

APPENDIX G

TERRAIN PROFILE

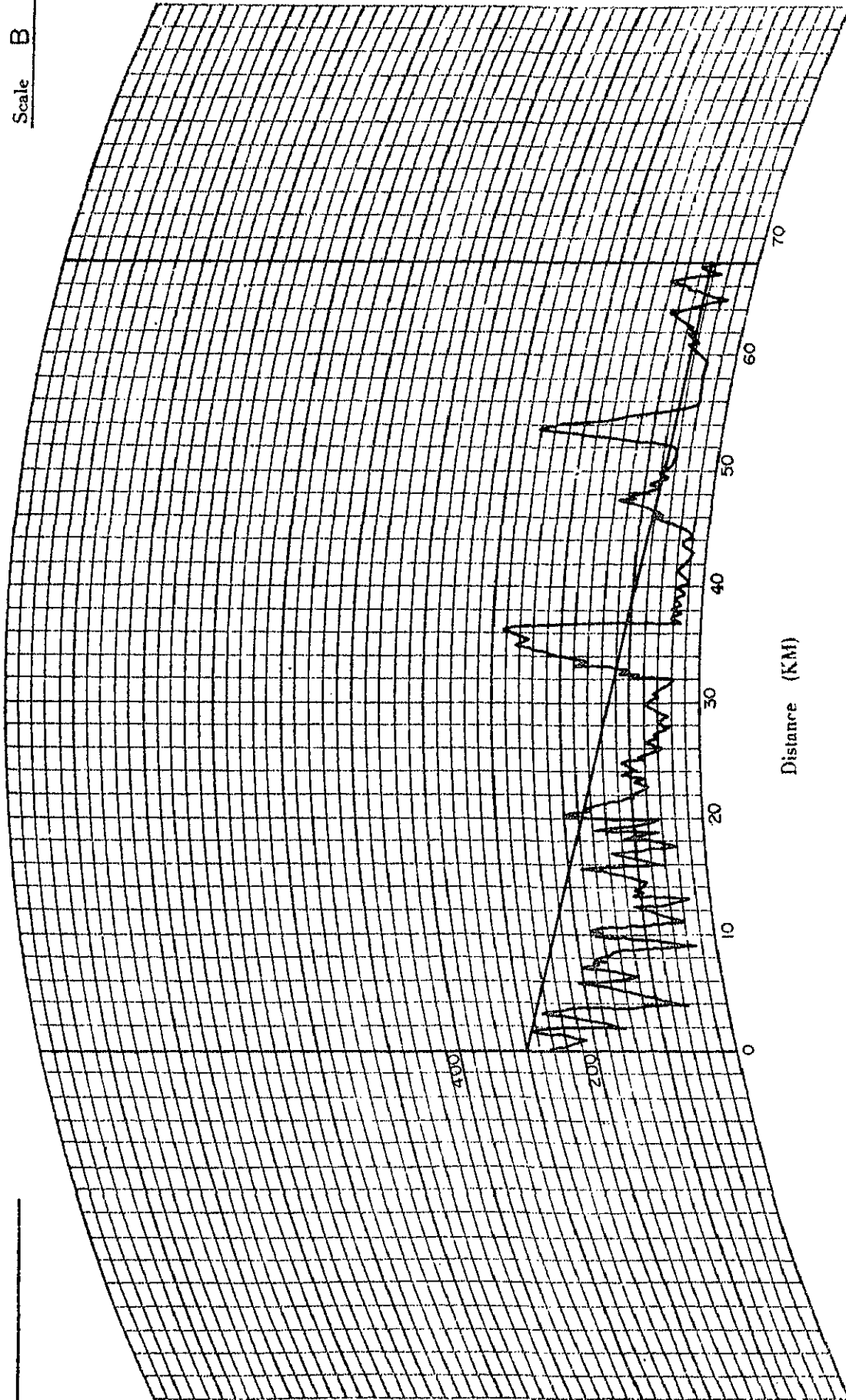
PROFILE (K=1/3)

Scale B

Full Scale
A = 4000m
B = 1000m
C = 250m

G I 1

Height (m)



Full Scale
A = 2000m
B = 1200m
C = 600m

Mt. Balat

Altitude 275 m

Antenna Height 30 m

Tangod

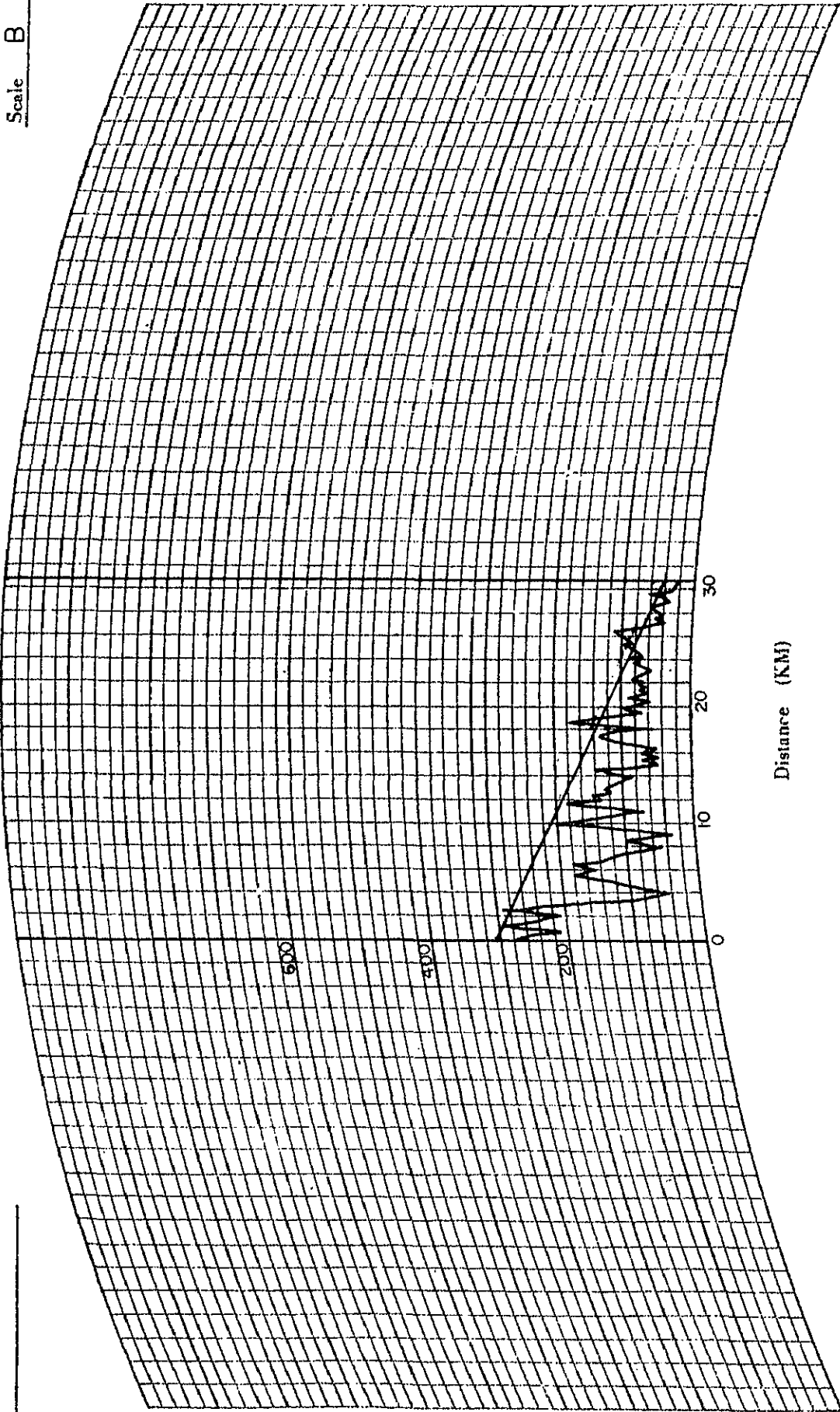
Altitude 45 m

Antenna Height 30 m

DATE	DESIGN	TRACE	CHECKED	APPR
DRAW NO.				M.P.E

PROFILE (K=1/3)

Scale B



Full Scale
 A = 1000m
 B = 1000m
 C = 250m

G I 2

Height (m)

Height (m)

Distance (KM)

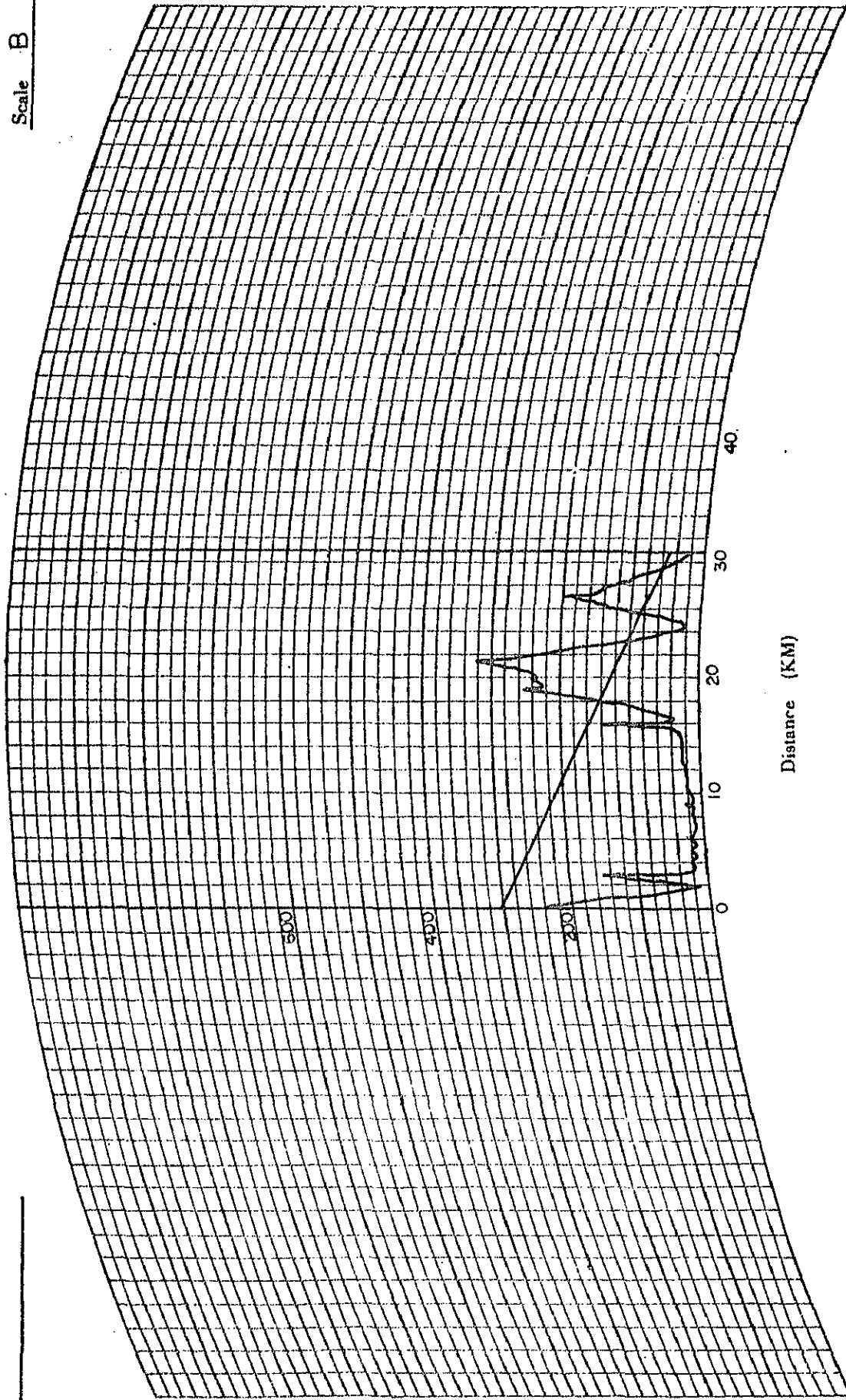
Mt. Balat Tangkulap
 Altitude 275 m Altitude 25 m
 Antenna Height 30 m Antenna Height 10 m
 Distance 31.1 KM

Full Scale
 A = 240km
 B = 120km
 C = 60km

DATE	DESIGN	TRACED	CHECKED	APPR
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PROFILE (K=1/3)

Scale B



Full Scale
 A= 1000m
 B= 1000m
 C= 250m

G I U

Height(m)

Height(m)

Distance (KM)

Mt. Balat

Ulu Kuamut

Full Scale
 A= 240km
 B= 120km
 C= 60km

Altitude 275 m

Altitude 25 m

Antenna Height 30 m

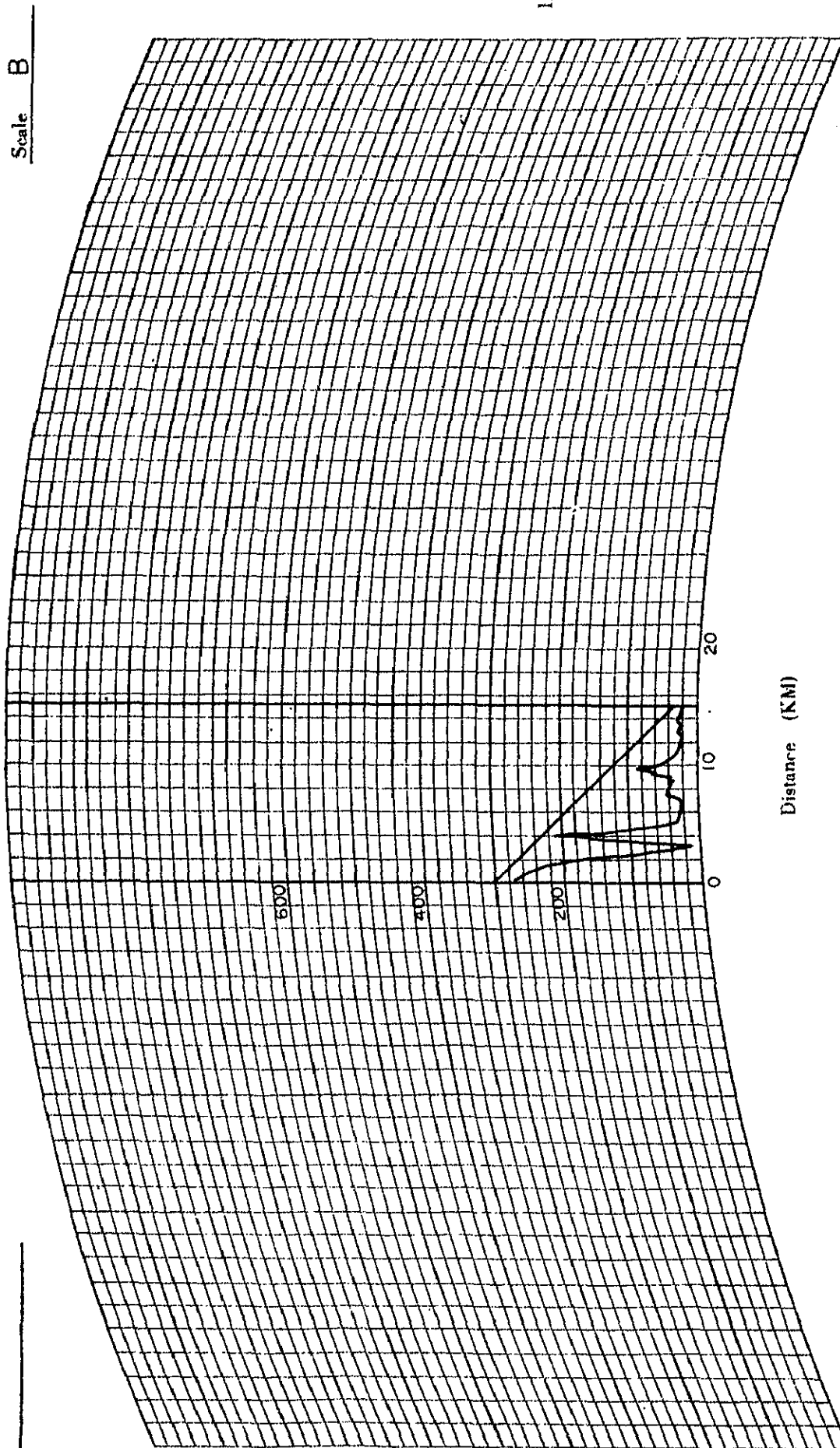
Antenna Height 30 m

31.3 KM

DATE	DESIGN	TRACED	CHECKED	APPR
DRAW NO.				M.P.E

PROFILE (K=4/3)

Scale B



Full Scale
 A= 4000m
 B= 1000m
 C= 250m

Height(m)

Height(m)

Distance (KM)

Mt. Balat Kuamut
 Altitude.....275.....m Altitude.....20.....m
 Antenna Height...30.....m Antenna Height...10.....m

DATE	DESIGN	TRACED	CHECKED	APPR
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Full Scale
 A= 240km
 B= 120km
 C= 60km

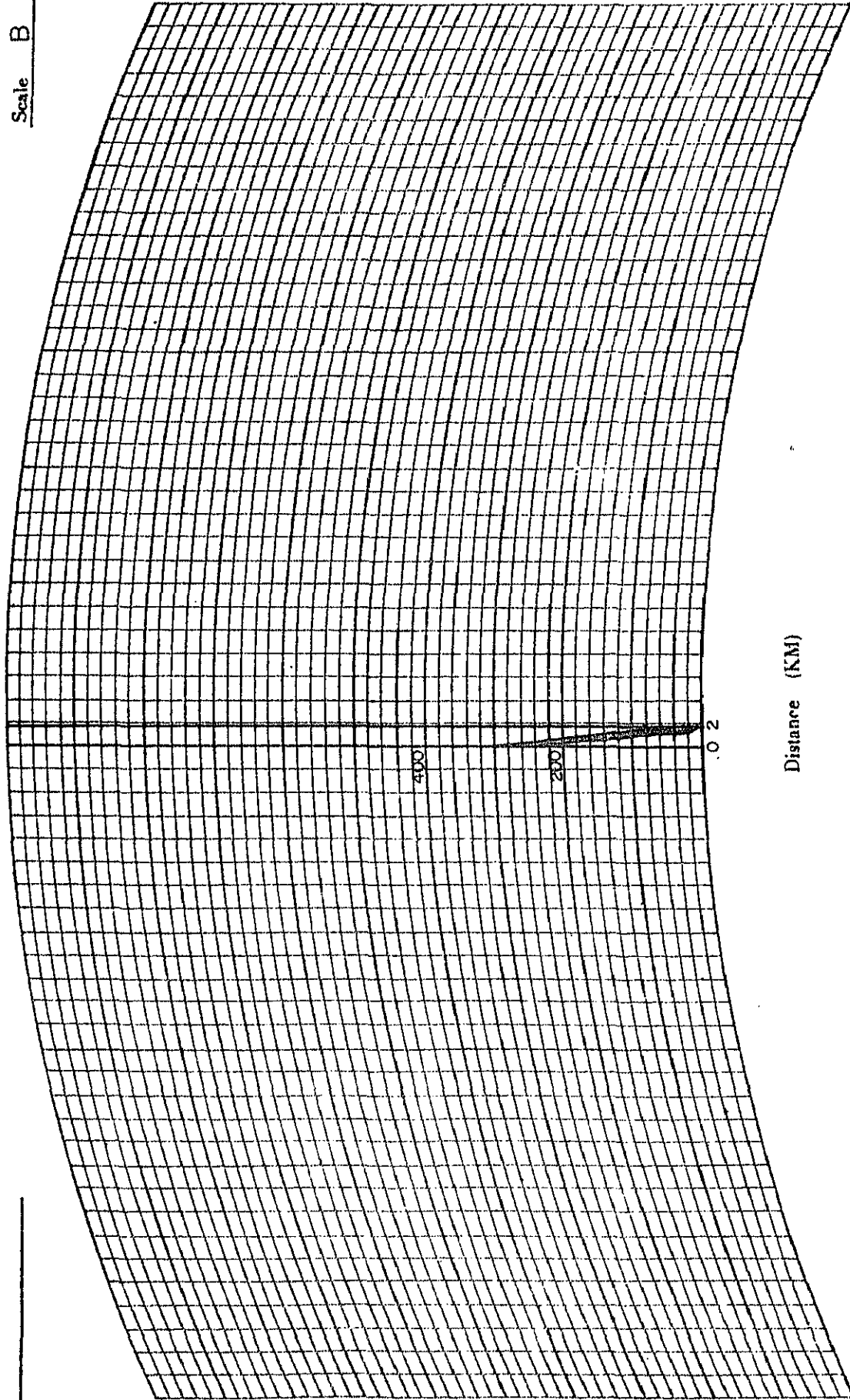
PROFILE (K=1/3)

Scale B

Full Scale
A = 4000m
B = 1000m
C = 250m

G I 5

Height (m)



Height (m)

Distance (KM)

Full Scale
A = 240km
B = 120km
C = 60km

Mt. Balat

Altitude 275 m

Antenna Height 30 m

Balat

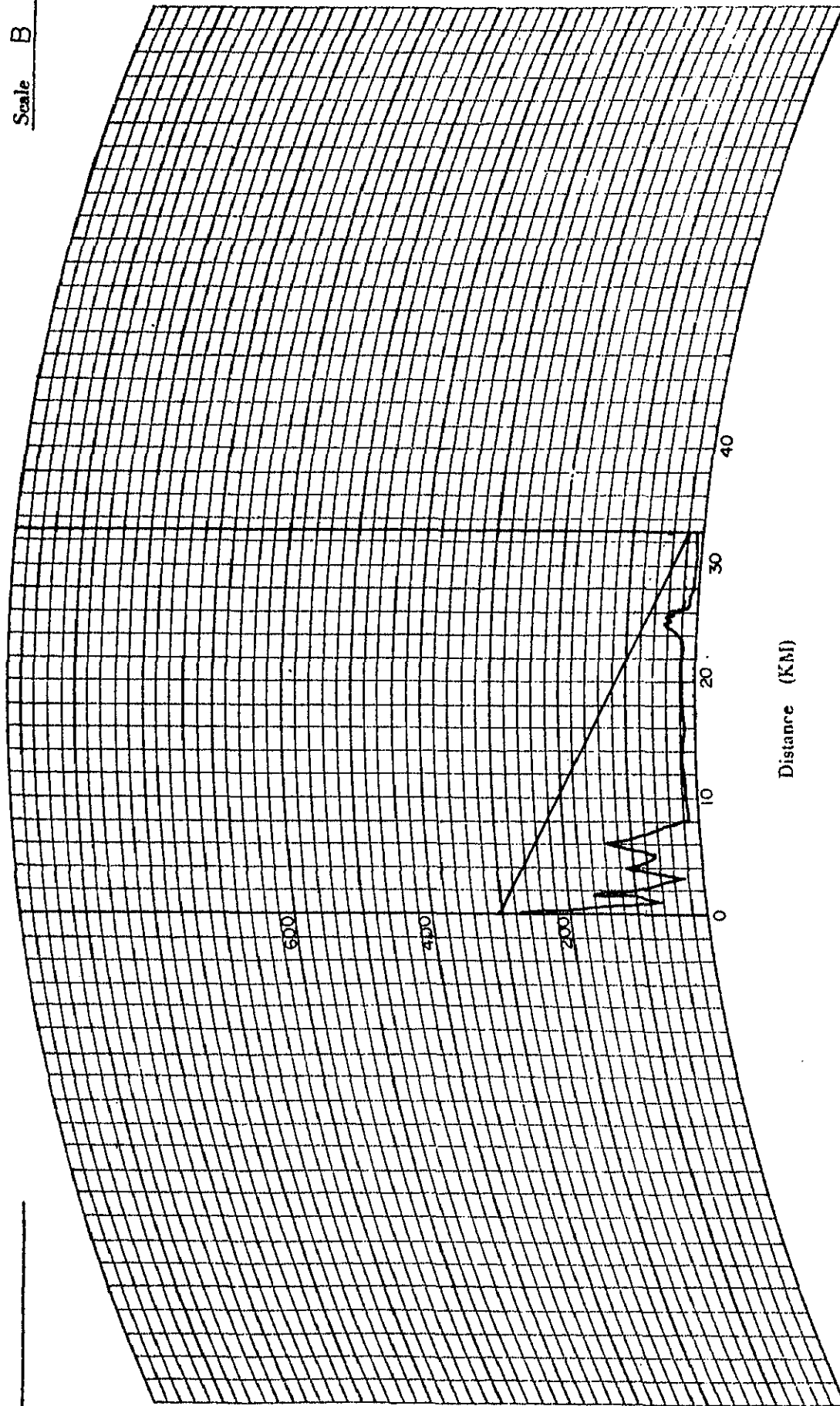
Altitude 15 m

Antenna Height 10 m

DATE	DESIGN	TRACED	CHECKED	APPR
DRAW NO.				M.P.E

PROFILE (K=1/3)

Scale B



Full Scale
 A = 1000m
 B = 1000m
 C = 250m

G 1 6

Height (m)

Height (m)

Distance (KM)

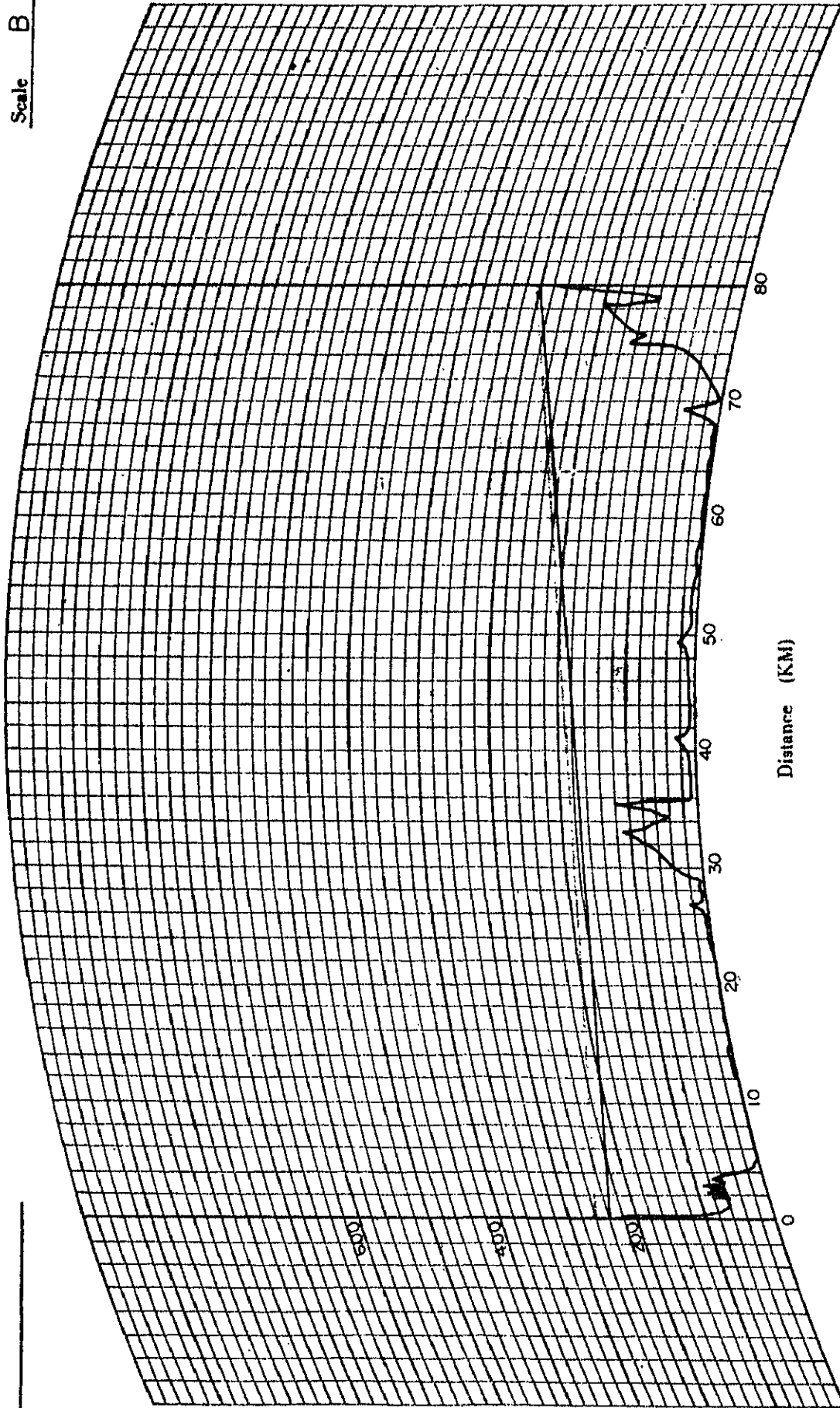
Mt. Balat Bukit Garam
 Altitude 275 m Altitude 8 m
 Antenna Height 30 m Antenna Height 1.0 m

Full Scale
 A = 240km
 B = 120km
 C = 60km

DATE	DESIGN	TRACED	CHECKED	APPR
DRAW NO. M.P.E				

PROFILE (K=1/3)

Scale B



Full Scale
 A= 4000m
 B= 1000m
 C= 250m

G I 8

Height(m)

Height(m)

Distance (KM)

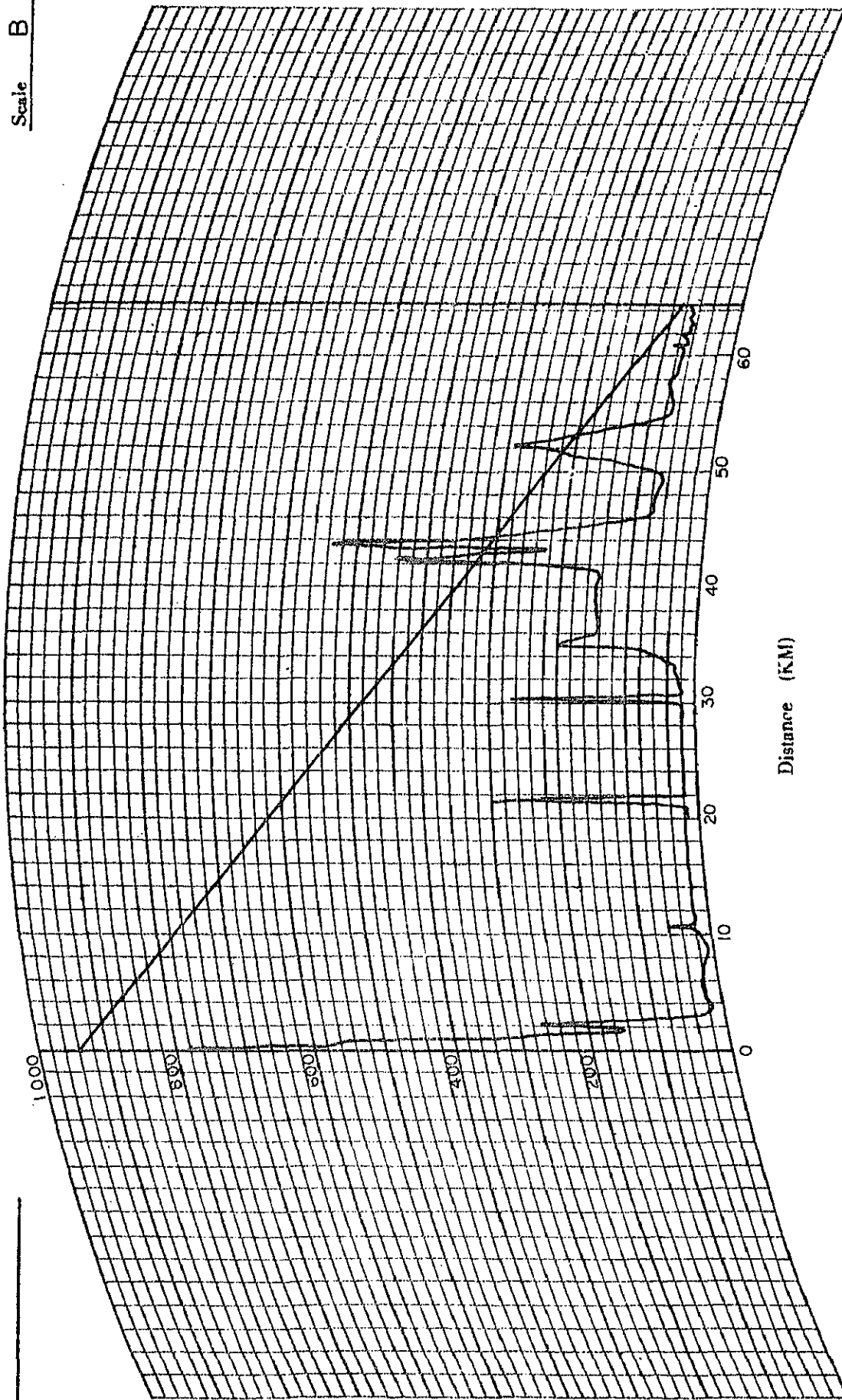
<u>Trig Hill</u>	<u>Mt. Balat</u>
Altitude <u>250</u> m	Altitude <u>275</u> m
Antenna Height <u>10</u> m	Antenna Height <u>30</u> m
	Distance <u>80.2</u> KM

DATE	DESIGN	CHECKED	APPR
DRAW NO.			M.P.E

Full Scale
 A= 240km
 B= 120km
 C= 60km

PROFILE (K=1/3)

Scale B



Full Scale
 A= 4000m
 B= 1000m
 C= 250m

G - 9

Height(m)

Height(m)

Distance (KM)

Mt. Serapi

Tebedu

Full Scale
 A= 240km
 B= 120km
 C= 60km

Altitude 910 m

Altitude 76 m

64.3 KM

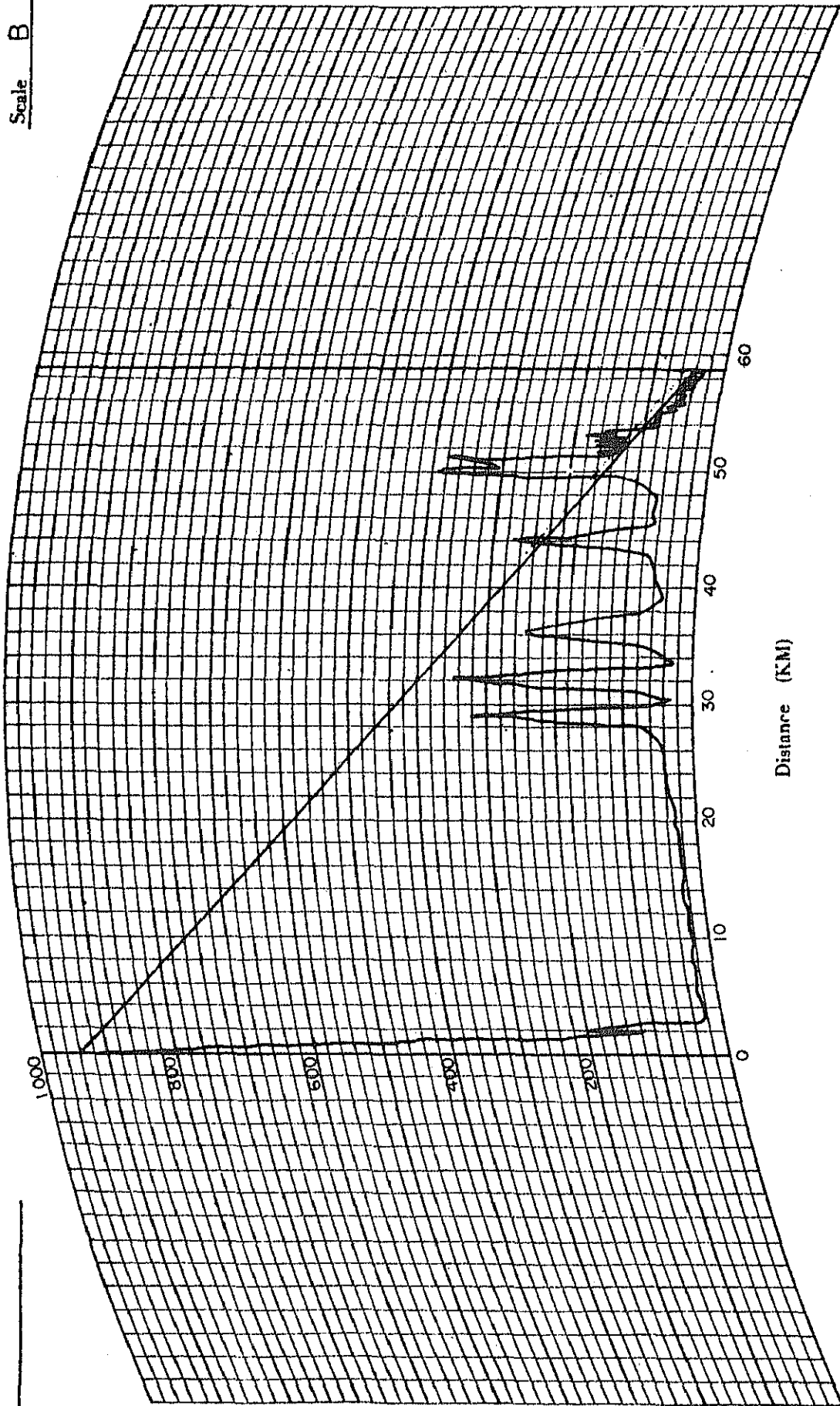
Antenna Height 30 m

Antenna Height 10 m

DATE	DESIGN	TRACED	CHECKED	APPR
DRAW NO. <u>M.P.E</u>				

PROFILE (K=1/3)

Scale B



Full Scale
A = 1000m
B = 1000m
C = 250m

G - 10

Height (m)

Height (m)

Distance (KM)

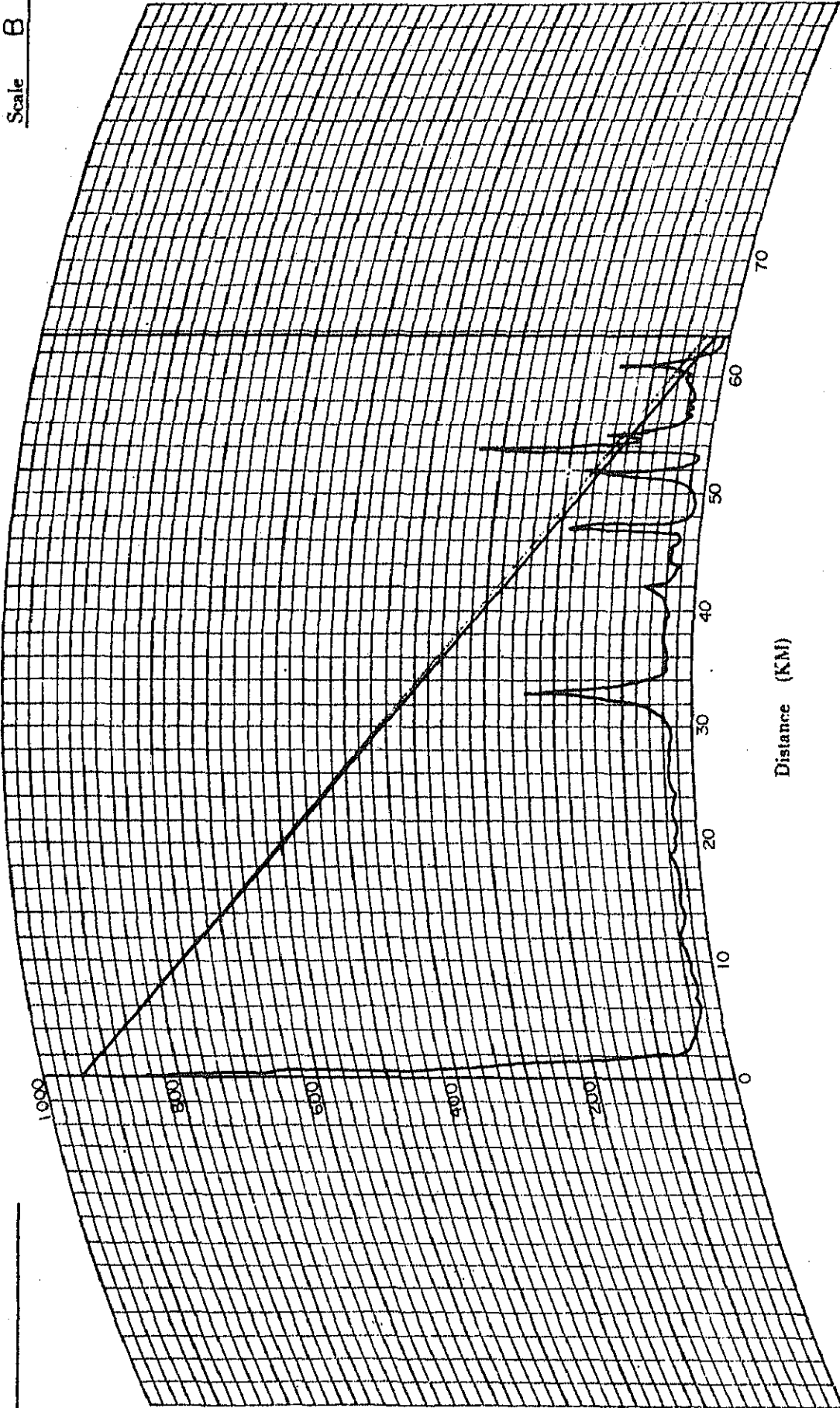
Full Scale
A = 240km
B = 120km
C = 60km

Mt. Serapi Kayan River
Altitude 910 m Altitude 30 m
Antenna Height 30 m Antenna Height 10 m

DATE	DESIGN	CHECKED	APPR
DRAW NO. <u>M.P.E</u>			

PROFILE (K=1/3)

Scale B



Full Scale
 A= 4000m
 B= 1000m
 C= 250m

G - 12

Height(m)

Height(m)

Distance (KM)

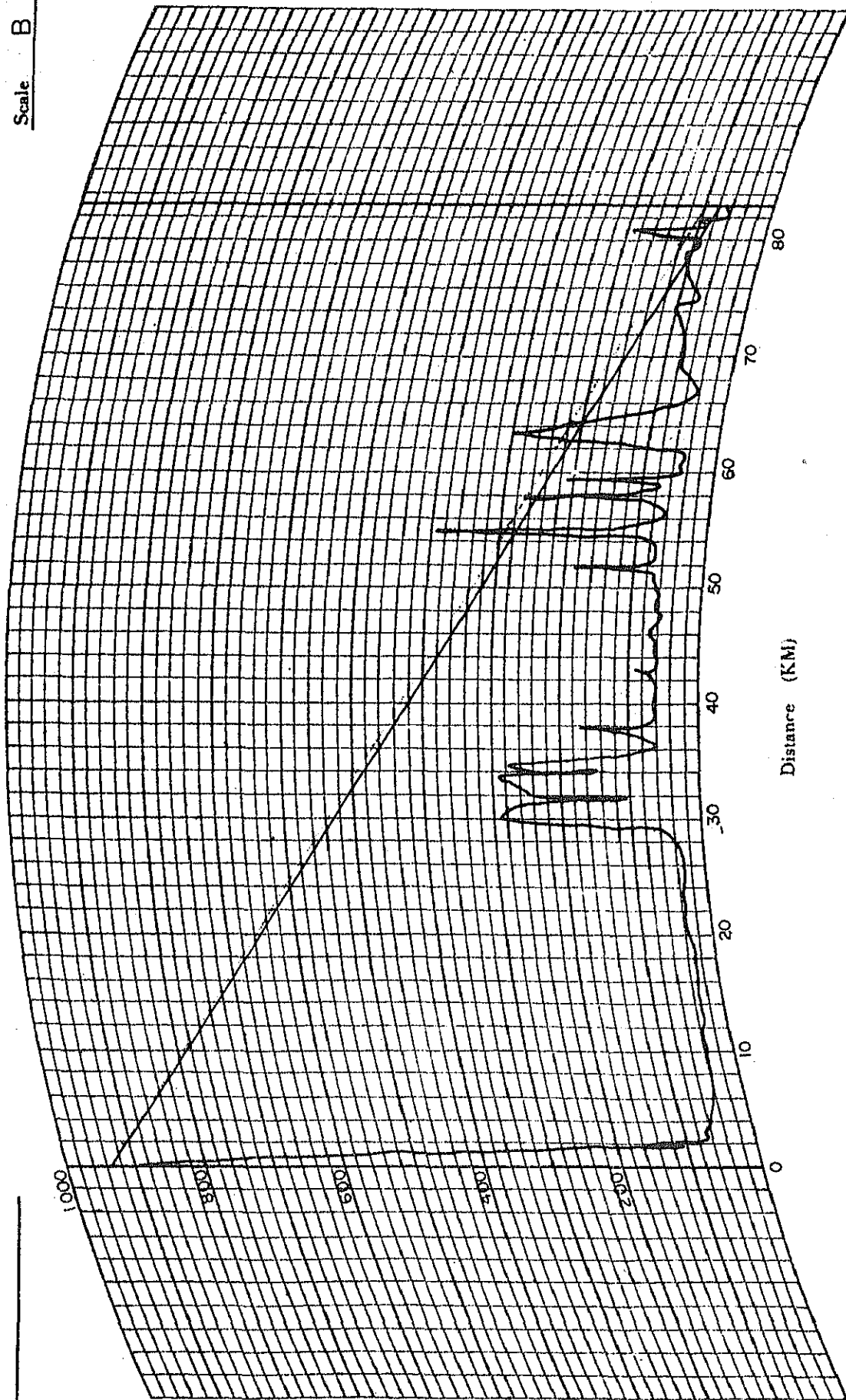
Mt. Serapi Tebakang
 Altitude 910 m Altitude 10 m
 Antenna Height 30 m Antenna Height 10 m

Full Scale
 A= 240km
 B= 120km
 C= 60km

DATE	DESIGN	TRACED	CHECKED	APPR
DRAW NO. M.P.E				

PROFILE (K=1/3)

Scale B



Full Scale
 A= 4000m
 B= 1000m
 C= 250m

G - 13

Height (m)

Height (m)

Distance (KM)

Mt. Serapi

Mongkos

Full Scale
 A= 240km
 B= 120km
 C= 60km

Altitude 910 m

Altitude 70 m

82.7 KM

Antenna Height 30 m

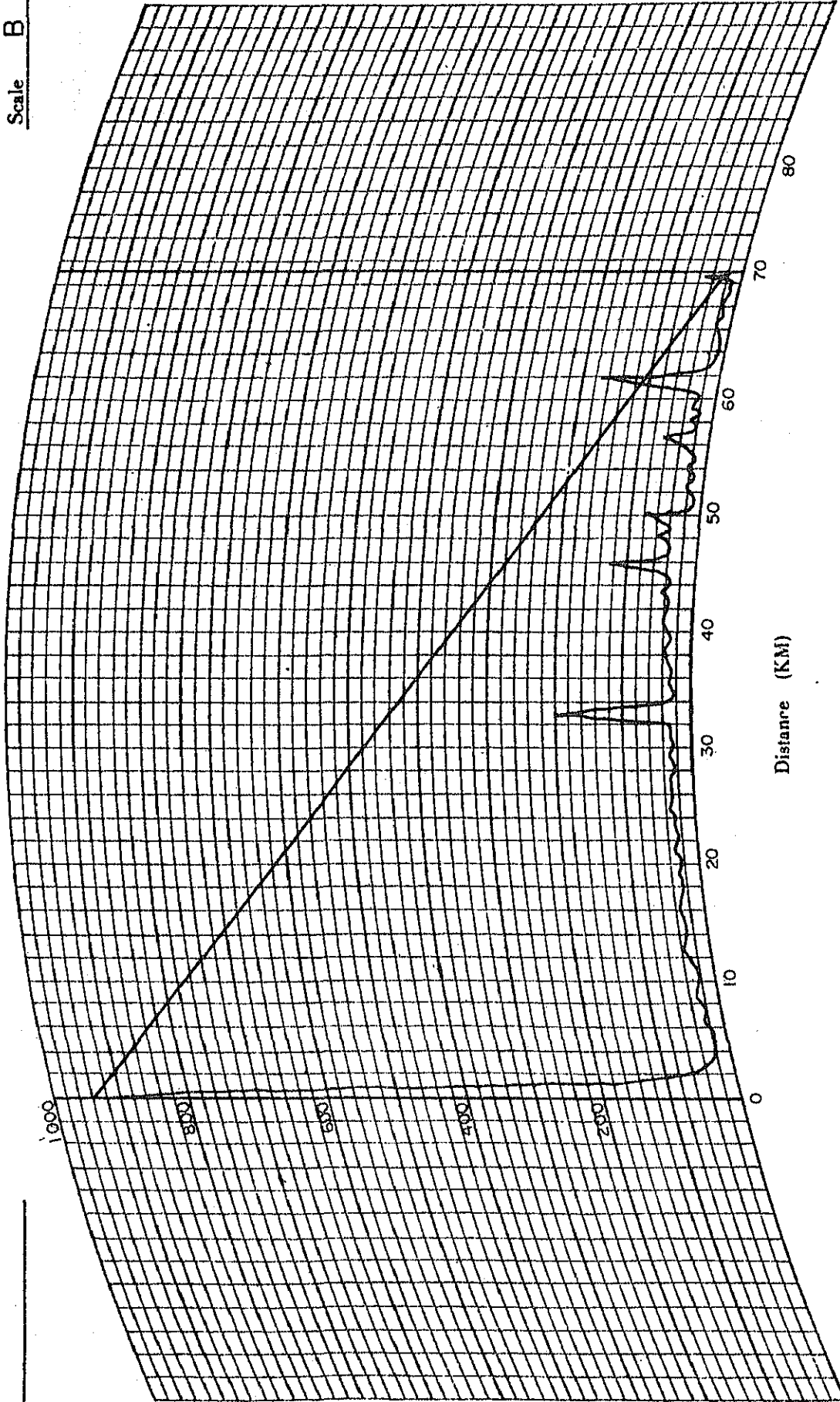
Antenna Height 10 m

DATE DESIGN CHECKED APPR

DRAW NO. M.PE

PROFILE (K=1/3)

Scale B



Full Scale
 A = 1000m
 B = 1000m
 C = 250m

G I 14

Height(m)

Height(m)

Distance (KM)

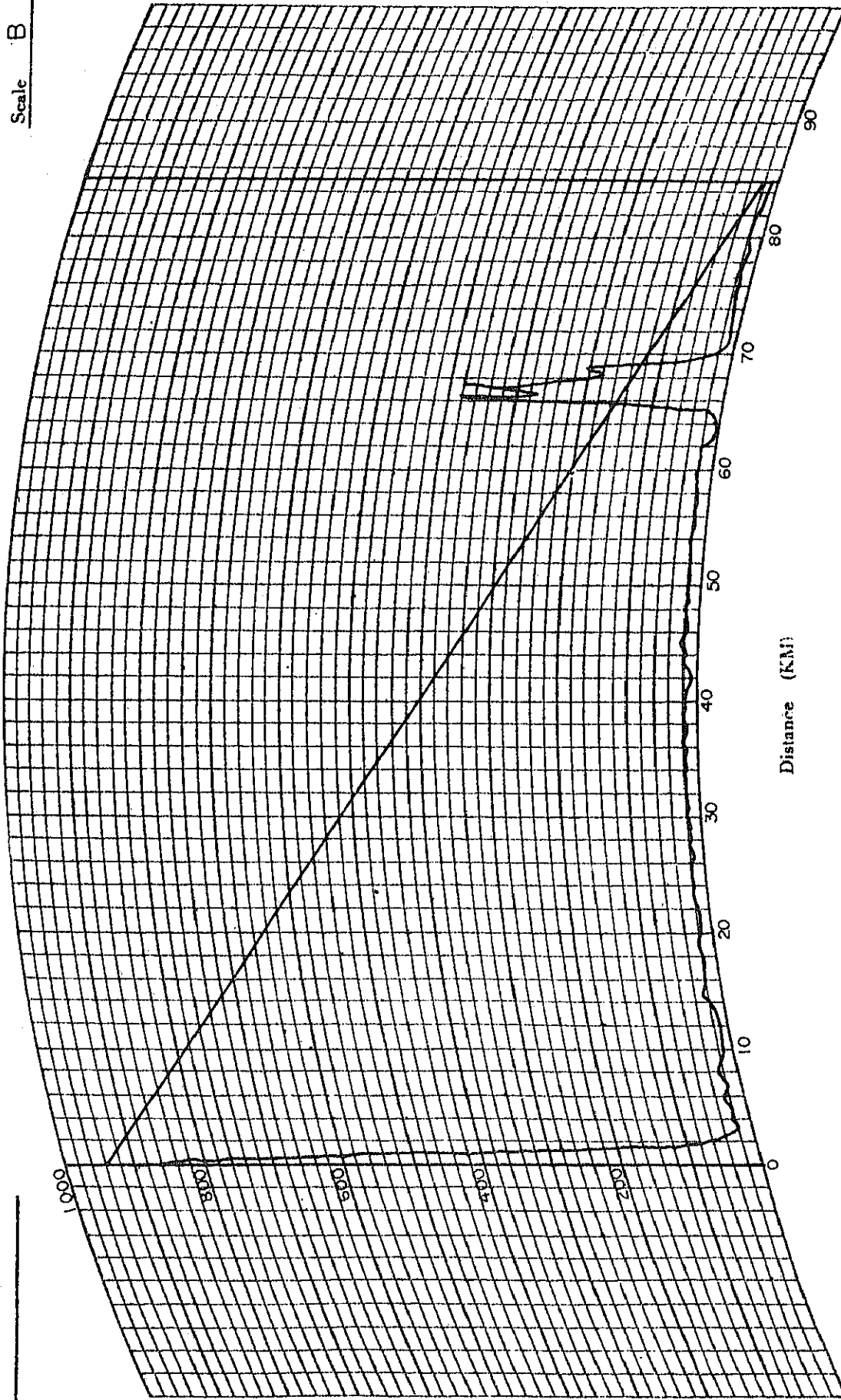
Full Scale
 A = 240km
 B = 120km
 C = 60km

Mt. Serapi Meringgu
 Altitude 910 m Altitude 15 m
 Antenna Height 30 m Antenna Height 10 m

DATE	DESIGN	TRACED	CHECKED	APPR.
DRAW NO. <u>M.P.E</u>				

PROFILE (K=1/3)

Scale B



Full Scale
A= 1000m
B= 1000m
C= 250m

G - 15

Height(m)

Height(m)

Distance (KM)

Full Scale
A= 240km
B= 120km
C= 60km

Mt. Serapi

Altitude 910 m

Antenna Height .. 30 m

Balai Ringin

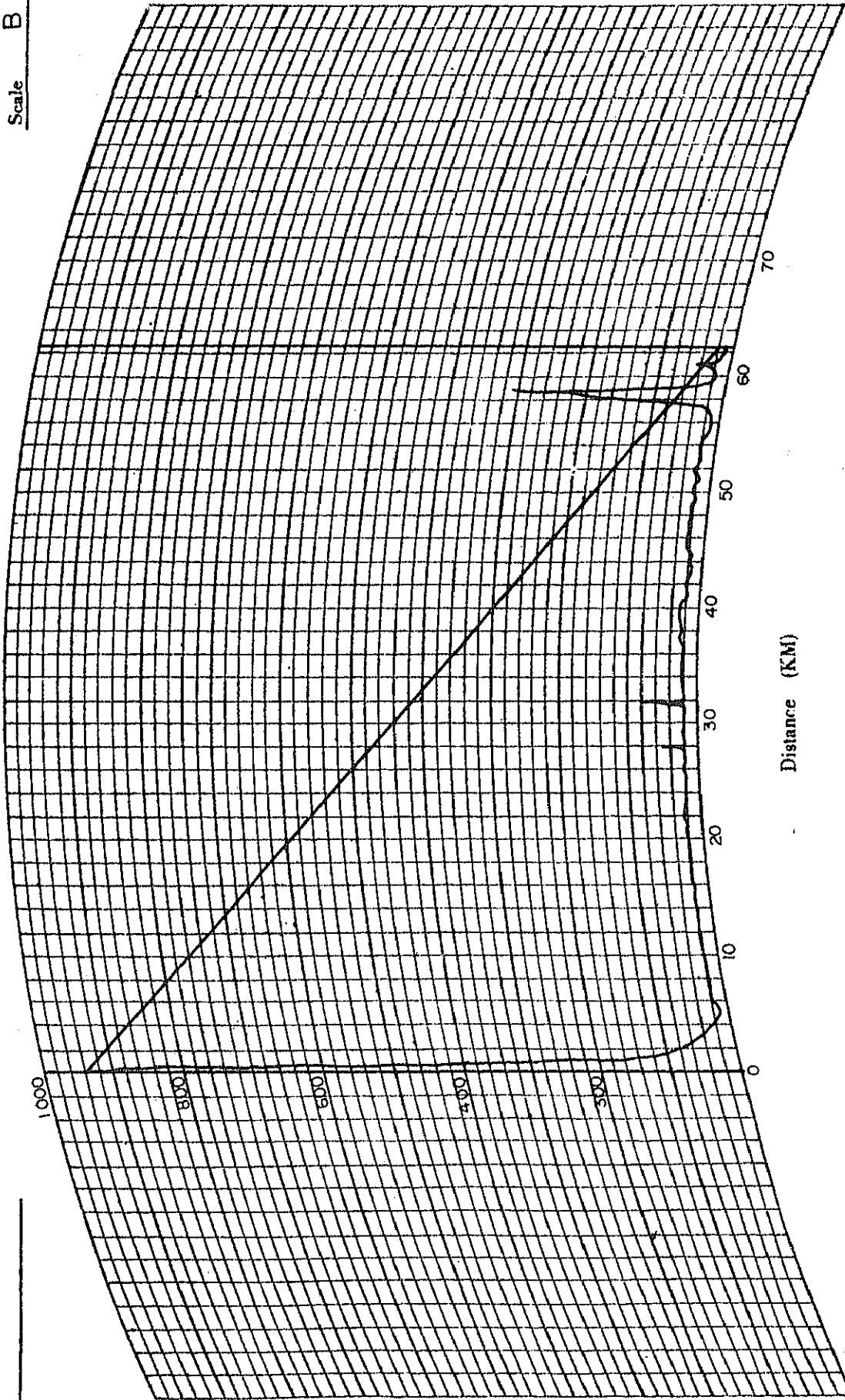
Altitude 10 m

Antenna Height .. 10 m

DATE	DESIGN	TRACED	CHECKED	APPR
DRAW NO. M.PE				

PROFILE (K=1/3)

Scale B



Full Scale
 A= 4000m
 B= 1000m
 C= 250m

G - 17

Height (m)

Height(m)

Distance (KM)

Full Scale
 A= 240km
 B= 120km
 C= 60km

Mt. Serapi Serian

Altitude 910 m

Altitude 10 m

62.8 KM

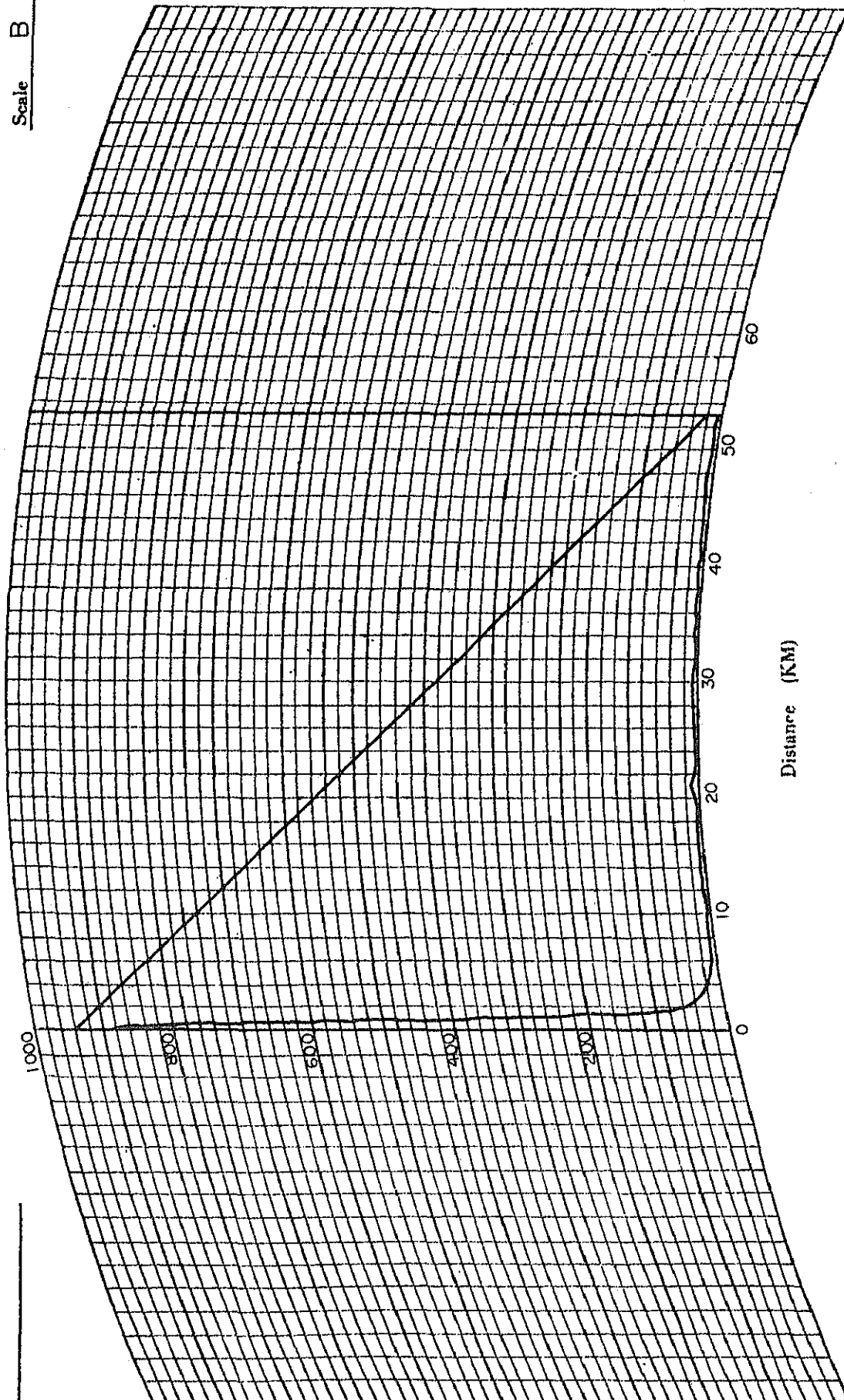
Antenna Height 30 m

Antenna Height 10 m

DATE	DESIGN	TRACED	CHECKED	APPR
DRAW NO.				M, PE

PROFILE (K=1/3)

Scale B



Full Scale
A = 4000m
B = 1000m
C = 250m

Height(m)

Height(m)

Distance (KM)

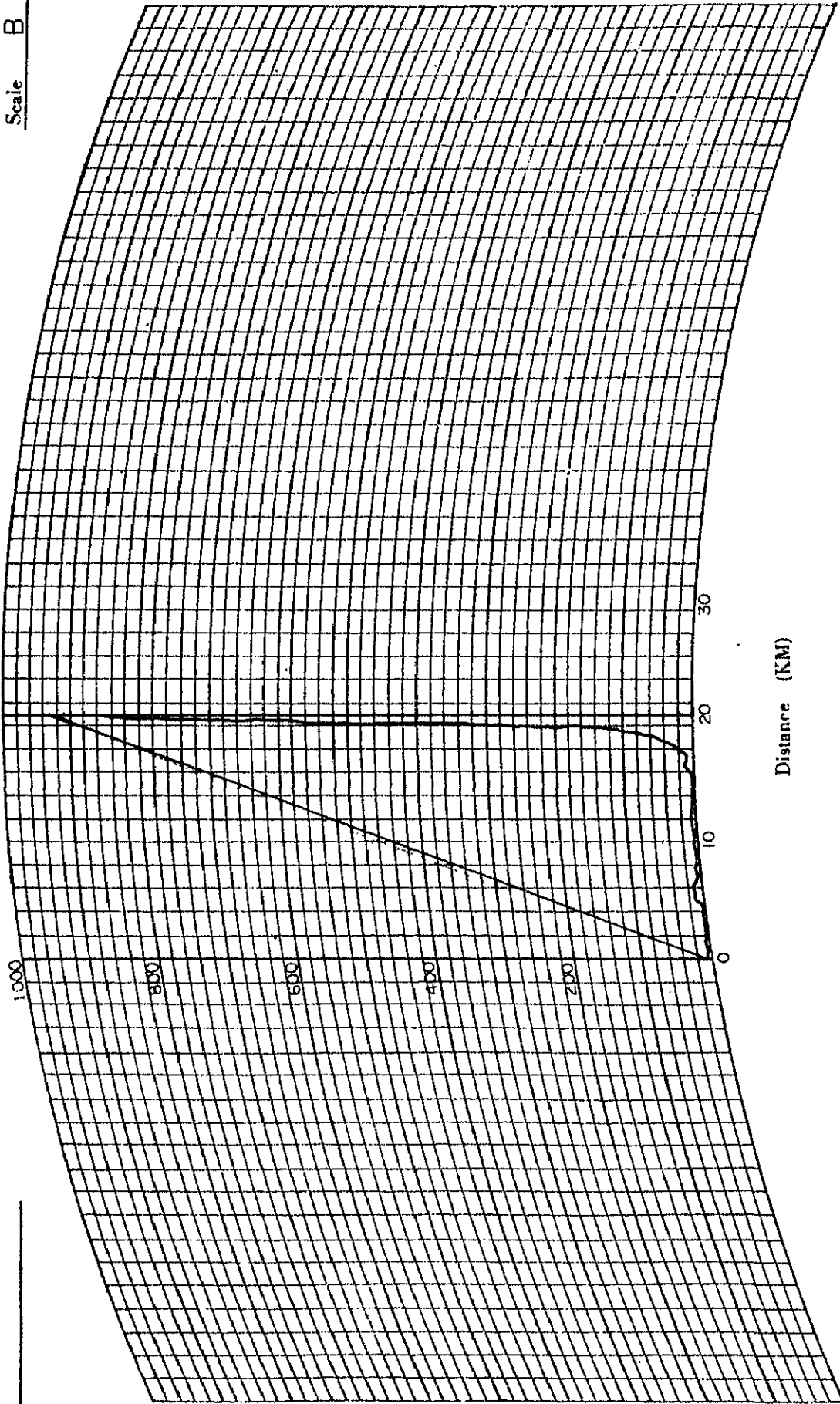
Full Scale
A = 240km
B = 120km
C = 60km

Mt. Serapi Altitude 910 m Antenna Height 30 m
 Ensengei Altitude 5 m Antenna Height 10 m

DATE	DESIGN	TRACED	CHECKED	APPR
DRAW NO.				M.P.E

PROFILE (K=1/3)

Scale B



Full Scale
 A = 1000m
 B = 1000m
 C = 250m

G - 20

Height (m)

Height (m)

Distance (KM)

DID Bintawa Mt. Serapi
 Altitude 55 m Altitude 910 m
 Antenna Height 10 m Antenna Height 30 m

DATE	DESIGN	TRACED	CHECKED	APPR
DRAW NO. <u>M.P.E</u>				

Full Scale
 A = 240km
 B = 120km
 C = 60km

APPENDIX H

RAINFALL AND WATER-LEVEL
TELEMETERING SYSTEM
STANDARD SPECIFICATIONS

RAINFALL AND WATER-LEVEL TELEMETERING SYSTEM

STANDARD SPECIFICATIONS

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CHAPTER 1 GENERAL

1-1 Scope

These specifications cover the rainfall and water-level telemetering system (called "this system" hereinafter) for river, dam and road management. Special operations and additional functions not covered by these specifications shall conform with the Specifications For Special Items (called "SSI" hereinafter).

1-2 Special Range

The basic system stipulated in these specifications shall not be modified by the previously mentioned SSI.

[COMMENT 1]

1. In principle, the functions that may be added according to SSI shall be within the range given in these Specifications.

1-3 Ambient Conditions

This system shall satisfy the ratings given in these Specifications under the following conditions:

Equipment Classification		Master station eq. and monitoring station eq.	Repeater station eq.	Gauging station eq.
Electrical section	Temp.	-5°C - +40°C	-10°C - +40°C	-10°C - +40°C
	Relative humidity	90% or less	90% or less	95% or less
Mechanical section	Temp.	+5°C - +40°C		
	Relative humidity	40% - 90%		

[COMMENT 2]

1. To operate the master station equipment and monitoring station equipment stably for an extended period of time, air conditioning and dustproofing measures should be considered.
2. "Mechanical section" indicates the typewriter.

3. When the relative humidity, one of the ambient conditions of the repeater station equipment, exceeds 90%, the cabinet shall employ a moistureproof construction in accordance with the specification of SSI. However, in this case, the additional functions shall be housed in a separate cabinet.

1-4 Power Requirement

The power supply operating range and ratings-guaranteed range of this system shall be as follows.

		Operating range	Ratings-guaranteed range
Master station eq. and Monitoring station eq.	Telemetering eq. and monitoring eq.	(1) DC 21.6V - DC 26.4V (+ ground) Ripple 3% or less Noise voltage 5mV or less (2) Single-phase AC 100V ± 10% 50Hz or 60Hz	(1) DC 21.6V - DC 26.4V (+ ground) Ripple 1% or less Noise voltage 5mV or less (2) Single-phase AC 100V ± 10% 50Hz or 60Hz
	Typewriter	Single-phase AC 100V ± 10% 50Hz or 60Hz	
Repeater station eq. and Gauging station eq.	Repeater eq. and Telemetering eq.	DC 10.5V - DC 16.5V (- ground) Ripple 3% or less Noise voltage 5mV or less	DC 10.8V - DC 14.5V (- ground) Ripple 1% or less Noise voltage 5mV or less

[COMMENT 3]

- Whether the power supplied to the master station equipment and monitoring station equipment is DC24V or AC100V must be specified in the SSI. However, even when this power is DC24V, the power supplied to the typewriter shall be AC100V.
- The power supply unit installed shall be for AC or DC operation depending on whether the power supplied to the master station equipment and monitoring station equipment is AC or DC.
- Because of the supply voltage of the newest circuit elements, DC power supply grounding is normally negative (-), but is made positive (+) when power is shared by multiplex radio equipment, telephone exchange or other similar equipment.

4. DC24V can be supplied to the repeater equipment and telemetering equipment by adding a DC-DC converter to each equipment.

1-5 Electrical and Mechanical Strength

No electrical or mechanical abnormalities shall occur after this system has been left standing for 4 hours under the following conditions.

- (1) Ambient temperature -20°C and $+50^{\circ}\text{C}$
- (2) Relative humidity 95% (ambient temperature $+35^{\circ}\text{C}$)

[COMMENT 4]

1. "Electrical and mechanical strength" indicates that the equipment provides normal operation when restored to the ambient conditions of par. 1-3 after standing under the above ambient conditions with the power supply to each equipment turned off.

1-6 Construction.

Printed circuit boards shall employ a plug-in system for easy mounting and dismounting, as standard. Inspection, adjustment and other operations shall be performed from the front of each unit.

1-6-1 Telemetering equipment for master station and monitoring station

Bay dimensions shall be 2,350 mm high, 520 mm wide and 250 mm deep or less. The front door shall be constructed to open outward to both sides from the center.

Connections to external devices shall be made at the top or bottom of the bay.

1-6-2 Repeater equipment

Bay dimensions shall be 2,000 mm high, 520 mm wide, and 250 mm deep or less. The front door shall be constructed to open outward to both sides from the center.

Connections to external devices shall be made at the top or bottom of the bay.

However, in the case of moistureproof construction, such construction shall be specified by SSI, and in this case the above bay dimensions shall not apply.

1-6-3 Telemetering equipment for gauging station

The cabinet shall be of wall-mount type having dimensions of 600 mm high, 600 mm wide, and 300 mm deep or less, and shall use packing considering moistureproofing.

[COMMENT 5]

1. A mounting base shall be necessary when the telemetering equipment for gauging station is not used as wall-mount type.

1-7 Coating

- 1-7-1 The bay and cabinet coating shall be baked coating after rust-resisting processing.
- 1-7-2 The color of the bay and cabinet shall be Munsell 2.5B6/3.
- 1-7-3 The color of operating console, etc. shall be specified separately with color sample, etc.

1-8 Nameplates

1-8-1 Equipment nameplate

The equipment name, model, serial No., date of manufacture and manufacturer's name shall be designated on the equipment nameplate.

1-8-2 Equipment main sections and main electrical parts indication

The main sections of the equipments shall be indicated by nameplates, engraving or stamping. Symbols or numbers of main electrical parts that can be collated with the circuit diagrams shall be indicated. Moreover, special handling precautions shall be indicated in red at the required points.

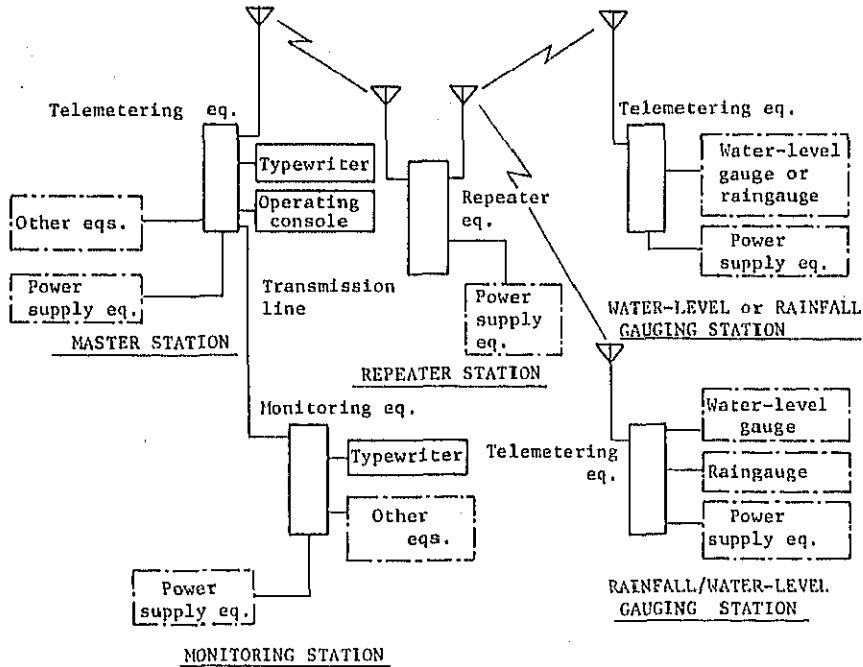
[COMMENT 6]

1. In case a radio equipment is installed, a radio equipment nameplate shall be fitted, together with the nameplate of the equipment on which it is installed.

CHAPTER 2 SYSTEM CONFIGURATION AND FUNCTIONS

2-1 System Configuration

This system shall consist of one master station and a maximum of 30 gauging stations (including repeater stations and monitoring stations as required), and shall have a system configuration as shown below.



TELEMETERING SYSTEM CONFIGURATION (Example)

- Legend :
1. --- Standard configuration equipments.
 2. --- Equipments outside the scope of these specifications.

[COMMENT 7]

1. In the telemetering system configuration diagram, the master station and repeater station are connected by a simplex radio link, but may also be connected by a multiplex radio link.
2. The monitoring station equipment may also be connected via a repeater station, or directly to the master station by a simplex radio link or multiplex radio link or other similar link.

2-2 Description of Operation

2-2-1 The master station shall gather and print rainfall, water-level

and other data by calling the gauging stations.

2-2-2 The gauging stations shall automatically send the data from a raingauge, a water-level gauge, etc. on calling from the master station.

2-2-3 The monitoring station shall receive and print the rainfall and water-level data from the gauging stations via the master station, the repeater station or directly.

2-2-4 When repeater stations are provided in this telemetering system, the repeater stations shall be automatically started before calling of the gauging stations, and shall be stopped after the end of control of the gauging stations.

2-3 System Functions

2-3-1 Calling mode

1) Automatic calling

This calling shall be started automatically by a clock, and shall be directed to all the gauging stations, except the stations that are shutdown, in the predetermined order. The calling shall be made at the following 6 intervals: 10 minutes, 15 minutes, 30 minutes, 1 hour, 3 hours, and 12 hours.

Moreover, automatic calling shall have priority over other modes of calling.

2) Manual calling

This calling shall be started manually and be directed to all the gauging stations or the gauging stations arbitrarily selected, in the predetermined order.

3) External start calling

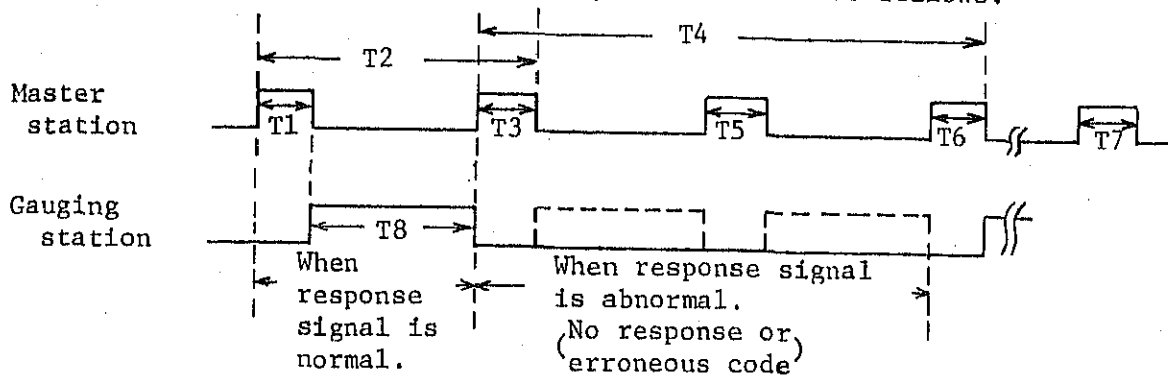
This calling mode shall permit gauging stations to be called by start signals from external devices.

4) Re-calling

If any error code has been detected in the data code from a gauging station, or if there is no response from a gauging station, that gauging station shall be automatically re-called once more. If there is an error code or a called gauging station failed to respond again, a visual and audible alarm shall be actuated and the system shall shift to the next operation.

[COMMENT 8]

1. The operation sequence of this system shall be as follows:



- T1: Date and time printing and No.1 station calling (including repeater station starting when there is a repeater station)
- T2: No.1 station processing
- T3: No.1 station printing and No.2 station calling
- T4: No.2 station processing
- T5: No.2 station re-calling
- T6: No.2 station printing and No.3 station calling
- T7: Final station printing (including repeater station stopping when there is a repeater station)
- T8: Response signal transmission

2-3-2 Response mode

The gauging station called from the master station shall convert the measured values into digital signals and then send the measurement code to the master station.

2-3-3 Data code check system

The master station shall perform the following code checks each time a data code is received:

- 1) Odd parity check at each digit
- 2) Check of total number of bits

2-3-4 Printing and display

The data code shall be received from the gauging stations, and the following printing and display operations shall be performed at the master station:

- 1) When the received data code is normal, the measured value and additional information shall be printed at the predetermined station position, and the data shall be digitally displayed.
- 2) When the received data code is faulty, printing and display of faulty code shall be performed. However, when total bits and station number bits are normal, processing for faulty code shall only be performed for the faulty digit.
- 3) Printing format shall be page tabulation by a typewriter. The date, time, measured values and additional informations for one measuring operation or monitoring operation shall be printed at the predetermined printing positions.

2-3-5 Number of connectable transmission lines

The telemetering equipment for master station and monitoring equipment shall be connectable to a maximum of 3 transmission lines by arbitrarily combining the following transmission lines. However, the data code from the transmission lines of 2 or more directions shall not be input simultaneously into the monitoring equipment.

- 1) Simplex radio links
- 2) Multiplex radio links
- 3) Wire line

2-3-6 Repeating system

- 1) The repeating system shall be of the following two kinds:
 - (1) Simplex radio link and simplex radio link repeating (Called "V-V repeating" hereinafter.)
 - (2) Multiplex radio link and simplex radio link repeating (Called "μ-V repeating" hereinafter.)
- 2) Transmitter and receiver
 - (1) The transmitters shall employ a No.1 unit/No.2 unit changeover system.
 - (2) The receivers shall employ a No.1 unit/No.2 unit parallel operation system.
- 3) Transmitter failure detection and changeover system
 - (1) When the output of a transmitter has dropped to 1/2 or more, failure display shall be actuated and operation shall be automatically switched to the other transmitter. However, switching shall not be performed if the other transmitter is already faulty.

- (2) Forced switching between the No.1 transmitter and No.2 transmitter by the local test buttons shall be possible.

4) Receiver failure detection

Receiver failure detection shall be performed by comparison and detection of the presence or absence of squelch voltage at the two receivers.

However, disconnection of the receiver judged to have failed shall be unnecessary. Moreover, the failure display shall be reset automatically when the failed receiver is judged to be normal.

2-3-7 Voice communication

Voice communication between the master station and gauging stations shall be possible in this system. Moreover, automatic calling shall have priority over voice communication.

2-4 Transmission System

2-4-1 General

- | | |
|---|---|
| (1) Communication system | Semi-duplex communication |
| (2) Calling signal system | 2-frequency series signal |
| (3) Data code system | Long-short pulse system
(RZ code system) |
| | Long mark (1) 60 ±12mSec |
| | Short mark (0) 20 ±4mSec |
| | Space 20 ±4mSec |
| (4) Transmission speed | 50 bauds |
| (5) Data code check system | Parity check at each digit
and total number of bits
check |
| (6) Modulation system
(measurement code) | Subcarrier frequency shift
system |
| (7) Subcarrier frequency (fo) | Specified from the following
frequencies by SSI. |
| | a. 2635 Hz |
| | b. 2465 Hz |
| | c. 2295 Hz |
| | d. 2125 Hz |
| | e. 1955 Hz |

(8) Frequency shift width (Δf)	Specified subcarrier frequency (f_0) ± 35 Hz
(9) Frequency shift direction	Mark ($f_0 + \Delta f$) Space ($f_0 - \Delta f$)
(10) Subcarrier shift frequency accuracy	± 6 Hz or less
(11) V-V repeater remote control signal system	2-frequency series signal system
(12) μ -V repeater control system	Ringer signal system (sent at control)

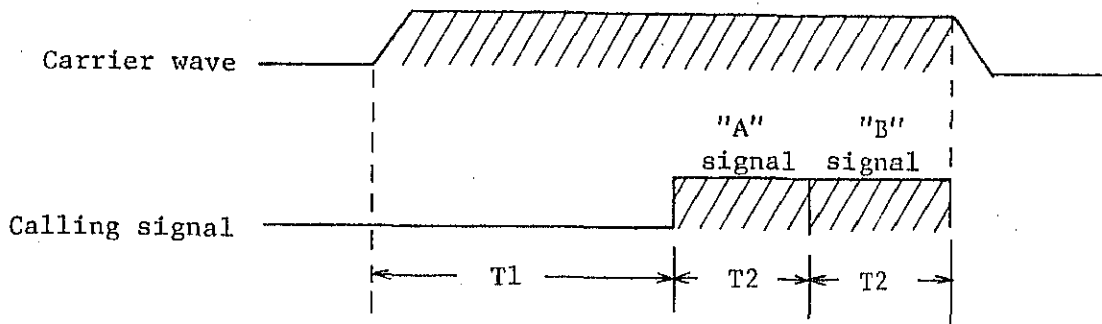
[COMMENT 9]

In the case of μ -V repeating, a ringer shall be sent for control to prevent abnormal operation of the transmitter by a trouble or momentary interruption of ringer circuit.

2-4-2 Calling signal system

1) Calling signal

The calling signal shall be a 2-frequency series signal system using frequencies in the voice band. The calling signals shall be sent in "A" signal, "B" signal order. The calling signals shall be sent in accordance with the following time chart.



T1: Unmodulated radio frequency send time: $1000 \pm 100\text{mSec}$

T2: "A" signal, "B" signal send time: $600 \pm 60\text{mSec}$

Moreover, sending of the remote control signal for V-V repeater shall conform to the above.

[COMMENT 10]

1. The unmodulated radio frequency send time shall be as indicated below, considering control of one repeater station. Total required time is 900mSec , but shall be $1000 \pm 100\text{mSec}$, considering the setting accuracy.

	Master station		Repeater station			Gauging station		Total
	Calling control	Tx	Rx	Repeat control	Tx	Rx	Signal detect	
Required time	50 mSec	100 mSec	200 mSec	100 mSec	100 mSec	200 mSec	150 mSec	900 mSec

2) Signal frequencies

The "A" signal and "B" signal used to call the gauging stations shall be specified from the following frequencies according to SSI.

(1) "A" signal

"A" Signal	Frequency
A 1	487.5 Hz
A 2	502.5
A 3	517.5
A 4	532.5
A 5	547.5
A 6	562.5
A 7	577.5
A 8	592.5
A 9	607.5
A 10	622.5
A 11	637.5
A 12	652.5
A 13	667.5
A 14	682.5
A 15	697.5

(2) "B" signal

"B" signal	Frequency	Remarks
B 1	412.5 Hz	
B 2	427.5	
B 3	442.5	
B 4	457.5	
B 5	472.5	
B 6	382.5	Repeating-start signal
B 7	397.5	Repeating-stop signal
B 8	352.5	
		No.1 → No.2 transmitter changeover signal (Repeater station)
B 9	367.5	No.2 → No.1 transmitter changeover signal (Repeater station)

[COMMENT 11]

The calling signals should be allocated as follows:

Gauging station	Calling signal
No. 1	: Am . B1
No. 2	: Am . B2
No. 3	: Am . B3
No. 4	: Am . B4
No. 5	: Am . B5
No. 6	: An . B1
No. 7	: An . B2

3) Repeater station control

In case there is a V-V repeater station in the transmission links, a repeating-start signal shall be automatically sent before calling of gauging stations, and a repeating-stop signal shall be sent after the end of measurement operation. B6, B7, B8 and B9 of the "B" signals added to the "A" signal shall be used as the repeater control signals.

4) Re-calling control

The time interval in which re-calling is performed shall be between 10Sec to 11Sec.

[COMMENT 12]

1. If the accuracy of calling time and the gauging station protective circuit are considered, the re-calling time interval is basically 9,420 mSec, but shall be 10,000mSec (10 Sec) — 11,000mSec (11 Sec), considering the setting accuracy.

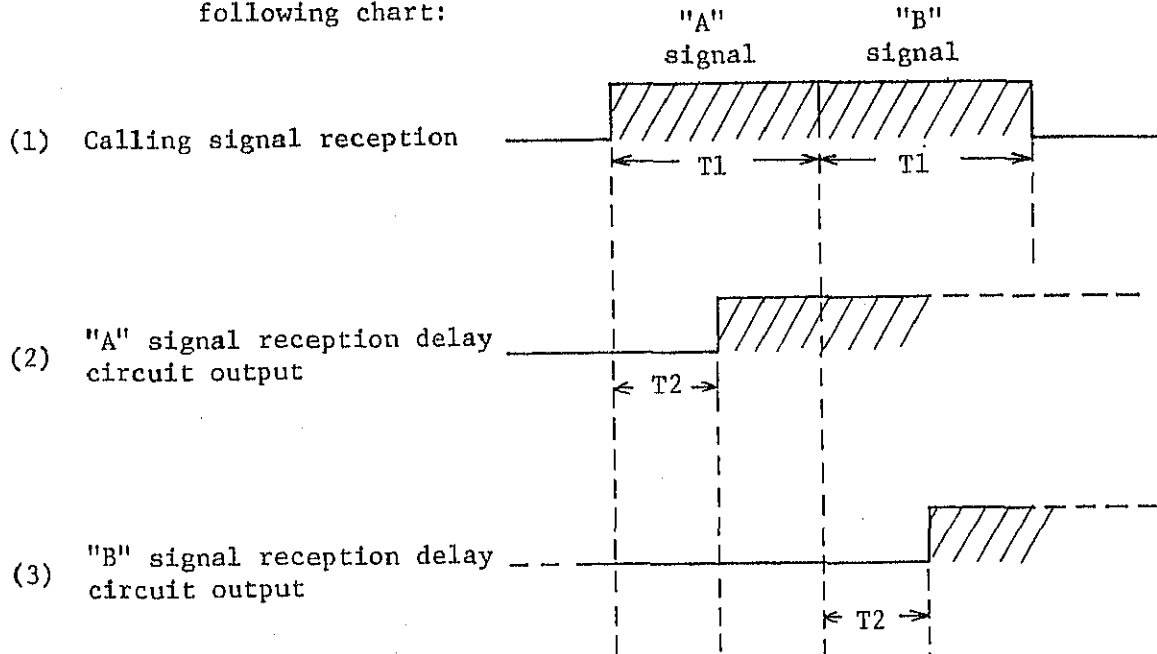
$$\text{(Maximum calling time) + (maximum gauging station protective circuit time) = 2,420mSec + 7,000mSec = 9,420mSec}$$

2-4-3 Gauging station receiving and responding system

Each gauging station shall send a response signal to the master station only when it has received its calling signal allocated.

1) Calling signal receiving time chart

The calling signal receiving time shall conform to the following chart:



T_1 : "A" signal/"B" signal send time: $600 \pm 60\text{mSec}$

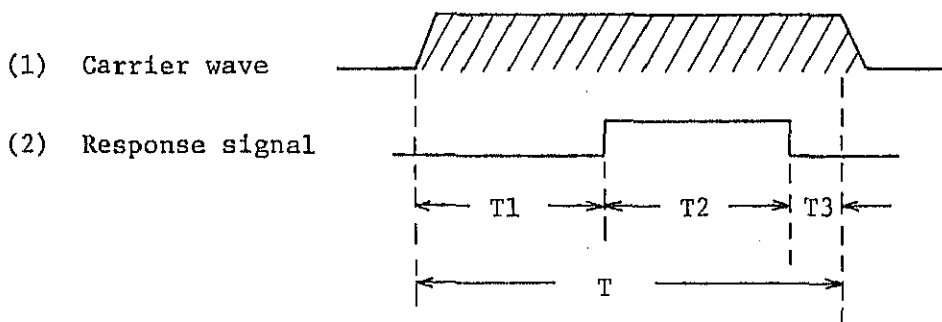
T_2 : Delay time for prevention of voice erroneous operation: 450mSec or more (including circuit delay time)

[COMMENT 13]

1. Voice noise is generally considered to be 250mSec or less. The delay time for prevention of voice erroneous operation shall be 450mSec by adding the 150mSec delay time of the signal detection elements to the 250mSec voice noise, plus a small margin.

2) Response signal transmission time chart

The response signal transmission time shall conform to the following chart:



T: Response signal

T1: Head space : 1,500 ±300mSec

T2: Data code : 1,344mSec (shortest code configuration) - 2,688mSec (longest code configuration)

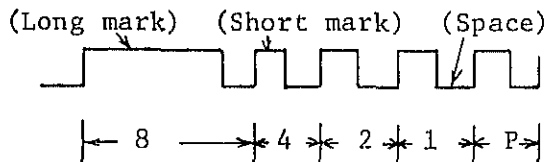
T3: End space : 80 ±16mSec

[COMMENT 14]

1. "Head space" is a signal used before the code to detect the beginning of the response signal from the gauging station at the receiving equipment (master station and monitoring station).
2. "End space" is a signal used after the code to detect the end of the response signal from the gauging station at the receiving equipment (master station and monitoring station).
3. The head space is 1,200mSec as shown below when control of one repeater is considered, but shall be 1,500 ±300mSec, considering the setting accuracy and other factors.

Gauging station		Repeater station			Master station		Total
Response control	Tx	Rx	Repeat control	Tx	Rx	Space detect	
50 mSec	100 mSec	200 mSec	100 mSec	100 mSec	200 mSec	450 mSec	1200 mSec

4. "Shortest code configuration" is a code configuration including one bit of long mark in each digit. The code configuration is shown below:



(The code configuration of the decimal number "8" is shown at the left.)

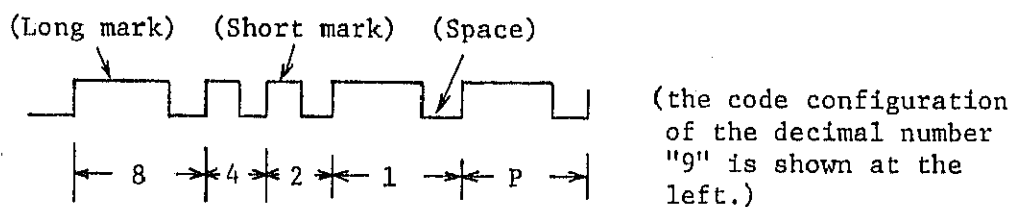
Therefore, the shortest time length per digit is as follows:

$$\begin{aligned} \text{Shortest time length per digit} &= (\text{long mark length} - 20\%) \times 1 + (\text{short mark length} - 20\%) \times 4 + (\text{space length} - 20\%) \times 5 = \\ &= (60\text{mSec} - 12\text{mSec}) \times 1 + (20\text{mSec} - 4\text{mSec}) \times 4 + \\ &= (20\text{mSec} - 4\text{mSec}) \times 5 = 48\text{mSec} \times 1 + 16\text{mSec} \times 4 \\ &+ 16\text{mSec} \times 5 = 192\text{mSec} \end{aligned}$$

Consequently, the code length for the shortest code configuration is given by the following equation.

$$\begin{aligned} \text{Shortest code length} &= (\text{shortest code length per digit}) \times 7 \\ &= 192\text{mSec} \times 7 = 1,344\text{mSec} \end{aligned}$$

5. "Longest code configuration" is a code configuration including three bits of long mark in each digit. The code configuration is shown below:



Therefore, the longest code length per digit is as follows:

$$\begin{aligned} \text{Longest code length per digit} &= (\text{long mark length} + 20\%) \times 3 + (\text{short mark length} + 20\%) \times 2 + (\text{space length} + 20\%) \times 5 = \\ &= (60\text{mSec} + 12\text{mSec}) \times 3 + (20\text{mSec} + 4\text{mSec}) \times 2 + \\ &= (20\text{mSec} + 4\text{mSec}) \times 5 = 72\text{mSec} \times 3 + 24\text{mSec} \times 2 \\ &+ 24\text{mSec} \times 5 = 384\text{mSec} \end{aligned}$$

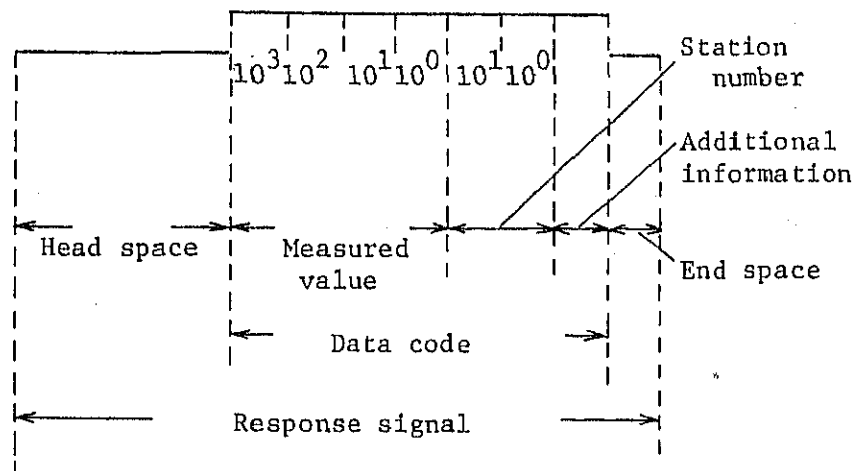
Consequently, the code length for the longest code configuration is given by the following equation.

$$\begin{aligned} \text{Longest code length} &= (\text{longest code length per digit}) \times 7 \\ &= 384\text{mSec} \times 7 = 2,688\text{mSec} \end{aligned}$$

6. The end space has a 4 space length that is impossible with the normal code configuration.

3) Response signal configuration

- (1) The configuration of the response signal sent in response to calling shall conform to the following diagram:



- (2) The data code items and number of digits shall be as follows:

Measured value: 4 digits

However, when the number of significant digits of the measured value is 3 digits, the 4th digit (thousands) shall be set to "0" as a dummy.

Station number: 2 digits

- Additional information: 1 digit, 1 item

- (3) The measured value, station number and additional information shall be binary-coded-decimal code to which a parity bit is added.

[COMMENT 15]

1. The correspondence between decimal value and binary-coded-decimal code is as follows:

1: long mark
0: short mark

		Decimal value									
		0	1	2	3	4	5	6	7	8	9
Binary-coded-decimal code	8	0	0	0	0	0	0	0	0	1	1
	4	0	0	0	0	1	1	1	1	0	0
	2	0	0	1	1	0	0	1	1	0	0
	1	0	1	0	1	0	1	0	1	0	1
	P	1	0	0	1	0	1	1	0	0	1

2. The raingauge uses 3 digits, but the water-level gauge uses 3 digits or 4 digits depending on the measurement site. When the number of measured digits is 3 digits, the number of digits to be sent out is uniformly 4 digits by adding "0" as a dummy.
3. The station number of gauging station should coincide with the calling order, considering coinstallation of a monitoring system.
4. The item of additional information handled by one gauging station shall be one of the following:
- (1) Power supply voltage drop
 - (2) Power supply abnormal
 - (3) Water level abnormal
 - (4) Housing door open/close
 - (5) Other specified items
5. The bit configuration of the additional information is as follows:

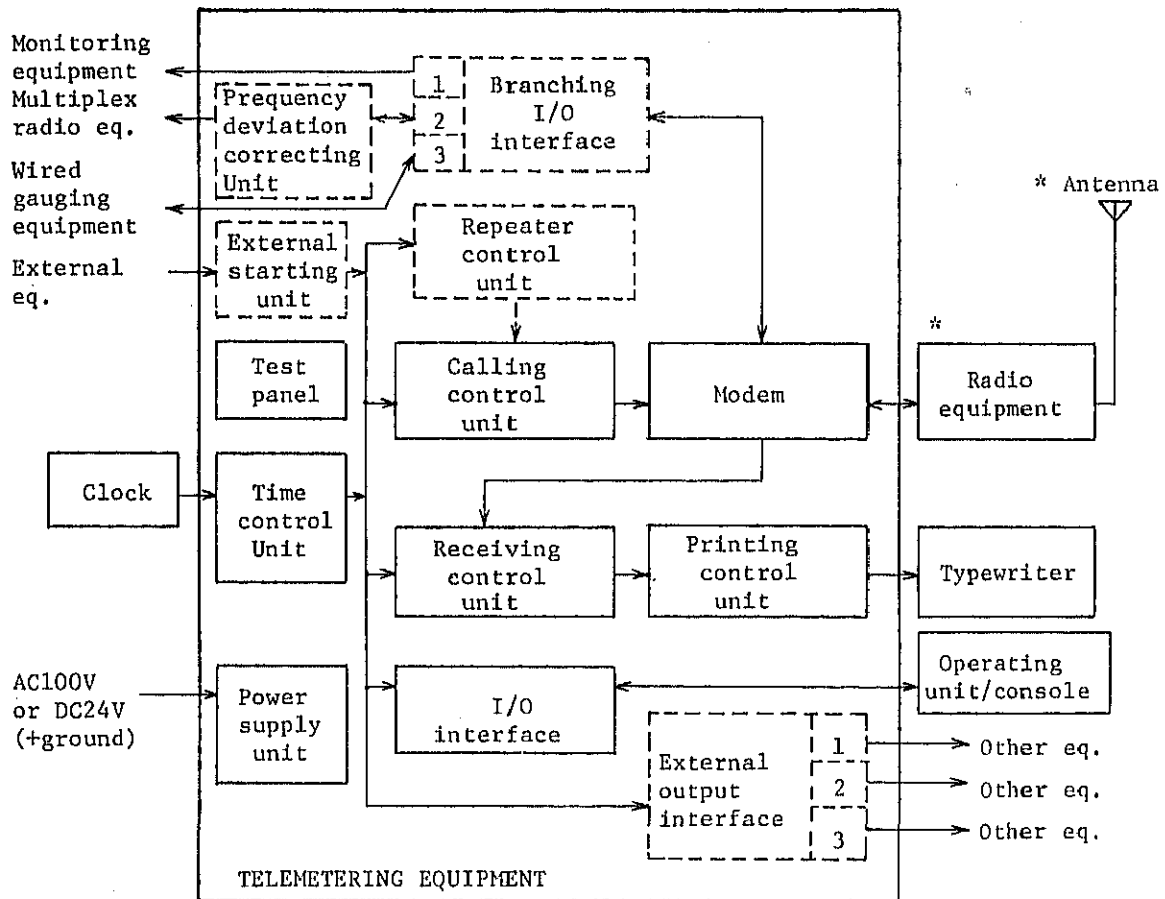
Item	Additional information bit format					Printing format
	8	4	2	1	P	
Normal	0	1	0	1	1	+
Abnormal	0	1	1	0	1	-

CHAPTER 3 EQUIPMENT COMPOSITION AND SPECIFICATIONS

3-1 Master station Equipment

3-1-1 Equipment composition

- 1) The equipment composition of the master station, including standard composition and optional functions, shall be as follows:



- Legend :
- 1. * ; Not used when connected to μ -V repeater.
 - 2. □ ; Standard composition
 - 3. □ ; Optional functions

2) Components shall be as follows:

	Name	Qty	Remarks
1	Telemetering equipment	1	
- 1	Modem	1	
- 2	Calling control unit	1	
- 3	Receiving control unit	1	
- 4	Printing control unit	1	
- 5	I/O interface 1	1	
- 6	Time control unit	1	
- 7	Test panel	1	
- 8	Power supply unit	1	
- 9	Bay	1	
-10	I/O interface 2	1	Optional function. Conforms with SSI.
-11	Frequency deviation correcting unit	1	"
-12	External output interface	1	"
-13	Repeater control unit	1	"
-14	External starting unit	1	"
2	Operating unit/console	1	Conforms with SSI.
3	Typewriter	1	
4	Radio equipment	1	Conforms with SSI.
5	Antenna equipment	1	"
- 1	Antenna	1	
- 2	Coaxial arrester	1	
6	Clock		Conforms with SSI.
7	Accessories	1 set	
- 1	Test cord	1	
- 2	Adjustment tools	1 set	
- 3	Handset	1	
- 4	Instruction manual	3 copies	Including those for each station equip- ment.
- 5	Test data	3 copies	
- 6	Technical service card	1 copy	In card case.
- 7	Accessory box	1	

[COMMENT 16]

The "Technical service card" for the master station consists of a block diagram, components diagram, transmitting and receiving radio frequencies table, send level table for each control signal and subcarrier signal frequency table, and has the following contents:

1. Block diagram

- (1) Diagram of each functional block. The operating system and each signal system are clearly indicated.
- (2) Symbols which can be collated with the components diagram of item 2 below are indicated at test points.
- (3) The standard level of each transmitting and receiving signal is entered in the system diagram.

2. Components diagram

- (1) The printed circuit boards and other units mounted in the telemetering equipment are clearly indicated in this diagram. Symbols that can be collated with the block diagram are indicated at the U-links and other test points.
- (2) The standard level, allowable range and measured value are stated at the transmitting and receiving signal test points.

3. Transmitting and receiving radio frequencies table

When the telemetering equipment is equipped with radio equipment, the frequencies and transmitting output of the radio equipment are entered in this table.

4. Send level table for each calling signal

The measured send level of each calling signal is entered in this table.

5. Subcarrier frequency table

The subcarrier frequency of the response signal used in this system is entered in this table.

The technical service card for the gauging stations, repeater stations, and monitoring stations shall also conform with the above.

3-1-2 Functions and ratings

1) Telemetering equipment

Of the following units, the modem, receiving control unit,

printing control unit, time control unit, and power supply unit shall also be applicable when these units are used at a monitoring station.

(1) Modem

This unit shall send the calling signals and convert the frequency modulated signals into pulse codes.

(2) Calling control unit

This unit controls calling of the gauging stations. A maximum calling capacity of this unit shall be 30.

(3) Receiving control unit

This unit shall convert the demodulated series code into parallel code, and perform code checks.

(4) Printing control unit

This unit shall output the following items in the parallel codes converted by the receiving control unit.

(a) Numbers and symbols: 1,2,3,4,5,6,7,8,9,0, +, -, & *

(b) Functions: Space, tabulation, carriage return, and power control

(5) I/O interface

This unit shall exchange signals between the calling control unit, receiving control unit, printing control unit and test panel, and shall exchange signals with external devices as operating units.

(6) Time control unit

This unit shall be driven by 1 minute pulses from the clock, and shall output the date and time data to the other units.

The date shall be changed automatically, and number of days of the month shall be set manually.

[COMMENT 17]

1. Measuring capacity of 30 stations has been selected, considering the data gathering time, but up to about 40 stations is possible, if necessary.
2. The time control unit may also be incorporated in the clock.

(7) Test panel

Telemetering equipment shall have the following functions for system monitoring and maintenance at the test panel, etc.

	Function	Operation	Display	Remarks
1	Test calling	o	-	Individual
2	Reset	o	-	For operation reset
3	Buzzer off	o	-	
4	Voice communication	o	-	
5	I/O level measurement	o	-	At U-links, etc. (By external measuring instruments)
6	Lamp test	o	-	
7	Calling frequency transmission	o	-	
8	Power ON/OFF	o	-	
9	Squelch adjustment	o	-	When equipped with radio equipment.
10	Typewriter printing ON/OFF	o	-	
11	Repeating start, stop control	o	-	When repeater station installed.
12	Data bit display	-	o	
13	Manual lock	-	o	
14	Receiving failure	-	o	
15	Transmitting	-	o	
16	Measuring	-	o	
17	Power	-	o	
18	Monitoring by voltmeter	-	o	Power supply voltage measurement use

(8) Power supply unit

This unit shall supply the necessary power to each unit. Its input shall be AC100V or DC24V (+ grounded).

[COMMENT 18]

1. Of the operating functions of the telemetering equipment, test calling and repeating start/stop control can be performed by setting the calling signal by a rotary switch or other switch, considering space and economy.
2. Of the operating functions of the telemetering equipment, the I/O level measurement is provided for measurement of the S/N ratios of the telecommunication links.

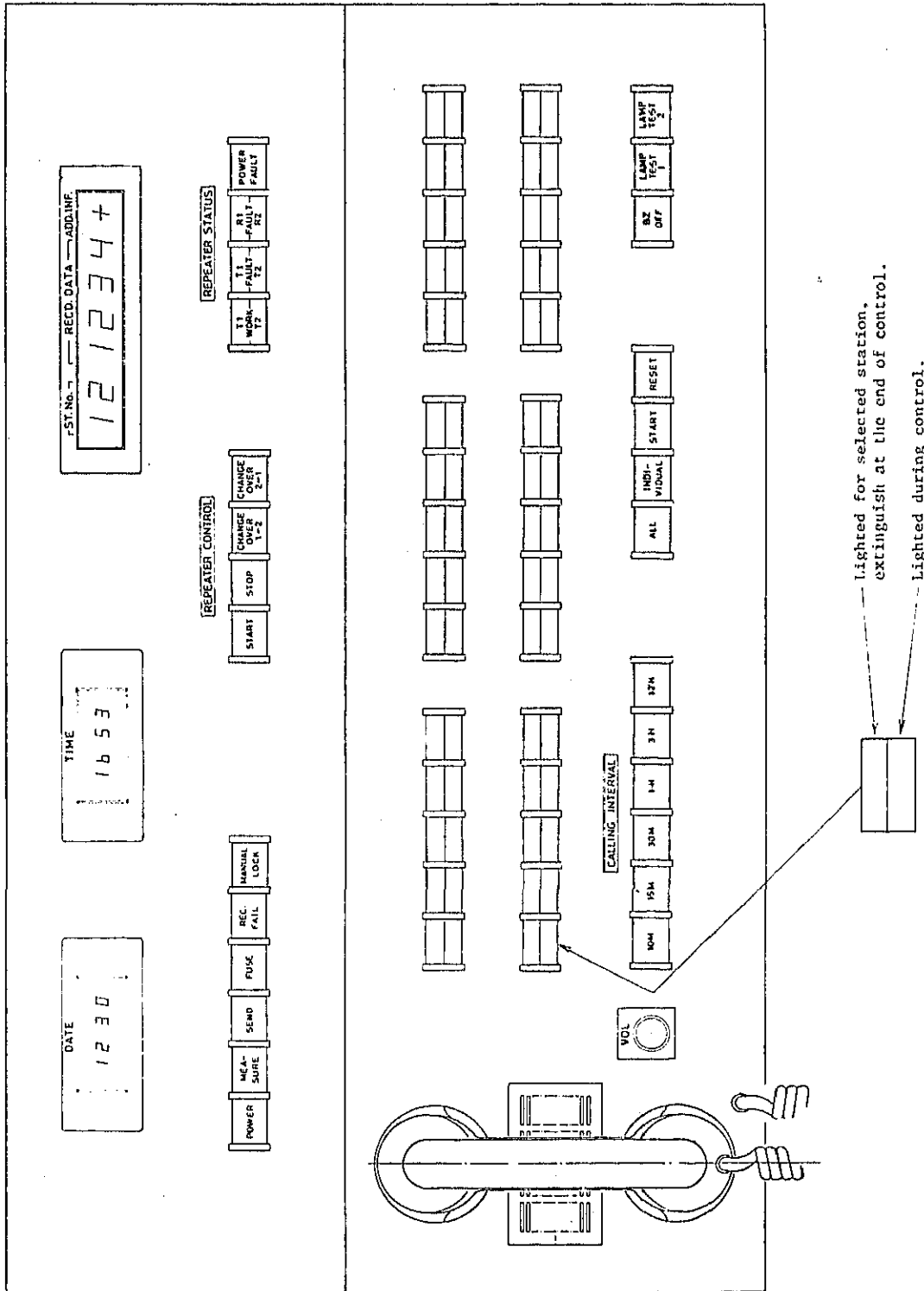
2) Operating unit/console

- (1) The operating unit shall be connected to the telemetering equipment and shall perform the following operations and display. It shall be of table-top type. However, it shall be of stand-alone type when an operating console is used.

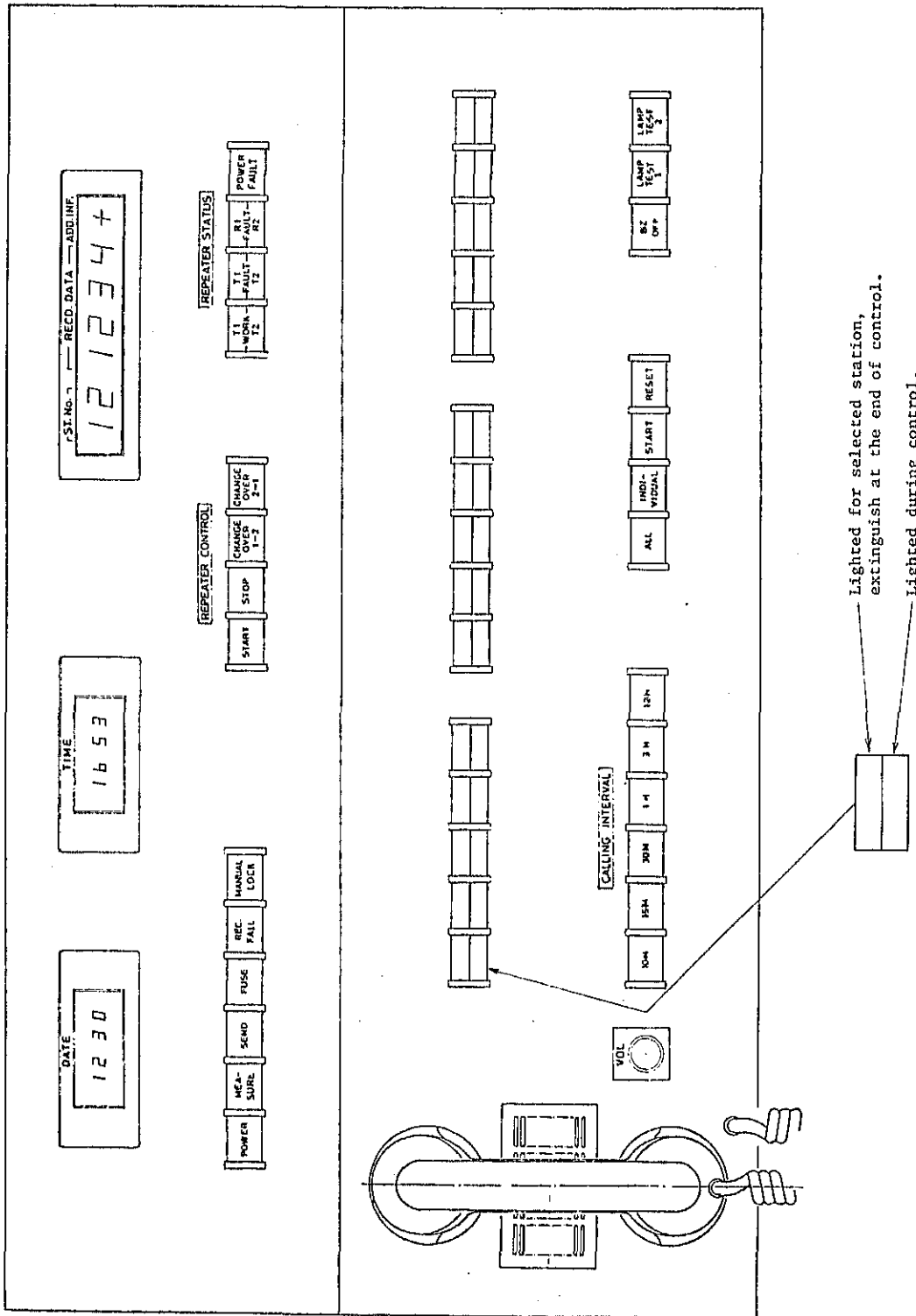
	Function	Operation	Display	Remarks
1	Station selection	o	-	Maximum 30 stations
2	Calling interval setting	o	-	10min, 15min, 30min, 1hr, 3hr, and 12hr
3	Measuring mode selection (All stations or individual stations)	o	-	
4	Manual starting, resetting	o	-	
5	Buzzer off	o	-	
6	Voice communication		-	
7	Transmitting	-	o	
8	Measuring	-	o	
9	Received data display	-	o	
10	Responding station	-	o	
11	Manual lock	-	o	
12	Receiving failure	-	o	
13	Time display, correction	o	o	Digital display
14	Power	-	o	
15	Burnt out fuse	-	o	
16	Lamp test	o	-	
17	Repeater control and display	o	o	Optional function

(2) The panel layout of the operating unit console shall be as follows.

a. For 30 stations capacity



b. For 15 stations capacity



c. Others

- (a) Dimensions shall be specified in SSI.
 - (b) If there is an unnecessary switch, that shall be provided as a spare one, but wiring shall not be performed.
 - (c) A time correction function must also be provided at the operating unit/console, in addition to those given above.
- d. When a stand-alone type operating console is required, it shall be specified in SSI.

[COMMENT 19]

1. A stand-alone type operating console conforms with the SSI but operation and display shall be within the range of functions of the operating unit, as a rule.
2. When the output of the A/D converter in dam water-level gauge or other similar sensor equipment is connected in parallel, a function that constantly displays the dam water level, etc. can be added according to SSI.

3) Typewriter

(1) Ratings

- (a) Carriage width 13, 18, 24 or 27 inches, specified in SSI.
- (b) Line feed 1/6, 1/4, 1/3 and 1/2 inch (Selectable in 4 steps)
- (c) Character size 12 chars/inch
- (d) Printing speed 4 chars/sec or greater (alphabet only)
- (e) Control keys Power, carriage return, tabulation, spacing and ribbon selection
- (f) Printing keys Numbers and alphabet
- (g) Maximum printing width (Carriage width - 1 inch)

(2) The following functions shall be remotely controllable.

- (a) Numbers 1,2,3,4,5,6,7,8,9 and 0

(b) Symbols	*, +, -,
(c) Others	Carriage return, tabulation, spacing and power control

[COMMENT 20]

1. One typewriter shall be connectable to one telemetering equipment.
2. The number of gauging stations printable at the typewriter is found as follows:

$$\text{Number of printable gauging stations} = \frac{[(\text{carriage width} - 1 \text{ inch}) \times \text{number of printing characters/inch} - (\text{number of date, time printing characters})]}{\text{Number of printing characters/station}}$$

(NOTE) Number of printing characters/inch: 12 chars/inch
 Number of printing characters/station: 8 chars/station
 Number of date printing characters: 8 chars
 Number of time printing characters: 8 chars

3. Zero suppression not performed.
4. Tabulation example

DATE	TIME	No. 1 station	No. 2 station	Remarks
U02U18UU	U12U00UU	U1234U+U	U2345U+U	Example of all stations calling.
U02U18UU	U12U08UU		U3456U-U	Example of individual station calling.

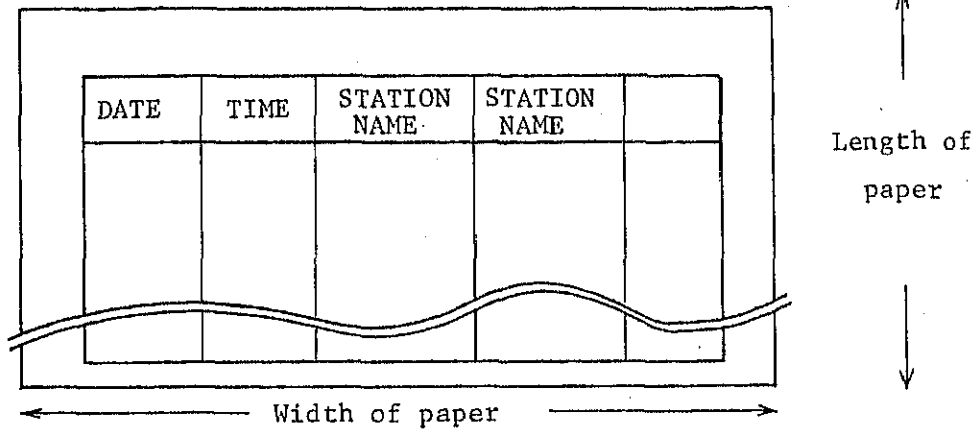
Example of power normal
Example of power abnormal

(NOTE) U indicates a space.

5. Deciding the recording paper

The width of the recording paper is decided from the number of gauging stations, and the length of the recording paper is decided from the number of lines printed on one sheet.

(Recording paper example)



(Legend)

The case when JIS standards A size and B size paper is used is shown below.
 (Conditions are 1/6 inch line feed and 1 inch = 25.4 mm margin at both ends of the paper.)

Paper size			Number of gauging stations	Number of printing lines	Typewriter
Standard	Width (mm)	Length (mm)			
A1	594	841	30 or less	186 or less	24 inches or 27 inches
A2	420	594	19 or less	128 or less	18 inches
A3	297	420	12 or less	87 or less	13 inches
B2	515	728	25 or less	159 or less	24 inches or 27 inches
B3	364	515	16 or less	109 or less	18 inches
B4	257	364	10 or less	73 or less	13 inches

4) Radio equipment

This equipment shall be installed at the telemetering equipment, and shall satisfy the following functions and ratings. Moreover, these specifications shall also be applicable when this equipment is used at the gauging stations, repeater

stations and monitoring stations.

(1) Functions

- (a) Antenna matchable range Standing wave ratio 2.0 or less
- (b) Transmitting output check By external meter
- (c) Modulation input check "
- (d) Demodulated output check "
- (e) Squelch adjustment Continuously variable
- (f) Demodulated output adjustment Standard value $\pm 3\text{dB}$
- (g) Monitor speaker volume adjustment 0 to 0.3W

(2) Transmitter ratings

- (a) Type of emission F2, F3
- (b) Output Specified out of 1W, 3W, and 10W according to SSI. Moreover, output rating shall be between +10% and -20% at 12.0V power supply voltage. (However, shall be within $\pm 10\%$ at 12.0V power supply voltage at normal temperature.)
- (c) Frequency 70MHz band or 400MHz band. Frequency, specified separately.
- (d) Antenna impedance 50 Ω
- (e) Modulation method Phase modulation
- (f) Modulation input 1kHz, linear up to 70%. Input required for 70% modulation is within $-4\text{dBm} \pm 3\text{dB}$.
- (g) Allowable frequency error Within $\pm 10 \times 10^{-6}$
- (h) Maximum frequency deviation Within $\pm 5\text{kHz}$

(i) Modulation frequency response	Referred to 1kHz, 30% modulation
	0.3kHz -10.5dB ±2dB
	2.0kHz + 6.0dB ±2dB
	2.7kHz + 8.5dB ±2dB
	3.0kHz + 8.0dB ±2dB
(j) S/N ratio	45dB or greater at 1kHz, 70% modulation
(k) Distortion	10% or less at 1kHz, 70% modulation
(l) Spurious	
70 MHz -----	1mW or less. Moreover, must be 80dB in-band, 60dB or more out-of-band lower than average power of fundamental wave.
400 MHz -----	1mW or less. Moreover, must be 60dB or more lower than average power of fundamental wave.
(m) Occupied bandwidth	Shall be within 16kHz.
(3) Receiver ratings	
(a) Frequency	70MHz band or 400MHz band. Frequency, specified separately.
(b) Antenna impedance	50 Ω
(c) Receiving system	Superheterodyne
(d) Allowable local oscillator frequency error	Within $\pm 10 \times 10^{-6}$
(e) Bandwidth	12kHz or greater at 6dB down
(f) Selectivity	Within 25kHz at 70dB down
(g) Receiving frequency response	Referred to 1kHz, 30% modulation
	0.3kHz ±10.5dB ±2dB
	2.0kHz - 6.0dB ±2dB
	2.7kHz - 8.5dB ±2dB
	3.0kHz - 9.5dB ±2dB
(h) S/N ratio	30dB or greater at 15dBμV input at 1kHz, 70% modulation

- | | |
|------------------------------------|---|
| (i) Squelch | Opened at 10dB or less noise suppression input voltage (or 0dB μ V or less input field strength). Continuously variable to 20dB noise suppression voltage. |
| (j) Receiving sensitivity | 70MHz band: 3dB μ V or less (2dB μ V or less at normal temperature)
400MHz band: 4dB μ V or less (3dB μ V or less at normal temperature) |
| (k) Spurious response | 70MHz band: -80dB or less
400MHz band: -70dB or less |
| (l) Blocking | With a wanted signal, 6dB higher than the necessary input voltage for 20dB noise quieting, the input voltage of an unwanted signal, 15kHz detuned in 70MHz band and 25kHz detuned in 400MHz band, shall be

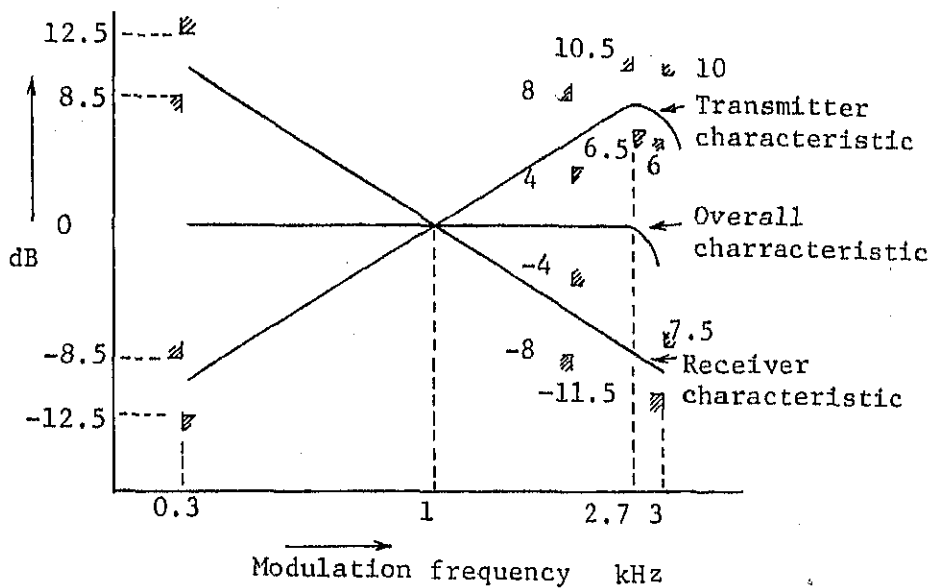
70MHz band: 80dB μ V or greater
400MHz band: 70dB μ V or greater |
| (m) Intermodulation characteristic | Noise quieting shall be 20dB or less when an unwanted signal causing an intermodulation is applied at 65dB μ V input voltage without any desired wave. |

(4) Others

This equipment shall be provided with functions which protect the transmitter and receiver against opening or shorting of the antenna system and excessive input. Moreover, external connections shall be made with N-type connectors.

[COMMENT 21]

1. Since this system uses audio band frequencies for the calling signals and response signals, the overall frequency response between the master station and gauging stations must be considered. The installation of a repeater station in the radio links has an especially large affect. Therefore, the conventional specifications have been modified as the characteristics shown below.



Moreover, the overall characteristic is flat from 0.3kHz to 2.7kHz because it has been determined from the minimum and maximum frequencies of the signals to be transmitted.

2. The standing wave ratio of the matchable load for the transmitter and receiver has been made 2.0 by the following reason. The standing wave ratio of the antenna is a maximum 1.5, but the standing wave ratio is generally assumed to be about 2.0 when the effects of insertion of a coaxial arrester and connectors, etc. are considered.

5) Antenna equipment

The antenna equipment shall fully satisfy the following specifications.

The specifications shall also be applicable when this equipment is used at gauging stations, repeater stations and monitoring stations.

(1) Antenna

- | | |
|-------------------------|---|
| (a) Frequency | 70MHz band or 400MHz band.
Specified in SSI. |
| (b) Type | Specified in SSI. |
| (c) Impedance | 50 Ω |
| (e) Standing wave ratio | 1.5 or less at the specified frequency |
| (f) Polarization | Vertical as standard |

(2) Coaxial arrester

A coaxial arrester which grounds lightning shall be provided between the antenna and radio equipment. This arrester shall not hinder the functions of the radio equipment.

a. Ratings

- (a) Impedance 50 Ω
- (b) Insertion loss 0.5dB or less
- (c) Standing wave ratio 1.2 or less at the specified frequency

[COMMENT 22]

1. The kinds and typical ratings of applicable antenna elements are as follows:

Kind	Gain (GIS)	Front-rear ratio	Frequency width in SWR rating (1.5)
3-element folded Yagi antenna	8 dB or more	13 dB or more	Specified frequency only
4-element folded Yagi antenna	9.5 dB or more	13 dB or more	do
5-element folded Yagi antenna	11 dB or more	13 dB or more	do
Braun antenna	2 dB or more	-----	do
Sleeve antenna	2 dB or more	-----	do
Wideband 3-element folded Yagi antenna	6 dB or more	10 dB or more	5 MHz
Wideband 5-element folded Yagi antenna	9 dB or more	10 dB or more	5 MHz

2. Since the gain and directivity will deteriorate substantially relative to the other frequency when a general antenna is used in a radio link having different transmitting and receiving frequencies and is set to only one of these frequencies, a wideband type antenna or separate transmitting and receiving antennas should be used when there is not so much margin in that radio link.

6) Clock

The clock shall fully satisfy the following specifications.

- | | |
|-------------------------------------|---|
| (1) Accuracy | Daily error within ± 3 seconds |
| (2) Output signal | 1 minute pulse signal |
| (3) Power failure
guarantee time | 30 minutes or more by floating
charge system |

[COMMENT 23]

Operation by applying an external 1 minute pulse to the time control unit is also possible. In this case, the clock is unnecessary. Moreover, when several clocks must be installed at the same station, the time control unit of each clock should be driven by a 1 minute pulse from the main clock.

3-1-3 Additional functions

The following functions may be added to the telemetering equipment according to SSI. Moreover, these specifications shall be applicable when the following units are used at the gauging stations and repeater stations.

1) I/O interface 2

This unit is used for connection to multiplex radio equipment and wire gauging equipment. It shall satisfy the following ratings.

- | | |
|-------------------|---|
| (1) I/O level | Settable within a range of 0 to -25dBm. |
| (2) I/O impedance | 600 Ω \pm 20% balanced |

[COMMENT 24]

1. When the data code is sent to another point, the received FS signal can be sent directly by branching circuit (hybrid transformer, etc.).
2. The number of I/O paths is a maximum of 3 paths. The number of paths equipped must be specified in SSI.

2) Frequency deviation correction unit

This unit is inserted when the frequency deviation caused by the multiplex radio circuit exceeds 1Hz. It shall satisfy the following ratings.

- (1) Maximum correctable frequency deviation Within $\pm 15\text{Hz}$
- (2) Correction accuracy $\pm 0.5\text{Hz}$

3) External output interface

This unit is used for connection to a display unit, etc. It shall satisfy the following conditions.

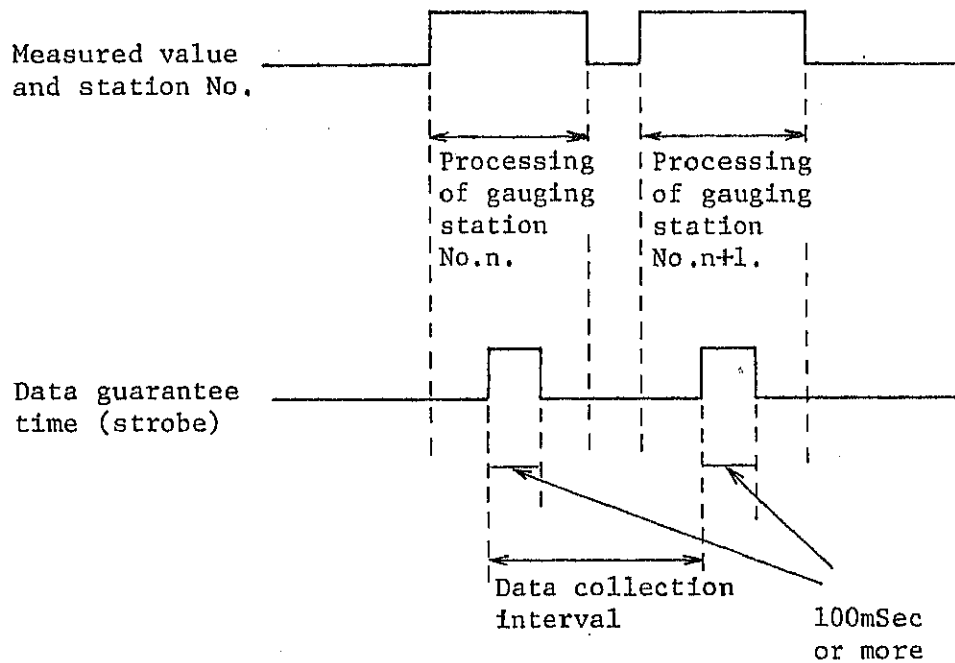
- (1) Shall be no-voltage contacts.
- (2) Shall close contacts by logic "1".
Load conditions shall be 50V, 50mA or less.
- (3) Kinds of output signals

a. Output format

Output signal name	Output signal contents	Signal format	Remarks
Measured value	BCD 4 digits 20 bits	Momentary signal	With odd parity bit at each digit.
Station No.	BCD 2 digits 10 bits	do.	do.
Current time	BCD 4 digits 13 bits	Continuous signal	Without parity bit
1 minute pulse	1 bit	do.	
Calling time interval	6 bits	do.	
Periodic measurement	1 bit	do.	
Manual measurement	1 bit	do.	
Measuring	1 bit	do.	
Master station power abnormal	1 bit	do.	
Strobe		Momentary signal	

b. Data guarantee time

Output of data shall conform with the following time chart.



[COMMENT 25]

1. The maximum number of output paths shall be 3.
The number of paths equipped must be specified in SSI.
2. The kinds of output signals must be selected and specified in SSI after an adequate study of the connected devices.

4) Repeater control unit

This unit shall have repeater station start/stop, transmitter switching, and receiving and processing function of repeater station status signal.

5) External starting

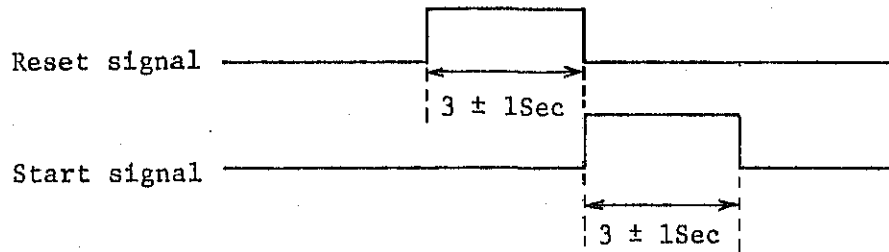
This unit shall have functions that permit starting of the telemetering equipment from the outside. Control by external starting shall be specified in SSI.

a. All gauging stations

b. Gauging stations set at the operating unit

c. Gauging stations specified beforehand

The time chart shall conform with the following:



The reset signal and start signal shall be relay contact input. Load capacity shall be 50V, 50mA or less.

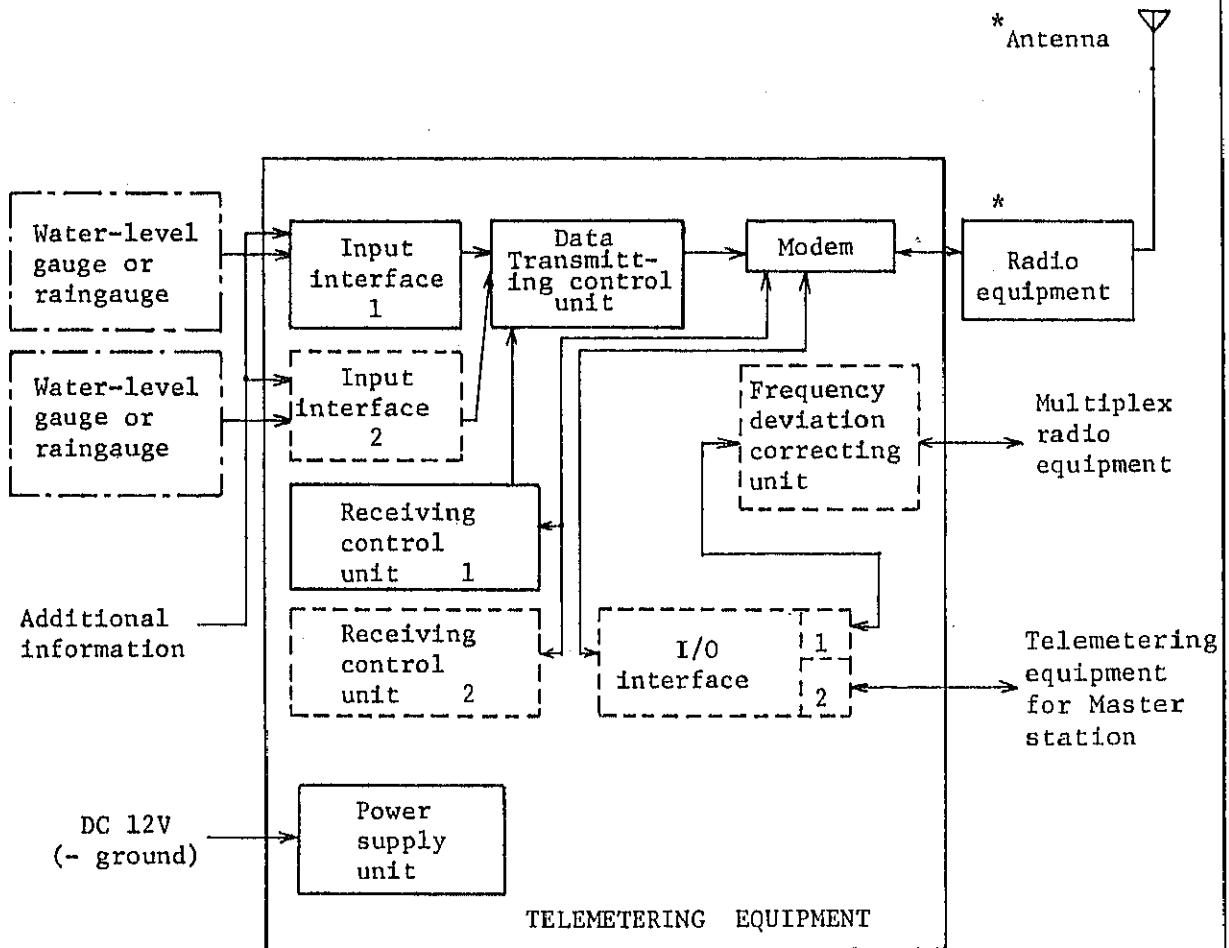
[COMMENT 26]

1. The reset signal for external starting resets all operations other than by automatic calling.
2. Of the additional functions of the telemetering equipment, those given in item (1) below are wired or provided with space at the time of delivery and may be added at the site after installation. However, addition and modification for the additional functions given in item (2) below at the site after installation is uneconomical, and may be made by providing a separate bay from the standpoint of space, etc., depending on the contents.
 - (1) Additional functions at the site after installation
 - a. Connection to multiplex radio equipment
 - b. Connection to wire gauging equipment
 - c. Connection to monitoring equipment
 - d. Connection to external interruption device
 - e. Connection to operator's console
 - (2) Additional functions which must be provided for at the time of delivery
 - a. Connection to a display unit
 - b. Connection to automatic gate control equipment
 - c. Connection to other equipment
 - d. Addition of repeater control function

3-2 Gauging Station Equipment

3-2-1 Equipment composition

- 1) The equipment composition of the gauging stations, including standard composition and optional functions, shall be as follows.



- Legend :
- 1. * Not used when connected to multiplex radio equipment or directly to telemetering equipment for Master station.
 - 2. Standard composition
 - 3. Optional function
 - 4. Equipment outside the scope of these specification.

2) Components shall be as follows:

	Name	Q'ty	Remarks
1	Telemetering equipment	1	
- 1	Modem	1	
- 2	Data transmitting control unit	1	
- 3	Receiving control unit 1	1	
- 4	Input interface 1.	1	
- 5	Power supply unit	1	
- 6	Cabinet	1	
- 7	I/O interface	1	Optional function. Conforms with SSI.
- 8	Frequency deviation correcting unit	1	"
- 9	Receiving control unit 2	1	"
-10	Input interface 2	1	"
2	Radio equipment	1	Conforms with SSI.
3	Antenna equipment	1	Conforms with SSI.
- 1	Antenna	1	
- 2	Coaxial arrester	1	
4	Repeater control unit	1	Conforms with SSI.
5	Accessories		
- 1	Hand microphone	1	
- 2	Test cord	1	
- 3	Adjustment tools	1 set	
- 4	Instruction manual	1 copy	
- 5	Test data	1 copy	
- 6	Technical service card	1 copy	In card case
- 7	Accessory box	1	

3-2-2 Functions and ratings

1) Telemetering equipment

(1) Modem

This unit shall have a modulation function which converts pulse code into a frequency modulated signal, and a demodulation function which receives the gauging station calling signal.

(2) Transmitting control unit

This unit shall have a function which converts the input signals from the rain gauge and water-level gauge into a response signal.

(3) Receiving control unit 1

This unit shall perform frequency discrimination of the calling signal (2-frequency series signal) from the master station and provide an output to the transmitting control unit only when the unique frequency pair to its own station has been received.

The number of stations controllable at this unit shall be one, but addition of one more station shall be possible according to SSI.

(4) Input interface 1

This unit shall be connected to the raingauge, water-level gauge, etc. and shall have a function which interface these devices to the transmitting control unit. The number of gauges connectable to this unit shall be one, as standard, but shall be expandable by one according to SSI.

(5) Power supply unit

This unit shall supply the necessary power to each unit. Its input shall be DC12V (- ground).

(6) Others

a. The following operations shall be performed.

	Item	Remarks
1	Speech	Hand microphone, speaker, volume adjustment
2	Data code test transmission	
3	Transmitter input level	Measured by U-link
4	Receiver output level	"
5	Calling signal selection filter input level	Measured by U-link or check terminal
6	FS modulator input signal level	

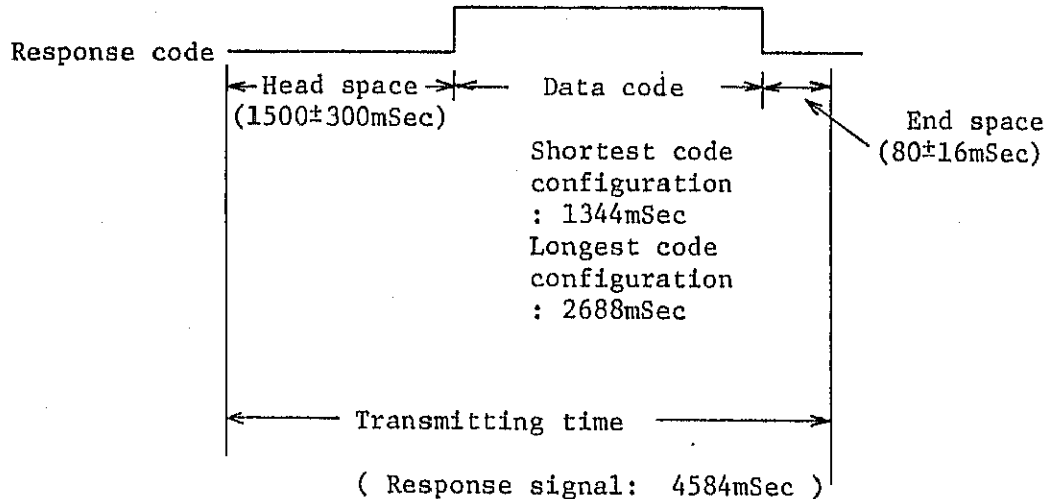
b. Protection circuit

A protection function that halts transmission after a fixed period of time to prevent the telemetering equipment from transmitting continuously because of

a failure in the transmitting control unit shall be provided.
 This protection circuit shall be set for a time length of 6 ± 1 seconds.

[COMMENT 27]

1. The setting time of the protection circuit is 4,584mSec as shown below, considering the maximum time of the response signal, but has been decided to be $6,000 \pm 1,000$ mSec considering the setting accuracy.



2) Repeater control unit

This unit shall be installed at the telemetering equipment, and shall have a function which sends the repeating-start signal and repeating-stop signal. It shall have a portable construction. This unit is installed according to SSI.

[COMMENT 28]

The repeater control unit has a printed circuit board construction, and can be used by installing it at the telemetering equipment. Moreover, it may be easily carried by placing it in a special box.

3-2-3 Additional functions

The following functions may be added to the telemetering equipment according to SSI.

1) Receiving control unit 2

Reception of one more calling signal from master station shall be possible by adding this unit.

2) Input interface 2

Connection of one more sensor shall be possible by adding this unit. In this case, the station No. shall be given separately.

3-2-4 Gauging station equipment current consumption

The current consumption of the gauging station equipment shall satisfy the following ratings at 12.0V power supply voltage.

Item		Current consumption
Stand-by		15 mA or less
Receiving		150 mA or less
Transmitting	1 W	2.0 A or less
	3 W	2.5 A or less
	10 W	5.5 A or less

[COMMENT 29]

1. Note that the following current consumptions shall be added to the above values when a water-level gauge is connected to the telemetering equipment.

- (1) A water-level gauge current consumption of about 0.5A may be necessary when a water-level gauge is connected directly to the telemetering equipment.
- (2) When the voltage induced from the outside into the telemetering equipment is considered, elimination of the induced voltage by inserting a relay circuit between the telemetering equipment and water-level gauge is necessary. In this case, the current consumption of the relay circuit is about 1.0A.

3-2-5 Raingauge and water-level gauge connection conditions

Connection of the telemetering equipment to a raingauge, water-level gauge, etc. shall satisfy the following conditions. However, the minimum value of detection by the raingauge shall be 1mm, and the minimum value of detection by the water-level gauge shall be 1cm.

1) Electrically connected raingauge and water-level gauge

- (1) Output format : No-voltage make contacts
(Closed by logic 1)

(2) Code format

- a. Water-level gauge : BCD code with odd parity bit per digit (maximum 4 digits).
- b. Raingauge : BCD code with odd parity bit per digit (maximum 3 digits).
Or contact signal of every 1mm (1 pulse/mm).

[COMMENT 30]

1. The following conditions are satisfied by gauging equipment requiring a gauging command.

- (1) Response time : Within 1 sec (Time from issuing of gauging command to transfer of data to telemetering equipment)
- (2) Data : Continuous up to release of gauging command

2. Water-level gauging equipment connected mechanically

When the telemetering equipment is connected to gauging equipment that does not output an electrical signal, a converter shall be added. Connection to this converter shall be mechanical. The converter shall satisfy the following conditions:

- Revolution of shaft : 1 revolution/m
- Torque : 500 g.cm or less
- Direction of rotation : Clockwise as viewed from the shaft



3. Since connection of water-level gauge and raingauge to telemetering equipment employs the following system, consideration must be given to their installation.

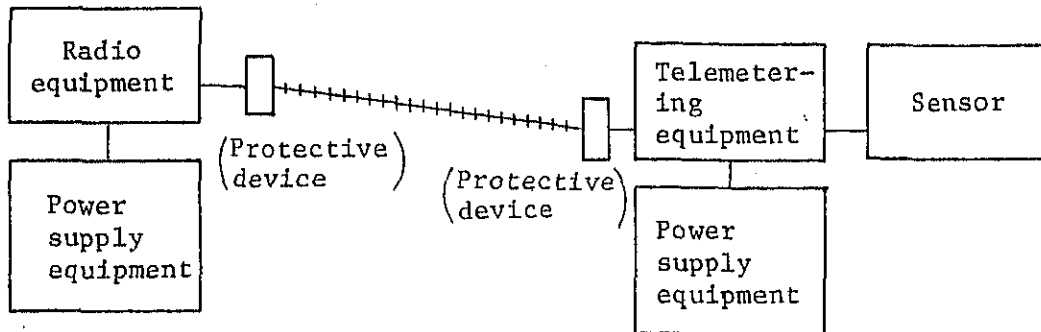
(1) Water-level gauge

Usually, an A/D converter shall be installed in the water-level gauge to output electrical signal, which is converted into response signal at the telemetering equipment. Since there are various kinds of format for output of the water-level gauge, consideration must be given to them.

(2) Raingauge

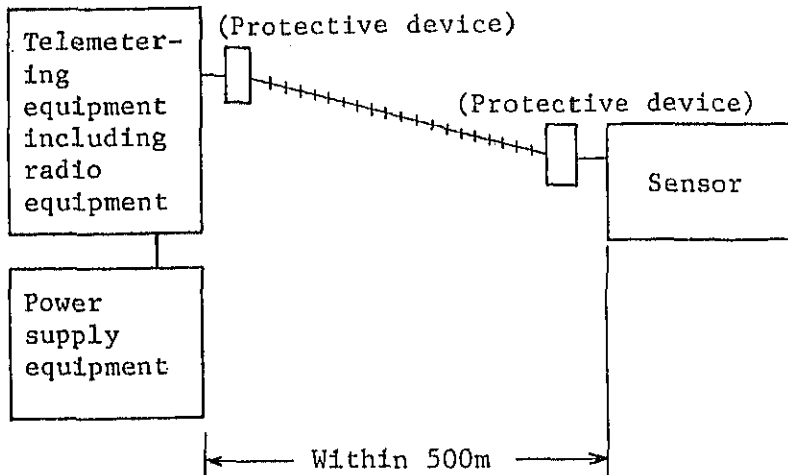
To obtain rainfall data, an A/D converter shall be installed in the raingauge, or a pulse counter which counts 1 mm pulses from raingauge shall be installed in the telemetering equipment.

4. In principle, the AC (FS signal) transmission system illustrated below shall be desirable when the telemetering equipment and radio equipment are separated.



Connection cable: 0.9 ϕ cable, as standard.

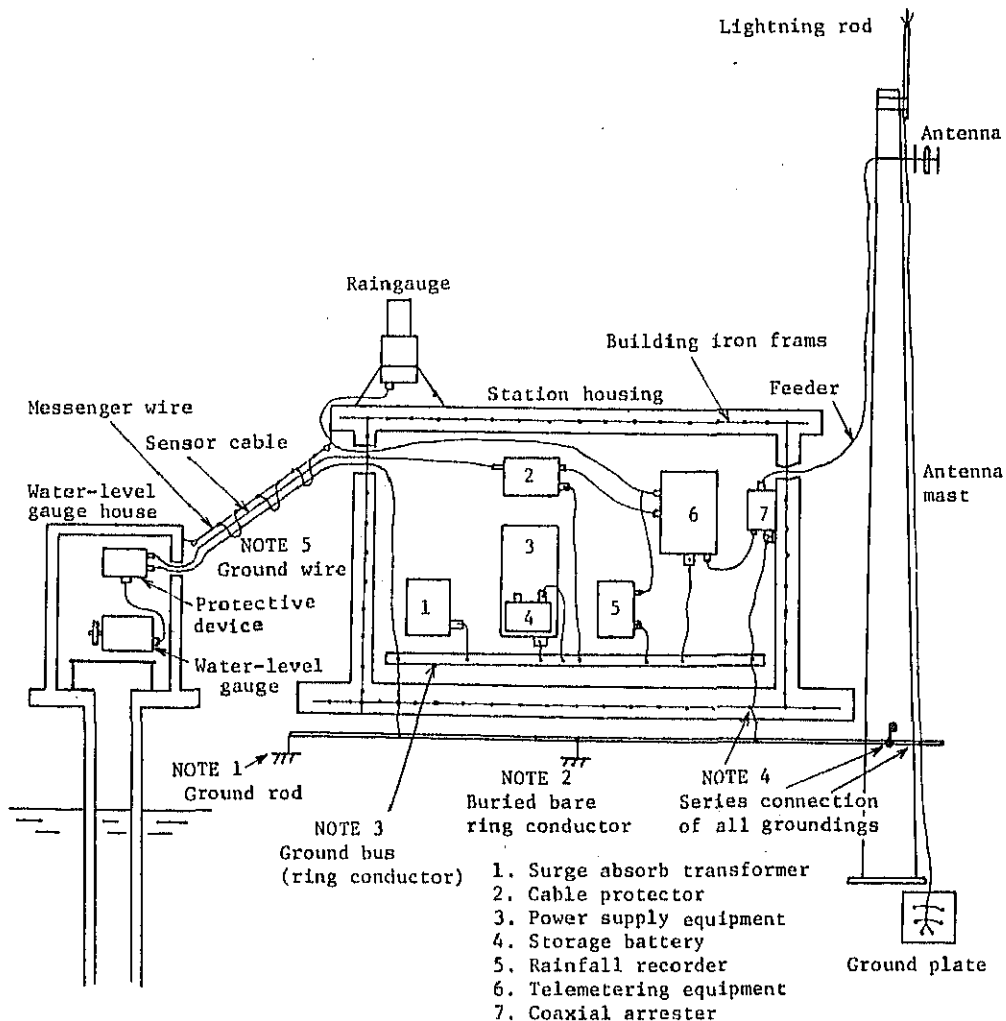
However, the DC transmission system illustrated below may be used when unavoidable, but the distance between the telemetering equipment and gauging equipment (sensor) is limited to approximately 500m. Since this system is easily struck by lightning, its use should be avoided in areas where lightning occurs frequently.



Connection cable: 0.9 ϕ cable, as standard.

5. Careful attention must be given to lightning damage when the telemetering equipment and gauging equipment (sensor) are separated. Lightning countermeasures including the facilities inside the station building, such as the following, must be taken when installed in areas where lightning frequently occurs.

- (1) In principle, installation of a lightning rod and surge absorb transformer and cable protector, etc.
- (2) Series connection of all groundings.
- (3) Installation of ring conductors inside and around the station housing.
- (4) Connection of structures inside the compound (iron tower, equipment, etc.) to the nearest ring conductor.
- (5) In principle, ground wire shall be 14mm^2 or larger copper wire, and connections shall be by telmit welding.
- (6) A target value of grounding resistance shall be 50Ω or less.
- (7) Example of grounding facilities of a gauging station is shown below.



NOTE 1 Ground rod

The number of rods is increased according to the grounding resistance by driving rods (1.5m) into the ground at intervals of 3m or more, or a grounding resistance reducing agent is used.

NOTE 2 Buried bare ring conductor

The various ground electrodes, etc. are connected. The wire is bare conductor of about 22[□], and grounding resistance reducing agent is used, as required.

NOTE 3 Ground bus (ring conductor)

The ground points of each facility inside the housing are connected in common.

NOTE 4 Series connection of all groundings

The various grounds and conductors and equipment installed in the same compound are connected in series by conductors of a necessary thickness.

NOTE 5 Ground wire

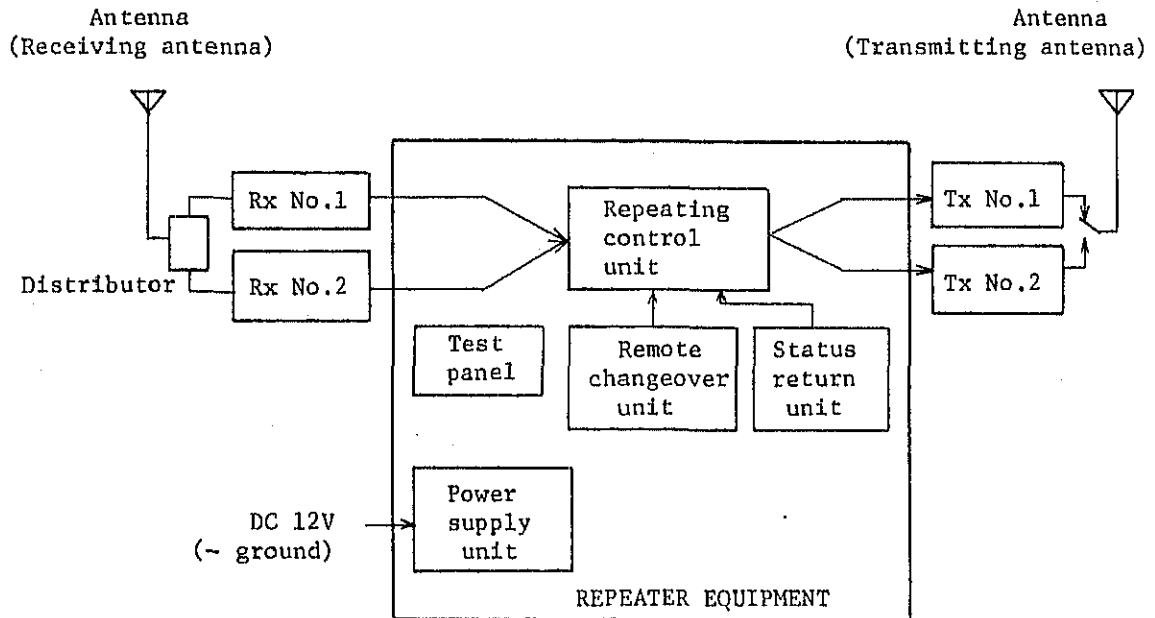
Ground wire is laid when necessary grounding resistance cannot be obtained at the water-level gauge installation site. When the water-level gauge is separated from the station housing, a cable protector is installed and a separate ground cable of 14[□] or greater is laid and connected to the other ground wire.

3-3 Repeater Station Equipment

3-3-1 Equipment composition

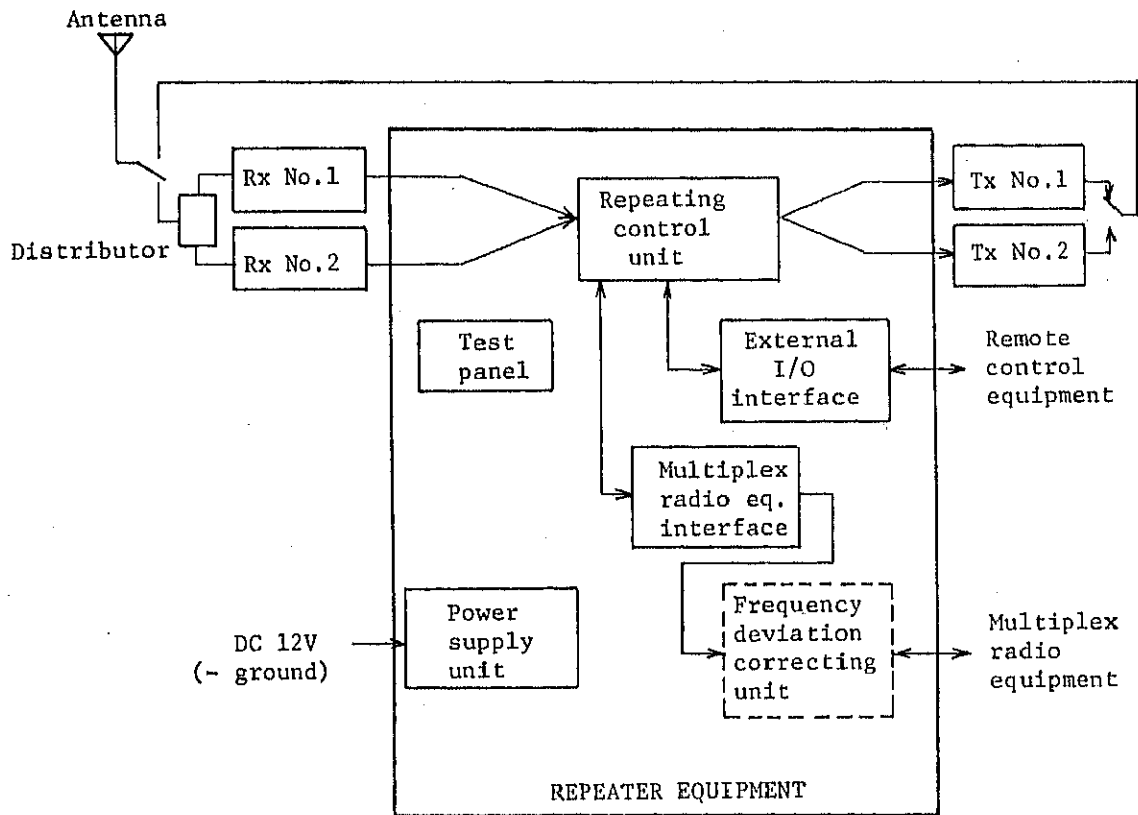
1) The repeater station equipment, including the standard composition and optional functions, shall be as follows.

(1) For V-V repeater



Legend : 1. Standard Composition

(2) For μ -V repeater



- Legend : 1. Standard composition
 2. Optional function

2) Components shall be as follows:

	Name	Q'ty	Remarks
1	Repeater equipment	1	
- 1	Repeating control unit	1	
- 2	Remote changeover unit	1	Installed for V-V repeating
- 3	Status return unit	1	"
- 4	Test panel	1	
- 5	External I/O interface	1	Installed for μ -V repeating
- 6	Multiplex radio eq. interface	1	"
- 7	Power supply unit	1	
- 8	Bay/Cabinet	1	
- 9	Frequency deviation correcting unit	1	Optional function
2	Radio equipment	1	Conforms with SSI.
- 1	Transmitter	2	
- 2	Receiver	2	
3	Antenna equipment	1	Conforms with SSI.
- 1	Antenna	1 set	
- 2	Distributor	1	Installed at repeater equipment
- 3	Filter	1	Conforms with SSI.
- 4	Coaxial arrester	1	
4	Accessories	1 set	
- 1	Test cord	1	
- 2	Adjustment tools	1 set	
- 3	Hand microphone	1	
- 4	Instruction manual	1 copy	
- 5	Test data	1 copy	
- 6	Technical service card	1 copy	In card case
- 7	Accessory box	1	

3-3-2 Functions and ratings

1) Repeater equipment

(1) Repeat control unit

This unit shall perform the receiver output repeating and receiver failure detection and automatic changeover by transmitter failure.

(2) Remote changeover unit

This unit shall be equipped for V-V repeating, and shall permit changeover of the transmitters by control signal from the master station.

(3) Status return unit

This unit shall be equipped for V-V repeating, and shall return the status of the repeater equipment to the master station. This unit shall use the telemetering equipment, and shall convert the repeater information into numerics and transmit them to the master station.

However, in this case, repeater information shall be handled per gauging station, and conversion into numerics shall be as follow.

Item	1,000 digit	100 digit	10 digit	1 digit
Transmitter No. 1 working	1			
Transmitter No. 2 working	2			
No transmitter failure		0		
Transmitter No. 1 failure		1		
Transmitter No. 2 failure		2		
No receiver failure			0	
Receiver No. 1 failure			1	
Receiver No. 2 failure			2	

Station No.; Station No. given to repeater station.

Additional information; Shall be 1 digit
(power supply information)

[COMMENT 31]

1. Since the repeater information which should be transmitted from the repeater station to the master station covers many items, the signal transmission system has been decided to be the same as that of the gauging station.

Moreover, if the same equipment as that of the gauging station equipment is installed as the repeater status return unit, this system is employed to simplify the processing method at the master station because the same maintenance as that of the telemetering equipment is possible and the signal format is the same.

2. Repeater information typeout example

DATE	TIME	Station A	Station B	Repeater station
02 18	12 00	1234 +	2345 +	1020 +

- NOTES: (1) The above is an example when the repeater station is the 3rd station.
- (2) Transmitter No.1 working, no transmitter failure, receiver No.2 failure and power normal are illustrated above.

(4) Test panel

The following functions shall be provided at the test panel for system monitoring and maintenance at the repeater equipment.

	Function	Operation	Display	Remarks
1	Power ON/OFF	0	-	
2	Transmitting display	-	0	
3	Speech	0	-	
4	Repeating-start	0	-	V-V repeating only
5	Repeating-stop	0	-	
6	Transmitter No. 1 working	0	0	Including change-over operation
7	" 2 "	0	0	
8	" 1 failure	-	0	
9	" 2 "	-	0	
10	Receiver No. 1 failure	-	0	
11	" 2 "	-	0	
12	Display OFF	0	-	May be replaced by door switch.
13	Transmitter changeover lock	0	-	
14	Receiver No. 1 disconnect	0	-	
15	" 2 "	0	-	

(5) External I/O interface

This unit shall be installed for μ -V repeating, and shall satisfy the following conditions.

a. Input conditions

- a) Shall be relay contact input.
- b) Shall close the contact by logic 1. Load capacity shall be 50V, 50mA or greater.
- c) Signal length shall be 200 \pm 100mSec.
- d) Kinds of control items
 - (a) Transmitter changeover No. 1 \rightarrow No. 2
 - (b) " " No. 2 \rightarrow No. 1
 - (c) Receiver No. 1 disconnect
 - (d) Receiver No. 2 disconnect
 - (e) Receiver parallel connection

b. Output conditions

- a) Shall be relay contact output.
- b) Shall close the contact by logic 1. Load conditions shall be 50V, 50mA or less.
- c) Kinds of output signals
 - (a) Transmitter No. 1 working
 - (b) Transmitter No. 2 working
 - (c) Receiver No. 1 failure
 - (d) Receiver No. 2 failure
 - (e) Transmitter No. 1 failure
 - (f) Transmitter No. 2 failure

(6) Multiplex radio equipment interface

This unit shall be equipped for μ -V repeater equipment and shall have a function that connects multiplex radio equipment and shall satisfy the following input/output conditions.

- a. I/O level Settable within a range of 0 to -25dBm.

b. I/O impedance 600Ω ±20% balanced

(7) Power supply unit

This unit shall supply the necessary power to the other units. Its input shall be DC 12V (- ground).

3-3-3 Repeater equipment current consumption

The current consumption of the repeater station equipment shall satisfy the following conditions at 12.0V power supply voltage.

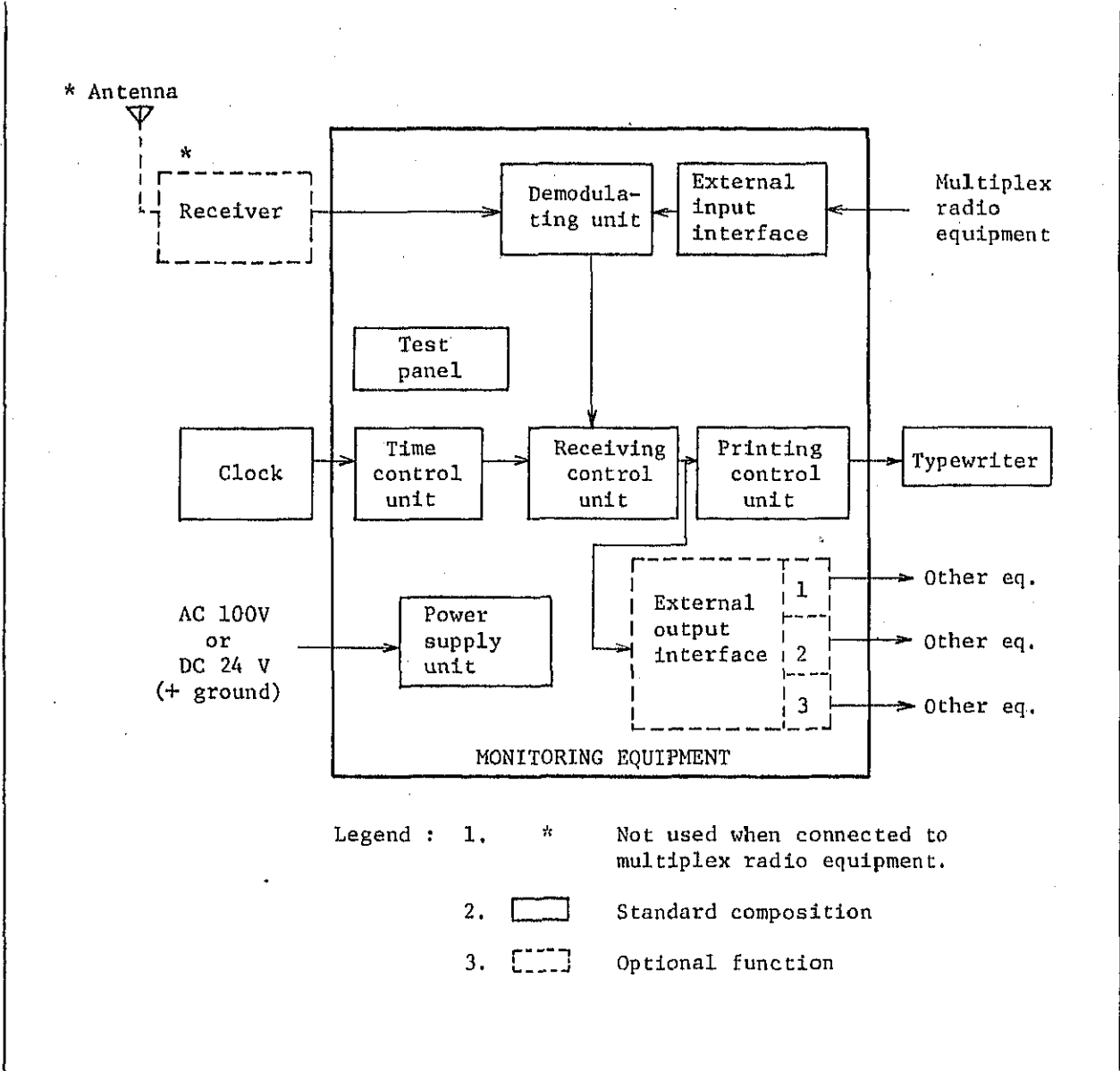
Item		Current consumption
Stand-by		50 mA or less
Receiving		1.3 A or less
Repeating	1 W	3.0 A or less
	3 W	3.5 A or less
	10 W	4.7 A or less

However, the current consumption in repeating shall increase 1.0A at status return unit operation (for V-V repeater).

3-4 Monitoring station Equipment

3-4-1 Equipment composition

- 1) The equipment composition of the monitoring station, including standard composition and optional functions, shall be as follows:



[COMMENT 32]

Monitoring performed by connection to multiplex radio equipment shall be the standard function, and antenna equipment and receiver shall be installed as optional components in the case of a simplex radio link.

2) Components shall be as follows:

	Name	Q'ty	Remarks
1	Monitoring equipment	1	
- 1	Demodulating unit	1	
- 2	Receiving control unit	1	
- 3	Printing control unit	1	
- 4	External input interface	1	
- 5	Test panel	1	
- 6	Time control unit	1	
- 7	Power supply unit	1	
- 8	Bay	1	
- 9	External output interface	1	Optional function
2	Typewriter	1	Same as par. 3-1-2 3)
3	Receiver	1	Conforms with SSI.
4	Antenna equipment	1	Conforms with SSI.
- 1	Antenna	1	
- 2	Coaxial arrester	1	
5	Clock	1	Conforms with SSI.
6	Accessories	1 set	
- 1	Test cord	1	
- 2	Adjustment tools	1 set	
- 3	Instruction manual	1 copy	
- 4	Test data	1 copy	
- 5	Technical service card	1 copy	In card case
- 6	Accessory case		

3-4-2 Functions and specifications

1) External input interface

This unit is used to connect to multiplex radio equipment. Its input conditions shall satisfy the following specifications.

(a) Input level Settable within the range of 0 to -25dBm

(b) Input impedance 600Ω ±20% balanced

2) Monitoring equipment

(1) Test panel

At the monitoring equipment, the following functions shall be provided at the test panel for system monitoring and maintenance.

	Function	Operation	Display	Remarks
1	Resetting	0	-	For operation resetting
2	Buzzer off	0	-	
3	Receiving tone monitor	-	0	
4	Input level measurement	0	-	U-link, etc. (By external measuring instrument)
5	Lamp test	0	-	
6	Typewriter printing ON/OFF	0	-	
7	Squelch adjustment	0	-	When receiver equipped
8	Data bit display	-	0	
9	Burn out fuse	-	0	
10	Power ON/OFF	0	-	
11	Power	-	0	
12	Monitoring by voltmeter	0	0	For power supply voltage measurement

3-4-3 Optional functions

The following functions shall be addable to the monitoring equipment according to SSI.

1) External output interface

This unit is used to connect to a display unit, etc. Its output shall satisfy the following conditions.

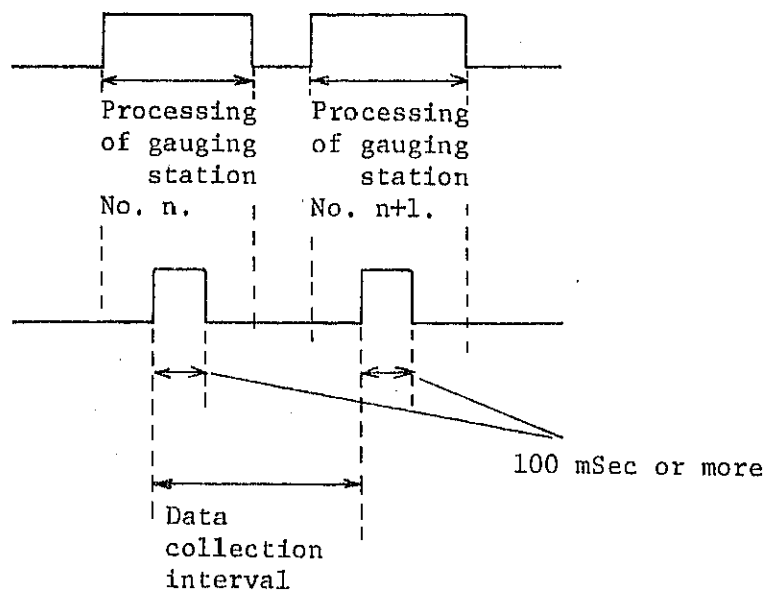
- (1) Shall be no-voltage contact.
- (2) Shall close the contact by logic 1.
Load conditions shall be 50V, 50mA or less.
- (3) Kinds of output signals

a. Output format

Output signal name	Output signal contents	Signal format	Remarks
Measured value	BCD 4 digits 20 bits	Momentary signal	With 1 bit odd parity at each digit
Station No.	BCD 2 digits 10 bits	do.	do.
Current time	BCD 4 digits 13 bits	Continuous signal	Without parity bit
1 minute pulse	1 bit	do.	
Monitoring	1 bit	do.	
Monitor station power abnormal	1 bit	do.	
Strobe		Momentary signal	

1. Data guarantee time

When data (momentary signal) are output to the outside, it shall conform with the following time chart.



[COMMENT 33]

1. The number of output paths shall be up to a maximum of 3 paths. The number of paths equipped must be specified in SSI.

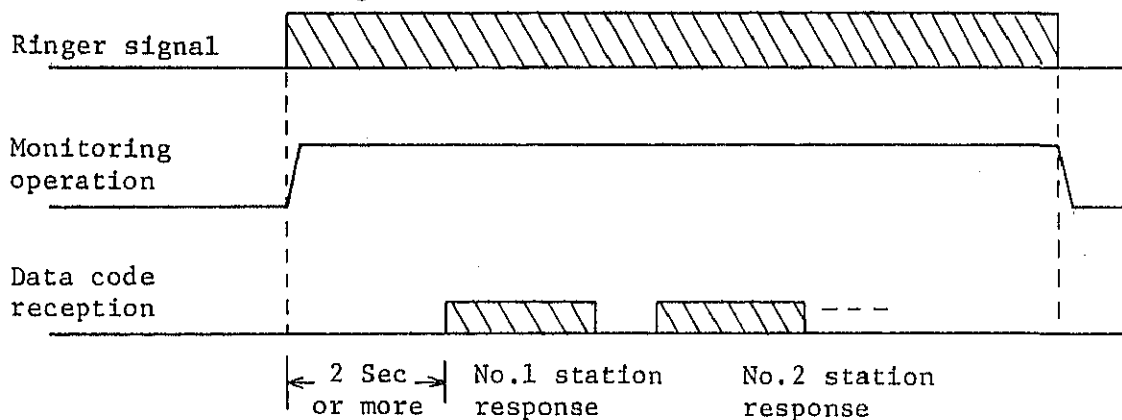
2. The kinds of output signals must be selected and specified in SSI after an adequate study of the connected devices.

3-4-4 The conditions of monitoring operation

The monitoring operation start and stop conditions shall conform with the following.

- 1) In case monitoring is performed by simplex radio links, the monitoring operation shall be started by detection of the subcarrier when the response signal has been directly input from the gauging station, and shall be ended by the timer after one series of operations is completed.
- 2) In case monitoring is performed by multiplex radio links, the monitoring operation signal (ringer signal) sent by the master station shall be received, and the monitoring operation shall be performed only while this signal is being received.

The operation time chart for this system shall conform with the following.



[COMMENT 34]

1. Monitoring by simplex radio links conforms with the system that starts operation on detection of the subcarrier.
2. When a ringer signal can be used in a monitoring system by multiplex radio links, monitoring by means of this signal is desirable. However, when the ringer signal cannot be used, monitoring should conform with the above.

3-4-5 Data processing

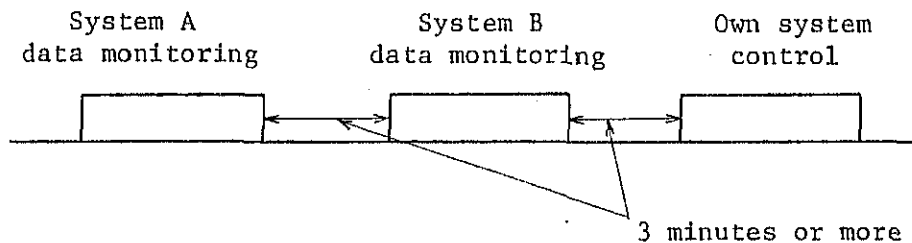
- 1) When the monitoring operation is started by inputting the response signal directly by means of a simplex radio link, all the data shall be printed at both all-station calling and individual station calling.
- 2) When the monitoring operation is started by the ringer signal

of multiplex radio link, only the data code of the gauging station received while the ringer signal is being received shall be printed.

- 3) The monitoring operation shall be performed from the lower gauging station number to the higher gauging station number, and printing shall not be performed when the station numbers are reversed during one monitoring operation.

3-4-6 System expansion function

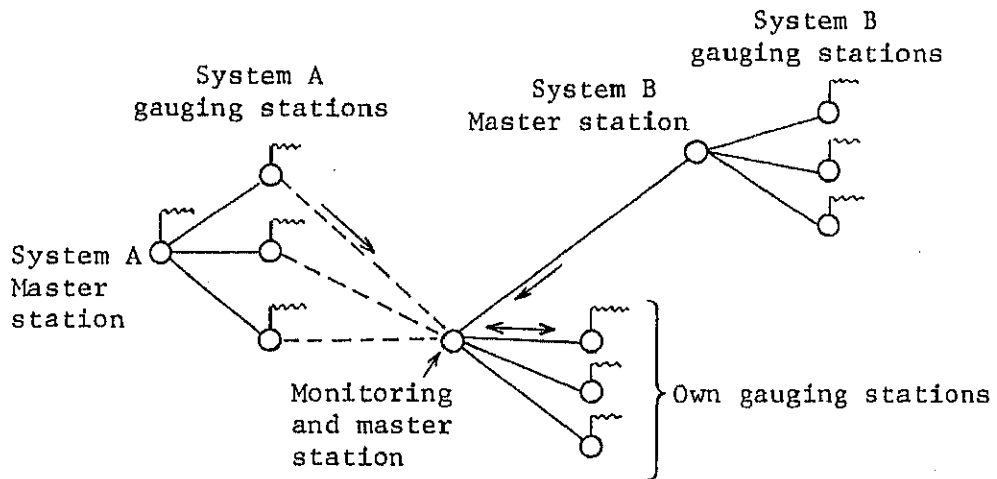
- 1) The number of monitoring systems connectable to this equipment shall be a maximum of two systems.
- 2) The functions of master station shall be addable to this equipment as required.
In this case the operating time chart shall conform with the following, and the order of each system shall be specified in the SSI.



- 3) The total number of gauging stations of the monitoring system and own system shall be within 30 stations. The station numbers in this case shall be one series of numbers for the entire system, and shall be assigned in calling order from low station number to high station number.
- 4) Printing shall be performed in one line for the entire system.

[COMMENT 35]

1. The transmission lines that can be connected to the monitoring/telemetering equipment according to these specifications shall be up to a maximum of 3 transmission lines by combining simplex radio links, multiplex radio links, and wire links. A system example is given below. (A repeater station may also be installed in the links, but is omitted here.)



2. In the system example given above, time management is performed perfectly and all stations can be assumed to be controlled by a single master station.
 As an example of time management, if time management is performed by the clock of each station, the interval of each system (data interval) must be about 3 minutes, considered from the stand point of clock accuracy.

3. Since processing is performed by station number, there must not be stations having the same station number, including the station numbers of the own system gauging stations.

APPENDIX I

CALCULATION IN THE CIRCUIT DESIGN WORK

CALCULATIONS IN THE CIRCUIT DESIGN WORK

1. Formula

The free space loss is calculated by the following formula:

$$\text{Free space loss (dB)} = 20 \log f + 20 \log d + 32.4$$

f : Frequency (MHz)

d : Distance (km)

The additional loss is derived from the following:

$$\begin{aligned} \text{Additional loss (dB)} &= \text{Diffraction loss (dB)} \\ &+ \text{Topography coefficient (dB)} \end{aligned}$$

Diffraction loss is found from Fig. 1 and Fig. 2.

Topography coefficient in the range of 0 to 25 dB is estimated according to the conditions of the propagation path.

The receiving noise power (Prn) is the noise power at the input terminal of the receiver and consisted of the internal noise power of the receiver (Prni) and the external noise power (Prnc).

$$\text{Prni (dBw)} = 10 \log KTBF$$

K : Boltzman's constant 1.38×10^{-28} joule/°K

T : Absolute temperature (Normal temperature 290°K)

B : Receiver equivalent noise bandwidth (Hz)

F : Noise figure

$$\text{Prni (dBm)} = 10 \lg B \text{ (KHz)} + F \text{ (dB)} - 144$$

$$\text{Prnc} = \text{Nc}$$

Nc: Deterioration by external noise (dB)

Therefore,

$$\text{Prn (dBm)} = 10 \log B \text{ (KHz)} + F \text{ (dB)} = 144 + \text{Nc (dB)}$$

The following values were used in this report.

$$B = 12 \text{ KHz}$$

$$F = 8 \text{ dB}$$

$$N_c = 10 \text{ dB}$$

Therefore,

$$P_{rn} = 10 \log 12 + 8 - 144 + 10 = -115 \text{ dBm}$$

The S/N (signal-to-noise ratio) improvement factor (I) is given by the following formula:

$$I \text{ (dB)} = 10 \log \frac{3 \cdot f_d^2 \cdot B}{2 \cdot f_m^3}$$

f_d : Maximum frequency deviation (KHz)

f_m : Modulation frequency (KHz)

B : Receiver equivalent noise bandwidth (KHz)

The following values were used in this report

$$f_d : 5 \text{ KHz}$$

$$f_m : 3 \text{ KHz}$$

$$B : 12 \text{ KHz}$$

Therefore,

$$I = 10 \log \frac{3 \times 5^2 \times 12}{2 \times 3^3} = 12 \text{ dB}$$

The threshold level (P_{th}) is given by the following equation:

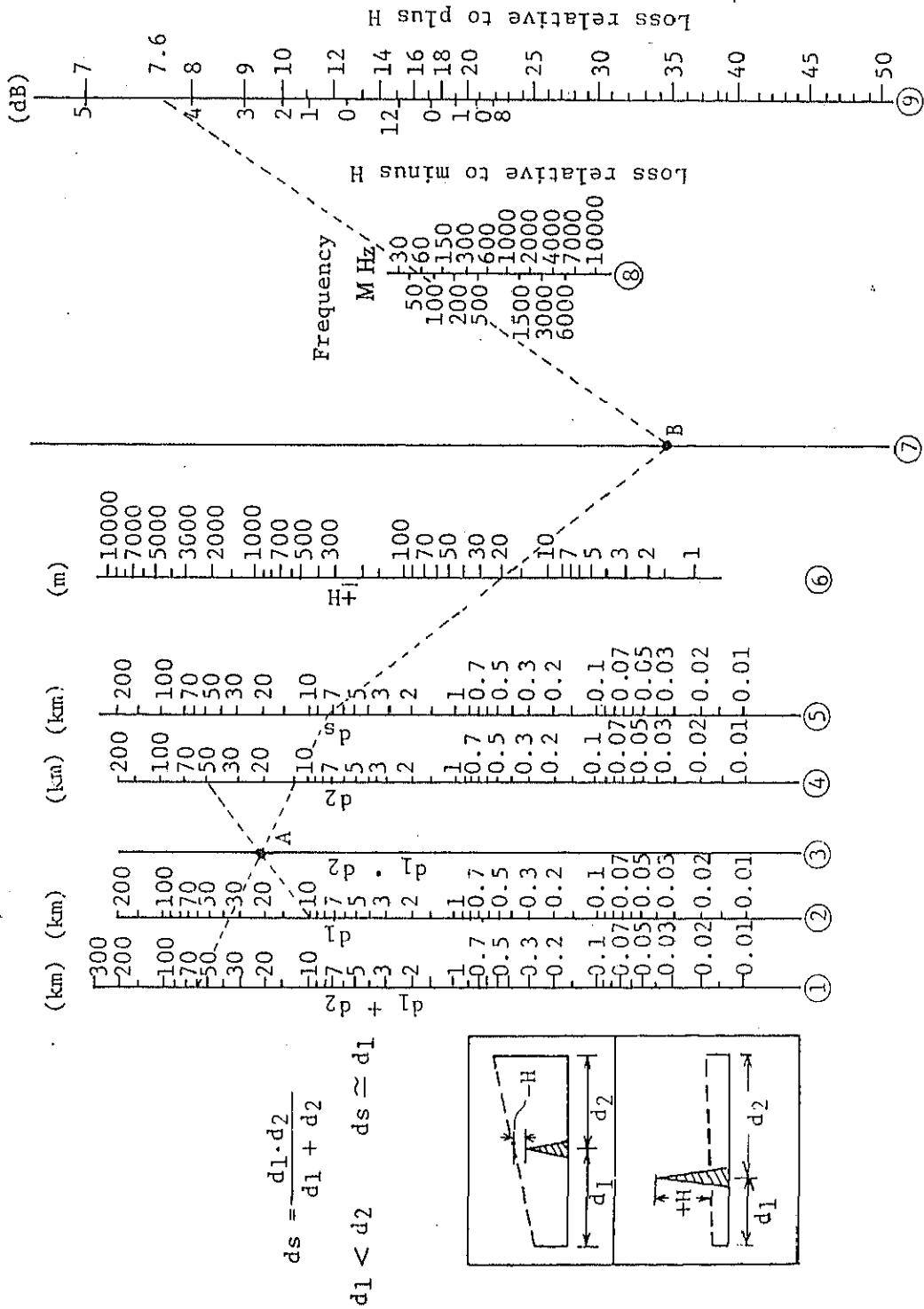
$$P_{th} \text{ (dBm)} = P_{rn} \text{ (dBm)} + 9$$

$$P_{rn} = 115 \text{ dBm}$$

Therefore

$$P_{th} = (-115) + 9 = -106 \text{ dBm}$$

Loss added to free space loss when there is diffraction by knife edge.



② → ④ → ③, ① → ⑤, ⑥ → ⑦, ⑧ → ⑨

2. Example

Kinabatangan River Basin

The free space loss and the additional loss between Mt. Balat and Kuamut are calculated as follows:

$$f : 70 \text{ MHz}$$

$$d : 15.3 \text{ km}$$

Therefore,

$$\begin{aligned} \text{Free space loss} &= 20 \log 70 + 20 \log 15.3 + 32.4 \\ &= 93 \text{ dB} \end{aligned}$$

$$\text{Diffraction loss} = 3 + 2 = 5 \text{ dB}$$

$$d_1 = 4 \text{ km}, \quad d_2 = 11.3 \text{ km}, \quad H_1 = -20 \text{ m}, \quad \Gamma_1 = 3 \text{ dB}$$

$$d_3 = 10 \text{ km}, \quad d_4 = 5.3 \text{ km}, \quad H_2 = -30 \text{ m}, \quad \Gamma_2 = 2 \text{ dB}$$

(see Fig. 3 and Fig. 4)

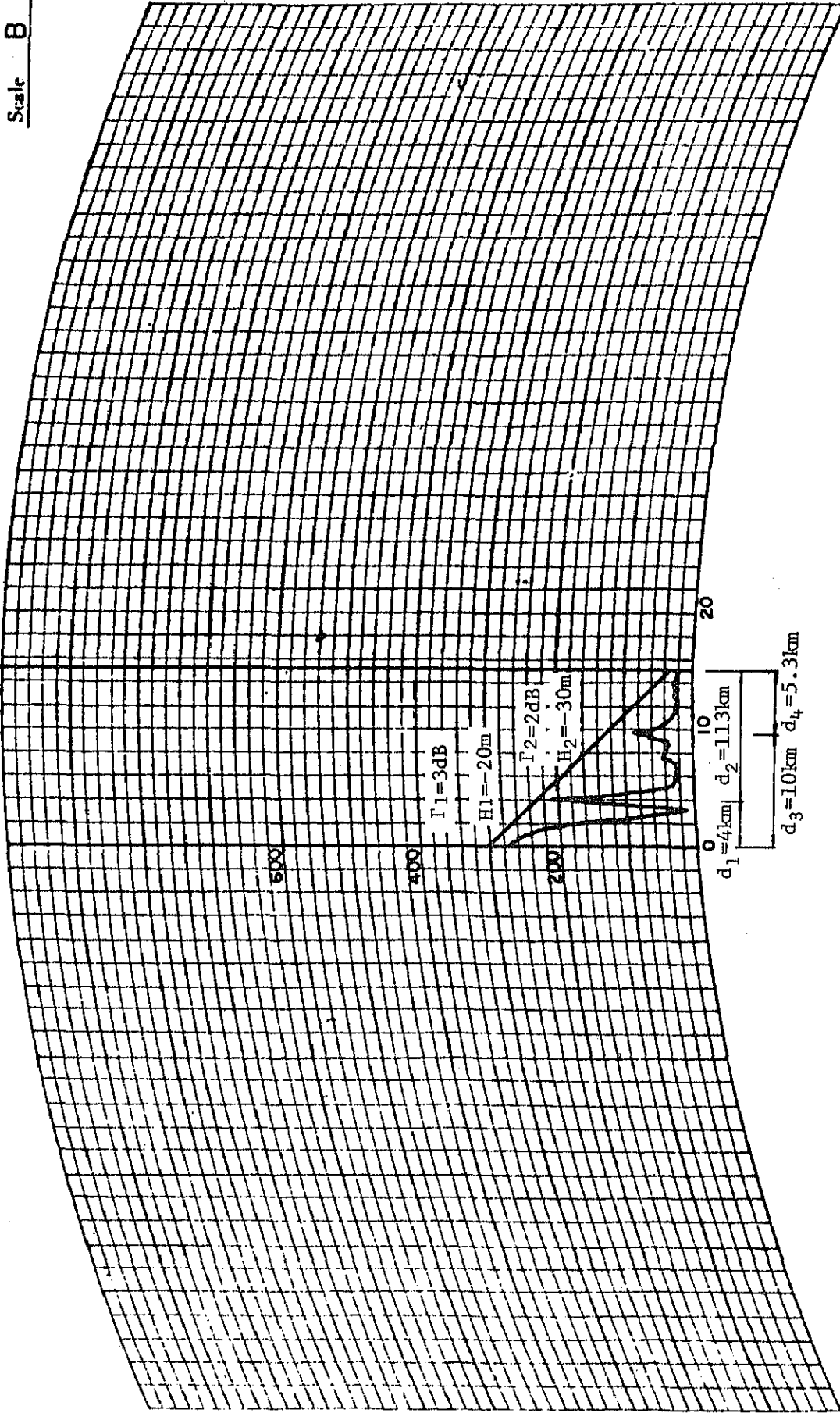
$$\text{Topography coefficient} = 25 \text{ dB}$$

Therefore,

$$\begin{aligned} \text{Additional loss} &= 5 + 25 \\ &= 30 \text{ dB} \end{aligned}$$

PROFILE (K=1/3)

Scale B



Full Scale
A = 1000m
B = 1000m
C = 250m

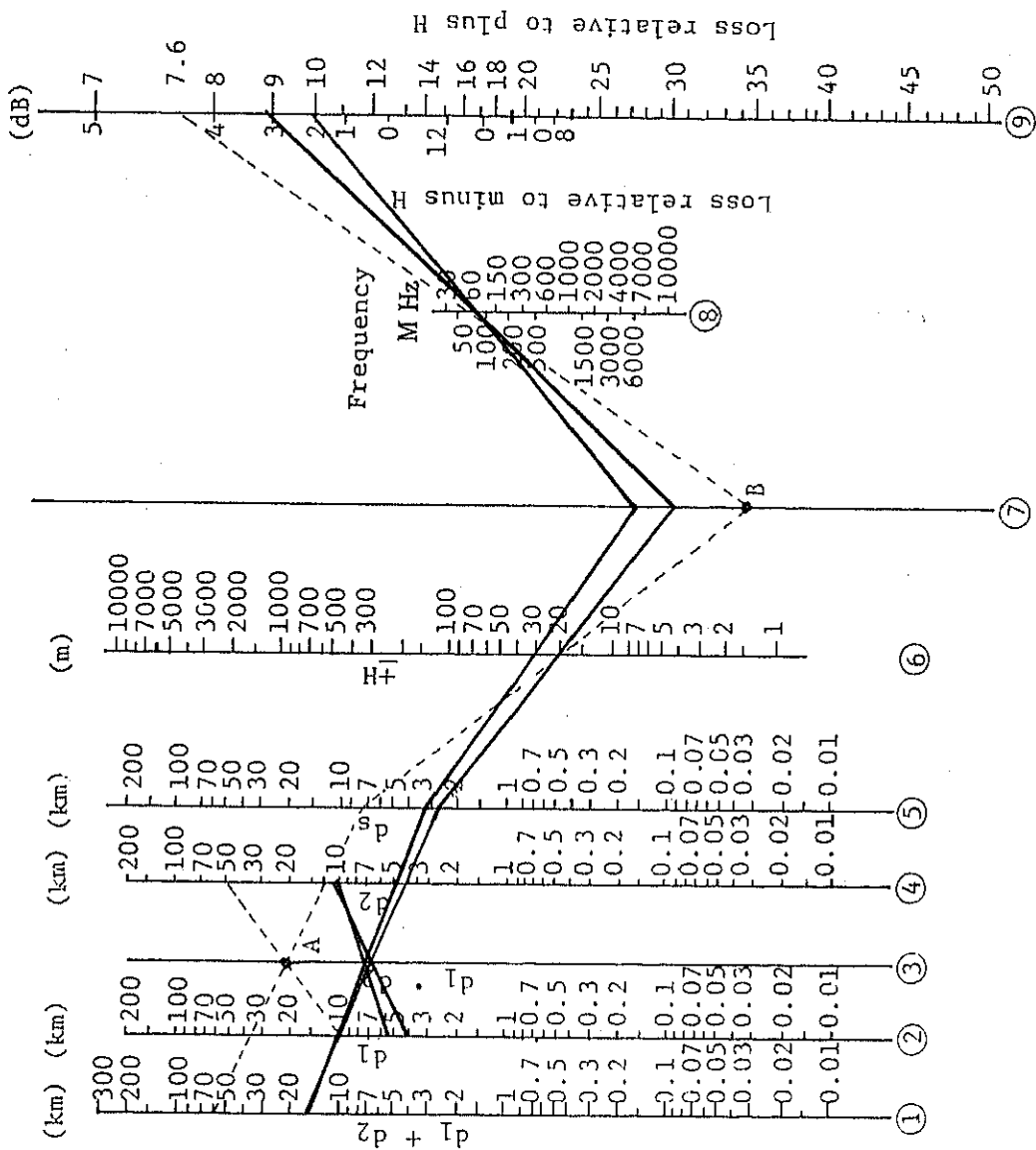
I - 6
Height(m)

DATE	DESIGN	TRACED	CHECKED	APPR
DRAW NO.				M.P.E

Mt. Balat Kuamut
 Altitude... 275 m Altitude... 20 m
 Antenna Height... 30 m Antenna Height... 10 m

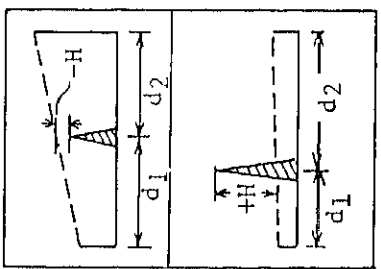
Full Scale
A = 200km
B = 120km
C = 60km

Loss added to free space loss when there is diffraction by knife edge.



$$ds = \frac{d_1 \cdot d_2}{d_1 + d_2} \quad ds \approx d_1$$

$d_1 < d_2$



- ② ④ → ③, ① ③ → ⑤, ⑤ ⑥ → ⑦, ⑦ ⑧ → ⑨

Sadong River Basin

The free space loss and the additional loss between Mt. Serapi and Serian are calculated as follows:

$$f : 70 \text{ MHz}$$

$$d : 62.8 \text{ km}$$

Therefore,

$$\begin{aligned} \text{Free space loss} &= 20 \log 70 + 20 \log 62.8 + 32.4 \\ &= 105.3 \text{ dB} \end{aligned}$$

$$\text{Diffraction loss} = 23 \text{ dB}$$

$$d_1 = 59 \text{ km}, \quad d_2 = 3.8 \text{ km}, \quad H_1 = 250 \text{ m}, \quad \Gamma_1 = 23 \text{ dB}$$

(See Fig. and Fig. 6)

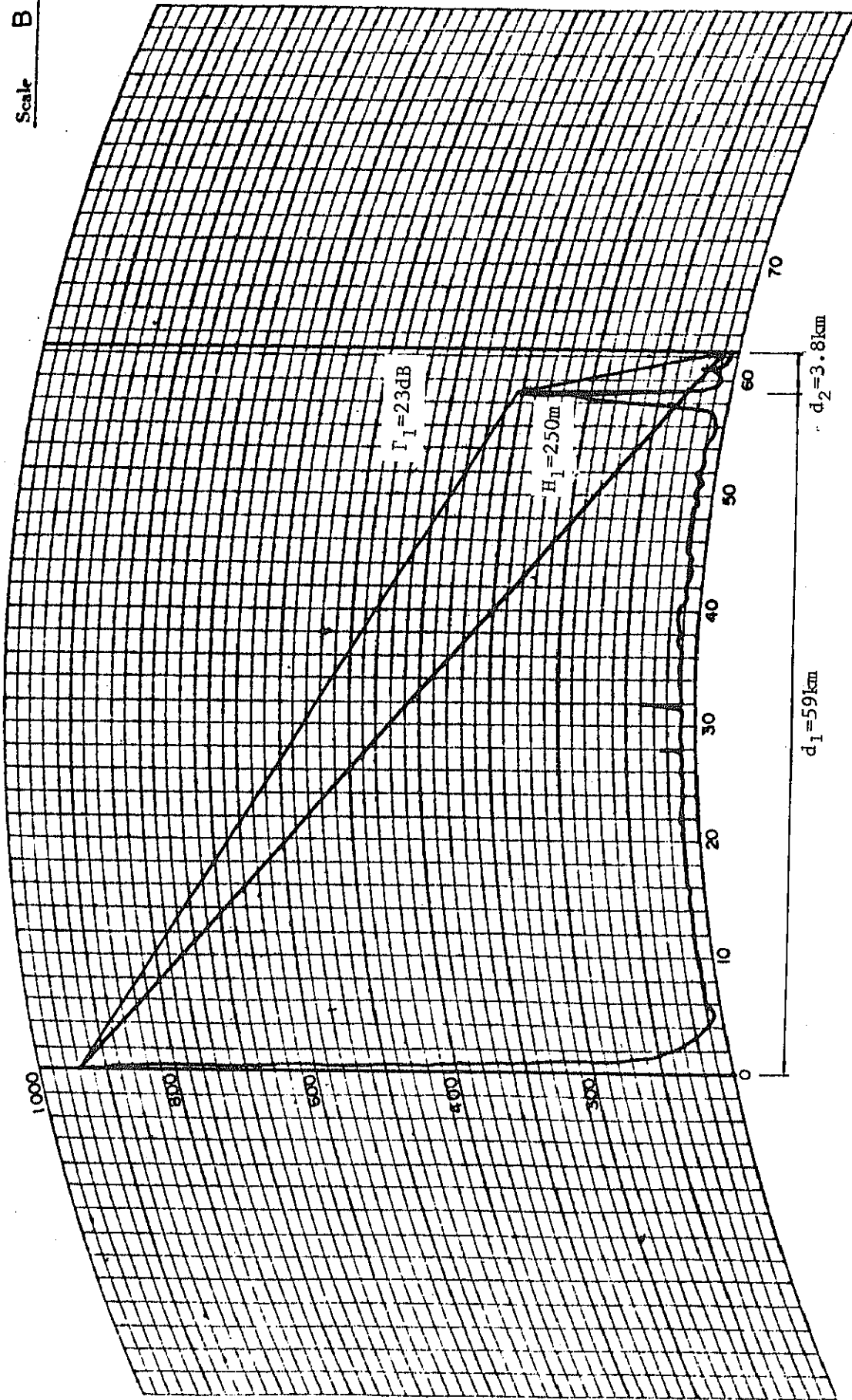
$$\text{Topography coefficient} = 0 \text{ dB}$$

Therefore,

$$\begin{aligned} \text{Additional loss} &= 23 + 0 \\ &= 23 \text{ dB} \end{aligned}$$

PROFILE (K=1/3)

Scale B



Full Scale
A = 1000m
B = 1000m
C = 250m

I - 9
Height (m)

Full Scale
A = 200km
B = 120km
C = 60km

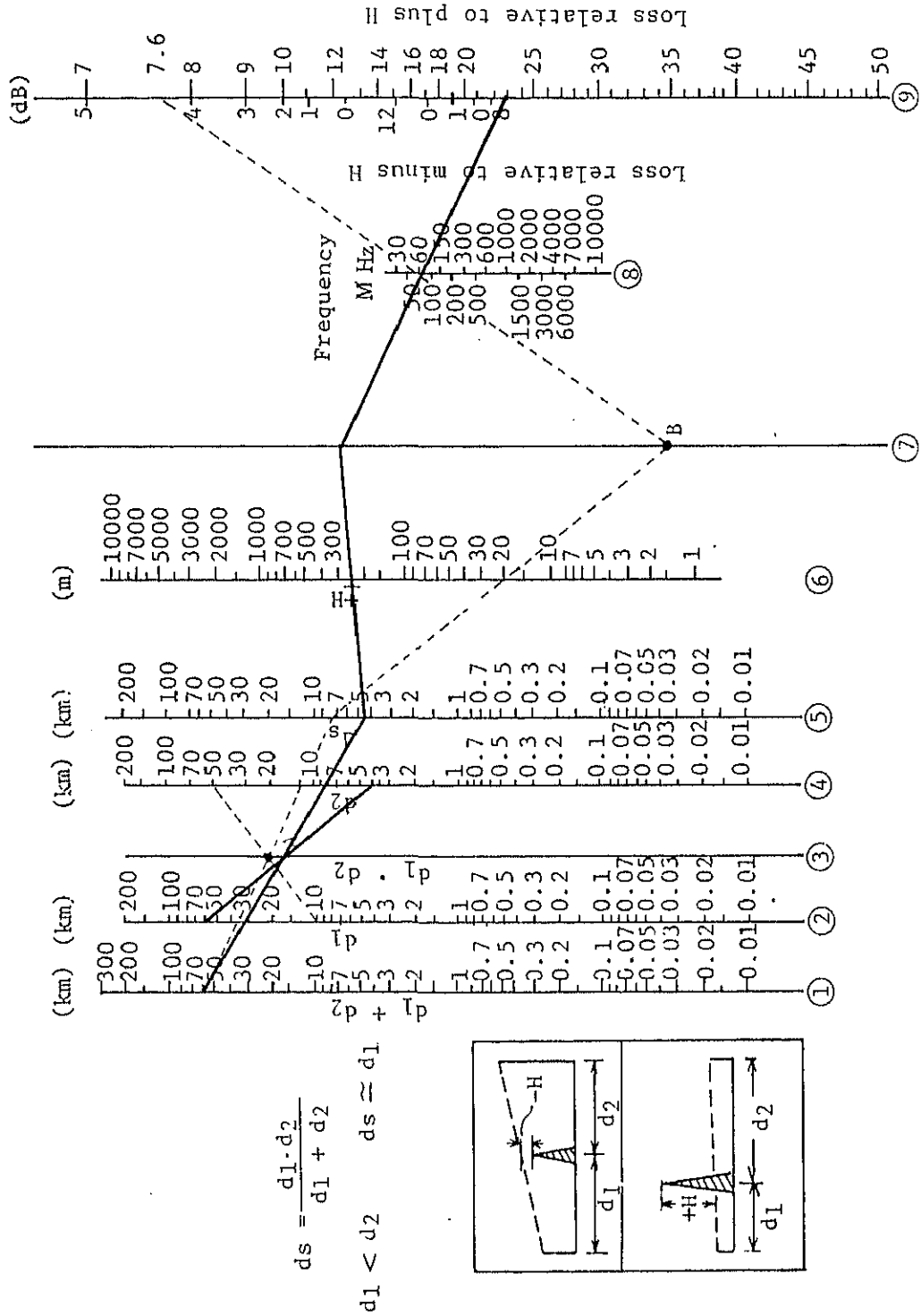
Mt Serapi
Altitude 910 m
Antenna Height 30 m

Altitude 10 m
Antenna Height 10 m

Serial

DATE	DESIGN	TRACED	CHECKED	APPR
DRAW NO.				M,PE

Loss added to free space loss when there is diffraction by knife edge.



② ④ → ③, ① ③ → ⑤, ⑤ ⑥ → ⑦, ⑦ ⑧ → ⑨

APPENDIX J

EXAMPLE OF CAPACITY CALCULATION

EXAMPLE OF CAPACITY CALCULATION

1. Kinabatangan River Basin

Conditions for capacity calculation of solar cell and storage battery are as follows:

Trig Hill Relay Station

Number of gauging stations: 20 stations

Calling signal time from master station: 2.5 sec/station

Response signal time from gauging station: 4.6 sec/station

Relay equipment current drain

Standby : 0.05A

Receiving : 1.3A

Transmitting: 4.0A (transmitting power 1W)

Measurement interval : 30 min (48 times/day)

Speech (maintenance) : 10 min/month (of these, 5 min is transmitting)

Storage battery used : Pocket type alkaline storage battery

Maintenance factor : 0.8

Minimum storage battery temperature: 5°C

Allowable minimum voltage: 1.1 V/cell

Assumed power interruption time: 6 days

Mt. Balat Relay Station

Number of gauging stations: 20 stations

Calling signal time from master station: 2.5 sec/station

Response signal time from gauging station: 4.6 sec/station

Relay equipment current drain

Standby : 0.05A

Receiving : 0.13A

Transmitting : 12A (Transmitting power 20W)

Measurement interval : 30 min (48 times/day)

Speech (maintenance) : 10 min/month (of these, 5 min is transmitting)

Storage battery used : Pocket type alkaline storage battery
Capacity correction coefficient : 0.7
Annual sunshine time : 2,000 hours
Maximum continuous non-sunshine time: 20 days

Gauging Station

Number of gauging stations: 20 stations
Calling signal time from master station: 2.5 sec/station
Response signal time from gauging station: 4.6 sec/station
Telemetry equipment current drain

Standby : 0.015A
Receiving : 0.15A
Transmitting : 12A (Transmitting power 20W)
 2.5A(" " 3W)
 2.0A(" " 1W)

Measurement interval : 30 min(48 times/day)
Speech (maintenance) : 10 min/month (of these, 5 min is transmitting)
Storage battery used : Pocket type alkaline storage battery
Capacity correction coefficient : 0.7
Annual sunshine time : 2,000 hours
Maximum continuous non-sunshine time : 20 days

For example, capacities of Mt. Balat and the gauging station using a 20W transmitting power radio equipment are calculated as follows:

Mt. Balat Relay Station

$$\begin{aligned} T_1 &= \text{Standby time} - T_2 - T_3 \\ &= 24 \text{ hours} \times 30 \text{ days} - 60 \text{ hours} - 60 \text{ hours} \\ &= 600 \text{ hours} \end{aligned}$$

$$\begin{aligned} T_2 &= \text{Receiving time} \\ &= (2.5 \text{ sec} + 4.6 \text{ sec}) \times 20 \text{ stations} \times 48 \text{ times} \times 30 \text{ days} \\ &\quad + 10 \text{ min} \times 20 \text{ stations} + 5 \text{ min} \\ &= 60 \text{ hours} \end{aligned}$$

$$\begin{aligned}
 T_3 &= \text{Transmitting time} \\
 &= (2.5 \text{ sec} + 4.6 \text{ sec}) \times 20 \text{ stations} \times 48 \text{ times} \times 30 \text{ days} \\
 &\quad + 10 \text{ min} \times 20 \text{ stations} + 5 \text{ min} \\
 &= 60 \text{ hours}
 \end{aligned}$$

$$\begin{aligned}
 I &= \text{Average load current} \\
 &= \frac{600 \text{ hours} \times 0.05\text{A} + 60 \text{ hours} \times 1.3\text{A} + 60 \text{ hours} \times 12\text{A}}{24 \text{ hours} \times 30 \text{ days}} \\
 &= 1.15\text{A}
 \end{aligned}$$

$$\begin{aligned}
 P &= \text{Solar cell output} \\
 &= 1.15\text{A} \times 12\text{V} \times 12 \\
 &= 166 \text{ W} \qquad \qquad \qquad \underline{168\text{W}}
 \end{aligned}$$

$$\begin{aligned}
 C &= \text{Capacity of storage battery} \\
 &= \frac{1.15\text{A} \times 24 \text{ hours} \times 20 \text{ days}}{0.7} \\
 &= 789 \text{ AH} \qquad \qquad \qquad \underline{800 \text{ AH}}
 \end{aligned}$$

Gauging Station (transmitting power 20 W)

$$\begin{aligned}
 T_1 &= \text{Standby time} - T_2 - T_3 \\
 &= 24 \text{ hours} \times 30 \text{ days} - 58 \text{ hours} - 2 \text{ hours} \\
 &= 660 \text{ hours}
 \end{aligned}$$

$$\begin{aligned}
 T_2 &= \text{Receiving time} \\
 &= (2.5 \text{ sec} \times 20 \text{ stations} \times 4.6 \text{ sec} \times 19 \text{ stations}) \times 48 \text{ times} \\
 &\quad \times 30 \text{ days} + 10 \text{ min} \times 19 \text{ stations} + 5 \text{ min} \\
 &= 58 \text{ hours}
 \end{aligned}$$

$$\begin{aligned}
 T_3 &= \text{Transmitting time} \\
 &= 4.6 \text{ sec} \times 48 \text{ times} \times 30 \text{ days} + 5 \text{ min} \\
 &= 2 \text{ hours}
 \end{aligned}$$

$$\begin{aligned}
 I &= \text{Average load current} \\
 &= \frac{660 \text{ hours} \times 0.015\text{A} + 58 \text{ hours} \times 0.15\text{A} + 2 \text{ hours} \times 12\text{A}}{24 \text{ hours} \times 30 \text{ days}} \\
 &= 0.06\text{A}
 \end{aligned}$$

$$\begin{aligned} P &= \text{Solar cell output} \\ &= 0.06\text{A} \times 12\text{V} \times 12 \\ &= 9 \text{ W} \qquad \qquad \qquad \underline{14 \text{ W}} \end{aligned}$$

$$\begin{aligned} C &= \text{Capacity of storage battery} \\ &= \frac{0.06 \text{ A} \times 24 \text{ hours} \times 20 \text{ days}}{0.7} \\ &= 41 \text{ AH} \qquad \qquad \qquad \underline{80 \text{ AH}} \end{aligned}$$

2. Sadong River Basin

Conditions for capacity calculation of solar cell and storage battery are as follows:

Mt. Serapi Relay Station

Number of gauging stations: 20 stations

Calling signal time from master station: 2.5 sec/station

Response signal time from gauging station: 4.6 sec/station

Relay equipment current drain

Standby : 0.05A

Receiving : 1.3A

Transmitting : 5.7A (Transmitting power 10 W)

Measurement interval : 30 min (48 times/day)

Speech (maintenance) : 10 min/month (of these, 5 min is transmitting)

Storage battery used : Pocket type alkaline storage battery

Maintenance factor : 0.8

Minimum storage battery temperature: 5°C

Allowable minimum voltage : 1.1V/cell

Assumed power interruption time: 6 days

Gauging Station

Number of gauging stations : 20 stations

Calling signal time from master station : 2.5 sec/station

Response signal time from gauging station : 4.6 sec/station

Telemetry equipment current drain

Standby : 0.015A

Receiving : 0.15A

Transmitting : 5.5A (Transmitting power 10W)

2.5A (" " 3W)

2.0A (" " 1W)

Measurement interval : 30 min (48 times/day)

Speech (maintenance) : 10 min/month (of these, 5 min is transmitting)

Storage battery used : Pocket type alkaline storage battery
 Capacity correction coefficient : 0.7
 Annual sunshine time : 2,000 hours
 Maximum continuous non-sunshine time : 20 days

For example, capacities of Mt. Serapi and the gauging stations using a 10W transmitting power radio equipment are calculated as follows:

Mt. Serapi Relay Station

$$\begin{aligned} T_1 &= \text{Assumed power interruption time} \\ &= 24 \text{ hours} \times 6 \text{ days} \\ &= 144 \text{ hours} \end{aligned}$$

$$\begin{aligned} T_2 &= \text{Receiving time} + T_3 \\ &= (2.5 \text{ sec} + 4.6 \text{ sec}) \times 20 \text{ stations} \times 48 \text{ times} \times 6 \text{ days} \\ &\quad + 10 \text{ min} \times 20 \text{ stations} + 5 \text{ min} + 15 \text{ hours} \\ &= 30 \text{ hours} \end{aligned}$$

$$\begin{aligned} T_3 &= \text{Transmitting time} \\ &= (2.5 \text{ sec} + 4.6 \text{ sec}) \times 20 \text{ stations} \times 48 \text{ times} \times 6 \text{ days} \\ &\quad + 10 \text{ min} \times 20 \text{ stations} + 5 \text{ min} \\ &= 15 \text{ hours} \end{aligned}$$

$$\begin{aligned} K_1 &= \text{Capacity conversion time relative to } T_2 \\ &= 6.5 \text{ hours} = 5 \text{ hours} + 144 \text{ hours} \\ &= 145.5 \text{ hours} \end{aligned}$$

$$\begin{aligned} K_2 &= \text{Capacity conversion time relative to } T_2 \\ &= 6.5 \text{ hours} - 5 \text{ hours} + 30 \text{ hours} \\ &= 31.5 \text{ hours} \end{aligned}$$

$$\begin{aligned} K_3 &= \text{Capacity conversion time relative to } T_3 \\ &= 6.5 \text{ hours} - 5 \text{ hours} + 15 \text{ hours} \\ &= 16.5 \text{ hours} \end{aligned}$$

$$\begin{aligned} C &= \text{Capacity of storage battery} \\ &= \frac{1}{0.8} \left[145.5 \text{ hours} \times 0.05A \times 2 + 31.5 \text{ hours} \times (1.3A - 0.05A) \right] \\ &= 207 \text{ AH} \qquad \qquad \qquad \underline{250 \text{ AH}} \end{aligned}$$

Gauging Station (Transmitting power 10W)

$$\begin{aligned} T_1 &= \text{Standby time} - T_2 - T_3 \\ &= 24 \text{ hours} \times 30 \text{ days} - 58 \text{ hours} - 2 \text{ hours} \\ &= 660 \text{ hours} \end{aligned}$$

$$\begin{aligned} T_2 &= \text{Receiving time} \\ &= (2.5 \text{ sec} \times 20 \text{ stations} + 4.6 \text{ sec} \times 19 \text{ stations}) \times 48 \text{ times} \\ &\quad \times 30 \text{ days} + 10 \text{ min} \times 19 \text{ stations} + 5 \text{ min} \\ &= 58 \text{ hours} \end{aligned}$$

$$\begin{aligned} T_3 &= \text{Transmitting time} \\ &= 4.6 \text{ sec} \times 48 \text{ times} \times 30 \text{ days} + 5 \text{ min} \\ &= 2 \text{ hours} \end{aligned}$$

$$\begin{aligned} I &= \text{Average load current} \\ &= \frac{660 \text{ hours} \times 0.015\text{A} + 58 \text{ hours} \times 0.15\text{A} + 2 \text{ hours} \times 5.5\text{A}}{24 \text{ hours} \times 30 \text{ days}} \\ &= 0.04\text{A} \end{aligned}$$

$$\begin{aligned} P &= \text{Solar cell output} \\ &= 0.04\text{A} \times 12\text{V} \times 12 \\ &= 4 \text{ W} \qquad \qquad \qquad \underline{7 \text{ W}} \end{aligned}$$

$$\begin{aligned} C &= \text{Capacity of storage battery} \\ &= \frac{0.04\text{A} \times 24 \text{ hours} \times 20 \text{ days}}{0.7} \\ &= 21 \text{ AH} \qquad \qquad \qquad \underline{40 \text{ AH}} \end{aligned}$$

