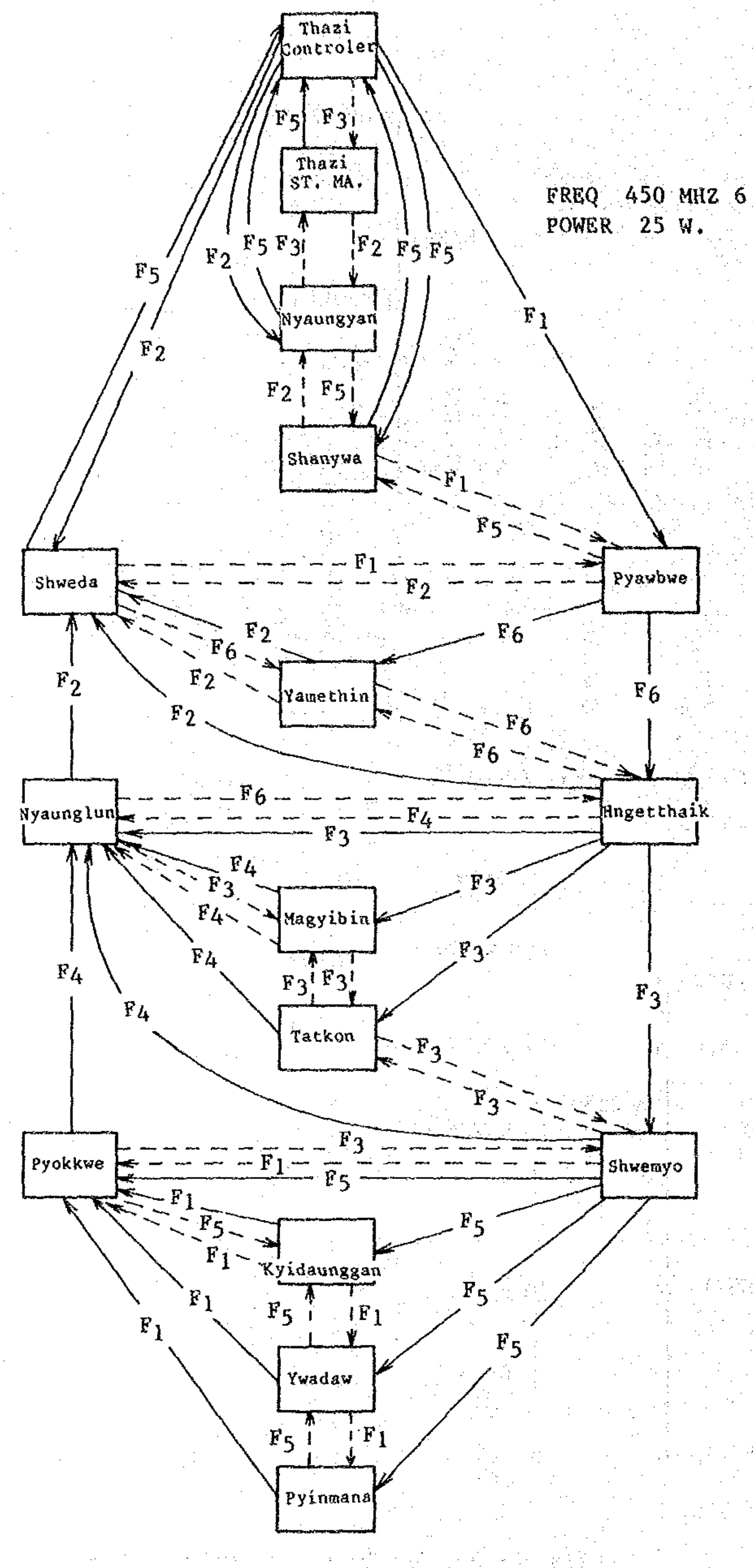


Fig. 5.5.6 Thazi-Pyinmana UHF Communication Link

Source: BRC

5-5-2 Signalling

(1) Outline

Investigation on the signalling facilities proved that most of them were installed when the railway had been first laid. The relay interlocking devices, supplied by a Japanese signal manufacturer, Kyosan Electric Co., in 1957 and installed at 30 stations, had been broken by stone-throwing or stolen in two to three years, and replaced by semaphores signals. This does not include some of the relay interlocking devices of the large attended stations of Toungoo, Pyinmana, Thazi, and Mandalay where stone-throwing or stealing had been difficult.

Those remaining relay interlocking devices are becoming deteriorated with the passage of time; it is 30 years since their installation. The mechanical interlocking devices at the other large stations, which were installed earlier, are operating with difficulty. Investigation proved that facilities were deteriorated especially in the Pegu, Pyuntaza, Myohang, and Letpadan stations, requiring immediate replacement.

Tables 5.5.2 and 5.5.3 show the existing interlocking devices and their ages. It was also found in the investigation that facility troubles are increasing every year. A certain line and section that have been repaired seem to have fewer facility troubles. This indicates that a serious accident may occur, if the trains are operated under the present facility conditions.

Table 5.5.4 shows the number of troubles by each facility on each line from 1983 through 1985. As can be seen, the number of facility troubles are increasing more on the line between Mandalay and Rangoon than on other lines. The number of facility troubles on the lines of Rangoon and Prome, and Pegu and Martaban slightly decreased in 1985 when the facilities were repaired.

Fig. 5.5.7 shows the tendency of trouble per line as well as the total.

The brake system on trains is of vacuum type. Some of the cars do not have a continuous brake system, and hence, should train separation occur during running, the separated train would not stop until the next station.

Fig. 5.5.8 shows the number of train separations. Train separation is discovered by the stationmaster who checks train ends.

Table 5.5.2 Number of Safety Equipment for Relay Interlocking Device and their Ages

Station	Installed	Passage year at 1986	Signal	Switch	Track circuit
Mandalay	1964	22	41	26	35 (AC)
Thazi	1963	23	57	32	31 (AC)
Pyinmana	1960	26	26	27	27 (AC)
Toungoo	1961	25	28	36	26 (AC)
Togyaungale	1970	16	9	14	7 (AC)
Thingangyun	"	"	10	6	15 (AC)
Malagon	"	"	11	13	23 (AC)
Pazundaung	"	"	7	12	27 (AC)
Danyingon	"	"	20	10	11 (AC)

Note: AC means alternating current

Source: BRC

Table 5.5.3 Number of Safety Equipment for Electric and Mechanical Interlocking Device and their Ages

Station	Installed	Passage year at 1986	Signal	Switch	Track circuit	Remarks
Pegu	1940	46	20	55	4 (DC)	Mechanical
Pyuntaza	1950	36	14	45	-	--- do ---
Rangoon	1950	36	21	68	70 (AC)	Electro Mechanical
Myohaung	1967	19	17	19	22 (AC)	Relay and Mechanical
Letpadan	1940	46	12	37	-	Mechanical
Thaton	1940	46	4	8	-	Key Interlocking
Martaban	"	46	2	7	-	--- do ---
Myitkyina	1945	41	2	6	-	Non Key Interlocking
Kawlin	1945	41	4	6	-	--- do ---
Prome	1940	46	2	11	-	Key Interlocking
Hlawga	1940	46	4	8	-	--- do ---

Note: DC means direct current

Source: BRC

Table 5.5.4 Number of Troubles on Signalling Facilities

No.	Section / Equipment	Block				Signal				Track Circuit			
	Year	83	84	85	Total	83	84	85	Total	83	84	85	Total
1	Rangoon - Mandalay	46	48	51	145	87	64	185	336	37	58	65	160
2	Rangoon - Prome	3	9	11	23	12	10	16	38	5	7	5	17
3	Pegu - Martaban	8	11	5	24	5	7	2	14	-	-	-	-
4	Mandalay - Myitkyina	15	7	11	33	6	6	2	14	1	5	-	6
5	Other	18	13	30	61	17	33	41	91	16	10	7	33
	Total	90	88	108	286	127	120	246	493	59	80	77	216

No.	Section / Equipment	Point Machine				Interlocking				Grand Total			
	Year	83	84	85	Total	83	84	85	Total	83	84	85	Total
1	Rangoon - Mandalay	54	57	109	220	6	3	5	14	227	222	413	86
2	Rangoon - Prome	5	6	2	13	4	9	6	19	28	40	38	10
3	Pegu - Martaban	1	2	-	3	2	1	-	3	15	21	4	4
4	Mandalay - Myitkyina	-	2	-	2	-	-	-	-	16	11	8	3
5	Other	24	20	37	81	-	-	-	-	69	70	113	25
	Total	84	87	148	319	12	13	11	36	355	384	576	141

Source: BRC

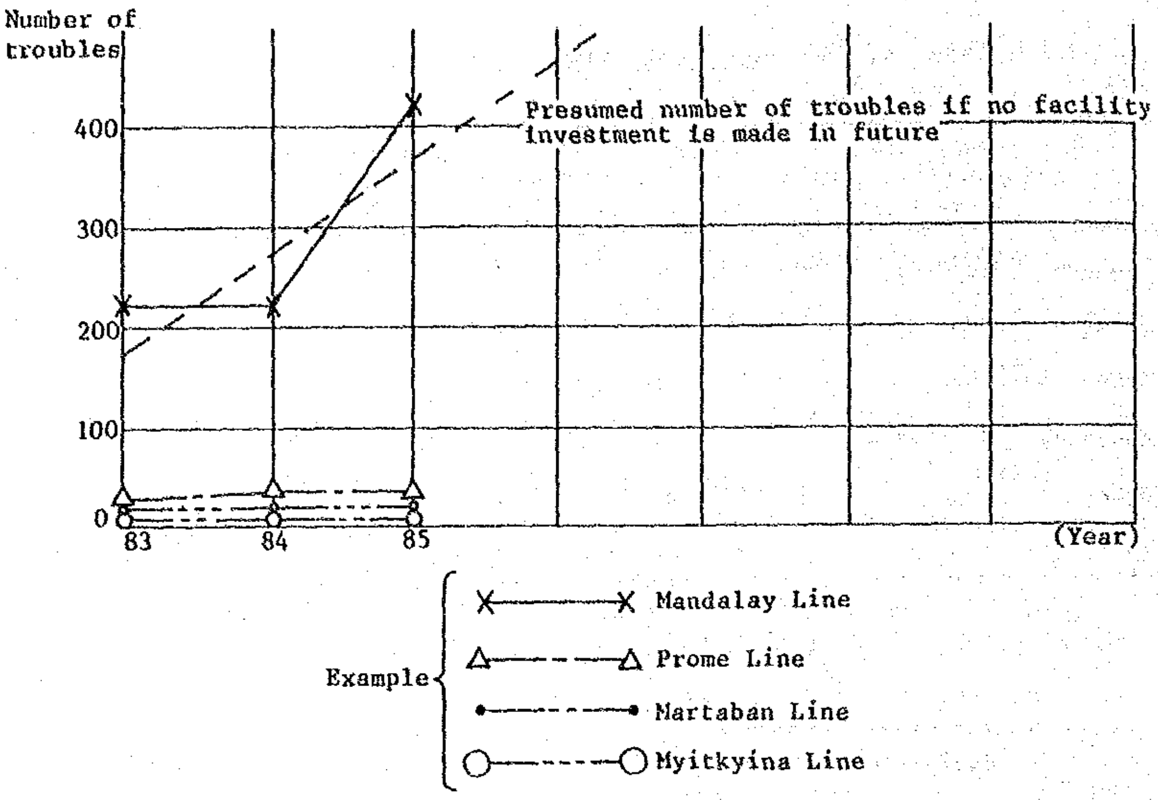


Fig. 5.5.7 Tendency of Trouble per Line

Source: BRC

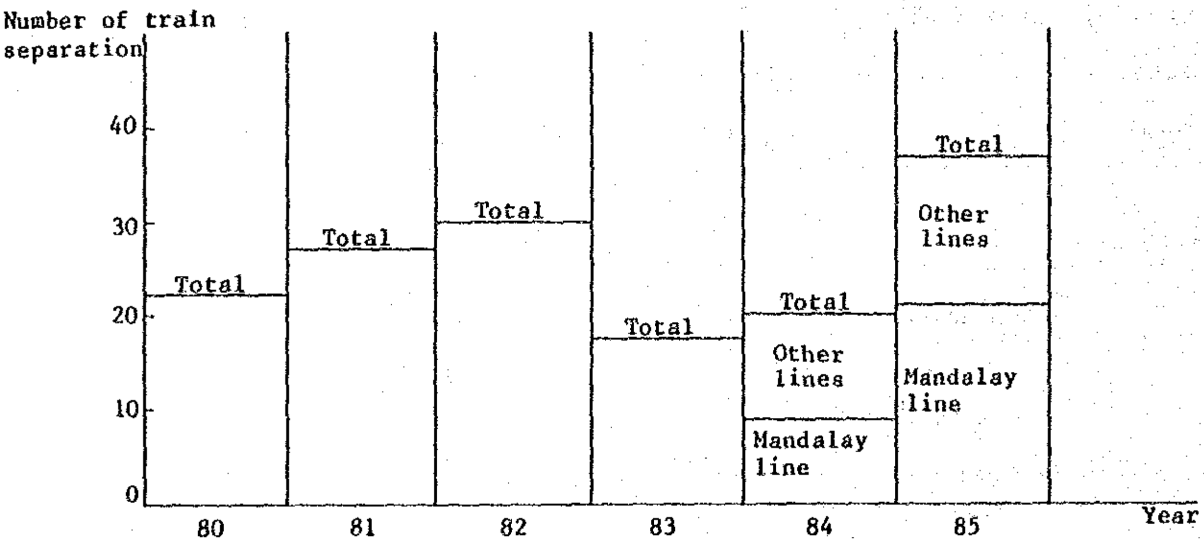


Fig. 5.5.8 Number of Train Separation

Source: BRC

(2) Present status

1) Block device

Block devices are used to ensure the safety of train operation. However, the fact is that they are not used on most lines due to defective telecommunications networks.

When the railway was first laid, a tokenless block system was adopted for the double-track sections between Rangoon and Pegu, and a token block system on the single-track sections between Pegu and Mandalay. As construction of the double-track sections proceeded from Pegu through Toungoo to Pyinmana, the token block system became useless. Between Pegu and Toungoo it was replaced by a paper line-clear ticket system in the 1960s. When double-track sections reached Pyinmana, a paper line-clear ticket system was adopted between Pegu and Pyinmana in the 1970s. The tokenless block system from Pegu to Pyinmana was unobtainable due to the shortage of materials at that time. The token block system between Pyinmana and Mandalay was replaced by a paper line-clear ticket system due to a defective telecommunications network.

As Fig. 5.5.9 shows, the paper line-clear ticket system is used between Pegu and Mandalay and between Mandalay and Myitkyina at present. Approximately 50 to 60 percent of the token block system between Pegu and Martaban, and Danyingon and Prome, was replaced with paper line-clear ticket systems due to telecommunications network trouble.

Thus, the paper line-clear ticket system, which relies on man's attentiveness, is used for train operation safety on 70 percent of four lines (1100 km out of approximately 1600 km) in BRC. Of the token block system, approximately 35 percent are being replaced by the paper line-clear ticket system due to telecommunications network trouble, etc.

2) Interlocking system

The interlocking system on the four lines is basically divided into six groups: the relay interlocking, used at 10 stations, electric interlocking, electro-mechanical interlocking, mechanical interlocking, key interlocking, and no interlocking at some stations. Fig. 5.5.10 shows the stations utilizing an interlock system.

The results of investigations show that on the four lines the relay interlocking is operated at nine stations.

Note: On the sections with no indication, paper line-clear ticket system or engine block system is used

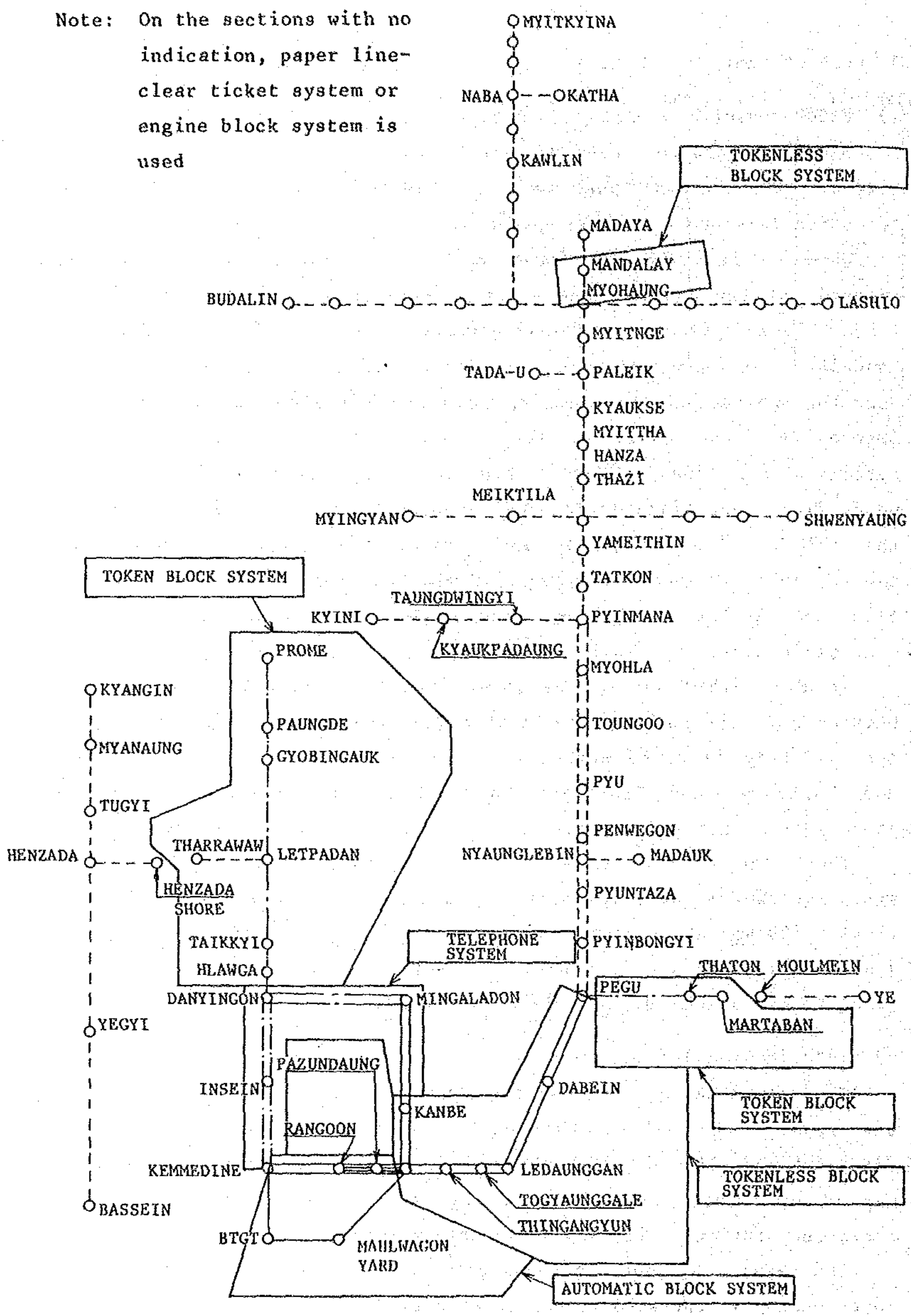


Fig. 5.5.9 Block System

Source: BRC

Note:
Ⓐ Relay Interlocking
Ⓑ Electric Interlocking
Ⓒ Electro-Mechanical Interlocking
Ⓓ Mechanical Interlocking
Other stations: Key Interlocking or without Key Interlocking station switch ▭,

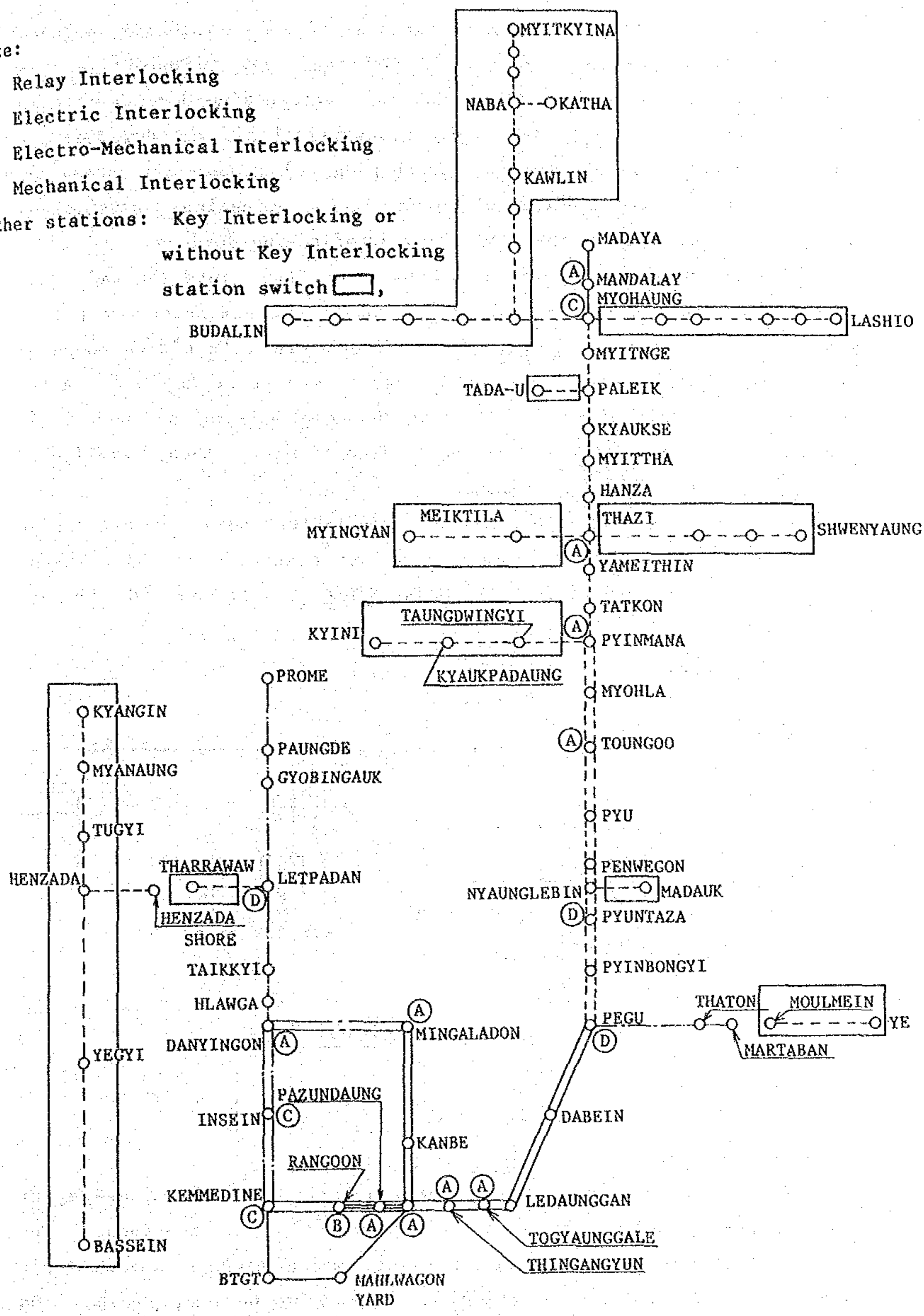


Fig. 5.5.10 Interlocking System

Source: BRC

The electric interlocking at Rangoon station is not being improved at this time, as its partial improvement is included in the electrification programme. The mechanical interlocking devices at main stations are considerably deteriorated, especially in the detector bar rod for proper switch movement, which has led to malfunction of switching due to the failure of locking. The mechanical interlocking devices will be replaced with the relay interlocking devices.

The intermediate stations adopts the key interlocking that interlocks with the signal. In this system, the stationmaster puts a master key in a key box located in the stationmaster's office to get a point key. Then, he puts that point key in the point key box. After locking, he takes a different key from the point key box and puts it in the signal key box so the signal can be free to work. These complicated procedures require about 15 minutes.

Furthermore, in order to cover the insufficient point key locking at the facing points, the train is driven into a station at a low speed, and a key bolt is used to lock the point. Fig. 5.5.11 shows the key box and related parts.

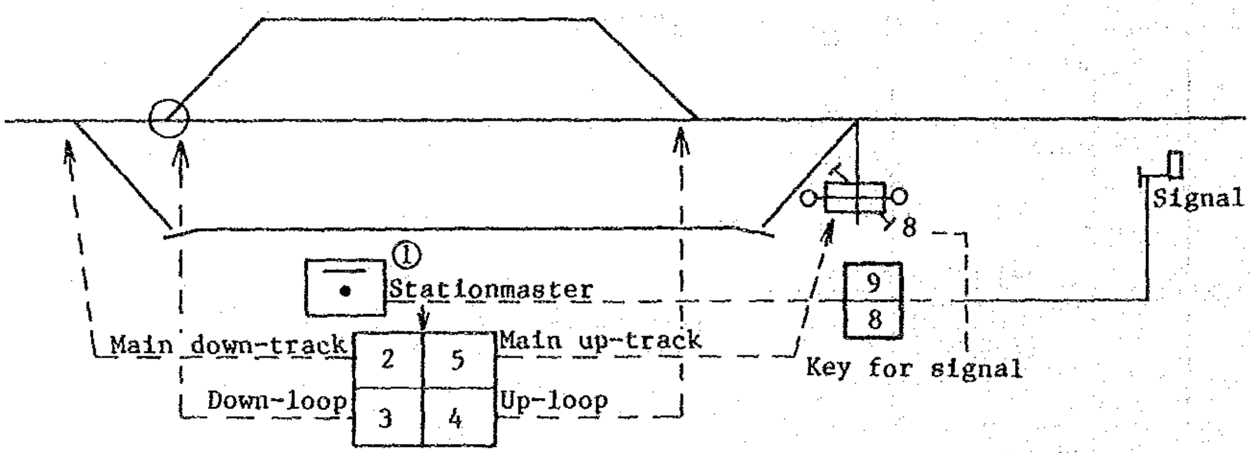


Fig. 5.5.11 Key Box and Related Parts

Source: BRC

3) Signal system

Most of the stations with a relay interlocking device use color light signals, while semaphores are used at other stations. The semaphore cannot be seen well at night, which hinders smooth train operation. Except some stations on the line between Rangoon and Mandalay which have electric semaphores with hand generators, the semaphores are all controlled by wire. In most stations with a semaphore, the stationmaster, instead of a starting signal, controls the starting of trains. The distant signals offsets the poor visibility of a semaphore of a home signal. Among the wire and electric bare wire control of distant signal, the latter is being little utilized due to control wire being stolen, thus limiting train speed considerably.

Fig. 5.5.12 shows signal system of all lines.

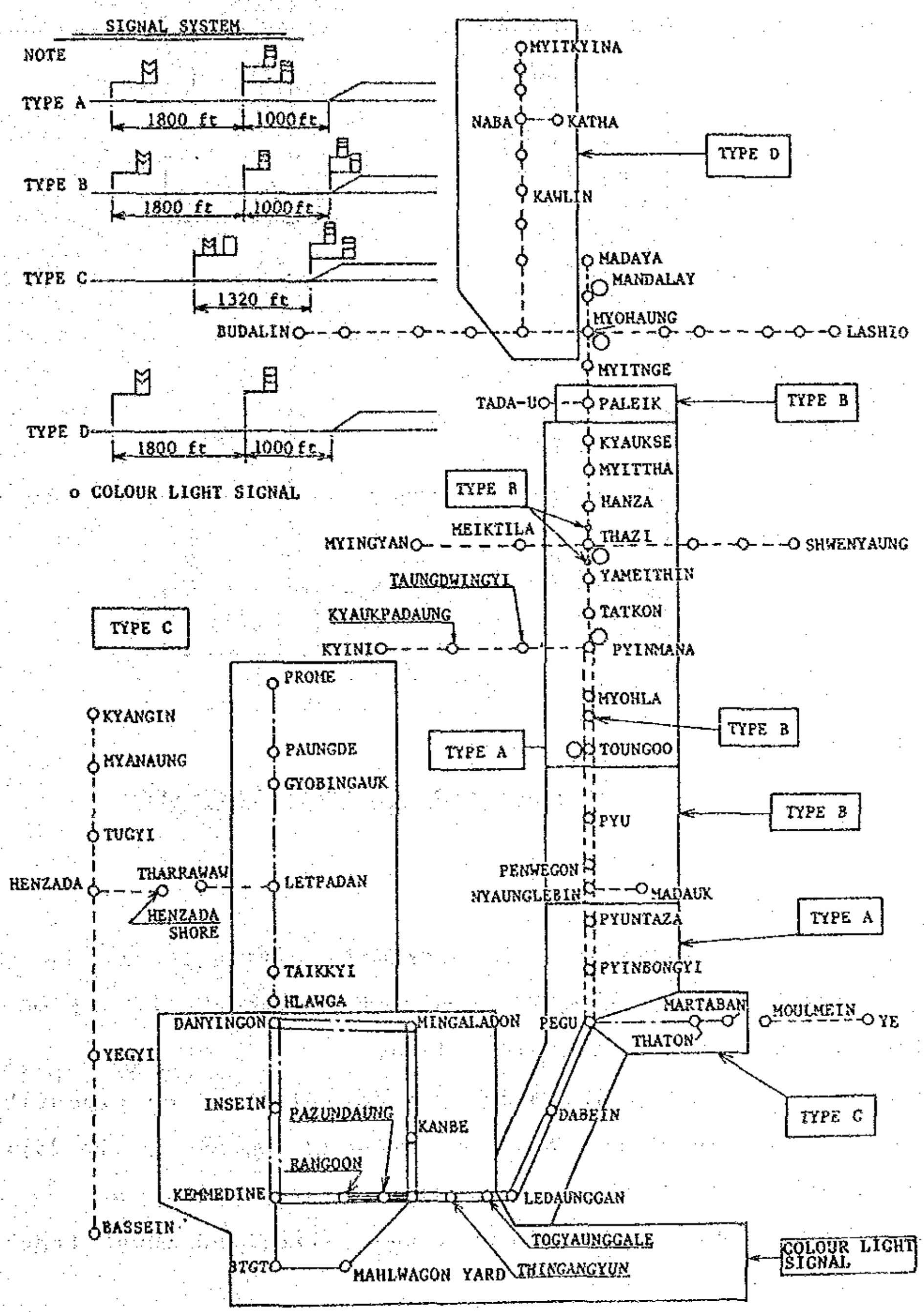


Fig. 5.5.12 Signal System

Source: BRC

4) Track circuit

Both direct current and alternating current systems are used in the track circuits as shown in Fig. 5.5.13.

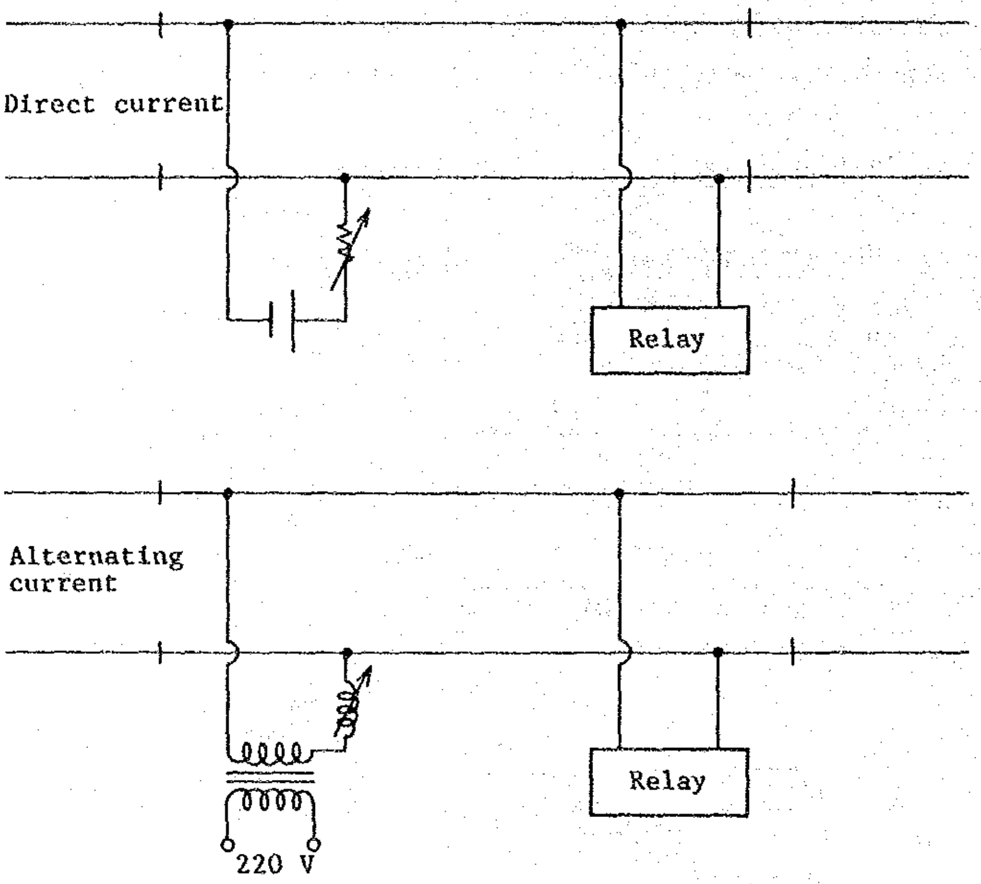


Fig. 5.5.13 Composition of Track Circuits

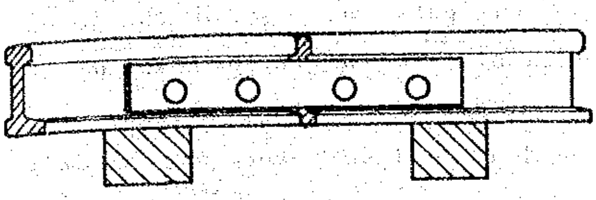
Source: BRC

Track circuit adjustment is extremely difficult due to the track being flooded during the rainy season. The short life of wooden rail insulators causes track circuit failure.

The rail insulators are made of wood, plastic, or glassfibre. The life of wooden insulators, which are made of bamboo or the like, is one or two months, while that of glassfibre is as long as six or seven years. The wooden insulator has a short life and makes track circuit maintenance hard.

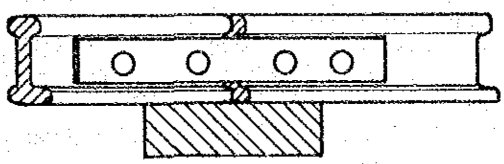
The track circuit structure will be also studied in order to extend its life. Fig. 5.5.14 illustrates the position of the existing sleeper and an improvement plan.

Existing Insulated Rail Joint

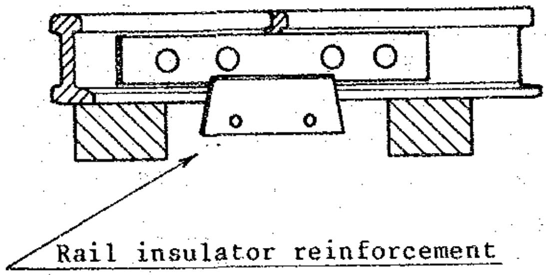


Improved Insulated Rail Joint

1. Position change of sleeper



2. Setting of rail insulator reinforcement



3. Introduction of glued insulated joint

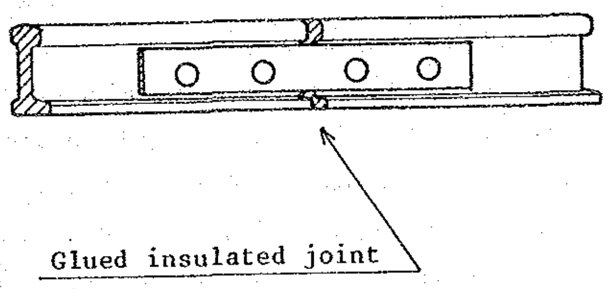


Fig. 5.5.14 Improvement of Insulated Rail Joint

Source: Study Team

5) Level crossing alarm

None of the four lines have level crossing alarm, so trains passing a level crossing have to decelerate. The gates of most of the level crossings are manually opened and closed. At the three stations of Toungoo, Thazi, and Mandalay, level crossing alarms have already been installed. Table 5.5.5 shows the number of level crossings on main roads.

Table 5.5.5 Number of Level Crossings by Line

Section	Rangoon - Mandalay	Pegu - Martaban	Rangoon - Prome	Myohaung - Myitkyina	Note
Between Stations	17 (10)	4 (2)	5 (3)	1 (1)	
In the Station	28 (11)	1 (1)	8 (2)	-	() Main Road Crossing
Total	45 (21)	5 (3)	13 (5)	1 (1)	

Source: BRC

(3) Maintenance

For maintenance of telecommunication and signalling, the whole railway is split into eight divisions, with the main stations being staffed as shown in Table 5.5.6. Each division is further divided into signalling and wireless, and other divisions would give assistance in case of trouble for system recovery. At the main stations, the maintenance work system operates in shifts of 24 hours, while daytime operation is adopted at ordinary stations and system recovery at night is on call.

At intermediate stations, an assistant inspector and a skilled laborer make the rounds of five stations in five days for checking. An inspector carries out maintenance work together with an assistant inspector and a skilled labourer once a month. Fig. 5.5.15 shows the division area of the maintenance work.

Table 5.5.6 Administration and Maintenance Staff of Signal & Telecommunication Department

	Division	Station	Inspector			Assistant Inspector			Skilled Labourer			Unskilled Labourer		
			S	W	T	S	W	T	S	W	T	S	W	T
1	Mohnyin	Mohnyin				1	1	2	2		2	4		4
2	Ywataung	Indaw				1		1	1	1	2	4		4
		Kanbalu					1	1		1	1			
		Ywataung	1		1	1		1	12		12	10		10
3	Mandalay	Kyaukme				1		1	2		2	2		2
		Maymyo				1		1	3		3	3		3
		Mandalay	1	1	2	1	1	2	21	8	29	15	5	21
		Myitnge				1		1	6		6	3		3
		Thazi	1		1	2	2	4	15	1	16	22	1	23
4	Toungoo	Ywmethin				1		1	6		6	4		4
		Pyinmana				1	1	2	10	2	12	10	1	11
		Toungoo	1		1	2	1	3	18	1	19	14	1	15
5	Pegu	Pyuntaza				1		1	9		9	7		7
		Pegu	1		1	1		1	12		12	11		11
		Paungde				1		1	3		3	2		2
		Letpadan	1		1	1	1	2	11		11	10	1	11
6	Rangoon	Rangoon	2	2	4	5	4	9	86	13	99	51	7	58
7	Thaton	Thaton	1		1	1	1	2	12	2	14	11		11
8	Henzada	Henzada				1		1	7		7	4		4
	TOTAL		9	3	12	24	13	37	236	29	265	186	17	203

S: Signalling
W: Wireless
T: Total

Remark	
Office Member	
Division Engineer	1
Jun. Division Engineer	1
Assistant Engineer	2
Office Staff	21
Study Assistant	5
Total	30
Office Member	30
Inspector	12
Assistant Inspector	37
Skilled Labourer	265
Unskilled Labourer	203
Grand Total	547

Source: BRC

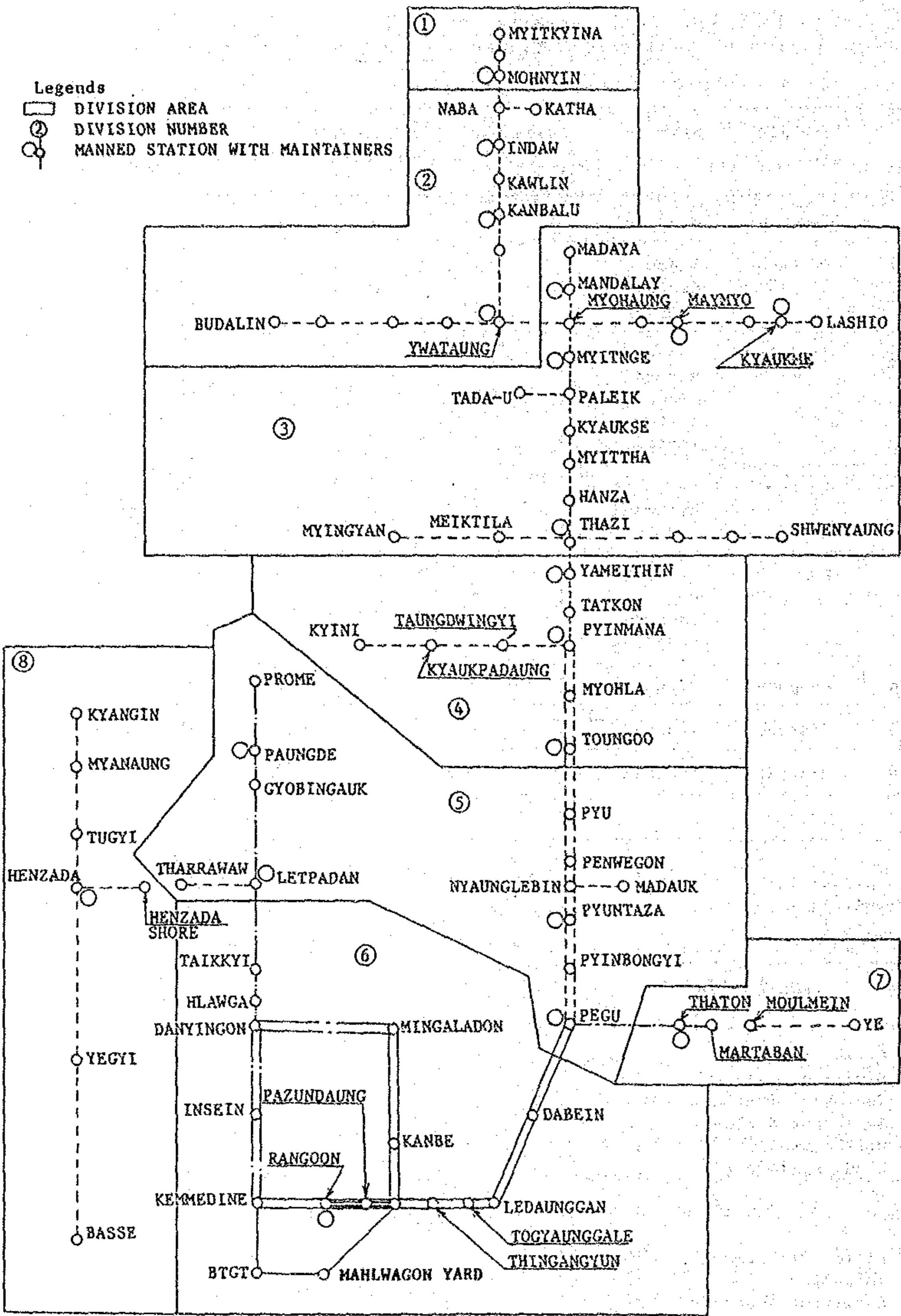


Fig. 5.5.15 Division Area (Signalling and Telecommunication)

Source: BRC

(4) Power supply

The power supply to each station on the four lines are extremely poor as shown in Table 5.5.7.

Table 5.5.7 Number of Stations with and without Power Supply

Classification	Mandalay Line	Martaban Line	Prome Line	Myitkyina Line
With Power Supply	56 (68.3)	1 (5.4)	21 (80.7)	13 (25.5)
Supply at night only	-	9 (47.3)	-	5 (9.1)
No Supply	26 (31.7)	9 (47.3)	5 (19.3)	32 (62.7)
E-G Generator	-	-	-	1 (2.7)
Total	82 (100)	19 (100)	26 (100)	51 (100)

Note: ( ) indicates percentage to the total number of stations on each line.

Source: BRC

Table 5.5.8 shows the number of power stoppage at main stations in one year.

Table 5.5.8 Number of Power Stoppage

Station	No. of power stoppage	EG
Rangoon	705	25 KV
Pazundung	545	
Insein	13	
Mahlwagon	54	
Togyaunggale	246	
Thazi	133	10 KV
Pyinmana	38	10 KV
Mandalay	11	
Toungoo	31	
Danyingon	18	
Thingangyun	369	
Kemmendine	13	
Myohaung	6	10 KV

Note: EG-Main stations are equipped with an engine generator.
Source: BRC

5-6 PC Sleeper Manufacturing and Rail Welding

5-6-1 PC Sleeper Manufacturing

PC Sleepers are manufactured only at BRC Bridge Girder Depot which is located at Mahlwagon, 4 km (M 2.5) North-East of Rangoon Station. At this Depot the prestressed Railway Bridges of maximum 18.3 m (66') span, are also manufactured since 1977. The function of the Depot is as follows:

(1) Manufacturing of prestressed concrete griders
(2) Manufacturing of prestressed concrete sleepers
(3) Fabrication of steel girders and trusses
(4) Mechanized maintenance of track
(5) Thermit welding
(6) Tube well drilling and watering arrangement
(7) Inspection and maintenance of major bridges

The number of staff and workers in the Depot are as follows:

Engineers and Supervisory Staff	=	12 persons
Office Staff	=	10 "
Skilled and unskilled workers for concrete bridge and sleeper	=	70 "
For others	=	226
Total		358 persons

5-6-2 Facilities for PC Sleeper Manufacturing

System = Pre-Tension Prestressed Concrete

Capacity = 400 sleepers per week
(There is an expansion plan of the Depot to increase the production of sleeper to 800 per week.)

Facility = Concrete Laboratory

Concrete mixer	18 Cft	=	2
Steel form		=	300
Form vibrator		=	2
Jack (pre-tension)	6 Ton	=	2
Overhead crane		=	1
Crushing plant		=	1
Curing pond		=	1

5-6-3 Manufacturing of PC Sleeper

The dimension of sleeper and its concrete proportion are listed in Table 5.6.1. The concrete sleeper casting bed has eight pre-tensioning lines. PC wires are pre-tensioned for 25 forms of sleeper by 6 ton Jack. And 12 concrete test pieces are moulded per 100 sleepers. These pieces are tested on the 3rd day, 7th day, 21st day and 28th day.

5-6-4 Rail Welding

Rail joint is the weakest part of the track. Lesser number of rail-joints results in low cost of maintenance, less number of fish-plates, decrease in wear and tear of the vehicle, and subsequently leads to smooth running of trains and comfort to passengers. BRC is experimentally using the Thermit welding method and its applied locations are limited as follows:

- a part of main line in the Rangoon Station Yard
- a part of main line in the Mandalay Station Yard
- a part of main line between Rangoon and Mandalay

Length of welded rails is 11.89 m (39') x 3 or 11.89 m (39') x 6. Since the mixture of the Thermit welding has to be imported, BRC has a plan to introduce Gas Pressure Welding, the materials of which are provided by local products.

Table 5.6.1 General Information on PC Sleeper Manufactured at the Bridge Girder Depot.

1. Dimension

Unit Weight	:	136	kg
Concrete Volume	:	0.056	m^3
Reinforcing Bar	:	0.9	kg
PC Wire	:	5	kg

2. Design Concrete Strength

At Transfer	=	4,100 lbs/in^2 = 288 kg/cm^2
After 28 days	=	6,500 lbs/in^2 = 455 kg/cm^2

3. Production

Capacity	=	400 pieces/week
Average Actual	=	300 pieces/week

4. Standard of Materials

Cement	=	BS
Reinforcing Bar	=	ASTM or JIS G 3532
PC Wire	=	ASTM or JIS G 3536

5. Concrete Proportion (per 18/12 ft^3)

Cement	=	50	kg
Water	=	20	kg
Sand	=	62.5	kg
Coarse Aggregate	=	125	kg
Admixture	=	120	cc

6. Work Schedule

Preparation Form Reinforcing Bar Arrangement Pre-stressing	1 day
Concrete Placing Curing Dismantle of Form Cut of Wire	3 days
Curing Store	7 days

7. Material Cost (per sleeper)

Cement	17.70	kyats
Sand	1.28	"
Coarse Aggregate	3.88	"
Admixture	1.27	"
Reinforcing Bar	4.63	"
PC Wire	33.15	"
	61.91	"

8. Electric Power Charge

0.15 - 0.37 kyats/Kw.H

9. Labour Cost (Present manufacturing)

	Salary	Number
Pre-stressing Worker A	220 (kyats/in)	1
" B	180	1
Common Worker	180	60
Bar Arrangement	180	88
Form	220	2
Concrete Mix	180	2
Mechanics	290	1
Skilled Worker	290	1
Driver (Forklift)	290	1
" (Crane)	290	1
" (Mixer)	220	1

5-7 *Related Railway Projects*

At this moment six related railway projects are being implemented or planned: five mainly by BRC and one by an outside body. Each of them is considerably related with the present facility improvement plan, though the progress stages for these related projects differ from implementation schedule of the facility improvement plan. The PTC microwave network project is not being handled by BRC, but it is also related to the plan.

Full coordination of the related projects will be made for establishing the facility improvement plans under the study. An outline of each project is as follows:

5-7-1 Track Improvement Plan

BRC has a plan to improve the track by replacing rails for the main lines with new rails and fittings purchased under an OECF commodity loan:

a) New head-hardened rail, B.S. 75R — 15,600 metric tons
b) Insulated fish plate for B.S. 75R — 1,000 pairs
c) Railway points and crossing 1 in 12, B.S. 75R — 55 sets
d) Fish plate, B.S. 75R — 50,000 pairs
e) Fish bolts and nuts, B.S. 75R — 220,000 Nos.
f) Sleeper screw spikes — 1,600,000 Nos.

Delivery of rails and fittings is expected in July, 1986, and they will be used on the Rangoon - Pegu main line and Rangoon Circular line. The implementation schedule will start in 1986-87.

The section on the main line is included in the study. So it will be necessary to coordinate BRC's track improvement plan with a facility improvement plan of track with respect to the facility level and safety standards.

5-7-2 Rolling Stock Modernization Plan

BRC has a programme to carry out the rolling stock modernization plan based on the following policy:

- To increase transport capability to meet demand by introducing new locomotives, passenger coaches, and wagons.
- To acquire advanced technology by performing heavy knock-down of locomotives, passenger coaches, and wagons.

The modernization plan includes:

a) OECF Loan

- Stage I		
Locomotive, 500 H.P.	7 (Qty.)	1987
Passenger coaches	71	1989
Wagons	100	1989
- Stage II		
Locommotive, 500 H.P.	5	Tender preparation
Passenger coaches	72	Tender preparation
Wagons	140	Tender preparation

b) French Loan

Locomotive, 2000 H.P.	15	1988

c) Federal Republic of Germany Loan

Locomotive, 1,200 H.P.	8	1987
Locomotive, 900 H.P.	11	1987

d) Yugoslavia Loan

Wagons	436	1987

5-7-3 Circular Line Electrification Project

The feasibility study on electrification of the Rangoon circular railway line was completed in March, 1985, which covers 67 km (42 miles) on the circular line and the suburban line up to Ywathagyi. The implementation schedule is not yet fixed. BRC has no plan at this moment to electrify beyond Ywathagyi, but, the facility improvement plan will be coordinated with cost estimated on the assumption that the section overlapping with the electrification project will be deleted.

The lines to be electrified are shown in Fig. 5.7.1.

5-7-4 Track Doubling Plan from Pyinmana to Mandalay

The section of the Mandalay line from Rangoon to Pyinmana has a double-track and the rest a single-track. The track capacity of the line is enough for present train operation requirement. However, traffic demand is expected to rise in the future, due to the line playing the role of a major means of transport in the country.

Taking this situation into account, BRC has a plan to build another track between Pyinmana and Mandalay to meet the increase in traffic demand. The plan is now in the design stage, and its implementation schedule is not yet fixed.

5-7-5 Expansion Plan of PC Sleeper Manufacturing

PC sleepers have been manufactured at the Bridge Girder Depot since 1977 to fulfill the good quality requirements of sleepers and to introduce modern track construction methods. PC sleepers are now used on the Rangoon Circular line and Rangoon - Pegu main line. The production capacity is not meeting the requirements. Therefore, it is planned to increase sleeper production at this depot. The expansion plan is now in the design stage to meet the target of 800 sleepers per week.

Production capacity of PC sleepers is the key to track improvement, and therefore, the facility improvement plan will include it, fully taking this into consideration.

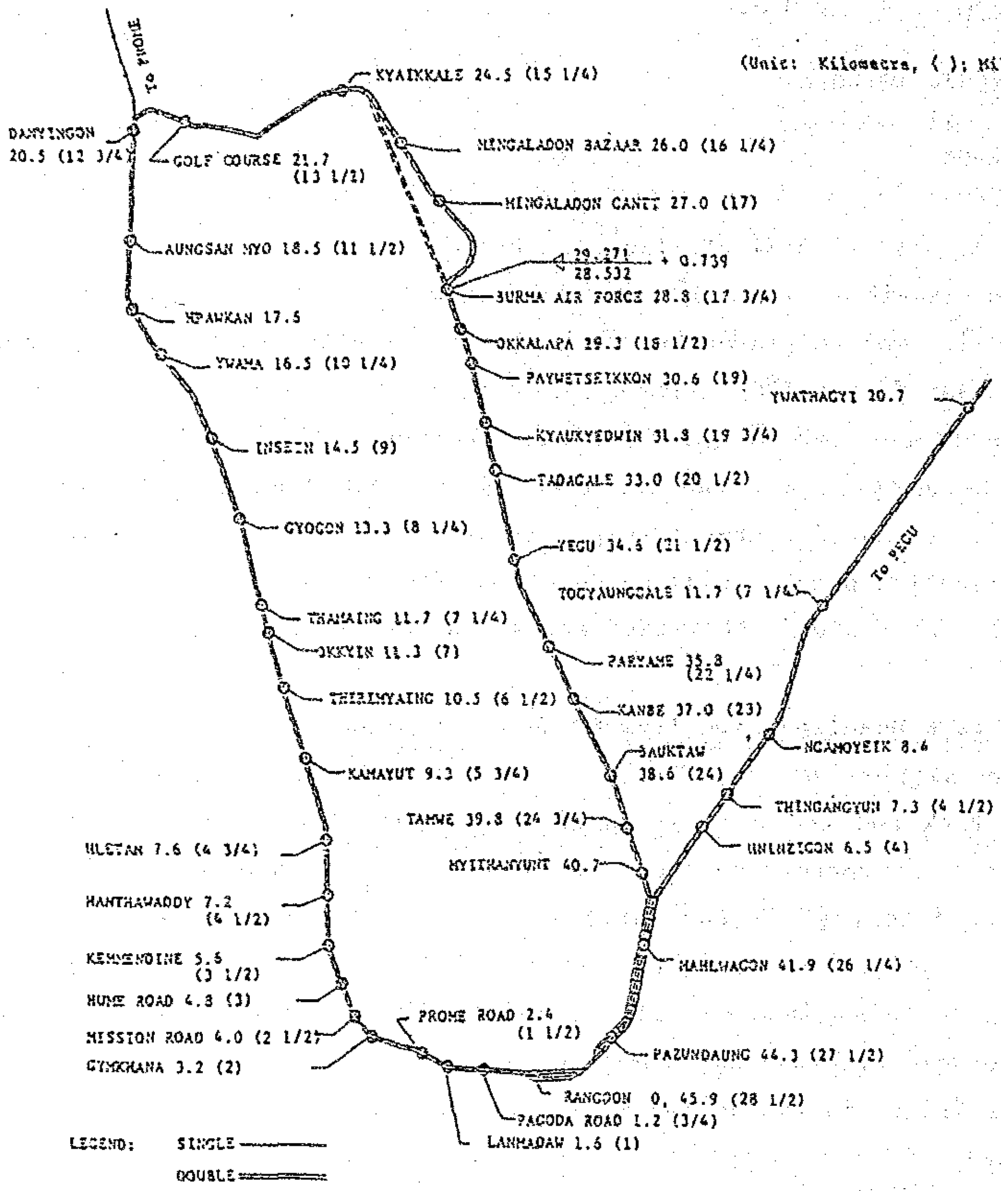


Fig. 5.7.1 The Circular and Suburban Lines to be Electrified

Source: BRC

5-7-6 PTC Microwave Network Project

PTC has two main trunk lines of a microwave network: one is the line with 120 channels between Rangoon and Martaban via Pegu, while the other is a Mandalay trunk line with 300 channels via Prome from Rangoon. At present, a new trunk line, branching at Pegu to Meiktila, is now under construction. 120 channels are expected to accommodate telephone communications. The routes of the network are shown in Fig. 5.7.2.

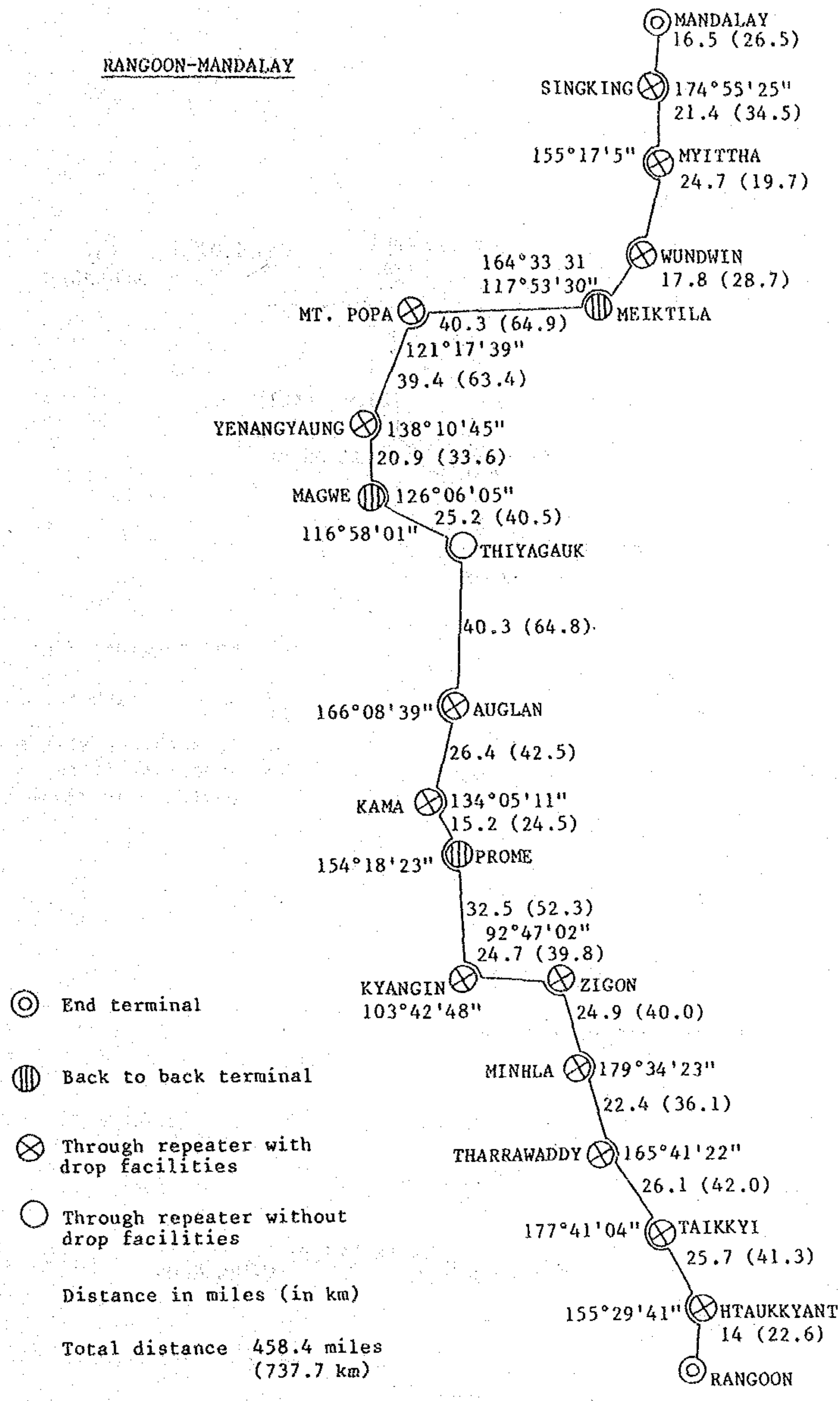


Fig. 5.7.2 PTC Microwave Route (No. 1)

Source: PTC

RANGOON-MOULMEIN

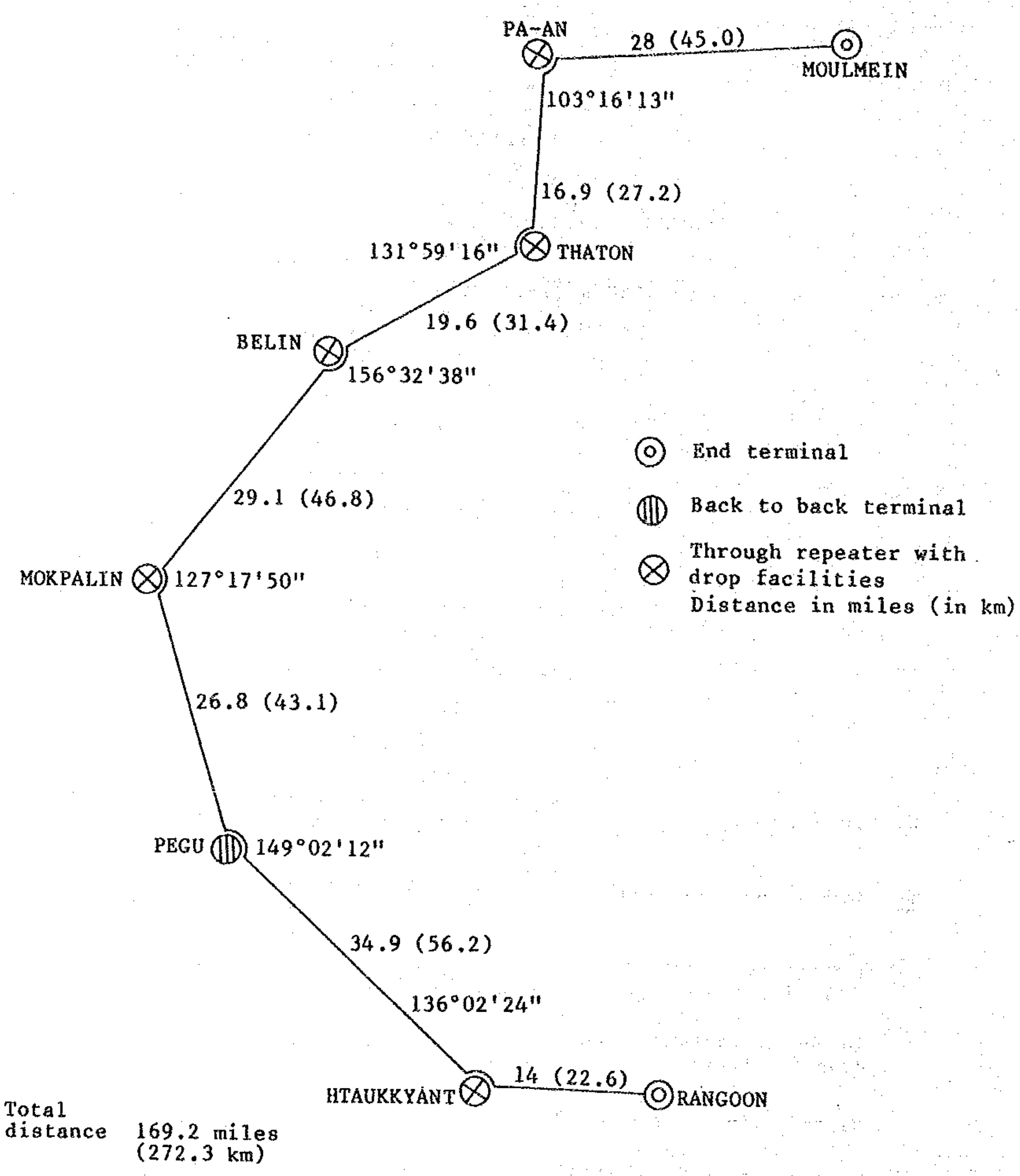


Fig. 5.7.2 PTC Microwave Route (No. 2)

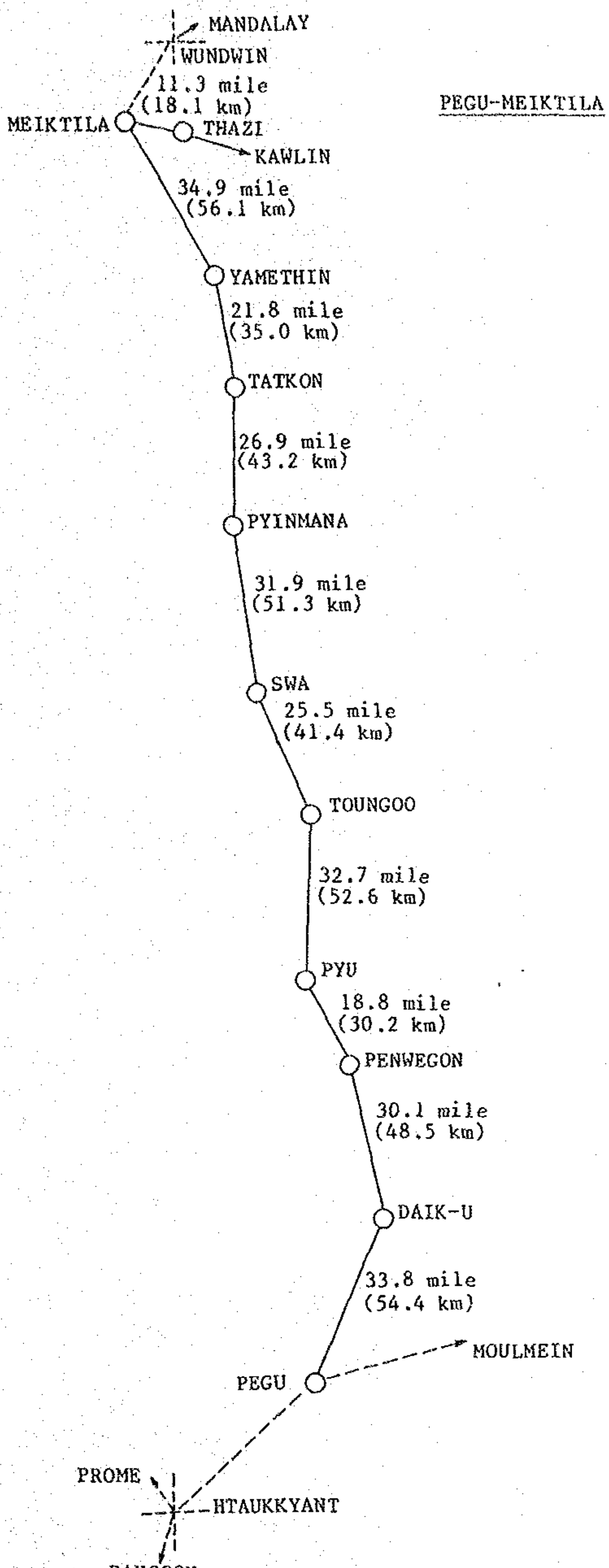


Fig. 5.7.2 PTC Microwave Route (No. 3)

CHAPTER 6 BASIC PLANNING

CHAPTER 6 BASIC PLANNING

6-1 Basic Policy on Establishing a Long-term Modernization Programme

6-1-1 General Policy

(1) Concept

A long-term modernization programme should be established on the concept of not only improving the present situation, but also building up a foundation for a reliable railway transport on a long-term basis, taking into consideration the actual situation of BRC and its future role as a main means of transport.

Considering that railway transport moves passengers and goods from place to place by rail, and also considering that this project aims at improving speed, safety, and punctuality of train operation, improvement of track, telecommunication and signalling over the entire line at the same stage is desirable as an urgent task.

However, a large amount of investment and manpower required for the improvement will restrict the project implementation in a short span of times. Therefore, it will be of importance to decide how to approach the improvement planning in the time span of near and far future.

The following three plans are considered basically as alternatives:

Plan 1: To complete the improvement by prioritizing line or section in view of the present situation of transport and priority order of lines or sections.

Plan 2: To complete the improvement by prioritizing equipment and devices, judging from the present operation condition of facilities.

Plan 3: To complete the improvement by prioritizing the systems (track, telecommunication, or signalling).

The railway is a big transport system composed of various systems, facilities, rolling stock, organizations, and personnel. Therefore, partially good products of high quality produced by the railway system will not meet the demands of customers, such as smooth train operation, until all of them function effectively together as a single unit.

To improve the transport situation of such a case as BRC, which has problems on both transport and facilities, not the parts of facilities or systems, but the facilities and systems in their entireties should be improved at the same stage. Otherwise, the large investment for railway transport cannot be expected to produce much benefit.

In this context, it seems that the most realistic plan is to carry out facility improvement by line or section. In other words, the most preferable plan of the three alternatives above will be plan 1.

(2) Prioritizing the lines

In prioritizing the lines to be selected for facility improvement, decisions should be made by taking into consideration the transport situation of the four lines.

Table 6.1.1 indicates the actual conditions of the four lines. The Mandalay line train-km is the highest among the four lines, which means the productivity of the line must be high to meet transport demand.

Judging from index figures such as train accident, safety facility trouble, and bare telecommunication line condition, the deterioration of facilities on the Mandalay line is far advanced. Moreover, it ranks first in transport volume among the four lines.

Thus, the Mandalay line will be the first to be improved in the immediate future for smooth and effective train operation, as it is the most important main line in the Burma Railway network.

However, the final decision on which line is to be selected for the first stage should be made after an overall evaluation, including an economic analysis for each line.

6-1-2 Staging and Targets

(1) Staging

In view of the present situation of the transport and facilities on the four lines, the long-term modernization programme for 20 years will consist of three stages:

First stage : 1986/87 - 1993/94 8 years
Second stage : 1994/95 - 1997/98 4 years
Third stage : 1998/99 - 2005/05 8 years

Table 6.1.1 Figures Showing the Present Characteristics of Four Lines

Item \ Line	Mandalay	Martaban	Prome	Myitkyina
Train-km/year (millions)	2.9	0.9	0.7	1.2
Transport (100 millions of Passenger -km/year)	16.6	3.4	2.6	5.2
(100 millions of ton-km/year)	2.6	0.1	0.5	0.6
Train accident (per million train km/year)	11.4	11.0	19.7	34.1
Engine trouble (per million train -km/year)	272	58	196	143
Punctuality (Percentage of express & mail trains on time)	23	32	23	4
Percentage of poor bare line telecommunication sections	57	32	38	25
Percentage of no existence of bare lines	31 (770 km)	0	11 (115 km)	0
Safety facility trouble (No. of failures per year)	291	36	13	12
(No. per station·year)	3.5	1.4	0.7	0.2
Power supply rate to stations (%)	70	53	81	35

Source: BRC

The staging, 8-4-8 years, comes from the concept that it will coincide with the four year economic plan of Burma, and also that it will take eight years to complete basic track improvement on the Mandalay line, which is a possible selection for the first stage.

Thus, the first stage, during which the Mandalay line will be improved, is eight years long, while the remaining 12 years are divided into two stages of four and eight years to implement the improvement of the other three lines. At the final eight-year stage, an overall improvement of the transport system of BRC will be done on all of the four lines.

(2) Setting of targets and goals

1) First stage

Restoration of railway's inherent functions by improving train speed and punctuality, and enhancing safe train operation on the line(s) selected.

The targets to be achieved on the Mandalay line are set as follows:

a) Train speed and scheduled time

		Passenger train	Freight train
Maximum train speed	:	80 km/h (50 mph)	56 km/h (35 mph)
Running time	:	10 hours	25 hours

To achieve the above target, that aims to improve working efficiency of locomotive and to provide better quality service to passengers, the following items will be taken into consideration.

- Passing speed at station area including facing and trailing points
- Passing speed at railway level crossing and bridges
- Number of stations and dwell time required for scheduled stops
- Relationship between the visible distance of a signal and the braking distance required at the maximum train speed
- Performance of rolling stock

b) Punctuality

To reduce habitual train delays by improving the train control and telecommunication system.

c) Train operation safety

To reduce train accidents which have been caused mainly by deterioration of track, telecommunication, and signalling facilities.

2) Second stage

Achievement of stable railway transport by enhancing punctuality and safety on the other three lines, and also by further improving operation service and increasing track capacity on the line selected at the first stage.

Concerning the Mandalay line (in Plan A), the target for decreasing the scheduled time by one hour will be fixed, while train speeds at station yards and curve sections will be improved, and safe train operation enhanced on the other two lines by improving telecommunication and signalling facilities.

3) Third stage

Establishment of BRC's transport foundation by improving the telecommunication and signalling facilities on the four main lines to achieve the final goal.

(3) Alternatives

Two alternatives, namely Plan A and Plan B, will be defined for the study.

1) Plan A

Plan A will achieve the three goals by improving the track on the Mandalay line, and telecommunication and signalling on the four main lines.

On the Mandalay line, 60 to 70 percent of the track will be improved at the first stage except curve sections and turnouts, and the rest at the second stage. This is the same as Plan B.

After achieving the 10-hour running time target by the basic facility improvement at the first stage, another target for the scheduled time between Rangoon and Mandalay will be set for nine hours at the second stage, reducing the time by one hour by replacing all remaining old turnouts by new ones for high speed, and also by improving some curve sections between stations and alignments at stations. Signalling facilities at the remaining stations and train radios will be adopted to promote even further smooth train operation, and also to reduce train accidents and delays.

At the final stage, the Mandalay line will be developed into a modernized railway transport system by introducing a CTC system and a wagon data processor and facsimile transmission system for freight cars.

The improvement of telecommunication and signalling will be made on the Martaban and Prome lines at the second and third stages, and on the Myitkyina line at the third stage.

2) Plan B

Plan B will require smaller investment for achieving the same targets including a reduction in the scheduled time on the Mandalay line, by executing the basic improvement on track, telecommunication, and signalling facilities at the first stage, which is the same as Plan A.

Starting the improvement of telecommunication and signalling facilities on the Martaban and Prome lines will be at the second stage, on the Myitkyina line at the final stage.

On these three lines, it is planned that the main telecommunication network will use a bare wire carrier system by improving the existing PTC lines to minimize investment.

Finally, selection of a plan or a modified plan from the two plans will be made by an overall evaluation.

The outlines of Plans A and B are shown respectively in Tables 6.1.2 and 6.1.3, and their effects on the improvement of train operation and rolling stock availability are shown in Table 6.1.4.

Table 6.1.2 Facility Imporovement Plan A

Note: ______ is not included in or different from plan B

Line \ Targets \ Staging	1st stage 1986/87 - 1993/94 (8 yrs)	2nd stage 1994/95 - 1997/98 (4 yrs)	3rd stage 1998/99 - 2005/06 (8 yrs)
	Scheduled time on the Mandalay line: 10 hrs	Scheduled time: 9 hrs	
Mandalay	- Track improvement . Replacement of rails, sleepers, and turnouts . Increase in ballast . Improvement of drain - Telecommunication improvement . Installation of UHF microwave network, telephone exchanges, and control telephones - Signalling improvement . Installation of colour light signals, interlocking devices (relay or electronic type) at three stations, electric lock devices for point, and level crossing alarm devices . Improvement of block system (token, tokenless or electronic type)	- Track . Replacement of rails, sleepers, and turnouts . Increase in ballast . Improvement of curve sections and drains - Telecommunication . Installation of train radio system - Signalling . Installation of interlocking devices (relay or electronic type) at the remaining stations	- Telecommunication . Installation of wagon data processor and facsimile transmission system for freight car . Installation of passenger information equipment - Signalling . Installation of CTC
Martaban		- Telecommunication . Installation of cable and carrier system, telephone exchanges, and control telephones - Signalling . Installation of colour light signals (distant, outer, start) electric lock devices for points, and level crossing alarm devices . Improvement of block system (token)	- Telecommunication . Installation of facsimile transmission system for freight car - Signalling . Installation of relay interlocking devices at major stations
Prome		- Telecommunication . Same as the Martaban line - Signalling . Same as the Martaban line	- Telecommunication . Same as the Martaban line - Signalling . Same as the Martaban line
Myitkyina			- Telecommunication . Same as the Martaban line at the 2nd and 3rd stages - Signalling . Same as the Martaban line at the 2nd and 3rd stages

Table 6.1.3 Facility Improvement Plan B

Note: ______ different from plan A

Line \ Targets \ Staging	1st stage 1986/87 - 1993/94 (8 yrs)	2nd stage 1994/95 - 1997/98 (4 yrs)	3rd stage 1998/99 - 2005/06 (8 yrs)
	Scheduled time on the Mandalay line: 10 hrs		
Mandalay	- Track improvement . Replacement of rails, sleepers and turnouts . Increase in ballast . Improvement of drain - Telecommunication improvement . Installation of UHF microwave network, telephone exchanges, and control telephones - Signalling improvement . Installation of colour light signals, interlocking devices (relay or electronic type) at three stations, electric lock devices for points, and level crossing alarm devices . Improvement of block system (token, tokenless or electronic type)	- Track . Replacement of rails, sleepers . Increase in ballast . Improvement of drain	
Martaban		- Telecommunication . Installation of bare-wire and carrier system, telephone exchanges, and control telephones - Signalling . Installation of colour light signals (distant, outer), electric lock devices for point, and level crossing alarm devices . Improvement of block system (token)	
Prome		- Telecommunication . Same as the Martaban line - Signalling . Same as the Martaban line	
Myitkyina			- Telecommunication . Same as the Martaban line at the 2nd stage Signalling . Same as the Martaban line at the 2nd stage

Table 6.1.4 Effects of the Improvement on Train Operation and Availability of Rolling Stock

Effect of the improvement	Present	Plan A	Plan B
Operation			
- Train speed (mph) [Md]	Passenger 40	50 (1st stage) 55 (2nd stage)	50
	Freight 25	35	35
- Scheduled time (hr) [Md]	Passenger 13:45	10 (1st stage) 9 (2nd stage)	10
	Freight 37:00	25	25
- Reduction in scheduled time (min) [Ma] [Pr] [My]		Passenger 60, 40,	60
		Freight 30, 20,	30
Safety			
- Decline in train accidents	110/Yr (Ave.) [Md]	70%	63%
	[Ma, Pr, My]	58%	53%
Punctuality			
- Train delay rate (average)	7.6% [Md]	1.7%	2.4%
	[Ma, Pr, My]	2.7%	3.4%
- On time arrival rate (express and mail train)	[Md] 23%	83%	76%
	[Ma] 32%	76%	70%
	[Pr] 23%	73%	66%
	[My] 4%	66%	58%
Rolling stock			
- Availability (Working efficiency)		Difference in number of rolling stock required between Plans A and B are shown in Table 6.2.4.	

Note: [Md], [Mr], [Pr], and [My] represent the Mandalay, Martaban, Prome and Myitkyina lines respectively.

Source: BRC and Study Team

6-2 Transport Plan

Transport plan is established, based on the traffic demand forecast.

6-2-1 Train Operation Standards

(1) Type of trains

Passenger:	Express train
	Ordinary train
	Local train
Freight:	Ordinary train

(2) Train make-up

The passenger train make-up and the average tonnage hauled by a freight train on the four lines are as shown in Table 6.2.1.

The express passenger train on the Mandalay line will be made up of 11 carriages, considering performance of diesel locomotive maximum speed and scheduled time. The make-up of other trains will remain the same as the present.

(3) Maximum speed

Mandalay Line:	Passenger train	80 km/h (50 mph)	1st stage
		88 km/h (55 mph)	2nd stage in Plan A
	Freight train	56 km/h (35 mph)	
Martaban Line, Prome Line, Myitkyina Line	Passenger train	48 km/h (30 mph)	(same as the present)
	Freight train	32 km/h (20 mph)	(same as the present)

Table 6.2.1 Train Make-Up and Average Hauling Tonnage

Train type	Mandalay Line	Martaban Line	Prome Line	Myitkyina Line
Express passenger train	2 Upper class cars + 8 Ordinary cars + 1 Brake van	1 Upper class car + 11 Ordinary cars + 1 Brake van	1 Upper class car + 12 Ordinary cars + 1 Brake van	—
Ordinary passenger train	2 Upper class cars + 9 Ordinary cars + 1 Luggage van + 1 Brake van	1 Upper class car + 8 Ordinary cars + 1 Luggage van + 1 Brake van	1 Upper class car + 7 Ordinary cars + 1 Luggage van + 1 Brake van	3 Upper class cars + 7 Ordinary cars + 1 Luggage van + 1 Brake van
Local passenger train	4 Ordinary cars + 1 Luggage van + 1 Brake van	—	—	9 Ordinary cars + 1 Luggage van + 1 Brake van
Freight train	502 tons	161 tons	340 tons	211 tons

Source: Study Team

(4) Scheduled time and speed

Table 6.2.2 shows the scheduled time and speed of typical express passenger trains for each line (ordinary passenger train for the Myitkyina line).

The scheduled time of passenger trains will be reduced by increasing train speed on the Mandalay line, and the same by increasing the point passing speed and decreasing train handling time for the other three lines. The scheduled time for freight trains will be mainly reduced by increasing train speed on the Mandalay line and reduced a little by decreasing train handling time on the other three lines.

Table 6.2.2 Future Operation of Typical Passenger Trains

Railway Line	Section	After completion of 1st stage			After completion of 2nd stage			After completion of 3rd stage		
		Scheduled Time	Reduction in Time	Scheduled Speed (km/h)	Scheduled Time	Reduction in Time	Scheduled Speed (km/h)	Scheduled Time	Reduction in Time	Scheduled Speed (km/h)
Mandalay	Rangoon – Mandalay	10°00'	3°45'	62	10°00' (9°00')	0' (1°00')	62 (69)	same as the left		
Martaban	Rangoon – Martaban	7°05'	30'	39	6°35'	30'	42	same as the left		
Prome	Rangoon – Prome	7°00'	0'	37	6°20'	40'	41	same as the left		
Myitkyina	Mandalay – Myitkyina	24°00'	0'	23	Same as the left			23°00'	60'	24

Note: Figures in ( ) indicate those of Plan A.

Source: Study team

6-2-2 Train Operation Plan

The number of scheduled trains will be as in Table 6.2.3 in conformity with the traffic demand forecast, based on the current train make-up and traffic volume.

The number of the trains will not exceed track capacity, but the details should be checked in the feasibility study.

Table 6.2.3 Number of Trains per Day on the Four Main Lines

Line	Type of Train	1993/94	1997/98	2005/06
Mandalay	Passenger	26	32	50
	Freight	17	21	30
Martaban	Passenger	11	13	19
	Freight	8	10	14
Prome	Passenger	8	10	14
	Freight	6	7	9
Myitkyina	Passenger	9	10	15
	Freight	16	19	26

Source: Study Team

6-2-3 Rolling Stock Plan

Table 6.2.4 shows the number of locomotives, passenger cars, and wagons required for the train operation plan.

In estimating the number, increased working efficiency of rolling stock by increase in train speed is considered.

Table 6.2.4 Number of Rolling Stock Required for the Four Main Lines

Railway Line	Type of Rolling Stock	1993/94	1997/98	2005/06
Mandalay	Locomotive	55	67(65)	98(98)
	Coach	231	285(280)	446(439)
	Wagon	7173	6784	9797(9746)
Martaban	Locomotive	24	28	39
	Coach	107	123	177
	Wagon	288	336	443(438)
Prome	Locomotive	20	23	32
	Coach	102	114	160
	Wagon	1409	1635	2237(2211)
Myitkyina	Locomotive	68	80	110
	Coach	185	219	303
	Wagon	1778	2087	2860(2832)

Note: Figures in ( ) indicate Plan A.

Source: Study Team

6-3 Basic Design Guides and Policies

The basic guides and policies to be followed in designing the facility improvement plan are as follows.

6-3-1 Design Conditions

(1) Train operation condition

The conditions are shown in Table 6.3.1.

Table 6.3.1 Train Operation Condition

Condition			Present		2005/6	
Maximum train speed	[Md]	Passenger	40 mph	(64 km/h)	55 mph	(88 km/h)
		Freight	20	(32 km/h)	35	(56 km/h)
	[Mr, Pr, Py]	Passenger	30	(48 km/h)	same as the present	
		Freight	20	(32 km/h)		
Number of trains per day	[Md]	Passenger	16		50	
		Freight	10		30	
	[Mr, Pr, My]	Passenger	8, 6, 6		17, 14, 15	
		Freight	4, 4, 10		14, 9, 26	
Passing tonnage (million-ton/yr)	[Md]		5.3		15.0	
Maximum axle load (ton)			12		13	

Note 1) Number of suburban trains are not included in the Rangoon-Pegu section.

2) [Md], [Mr], [Pr] and [My] represent the Mandalay, Martaban, Prome, and Myitkyina lines, respectively.

Source: BRC and Study Team

(2) Climatic condition

1) Characteristics of climate

The climate consists of a rainy season and a dry season that are clearly distinguishable. The former is from May to October and the latter the rest of the year. The differences between high and low temperatures does not differ much throughout the year.

2) Cyclone

Cyclones often occur from May to October. But the frequency of the passing through the Rangoon area is only about once every five years.

The maximum wind velocity of cyclones, being more than 100 mph (45 m/s) at the Burmese shore, is only about 70 mph (31 m/s) when they reach the Rangoon area.

3) Temperature

The maximum temperature is 40.2°C and the minimum 14.0°C for the past three years in Rangoon.

Monthly average temperatures for the past three years are shown in Table 6.3.2.

Table 6.3.2 Average Temperature

(Unit: °C)

City \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Rangoon	24.3	27.4	29.1	31.1	30.2	27.3	27.3	27.5	27.4	27.7	27.0	24.6
Mandalay	20.6	23.3	27.5	31.2	32.0	30.8	30.0	29.5	27.6	27.3	23.0	23.3
Tokyo (for ref.)	4.1	4.8	7.9	13.5	18.0	21.3	25.2	26.7	23.0	16.9	11.7	6.6

Source: BRC

4) Rainfall

The total monthly rainfall for the past three years is shown in Table 6.3.3.

Table 6.3.3 Total Monthly Rainfall

(Unit: mm)

City \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Rangoon	0	0	0	11	206	590	601	597	331	253	60	3
Mandalay	0	0	0	36	85	85	64	94	123	124	31	11
Tokyo (for ref.)	49	65	98	122	145	192	140	153	182	203	96	58

Source: BRC

6-3-2 Design Policies

(1) Fundamental design policy

To achieve the goals set in section 6-1-2 in an effective way, facility improvement should be carried out by resolving its respective problems.

The relationship between the problems, the suggested facility improvement of track, telecommunication, and signalling, and their contribution to the goals is shown in Fig. 6.3.1.

(2) Guiding policies

In drawing up a facility improvement plan, the following items should be fully taken into account in consideration of the situation in Burma and BRC.

1) Establishment of adequate facility standards

Standards for each system should be set, taking into consideration such situations as train operation and importance of the line.

2) Coordination of standardization concepts and new technology

In introducing new technology and modern equipment, consideration should be paid to achieve coordination with standardization concepts for inspection and maintenance of new equipment.

3) Coordination with related projects

There should be sufficient coordination with the projects or plans listed in section 5-7.

The following items should basically be taken into consideration.

a) Track improvement plan

- An optimum track structure will be recommended, which should be common to the track improvement in the modernization programme.

b) Rolling stock modernization plan

- For the ongoing modernization plan, the number and performance of rolling stock will be proposed in the present study.

c) Circular line electrification project

- The present study will be based on the premise that the overlapped sections between Rangoon and Ywathagyi will be electrified before the implementation of the present study.

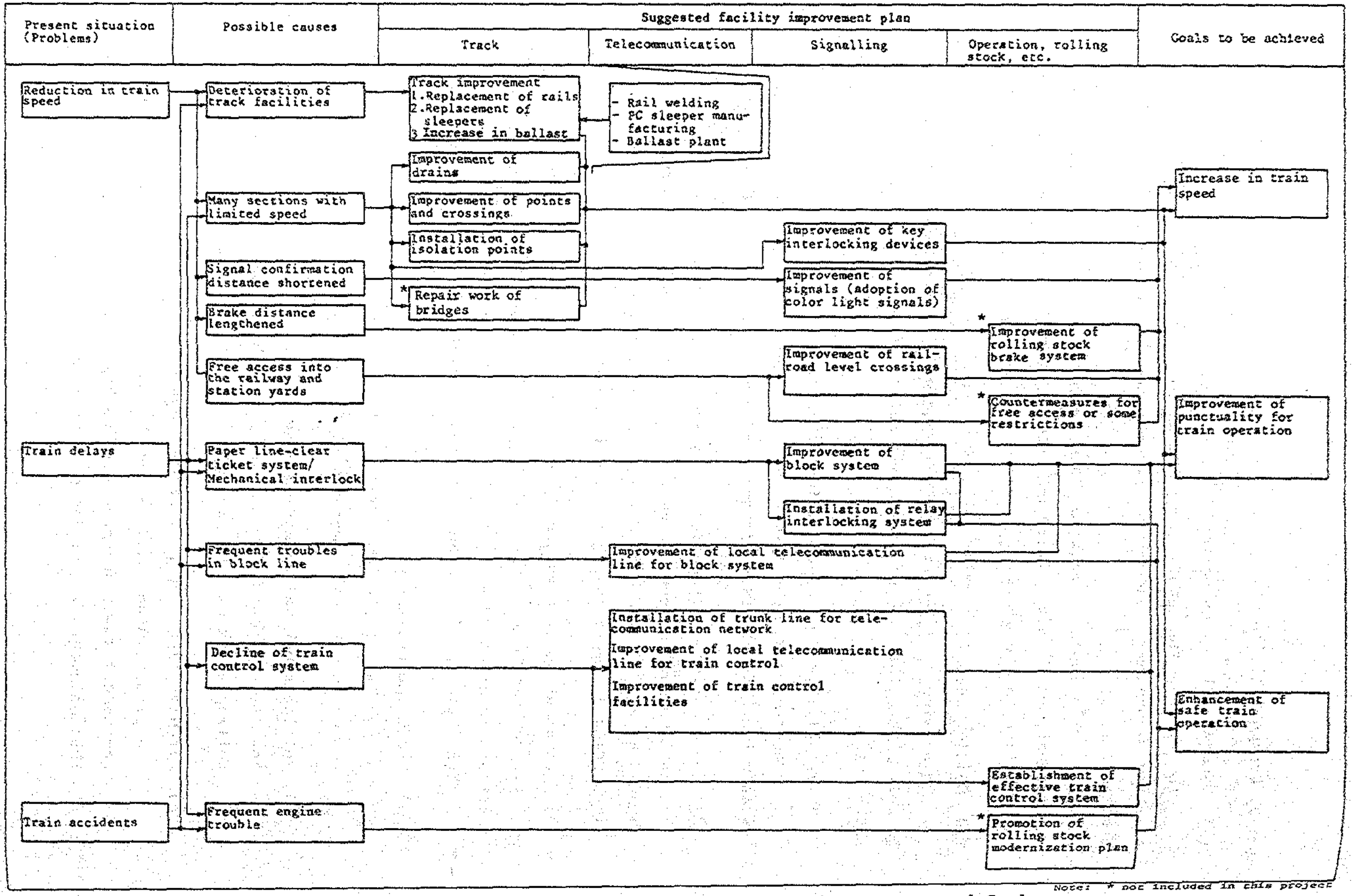


Fig. 6.3.1 Relationship between Problems, Improvement and Goals

d) Track doubling plan from Pyinmana to Mandalay

- The plan will be taken into consideration in the present study.

e) Expansion programme of PC sleeper manufacturing

- Some recommendations to the program will be made to meet the production requirements for track improvement.

f) PTC microwave network project

- The project is now under the construction stage. Due to the limited capacity of the PTC microwave network and the locations of microwave stations not meeting BRC's requirements, a separate plan to establish a BRC's main trunk line of telecommunication will be made in the present study.

4) The equipment or the system to be recommended should be studied, taking into consideration the following particulars.

- The equipment should be of an energy-saving type as much as possible, in consideration of the power supply situation.

- The equipment should permit functions to expand in the future and should have as few troubles as possible to minimize additional modification in the future.

- The equipment installed in some areas should be protected from excess moisture and floods, taking into consideration that almost half the year consists of a rainy season.

- The equipment should have sufficient spare parts for effective maintenance.

5) Comparative evaluation of alternatives

In recommending the best plan, an overall evaluation should be made by comparing it with alternatives as many as possible, keeping in mind economy, reliability, maintenability, and the like.

6) Drawing up an effective execution plan

To achieve the targets in each stage effectively, an execution plan for track, telecommunication, and signalling should be coordinated. Furthermore, the track improvement schedule should be made in full consideration of PC sleeper and ballast supplies.

6-4 Technology Transfer

Technology transfer for the railway modernization should be carried out essentially through the stages of study, detailed design, implementation, and commissioning.

The long-welded rails and PC sleepers to be adopted for the Mandalay line are quite important for track improvement and its modernization. Therefore, during the study stage, the following items on long-welded rails and PC sleepers will be provided.

- Guidance or recommendations
- Design of standards
- Essentials of specifications
- Training curriculum

At the first step, a guideline or recommendations on rail welding and PC sleeper manufacturing will be prepared with emphasis on quality control and production management in the present study.

CHAPTER 7 FACILITY IMPROVEMENT PLAN

CHAPTER 7 FACILITY IMPROVEMENT PLAN

7-1 Track

7-1-1 Basic Policy of Track Improvement

As to railway transportation, it is very important that tracks are maintained in good condition. Tracks sustain daily train loads and are affected by nature, resulting in track irregularities, and gradual wear and decay of track material. Therefore, tracks require repair work and replacement to maintain them at a fixed level.

The track improvement plan is based on the actual conditions of the facilities. Long-welded rails and PC sleepers should be introduced for track strengthening.

In addition to making maximum use of the present facilities of rail welding and PC sleeper manufacturing, expansion and establishment of the facilities are necessary to make up for shortages.

As for the track maintenance system, effective maintenance methods and tolerance limits should be considered to maintain good track conditions.

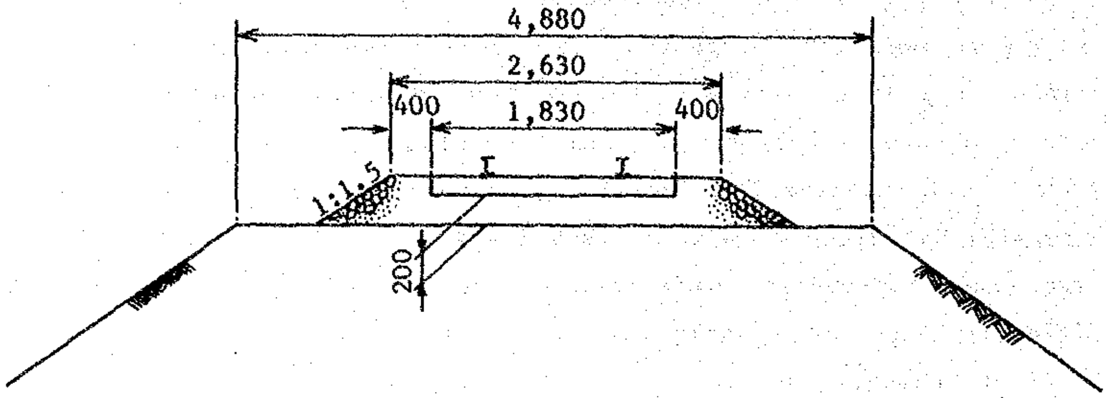
7-1-2 Standard Track Structure

The long-welded track has to be designed so that it is strong enough to endure train loads and large axial force with the influence of temperature, without any creeping or buckling. It is most important that the welded part of the rail does not break, and that rails not creep on the sleepers or buckle (deformation) at high temperatures.

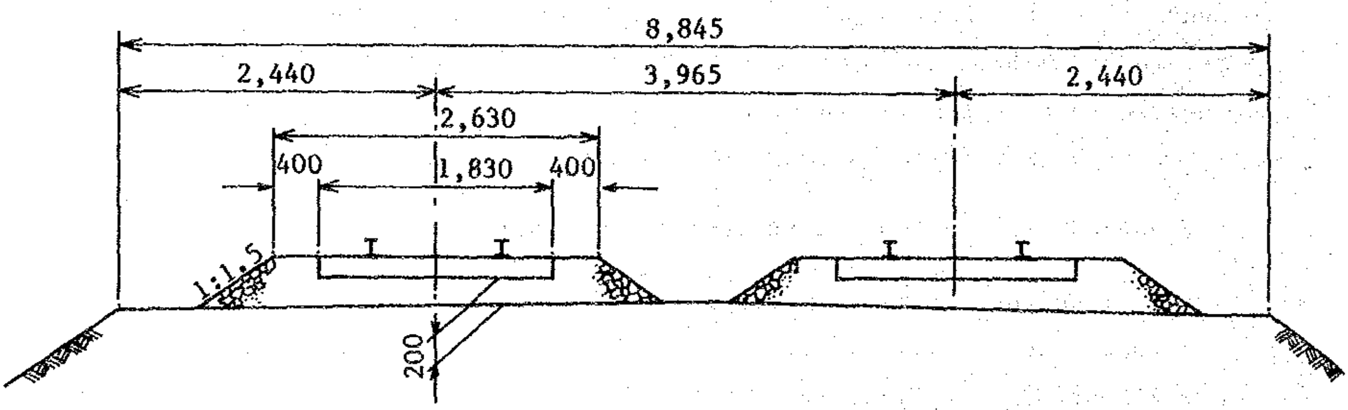
Standards of the track structure are as follows:

- Rail weight .... 75 lb/y (37 kg/m)
- Fastening .... Double elastic fastening
- Sleeper .... PC sleeper
- No. of sleepers .... 1,514 pcs/km or more
- Ballast .... Crushed stone
- Ballast section .... As Fig. 7.1.1

Described on the following pages are details of the standards.



Single Track



Double Track

Fig. 7.1.1 Standard Ballast Section

(1) Rail weight

Rail weight is generally determined by various conditions such as maximum train speed, passing tonnage, maximum axle load, and track maintenance cost. The rail to be used is 75 lb (37 kg) in weight, the same as the existing one, since the comparatively small maximum axle load of 13 tons makes the bearing capacity of the track small.

(2) Fastening

On fastening ordinary jointed rails to sleepers, dog spikes are usually used, in which case the joint gap adjusts to the rail expansion. However, the approximately 100 m long welded rail expands and contracts at both ends and the central section receives large axial force without expansion or contraction. Therefore, a large fastening force is applied to the track and the axial force is given to the sleepers, while the resistance is born by the ballast. The large rail fastening force is provided by the double elastic fastening method, in which the elastic clips are fastened to the rail bottom, and the track pad inserted into the rail bottom provides top and bottom elasticity.

(3) Sleeper

Most existing sleepers made of soft wood are defective as their life is short, and it is especially difficult to obtain hard sleepers here. The use of PC sleepers would be indispensable in the future.

PC sleepers have a longer life, require lower maintenance costs, and have a lesser chance of track irregularities than wooden sleepers. The long-welded rails must be fastened to PC sleepers in order to ensure the fastening strength and to minimize track irregularities. The number of sleepers is 1,514 pieces or more per kilometer.

(4) Ballast increase

The shortage of ballast may lead to track irregularity or buckling at high temperatures. Therefore, the fixed amount of ballast must be always secured and the ballast should be sufficiently compacted. The track with long-welded rails requires large lateral resistance of ballast, which is obtained by a wide ballast shoulder and gentle side gradient, to endure the large axial force so as not to cause rail buckling.

7-1-3 Track Improvement Outline

(1) Rail replacement

1) Ordinary rail

Ordinary rails will be used where the long-welded rail laying is hard or urgent rail replacement needed.

In principle, welded rails of 39 ft x 3 pcs. (35.7 m), which is the optimum length for various conditions, will be used, since rail of standard length (39 ft, 11.9 m) requires a large number of joints. Before reusing old rails, about 50 cm at both ends should be cut off to remove any part demaged by battering, bending, or bolt holes.

2) Long-welded rail

Basic track conditions capable for laying of long-welded rails are as follows:

- Curve radius to be 600 m or more.
- Curve radius should be 1,000 m or more each if track is continuously laid in reverse curves.
- Vertical curve radius for changing point of grade to be 3,000 m or more.
- Ballast-less bridge length to be 25 m or less.
- Not at, or in front of, or after the level crossing if possible.
- On good roadbed.

As to the track with the long-welded rails, it is necessary to strengthen fastenings, to make use of PC sleepers, and to strengthen resistance of ballast. It must therefore be replaced only after the sleepers have been replaced with PC sleepers and ballast is increased.

(2) Sleeper replacement

a. PC sleeper

PC sleepers will be used at all tracks except where PC sleeper laying is difficult, such as on bridges, at level crossings and sharp curves.

b. Wooden sleeper

Wooden sleepers will be laid where PC sleeper laying is difficult, or temporarily to reduce the rate of faulty sleepers before the completion of the track improvement work. The percentage of defective wooden sleepers should be maintained within the 20 percent range.

c. Bridge sleeper

Defective bridge sleepers will be replaced when the hook bolts are repaired. The sleeper connecting materials that keep the sleeper spacing are installed.

(3) Increase in ballast

In all sections, the ballast should have a fixed section. The ballast containing a large volume of soil (30 percent or more) must be screened. The range of ballast screening is as shown in Fig. 7.1.2.

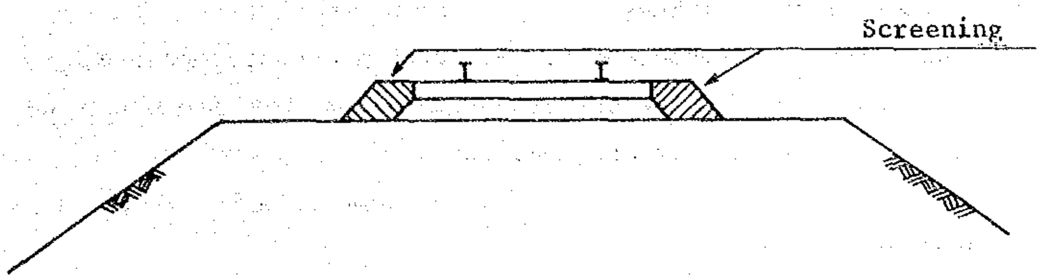


Fig. 7.1.2 The Range of Ballast Screening

(4) Turnout replacement

Turnouts will be entirely replaced if they are wholly worn out or loosened, while partial replacement will be carried out if they are partially worn or loosened at the tongue rail, crossing, and guard rail.

Prior to the turnout replacement, study should be made on the removal of unused or seldom-used turnouts to make the track straight. The turnouts to be removed are the following ones on the main track.

- turnout to sidetrack
- turnout for a crossover between main tracks at one end of a station

In plan B, the number of turnouts to be entirely replaced is about 40 percent of that of plan A.

(5) Improvement of curve

The speed restriction to the current maximum speed of 69 km/h (43 mph) or less is only required at 10 curves on both up-and down-tracks.

However, for the future increase in train speed, curves whose radius is 699 m (2 1/2°) or less are improved where possible, and for curves with deficiency of the cant, the cant will be improved and the transition curve extended.

In plan B, improvement of the curves (other than the cant and transition curves) is not included.

(6) Improvement of drainage

The improvement of drainage will be carried out where the roadbed drainage is ineffective against track submergence. The improvement plan covers the sections to the Toungoo station, excluding the stations without a turnout. The submerged tracks between stations will be improved by increasing the ballast thickness.

The building of embankments, a drastic countermeasure, is not appropriate when its high construction cost and low frequency of submergence of the permanent way are considered.

7-1-4 Improvement Plan

- Rail replacement
  - . Ordinary rail — 190 km
  - . Long-welded rail — 610 km
- Sleeper replacement
  - . PC sleeper — 1,440,000 pieces
  - . Wooden sleeper — 180,000 pieces
  - . Bridge sleeper — 8,000 pieces
- Increase of ballast — 605,000 m3
- Turnout replacement
  - . Entire — 230 sets (about 40% in Plan B)
  - . Partial — 100 sets
- Improvement of curves — 63 points (not included in Plan B)
- Improvement of drainage — 34 points

7-2 Train Operation Control

7-2-1 New Control System

Of the trains now operated, the ratio of passenger and freight trains for long distance is considerably high due to the social and economic circumstances in Burma. As the transport demand expands, the number of trains will increase further in the future.

In order to maintain safe and punctual train operation with higher speed and bigger traffic, control work that can control the whole operation of long-distance trains is indispensable.

As shown in Fig. 7.2.1, the new control system has a two-tiered structure: first, the divisional control offices that directly control train operation within each division; second, the central control office that comprehensively control train operation extending more than two divisions.

The divisional and central control offices exchange information on the condition of locomotives, coaches, and wagons to provide an appropriate and efficient rolling stock operation.

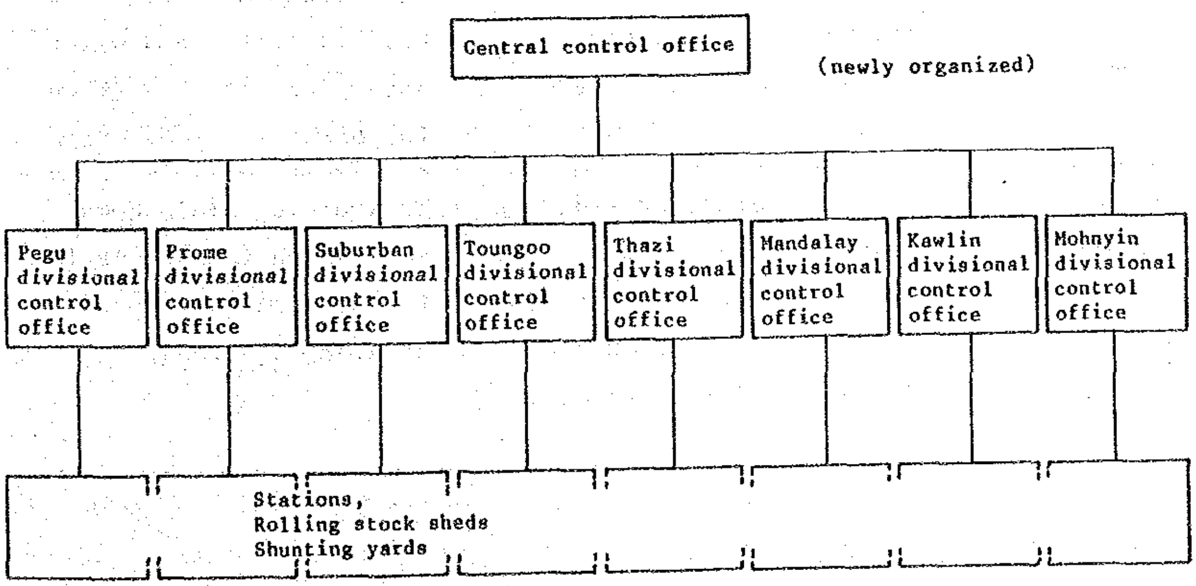


Fig. 7.2.1 New Control System

Main functions of each control system are shown in Table 7.2.1.

Table 7.2.1 Main Functions of the Control System

Section	Function	Facilities
Central control office	o To oversee the conditions of all lines, especially express trains o To give high priority to express train recovery, when the train schedule is disturbed	o To improve mainly the communication facilities for divisional control offices o To introduce wagon data processor system on the Mandalay line (Plan A)
Divisional control office	o To grasp train operation conditions within the control area. o To judge local train suspension, etc. o To grasp information on locomotives, passenger coaches, wagons, drivers, etc.	o To improve mainly the communication facilities for stations, rolling stock sheds, shunting yards, etc. o To introduce train radios, CTC, facsimile and wagon data processor system on the Mandalay line. (Plan A)
Station Rolling stock shed Shunting yard	o To periodically provide the control office with information on train operations, rolling stock conditions, their locations, etc.	o To improve mainly communication facilities for the control office and adjacent stations.

7-2-2 Facility Improvement

For effective operation of the new control system, various control facilities will be installed at the central control office, each divisional control office, and each field office, as shown in Table 7.2.1.

(1) Control telephone equipment

The central control office, each divisional control office, and each field office will be equipped with controller telephone, through which information and directives necessary for train operation and allocation of locomotives, coaches, and wagons are dispatched.

(2) Wagon data processor system

The central control office and each divisional control office on the Mandalay line will be equipped with a wagon data processor unit. Wagon data is first collected from the field offices and put into units at divisional control offices, then transmitted through telephone lines to the unit at the central control office for comprehensive control of the wagon data and wagon location identification.

(3) CTC system

A CTC system to be introduced on the Mandalay line will centralize the train route control of each station, automatically display the train number and its position on a train location indicator and record train diagrams. Train positions are traced by track circuits or a train shift system using axle counters.

(4) Train radio system

Train radio system to be installed on the Mandalay line, which enables direct communication between controller and driver, will further enhance efficiency of train control especially in case of operational disturbance such as engine troubles, signalling failure, etc.

7-3 Telecommunication

7-3-1 Outline

(1) The facility improvement plan of telecommunication basically covers the installation of main trunk lines for the railway telecommunication network, telephone exchanges, control telephone, and train radio to enhance safety train operation and its efficiency.

(2) Composition of telecommunication line

A network of telecommunication lines required for services in BRC will be composed of the following:

- Block lines
- Station-to-station lines
- Control telephone lines
- Exchange tie and subscriber lines
- Wayside telephone lines
- Train radio system (Plan A)
- Facsimile transmission lines (Plan A)
- Other information transmission lines

(3) Basic conditions

For these lines to meet increasing services, further expansion should be taken into consideration; and under this plan, the installation of lines should be made appropriately, not excessively.

Planning will be made with the following points taken into account:

- Distance between stations
- Distance between exchanges
- Places without electric power
- Sunshine hours in wet season
- Water on both sides of the track in wet season

(4) Facility plan

1) Speech loss

A plan will be made to set at 40 dB or less (equivalent in terms of speech loss) in the BRC network of exchange subscriber lines; however, the Myitkyina Line has some places where it is too difficult to apply this. Control telephone is set at 20 dB or less, and 40 dB or less at simultaneous calls.

2) Transmission line

A plan will provide the Mandalay Line with UHF microwave network system and underground cables, and the other lines with underground cables and cable carriers. Underground cables will be installed on the roadbed 2 meters away from the track center, 0.75 meters deep.

The Martaban, Prome and Myitkyina lines will use bare lines of the PTC, because cabling is too expensive from the viewpoint of their transmission volume.

3) Telephone exchange

Fig. 7.3.1 shows the installation plan.

4) Control telephone

The existing control calling equipment at each station will be replaced by a new one and also, if necessary, a slave telephone will be set at some stations. This equipment will be used for arranging train operation and collecting freight train information.

5) Wagon data processor system (Plan A)

Wagon data processor unit will be installed at the central control office and each divisional control office on the Mandalay line. Each unit will be linked by telephone exchange network.

6) Facsimile equipment (Plan A)

A plan will provide every line with facsimile equipment for transmitting freight information.

7) Passenger information equipment (Plan A)

A plan will install passenger information equipment at major stations.

8) Train radio system (Plan A)

A plan will establish a train radio system and enable controllers, stationmasters, and train crew to call each other on the Mandalay Line.

9) Wayside telephone

A plan will install a terminal box at intervals of one kilometer between stations.

10) Medium-and high-frequency wireless system

The wireless system is too old and too deteriorated, but will not be included in the plan.

11) Power supply facility improvement

Solar cell for the telecommunication equipment will not be used in this project, because of the short sunshine hours as mentioned in Section 5-5-1.

Telecommunication equipment will work on the power from EPC or from engine generators jointly used for signalling facilities at each station.

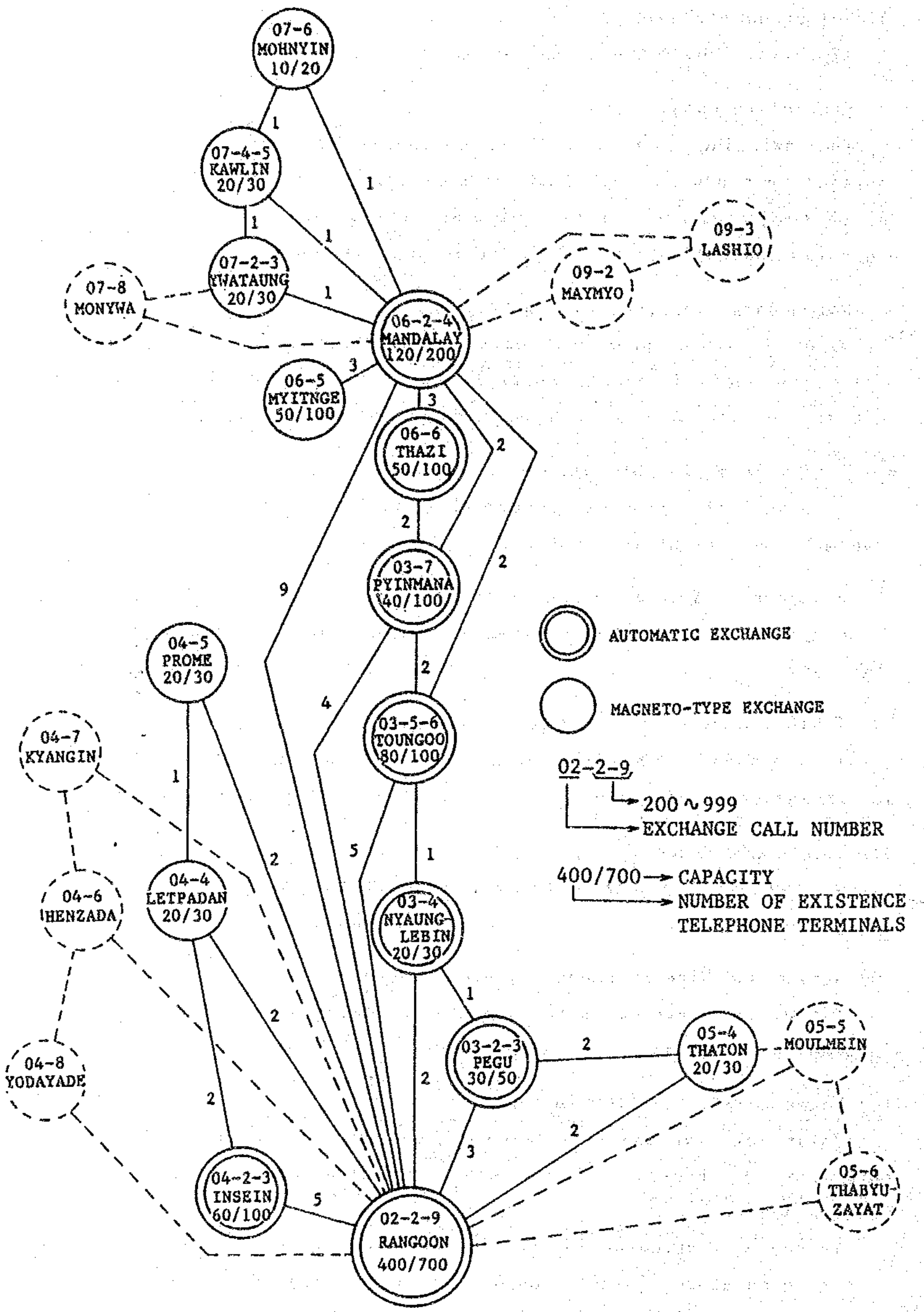


Fig. 7.3.1 BRC Exchange Network Plan

Source: Study Team

(5) Improvement Plan

The improvement plan is detailed in Table 7.3.1.

Table 7.3.1 Installation in the Improvement Plan (No. 1)

Line	Plan / Stage	A	B
Mandalay	1st	o U.H.F microwave network system. o 20-pair underground cable o Automatic exchange equipment (Myitnge is magneto exchange) o Control telephone equipment	Same as plan A
	2nd	o Train radio system	
	3rd	o Wagon data processor system o Facsimile equipment o Passenger information equipment	
Martaban	2nd	o 14-pair underground cable o Cable carrier system o Magneto exchange equipment (Thaton) o Control telephone equipment	o Bare wire transmission line o Bare line carrier system o Magneto exchange equipment (Thaton) o Control telephone equipment
	3rd	o Facsimile equipment	

Line	Stage	Plan A	Plan B
Prome	2nd	o 14-pair underground cable o Cable carrier system o Automatic exchange equipment (Insein) o Magneto exchange equipment (Letpadan, Prome) o Control telephone equipment	o Bare wire transmission line o Bare line carrier system o Automatic exchange equipment (Insein) o Magneto exchange equipment (Letpadan) o Control telephone equipment
	3rd	o Facsimile equipment	
Myitkyina	3rd	o 14-pair underground cable o Cable carrier system o Magneto exchange equipment (Ywataung, Kawlin Mohnyin) o Control telephone equipment o Facsimile equipment	o Bare wire transmission line o Bare line carrier system o Magneto exchange equipment (location is same as plan A) o Control telephone equipment

Source: Study Team

7-3-2 Improvement Plan

(1) Mandalay line

1) Transmission line

For a transmission line, there are various systems: UHF microwave network system and copper cable system, optical fiber cable with pulse code modulation and copper cable system, and digital remote area subscriber radio telephone system (DRSS). The optical fiber cable system is considerably expensive, and to provide the train radio system, it is necessary to set up steel towers. DRSS is designed to connect widely spread subscribers with the exchange. Therefore, to use it in the railway, there are many restrictions in composing lines, and especially, the number of common-use lines for suscribers will decrease due to the composition of exclusive lines. For instance, it is too difficult to compose exclusive lines, each connecting two adjacent stations. With this system, it is also difficult for maintenancemen to know the status of the radio equipment installed at each station, and it will take much time to restore the system when failed. DRSS requires a stable electric power source at each station. The UHF microwave system is therefore more advantageous than the others.

A study has been made on the use of solar cell only to find that this is not economical because the sunshine hours is short. The comparison is as shown in Table 7.3.2.

The UHF microwave network system and cable system will be used, capable of providing train block lines, level crossing warning lines, station-to-station lines, subscriber lines, wayside telephone lines, train radio system, CTC system, and others for transmitting various information. The UHF microwave will be at 1.5 GHz with 120 channels and the base station will be established at selected stations with an electric power source available. Underground cables will be of aluminum sheath, 20 pairs of core, and 0.9 mm, taking into account the future a.c. electrification. Station-to-station lines and exchange subscriber lines will be used for wayside telephones. These exchange subscriber lines will be connected to the manual switching board of the automatic exchanges. The composition is as shown in Fig. 7.3.2.

Table 7.3.2 Comparison of Transmission Systems

	UHF microwave network system + Cable	Optical Cable + Cable	D.R.S.S.
Cost	△	△	○
Maintenance	○	○	△
Possibility of Expansion	○	○	×
Power Supply	△	△	×
Signalling	○	○	△
Relation to Train Radio System	○	△	△

Note: ○ suitable, △ medium, × unsuitable

Source: Study Team

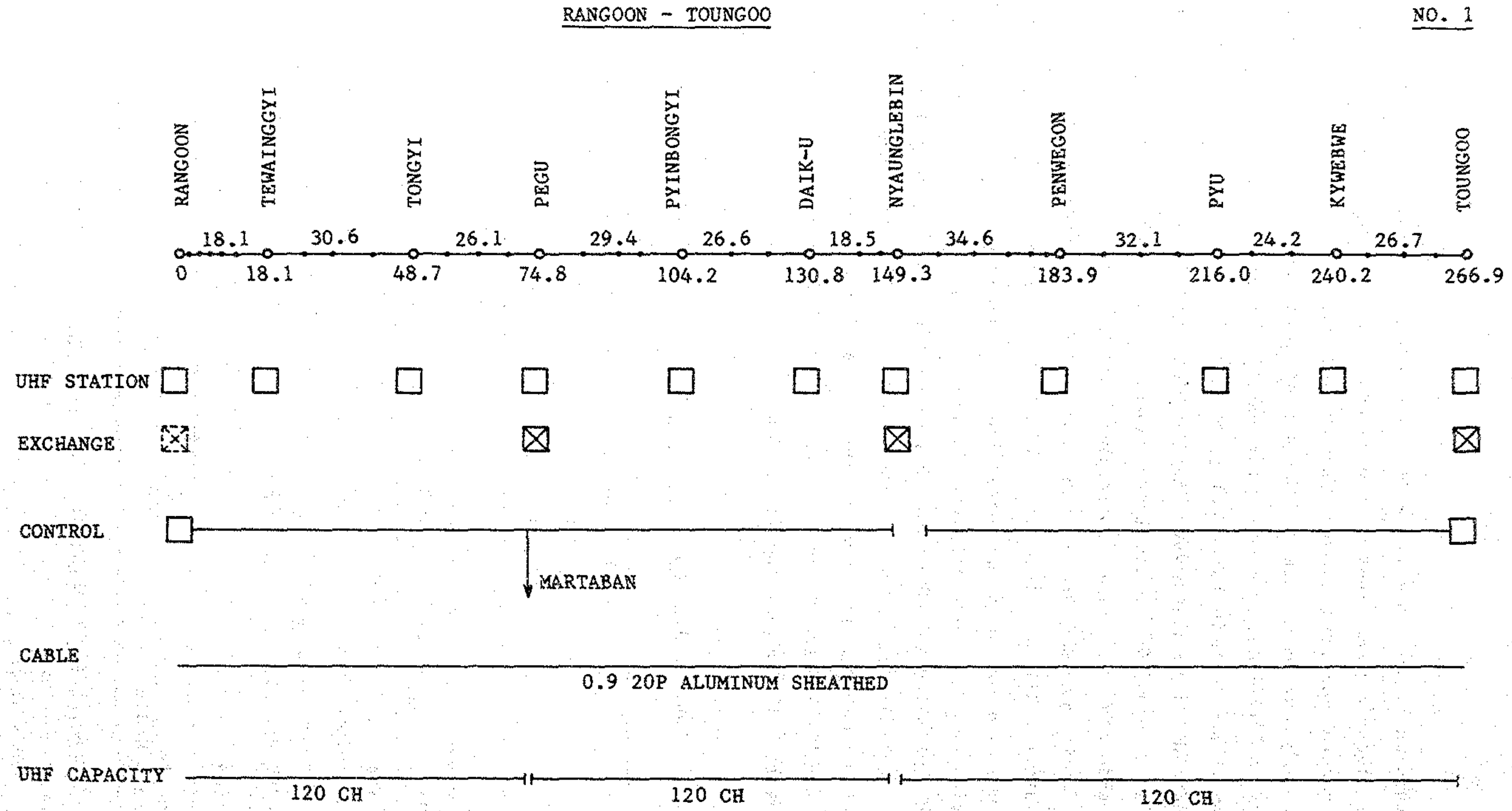


Fig.7.3.2 Composition of Transmission Line (Mandalay Line)

Source: Study Team

TOUNGOO - MANDALAY

No. 2

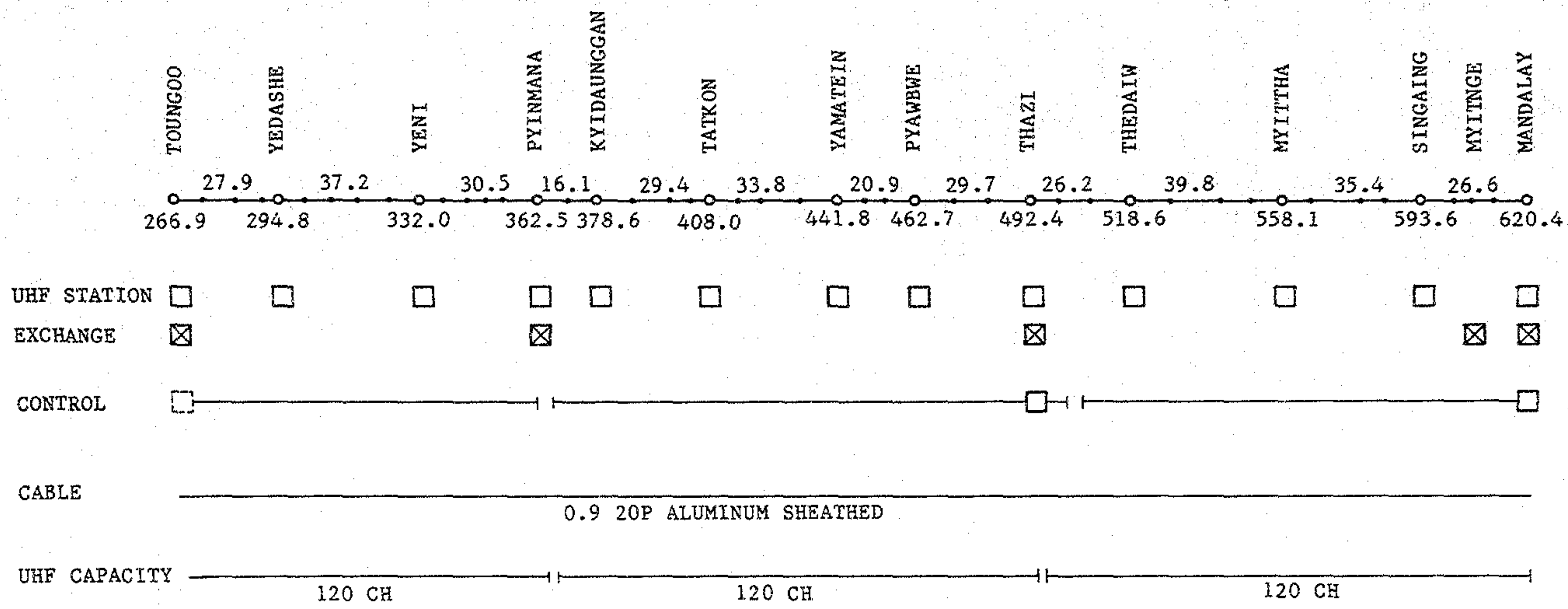


Fig.7.3.2 Composition of Transmission Line (Mandalay Line)

Source: Study Team

TOUNGOO - MANDALAY

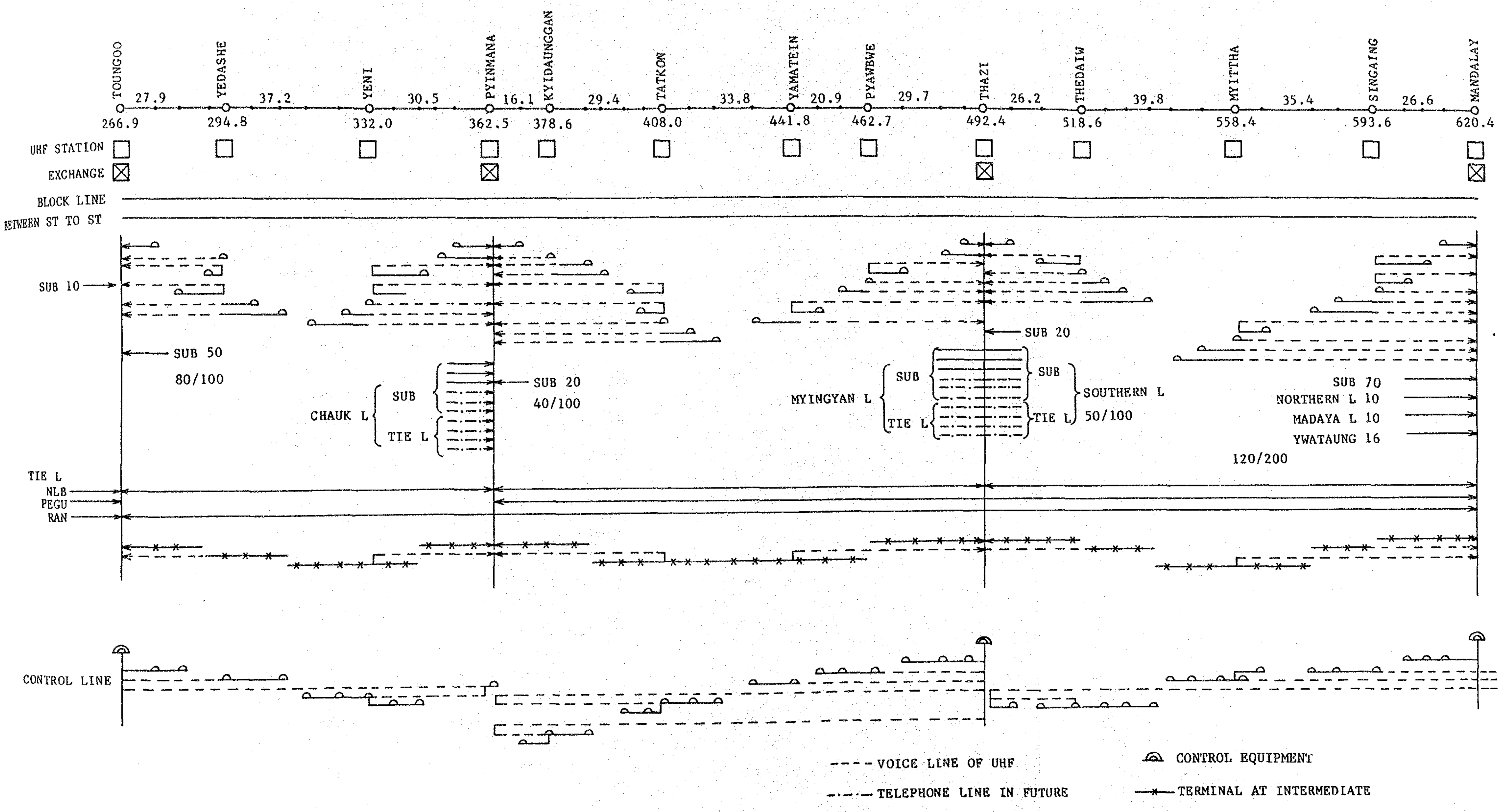


Fig. 7.3.2 Composition of Transmission Line

Source: Study Team

2) Exchange equipment

Exchanges will be installed at Pegu, Nyaunglebin, Toungoo, Pyinmana, Thazi, Mandalay, and Myitnge. Taking into consideration the reduction of speech loss and facsimile transmission, the exchanges will be four-line automatic electronic ones. Manual switchboards will be provided for PTC reception and information. But the Myitnge exchange is of the magneto type. Intermediate station telephone lines will be made independently, being one line.

3) Control telephone equipment

Divisional control offices and their areas of responsibility will be the same as they are at present. The main equipment under the frequency selection calling system will be provided at Rangoon, Toungoo, Thazi, and Mandalay, and slave telephones at each station and other places where necessary.

Along with cabling on the Mandalay Line, it is considered necessary to change control telephone lines on the Martaban Line and also to provide code relay equipment and an electric power source at Pegu. For this purpose, the Mandalay and Martaban lines will be separated until the completion of the Martaban line improvement. Slave control telephones will be provided with small-sized rectifiers and batteries; dry batteries will be used at stations without electric power source.

4) Wagon data processor system

The system centralizes wagon location control to make an appropriate wagon distribution plan and improve the efficiency of wagon operation.

As shown in Fig. 7.3.3, the wagon data processor units will be installed at the central control office and each divisional control office. The wagon data is collected at the divisional control offices from each station by telephone and put into a processor unit, then it is transferred to the central control office over telephone lines. The wagon data processor unit of the central control office forms a wagon distribution plan, which is transferred to each divisional control office, for giving wagon distribution instructions to each field office by telephone.

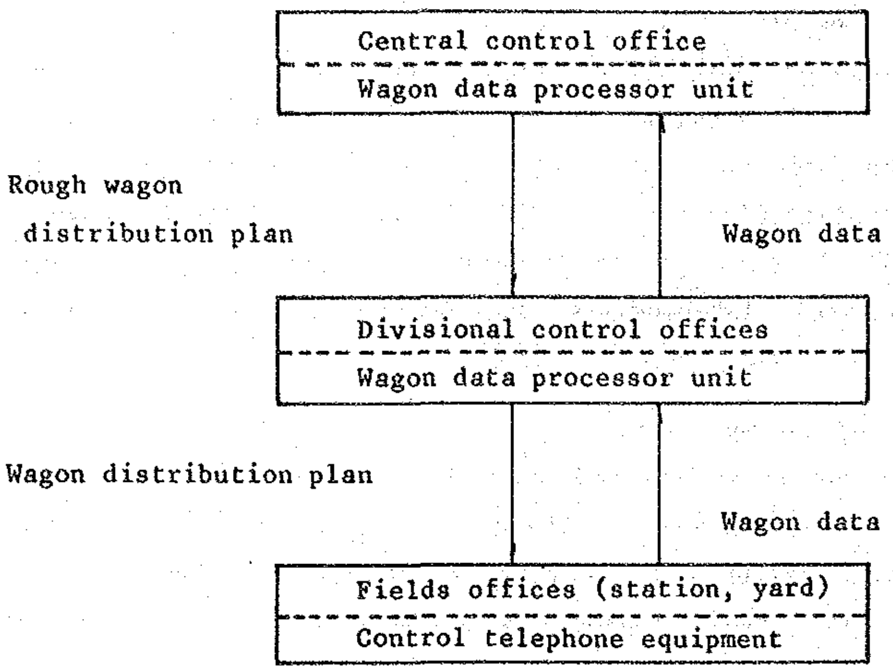


Fig. 7.3.3 System Configuration of Wagon Data Processor System

5) Facsimile equipment

To enhance operational efficiency, freight information will be transmitted between Mahlwagon, Myohaung Yards, and the main stations by using facsimile equipment via exchange lines.

6) Passenger information system

Passenger information system will be provided in major stations to indicate information, such as train numbers, arrivals and train departure time at platforms.

7) Train radio system

The system will be of simultaneous transmission/reception, up/down joint use, 150 MHz. The base station will be located at the place where the UHF microwave system is installed. Control equipment will be provided at each divisional control office, and a voice used to call trains. The composition is as shown in Fig. 7.3.4.

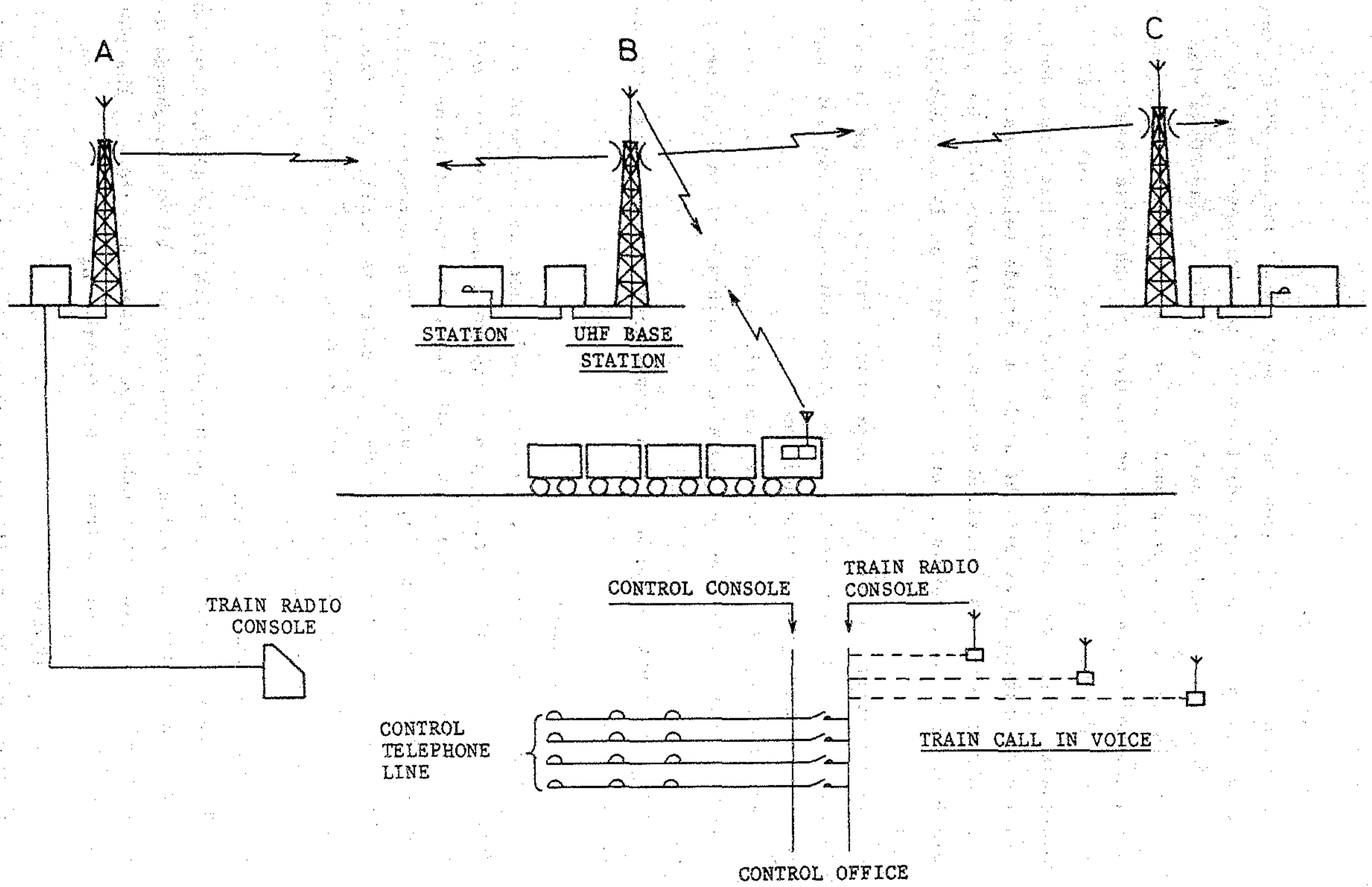


Fig. 7.3.4 Train Radio System

Source: Study Team

(2) Martaban line

1) Transmission line

A study has been made about underground cables and the UHF microwave network system. Since the distance of the Martaban Line is 203 km (127 miles) and the number of calls is small, it is planned as Plan A to provide 14 pairs of underground cables and 12-channel carriers for services; however, a noise problem remains, though noise level is not so high to disturb the business communication. In the future, UHF microwave will be adopted to extend lines toward Moulmein. Station-to-station lines will be used for wayside telephones. Power to the carrier repeaters installed at no-power stations will be supplied via cable core from terminal set. The composition is as shown in Fig. 7.3.5.

Plan B calls for the use of bare lines, installation of bare wires, jointly using the PTC route. The wires borrowed from PTC must be repaired to be kept in good condition.

For the tie line, a carrier system will be put on the bare line. In this case, carrier frequencies and wire positions must be discussed with PTC.

Bare lines will often be stolen, insulators broken, along with other troubles.

2) Exchange equipment

An automatic electronic exchange will not be suitable for the Martaban Line, since electric power equipment and repeaters will be quite expensive to provide, as most lines to the stations will be carriers. In addition, the capacity of the automatic electronic exchange is too large. The number of calls is small; therefore, an magneto exchange will be provided at Thaton, and subscriber lines connected to the Pegu exchange too.

3) Control telephone equipment

The main equipment will be jointly used with the Mandalay Line, and the frequency selection calling system adopted. Slave telephones will be provided at stations and other places where necessary. The power supply will be the same as that of the Mandalay Line.

4) Facsimile equipment

Freight information will be transmitted to the Mahlwagon yard from main station by facsimile equipment.

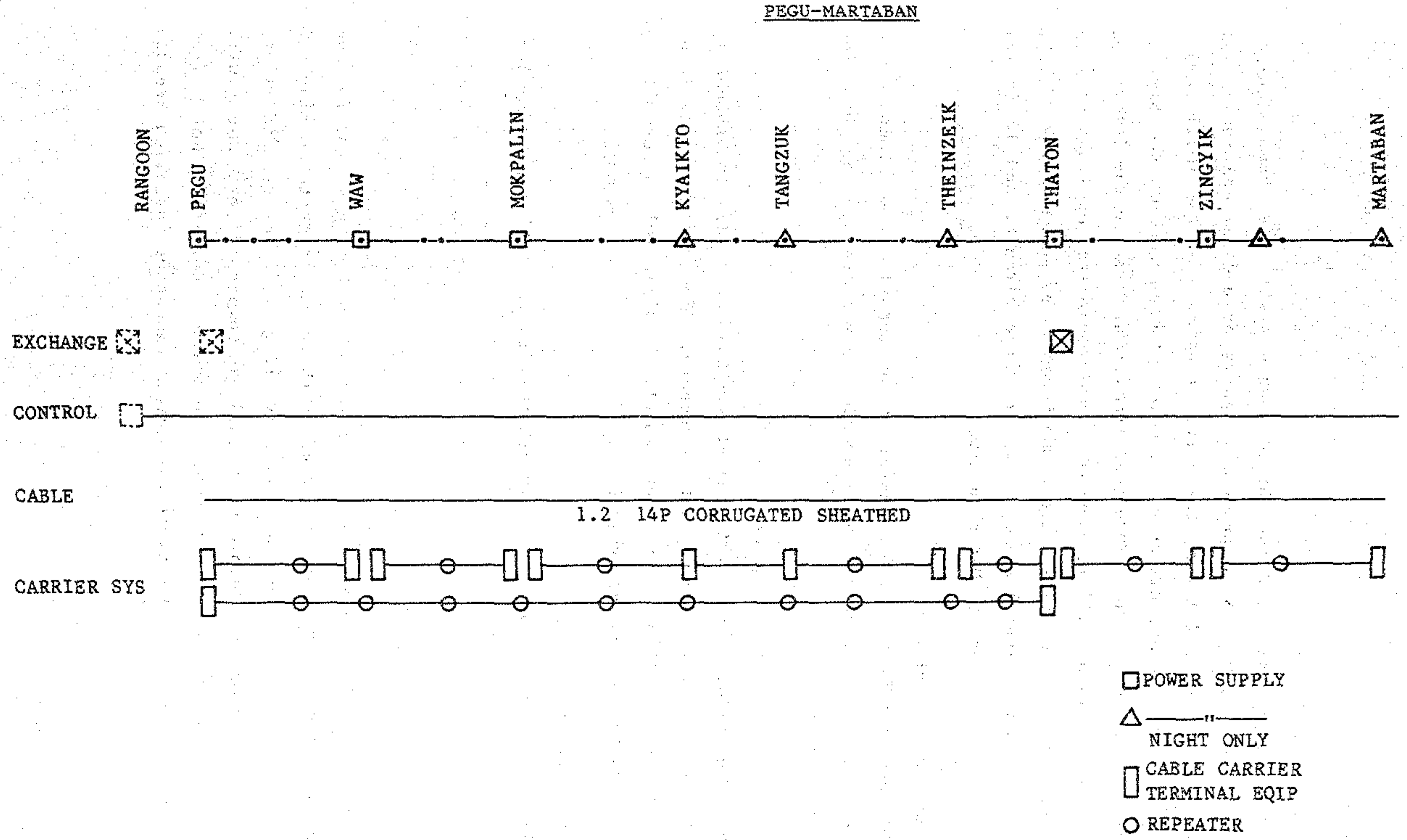


Fig. 7.3.5 Composition of Transmission Line (*Martaban Line*)

Source: Study Team

(3) Prome line

1) Transmission line

Underground cables and the UHF microwave system have been studied. It is planned as Plan A to provide 14 pairs of underground cables and 12-channel carriers, 2 types, for services because of the small number of lines and the short distance. A noise problem will be the same as that on the Martaban line. To extend lines from Prome in the future, on UHF microwave system will be adopted. Station-to-station lines will be used for wayside telephones. The composition is as shown in Fig. 7.3.6.

Plan B adopts installation of a bare line circuit, and it is the same as mentioned for the Martaban Line.

2) Exchange equipment

Magneto exchange will be installed at Letpadan and Prome. The reasons why magneto exchanges will be adopted are the same as those for the Martaban Line.

3) Control telephone equipment

Main equipment will be provided at Rangoon, and slave telephones at each station and other places where necessary. The calling system is of the frequency selection. The power supply to slave telephones will be the same as that of the Martaban Line.

4) Facsimile equipment

Freight information will be transmitted to the Mahlwagon yard from main station by facsimile.

(4) Myitkyina line

1) Transmission line

Lines will be composed of 14 pairs of underground cables and 12-channel carriers, 2 types, the same as those of the Martaban Line and Prome Line. This line is extremely long, 545 km or 342 miles; therefore, if carrier equipment is used to compose lines, noise will become larger; the longer the line, the worse the noise. North from Kawlin on this line, a UHF microwave system cannot be installed because

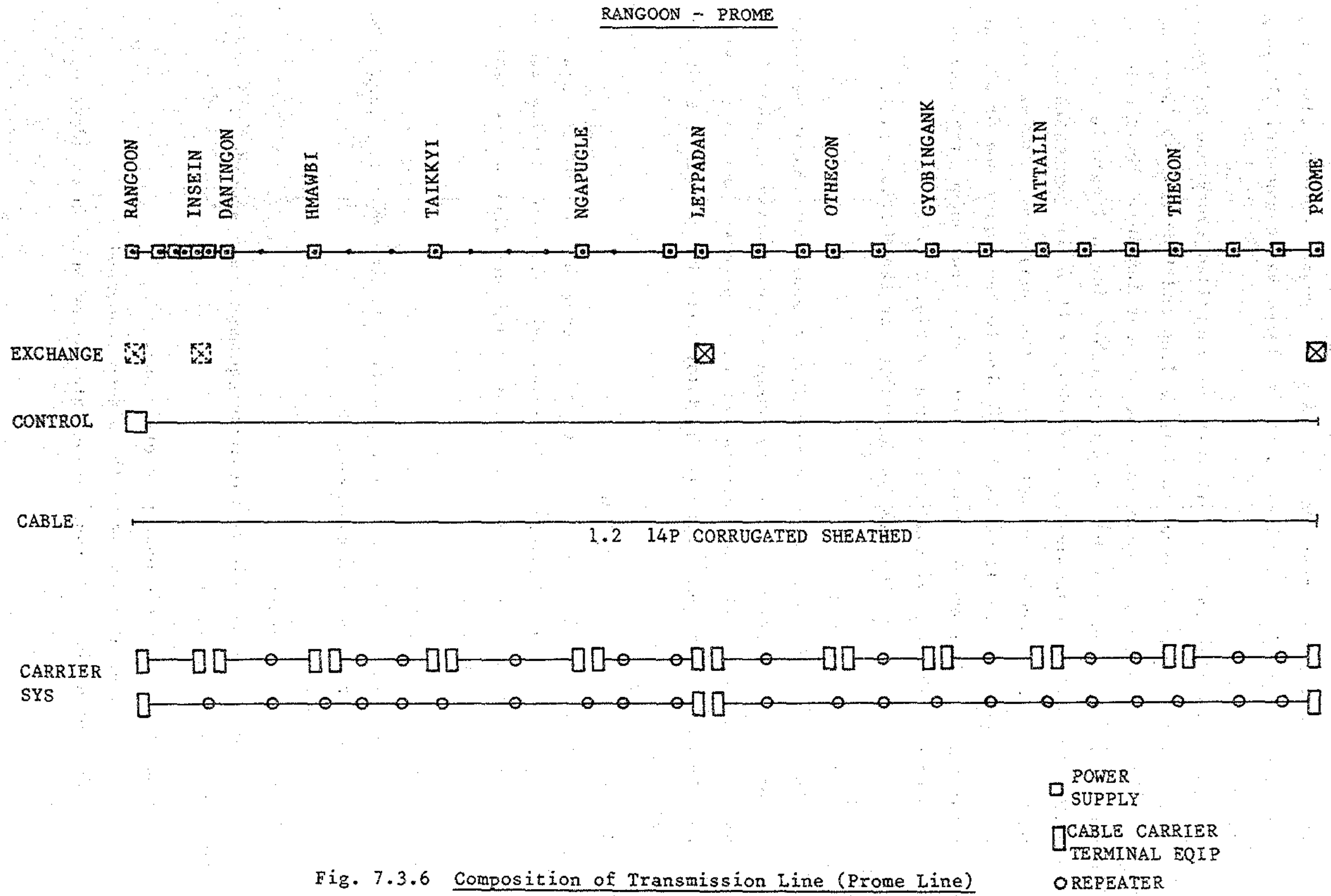


Fig. 7.3.6 Composition of Transmission Line (Prome Line)

Source: Study Team

of the mountanious areas and no electric power source; also, the capacity of the lines required is not so large as to use optical fiber cables.

Telephone line loading coils will be installed every one kilometer because the distance between stations is long and line loss is large and it is too difficult to reduce the loss without loading. There might be cases where frequency width is not suitable for a facsimile on this line. The use of a facsimile, therefore, will be limited to the place which can be connected directly with the carriers. Under these circumstances, noise will become larger due to the series use of carrier equipment. Station-to-station lines will be used for wayside telephones. The composition is as shown in Fig. 7.3.7.

Bare line plan is the same as described for the Martaban Line.

2) Exchange equipment

The number of places to provide exchange equipment cannot be small because the subscriber lines are composed by carriers; therefore, magneto exchanges will be installed at three places: Ywataung, Kawlin and Mohnyin. Stations close to Mandalay will be connected with the Mandalay exchange.

3) Control telephone equipment

Divisional control offices will be provided at three places: Mandalay, Kawlin and Mohnyin. The frequency selection calling system will be adopted. Power supply to slave telephones will be the same as that of the Martaban Line.

4) Facsimile equipment

Freight information will be transmitted to the Myohaung yard from main station by facsimile equipment.

7-3-3 Improvement Effects

The improvement of telecommunication equipment and systems will bring about the following effects:

(1) Enhancement of train operation efficiency

- Smooth communication among the places concerned
- Shortened time for transmitting information when an accident occurs

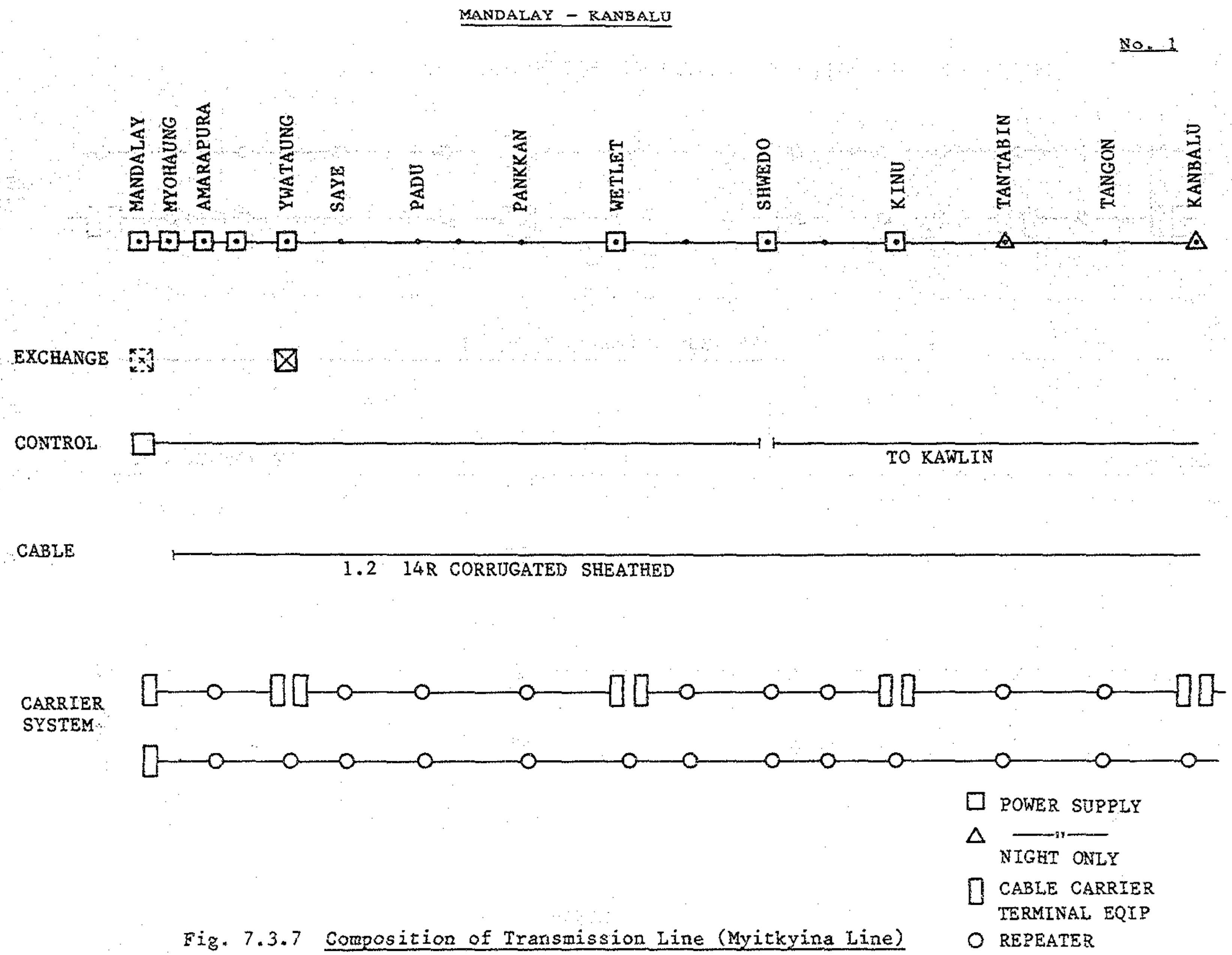


Fig. 7.3.7 Composition of Transmission Line (Myitkyina Line)

Source: Study Team

KANBALU - MAWLU

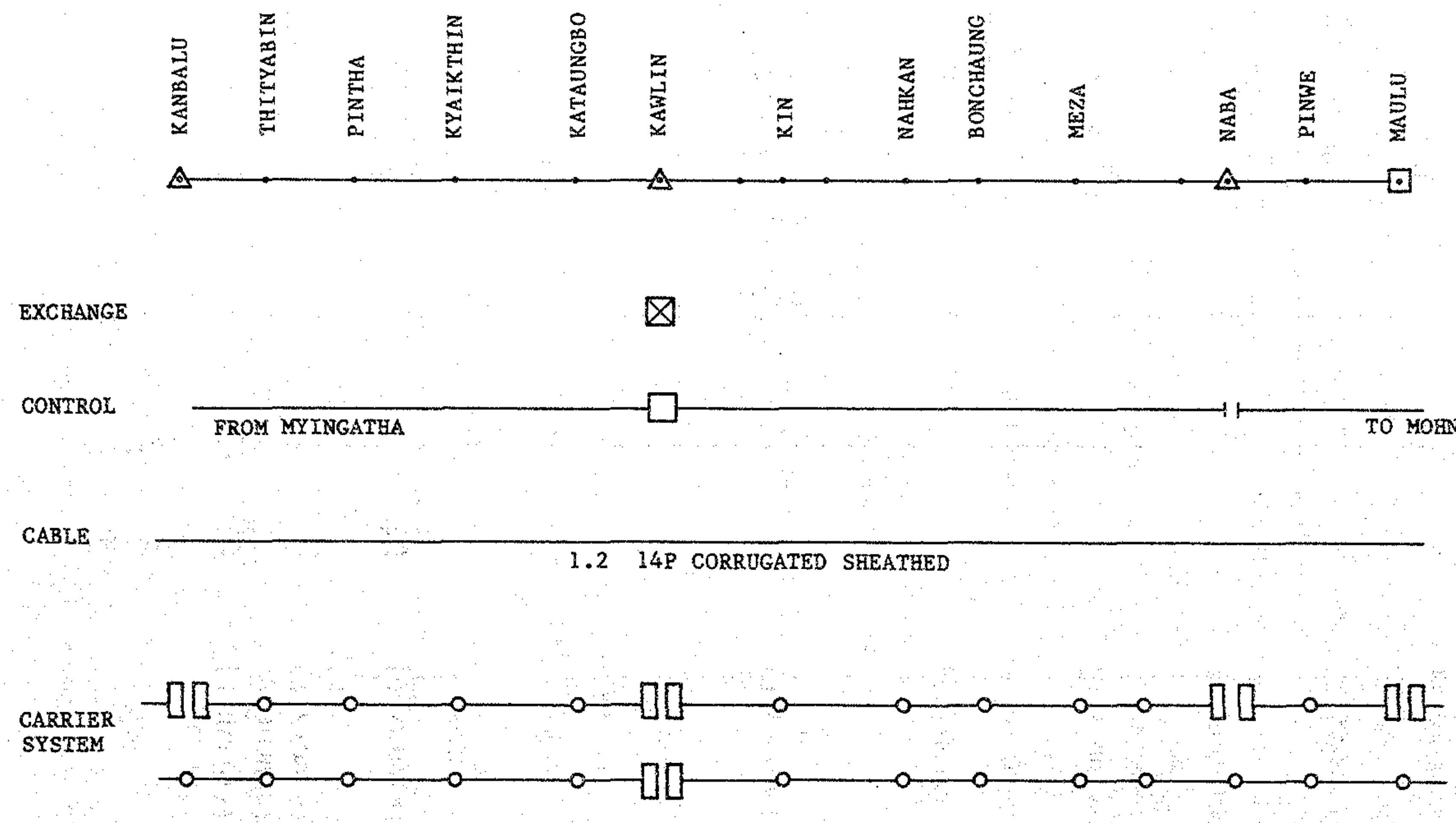


Fig. 7.3.7 Composition of Transmission Line (Myitkyina Line)

Source: Study Team

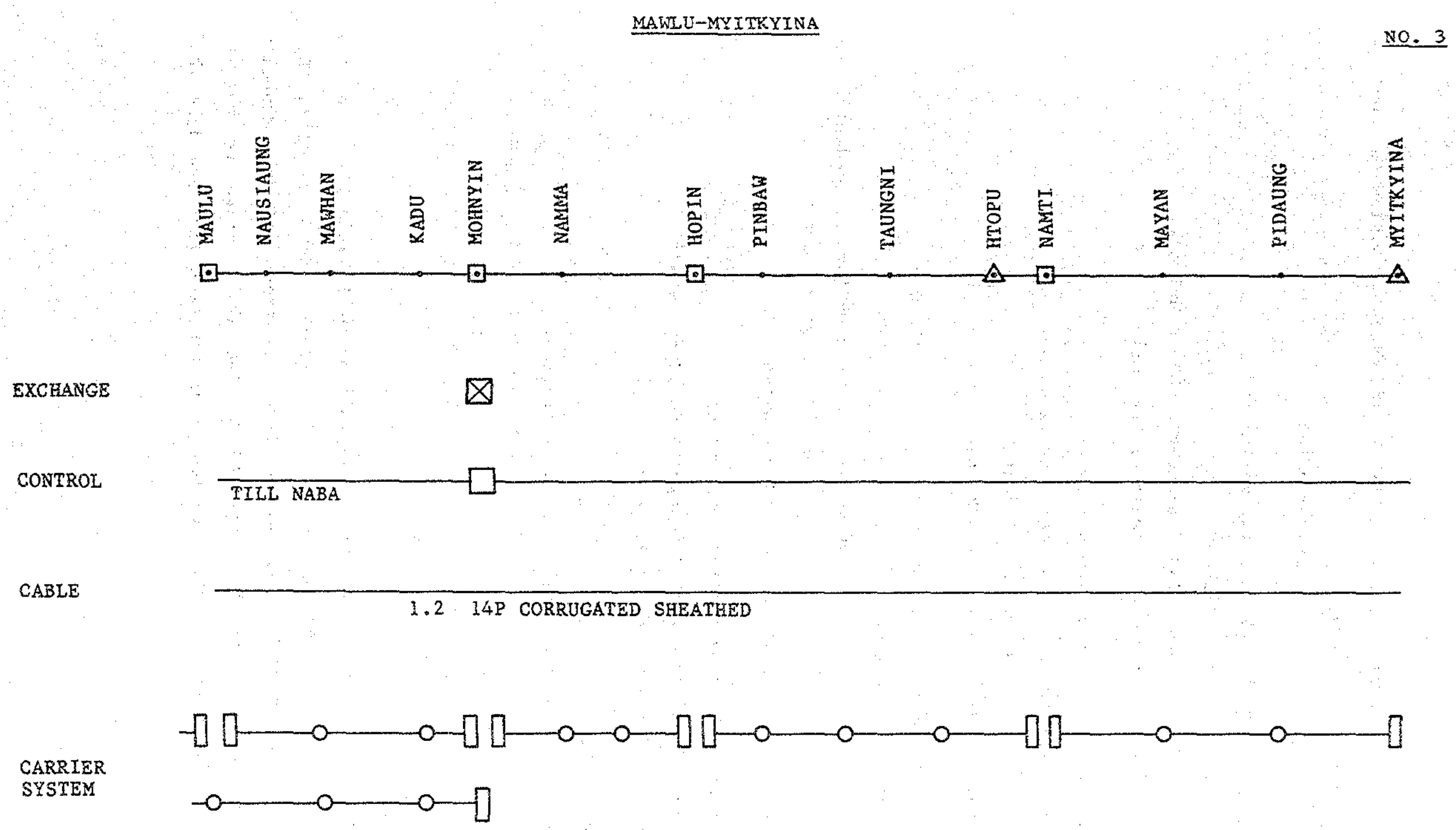


Fig. 7.3.7 Composition of Transmission Line (Myitkyina Line)

Source: Study Team