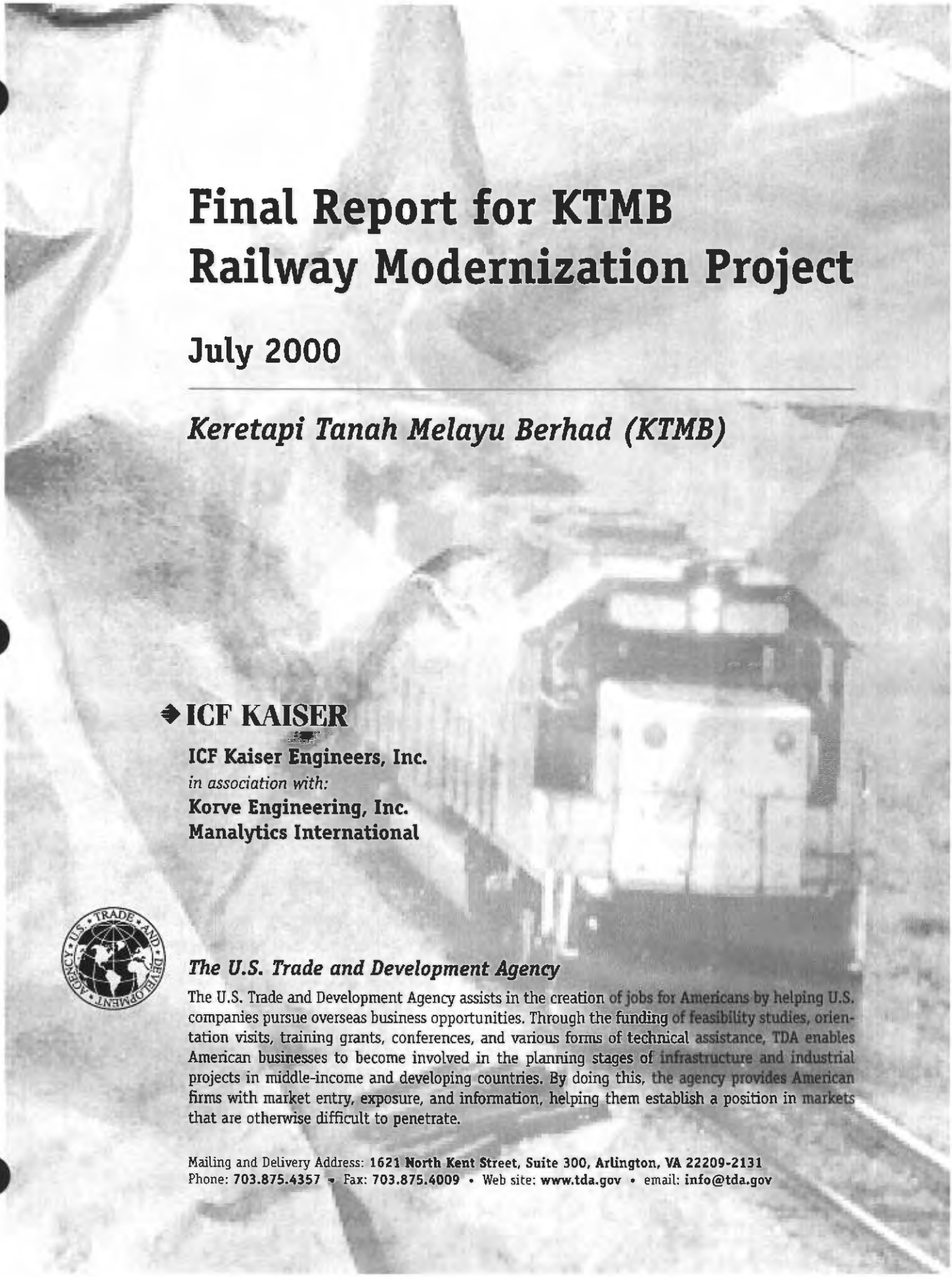

Final Report for KTMB Railway Modernization Project

July 2000

Keretapi Tanah Melayu Berhad (KTMB)

ICF KAISER

ICF Kaiser Engineers, Inc.
in association with:
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(Please note that the appendices are comprised of all prior deliverables on this project.)

Task 1 – Workshop: Deliverable 1 – Functional Design Criteria

Task 1 – Workshop: Deliverable 2 – Concept Design Report

Task 2 – Signal, Communications & Dispatch System: Deliverable 1 – Data Collection & Assembly Report

Task 2 – Signal, Communications & Dispatch System: Deliverable 2 – Signaling and Communications Improvement Study

Task 3 – Intermodal Business Development: Deliverable 1 – First Interim Report

Task 3 – Intermodal Business Development: Deliverable 2 – Second Interim Report

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KTMB RAILWAY MODERNIZATION PROJECT
FINAL REPORT

Prepared By
Korve Engineering, Inc.
And ICF Kaiser Engineers
September 1999

Korve Engineering

September 3, 1999

Mr. John Bergerson
ICF Kaiser Engineers
2101 Webster Street, Suite 1000
Oakland, California 94612-3060

RE: KTMB Workshop - Final Report

Dear John:

Enclosed are four copies of our KTMB Workshop Project Final Submittal. This submittal includes the conceptual workshop layouts for three alternative sites, the capital cost estimates for each of the alternatives, and the discussion on third party management and maintenance.

Please forward any comments that you or KTMB may have so that they can be incorporated. Please contact me at (303) 623-1287 if you have any questions.

Sincerely,

Ronald E. Rypinski

Cc: Karl Schaarschmidt
File

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KTMB RAILWAY MODERNIZATION PROJECT
FINAL REPORT

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KTMB WORKSHOP PROJECT

INTRODUCTION

This Final Report for the KTMB Workshop Project represents the compilation of the previous task products into a single document. This Final Report includes the products from Task 1 – Functional Design Criteria, Task 2 – Conceptual Design Report, and Third Party Management and Maintenance. In addition, the report for the data-gathering trip to Malaysia is included in Appendix A.

The KTMB Workshop Project evaluated three alternative yard site layouts. Alternative Layout #1 involved the existing workshop site at Falim and the site layout developed by KTMB. Alternative Layout #2 utilized the existing KTMB property located adjacent to the Seremban EMU Station. Alternative Layout #3 involved an unidentified, but more ideal, site. The estimated capital costs for each of the Alternative Layouts are $310.4 million for Alternative #1, $337.5 million for Alternative #2 and $364.2 million for Alternative #3. Alternative Layout #2 appears to be the better site for the new workshop. The site is adequate in size, is within a reasonable commute time from Kuala Lampur, is almost entirely owned by KTMB, and can be constructed without disrupting on-going operations. However, a site with similar characteristics that is located closer to Kuala Lampur would be preferred.

The analysis of third party management and maintenance resulted in the recommendation to continue using third party contractors for management and supervision and to lengthen the contract period from 3 to 5 years to provide for continuity of personnel, adequate training of the existing workforce, and the time necessary to implement new maintenance programs and capital improvements.

The importance of the new workshop cannot be overemphasized. Without a proper workshop for major overhaul and repair, the performance and availability of the locomotive fleet, carriage fleets and wagon fleet will be difficult to sustain, let alone improve.

1.0 TASK 1 - FUNCTIONAL DESIGN CRITERIA

This functional design criteria has been developed in accordance with Part 1 of the Workshop Project. The functional design criterion incorporates information and data collected from KTMB as well as relevant observations made during site visits to various KTMB maintenance depots. The purpose of the functional design criteria is to establish the basic requirements and characteristics necessary for the conceptual design of the new workshop. The functional design criterion includes consideration for locomotives, EMU's, coaches, and freight wagons.

1.1. GENERAL WORKSHOP REQUIREMENTS

1.1.1 EXISTING AND OTHER DEPOTS

Locomotives, coaches and wagons are serviced, maintained, and repaired at several existing depots. A new coach depot is under construction. These depots do not perform any overhauls or major repairs. What is left of KTMB's major workshop for overhaul and major repairs exists at the Sentul Workshop in Kuala Lumpur. The site of the Sentul Workshop was sold in 1993 to a private developer who now controls most of the original 96 acres of the site. The remaining facility primarily performs overhauls and major repairs on locomotives. An in-floor wheel-truing machine also turns wheels on both locomotives and coaches. The Sentul Workshop is existing on borrowed time (and restraining orders).

A new coach depot is under construction at the site of a new Central Station complex in Kuala Lumpur. The new depot is located just south of the existing 90-year old coach depot. The new facility is not designed to perform overhauls and major repairs to coaches. The new coach depot is scheduled for completion in approximately 2 years.

Other depots and facilities that will perform servicing, maintenance, and repair (excluding overhauls and major repairs) on rolling stock are summarized as follows:

Rolling Stock	Depot Location
Locomotives	Falim, Gemas, Prai, Singapore, and Tumpat
Coaches	Kuala Lumpur (new depot in 2 years) and Tumpat
Wagons	Falim, Prai, Gemas, Port Klang, and Tumpat
EMU'S	Kuala Lumpur (built in 1995)

1.1.2. NEW WORKSHOP FUNCTIONS AND ACTIVITIES

A. The new workshop shall be capable of performing the following maintenance activities for locomotives, coaches, and wagons as appropriate:

1) Fueling, cleaning, and servicing

2) Daily inspections

3) Periodic examinations (PE's)

4) Unscheduled repairs of failures/incidents

5) Wheel truing (with wheels under equipment)

6) Exterior washing and cleaning

7) Overhauls and major repairs

8) Component replacements, repair, and overhaul (excluding some components to be out-shopped)

9) Painting (including preparation)

10) Load testing (locomotives and power generator cars)

B. The new workshop shall also include provisions for the following support and ancillary activities and requirements:

1) Inventory control office and storeroom facility

2) Rolling stock maintenance personnel restrooms, lockers, etc.

3) Training room and conference rooms

4) Rolling stock supervision and administrative offices and restrooms

5) Transportation facilities including offices and train crew lockers, restrooms, etc. as required

6) Guardhouse at the main entrance to the site

7) Security personnel office

C. The new workshop shall be designed to support a unit exchange maintenance philosophy to minimize down-time. Components and assemblies that are scheduled for overhaul or that are defective will be removed and replaced with a known operable spare component or assembly. The locomotive, coach, or wagon will be returned to service and the component or assembly will be overhauled or repaired and placed into the spare inventory pool.

1.1.3. WORKSHOP EQUIPMENT

A. Most of the major shop equipment and machinery for the new workshop shall also be new. The majority of the existing shop equipment and machinery dates from the 1930's to the 1970's. Most of the heavy shop equipment acquired in the 1980's is in need of major rebuilding. The criteria for shop equipment and machinery shall be as follows:

1) Equipment and machinery that is integrated into the shop building structure shall be new. This precludes disruption to on-going maintenance activities during the construction of a new shop. Examples of this type of shop equipment are overhead bridge cranes, jib cranes, underfloor wheel truing machine, drop tables, in-floor jacks, painting booth, transfer table (if necessary); and wheel press.

2) Equipment and machinery that meets the following requirements shall be relocated to the new workshop:

- Equipment that is duplicated or is not used frequently and can be spared during a rebuilding period or new workshop construction phase; and

- Equipment that has either a remaining life of at least 10 years or can be economically rebuilt. Examples of this type of shop equipment are lathe, boring machine, air compressor, resistance load bank, drilling machine, governor test machine, brake test stand, and hydraulic press.

B. Equipment and machinery that is in working condition or that can be economically rebuilt that will become available after the existing Sentul Workshop is closed shall be either relocated to the new workshop (as a spare or for future expansion) or to an existing workshop that is in need of the equipment. For example the existing underfloor wheel truing machine could be used at the existing Falim Depot, the new coach depot at the Central Terminal site in Kuala Lumpur, or the EMU workshop.

1.2. KTMB ROLLING STOCK

The locomotive, coach, wagon, and EMU fleets consist of the following equipment:

1.2.1. Locomotives

Quantity	Class	Year	Remarks
10	18	1979	1 scheduled for scrap
10	19	1983	
25	22	1971	8 scheduled for scrap
15	23	1983	3 scheduled for scrap
26	24	1987	7 scheduled for scrap
12	25	1990	-----
98	Subtotal KTMB loco's		19 Scheduled for scrap
31	Indian Railway		
129	**Total KTMB and IR locomotives**		

1.2.2. Passenger Coaches and Equipment

Quantity	Class	Description
14	ADNF	Air Conditioned Day and Night First Class
11	AFC	Air Conditioned First Class
40	ADNS	Air Conditioned Day & Night Second Class
76	ASC	Air Conditioned Second Class
49	AEC	Air Conditioned Economy Class
13	ABC	Air Conditioned Buffet Coach
1	SK	Air Conditioned Special VIP Coach
10	BC	Buffet Coach
1	DNS	Day and Night Second Class
3	NS	Night Second Class
40	TC	Third Class
21	PV	Parcel Van
22	BBV/BWV/CV	Bogie Brake/Bogie Workman/Catering Van
22	PGC	Power Generator Car
323	**TOTAL**	

1.2.3. Freight Wagons

Quantity - 8 Wheeler	Quantity - 4 Wheeler	Wagon Type	Wagon Description
790	0	BBC	Bulk Cement Hopper
1170	284	BCF/CF	Container Wagon
35	0	BBS	Bulk Sugar
219	50	BFL/FL	Flat, low side
100	67	BLW/LW	Log Wagon
292	511	BCG/CG	Covered Goods
374	3	BTO/TO	Tank, Oil
152	0	BLC	Log and Container
50	0	BFW	Flat
100	0	BEB	Engineering Ballast
38	0	BHW	Hopper Wagon
24	15	BCP/CPT	Container Platform
5	0	BHS	High Side Wagon
4	3	BHT/HCW	Horse/Cattle Wagon
4	0	BWW	Well Wagon
3	1	BTW/TW	Tank, Water
2	2	BTP/TP	Tank, Palm Oil
20	0	BTL	Tank, Latex
12	0	BTA	Tank, Ammonia
13	0	BRW	Rail Wagon
12	0	BPW	Pallet Wagon
3	4	BCR/CR	
45	0	BGB	Goods Brake
6	1	BLT/LT	Loco Tool Van
22	0	BMV	Motor Van
0	13	SW	Shunting Wagon
0	18	LS	Low Side Wagon
3495	**972**	**TOTAL**	

1.2.4. Electric Multiple Unit (EMU)

3 Unit Sets Quantity	Class	Built	Manufacturer
18	81	1994	JTS – Austria
22	82	1996	UCW – South Africa
21	83	1996	Marubeni – Japan
61	**TOTAL**		

1.2.5. Rolling Stock Physical Dimensions

The minimum and maximum physical dimensions for KTMB rolling stock (in MM and ft – in) and maximum weights (in tons) for locomotives in working order and empty coach, wagon, and EMU equipment are as follows:

Dimension	Locomotives Class 18 & 19	Locomotives Class 22 To 25	Coaches	Bogie Wagons (8 Wheel)	Wagons (4 Wheel)	3-Unit Emu (12 Axle)
Length: Min	N/A	15,259 (50'-3/4")	19,177 (62'-11")	10,617 (34'-10")	5512 (18'-1")	68,707 (225'-5")
Max		18,542 (60'-10")	22,860 (75'-0")	18,186 (59'-8")	7849 (25'-9")	69,317 (227'-5')
Height: Min	N/A	3747 (12'-3-1/2")	3581 (11'-9")	1047 (3'-5")	1194 (3'-11")	3759 (12'-4")
Max		3861 (12'-8")	3835 (12'-7")	3556 (11'-8")	3658 (12'-0")	
Width: Min	N/A	2743 (9'-0")	2565 (8'-5")	2134 (7'-0")	2134 (7'-0")	2442 (8'-8")
Max		2794 (9'-2")	2972 (9'-9")	2794 (9'-2")	2591 (8'-6")	2692 (8'-10")
Bogie Centers: Min	N/A	8001 (26'-3")	12,801 (42'-0")	5639 (18-6")	2591 (8'-6")	15,799 (51'-10")
Max		10,300 (33'-9-1/2")	15,011 (49'-3")	13,132 (43'-1")	4191 (13'-9")	
Bogie Axle Centers: Min	N/A	3289 (10'-9-1/2")	2007 (6'-7")	1448 (4'-9")	Does not apply to 2-axle wagons	2286 (7'-6")
Max		4407 (14'-51/2")	2210 (7'-3")	1753 (5'-9")		
Maximum Weight	58.4	90.0	N/A	N/A	N/A	143.4

1.3. NEW WORKSHOP YARD TRACKWORK

1.3.1 Trackwork associated with the new workshop shall meet the following criteria:

A. Workshop and yard trackwork shall be designed for an axle loading of 20 tonnes (1 tonne = 2200 lbs.)

B. Track gauge shall be meter gauge, 1000 mm (approximately 3'-3 3/8") nominal.

C. Turnouts for yard and workshop trackage shall be Number 9, minimum.

D. Rail section shall be 80 Kg per meter.

E. Wooden sleepers (crossties) shall be used and shall be 254 mm (10 inches) x 127 mm (5 inches) in cross-section and 180 cm (6'-0') in length. Sleeper density, excluding turnouts shall be 1540 per Km (sleeper centers of 648 mm or 25 ½ inches).

F. The minimum radius for curved track shall be 109 meters (358 feet).

G. The minimum tangent length between curves shall be 15.24 meters (50'-0")

H. The minimum clearance dimensions shall be as follows:

1)	Center to center of any track	3660 mm (12'-0")
2)	Center to center of yard track	4265 mm (14'-0")
3)	Center to center of workshop track	4570 mm (15'-0")
4)	Height at center of track for overhead structure	4265 mm (14'-0")
5)	Horizontal distance from center of track to any structure from Top of rail to 900 mm (3'-0") Above top of rail	1370 mm (4'-6")
6)	Horizontal distance from center of track to any structure from 900 mm (3'-0) to 3125 mm (10'-0") above top of rail	1980 mm (6'-6')

1.4. NEW WORKSHOP SITE REQUIREMENTS

1.4.1 In addition to the new workshop buildings, the new workshop site shall include the following requirements and features:

A. Perimeter fencing with access gates

B. Guardhouse at main roadway entrance to the site

C. Site access roadways and service aisles

D. Site lighting for roadways, service aisles, building perimeters, fueling and servicing facilities and tracks, guardhouse, washer, and other yard activity areas and facilities

E. Locomotive and coach washer with water reclamation system

F. Cleaning platform equipped with lighting, water, compressed air, and electrical outlets for heavy coach interior cleaning and for cleaning coach interiors prior to being released for service. The cleaning platform shall be located adjacent to, or on the same track as, the locomotive and coach washer

G. Locomotive fueling, sanding, and servicing facility with a minimum of four above-ground storage tanks capable of storing a total of 500,000 liters of diesel fuel. Fueling tracks shall include concrete slab track with diesel fuel recovery and fire protection systems

H. Hazardous materials storage building equipped with fire protection and spill containment and reclamation systems

I. Wastewater reclamation and treatment system for workshop buildings and other wastewater producing areas and facilities

J. Employee parking area(s)

K. Substation for the supply of yard and workshop electrical power

L. Sufficient yard trackage for the following:

1) Lead tracks to/from the main line

2) Storage tracks for arriving and departing locomotives, coaches, and wagons

3) Long term storage tracks for locomotives, coaches, and wagons

4) Workshop lead trackage

5) Connecting trackage between yard storage, workshops, fueling, cleaning, washing, and other activity areas and facilities

6) Trackage for shunting, run-around, and bypass movements

7) Other trackage as may be required to promote efficient use of the available site

1.4.2 New Workshop Site Selection

The selection of a site for the new workshop shall include consideration for the following:

A. Site location. The location of the new workshop site should be convenient for the movement of rolling stock to and from the facility. Dead-head, or non-revenue, mileage should be minimized. Convenient

access for locomotives and coaches shall be more important than access for freight wagons. The site should be located either where an adequate work force is available or where the relocation of the existing work force is economical.

B. Site Size. The site must be large enough to accommodate the needs and requirements described for the new locomotive, coach, and wagon workshop.

C. Site characteristics. The site must be configured so as to be useable with a minimum of wasted space. The site must be accessible to the main line and must allow for an efficient arrangement of trackage, structures, roadways, and other features.

D. Future expansion. The site should allow for the efficient staging of initial construction and for future expansion with minimal disruption to on-going operations.

1.5 NEW WORKSHOP REQUIREMENTS

The new workshop shall accommodate the following facilities and requirements for locomotives, coaches, and wagons. Facilities and requirements that are unique to each type of rolling stock are presented first. These are followed by the facilities and requirements that are common to two or more of the types of rolling stock.

1.5.1 Locomotives

A. The new workshop shall be capable of performing heavy repair and overhaul for a fleet of approximately 120 locomotives. The fleet of 120 locomotives allows for the retirement of approximately 20 of the total of 98 existing KTMB locomotives, the return of the 31 locomotives from Indian Railway, and the acquisition of some 40 new locomotives. In addition, the new workshop shall be capable of accommodating the fueling, servicing, running repairs, and periodic examinations for approximately 30 to 40 locomotives that may, depending upon the actual location selected for the new workshop, be based at the facility or undergoing major repair or overhaul at the facility.

B. The new workshop shall be designed to promote and maintain a daily locomotive availability of at least 80% to 85%. NOTE: the construction of the new workshop will not necessarily guarantee 80% to 85% availability for locomotives because not all locomotives will be based at the facility. Capital improvements to the other locomotive depots, which are in poor condition, will likely be necessary before the desired daily locomotive availability will be consistently achieved.

C. Based upon data available from KTMB and upon experience with similar facilities in North America, the number of locomotive work positions, or spots, needed in the new workshop are as follows:

Locomotive Function Or Activity	Number Of Work Positions	Remarks
a. Fueling/servicing	4	Also includes fuel drain-off capability
b. Inspections/running repairs	4	Daily and 15-day inspections
c. Periodic examinations	3	45-day interval
d. Repairs/failure repairs	2	Based upon 40 locomotives
e. Overhauls/major repairs	10	Every 4 years (24,000 engine hours)
f. Static power testing	2	
Total locomotive positions	25	
Note: Washing, wheel truing, paint preparation, and painting are covered in Section D., Common Facilities for Rolling Stock.		

1.5.2 Coaches

A. The passenger coach portion of the new workshop shall be capable of performing overhauls, major repairs, limited periodic examinations, minor repairs, cleaning, and servicing for a fleet of at least 257 passenger coaches, 22 power generator cars, and 20 to 25 parcel and other vans.

B. Based upon data available from KTMB, including drawings for a proposed new workshop at Falim, the number of coach work positions needed in the new workshop are as follows:

Coach Function Or Activity	Number Of Work Positions	Remarks
a. Underframe cleaning	1	
b. Static power testing	1	For power generator cars
c. Periodic examinations	1	Limited to cars in shop area
d. Repairs/fail repairs	1	Limited to cars in shop area
e. Overhauls/major repairs	10	3 year overhaul interval
f. Coach interior cleaning	1	Locate near exterior washer
Total coach positions	15	
Note: Exterior washing, wheel truing, paint preparation, and painting are covered in Section D. Common Facilities for Rolling Stock		

1.5.3. Freight Wagons

A. The wagon portion of the new workshop shall be capable of performing overhauls and major repairs for a fleet of approximately 4500 freight wagons.

B. Based upon data available for KTMB, including drawings for a proposed new workshop at Falim, the number of wagon work positions needed in the new workshop are as follows:

Wagon Function Or Activity	Number Of Work Positions	Remarks
a. Periodic examinations/repairs	2	6-month interval
b. Intermediate overhaul	6	Bi-annual
c. Overhaul/major repair	24	4-year interval
d. Painting and preparation	2	
Total wagon positions	34	
NOTE: Wheel truing for wagons will be performed on a wheel lathe machine on wheel sets only (wheels removed from wagons).		

1.5.4 Common Facilities for Rolling Stock

A. The following facilities are common to both locomotives and coaches:

1) Exterior washer. One washer will be sufficient for washing locomotives and coaches.

2) Wheel truing. One in-floor wheel truing machine should be sufficient if the wheel truing machine is operated for 2 shifts/day, 5 days/week and assuming that, on the average, each locomotive, power generator car, and coach requires wheel truing 1.5 times per year at 8 shop hours per visit. (120 loco + 280 PGC/coaches = 400 x 1.5 visits = 600 visits/year. 600 visits x 8 hours = 4800 hours ÷ 4176 available shop hours = 1.15 wheel truing machine spots). An above-floor wheel lathe should be available to provide additional wheel truing capacity for wheel sets that have been removed from locomotives, power generator cars, and coaches.

3) Paint preparation and painting. Three booths, 2 for preparation and 1 for painting/drying, should be sufficient if it is assumed that 2 shifts/day, 5 days/week will be worked, that repainting is necessary every 6 years, that 96 shop hours are required for paint preparation, and that 60 shop hours are required for painting and drying. The calculations are as follows:

- 120 loco + 280 PGC/coaches = 400 units ÷ 6 year interval = 67 units/year.
- 67 units/year x 96 shop hours preparation time = 6432 hours/year ÷ 4176 available shop hours = 1.5 booths for paint preparation.
- 67 units/year x 60 shop hours painting/drying time = 4020 hours/year ÷ 4176 available shop hours = 1.0 booths for painting and drying.

1.5.5 Electric Multiple Units

A. The existing EMU Workshop in Kuala Lumpur is in need of additional improvements. The following improvements have been identified by KTMB personnel and were confirmed as being necessary during our site visit:

1) In-floor wheel truing machine. Wheel truing is currently performed with the wheels removed from the car. This practice is inefficient and time consuming. Space does exist within the workshop for the installation of an in-floor wheel truing machine.

2) Paint preparation and paint booth. The existing paint booth is inadequate as only one of the three car units can be accommodated at a time. The paint booth needs to be capable of accommodating an entire 3-unit car. Space does exist to lengthen the paint booth to the needed length.

3) Car exterior washer. While a car washer does exist, it does not include a wastewater recycling system.

4) Additional overhaul work positions. Only two car work positions are currently equipped with in-floor car hoists and carbody supports. Overhauls and repairs that require the removal and replacement of major undercar components must be performed at these two locations as the other four-car work positions are over pits. As the EMU fleet ages, an additional two car work positions will be required. The two new work locations could be equipped with either in-floor hoists and carbody supports or portable electric jacks and carbody stands. The use of portable jacks and stands would be cost effective and would be adequate for overhauls and major repairs that involve longer periods of shop time.

Given the electrification and other physical differences, EMU activities should be kept separate from the maintenance and repair activities of the other types of rolling stock.

1.5.6 Component Overhaul and Repair

In addition to the shop work positions for locomotives coaches, and wagons, the new workshop shall include overhaul and repair facilities for rolling stock assemblies and components. Common assemblies and components (e.g. couplers wheels and axles, brake valves, glazing, etc.) shall be overhauled and repaired in designated common areas within the workshop. The component overhaul and repair facilities shall include consideration for the following types of rolling stock assemblies and components:

A. Locomotives

1) Diesel engines

2) Generators

3) Traction motors (excluding rewinding)

4) Governors and injectors

5) Brake valves, piping and equipment

6) Bogie frames, bolsters, and parts

7) Wheels, axles, gears, and bearings

8) Cab controls, gauges, and equipment

9) Couplers and draft gears

10) Cooling radiators and fans

11) Electrical cabinets and equipment

12) Glazing

13) Batteries

B. Coaches

1) Bogie frames, bolsters, and parts

2) Wheels, axles, and bearings

3) Brake valves, piping, and equipment

4) Couplers and draft gears

5) Electrical equipment and fixtures

6) Seats, tables, beds, and other furniture

7) Showers, toilets, and sinks

8) Glazing

9) Carpets, flooring, window shades, curtains, etc.

10) Air conditioning units and equipment

11) Doors and door operators and hardware

12) Stoves, ovens, refrigerators, vending machines, and other appliances

13) Batteries

C. Freight Wagons

1) Bogie Frames, bolsters, and parts

2) Wheels, axles, and bearings

3) Brakes, valves, piping, and equipment

4) Couplers and draft gears

5) Doors, hatches, valves, and associated hardware

The component overhaul and repair facilities shall also include consideration for the outsourcing of such work to contract vendors and suppliers. The potential use of contract vendors and suppliers shall be based upon the following considerations:

A. Availability of qualified local facilities and skills

B. Complexity of the work and special skills, machinery, and tool requirements

C. Frequency and volume of the work

D. Additional spares inventory required to maintain the required availability of components: and

E. Potential cost savings or increase in costs

1.6 ASSESSMENT OF SPARE PARTS

This portion of the study assesses the spare parts situation for each class of locomotive currently in use by KTMB.

Because of the sale and redevelopment of the Sentul yard site, parts storage is being transferred from the Sentul Shop area to other depot locations. Small components and assemblies are currently stored in various depots and warehouses. Larger assemblies such as trucks, wheel sets and couplers are stored at the Sentul shop as well as other depots such as Falim.

The shop stores at Sentul supports locomotive overhaul, major repairs, periodic examinations, running repairs, and overhaul and remanufacture of locomotive assemblies and components.

KTMB (Bombardier) is currently developing and implementing a proper and comprehensive inventory control system for locomotives, coaches, and wagons.

1.6.1. Inventory Catalog Description

A computer run from the Sentul Inventory Catalog for Sections 22, 23, 24, and 25 was provided by KTMB. The sections provided for locomotives address the 22000, 23000, 24000, and 25000 class locomotives, respectively. Inventory catalog sections for coaches and for 17000, 18000, and 19000 class locomotives were not provided.

The amount of inventory detail differs drastically by locomotive type. Using page count as a measurement of detail, the Inventory Catalog for the 23000-class locomotive consists of 473 pages while the 24000-class catalog consists of 110 pages. While the complexity of the locomotive classes is relatively equivalent, the differences in detail can probably be attributed to the locomotive builders since each class of locomotive was provide by a different builder.

The Inventory Catalog lists each assembly, sub-assembly, and component by locomotive class then by Item Number, Class, Description Unit, Part Number/Drawing Number, Store, and Bin. As with most inventory catalogs, the suppliers parts catalogs must be used in conjunction with this inventory catalog.

Item Number: The first two digits identify the locomotive class. The next four digits identify the assembly and the last five digits identify the sub-assembly/ component. Variations of this inventory numbering system are commonly used by most railroads and operating authorities. Generally, major assemblies for each class of locomotive would use the same numbering sequence. There is no consistency for assembly numbers in this Inventory Catalog, as an example, traction motors are listed as 3100 series for the 23000 class locomotives and 1200 for the 24000 class locomotives.

Class: A Class Number, from 0 to 8, is assigned to each assembly, sub-assembly, and component. There is no apparent indication as to the significance of the class numbers.

Description: Generally, the assembly, sub-assembly, then the component are described in sequence. The inconsistencies with this description format that are found within this Inventory Catalog are not detrimental to its use.

Unit: Although some "kits" appear in the "Description" column, the only units of measurement listed are "unit" or "set".

Part Number/Drawing Number: The locomotive supplier's Part Number and/or Drawing Number are provided.

1.6.2. Inventory Catalog Assessment

This Inventory Catalog only covers the Sentul stores and is intended to be used with the locomotive supplier's catalogs. An Inventory Catalog for the entire system would be required to evaluate inventory levels.

This Inventory Catalog does not identify the quantity of components and assemblies in stock. As a minimum, maximum and minimum quantities for each item maintained in inventory along with the actual quantity in inventory should be identified. Inventory levels and re-order trigger points should be set based on projected usage, lead times, and anticipated production of equipment overhauls and scheduled maintenance. Particular attention must be paid to consumable items such as filters, lamps and motor brushes.

A companion Inventory Catalog to the one provided would be sorted by each assembly, sub-assembly, and component by supplier's Part Number/Drawing Number Cross references to the Item Number and usage on other Locomotive classes should be provided. This companion Inventory Catalog is easily produced from this database with modern high-speed computer equipment.

Since the Sentul shop overhauls locomotives and major locomotive assemblies, KTMB should consider developing overhaul kits which support discreet work scopes. An example would be a kit containing all the parts necessary to overhaul a relatively simple assembly such as a brake valve or a more complex assembly such as an air compressor. These kits provide a more consistent quality for overhauled components by eliminating discretionary replacement of components by the technician.

The description of "kits" when they do appear in the Description column are generally vague. The nature of the kit and the applicable assembly/sub-assembly should be identified.

1.6.3. Inventory Assessment

Since the quantity levels of inventory for the assemblies, sub-assemblies and components were not provided, the adequacy of the inventory at Sentul cannot be evaluated at this time. An Inventory Catalog which includes the actual quantity of material in inventory with maximum and minimum inventory levels would be required for the evaluation.

1.6.4. Summary

The Sentul Inventory Catalog when used in conjunction with supplier parts catalogs and a companion Inventory Catalog sorted by Part Number/Drawing Number is sufficient for cataloging and retrieving inventory. Actual inventory levels with maximum and minimum levels must be provided in the Inventory Catalog.

Since actual inventory levels were not provided, an evaluation/assessment of the inventory could not be made. It is understood that KTMB is currently striving to improve the inventory system and reports. Unfortunately, the available computer system is some 35 years old and is very time consuming to operate.

1.6.5. Recommendations

Actual inventory levels with maximum and minimum quantities needs to be developed and input into the inventory system. A companion Inventory Catalog sorted by supplier Part Number./Drawing Number also needs to be developed. A modern high-speed computer needs to be provided to accommodate the needs of the inventory control function.

"Kits" of parts should be developed to address specific work task and activities and to promote consistency and quality of locomotive maintenance and overhaul as well as component overhaul.

1.7. MAINTENANCE PROGRAMS

KTMB workshops support locomotive, EMU, passenger coach and freight wagon maintenance. This analysis of KTMB maintenance practices only addresses maintenance and overhaul practices for the locomotives. There was insufficient information provided to analyze EMU, passenger coach and freight wagon maintenance practices.

Even with the limited KTMB maintenance and service information provided for EMU's, passenger coaches and freight wagons, the data indicates that the Bombardier management team is taking appropriate steps to develop the required maintenance programs.

KTMB maintains a fleet of 78 road locomotives and 20 switch/shuttle locomotives. KTMB road and switch locomotives are identified in Table No. 1. In addition, KTMB leases a fleet of 31 road locomotives, from Indian Railway, identified as 6000 Class locomotives in Table No. 2. The 6000 Class locomotives are serviced by the Indian Railroad, the

leasing agency. This maintenance analysis will consider the impact on maintenance if the leased locomotives are replaced by up to 30 KTMB locomotives.

1.7.1. Scheduled Maintenance

KTMB provided locomotive maintenance procedures that were based on both engine time and calendar time. The content of the maintenance procedures is discussed in the succeeding pages of this section.

Early maintenance practices, exemplified by 1988 vintage PKJE procedures, were based on diesel engine operating time, "engine time." Each locomotive received a daily inspection. Progressive maintenance was based on multiples of 250 engine hours. The least intensive maintenance occurred at 250 hours with more intensive maintenance occurring at 500 hours, 1500 hours, 3000 hours, and 6000 hours. The most intensive level of maintenance occurred at 12,000 hours. The maintenance cycles repeat after each scheduled maintenance threshold is achieved.

Current maintenance practices are based on calendar days. Each road locomotive receives an in-bound daily inspection at the end of each trip. Routine inspections occur at 15-day intervals with more intensive PE inspections occurring at 45-day intervals. The cycle repeats after each 45-day period. Intense maintenance intervals beyond 45-day do not appear to be addressed at this time.

As presented in Table No. 2, the average road locomotive in-service time for the month of June, 1998 was 301.6 hours. Considering that road locomotives are under power when shuttling to and from trains, an additional factor of 30% was added to the average locomotive in-service time to calculate engine time. For this analysis, average engine time is estimated at 200 hours and 600 hours, respectively for the 15-day and 45-day inspections.

Although the actual engine time and mileage/kilometers operated were not provided, road locomotives should be overhauled on a four-year cycle based on an estimated average monthly engine time of 400 to 500 hours. The average engine time on a locomotive at the end of five years service is estimated at 24,000 hours, the OEM's recommend overhaul interval. As shown in Table No. 3 the 22000 and 25000 Classes locomotive are just finishing an overhaul cycle and the 23000 and 24000 Classes are just beginning the cycle.

1.7.2. Unscheduled Locomotive Maintenance

Based on current performance, each road locomotive can be expected to experience 1.5 days road failure and 1.5 days unscheduled repair during each 45-day period. Successful implementation of the 45-day (PE) inspection cycle is expected to reduce failure incidences and unscheduled maintenance. To date, there is no supporting data to verify a new failure/repair rate.

Based on the June, 1998 data which is summarized in Table No. 3, only 23 of the 60 serviceable road locomotives have been overhauled an additional 18 are in service but are over-due for overhaul, and 14 are out of service and overdue for overhaul. Overhauled locomotives have a higher level of reliability than units that are in-service, but overdue for overhaul. Maintenance records appear to support this conclusion.

While KTMB's practice of de-rating locomotives and dispatching them with a pair of disabled motors improves availability, it also has an adverse impact on unscheduled maintenance.

KTMB schedules maintenance on 15-day and 45-day cycles in addition to daily inspections. For this report, one calendar month of 30 days is considered. The shop workload assumes a fleet size of 60 serviceable locomotives with two locomotives out of service at any given time for overhaul. Heavy maintenance such as wheel repair/replacement and engine work is considered major repairs.

Although the study team was advised that KTMB overhauls/remanufactures major locomotive assemblies such as traction motors, generators and diesel engines, procedures were not provided and therefore the impact on shop workload could not be assessed.

1.7.3. Maintenance Procedures

KTMB provided a 1998 vintage progressive maintenance procedure, based on 250-hour locomotive engine time intervals. The procedure consists of seven stages of maintenance starting with daily inspections and progressing to a 12,000-hour inspection. The components that require inspection, maintenance, or replacement are identified along with an inspection criterion. Inspection data sheets for accountability are missing.

KTMB (Bombardier) "Daily Maintenance" User's Procedures were provided. These procedures appear to be based on the 1988 vintage Stage I procedures. The components that require inspection, maintenance, or replacement are identified along with an inspection criterion. Sign-off sheets are provided to record inspection data and record defects and unscheduled maintenance. A signature by the Depot Manager provides accountability. The procedure appears to be well prepared and realistic. The procedure appears adequate to ensure that a locomotive is operational and suitable for service at the end/beginning of each service day. There is conflicting information whether the inspection is done at the end or beginning of the service day. Estimated inspection time is 30 minutes. This basic procedure is typical of equivalent procedures in use by other operating railroads.

The KTMB Bombardier "15-Day Maintenance" User's Procedures were provided. The procedures appear to be based on the 1988 vintage Stage II procedures. The components that require inspection, maintenance, or replacement are identified along with an inspection criterion. Sign off sheets are provided to record inspection results and record defects and unscheduled maintenance. The signature of the Depot Manager provided accountability. The procedures appear to be well written and practical. The procedure is designed to ensure that consumable material such as lubricants, motor brushes and filters are inspected and maintained to OEM recommended standards. Estimated inspection time is two hours.

Inspection procedures for the 45-Day (PE) Inspection were not provided. The Bombardier management team at KTMB appears to be in the development stages of this program.

Although locomotive overhauls are in progress at Sentul, a work scope of the overhauls were not provided. The overhaul duration is scheduled for 90 days with a longer-term goal of 60 to 75 days per overhaul. Records indicate that currently overhaul duration frequently exceeds 90 days.

1.7.4. Summary

Shop procedures for "Daily" and "15-Day" Inspections are well thought out and more than adequate for the intended inspection periods. Accountability is provided with the sign-off sheets. Shop procedures for the "45-Day (PE)" was not available.

KTMB is playing catch-up with the locomotive overhauls. Approximately 1/3 of the fleet of 60 serviceable locomotives is out of service and waiting overhaul, 1/3 of the locomotives are in-service and are overdue for overhaul, and 1/3 have been overhauled. Locomotives over due for overhaul appear to be seriously impacting fleet availability.

Locomotive failure data was not available, therefore, failure trends could not be assessed.

Based on the available information, the Bombardier management team at KTMB appears to be taking the appropriate measures to improve locomotive availability in spite of the fact that the major overhaul workshop is living on borrowed time, most of the existing depots are in poor physical condition and are in need of rehabilitation, there is essentially no capital program for improvements, and the computer system is old and outdated.

TABLE NO. 1
KTMB FEASIBILITY STUDY
LOCOMOTIVE CHARACTERISTICS

Class	Year Purchased	Builder	Quantity Purchased	Units In-Service	Engine	Max. Tractive Effort (kg.)	Max. Tractive Effort (lb.)	Type of Service	Max. Speed (mph)	Max. Speed (kmh)
17000	1964	Kisha Seizo Kaisha Ltd.	15	0	EMD 12V-71 410 H.P.	10,976	24,200	Switch	35	56.3
18000	1979	Brush Electrical Machine Ltd.	10	9	M.T.U. 6V 396 TC 12 600 H.P.	15,497	34,164	Switch	15	24.1
19000	1983	Hitachi Ltd.	10	10	M.T.U. 6V 396 TC 12 650 H.P.	17,500	38,580	Switch	43.5	70
22000	1971	English Electric – AE1	40	17	EE 8CS VT Mark III 1710 H.P.	18,280	40,300	Road	60	96.5
23000	1983	Hitachi Ltd.	15	12	Semt-Pielstick 12-PA4 200 VG 2160 H.P.	**19,400 26,000	**42,770 57,320	Road	68.4	110
24000	1987	Toshiba Corp.	26	19	Semt-Pielstick 12-PA4 200 VG 2160 H.P.	19,690	43,409	Road	74.6	120
25000	1990	EMD Canada	12	12	EMD 8-645 E 3C 2500 H.P.	19,867	43,800	Road	66.5	107

Notes:

These engine ratings are estimates based on known locomotive characteristics.
KTMB locomotives in-service is based on June, 1998 data.

TABLE NO. 2
KTMB FEASIBILITY STUDY
DISTANCE/INSPECTION ESTIMATE

Class	Units Available	Units Out of Service	Units In-Service	Distance (km)	Distance (m)	Average Distance (km)	Average Loco Distance (m)	Time In-Service (hr)	Average Time In-Service (hrs)	Min. No. Insp./Mo.	Tonnes
6000	N/A	N/A	37	328,690.6	204,439	8884	5520	10,941.3	295.7	43.8	499,816
22000	17	9	8	47,131.2	29,286	5891	3660	2431.2	303.9	9.7	128,445
23000	12	7	5	36,267.6	22,536	7254	4507	1821.6	364.3	7.3	111,461
24000	19	4	15	112,060.3	69,631	7471	4642	4150.8	276.7	16.6	312,712
25000	12	0	12	147,184	91,456	12265	7621	3879.3	323.3	15.5	210,770
TOTALS	**60**	**20**	**77**	**671,333.7**	**417,147**	**8353**	**5190**	**23,224.2**	**301.6**	**92.9**	**1,263,204**

Notes:

The information in this Table is derived from the KTMB Monthly Locomotive Activity for June 1998.

The information provided herein only addresses road locomotives.

Minimum Number of Inspections Per Month = Time In-Service/250 Hours. 250 Hours in the time between inspections. This calculation assumes only in-service time counts. Since inspection frequency is driven by engine clock time, this calculation may be off by a factor of 20% to 30%.

The number of 6000 series locomotives is for June 1998. 6000 series locomotives are being leased from and are maintained.

2.0 TASK 2 – CONCEPTUAL DESIGN REPORT

2.1. GENERAL

This conceptual Design Report consists of three potential workshop site layouts and an analysis of utilizing private sector third party management and/or maintenance for KTMB owned rolling stock. The estimated capital costs for each of the three conceptual yard site layouts are also provided.

2.2. CONCEPTUAL WORKSHOP SITE LAYOUTS

Conceptual workshop site layouts are provided for three potential sites. Alternative Layout #1 is a concept prepared by KTMB for the existing depot site at Falim. Alternative Layout #2 utilizes the existing site at Seremban. Alternative Layout #3 represents a potential layout for a non-specific, more ideal site. Such a site might be located near Rawang or some other site near Kuala Lumpur. Each of the conceptual layouts utilizes the workshop designs and arrangements developed by KTMB for the new workshop at Falim (Alternative Layout #1). This approach utilizes the effort that has already been expended to develop the detailed workshop floor plans even though the plans could not be located during our visit. No other sites capable of accommodating all of the required functions were identified that were within a reasonable daily commute distance, 50 to 100 kilometers, of Kuala Lumpur.

2.2.1. ALTERNATIVE LAYOUT #1 – FALIM SITE

The existing workshop at Falim is located near the western main line at Ipoh. The Falim site is approximately 207 kilometers north of Kuala Lumpur. The existing facilities do not occupy the entire site, which is approximately 24 hectares (59 acres) in size. The site is stub-ended due to the single connection with the main line, which locates the workshop at the end of a spur line.

In accordance with the site layout developed by KTMB, the Falim site accommodates all of the required functions for the servicing, maintenance, repair and overhaul of locomotives, carriages, and wagons and their respective assemblies and components. Separate facilities are provided for the following functions and activities:

A. Locomotive servicing, washing, and fueling

B. Locomotive maintenance and overhaul

C. Carriage servicing, maintenance, and overhaul

D. Wagon maintenance and overhaul

E. Wheel and axle work

F. Central stores

G. Engineering

H. Depot control

Because the Falim site is over two hours by automobile from Kuala Lumpur, provision is also made for potential housing for relocated employees. The relocation of current employees will be necessary due to the lack of an appropriately skilled workforce in the Ipoh area.

The construction of a new workshop on the Falim site will have to be phased. The existing facility cannot be completely shut down while a new workshop is constructed. Some functions such as wheel work and wagon work may have to be temporarily restricted or performed elsewhere while a new workshop is constructed. The new locomotive shop will likely be constructed first, followed by the new carriage workshop and the new wagon workshop. Some wagon work could be temporarily performed in the locomotive workshop during the construction period.

While some major items of shop equipment such as the wheel lathe, re-railing equipment, and various grinding, shaping, and drilling machines can be utilized in the new workshops, other major equipment such as overhead cranes, lifting jacks, and the drop table will need to remain in use during the construction of the new workshops. Many of the overhead cranes which are less than 15 to 20 years old could be renovated and reused in the component repair and overhaul areas of the new workshops once they are completed. The reuse of existing shop equipment from the Sentul workshop is also dependent upon the construction phasing of the new Falim workshop. The Sentul facility needs to remain in operation during the construction period for the new locomotive workshop, thus some major equipment such as overhead cranes, load test banks, underfloor wheel lathe, and various shop machinery can not be relocated until the new locomotive workshop has been completed. In some instances, the existing shop equipment located at Sentul is too old (dating from the 30's, 40's and 50's) or is defective and therefore it would not be cost effective to rehabilitate and reuse such equipment.

The major advantages and disadvantages of construction of a new workshop at the Falim site are as follows:

ADVANTAGES:

A. KTMB already owns the Falim site.

B. The site accommodates the required functions.

DISADVANTAGES:

A. The site is too far from Kuala Lumpur for employees to commute to/from work on a daily basis. Current employees will have to be relocated due to the lack of the necessary skills in the local workforce.

B. Construction phasing will cause disruption to on-going activities.

C. Locomotives and carriages will have to be moved over the long distance between Kuala Lumpur and other locations and the new workshop.

D. The site will likely require environmental cleanup of contaminated soil (i.e. diesel fuel, oil, and grease) before new construction can begin.

E. A school currently located on the site will need to relocate. KTMB will have to provide the land for the relocated school.

2.2.2. ALTERNATIVE LAYOUT #2 – SEREMBAN SITE

Alternative layout #2 utilizes the existing KTMB property located adjacent to the EMU station at Seremban. The Seremban site is located approximately 70 kilometers south of Kuala Lumpur adjacent to the western main line to Gemas. The site consists of a total of approximately 34 hectares (84 acres), but is divided by an elevated roadway near the middle of the site. New EMU layover tracks and a cleaning platform have been constructed in the southern portion of the site. A section of property located in the northern portion of the site and adjacent to the elevated roadway is occupied by a non-railroad user. A large KTMB communications tower is also located adjacent to the elevated roadway in the southern portion of the site.

The Seremban site can accommodate new workshops for locomotives, carriages, and wagons in addition to the new EMU layover tracks. The new locomotive and carriage workshops are located in the northern portion of the site while the new wagon workshop is located in the southern portion of the site adjacent to the new EMU layover tracks. Equivalent property is available in the southern portion of the site for the relocation of the non-railroad user currently located in the northern portion of the site.

Construction of the new workshops will not impact current EMU operations and activities. As with Alternative Layout #1 described above, some major shop equipment will have to be purchased new (i.e. overhead cranes, hoists and jacks, drop tables, etc.) in order to allow the current activities at Sentul to continue during construction. Once the new workshop at Seremban is completed, some of the more modern shop equipment can be relocated.

The major advantages and disadvantages of the Seremban site are as follows:

ADVANTAGES:

A. KTMB already owns most of the site.

B. The site accommodates the required functions.

C. Existing employees can commute to/from work on the EMU trains (travel time from Kuala Lumpur is approximately one hour).

D. The facility can be constructed either all at once or one workshop at a time depending upon funding constraints.

DISADVANTAGES:

A. An elevated roadway divides the site, but does not need to be relocated.

B. The non-railroad occupant will have to be relocated from the northern portion to the southern portion of the site.

C. Rolling stock (locomotives, carriages, and wagons) will have to be moved between Kuala Lumpur and other locations and the Seremban site.

2.2.3. ALTERNATIVE LAYOUT #3 – UNIDENTIFIED SITE

Alternative Layout #3 differs from the other two conceptual layouts in that the workshop design represents a more ideal layout and does not conform to any specific site. The layout could potentially be accommodated at a location such as Rawang or another site near Kuala Lumpur. Layout #3 also reflects the North American philosophy of using double-ended tracks whenever possible. The site for Alternative #3 will need to be 36 to 39 hectares (90 to 96 acres) in size. The layout is designed to be adjacent and parallel to a main line. The layout allows access to most of the workshop facilities from either end.

The advantages and disadvantages of Alternative layout #3 are as follows:

ADVANTAGES:

A. The layout is more efficient than a primarily stub-ended facility.

B. The layout can be modified to fit a shorter, but wider site or to meet some other site characteristic.

C. The facility can be constructed either all at once or one workshop at a time depending upon the availability of funds.

DISADVANTAGES:

A. The layout requires more property and a site, which KTMB probably does not own.

B. The overall cost will be higher than for a primarily stub-ended site.

2.3. CAPITAL COST ESTIMATES

The capital cost estimates for each of the three alternative workshop site layouts are presented in this section. The costs are based upon metric units and are in 1999 U.S. dollars. The cost estimates are conceptual and are based upon general characteristics such as the overall site size, the amount of building or facility floor space by type of building, the amount of trackage and quantity of turnouts, and the individual cost for certain specific items. The cost estimates include design and construction management (12%) and contingency (25%), but exclude any property acquisition or relocation costs. The cost estimates reflect the cost of construction and procurement in North America. While the actual costs will undoubtedly be lower due to the lower material prices and labor rates in Malaysia, the current economic conditions make it difficult to accurately identify the value of the potential savings.

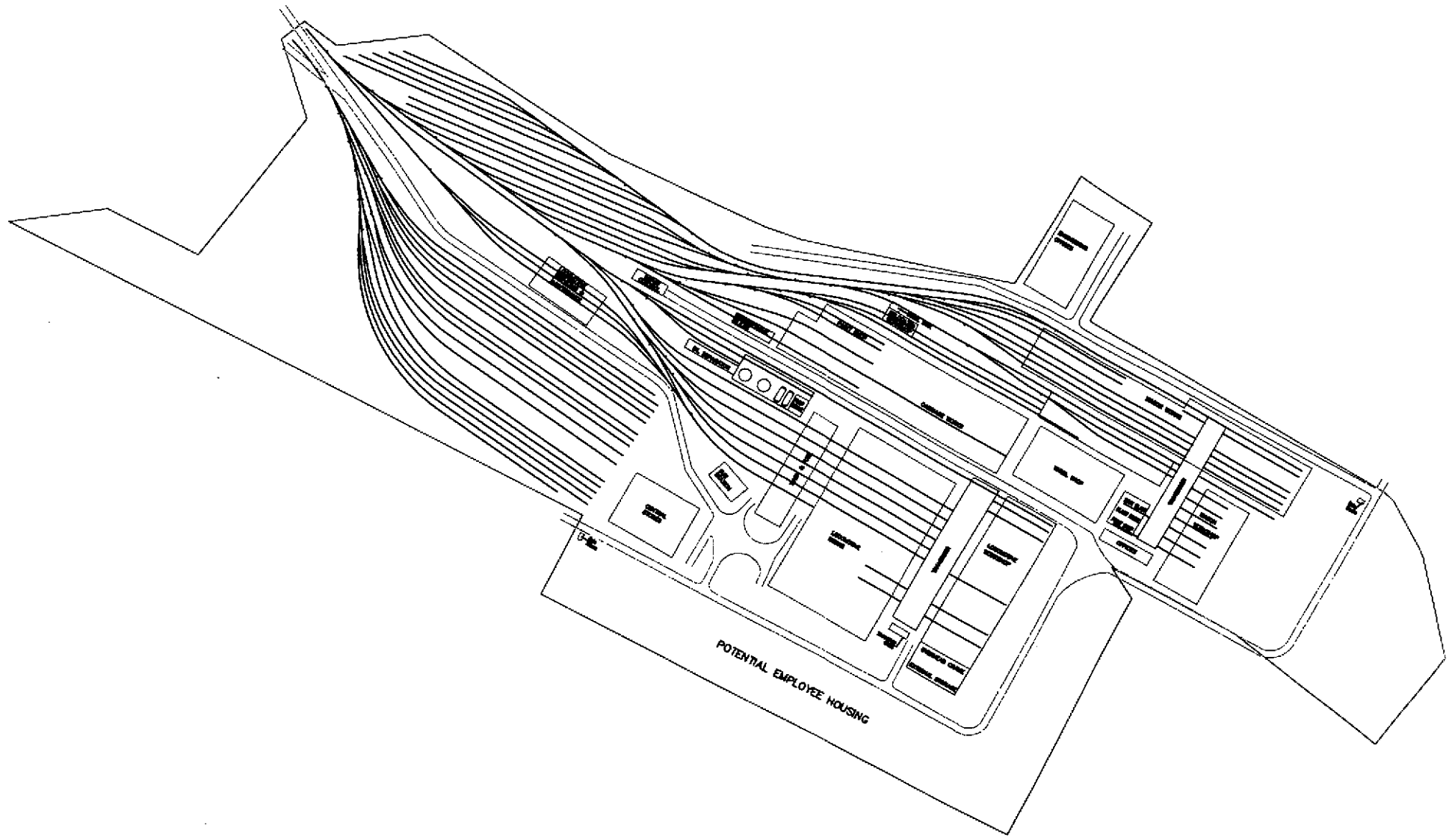
The cost estimates for each of the three alternative workshop site layouts are summarized below and are presented in more detail on the following pages.

Alternative Layout #1: $310.4 million
Alternative Layout #2: $337.5 million
Alternative Layout #3: $364.2 million

CAPITAL COST ESTIMATES ALTERNATIVE #1

Line Item	Description	Quantity	Unit	Unit Cost*	Total Cost*	Remarks
1	Site Civil and Drainage	240,737	SQ M	48.88	11,660,710	
2	Site Lighting and Fencing	240,737	SQ M	32.29	7,773,807	
3	Site Roadways	240,737	SQ M	75.35	18,138,883	
4	Wastewater/Environmental System	240,737	SQ M	10.76	2,591,269	
5	Fire Protection System	240,737	SQ M	10.76	2,591,269	
6	Trackage, 80kg Rail, Wood Sleepers	13,400	LIN M	492.14	6,594,609	
7	Turnouts, #9, 80kg Rail, Wood Sleepers	65	EACH	75,000.00	4,875,000	
8	Track Bumper Stops	28	EACH	2,500.00	70,000	
9	Locomotive Service/Fuel/Wash	3,190	SQ M	3229.17	10,301,052	
10	Locomotive Shop & Fixed Equipment	15,200	SQ M	4306.56	65,444,512	
11	Carriage Shop & Fixed Equipment	8,125	SQ M	3229.17	26,237,006	
12	Wagon Shop & Fixed Equipment	10,805	SQ M	3229.17	34,891,182	
13	Wheel Shop & Fixed Equipment	2,800	SQ M	4306.56	12,055,568	
14	Central Stores	2,080	SQ M	2152.78	4,477,782	
15	Depot Control	200	SQ M	1614.59	322,917	
16	Offices	2,773	SQ M	807.29	2,238,622	
17	Gate House	30	SQ M	269.10	8,073	2 Gatehouses
18	Depot Substation	375	SQ M	3767.37	1,412,762	
19	Traverser Table	2	EACH	500,000	1,000,000	
20	Overhead Crane, Outdoor	2	EACH	200,000	400,000	
21	Portable Shop Equipment	1	L SUM	1,000,000	1,000,000	
SUBTOTAL					**$214,085,024**	
Design, Construction Management, Etc.			15%		32,112,754	
Contingency			30%		64,225,507	
TOTAL ESTIMATED CAPITAL COST					**$310,423,285**	

* All Costs are in 1999 U.S. Dollars and exclude property costs and relocated employee housing costs.



NO.	REVISIONS	BY	DATE	APPR.

SCALE:
1 cm = 40 m
ORGINAL SCALE IN CENTIMETERS
0 5

Korve Engineering
1610 Wynkoop St.
Suite 200
Denver, CO 80202
(303) 623-1287

KTMB
WORKSHOP PROJECT

DESIGNED:	KTMB
DRAWN:	M. Lee
CHECKED:	R. Rypinski
REVIEWED:	
FILE NAME:	
DATE:	1/19/99

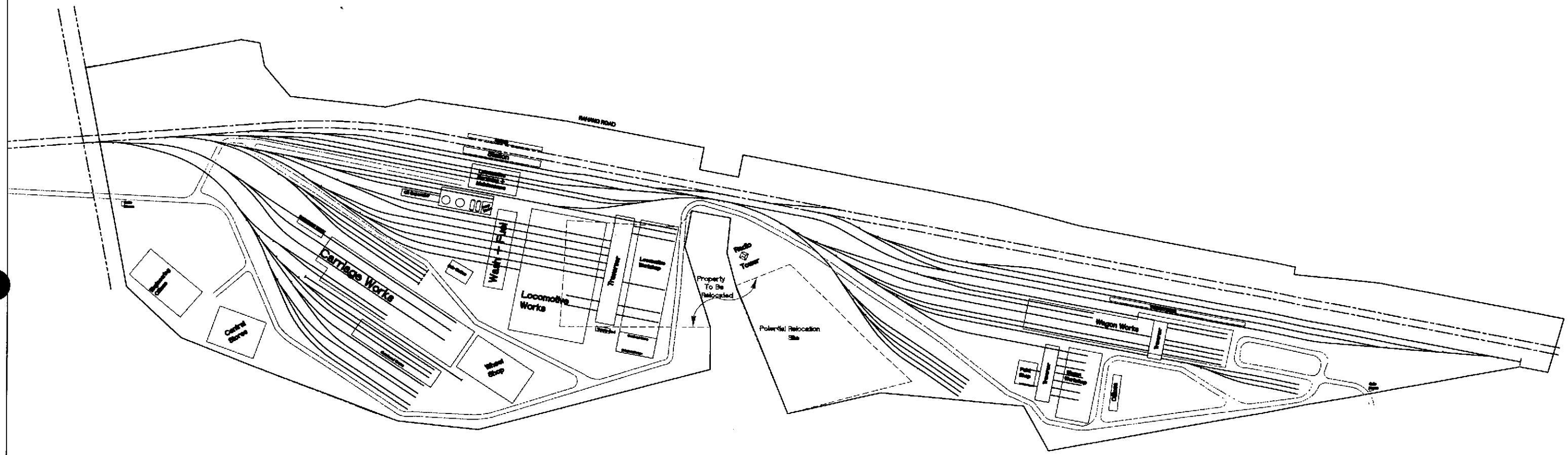
KTMB WORKSHOP
CONCEPTUAL LAYOUT
ALTERNATIVE 1

FELIM SITE

CAPITAL COST ESTIMATES ALTERNATIVE #2

Line Item	Description	Quantity	Unit	Unit Cost*	Total Cost*	Remarks
1	Site Civil and Drainage	339,707	SQ M	48.44	16,454,575	
2	Site Lighting and Fencing	339,707	SQ M	32.29	10,969,717	
3	Site Roadways	339,707	SQ M	75.35	25,596,005	
4	Wastewater/Environmental System	339,707	SQ M	10.76	3,656,572	
5	Fire Protection System	339,707	SQ M	10.76	3,656,572	
6	Trackage, 80kg Rail, Wood Sleepers	14,500	LIN M	492.14	7,135,958	
7	Turnouts, #9, 80kg Rail, Wood Sleepers	66	EACH	75,000.00	4,950,000	
8	Track Bumper Stops	19	EACH	2,500.00	47,500	
9	Locomotive Service/Fuel/Wash	3,190	SQ M	3229.17	10,301,052	
10	Locomotive Shop & Fixed Equipment	15,200	SQ M	4305.56	65,444,512	
11	Carriage Shop & Fixed Equipment	8,125	SQ M	3229.17	26,237,006	
12	Wagon Shop & Fixed Equipment	10,805	SQ M	3229.17	34,891,182	
13	Wheel Shop & Fixed Equipment	2,800	SQ M	4305.56	12,055,568	
14	Central Stores	2,080	SQ M	2153.78	4,477,782	
15	Depot Control	200	SQ M	1614.59	322,917	
16	Offices	2,773	SQ M	807.29	2,238,622	
17	Gate House	30	SQ M	269.10	8,073	2 Gatehouses
18	Depot Substation	375	SQ M	3767.37	1,412,762	
19	Traverser Table	3	EACH	500,000	1,500,000	
20	Overhead Crane, Outdoor	2	EACH	200,000	400,000	
21	Portable Shop Equipment	1	L SUM	1,000,000	1,000,000	
SUBTOTAL					**$232,756,375**	
Design, Construction Management, Etc.			15%		34,913,456	
Contingency			30%		69,826,913	
TOTAL ESTIMATED CAPITAL COST					**$337,496,744**	

* All Costs are in 1999 U.S. Dollars and exclude property costs.



NO.	REVISIONS	BY	DATE	APPR.

SCALE: 1 cm = 40 m

ORGINAL SCALE IN CENTIMETERS

0 5

Korve Engineering
1600 Wynkoop St.
Suite 200
Denver, CO 80202
(303) 623-1257

KTMB
WORKSHOP PROJECT

DESIGNED: R. Rypinski
DRAWN: M. Lee
CHECKED: R. Rypinski
REVIEWED:
FILE NAME:
DATE: 8/18/89

KTMB WORKSHOP CONCEPTUAL LAYOUT ALTERNATIVE 2

SEREMBAN SITE

CAPITAL COST ESTIMATES ALTERNATIVE #3

Line Item	Description	Quantity	Unit	Unit Cost*	Total Cost*	Remarks
1	Site Civil and Drainage	390,297	SQ M	48.44	18,905,030	
2	Site Lighting and Fencing	390,297	SQ M	32.29	12,603,354	
3	Site Roadways	390,297	SQ M	75.35	29,407,825	
4	Wastewater/Environmental System	390,297	SQ M	10.76	4,201,118	
5	Fire Protection System	390,297	SQ M	10.76	4,201,118	
6	Trackage, 80kg Rail, Wood Sleepers	29,900	LIN M	492.14	14,714,837	
7	Turnouts, #9, 80kg Rail, Wood Sleepers	88	EACH	75,000.00	6,600,000	
8	Track Bumper Stops	8	EACH	2,500.00	20,000	
9	Locomotive Service/Fuel/Wash	3,190	SQ M	3229.17	10,301,052	
10	Locomotive Shop & Fixed Equipment	15,200	SQ M	4305.56	65,444,512	
11	Carriage Shop & Fixed Equipment	8,125	SQ M	3229.17	26,237,006	
12	Wagon Shop & Fixed Equipment	10,805	SQ M	3229.17	34,891,182	
13	Wheel Shop & Fixed Equipment	2,800	SQ M	4305.56	12,055,568	
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18	Depot Substation	375	SQ M	3767.37	1,412,762	
19	Traverser Table	3	EACH	500,000	1,500,000	
20	Overhead Crane, Outdoor	3	EACH	200,000	600,000	
21	Portable Shop Equipment	1	L SUM	1,000,000	1,000,000	
SUBTOTAL					**$251,142,758**	
Design, Construction Management, Etc.			15%		37,671,414	
Contingency			30%		75,342,827	
TOTAL ESTIMATED CAPITAL COST					**$364,156,999**	

* All Costs are in 1999 U.S. Dollars and exclude property costs and relocated employee housing costs.

2.4. SUMMARY

In summary, it appears that Alternative Layout #2 at Seremban would be the better site for the new workshop. The site is adequate in size, is adjacent to the EMU station, is within a reasonable daily commute time from Kuala Lumpur, is mostly owned by KTMB, and can be constructed without disrupting on-going EMU operations or rolling stock servicing and maintenance. However, before a definite decision is made relative to the Seremban site, a dedicated effort should be made to identify any acceptable site or sites which are located closer to Kuala Lumpur and therefore the existing EMU facility and the new carriage servicing and running maintenance facility that is currently under construction.

2.5. THIRD PARTY MANAGEMENT AND MAINTENANCE

2.5.1. BACKGROUND

KTMB Railway Rolling Stock servicing, maintenance and repair is performed at depot locations throughout Malaysia, as shown below:

A. Locomotives at Falim, Gemas, Prai, Singapore and Tumpat

B. Coaches at Kuala Lumpur (new depot in 2 years) and Tumpat

C. Wagons at Falim, Prai, Gemas, Port Klang, and Tumpat

D. EMU's at Kuala Lumpur

Overhaul and major repairs are currently performed only on locomotives at the Sentul Workshop in Kuala Lumpur. The Sentul Workshop will eventually be replaced by a new workshop. Functional design of maintenance facilities, including existing facilities and a new workshop, has been described in "KTMB Railway Modernization Project Workshop Project – Task 1 - Functional Design Criteria", dated October, 1998 prepared by KORVE Engineering and ICF Kaiser Engineers.

Total rolling stock includes 129 KTMB and Indian Railway locomotives, 323 coaches, 4467 wagons and 61 EMU's.

Approximately 820 employees perform these maintenance functions. These employees work within the Fleet Maintenance and Engineering Organization headed by a General Manager. There are seven direct reports to the General Manager as follows:

A. Senior Manager Motive Power Division

B. Senior Manager Carriage and Wagon Division

C. Senior Manager Engineering Services

D. Senior Manager EMU Division

E. Senior Manager Finance and Administration

F. Senior Manager Procurement

G. Senior Manager Stores and Asset Disposal

Bombardier supplies the General Manager under a short term, renewable, management contract.

Maintenance functions are performed in the Motive Power Division, Carriage & Wagon Division, EMU Division, Engineering Services and Stores & Asset Disposal. The Motive Power division contains 307 people. The Carriage and Wagon Division contains 412 people. The EMU Division contains 75 people. The Engineering Services Department contains 26 people.

2.5.2. SCOPE

The scope of this analysis is to evaluate the feasibility of using a private sector maintenance contractor to perform maintenance for KTMB of owned locomotives, EMU's, coaches and wagons.

Two options have been evaluated:

A. Management of existing operations and people using a qualified superintendent and management team

B. Performance of all maintenance on an outsource basis by leasing the existing workshop facility to a maintenance service firm.

2.5.3. MAINTENANCE PROGRAMS

In order to evaluate options for maintenance of KTMB rolling stock, it is necessary to understand required maintenance programs and measures of effectiveness of these programs. KTMB workshops provide servicing and maintenance for locomotives, passenger coaches, freight wagons and EMU's. The above referenced report provides an analysis of locomotive maintenance and overhaul practices. Insufficient information was provided for analysis of EMU, coach and wagon maintenance practices.

Items measured for locomotives include scheduled maintenance, unscheduled maintenance, maintenance procedures (consisting of seven stages of maintenance beginning with daily inspections and progressing to a 12,000-hour inspection).

Current maintenance practices are based on calendar days. Each road locomotive receives an in-bound daily inspection at the end of each trip. Routine inspections occur at 15-day intervals with PE (Programmed Examination) inspections occurring at 45-day intervals.

2.5.4. OPTIONS FOR THIRD PARTY MANAGEMENT AND MAINTENANCE

KTMB has had studies conducted by outside consultants (Bombardier and Canac) that suggest that the existing workforce needs additional training and management techniques to perform effective rolling stock maintenance. These studies have not been made available for this feasibility analysis.

The current workforce includes a mixture of contract employees from Bombardier who are performing selective management services; engineers from an Indian Railway company who are running a portion of the Gemas shop to maintain locomotives; and local Malaysian workers who perform the servicing and maintenance on locomotives, coaches, wagons, and EMU's.

The Malaysian workers perform the following servicing, maintenance, and overhaul activities:

A. Maintenance supervision

B. Fueling, cleaning and servicing

C. Daily inspections

D. Periodic inspections

E. Unscheduled repairs of failures/incidents

F. Wheel truing (with wheels under equipment)

G. Exterior washing and cleaning

H. Overhauls and major repairs

I. Component replacements, repair and overhaul

J. Painting plus preparation

K. Load testing (locomotives and power generator cars)

Some of these maintenance activities are better suited to third party management than others. Activities that require higher skill levels are candidates for third party management. Activities that require lower skill levels are candidates for local labor. The potential activities that are applicable to third party management are as follows:

A. Maintenance supervision

B. Daily inspections

C. Periodic inspections

D. Unscheduled repairs of failures/incidents

E. Underfloor wheel truing

F. Overhauls and major repairs

G. Component repair and overhaul

H. Painting

I. Load testing

Activities that are applicable to local labor are as follows:

A. Fueling and servicing

B. Interior cleaning

C. Exterior washing

D. Paint preparation

E. Assisting with maintenance, repairs, and overhauls

It must, however, be noted that the above division of activities assumes that local labor either cannot or does not want to be trained to learn and master the necessary skills. A comprehensive and properly administered training program will result in a local workforce that is capable of performing any and all of the required maintenance activities. Quite often, the necessary environment for success can be accomplished with new management and new management techniques.

2.5.5. MANAGE EXISTING OPERATIONS WITH CONTRACT MANAGEMENT TEAM

The current KTMB maintenance program is managed by contract employees from Bombardier, who are under contract for six-month periods. The Bombardier contract has continuously been amended. However, this procedure is very awkward as six months is not a sufficient amount of time to accomplish most of the necessary objectives.

The function Design Criteria Report evaluated the current maintenance programs. This report stated that the

> "Bombardier management team is taking appropriate steps to develop the required maintenance programs.... Based on the available information, the Bombardier Management team at KTMB appears to be taking the appropriate measures to improve locomotive availability in spite of the fact that the major overhaul workshop is living on borrowed time, most of existing depots are in poor physical condition and are in need of rehabilitation, there is essentially no capital program for improvements, and the computer system is old and outdated."

Previous consultant studies performed for KTMB indicate that the existing workforce requires training in all aspects of railway rolling stock maintenance and procedures. In addition, a training course program and schedule needs to be developed and implemented for the local workforce.

The current management is obviously making progress with the overall improvement of locomotive, carriage, and wagon maintenance for KTMB. This effort represents proof that the use of a qualified maintenance management team can be successful for KTMB in Malaysia.

2.5.6. OUTSOURCE ALL MAINTENANCE

Outsourcing all maintenance involves eliminating the majority of the local Malaysian workforce. In addition, a Senior Manager with a small staff at KTMB would have to provide daily supervision and administration of the maintenance contract.

The outsourcing of all or most of the maintenance function to a management and maintenance contractor result in a smaller, but higher skilled and higher paid workforce. While this may not significantly impact the local economies financially, it would increase local unemployment levels. In order to assure their success, the third party contractor will want to have reasonably modern workshop facilities. KTMB would therefore have to invest in new and rehabilitated workshops and shop equipment at significant cost.

This option would create disruption to the local Malaysian economy, eliminating almost 800 positions currently filled by local Malaysians. While many of the local workers might get jobs with local contract service shops which would likely evolve to support a smaller, more skilled workforce, the economic impact may not be acceptable at this time due to the current Malaysian economic conditions.

2.5.7. CONCLUSION

The recommendation is to continue using third party contractors for management and overall supervision, but to lengthen the contract to 3 to 5 years, depending upon local procurement restrictions, to provide continuity of management personnel and prevent disruption in maintenance activities. The management team should also be given the time and the resources necessary to adequately train the existing workforce. A capital budget should also be established in order to begin the much-needed rehabilitation of existing depots (excluding the Sentul locomotive facility and the carriage depot at KL, which will be replaced) and for the construction of the new workshop.

APPENDIX A

APPENDIX A

KTMB WORKSHOP PROJECT
TRIP REPORT - DATA GATHERING

From July 26, 1998 to August 8, 1998 Karl Schaarschmidt and Ronald Rypinski of Korve Engineering traveled to Kuala Lumpur, Malaysia for the initial work on the KTMB Workshop Project. The purpose of the trip was to meet with key KTMB workshop personnel, to inspect existing KTMB workshop facilities, and to gather available information and data necessary for accomplishing the scope of work required for the Workshop Project. The highlights of our trip are presented in this trip report.

Wednesday, July 29th:

We contacted Mr. Michael Shaman, General Manager of Fleet Maintenance & Engineering, to arrange an introductory meeting. While Mr. Shaman could not meet with us, he did establish a meeting in his office for 0900 hours on Thursday. After a brief meeting with Mr. Shaman, we would meet with the key members of his staff.

We prepared a basic handout package for the meeting with the KTMB staff. The handout included the goals, site visits, and data to be collected for the Workshop Project. We spent the rest of the time investigating the Star Light Rail Line, the EMU line, and Kuala Lumpur.

Thursday, July 30th:

We met with Mr. Shaman as scheduled and he provided a general overview of the KTMB operation and shops. He also discussed Bombardier Transportation's role with the KTMB. We briefly discussed the goals and needs of the Workshop Project. We then met with Mr. Shaman and the following Section Managers:

Khor Cheng Chye	SM, Motive Power Division
Tawil Hj. Adnan	SM, Engineering Services
Ariffin Nawawi	SM, EMU Division
Andre Nadon	SM, Management Supply, Rolling Stock
Paris B. Keleng	SM, Finance & Administration
Johari Kamal	Manager, Planning & Schedule

Mr. Shaman opened the meeting with introductions and a brief explanation of why we were there. He also made it very clear that everyone was to cooperate to the extent that their day to day duties allowed. We agreed that the needs of the railroad came first. As it turned out, the cooperation of Mr. Shaman and his staff was superb. The meeting resulted in the establishment of our itinerary and the designation of individuals responsible for providing escort for the site visits and for the gathering of the data that we requested. During the meeting it also became clear that the operation of the KTMB shops was under much better control than the Workshop Project work scope led us to believe. Locomotive availability was much improved, preventive maintenance for all rolling stock was being addressed, and the inventory and control of spare parts was being improved. While such improvements and institutional changes cannot occur overnight, progress is definitely being made in the right direction.

Friday, July 31st:

We toured the central locomotive shop with Mr. Khor Cheng Chye, met with Mr. Andre Nadon of Bombardier to discuss inventory and stores, and toured the EMU shop with Mr. Ariffin Nawawi.

The central locomotive shop located near Kuala Lumpur in Sentul is living on borrowed time. The entire 96 acre site was sold to a private developer in 1993. A new replacement site was not acquired. Only about 18 or 20 acres of the original site are currently in use for locomotive work. The rest of the site is now either a golf course or vacant land with lots of vegetation. Therefore, KTMB currently has no shop for major/heavy coach and wagon work and, once the existing site is lost, will have no major/heavy locomotive shop capability! The existing locomotive shop is outdated and has several areas with serious fuel, oil, and other soil contaminants.

The current effort relative to inventory and stores is one of gaining knowledge and control of spare parts. Spare parts are scattered throughout the system and hundreds of parts are not listed in the inventory system. Many of the parts were scattered to other locations whey they had to be removed from the central locomotive shop as parts of the site were taken over by the developer. Additional controlled storage areas are being created to accommodate parts which are being located and placed in the inventory system. The main stores is currently located some 35 kilometers from Kuala Lumpur. The age of much of the rolling stock makes obtaining spare parts difficult as well as expensive.

The EMU shop is a modern facility, completed in May 1995, that is located on a 12 acre site adjacent to the central locomotive shop in Sentul. The EMU shop is not located on land which was sold to the private developer. The facility does not include either a wheel truing machine or a point booth. Wheel truing is currently performed at the adjacent central locomotive shop. It is also suspected that the EMU shop is lacking at least two car sets (a set consists of 3 units) of shop space for future major overhaul work. The existing car washer does not include a water recycling system.

Saturday, August 1st:

We toured the existing coach shop located near the new Central Station and the new coach shop, which are under construction in Kuala Lumpur. We also toured the wagon shop located at Port Klang.

The existing coach depot is some 90 years old. Construction of the new coach depot will be completed in 2 years. Like the existing shop, the new facility will not accommodate major/heavy coach work or wheel truing. In order to survive until the new coach depot is completed, 3 tracks in the existing depot have been rehabilitated. This work had to be done as the condition of several tracks is so bad that coaches cannot be moved over the rails without derailing.

The wagon depot at Port Klang is basically a repair shed with both ends and one side open to the elements. The shop cannot accommodate heavy/major wagon work. While bogies are repaired here, wheels are sent to Falim for replacement or truing. While many of the freight wagons are owned by KTMB, the current trend for the newer wagons involves joint ownership. KTMB provides the wagon frame and bogies and the shipper supplies the tank, cement hopper, or other desired wagon body. KTMB maintains the entire wagon. Minor locomotive work and fueling are also performed at the Port Klang depot. A small enclosed space is being setup for the repair of coach air conditioning units. While this location is remote from the coach depot, the permitting process allowing the handling of the freon used in the coach air conditioning systems influenced the location decision.

Sunday, August 2nd:

We spent some time discussing our progress and what we learned thus far. We also spent some time coordinating and comparing notes with Jesse Phillips and Mike Cook of ICF Kaiser.

Monday, August 3rd:

We visited the potential site for a new heavy/major repair depot at Seremban with Mr. Johari Kamal. This site is located adjacent to the Seremban EMU Station. It is a long, but narrow site which is bisected by an elevated roadway. Four new EMU layover tracks and a cleaning platform are being constructed in the southern portion of the site. A few tracks remaining from a previous freight yard are located in the northern portion of the site.

Tuesday, August 4th.

We traveled to Falim, near Ipoh, with Mr. Khor Cheng Chye. The depot at Falim is located at the end of a short spur track which connects with the main line near the Ipoh Station. Wagon maintenance and repair and locomotive maintenance and fueling are currently performed at the facility. No heavy/major work is performed on either wagons or locomotives. The shop buildings are old and in need of significant work. The ground in front of the depot is contaminated with diesel fuel, grease, and oil. A wheel/axle set drop table exists, but has standing water and oil in the bottom of the pit. A wheel truing machine also exists, but wheel sets must be removed from the bogie as the machine is not an underfloor type. Piles of couplers, brake levers, and other parts are located outdoors behind the shop as are stocks of bogies and bogie frames. The parts were placed at Falim when they had to be quickly removed from the Sentul locomotive depot when the private developer took control of part of the site. The parts have yet to be entered into the inventory system.

The Falim site consists of approximately 60 to 70 acres and is a potential location for a new heavy/major depot for locomotives, coaches, and wagons. We were given a copy of the site plan for a new facility which as been designed for this location. A bid package has actually been prepared for the new facility. Unfortunately, a copy of Volume 1 of the text and detailed drawings could not be located at the KTMB Headquarters in Kuala Lumpur. Mr. Tawil Hj. Adnan said he would let us know is he could locate the missing documents. The new complex was designed as a stub-ended facility due to its relationship to the main line. Employee housing was also included in order to encourage existing staff to relocate from Kuala Lumpur, which is some 250 kilometers distant. The design should be carefully reviewed to see if additional improvements are possible.

Wednesday, August 5th:

We met with Mr. Michael Shaman for a debriefing session. We discussed our site visits, the data we had received, management and maintenance outsourcing, inventory control, and the data we still needed, among other relevant topics. He arranged for us to meet with Mr. Victor Mizrahi of Canac. Mr. Mizrahi showed us a copy of a Maintenance Strategy Report prepared by Canac in March, 1997. He said that if Mr. Shaman approved, he would send us a copy subject to certain proprietary conditions. Per Mr. Shaman, we also tried to meet with Ms. Rahmah Ismail, Director of Human Resources. We wanted a copy of a study that KTMB performed which evaluated employee skills and qualifications. Unfortunately, Ms. Ismail was unavailable and could not meet with us. We left a note for Mr. Shaman (he had to attend a meeting in the afternoon) requesting that a copy of the Canac report and the Human Resources study be sent to Denver. We also left a message with Mr. Khor Cheng Chye requesting that any documentation on the condition of each out of service locomotive be sent to us.

We left Kuala Lumpur on Thursday, August 6th. We were pleased with the cooperation and our progress and the thought that the remaining data that we needed would be forthcoming. We returned with much of the needed data including the following:

- Site plans for each of the sites we visited plus a few of the other more remote sites that we and KTMB felt we did not have to visit (these other sites were locations for minor work or were simply end-of-line facilities)
- Sample preventive maintenance activity lists for locomotives, EMU's, coaches, and wagons
- Inventory report for locomotive spare parts
- Summary plans for locomotive overhauls and achieving locomotive availability
- General information about the Fleet Maintenance and Engineering Department as well as the KTMB system

We also returned with several rolls of photographs. On August 12, we sent an e-mail to Mr. Shaman thanking him and his staff for their assistance and reiterating the data that we still needed.

Next Steps:

Over the next few months, we plan to accomplish the following tasks:

- Obtain the data that we still need;
- Re-examine and establish ICF Kaiser's participation relative to the Workshop Project;
- Prepare the draft functional design criteria report;
- Begin preparation of conceptual plans for a new heavy/wagon repair facility for locomotives, coaches, and wagons for the Seremban site, the Falim site, and another generic site such as Rawang (located 35 kilometers north of Kuala Lumpur). If necessary, we will examine options which separate some of the heavy/major repair functions. For example, the site at Seremban may only accommodate locomotive and coach/EMU work with heavy wagon work performed at Falim; and
- Prepare the draft management and maintenance outsourcing report.

While we found that locomotive availability, rolling stock scheduled maintenance programs and inventory control are more advanced than anticipated, we feel that KTMB needs a master plan for improving existing depots and for constructing heavy/major repair and overhaul facilities. It is suggested that the effort and expense which was thought to be necessary for the scheduled maintenance and inventory tasks be redirected to conducting a 2 or 3 day seminar/working group session in Kuala Lumpur once we have prepared the required draft reports and conceptual site layout drawings. The purpose of the seminar would be to obtain agreement for all concerned (KTMB, TDA, and consultants) as to the direction and requirements necessary for KTMB's near-term and long-term success. The Workshop Project seminar could be held in conjunction with similar sessions for the signaling and communications and the intermodal projects.

EXECUTIVE SUMMARY & FINAL REPORT
TASK 2
SIGNALING, COMMUNICATIONS AND DISPATCH PROJECT

Introduction and Project Objectives

The new management of KTMB recognized that in order to expand the capacity of the railroad significant improvements in both signaling and communications would be required. KTMB, with the support of the USTDA, wished to evaluate their existing system and then define a prioritzed approach to improving their train to wayside communications and to upgrade their signaling system to various levels as a function of traffic density.

The specific objectives of the work to be performed were:

- Identify and quantify the productivity improvements that can be achieved for KTMB through improvements in signaling, communications and dispatch;
- Identify the costs and benefits involved in using improvements in signaling and communications to expand KTMB capacity, especially in the most heavily utilized sections of the railway such as the segment between Rawang and Ipoh
- Determine the cost of taking the necessary first step in using improvements in signaling and communications to expand KTMB capacity. That first step is the creation of a backbone for a KTMB communications network by linking the railroad to the fiber-optic network installed along the entire KTMB right-of-way,
- Quantify, for each segment of the railroad, (1) the minimum cost for installing signal and communications systems to facilitate remote control of train operations and (2) the expected reduction in operating expenses that will occur.

Previous Work

The Signals, Communcations and Dispatch Project used information provided in the following references to benchmark some of the data contained in the cost analysis conducted in the Study.

- Definitional Mission

  The U.S. Trade and Development Agency commissioned a definitional mission to evaluate a KTM Berhad railway modernization project in March 1998. The study outlined an approach in three areas to improve the Malaysian Railway operation and revenue. One area was the signalling, communication and dispatch, which recommended a phased study to further detail the modernization program.

- Radio Communication Improvement Proposal

  A proposal for a radio communication system upgrade was submitted by Motorola in August 1998, to provide a system-wide train to wayside voice and (optional) data radio link to a centralized dispatching facility.

Methodolgy and Project Tasks

The methodological approach was a two-phase workplan. The first phase primarily consisted of data collection and assembly of the data. The second phase involved assessment of the data, establishing study criteria, development of alternatives, preparation of a cost/benefit analysis for

each alternative system and subsystem, and development of conclusions and recommendations for communications and signaling systems improvements. More specifically, the tasks included:

Phase 1

Task 1 - a comprehensive inventory and site survey of KTMB's existing signal and communication systems including:

- Signal System Line Segments & Inventory

  Padang Besar to Ipoh to Rawang
  Seremban to Gemas to Johor Bahru
  Tumpat to Gemas

  The double-track segment between Rawang and Seremban which has CTC was not surveyed.

- Schematic Signal Layout Drawings were developed and prepared to include track and signal schematic layout drawings showing the existing track and signal operating system layouts, by station, for each of the line segments listed above. These drawings were prepared in AutoCAD format.

- Communication System Inventory

  A comprehensive description, including schematic line diagrams, as necessary, of the existing KTMB-owned communication facilities was prepared. These facilities included radio, fiber-optic cable, telephone dispatcher circuits, pole lines, voice and or data truck circuits wholly owned and maintained by KTMB.

  Also prepared a listing, with schematic drawings, of all railroad long-haul circuits currently leased by KTMB. Such circuits included, but are not limited to, ticket and reservation system, advance consists, voice trunk lines, data truck lines, etc.

Task 2 - A radio propagation study was undertaken to determine site coverage for eight KTMB base stations in the Klang Valley.

Task 3 - At the conclusion of Phase 1, the data was presented in a report which included descriptions of the existing systems studied, and preliminary recommendations as to which of the more promising system upgrades should be studied further in Phase 2.

Phase 2

Task 1 – Study criteria were developed to evaluate the various alternatives. These criteria included:

- Existing train traffic densities, by segments
- Potential future changes in rail traffic
- Comparative capital costs
- Increase/decrease in operating and maintenance costs
- Overall cost effectiveness
- Comparative reliability

- Comparative maintainability
- Comparative safety assessment

Task 2 - Technical descriptions were developed for each of the alternatives to be evaluated, considering the evaluation criteria.

Task 3 - Cost/Benefit analyses were conducted and documented for each system and subsystem alternative studied. Both quantitative and qualitative factors were considered in the analysis process, and their relative merits discussed.

Task 4 – Conclusions and recommendations were developed and presented, including:

- Recommended prioritization, by segment, of signal system upgrades
- Costs, by line segment, of the recommended signal system upgrades
- Costs by system and/or subsystem of communication system upgrades.
- A recommended implementation plan for each signal or communication upgrade.

Summary of Major Findings and Recommendations

The study identified a number of improvements that can be made to KTMB's communications system and signaling system. The study also addressed the viability of these improvements and recommends how these improvements could be implemented in a prioritized manner to provide the railroad with the best operational, capacity and throughput improvements in the most cost effective manner. The following sections provide the recommended prioritization scenarios for each system, and a recommended phased implementation program. It is recognized that there are many ways to implement the improvements that are suggested. The proposed phased approach, which will spread the costs over time while offering significant benefits to the most crucial areas in the short term, appears to offer the most benefit to KTMB.

Prioritization Scheme

The study addressed communications and signaling as two separate systems, recognizing that they in fact must work together to provide KTMB with communications and control functions to improve railroad operations and safety. Prioritization recommendations are presented below by system. The Phased Implementation Program in the subsequent section addresses how both systems can be integrated to provide the best overall upgrade solution.

Communications

Now that the Fiberail network has been implemented, the remote segments of the railroad are able to be served by a modern communication system at a reasonable cost. Based on the preliminary estimates developed in this study, the land based voice and data communication system appears to be the most cost effective system the railway can implement because of the global system visibility the Control Center will have of the entire railroad operation. The communications system implemented will also provide the capability to remotely control passing track switches throughout the KTMB network (discussed later in this section).

Priority One - Train to Wayside Voice Communication

The study outlined an initial investment of $7.6 million USD for a land based train to wayside radio communication system. With the introduction of a computer aided dispatch function and strict updated operating rules and procedure, this investment would provide for an immediate and significant improvement in railroad efficiency.

Priority Two - Train to Wayside Data Communication

To compliment the voice communication, a train to wayside data transmission is recommended as the next step in the modernization program. The study outlined an initial investment of $4.8 million USD for a land based train to wayside data and GPS based train position transmission system. This system would compliment the computer aided dispatch function and would enable complete visibility of the entire railroad.

With the implementation of updated operating rules and procedures, the potential savings are estimated at a 50% reduction in the field (station) staffing. These updated procedures would change the operation from the old token key mode to a time separation operation, thus enabling significantly higher safe train traffic.

Integrated Communication Option

The study also outlined possible investment savings by implementing the voice and data/GPS land based radio transmission system in one phase. The estimated capital cost would be in the range of $10.3 million USD, a savings of more than $2 million over the two step implementation.

Signals

The CTC based signaling expansion maintains a operatiing mode known to KTMB and does not (if it is wayside based with no cab signals) require added locomotive equipment. The prioritization scenarios for upgrading the current signaling system are presented below. A brief description of the existing equipment and its applicability for CTC or remote control type of operation is also included for each scenario.

Priority One

For the Rawang - IPOH segment and the Serembamn - Gemas segment the best solution is to expand the existing CTC used in the Kuala Lumpur area to cover both segments. This may not be the least cost alternative, but it is the most effective way to provide a significant increase in system throughput and capacity increase capability. By using known technology, on-hand spare parts and pre-trained maintenance staff this would reduce the operating costs, streamline the implementation cost and probably assure a smooth and timely service integration.

From Rawang to IPOH all the equipment shown as existing on the inventory drawings are "Lever Ground Frame (LGF) Interlockings) of various sizes. These devices would not be usable for a CTC application. Therefore, this segment requires a complete set of new CTC equipment. This is a 175-Km segment with 18 passing loop stations.

From Seremban to Gemas, all the equipment shown on the drawings is "Relay Interlocking" of various sizes. This equipment would be upgradable to a CTC level application requiring less equipment. This is a 102-KM segment with 7 passing loop stations.

Priority Two

The second priority is the improvement of traffic management for the Padang Besar – IPOH line and for the line from Gemas to Johor Bahru. This upgrade can be accomplished in various ways.

1. Conventional CTC type of land based signaling with "hard wired" type system and land line communication.
2. Use of the Balise based, almost CTC type, signaling with landline-radio based communication.
3. Use of remote control passing track block (relay interlocking) signaling through the use of either land based or satellite based data transmission system option. Some of the considerations for each of these options include:

    - If a land based radio system is selected for the voice communication over the entire system, then it is logical to include the data/location feature that this system can support. This would provide an integrated network where remote locations would be accessible through the Fiberail network to allow radio-based control of the switches. The switch status could also be transmitted to the Control Center via wayside data collection radios. The cost of this approach would be mainly in the hardware as there is no airtime cost, only Fiberail network cost, which is a long term lower cost item.

    - If a satellite based voice communication system, such as Iridium, is selected, data transmission would not be integrated. A different satellite based data communication system, e.g. Qualcomm, would have to also be implemented. The system includes train relative positioning with two-way data transmission and possible wayside data acquisition equipment that could provide switch remote control and switch status to the Control Center.

      The initial costs of these satellite based systems, both voice (Iridium) and data (Qualcomm) are not as high because they requires no physical carrier. Each location requires a voice terminal (telephone) and a data terminal. Both are implemented using separate networks, and the major cost will be the airtime for these two independent networks.

Once the data network is implemented (either of the two) then the improvement of the signaling system can take place on a site by site basis. The choice will be one of front-end cost (land based) versus long term operating cost (satellite based).

The existing signaling system equipment from Gemas to Johor Bahru is "Relay Interlocking" of various sizes. (Except for the Johor Bahru LGF). This equipment would be upgradable to a remote control type of operation using either landlines and/or radio. This is a 224-KM segment with 19 passing loop stations.

From IPOH to Padang Besar, all the equipment shown on the drawings are LGF Interlocking of various sizes (except for five stations with relay interlocking). These LGF devices would not be usable for remote control passing block interlocking. The five existing relay interlocked stations.would be convertible. Therefore, this segment requires new equipment for the remote

control relay interlocking upgrade of the LGF interlockings. This is a 338-KM segment with 32 passing loop stations.

Priority Three

The third priority is the improvement of the East line from Gemas north to Tumpat. This line is the segment with the least amount of automation installed. The majority of the passing tracks are completely manual (no LGF's or track blocks). The recommended solution is the use of remote control passing track block signaling using one of three options.

1. Using a land based balise style system with radio communication, e.g. Adtranz
2. Using the Motorola land based data radio to provide location and remote control of the passing tracks.
3. Using the Qualcom satellite based data system to provide location and remote control of the passing tracks.

From Gemas to Tumpat seven of the 24 stations use LGF interlockings. The balance use non-interlocked manual operation. This segment requires all new equipment for the remote control relay interlocking implementation. This is a 528-KM segment with 24 passing loop stations.

Phased Implementation Recommendations

Although the new technologies in satellite communication are appealing, the application involved here would be half served. The initial capital investment would certainly be lower than the land-based radio but the operation cost over time would make it more expensive due to the high airtime cost.

For the railroad, the use of the Fiberail network with a land-based radio system appears to be the most viable solution. Fiberail already covers the entire rail system. An integrated, KTMB dedicated communications network will probably pay for itself in cost savings achieved in elimination of the wayside dispatch, wire maintenance, and manned track loop station functions; and elimination of leased land lines for ticketing and other company activities. These savings could equal the cost of implementing the land-based communications alternative using Fiberail. This would make the company communications cost independent and sheltered from price increases, stabilizing the long-term life cycle costs and making them more predictable.

On the basis of this study and its results, it is recommended that a three-phase implementation program be considered by KTMB.

Phase One – implement a systemwide voice and data/location communication system through the procurement of a land based radio link system to be carried on the Fiberail network, such as the Motorola voice and data/GPS system.

Phase Two – implement signaling improvements in the higher traffic density segments, including:

1. The IPOH to Rawang segment to be converted to full wayside CTC
2. The Seremban to Gemas segment to be upgraded to full wayside CTC
3. The Gemas to Johor Bahru segment to be upgraded to a radio based, remote control segment.

Phase Three – Implement relay interlocking with radio based remote control signaling improvements for the other railroad segments.

1. The IPOH to Padang Besar segment to be converted to a radio based, remote control segment
2. The Gemas to Tumpat segment to be converted to a radio based, remote control segment.

Phase One and Phase 2.1 and 2.2 could be implemented in parallel followed by 2.3, 3.1 and 3.2. If funding limitations do not permit the parallel implementation approach, then implementing Phase One with both voice and data is the first step that should be taken.

Opportunities for U.S. Firms

The opportunities for companies who qualify as US firms under USTDA's definition to provide either goods or services to KTMB are quite significant for both the communications and signaling system modernization programs. Specific services that could be provided by U.S. firms include engineering, procurement management and installation management for the signaling system upgrades and the communication system. Equipment supply and installation for both systems could also be provided by U.S. firms. The communications systems identified in the report as representative can be U.S. sourced (Motorola, Iridium, Qualcomm), and these firms would obviously be potential suppliers. The signaling system elements could also be supplied by firms with manufacturing facilities in the U.S. Many of the railroad signaling firms have plants throughout the world, including the United States. These firms are capable of sourcing equipment and software from many locations, and they can meet a "Buy America" requirement by utilizing their U.S. facilities. Possible candidate suppliers with US manufacturing capability include Adtranz, Alstom, Ansaldo, Harmon, Safetran Systems, and Siemens.

The sources of funding for the proposed improvements and any requirements attached to the funds will constrain the list of potential suppliers. Similarly, the technical requirements for the items being procured can limit the list of qualified suppliers. If KTMB received US government sourced funding for some portion of their upgrade program, then there is precedent for applying "Buy America" rules. Without such restrictions, the competition will be open, with cost factors as well as functionality and performance playing primary roles in the selection process.

KTMB Intermodal Project
Executive Summary and Final Report

December 1999

I. Introduction and Project Objectives -

The new management at KTMB recognized the importance of having a workable intermodal strategy for the railroad. For the last five years (from 1994 to 1998) revenue from intermodal traffic has been essentially constant (in the range of 20 million ringit. This is in spite of the rapid growth of the Malaysian economy during that time. Share performance in the intermodal market was clearly declining. KTMB, with the support of USTDA, wished to examine the opportunities available to reverse this performance in the intermodal market and create an aggressive strategy that would grow the business.

A number of major changes in the Malaysian economy make the intermodal segment even more important than when the project began. The loss of a major petroleum movement upon the opening of the new Kuala Lumpur airport, combined with the virtual cessation of cement movements, make it clear that intermodal traffic will assume even greater importance than in the past.

This final report and executive summary presents the completed intermodal strategy and abstracts from the interim reports key findings and conclusions on which the strategy was based. The key strategy elements were presented in the third interim report, submitted in November of 1999 and there were no significant alterations between that report and this summary.

II. Methodology and Project Tasks

The methodological approach was a three-phase workplan consisting of 10 major work elements. The details of the approach were presented in the proposal submission.

The overall approach was to evaluate KTMB's position in the current market, isolate strengths and weaknesses based upon input from the customer and competitive communities and develop a strategy consistent with expected market behavior that best served KTMB's future needs. This approach heavily weighted direct input from the customer and competitive community, both within Malaysia and among major shipping companies throughout the world who had major operations within Malaysia. The experience of other newly privatized rail operations clearly demonstrated that a shift to market-based approaches was key to long term success.

The specific tasks undertaken were to:

- Estimate Market Size (Element I)
- Evaluate Current Competitive Options (Elements II and parts of III)
- Assess KTMB's Competitive Position (Elements III, IV, VI)
- Evaluate Likely Market Changes (Element V)
- Develop and Present Strategic Options (Elements VII)
- Evaluate Capital and Organizational Requirements (Element VIII)
- Recommend an Intermodal Strategy for KTMB's (Elements IX and X)

As each of these tasks progressed, their status was presented in the respective interim reports. Based upon input from the KTMB staff and recognizing the significant changes occurring in the Malaysian economy, some sub-tasks were slightly modified to recognize the rapid changes in the market. None of these changes were significant.

Three interim reports were presented during the course of the project, detailing progress to that point in the project and seeking input to the later work. One such report was delivered in person and the others were submitted as written briefings. All reports are attached as appendices to this summary.

The work extended from mid 1998 to late 1999, which was longer than initially called for. Significant disruptions in the Malaysian economy during the SE Asian economic crisis and the short-term disarray in the transportation patterns in SE Asia occasioned the delay. These short-term issues created a series of market conditions on which it would have been inappropriate to develop a longer-range strategy and created sufficient confusion in the minds of many customers that some of the market input was significantly delayed.

III. Summary of Major Findings and Conclusions

Major findings and conclusions were developed in four principal areas:

(1) Size, characteristics, and potential growth of the relevant intermodal markets
(2) Major customer needs, current and future
(3) KTMB's perceived position and strengths in the marketplace
(4) Requirements for KTMB's intermodal strategy
(5)

Each of the interim reports detailed specific findings at increasing levels of detail as the project progressed. The strategy recommendation summarize in Section IV of this report is based largely upon this market input and evaluation.

This synopsis presents only the major findings of the work directly impinging upon final strategy development and recommendations; more detailed customer input is provided in both the first and second interim reports.

Major market findings and conclusions include:

1. The relevant intermodal market is approximately 1.5 million teus annually, heavily tied to international flows and significantly influenced by forwarders –

   While the total market for intermodal moves within Malaysia is estimated at nearly 3.0 million teus, only about half of that market is relevant to KTMB given the characteristics of length of haul and schedules. This relevant market is almost entirely related to the international flow of boxes, both empty and loaded. There is virtually no intra-Malaysia flow of cargo that is seen as a major opportunity. International forwarders are key to these flows and often choose the routing of the cargo for the beneficial owners.

2. KTMB's share of the relevant market is declining due to perceived inability/unwillingness to meet facing lorry competition, particularly in major lanes –

   Over the last 5-8 years, KTMB's share has been declining. While overall volumes on the railroad remain relatively constant, the market has grown significantly, with lorries taking most of the growth. The interport market has also grown significantly based upon vessel redeployment, and KTMB has not participated to any degree in that market. This erosion in share has been caused, in the minds of customers, by the railroad's unwillingness to economically compete with lorry traffic and inability to provide the required service levels.

3. Inland container depot services and locations will be important to any workable intermodal strategy –

   Key customers were adamant that inland depots and expanded services at the depots would be mandatory for KTMB to improve its position in the relevant market. Schedules between depots and from depots to port facilities are critical to increased flows.

4. Consistent service (defined as 85% delivered within 2 hours) at lorry competitive prices will be required to gain business; without this KTMB will not participate in major moves of loaded containers

Customers were clear that service competitive with lorries would be required. For most moves of loaded containers to vessels, this will require service within 2 hours of promised arrival at least 85% of the time. This is driven by ships' schedules, since being two hours beyond cut-off will ensure the container misses the ship and may have to wait as long as a week to meet another ship.

5. Scheduled, single container service will be necessary for significant growth of KTMB's intermodal business

   Many customers do not have and are unwilling to commit sufficient volumes to create a train dispatch. They desire single container service, with volume "breaks" at the five, ten and twenty container level. Continuing to require full train volumes will limit KTMB's customer base to several of the larger shipping companies and forwarders.

6. "One stop" shopping for intermodal container services is critical to improved KTMB market share -

   Forwarders currently offer "one stop" services to major customers. If KTMB wishes to expand its position with the beneficial owner community, and even with selected shipping companies, the ability to coordinate the entire move will be essential. KTMB cannot grow its business significantly by only providing the rail linehaul service to customers and expecting them to arrange drays, documentation and other related services.

While there were man other findings from the field survey portion of the work, these are the conclusions most germane to key components of the intermodal strategy. These other findings are included primarily in Interim Reports 1 and 2.

IV. Intermodal Strategy Recommendations

Based upon market input, discussions with KTMB management and evaluation of the intermodal strategies of similarly positioned, newly privatized rail operations in other parts of the world, the study team developed a specific intermodal strategy for KTMB. This strategy focuses upon creating a viable, basic intermodal service on key corridors with supporting inland depot services. The strategy builds upon this basic network to offer lorry-competitive services

directly to the beneficial owners of cargo. From this level, KTMB can then move to higher "value added" logistics services.

The complete strategy recommendation and its organizational implications, are presented in the Third Interim Report, chapters III, IV and V. The major strategy components include:

1. **Focus on providing the "basic" intermodal service in a consistent, competitive fashion**

   This involves establishing intermodal train schedules between key inland depots and ports. At a minimum, this network should include Ipoh, Segamat, Nilia, Port Kelang, Wesport, Butterworth, Jahor Bahru and Penang. All of these nodes are important to establishing credible intermodal service. KTMB should establish fixed train departure and arrival times, scheduled to be consistent with vessel departures. These schedules should not require full train commitments, but should run for six months as the volume builds. At the same time, depot services should be expanded to include container interchange services, M&R, container inventory and information services relative to box status. This will also require customer service improvements for intermodal customers.

2. **Initiate a direct "retail" strategy, focused upon beneficial owners of traffic -**

   Once the basic service has begun to demonstrate the commitment of the railroad to scheduled, competitive service, KTMB can begin to focus upon "retail" customers, or beneficial cargo owners. This will require single container, door-to-vessel service on a highly reliable basis. It will require upgrading of information systems relative to container status and significantly improved customer service functions. To offer such services, some ability to provide trucking will also be required.

3. **Move toward the "value-added" logistics segments -**

   Finally, having established the reliability of single container services to beneficial owners of cargo, and having strengthened the internal capabilities to provide services beyond the railroad, KTMB is in a position to join the worldwide movement toward carrier provision of logistics services. Provision of such services may require a separate organization outside of the railroad, depending upon how MMF is incorporated into the earlier strategy components. In either event, it will provide the opportunity to utilize

KTMB's intermodal service as the core transportation component of broader based logistics packages. It will likely require a partner to be effective.

The implementation of this strategy will require significant changes in the commercial and operating organizations at KTMB. The major changes are:

- Significant strengthening of the commercial or traffic function at KTMB
- Incorporating MMF into the KTMB marketing organization, particularly as the move toward logistics services accelerates
- Creating operating partnerships with truckers and probably container depot operators
- Creation of an intermodal business unit at KTMB responsible for both marketing and operating functions of the intermodal product
- Significant strengthening of the customer service function
- Significant upgrade of current information systems

All of these changes can be implemented over the period of time that the intermodal strategy is implemented. It is the team's judgement that it will take something in the range of six months to a year to adequately implement the first phase of the strategy. Perhaps two additional years will be required to implement the "retail" component and that it will likely be 3+ years before KTMB can comfortably address the value-added logistics component.

Overall, the strategy should be seen as a gradual transition from basic, reliable, high volume intermodal transportation, through door-to-door provision of transportation utilizing intermodal line haul to, finally, providing full-fledged logistics services.

V. Opportunities for Cooperation with US firms

US companies have had significant experience in various phases of intermodal development and are well positioned to assist KTMB in its development. The form of cooperation can range from the US firm acting as a vendor to KTMB for specific services or products, to more complicated joint venture arrangements. The team has identified below some of the specific areas within which US companies should consider participation.

In implementing "basic" intermodal strategy...

1. US rail, consulting and software firms have scheduling programs that can assist in developing competitive intermodal schedules

2. US leasing companies could manage and operate the key inland terminals, removing the burden from KTMB and reducing capital requirements
3. US shipping companies can participate or manage the required upgraded customer service activities required to build customer confidence

For the "retail" strategy component...

1. US-based IMC's might be willing to assume the major marketing task
2. US-based shipping companies are well positioned to assist in the customer service activity
3. US-based leasing companies could provide the equipment and capital resources necessary to serve a wide range of customers

For the "logistics" component of the intermodal strategy...

1. A US-based third party logistics company could perform many of the required tasks as KTMB skills are being developed
2. US software companies are well positioned to provide the information technology resources required to manage this business
3. US-based third party logistics companies could also provide the logistics engineering talent required to grow this business

The team has not tested the relative level of interest of the various US firms in participating in these ventures. However, during the interview process with major shipping companies, forwarders and container lessors, it was clear that sufficient interest is present that KTMB should consider an active program to discuss opportunities with US companies. Once the basic strategy recommendation has been accepted and KTMB wishes to begin serious implementation, the team will provide specific suggestions as to approach and specific companies. As part of this effort, Manalytics International would be pleased to propose a specific approach and to participate in the effort.

* * * * * * * * * * * *

We have enjoyed working with KTMB on this important project and believe that the implementation of the suggested intermodal strategy will arrest the decline in market share and position the railroad to participate in an expanded list of logistics services. This completes our efforts under the current USTDA sponsored project.

Respectfully submitted,

Manalytics International

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October 14, 1998

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General Manager (Freight)
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50621 Kuala Lumpur
Malaysia

Subject: **Transmittal of Deliverable #1 - Workshop Task**
Functional Design Criteria
KTMB Railway Modernization Project

Dear Sir:

Attached please find the subject deliverable for KTM's review. This deliverable is the initial one under the Workshop Task. Our designated KTM responsible person for this task is Michael Shaman. I would appreciate it if you could pass this Deliverable to Mr. Shaman for his review and approval. I have also included a transmittal letter to Mr. Shaman with the Deliverable.

For your information, we will be transmitting the initail Delivcrable of the Signalling and Communication Task in the near future for KTM's review. With that submission we will include Invoice #3 which is payable by TDA upon KTM's notification to TDA that the Milestone associated with that invoice has been met by ICF Kaiser.

Very truly yours,

John H. Bergerson
Project Manager and Senior Vice President
Attachments

cc: Ron Rypinski - Korve (w/o)

c:\my documents\ktmb004.doc

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October 14, 1998

Mr. Michael Shaman
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Malaysia

Subject: **Transmittal of Deliverable #1 - Workshop Task**
Functional Design Criteria

Dear Mr. Shaman:

Attached is our first deliverable. We would appreciate your review of the document to make certain that we have correctly understood the data that you and your staff have provided to our team during their initial trip to Kuala Lumpur. Please contact Ron Rypinski directly if you have any questions or issues related to this document.

As of today, there are several pieces of requested data that we have not received. These data itmes are listed below:

1. Copy of the Maintenance Strategy Report Prepared by CANAC (we spoke with Victor Mizrahi and he just needs your approval to send us the copy);

2. Copy of summary of the employee skills and qualifications report from Human Resources (Ms Rahmah Ismail was not available to speak with us on our last day in Malaysia; and

3. A description of the condition or what needs to be done for each of the out-of-service locomotives that could potentially be returned to service. (I left a message for Khor before we left Malaysia concerning this request).

If this document is acceptable to you upon your review of it, please advise Mr. Radzak. Under our contract with KTM and the USTDA, payment for our services by TDA requires that we produce specific deliverables that are acceptable to KTM. Thank you for your prompt review of the document.

Very truly yours,

John H. Bergerson
Project Manager and Senior Vice President

KTMB RAILWAY MODERNIZATION PROJECT

WORKSHOP PROJECT – TASK 1

FUNCTIONAL DESIGN CRITERIA

Prepared By
Korve Engineering and
ICF Kaiser Engineers

October 1998

KTMB WORKSHOP PROJECT

FUNCTIONAL DESIGN CRITERIA

SECTION	TITLE	PAGE
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KTMB WORKSHOP PROJECT

FUNCTIONAL DESIGN CRITERIA

This functional design criteria has been developed in accordance with Part 1 of the Workshop Project. The functional design criteria incorporates information and data collected from KTMB as well as relevant observations made during the site visits to various KTMB maintenance depots. The purpose of the functional design criteria is to establish the basic requirements and characteristics necessary for the conceptual design of the new workshop. The functional design criteria includes consideration for locomotives, EMU's, coaches, and freight wagons.

I. GENERAL WORKSHOP REQUIREMENTS

A. EXISTING AND OTHER DEPOTS

1 Locomotives, coaches and wagons are serviced, maintained, and repaired at several existing depots. A new coach depot is under construction. These depots do not perform any overhauls or major repairs. What is left of KTMB's major workshop for overhaul and major repairs exists at the Sentul Workshop in Kuala Lumpur. The site of the Sentul Workshop was sold in 1993 to a private developer who now controls most of the original 96 acres of the site. The remaining facility primarily performs overhauls and major repairs on locomotives. An in-floor wheel truing machine also turns wheels on both locomotives and coaches. The Sentul Workshop is existing on borrowed time (and restraining orders).

A new coach depot is under construction at the site of a new Central Station complex in Kula Lumpur. The new depot is located just south of the existing 90-year old coach depot. The new facility is not designed to perform overhauls and major repairs to coaches. The new coach depot is scheduled for completion in approximately 2 years.

Other depots and facilities that will perform servicing, maintenance, and repair (excluding overhauls and major repairs) on rolling stock are summarized as follows:

ROLLING STOCK	DEPOT LOCATION
Locomotives	Falim, Gemas, Prai, Singapore, and Tumpat
Coaches	Kuala Lumpur (new depot in 2 years) and Tumpat
Wagons	Falim, Prai, Gemas, Port Klang, and Tumpat
EMU	Kuala Lumpur (built in 1995)

B. NEW WORKSHOP FUNCTIONS AND ACTIVITIES

1. The new workshop shall be capable of performing the following maintenance activities for locomotives, coaches, and wagons as appropriate:
   a. Fueling, cleaning, and servicing
   b. Daily inspections
   c. Periodic examinations (PE's)
   d. Unscheduled repairs of failures/incidents
   e. Wheel truing (with wheels under equipment)
   f. Exterior washing and cleaning
   g. Overhauls and major repairs
   h. Component replacements, repair, and overhaul (excluding some components to be out-shopped)
   i. Painting (including preparation)
   j. Load testing (locomotives and power generator cars)

2. The new workshop shall also include provisions for the following support and ancillary activities and requirements:
   a. Inventory control office and storeroom facility
   b. Rolling stock maintenance personnel restrooms, lockers, etc.
   c. Training room and conference rooms.
   d. Rolling stock supervision and administrative offices and restrooms.
   e. Transportation facilities including offices and train crew lockers, restrooms, etc. as required.
   f. Guardhouse at the main entrance to the site
   g. Security personnel office.

3. The new workshop shall be designed to support a unit exchange maintenance philosophy to minimize down-time. Components and assemblies that are scheduled for overhaul or that are defective will be removed and replaced with a known operable spare component or assembly. The locomotive, coach, or wagon will be returned to service and the component or assembly will be overhauled or repaired and placed into the spare inventory pool.

C. WORKSHOP EQUIPMENT

1. Most of the major shop equipment and machinery for the new workshop shall also be new. The majority of the existing shop equipment and machinery dates from the 1930's to the 1970's. Most of the heavy shop equipment acquired in the 1980's is in need of major rebuilding. The criteria for shop equipment and machinery shall be as follows:

   a. Equipment and machinery that is integrated into the shop building structure shall be new. This precludes disruption to on-going maintenance activities during the construction of a new shop. Examples of this type of shop equipment are overhead bridge cranes, jib cranes, underfloor wheel truing machine, drop tables, in-floor jacks, painting booth, transfer table (if necessary); and wheel press.

   b. Equipment and machinery that meets the following requirements shall be relocated to the new workshop:
      - Equipment is duplicated or is not used frequently and can be spared during a rebuilding period or new workshop construction phase; and
      - Equipment has either a remaining life of at least 10 years or can be economically rebuilt. Examples of this type of shop equipment are lathe, boring machine, air compressor, resistance load bank, drilling machine, governor test machine, brake test stand, and hydraulic press.

   c. Equipment and machinery that is in working condition or that can be economically rebuilt which will become available after the existing Sentul Workshop is closed shall be either relocated to the new workshop (as a spare or for future expansion) or to an existing workshop that is in need of the equipment. For example; the existing underfloor wheel truing machine could be used at the existing Falim Depot, the new coach depot at the Central Terminal site at Kuala Lumpur, or the EMU workshop.

II KTMB ROLLING STOCK

The locomotive, coach, wagon, and EMU fleets consist of the following equipment:

A. Locomotives

QUANTITY	CLASS	YEAR	REMARKS
10	18	1979	1 scheduled for scrap
10	19	1983	
25	22	1971	8 scheduled for scrap
15	23	1983	3 scheduled for scrap
26	24	1987	7 scheduled for scrap
12	25	1990	
98	Subtotal KTMB locos		19 Scheduled for scrap
31	Indian Railway		
129	Total KTMB and IR locomotives		

B. Passenger Coaches and Equipment

Quantity	Class	Description
14	ADNF	Air Conditioned Day and Night First Class
11	AFC	Air Conditioned First Class
40	ADNS	Air Conditioned Day & Night Second Class
76	ASC	Air Conditioned Second Class
49	AEC	Air Conditioned Economy Class
13	ABC	Air Conditioned Buffet Coach
1	SK	Air Conditioned Special VIP Coach
10	BC	Buffet Coach
1	DNS	Day and Night Second Class
3	NS	Night Second Class
40	TC	Third Class
21	PV	Parcel Van
22	BBV/BWV/CV	Bogie Brake/Bogie Workman/Catering Van
22	PGC	Power Generator Car
301	TOTAL	

C. Freight Wagons

Quantity 8 Wheeler	Quantity 4 Wheeler	Wagon Type	Wagon Description
790	0	BBC	Bulk Cement Hopper
1170	284	BCF/CF	Container Wagon
35	0	BBS	Bulk Sugar
219	50	BFL/FL	Flat, low side
100	67	BLW/LW	Log Wagon
292	511	BCG/CG	Covered Goods
374	3	BTO/TO	Tank, Oil
152	0	BLC	Log and Container
50	0	BFW	Flat
100	0	BEB	Engineering Ballast
38	0	BHW	Hopper Wagon
24	15	BCP/CPT	Container Platform
5	0	BHS	High Side Wagon
4	3	BHT/HCW	Horse/Cattle Wagon
4	0	BWW	Well Wagon
3	1	BTW/TW	Tank, Water
2	2	BTP/TP	Tank, Palm Oil
20	0	BTL	Tank, Latex
12	0	BTA	Tank, Ammonia
13	0	BRW	Rail Wagon
12	0	BPW	Pallet Wagon
3	4	BCR/CR	
45	0	BGB	Goods Brake
6	1	BLT/LT	Loco Tool Van
22	0	BMV	Motor Van
0	13	SW	Shunting Wagon
0	18	LS	Low Side Wagon
3495	972	TOTAL	

D. Electric Multiple Unit (EMU)

3 Unit Sets Quantity	Class	Built	Manufacturer
18	81	1994	JTS – Austria
22	82	1996	UCW – South Africa
21	83	1996	Marubeni – Japan
61	TOTAL		

E. Rolling Stock Physical Dimensions

The minimum and maximum physical dimensions for KTMB rolling stock (in MM and ft – in) and maximum weights (in tons) for locomotives in working order and empty coach, wagon, and EMU equipment are as follows:

DIMENSION	LOCOMOTIVES CLASS 18 & 19	LOCOMOTIVES CLASS 22 TO 25	COACHES	BOGIE WAGONS (8 WHEEL)	WAGONS (4 WHEEL)	3-UNIT EMU (12 AXLE)
Length: Min	N/A	15,259 (50'-3/4")	19,174 (62'-11")	10,598 (34'-10")	5506 (18'-1")	68,700 (225'-5")
Max		18,541 (60'-10")	22,846 (75'-0")	18,193 (59'-8")	7855 (25'-9")	69,320 (227'-5')
Height: Min	N/A	3747 (12'-31/2")	3557 (11'-9")	1020 (3'-5")	1192 (3'-11")	3752 (12'-4")
Max		3860 (12'-8")	3835 (12'-7")	3835 (11'-8")	3656 (12'-0")	
Width: Min	N/A	2743 (9'-0")	2564 (8'-5")	2134 (7'-0")	2134 (7'-0")	2636 (8'-8")
Max		2795 (9'-2")	2972 (9'-9")	2799 (9'-2")	2600 (8'-6")	2700 (8'-10")
Bogie Centers: Min	N/A	8001 (26'-3")	12,801 (42'-0")	5639 (18-6")	2591 (8'-6")	15,800 (51'-10")
Max		10,300 (33'-91/2")	15,000 (49'-3")	13,132 (43'-1")	4191 (13'-9")	
Bogies Axle Centers Min	N/A	3289 (10'-9 ½")	2000 (6'-7")	1448 (4'-9")	Does not apply to 2-axle wagons	2300 (7'-6")
Max		4407 (14'-51/2")	2200 (7'-3")	1753 (5'-9")		
Maximum Weight	58.4	90.00	N/A	N/A	N/A	143.4

III NEW WORKSHOP YARD TRACKWORK

A. Trackwork associated with the new workshop shall meet the following criteria:

1. Workshop and yard trackwork shall be designed for an axle loading of 20 tonnes (1 tonne = 2200 lbs.)
2. Track gauge shall be meter gauge, 1000 mm (approximately 3'-3 3/8") nominal.
3. Turnouts for yard and workshop trackage shall be Number 9, minimum.
4. Rail section shall be 80 Kg per meter.
5. Wooden sleepers (crossties) shall be used and shall be 254 mm (10 inches) x 127 mm (5 inches) in cross-section and 180 cm (6'-0') in length. Sleeper density, excluding turnouts shall be 1540 per Km (sleeper centers of 648mm or 25 ½ inches).
6. The minimum radius for curved track shall be 109 meters (358 feet).
7. The minimum tangent length between curves shall be 15.24 meters (50'=0")
8. The minimum clearance dimensions shall be as follows:

a.	Center to center of any track	3660 mm (12'-0")
b.	Center to center of yard track	4265 mm (14'-0")
c.	Center to center of workshop track	4570 mm (15'-0")
d.	Height at center of track for overhead structure	4265 mm (14'-0")
e.	Horizontal distance from center of track to any structure from top of rail to 900 mm (3'-0") above top of rail	1370 mm (4'-6")
f.	Horizontal distance from center of track To any structure from 900 mm (3'-0") to 3125 mm (10'-3') above top of rail	1980 mm (6'-6")

IV NEW WORKSHOP SITE REQUIREMENTS

A. In addition to the new workshop buildings, the new workshop site shall include the following requirements and features

1. Perimeter fencing with access gates.
2. Guardhouse at main roadway entrance to the site.
3. Site access roadways and service aisles.
4. Site lighting for roadways, service aisles, building perimeters, fueling and servicing facilities and tracks, guardhouse, washer, and other yard activity areas and facilities.
5. Locomotive and coach washer with water reclamation system.
6. Cleaning platform equipped with lighting, water, compressed air, and electrical outlets for heavy coach interior cleaning and for cleaning coach interiors prior to being released for service. The cleaning platform shall be located adjacent to, or on the same track as, the locomotive and coach washer.
7. Locomotive fueling, sanding, and servicing facility with a minimum of four above-ground storage tanks capable of storing a total of 500,000 liters of diesel fuel. Fueling tracks shall include concrete slab track with diesel fuel recovery and fire protection systems.
8. Hazardous materials storage building equipped with fire protection and spill containment and reclamation systems.
9. Wastewater reclamation and treatment system for workshop buildings and other wastewater producing areas and facilities.
10. Employee parking area(s).
11. Substation for the supply of yard and workshop electrical power.
12. Sufficient yard trackage for the following:
    a. Lead tracks to/from the main line
    b. Storage tracks for arriving and departing locomotives, coaches, and wagons.
    c. Long term storage tracks for locomotives, coaches, and wagons.
    d. Workshop lead trackage.
    e. Connecting trackage between yard storage, workshops, fueling, cleaning, washing, and other activity areas and facilities.
    f. Trackage for shunting, run-around, and bypass movements.
    g. Other trackage as may be required to promote efficient use of the available site.

A. New Workshop Site Selection

The selection of a site for the new workshop shall include consideration for the following:

1. Site location. The location of the new workshop site should be convenient for the movement of rolling stock to and from the facility. Dead-head, or non-revenue, mileage should be minimized. Convenient access for locomotives and coaches shall be more important than access for freight wagons. The site should be located either where an adequate work force is available or where the relocation of the existing work force is economical.
2. Site Size. The site must be large enough to accommodate the needs and requirements described for the new locomotive, coach, and wagon workshop.
3. Site characteristics. The site must be configured so as to be useable with a minimum of wasted space. The site must be accessible to the main line and must allow for an efficient arrangement of trackage, structures, roadways, and other features.
4. Future expansion. The site should allow for the efficient staging of initial construction and for future expansion with minimal disruption to on-going operations.

V. NEW WORKSHOP REQUIREMENTS

The new workshop shall accommodate the following facilities and requirements for locomotives, coaches, and wagons. Facilities and requirements that are unique to each type of rolling stock are presented first. These are followed by the facilities and requirements that are common to two or more of the types of rolling stock.

A. Locomotives

1. The new workshop shall be capable of performing heavy repair and overhaul for a fleet of approximately 120 locomotives. The fleet of 120 locomotives allows for the retirement of approximately 20 of the total of 98 existing KTMB locomotives, the return of the 31 locomotives from Indian Railway, and the acquisition of some 40 new locomotives. In addition, the new workshop shall be capable of accommodating the fueling, servicing, running repairs, and periodic examinations for approximately 30 to 40 locomotives that may, depending upon the actual location selected for the new workshop, be based at the facility or undergoing major repair or overhaul.

2. The new workshop shall be designed to promote and maintain a daily locomotive availability of at least 80% to 85%. NOTE: the construction of the new workshop will not necessarily guarantee 80 to 85% availability for locomotives because not all locomotives will be based at the facility. Capital improvements to the other locomotive depots which are in poor condition will likely be necessary before the desired daily locomotive availability will be consistently achieved.

3. Based upon data available from KTMB and upon experience with similar facilities in North America, the number of locomotive work positions, or spots, needed in the new workshop are as follows:

LOCOMOTIVE FUNCTION OR ACTIVITY	NUMBER OF WORK POSITIONS	REMARKS
a. Fueling/servicing	4	Also includes fuel drain-off capability
b. Inspections/running repairs	4	Daily and 15 day inspections
c. Periodic examinations	3	45 day interval
d. Repairs/failure repairs	2	Based upon 40 locomotives
e. Overhauls/major repairs	10	Every 4 years (24,000 engine hours)
f. Static power testing	2	
Total locomotive positions	25	

Note: Washing, wheel truing, paint preparation, and painting are covered in Section D., Common Facilities for Rolling Stock.

B. Coaches

1. The passenger coach portion of the new workshop shall be capable of performing overhauls, major repairs, limited periodic examinations, minor repairs, cleaning, and servicing for a fleet of at least 257, passenger coaches, 22 power generator cars, and 20 to 25 parcel and other vans.

2. Based upon data available from KTMB including drawings for a proposed new workshop at Falim, the number of coach work positions needed in the new workshop are as follows:

COACH FUNCTION OR ACTIVITY	NUMBER OF WORK POSITIONS	REMARKS
a. Underframe cleaning	1	
b. static power testing	1	For power generator cars
c. Periodic examinations	1	Limited to cars in shop area
d. Repairs/fail repairs	1	Limited to cars in shop area
e. Overhauls/major repairs	10	3 year overhaul interval
f. coach interior cleaning	1	Locate near exterior washer
Total coach positions	15	

Note: Exterior washing, wheel truing, paint preparation, and painting are covered in Section D. Common Facilities For Rolling Stock

C. Freight Wagons

1. The wagon portion of the new workshop shall be capable of performing overhauls and major repairs for a fleet of approximately 4500 freight wagons.
2. Based upon data available for KTMB including drawings for a proposed new workshop at Falim, the number of wagon work positions needed in the new workshop are as follows:

WAGON FUNCTION OR ACTIVITY	NUMBER OF WORK POSITIONS	REMARKS
a. Periodic examinations / repairs	2	6-month interval
b. Intermediate overhaul	6	Bi-annual
c. Overhaul/major repair	24	4-year interval
d. Painting and preparation	2	
Total wagon positions	34	

NOTE: Wheel truing for wagons will be performed on a wheel lathe machine on wheel sets only (wheels removed from wagons).

D Common Facilities for Rolling Stock

1. The following facilities are common to both locomotives and coaches:

   a. Exterior washer. One washer will be sufficient for washing locomotives and coaches.
   b. Wheel truing. One in-floor wheel truing machine should be sufficient if the wheel truing machine is operated for 2 shifts/day, 5 days/week and assuming that, on the average, each locomotive, power generator car, and coach requires wheel turing 1.5 times per year at 8 shop hours per visit. (120 loco + 279 PGC and coaches = 400x1.5 visits = 600 visits/year. 600 visits x 8 hours = 4800 hours ÷4176 available shop hours = 1.15 wheel truing machine spots). An above-floor wheel lathe should be available to provide additional wheel turing capacity for wheel sets that have been removed from locomotives, power generator cars, and coaches.
   c. Paint preparation and painting. Three booths, 2 for preparation and 1 for painting/drying, should be sufficient if it is assumed that 2 shifts/day, 5 days/week will be worked, that repainting is necessary every 6 years, that 96 shop hours are required for paint preparation, and that 60 shop hours are required for painting and drying. The calculations are as follows:

- 120 loco 280 PGC's and coaches = 400 units ÷ 6 year interval = 67 units/year.
- 67 units/year x 96 shop hours preparation time = 6432 hours/year ÷4176 available shop hours = 1.5 booths for paint preparation.
- 67 units/year x 60 shop hours painting/drying time = 4020 hours/year ÷4176 available shop hours = 1.0 booths for painting and drying.

E. Electric Multiple Units

1. The existing EMU Workshop in Kuala Lumpur is in need of additional improvements. The following improvements have been identified by KTMB personnel and were confirmed as being necessary during our site visit:

   a. In-floor wheel truing machine. Wheel truing is currently performed with the wheels removed from the car. This practice is inefficient and time consuming. Space does exist within the workshop for the installation of an in-floor wheel truing machine.

b. Paint preparation and paint booth. The existing paint booth is inadequate as only one of the three car units can be accommodated at a time. The paint booth needs to be capable of accommodating an entire 3-unit car. Space does exist to lengthen the paint booth to the needed length.

c. Car exterior washer. While a car washer does exist, it does not include a wastewater recycling system.

d. Additional overhaul work positions. Only two car work positions are currently equipped with in-floor car hoists and carbody supports. Overhauls and repairs that require the removal and replacement of major undercar components must be performed at these two locations as the other four car work positions are over pits. As the EMU fleet ages, an additional two car work positions will be required. The two new work locations could be equipped with either in-floor hoists and carbody supports or portable electric jacks and carbody stands. The use of portable jacks and stands would be cost effective and would be adequate for overhauls and major repairs that involve longer periods of shop time.

Given the electrification and other physical differences, EMU activities should be kept separate from the maintenance and repair activities of the other types of rolling stock.

F. Component Overhaul and Repair

In addition to the shop work positions for locomotives coaches, and wagons, the new workshop shall include overhaul and repair facilities for rolling stock assemblies and components. Common assemblies and components, (e.g. couplers wheels and axles, brake valves, glazing, etc.) shall be overhauled and repaired in designated common areas within the workshop. The component overhaul and repair facilities shall include consideration for the following types of rolling stock assemblies and components:

1. Locomotives

a. Diesel engines
b. Generators
c. Traction motors (excluding rewinding)
d. Governors and injectors
e. Brake valves, piping and equipment
f. Bogie frames, bolsters, and parts
g. Wheels, axles, gears, and bearings
h. Cab controls, gauges, and equipment
i. Couplers and draft gears
j. Cooling radiators and fans
k. Electrical cabinets and equipment
l. Glazing
m. Batteries

2. Coaches

a. Bogie frames, bolsters, and parts
b. Wheels, axles, and bearings
c. Brake valves, piping, and equipment
d. Couplers and draft gears
e. Electrical equipment and fixtures
f. Seats, tables, beds, and other furniture
g. Showers, toilets, and sinks
h. Glazing
i. Carpets, flooring, window shades, curtains, etc.
j. Air conditioning units and equipment
k. Doors and door operators and hardware
l. Stoves, ovens, refrigerators, vending machines, and other appliances
m. Batteries

3. Freight Wagons

a. Bogie frames, bolsters, and parts
b. Wheels, axles, and bearings
c. Brake valves, piping, and equipment
d. Couplers and draft gears
e. Doors, hatches, valves, and associated hardware

The component overhaul and repair facilities shall also include consideration for the outsourcing of such work to contract vendors and suppliers. The potential use of contract vendors and suppliers shall be based upon the following considerations:

1. Availability of qualified local facilities and skills;
2. Complexity of the work and special skills, machinery, and tool requirements;
3. Frequency and volume of the work;
4. Additional spares inventory required to maintain the required availability of components: and
5. Potential cost savings or increase in costs.

VI ASSESSMENT OF SPARE PARTS

This portion of the study assesses the spare parts situation for each class of locomotive currently in use by KTMB.

Because of the sale and redevelopment of the Sentul yard site, parts storage is being transferred from the Sentul Shop area to other depot locations. Small components and assemblies are currently stored in various depots and warehouses. Larger assemblies such as trucks, wheel sets and couplers are stored at the Sentul shop as well as other depots such as Falim.

The shop stores at Sentul supports locomotive overhaul, major repairs, periodic examinations, running repairs, and overhaul and remanufacture of locomotive assemblies and components

KTMB (Bombardier) is currently developing and implementing a proper and comprehensive inventory control system for locomotives, coaches, and wagons..

A. Inventory Catalog Description:

A computer run from the Sentul Inventory Catalog for Sections 22, 23, 23, and 25 was provided by KTMB. The sections provided for locomotives address the 22000, 23000, 24000, and 25000 class locomotives, respectively. Inventory catalog sections for coaches and for 17000, 18000, and 19000 class locomotives were not provided.

The amount of inventory detail differs drastically by locomotive type. Using page count as a measurement of detail, the Inventory Catalog for the 23000 class locomotive consists of 473 pages while the 24000 class catalog consists of 110 pages. While the complexity of the locomotive classes is relatively equivalent, the differences in detail can probably be attributed to the locomotive builders since each class of locomotive was provide by a different builder.

The Inventory Catalog lists each assembly, sub-assembly, and component by locomotive class by: Item Number, Class, Description Unit, Part Number/Drawing Number, Store, and Bin. As with most inventory catalogs, Supplier's Parts Catalogs must be used in conjunction with this inventory catalog.

Item Number: The first two digits identify the locomotive class. The next four digits identify the assembly and the last five digits identify the sub-assembly/ component. Variations of this inventory numbering system are commonly used by most railroads and operating authorities. Generally, major assemblies for each class of locomotive would use the same numbering sequence. There is no consistency for assembly numbers in this Inventory Catalog, as an example, traction motors are listed as 3100 series for the 23000 class locomotives and 1200 for the 24000 class locomotives.

Class: A Class Number, from 0 to 8, is assigned to each assembly, sub-assembly, and component. There is no apparent indication as to the significance of the class numbers.

Description: Generally, the assembly, sub-assembly, then the component are described in sequence. The inconsistencies with this description format that are found within this Inventory Catalog are not detrimental to its use.

Unit: Although some "kits" appear in the "Description" column, the only units of measurement listed are "unit" or "set".

Part No/Drawing No: The locomotive supplier's Part Number and/or Drawing Number are provided.

B. Inventory Catalog Assessment:

This Inventory Catalog only covers the Sentul stores and is intended to be used with the locomotive supplier's catalogs. An Inventory Catalog for the entire system would be required to evaluate inventory levels.

This Inventory Catalog does not identify the quantity of components and assemblies in stock. As a minimum, maximum and minimum quantities for each item maintained in inventory along with the actual quantity in inventory should be identified. Inventory levels and re-order trigger points should be set based on projected usage, lead times, and anticipated production of equipment overhauls and scheduled maintenance. Particular attention must be paid to consumable items such as filters, lamps and motor brushes.

A companion Inventory Catalog to the one provided would sorted by each assembly, sub-assembly, and component by supplier's Part No./Drawing No. cross references to the Item Number and usage on other Locomotive classes should be provided. This companion Inventory Catalog is easily produced from this data base with modern high speed computer equipment.

Since the Sentul shop overhauls locomotives and major locomotive assemblies, KTMB should consider developing overhaul kits with which support discreet work scopes. An example would be a kit containing all the parts necessary to overhaul a relatively simple assembly such as a brake valve or a more complex assembly such as an air compressor. These kits provide a more consistent quality for overhauled components by eliminating discretionary replacement of components by the technician.

The description of "kits" when they do appear in the Description column are generally vague. The nature of the kit and the applicable assembly/sub-assembly should be identified.

C. Inventory Assessment:

Since the quantity levels of inventory for the assemblies, sub-assemblies and components were not provided, the adequacy of the inventory at Sentul cannot be evaluated at this time. An Inventory Catalog which includes the actual quantity of material in inventory with maximum and minimum inventory levels would be required for the evaluation.

D. Summary:

The Sentul Inventory Catalog when used in conjunction with supplier parts catalogs and a companion Inventory Catalog sorted by Part No./Drawing No. is sufficient for cataloging and retrieving inventory. Actual inventory levels with maximum and minimum levels must be provided in the Inventory Catalog. Since actual inventory levels were not provided, an evaluation/assessment of the inventory could not be made. It is understood that KTMB is currently striving to improve the inventory system and reports. Unfortunately, the available computer system is some 35 years old and is very time consuming to operate.

E. Recommendations:

Actual inventory levels with maximum and minimum quantities needs to be developed and input into the inventory system. A companion Inventory Catalog sorted by supplier Part No./Drawing No. also needs to be developed. A modern high speed computer needs to be provided to accommodate the needs of the inventory control function.

Develop Kits of parts to address specific work task and activities and to promote consistency and quality of locomotive maintenance and overhaul and component overhaul.

VII MAINTENANCE PROGRAMS

KTMB workshops support locomotive, EMU, passenger coach and freight wagon maintenance. This analysis of KTMB maintenance practices only addresses maintenance and overhaul practices for the locomotives. There was insufficient information provided to analyze EMU, passenger coach and freight wagon maintenance practices.

Even with the limited KTMB maintenance and service information provided for EMU's, Passenger coaches and freight wagons, the data indicates that the Bombardier management team is taking appropriate steps to develop the required maintenance programs.

KTMB maintains a fleet of 78 road locomotives and 20 switch/shuttle locomotives. KTMB road and switch locomotives are identified in Table No. 1. In addition, KTMB leases a fleet of 31 road locomotives, from Indian Railway, identified as 6000 Class locomotives in Table No.2. The 6000 Class locomotives are serviced by the Indian Railroad, the leasing agency. This maintenance analysis will consider the impact on maintenance if the leased locomotives are replaced by up to 30 KTMB locomotives.

A. Scheduled Maintenance:

KTMB provided locomotive maintenance procedures that were based on both engine time and calendar time. The content of the maintenance procedures is discussed in the succeeding pages of this section.

Early maintenance practices, exemplified by 1988 vintage PKJE procedures, were based on diesel engine operating time, "engine time". Each locomotive received a daily inspection. Progressive maintenance was based on multiples of 250 engine hours. The least intensive maintenance occurred at 250 hours with more intensive maintenance occurring at 500 hours, 1500 hours, 3000 hours, and 6000 hours, the most intensive level of maintenance occurred at 12,000 hours. The maintenance cycles repeat after each scheduled maintenance threshold is achieved.

Current maintenance practices are based on calendar days. Each road locomotive receives an in-bound daily inspection at the end of each trip. Routine inspections occur at 15-day intervals with more intensive PE inspections occurring at 45-day intervals. The cycle repeats after each 45-day period. Intense maintenance intervals beyond 45-days do not appear to be addressed at this time.

As presented in Table No. 2, the average road locomotive in-service time for the month of June 1998 was 301.6 hours. Considering that road locomotives are under power when shuttling to and from trains, an additional factor of 30% was added to the average locomotive in-service time to calculate engine time. For this analysis, average engine time is estimated at 200 hours and 600 hours, respectively for the 15 day and 45 day inspections.

Although the actual engine time and mileage/kilometers operated were not provided, road locomotives should be overhauled on a four-year cycle based on an estimated average monthly engine time of 400 to 500 hours. The average engine time on a locomotive at the end of five years service is estimated at 24,000 hours, the OEM's recommend overhaul interval. As shown in Table No.3 the 22000 and 25000 Classes locomotive are just finishing an overhaul cycle and the 23000 and 24000 Classes are just starting the cycle.

B. Unscheduled Locomotive Maintenance:

Based on current performance, each road locomotive can be expected to experience 1.5 road failure and 1.5 unscheduled repair during each 45-day period. Successful implementation of the 45-day (PE) inspection cycle is expected to reduce failure incidences and unscheduled maintenance. To date, there is no supporting data to verify a new failure/repair rate.

Based on the June 1998 data which is summarized in Table No. 3, only 23 of the 60 serviceable road locomotives have been overhauled, 18 additional are in service but are over-due for overhaul, and 14 are out of service and over-due for overhaul. Overhauled locomotives have a higher level of reliability than units that are in-service, but over-due for overhaul. Maintenance records appear to support this conclusion.

While KTMB's practice of de-rating locomotives and dispatching them with a pair of motors disabled improves availability, it also has an adverse impact on unscheduled maintenance.

KTMB schedules maintenance on 15-day and 45-day cycles in addition to daily inspections. For this report, one calendar month of 30 days is considered. The shop workload assumes a fleet size of 60 serviceable locomotives with two locomotives out of service at any given time for overhaul. Heavy maintenance such as wheel repair/replacement and engine work is considered major repairs.

Although the study team was advised that KTMB overhauls/remanufactures major locomotive assemblies such a traction motors, generators and diesel engines, procedures were not provided and therefore the impact on shop workload could not be assessed.

C. Maintenance Procedures:

KTMB provided a 1998 vintage progressive maintenance procedure, based on 250-hour locomotive engine time intervals. The procedure consists of seven stages of maintenance starting with daily inspections and progressing to a 12,000-hour inspection. The components that require inspection, maintenance, or replacement are identified along with an inspection criterion. Inspection data sheets for accountability are missing.
Bombardier KTMB "Daily Maintenance" User's Procedures were provided. These procedures appear to be based on the 1988 vintage Stage I procedures. The

components that require inspection, maintenance, or replacement are identified along with an inspection criterion. Sign-off sheets are provided to record inspection data and record defects and unscheduled maintenance. A signature by the Depot Manager provides accountability. The procedure appears to be well prepared and realistic. The procedure appears adequate to ensure that a locomotive is operational and suitable for service at the end/beginning of each service day. There is conflicting information whether the inspection is done at the end or beginning of the service day. Estimated inspection time is 30 minutes. This basic procedure is typical of equivalent procedures in use by other operating railroads.

The Bombardier/KTMB "15-Day Maintenance" User's Procedures were provided. The procedures appear to be based on the 1988 vintage Stage II procedures. The components that require inspection, maintenance, or replacement are identified along with an inspection criterion. Sign off sheets are provided to record inspection results and record defects and unscheduled maintenance. The signature of the Depot Manager provided accountability. The procedures appear to be well written and practical. The procedure is designed to ensure that consumable material such as lubricants, motor brushes and filters are inspected and maintained to OEM recommended standards. Estimated inspection time is two hours.

Inspection procedures for the 45-Day (PE) Inspection were not provided. The Bombardier management team at KTMB appears to be in the development stages of this program.

Although locomotive overhauls are in progress at Sentul, a work scope of the overhauls was not provided. The overhaul duration is scheduled for 90 days with a longer-term goal of 60 to 75 days per overhaul. Records indicate that currently overhaul duration frequently exceeds 90 days.

D. Summary:

Shop procedures for "Daily" and "15-Day" Inspections are well thought out and more than adequate for the intended inspection periods. Accountability is provided with the sign-off sheets. Shop procedures for the "45-Day (PE)" was not available.

KTMB is playing catch-up with the locomotive overhauls. Approximately 1/3 of the fleet of 60 serviceable locomotives is out of service and waiting overhaul, 1/3 of the locomotives are in-service and are over-due for overhaul, and 1/3 have been overhauled. Locomotives over due for overhaul appear to be seriously impacting fleet availability.

Locomotive failure data was not available, therefore, failure trends could not be assessed.

Based on the available information, the Bombardier management team at KTMB appears to be taking the appropriate measures to improve locomotive availability in spite of the fact that the major overhaul workshop is living on borrowed time, most of the existing depots are in poor physical condition and are in need of rehabilitation, there is essentially no capital program for improvements, and the computer system is old and outdated.

Table No. 1

Locomotive Characteristics

Class	Year Purchased	Builder	Quantity Purchased	Units In-Service	Engine	Tractive Effort Max. - Kg	Tractive Effort Max. - lbs	Type of Service	Max. Speed mph	Max. Speed Km/hr
17000	1964	Kisha Seizo Kaisha Ltd.	15	0	EMD 12V-71 410 H.P.	10,976	24,200	Switch	35	56.3
18000	1979	Brush Electrical Machine Ltd.	10	9	M.T.U 6V 396 TC 12 600 H.P	15,497	34,164	Switch	15	24.1
19000	1983	Hitachi Ltd.	10	10	M.T.U 6V 396 TC 12 650 H.P	17,500	38,580	Switch	43.5	70
22000	1971	English Electric - AE1	40	17	EE 8CS VT Mark III 1710 H.P	18,280	40,300	Road	60	96.5
23000	1983	Hitachi Ltd.	15	12	Semt-Pielstick 12-PA4 200 VG 2160 H.P	** 19,400 26,000	** 42,770 57320	Road	68.4	110
24000	1987	Toshiba Corp.	26	19	Semt-Pielstick 16-PA4 200 VG 2400 H.P	19,690	43,409	Road	74.6	120
25000	1990	EMD Canada	12	12	EMD 8-645 E 3C 2500 H.P.	19,867	43,800	Road	66.5	107

NOTE 1: ** These engine ratings are estimates based on known locomotive characteristics.

Note2: KTMB locomotives in-service is based on June 1998 data.

Table No. 2

Distance/Inspection Estimate

Class	Units Available	Units Out of Service	Units In-Service	Distance Kilo	Distance Miles	Average Kilo/Loco	Average Miles/Loco	Time (hrs) In-Service	Ave. Time In-Service	Min. No. Insp./Mo.	Tonnes
6000	N/A	N/A	37	328690.6	203875	8884	5510	10941.3	295.7	43.8	499816
22000	17	9	8	47131.2	29234	5891	3654	2431.2	303.9	9.7	128445
23000	12	7	5	36267.6	22496	7254	4499	1821.6	364.3	7.3	111461
24000	19	4	15	112060.3	69507	7471	4634	4150.8	276.7	16.6	312712
25000	12	0	12	147184	91293	12265	7608	3879.3	323.3	15.5	210770
TOTALS	60	20	77	671333.7	416405	8719	5408	23224.2	301.6	92.9	1263204

NOTE 1: The information in this Table is derived from the KTMB Monthly Locomotive Activity for June 1998.

NOTE 2: The information provided herein only addresses road locomotives.

NOTE 3: Minimum Number of Inspections per Month = Time In-Service / 250 Hours. 250 Hours is the time between inspections.
This calculation assumes only in-service time counts.
Since inspection frequency is driven by engine clock time, this calculation may be off by a factor of 20% to 30%.

NOTE 4: The number of 6000 series locomotive is for June 1998. 6000 series locomotives are being leased from and are maintained

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April 2, 1999

Encik Abdul Radzak b. Abd. Malek
General Manager (Freight)
KTM Berhad
Jalan Sultan Hishamuddin
50621 Kuala Lumpur
Malaysia

Subject: **Transmittal of Deliverable #2 - Workshop Task**
Concept Design Report
KTMB Railway Modernization Project

Dear Sir:

Attached please find three copies of the subject deliverable for KTM's review. Our designated KTM responsible person for this task is Michael Shaman. I would appreciate it if you could pass this Deliverable to Mr. Shaman for his review and approval. I have also included a transmittal letter to Mr. Shaman with the Deliverable.

Very truly yours,

John H. Bergerson
Project Manager and Senior Vice President
Attachments

cc: Ron Rypinski - Korve (w/o)

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ICF Kaiser Engineers, Inc.
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April 2, 1999

Mr. Michael Shaman
General Manager
Fleet Maintenance and Engineering
KTM Berhad
Jalan Sultan Hishamuddin
50621 Kuala Lumpur
Malaysia

Subject: **Transmittal of Deliverable #2 - Workshop Task**
Conceptual Design Report

Dear Mr. Shaman:

Attached are three copies of our second deliverable. We would appreciate your review of the document. If this document is acceptable to you upon your review of it, please advise Mr. Radzak. Under our contract with KTM and the USTDA, payment for our services by TDA requires that we produce specific deliverables that are acceptable to KTM. Thank you for your prompt review.

Please contact Ron Rypinski directly if you have any questions or issues related to this document.

Very truly yours,

John H. Bergerson
Project Manager and Senior Vice President

Attachments

cc: Ron Rypinski - Korve (w/o)

Korve
Engineering

March 29, 1999

John Bergerson
ICF Kaiser Engineers
2101 Webster Street
Suite 1000
Oakland, CA 94612-3060

Dear John,

Enclosed are four copies of our KTMB Workshop Project Task 2 submittal. This submittal includes the conceptual workshop layouts for three alternative sites and the capital cost estimates for each of the alternatives. In addition, a discussion on third party management and maintenance is provided in Section V.

Please forward any comments that you or KTMB may have so that they can be incorporated. Please contact me at (303) 623-1287 if you have any questions.

Sincerely,

Ronald E. Rypinski

Cc: Karl Schaarschmidt

A California Corporation

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KTMB RAILWAY MODERNIZATION PROJECT

WORKSHOP PROJECT – TASK 2

CONCEPTUAL DESIGN REPORT

Prepared By
Korve Engineering and
ICF Kaiser Engineers

March 1999

KTMB CONCEPTUAL DESIGN REPORT

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KTMB WORKSHOP PROJECT

CONCEPTUAL DESIGN REPORT

1 GENERAL

This conceptual Design Report consists of three potential workshop site layouts and an analysis of utilizing private sector third party management and/or maintenance for KTMB owned rolling stock. The estimated capital costs for each of the three conceptual yard site layouts are also provided.

II CONCEPTUAL WORKSHOP SITE LAYOUTS

Conceptual workshop site layouts are provided for three potential sites. Alternative Layout #1 is a concept prepared by KTMB for the existing depot site at Falim. Alternative Layout #2 utilizes the existing site at Seremban. Alternative Layout #3 represents a potential layout for a non-specific, more ideal site. Such a site might be located near Rawang or some other site near Kuala Lumpur. Each of the conceptual layouts utilizes the workshop designs and arrangements developed by KTMB for the new workshop at Falim (Alternative Layout #1). This approach utilizes the effort that has already been expended to develop the detailed workshop floor plans even though the plans could not be located during our visit. No other sites capable of accommodating all of the required functions were identified that were within a reasonable daily commute distance, 50 to 100 kilometers, of Kuala Lumpur.

A. ALTERNATIVE LAYOUT #1 – FALIM SITE

The existing workshop at Falim is located near the western main line at Ipoh. The Falim site is approximately 207 kilometers north of Kuala Lumpur. The existing facilities do not occupy the entire site, which is approximately 24 hectares (59 acres) in size. The site is stub-ended due to the single connection with the main line, which locates the workshop at the end of a spur line.

In accordance with the site layout developed by KTMB, the Falim site accommodates all of the required functions for the servicing, maintenance, repair and overhaul of locomotives, carriages, and wagons and their respective assemblies and components. Separate facilities are provided for the following functions and activities:

- Locomotive servicing, washing, and fueling
- Locomotive maintenance and overhaul
- Carriage servicing, maintenance, and overhaul
- Wagon maintenance and overhaul
- Wheel and axle work
- Central stores
- Engineering
- Depot control

Because the Falim site is over two hours by automobile from Kuala Lumpur, provision is also made for potential housing for relocated employees. The relocation of current employees will be necessary due to the lack of an appropriately skilled workforce in the Ipoh area.

The construction of a new workshop on the Falim site will have to be phased. The existing facility cannot be completely shut down while a new workshop is constructed. Some functions such as wheel work and wagon work may have to be temporarily restricted or performed elsewhere while a new workshop is constructed. The new locomotive shop will likely be constructed first, followed by the new carriage workshop and the new wagon workshop. Some wagon work could be temporarily performed in the locomotive workshop during the construction period.

While some major items of shop equipment such as the wheel lathe, rerailing equipment, and various grinding, shaping, and drilling machines can be utilized in the new workshops, other major equipment such as overhead cranes, lifting jacks, and the drop table will need to remain in use during the construction of the new workshops. Many of the overhead cranes which are less than 15 to 20 years old could be renovated and reused in the component repair and overhaul areas of the new workshops once they are completed. The reuse of existing shop equipment from the Sentul workshop is also dependent upon the construction phasing of the new Falim workshop. The Sentul facility needs to remain in operation during the construction period for the new locomotive workshop, thus some major equipment such as overhead cranes, load test banks, underfloor wheel lathe, and various shop machinery can not be relocated until the new locomotive workshop has been completed. In some instances, the existing shop equipment located at Sentul is too old (dating from the 30's, 40's and 50's) or is defective and therefore it would not be cost effective to rehabilitate and reuse such equipment.

The major advantages and disadvantages of construction a new workshop at the Falim site are as follows:

ADVANTAGES:

1. KTMB already owns the Falim site.
2. The site accommodates the required functions.

DISADVANTAGES:

1. The site is too far from Kuala Lumpur for employees to commute to/from work on a daily basis. Current employees will have to be relocated due to the lack of the necessary skills in the local workforce.
2. Construction phasing will cause disruption to on-going activities.
3. Locomotives and carriages will have to be moved over the long distance between Kuala Lumpur and other locations and the new workshop.
4. The site will likely require environmental cleanup of contaminated soil (i.e. diesel fuel, oil, and grease) before new construction can begin.
5. A school currently located on the site will need to relocate. KTMB will have to provide the land for the relocated school.

B. ALTERNATIVE LAYOUT #2 – SEREMBAN SITE

Alternative layout #2 utilizes the existing KTMB property located adjacent to the EMU station at Seremban. The Seremban site is located approximately 70 kilometers south of Kuala Lumpur adjacent to the western main line to Gemas. The site consists of a total of approximately 34 hectares (84 acres), but is divided by an elevated roadway near the middle of the site. New EMU layover tracks and a cleaning platform have been constructed in the southern portion of the site. A section of property located in the northern portion of the site and adjacent to the elevated roadway is occupied by a non-railroad user. A large KTMB communications tower is also located adjacent to the elevated roadway in the southern portion of the site.

The Seremban site can accommodate new workshops for locomotives, carriages, and wagons in addition to the new EMU layover tracks. The new locomotive and carriage workshops are located in the northern portion of the site while the new wagon workshop is located in the southern portion of the site adjacent to the new EMU layover tracks. Equivalent property is available in the southern portion of the site for the relocation of the non-railroad user currently located in the northern portion of the site.

Construction of the new workshops will not impact current EMU operations and activities. As with Alternative Layout #1 described above, some major shop equipment will have to be purchased new (i.e. overhead cranes, hoists and jacks, drop tables, etc.) in order to allow the current activities at Sentul to continue during construction. Once the new workshop at Seremban is completed, some of the more modern shop equipment can be relocated.

The major advantages and disadvantages of the Seremban site are as follows:

ADVANTAGES:

1. KTMB already owns most of the site
2. The site accommodates the required functions
3. Existing employees can commute to/from work on the EMU trains (travel time from Kuala Lumpur is approximately one hour).
4. The facility can be constructed either all at once or one workshop at a time depending upon funding constraints.

DISADVANTAGES:

1. An elevated roadway divides the site, but does not need to be relocated.
2. The non-railroad occupant will have to be relocated from the northern portion to the southern portion of the site.
3. Rolling stock (locomotives, carriages, and wagons) will have to be moved between Kuala Lumpur and other locations and the Seremban site.

C. ALTERNATIVE LAYOUT #3 – UNIDENTIFIED SITE

Alternative Layout #3 differs from the other two conceptual layouts in that the workshop design represents a more ideal layout and does not conform to any specific site. The layout could potentially be accommodated at a location such as Rawang or another site near Kuala Lumpur. Layout #3 also reflects the North American philosophy of using double-ended tracks whenever possible. The site for Alternative #3 will need to be 36 to 39 hectares (90 to 96 acres) in size. The layout is designed to be adjacent and parallel to a main line. The layout allows access to most of the workshop facilities from either end.

The advantages and disadvantages of Alternative layout #3 are as follows:

ADVANTAGES:

1. The layout is more efficient than a primarily stub-ended facility.
2. The layout can be modified to fit a shorter, but wider site or to meet some other site characteristic.
3. The facility can be constructed either all at once or one workshop at a time depending upon the availability of funds.

DISADVANTAGES:

1. The layout requires more property and a site which KTMB probably does not own.
2. The overall cost will be higher than for a primarily stub-ended site.

III CAPITAL COST ESTIMATES

The capital cost estimates for each of the three alternative workshop site layouts are presented in this section. The costs are based upon metric units and are in 1999 U.S. dollars. The cost estimates are conceptual and are based upon general characteristics such as the overall site size, the amount of building or facility floor space by type of building, the amount of trackage and quantity of turnouts, and the individual cost for certain specific items. The cost estimates include design and construction management (12%) and contingency (25%), but exclude any property acquisition or relocation costs. The cost estimates reflect the cost of construction and procurement in North America. While the actual costs will undoubtedly be lower due to the lower material prices and labor rates in Malaysia, the current economic conditions make it difficult to accurately identify the value of the potential savings.

The cost estimates for each of the three alternative workshop site layouts are summarized below and are presented in more detail on the following pages.

Alternative Layout #1	$310.4 million
Alternative Layout #2	$337.5 million
Alternative Layout #3	$364.2 million

KTMB WORKSHOP PROJECT CAPITAL COST ESTIMATES

ITE LAYOUT ALTERNATIVE # 1

LINE ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST *	TOTAL COST *	REMARKS
1	SITE CIVIL AND DRAINAGE	240,737	SQ M	48	11,660,710	
2	SITE LIGHTING AND FENCING	240,737	SQ M	32	7,773,807	
3	SITE ROADWAYS	240,737	SQ M	75	18,138,883	
4	WASTEWATER/ENVIRONMENTAL SYS	240,737	SQ M	11	2,591,269	
5	FIRE PROTECTION SYSTEM	240,737	SQ M	11	2,591,269	
6	TRACKAGE, 80kg rail, wood sleepers	13,400	LIN M	492	6,594,609	
7	TURNOUTS, # 9, 80kg rail, wood slprs	65	EACH	75,000	4,875,000	
8	TRACK BUMPER STOPS	28	EACH	2,500	70,000	
9	LOCOMOTIVE SERVICE/FUEL/WASH	3,190	SQ M	3229	10,301,052	
10	LOCOMOTIVE SHOP & FIXED EQUIP	15,200	SQ M	4306	65,444,512	
11	CARRIAGE SHOP & FIXED EQUIP	8,125	SQ M	3229	26,237,006	
12	WAGON SHOP & FIXED EQUIPMENT	10,805	SQ M	3229	34,891,182	
13	WHEEL SHOP & FIXED EQUIPMENT	2,800	SQ M	4306	12,055,568	
14	CENTRAL STORES	2,080	SQ M	2153	4,477,782	
15	DEPOT CONTROL	200	SQ M	1615	322,917	
16	OFFICES	2,773	SQ M	807	2,238,622	
17	GATE HOUSE	30	SQ M	269	8,073	2 Gatehouses
18	DEPOT SUBSTATION	375	SQ M	3767	1,412,762	
19	TRAVERSER TABLE	2	EACH	500,000	1,000,000	
20	OVERHEAD CRANE, outdoor	2	EACH	200,000	400,000	
21	PORTABLE SHOP EQUIPMENT	1	L SUM	1,000,000	1,000,000	
	SUBTOTAL				**214,085,024**	
	DESIGN , CONSTRUCTION MANAGEMENT, ETC.		15%		32,112,754	
	CONTINGENCY		30%		64,225,507	
	TOTAL ESTIMATED CAPITAL COST				**$310,423,285**	

* ALL COSTS ARE IN 1999 U.S. DOLLARS AND EXCLUDE PROPERTY COSTS AND RELOCATED EMPLOYEE HOUSING COSTS.

KTMB WORKSHOP PROJECT CAPITAL COST ESTIMATES

SITE LAYOUT ALTERNATIVE # 2

LINE ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST *	TOTAL COST *	REMARKS
1	SITE CIVIL AND DRAINAGE	339,707	SQ M	48	16,454,575	
2	SITE LIGHTING AND FENCING	339,707	SQ M	32	10,969,717	
3	SITE ROADWAYS	339,707	SQ M	75	25,596,005	
4	WASTEWATER/ENVIRONMENTAL SYS	339,707	SQ M	11	3,656,572	
5	FIRE PROTECTION SYSTEM	339,707	SQ M	11	3,656,572	
6	TRACKAGE, 80kg rail, wood sleepers	14,500	LIN M	492	7,135,958	
7	TURNOUTS, # 9, 80kg rail, wood slprs	66	EACH	75,000	4,950,000	
8	TRACK BUMPER STOPS	19	EACH	2,500	47,500	
9	LOCOMOTIVE SERVICE/FUEL/WASH	3,190	SQ M	3229	10,301,052	
10	LOCOMOTIVE SHOP & FIXED EQUIP	15,200	SQ M	4306	65,444,512	
11	CARRIAGE SHOP & FIXED EQUIP	8,125	SQ M	3229	26,237,006	
12	WAGON SHOP & FIXED EQUIPMENT	10,805	SQ M	3229	34,891,182	
13	WHEEL SHOP & FIXED EQUIPMENT	2,800	SQ M	4306	12,055,568	
14	CENTRAL STORES	2,080	SQ M	2153	4,477,782	
15	DEPOT CONTROL	200	SQ M	1615	322,917	
16	OFFICES	2,773	SQ M	807	2,238,622	
17	GATE HOUSE	30	SQ M	269	8,073	2 Gatehouses
18	DEPOT SUBSTATION	375	SQ M	3767	1,412,762	
19	TRAVERSER TABLE	3	EACH	500,000	1,500,000	
20	OVERHEAD CRANE, outdoor	2	EACH	200,000	400,000	
21	PORTABLE SHOP EQUIPMENT	1	L SUM	1,000,000	1,000,000	
	SUBTOTAL				**232,756,375**	
	DESIGN , CONSTRUCTION MANAGEMENT, ETC.		15%		34,913,456	
	CONTINGENCY		30%		69,826,913	
	TOTAL ESTIMATED CAPITAL COST				**$337,496,744**	

* ALL COSTS ARE IN 1999 U.S. DOLLARS AND EXCLUDE PROPERTY COSTS.

KTMB WORKSHOP PROJECT CAPITAL COST ESTIMATES

SITE LAYOUT ALTERNATIVE # 3

LINE ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST *	TOTAL COST *	REMARKS
1	SITE CIVIL AND DRAINAGE	390,297	SQ M	48	18,905,030	
2	SITE LIGHTING AND FENCING	390,297	SQ M	32	12,603,354	
3	SITE ROADWAYS	390,297	SQ M	75	29,407,825	
4	WASTEWATER/ENVIRONMENTAL SYS	390,297	SQ M	11	4,201,118	
5	FIRE PROTECTION SYSTEM	390,297	SQ M	11	4,201,118	
6	TRACKAGE, 80kg rail, wood sleepers	29,900	LIN M	492	14,714,837	
7	TURNOUTS, # 9, 80kg rail, wood slprs	88	EACH	75,000	6,600,000	
8	TRACK BUMPER STOPS	8	EACH	2,500	20,000	
9	LOCOMOTIVE SERVICE/FUEL/WASH	3,190	SQ M	3229	10,301,052	
10	LOCOMOTIVE SHOP & FIXED EQUIP	15,200	SQ M	4306	65,444,512	
11	CARRIAGE SHOP & FIXED EQUIP	8,125	SQ M	3229	26,237,006	
12	WAGON SHOP & FIXED EQUIPMENT	10,805	SQ M	3229	34,891,182	
13	WHEEL SHOP & FIXED EQUIPMENT	2,800	SQ M	4306	12,055,568	
14	CENTRAL STORES	2,080	SQ M	2153	4,477,782	
15	DEPOT CONTROL	200	SQ M	1615	322,917	
16	OFFICES	2,773	SQ M	807	2,238,622	
17	GATE HOUSE	30	SQ M	269	8,073	2 Gatehouses
18	DEPOT SUBSTATION	375	SQ M	3767	1,412,762	
19	TRAVERSER TABLE	3	EACH	500,000	1,500,000	
20	OVERHEAD CRANE, outdoor	3	EACH	200,000	600,000	
21	PORTABLE SHOP EQUIPMENT	1	L SUM	1,000,000	1,000,000	
	SUBTOTAL				**251,142,758**	
	DESIGN , CONSTRUCTION MANAGEMENT, ETC.		15%		37,671,414	
	CONTINGENCY		30%		75,342,827	
	TOTAL ESTIMATED CAPITAL COST				**$364,156,999**	

* ALL COSTS ARE IN 1999 U.S. DOLLARS AND EXCLUDE PROPERTY COSTS.

IV. SUMMARY

In summary, it appears that Alternative Layout #2 at Seremban would be the better site for the new workshop. The site is adequate in size, is adjacent to the EMU station and is within a reasonable daily commute time from Kuala Lumpur, is mostly owned by KTMB, and can be constructed without disrupting on-going EMU operations or rolling stock servicing and maintenance. However, before a definite decision is made relative to the Seremban site, a dedicated effort should be made to identify any acceptable site or sites which are located closer to Kuala Lumpur and therefore the existing EMU facility and the new carriage servicing and running maintenance facility that is currently under construction.

V. THIRD PARTY MANAGEMENT AND MAINTENANCE

A. BACKGROUND

KTMB Railway Rolling Stock servicing, maintenance and repair is performed at depot locations throughout Malaysia, as shown below:

- Locomotives at Falim, Gemas, Prai, Singapore and Tumpat
- Coaches at Kuala Lumpur (new depot in 2 years) and Tumpat
- Wagons at Falim, Prai, Gemas, Port Klang, and Tumpat
- EMU's at Kuala Lumpur

Overhaul and major repairs are currently performed only on locomotives at the Sentul Workshop in Kuala Lumpur. The Sentul Workshop will eventually be replaced by a new workshop. Functional design of maintenance facilities, including existing facilities and a new workshop, has been described in "KTMB Railway Modernization Project Workshop Project – Task 1 Functional Design Criteria", dated October, 1998 prepared by KORVE Engineering and ICF Kaiser Engineers.

Total rolling stock includes 129 KTMB and Indian Railway locomotives, 323 coaches, 4467 wagons and 61 EMU's.

Approximately 820 employees perform these maintenance functions. These employees work within the Fleet Maintenance and Engineering Organization headed by a General Manager. There are seven direct reports to the General Manager as follows:

- Senior Manager Motive Power Division
- Senior Manager Carriage and Wagon Division
- Senior Manager Engineering Services
- Senior Manager EMU Division
- Senior Manager Finance and Administration
- Senior Manager Procurement
- Senior Manager Stores and Asset Disposal

Bombardier supplies the General Manager under a short term, renewable management contract.

Maintenance functions are performed in the Motive Power Division, Carriage & Wagon Division, EMU Division, Engineering Services and Stores & Asset Disposal. The Motive Power division contains 307 people. The Carriage and Wagon Division contains 412 people. The EMU Division contains 75 people. The Engineering Services Department contains 26 people.

B. SCOPE

The scope of this analysis is to evaluate the feasibility of using a private sector maintenance contractor to perform maintenance for KTMB of owned locomotives, EMU's, coaches and wagons.

Two options have been evaluated:

1) Manage existing operations and people using a qualified superintendent and management team
2) Perform all maintenance on an outsource basis by leasing the existing workshop facility to a maintenance service firm.

C. MAINTENANCE PROGRAMS

In order to evaluate options for maintenance of KTMB rolling stock, it is necessary to understand required maintenance programs and measures of effectiveness of these programs. KTMB workshops provide servicing and maintenance for locomotives, passenger coaches, freight wagons and EMU's. The above referenced report provides an analysis of locomotive maintenance and overhaul practices. Insufficient information was provided for analysis of EMU, coach and wagon maintenance practices.

Items measured for locomotives include scheduled maintenance, unscheduled maintenance, maintenance procedures (consisting of seven stages of maintenance beginning with daily inspections and progressing to a 12,000 hour inspection).

Current maintenance practices are based on calendar days. Each road locomotive receives an in-bound daily inspection at the end of each trip. Routine inspections occur at 15 day intervals with PE (Programmed Examination) inspections occurring at 45 day intervals.

D. OPTIONS FOR THIRD PARTY MANAGEMENT AND MAINTENANCE

The KTMB has had studies done by outside consultants (Bombardier and Canac) that suggest that the existing workforce needs additional training and management techniques to perform effective rolling stock maintenance. These studies have not been made available for this feasibility analysis.

The current workforce includes a mixture of contract employees from Bombardier who are performing selective management services; engineers from an Indian Railway company who are running a portion of the Gemas shop to maintain locomotives; and local Malaysian workers who perform the servicing and maintenance on locomotives, coaches, wagons, and EMU's.

The Malaysian workers perform the following servicing, maintenance, and overhaul activities:

Maintenance

- Maintenance supervision
- Fueling, cleaning and servicing
- Daily inspections
- Periodic inspections
- Unscheduled repairs of failures/incidents
- Wheel truing (with wheels under equipment)
- Exterior washing and cleaning
- Overhauls and major repairs
- Component replacements, repair and overhaul
- Painting plus preparation
- Load testing (locomotives and power generator cars).

Some of these maintenance activities are better suited to third party management than others. Activities that require higher skill levels are candidates for third party management. Activities that require lower skill levels are candidates for local labor. The potential activities that are applicable to third party management are as follows:

- Maintenance supervision
- Daily inspections
- Periodic inspections
- Unscheduled repairs of failures/incidents
- Underfloor wheel truing
- Overhauls and major repairs
- Component repair and overhaul
- Painting
- Load testing

Activities that are applicable to local labor are as follows:

- Fueling and servicing
- Interior cleaning
- Exterior washing
- Paint preparation
- Assisting with maintenance, repairs, and overhauls

It must, however, be noted that the above division of activities assumes that local labor either cannot or does not want to be trained to learn and master the necessary skills. A comprehensive and properly administered training program will result in a local workforce that is capable of performing any and all of the required maintenance activities. Quite often, the necessary environment for success can be accomplished with new management and new management techniques.

E. MANAGE EXISTING OPERATIONS WITH CONTRACT MANAGEMENT TEAM

The current KTMB maintenance program is managed by contract employees from Bombardier, who are under contract for six month periods. The Bombardier contract has continuously been amended. However, this procedure is very awkward as six months is not a sufficient amount of time to accomplish most of the necessary objectives.

The function Design Criteria Report evaluated the current maintenance programs. This report stated that the

> "Bombardier management team is taking appropriate steps to develop the required maintenance programs.... Based on the available information, the Bombardier Management team at KTMB appears to be taking the appropriate measures to improve locomotive availability in spite of the fact that the major overhaul workshop is living on borrowed time, most of existing depots are in poor physical condition and are in need of rehabilitation, there is essentially no capital program for improvements, and the computer system is old and outdated."

Previous consultant studies performed for KTMB indicate that the existing workforce requires training in all aspects of railway rolling stock maintenance and procedures. In addition, a training course program and schedule needs to be developed and implemented for the local workforce.

The current management is obviously making progress with the overall improvement of locomotive, carriage, and wagon maintenance for KTMB. This effort represents proof that the use of a qualified maintenance management team can be successful for KTMB in Malaysia.

F. OUTSOURCE ALL MAINTENANCE

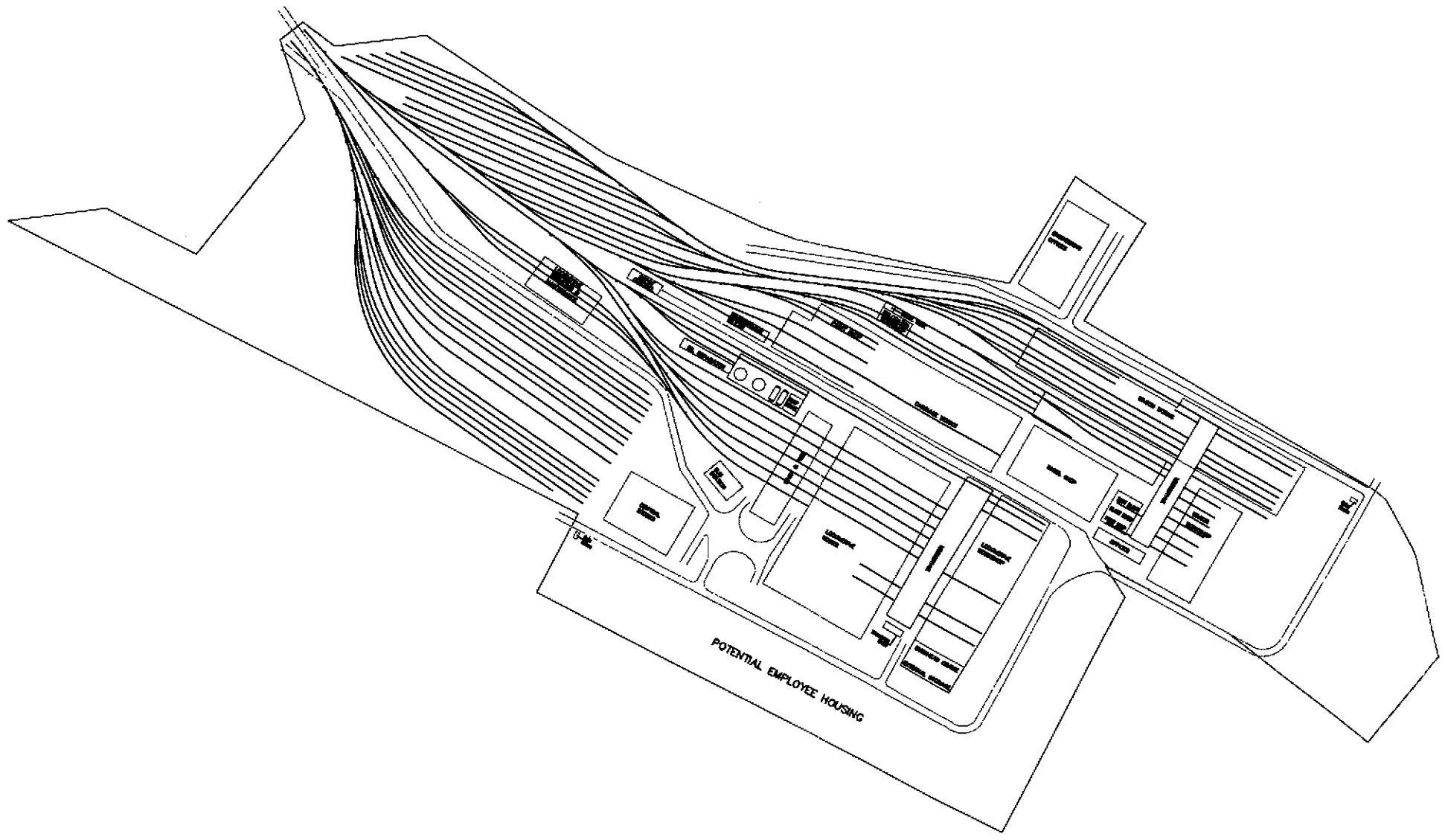
Outsourcing all maintenance involves eliminating the majority of the local Malaysian workforce. In addition, a Senior Manager with a small staff at KTMB would have to provide daily supervision and administration of the maintenance contract.

The outsourcing of all or most of the maintenance function to a management and maintenance contractor result in a smaller, but higher skilled and higher paid workforce. While this may not significantly impact the local economies financially, it would increase local unemployment levels. In order to assure their success, the third party contractor will want to have reasonably modern workshop facilities. KTMB would therefore have to invest in new and rehabilitated workshops and shop equipment at significant cost.

This option would create disruption to the local Malaysian economy, eliminating almost 800 positions currently filled by local Malaysians. While many of the local workers might get jobs with local contract service shops which would likely evolve to support a smaller, more skilled workforce, the economic impact may not be acceptable at this time due to the current Malaysian economic conditions.

G. CONCLUSION

The recommendation is to continue using third party contractors for management and overall supervision, but to lengthen the contract to 3 to 5 years, depending upon local procurement restrictions, to provide continuity of management personnel and prevent disruption in maintenance activities. The management team should also be given the time and the resources necessary to adequately train the existing workforce. A capital budget should also be established in order to begin the much needed rehabilitation of existing depots (excluding the Sentul locomotive facility and the carriage depot at KL which will be replaced) and for the construction of the new workshop.



NO.	REVISIONS	BY	DATE	APPR.

SCALE:
1 cm = 40 m
ORGINAL SCALE IN CENTIMETERS
0 5

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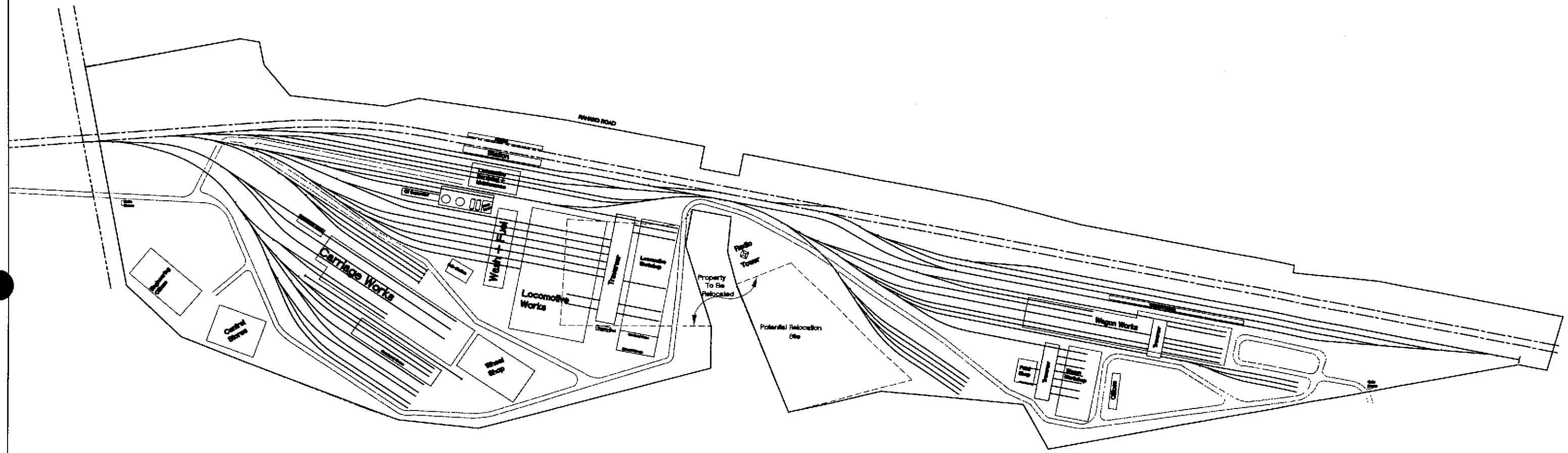
KTMB
WORKSHOP PROJECT

DESIGNED:	KTMB
DRAWN:	M. Lee
CHECKED:	R. Rypinski
REVIEWED:	
FILE NAME:	
DATE:	1/19/99

KTMB WORKSHOP CONCEPTUAL LAYOUT ALTERNATIVE 1

FELIM SITE



NO.	REVISIONS	BY	DATE	APPR.

SCALE: 1 cm = 40 m

ORGINAL SCALE IN CENTIMETERS

0 5

Korve Engineering
1160 Wynkoop St.
Suite 200
Denver, CO 80202
(303) 623-2887

KTMB
WORKSHOP PROJECT

DESIGNED: R. Ripstaid
DRAWN: M. Low
CHECKED: R. Ripstaid
REVIEWED:
FILE NAME:
DATE: 8/18/97

KTMB WORKSHOP CONCEPTUAL LAYOUT ALTERNATIVE 2

SEREMBAN SITE

ICF KAISER
ICF KAISER ENGINEERS AND CONSTRUCTORS

ICF Kaiser Engineers, Inc.
2101 Webster Street, Suite 1000
Oakland, CA 94612-3060
510/419-6000 Fax 510/419-5355
http://www.icfkaiser.com

November 13, 1998

Encik Abdul Radzak b. Abd. Malek
General Manager (Freight)
KTM Berhad
Jalan Sultan Hishamuddin
50621 Kuala Lumpur
Malaysia

Subject: **Transmittal of Deliverable #1 – Signals, Communications and Dispatch Task Data Collection & Assembly Report And Transmittal of Invoice No. 11-0070 KTMB Railway Modernization Project**

Dear Sir:

Attached please find the subject deliverable for KTM's review. This deliverable is the initial one under the Signals & Communications Task. Our designated KTM responsible person for this task is Lee Heng Cheong. I would appreciate it if you could pass this Deliverable to Mr. Lee for his review and approval. I have also included a transmittal letter to Mr. Lee with the Deliverable.

We have included with this Deliverable, Invoice No. 11-0070 which is payable by TDA upon KTM's notification to TDA that the Milestone associated with that invoice has been met by ICF Kaiser. This Deliverable completes the requirements for the Milestone associated with our 3rd invoice. Please approve the invoice as soon as possible by signing in the space provided for "Client Authorization", and forward the signed invoice by fax to Ms. Noreen St. Louis, Finance Manager, U.S. Trade and Development Agency at (703)875-4009 in Arlington, Virginia, USA.

Very truly yours,

John H. Bergerson
Project Manager and Senior Vice President
Attachments

cc: Charles Fisher (w/o)

c:\docs\ktmb\ktmb007.doc

ICF KAISER

ICF KAISER ENGINEERS AND CONSTRUCTORS

ICF Kaiser Engineers, Inc.
2101 Webster Street, Suite 1000
Oakland, CA 94612-3060
510/419-6000 Fax 510/419-5355
http://www.icfkaiser.com

November 13, 1998

Mr. Lee Heng Cheong
General Manager
Signals & Communications
KTM Berhad
Tkt 1 No. 14, Jln Vivekananda
Off Jin Tun Sambanthan
50470 Kuala Lumpur
Malaysia

Subject: **Transmittal of Deliverable #1 - Signals, Communications & Dispatch Task Data Collection and Assembly Report**
KTMB Railway Modernization Project

Dear Mr. Lee::

Attached is our first deliverable. We would appreciate your review of the document to make certain that we have correctly understood the data that you and your staff have provided to our team during their initial trip to Kuala Lumpur. Please contact Charles Fisher directly if you have any questions or issues related to this document.

We have not included one element of the initial task in this document due to a delay in obtaining base mapping. This element is the propagation study. We will complete that work in the coming month, and submit a separate memorandum report.

If this document is acceptable to you upon your review of it, please advise Mr. Radzak. Under our contract with KTM and the USTDA, payment for our services by TDA requires that we produce specific deliverables that are acceptable to KTM. Thank you for your prompt review of the document

Very truly yours,

John H. Bergerson
Project Manager and Senior Vice President

Enclosures

c:\docs\ktmb\ktmb006.doc

KTMB RAILWAY
MODERNIZATION PROJECT

Signal, Communications, and Dispatch Project

Phase 1
Data Collection and Assembly Report

November 1998

ICF Kaiser Engineers, Inc. • 2101 Webster Street, Suite 1000 • Oakland, California 94612

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Trains Magazine Article on Hydra-switch ..... J

Copy of Ad for Hydra-switch ..... K

SIGNAL & COMMUNICATIONS INVENTORY

The signal inventory, Attachment A, consists of 103 CAD drawings of passing loops under the title of the respective station involved. The nomenclature and symbology follow KTM's CAD standards. The "Station Drawing List" at the front of set of drawings lists the 103 stations, one per sheet, that are included in the package. The column entitled "Type" lists the type, if any, of interlocking for the respective location. The column entitled "Signal Sys." lists what type of signaling or train control is being used at the respective location. Reference to the individual drawings will give information as to the type of interlocking machine, its size and the location of switch points and signals.

The wire line communications inventory, Attachment B, consists of 66 CAD drawings of wire line circuits. These are KTM generated CAD drawings and show in detail each active wire, its pin termination, its origin and destination and in most cases its application. Segments of underground cable are shown with an indication of the number of pairs and the diameter of the wires in the cable segment.

The KTM fiber network inventory, Attachment C, consists of seven new CAD generated drawings showing the arrangement of KTM's fiber system. The first six of these drawings show:

- 34 Mb/s Optical Line Terminal Equipment
- Third Order Multiplex Equipment
- 8 Mb/s Optical Line Terminal Equipment
- Second Order Multiplex Equipment
- First Order Multiplex Equipment
- 2 Mb/s Branching Equipment
- 2 Mb/s Branching Loop Protection
- Data Interface Unit 2M for Radio System
- Data Interface Unit for SPT, Signaling (V.24/28)
- Data Interface Unit for Passenger Information and Ticketing (V.35)
- E & M Voice Frequency for SPT. Dispatch Telephone and SCADA
- Subscriber Card for PABX Extension
- Exchange Card for PABX Extension
- Ring Generator

The seventh sheet shows 8 Mb/s channel allocation, Kuala Lumpur - Sentul. The following channel applications are shown:

- Radio Control (Inbound)
- Radio Control (Outbound)
- Radio Traffic (Voice)
- Radio Standby
- Service Radio (Voice)
- Signal Post Telephone (Data)
- Signal Post Telephone (Voice)
- Billing System (Data)
- Dispatch Telephone (Voice)
- Ticketing (Data)
- Passenger Information (Data)
- SCADA (Data)
- Signaling (9600 B/s, Data)
- Signaling (2400 B/s, Data)
- PABX Extension (Voice)
- SCADA PABX Extension (Voice)

The leased line inventory, Attachment D, consists of three sheets of tables listing the 60 segments of leased circuits from Fiberail. The leased circuits are used exclusively for data. The following items are considered in the table on the three sheets:

- Reference Number
- Agreement Number
- Location
- Address(es) of the terminations of the circuit in the Agreement
- Date Valid Until
- Yearly Rental
- Status

A fourth sheet is a CAD drawing showing a diagram of how the leased circuits are used to connect remote sites to the headquarters LAN. It shows the bit rate of the connecting leased line as well as the CISCO routers and gateways used to distribute the data.

PRELIMINARY RECOMMENDATIONS
OF THE
MORE PROMISING SYSTEM UPGRADES

It is recognized that KTM's primary need for system improvement is a radio communication system that will encompass the whole railroad. With recent technological advances there are several alternatives to achieve this. In addition to the multi base station conventional mobile radio system there are two satellite based communication systems now available in Malaysia (Iridium and QualComm's OmniTRACS) as well as the proposed IMT-2000.

We propose to use the conventional mobile radio system costs as the standard to judge the cost effectiveness of any alternatives. The cost of the radio equipment proposed by Motorola in their proposal to KTM, dated August 11, 1998 will be augmented with the computed costs of leased circuits on the Fiberail network, needed to communicate with and control the 80 sites estimated by Motorola to be needed to cover the whole railroad.

Iridium has just recently gone on the air. They offer two types of portable cell phone like instruments. One is for use on the Iridium network only and the other is a combination cell phone and Iridium network phone. The combination phone would allow the use of any local cellular network when such coverage is available at a tariff that is lower than the Iridium tariff. The Iridium tariff is approximately $1.50/minute. It is assumed that when all of Malaysia is covered by IMT-2000, the combination instrument could be used exclusively in the IMT-2000 mode. (See Attachment E, Iridium marketing material dated October 20, 1998)

A much more interesting option is the use of QualComm's satellite network. QualComm is presently operating their OmniTRACS system for the trucking industry in Malaysia. QualComm has developed a specific application of OmniTRACS for railroad use. The attached articles describe how AMTRAK has applied this service to communicate with their long distance passenger trains throughout the U.S. Additionally QualComm has indicated that a system is in operation in Brazil for "Railroad Cargo Companies" that is an application on single track railroad to control meets of opposing moves of freight trains.

QualComm has stated that there are applications of fixed OmniTRACS terminals that are used for Supervisory Control and Data Acquisition (SCADA). Thus, it would appear that as well as communicating with locomotives, OmniTRACS could be used to control switches and signal at passing loops. By adding a small portable printer in the locomotive cabs, hard copies of train orders could be transmitted and confirmed via OmniTRACS.

The use of OmniTRACS fixed terminals would allow the incremental replacement of manually controlled passing loops. That is, the loops could be upgraded as retirement or other attrition takes place.

(See Attachment F, reprint of article written by Bill Stroud, Manager Radio Engineering, Amtrak, Attachment G, copy of article in October 1998 issue of Trains magazine and Attachment H, OmniTRACS marketing brochure.)

The attached article (Attachment I) from the IEEE Communications Magazine, written by Malaysian authors, indicates that there are efforts ongoing in Malaysia to bring IMT-2000 (International Mobile Telecommunications in the year 2000) into being between 2000 and 2005. If IMT-2000 lives up to its promises, it would offer reliable coverage of all of Maylaysia at a per call cost far below Iridium and possibly somewhat less than present day cellular phone calls.

We could also look at ways to make more efficient use of your leased 64 Kb/s circuits. These circuits could be sub-multiplexed to give 16 to 32 Kb/s voice circuits, allowing the remaining bit traffic to be used as needed for data communication for ticketing and resource control.

With respect to upgrading signaling the following options bare consideration.

Further expansion of the existing CTC system.

Remote control of switches and signals via data links leased from Fiberail.

Applying the European technology of using balises to communicate to trains speed vs. profile, limits of authority, route selection, etc. There has been a joint development effort of several European signal companies to develop an intelligent balise. Train borne equipment activates the balise with a burst of microwave power and the balise "telegraphs" back to the train the necessary information to allow the train to proceed, either to the next balise or to a limit of authority. The train contains a vital computer arrangement that enforces speed limits and stops at limits of authority. AdTranz has developed a variation of this technology for use on low traffic density track areas in England.

Remote control of switches and signals and transmission of train orders via QualComm's OmniTRACS, satellite communications system. This system has the capability of furnishing an on site large screen display, showing the location of each locomotive that has its on board terminal active and would also show the status of equipment controlled by fixed remote units, i.e., the status of each switch and the aspect of each signal.

Attachment J, reprint of article in October 1998 Trains magazine describing the "Hydra-switch and Attachment K, a copy of an ad for the Hydra-switch from one of the railroad news magazines are included as examples of reliable, less expensive than traditional,

Regardless of which option is implemented, the improved communications with running trains will allow more efficient use of single track mainline, allowing meets to be planned and optimized in real time.

Attachment A

Signal Inventory

KTMB
RAILWAY MODERNIZATION PROJECT

Station Drawings

KTMB STATION DRAWING LIST

SHEET NO.	STATION	K.M. POST	T.T.	TYPE	CROSSING TYPE	XING T.T.	XING K.M.	SIGNAL SYS.
001	PADANG BESAR	157.75	98/05	RELAY INTERLOCKING				TOKEN KEY
002	BUKIT KETRI	138.75	86/8	HIGH POINT INDICATOR				TOKEN KEY
003	ARAU	128.5	80/1	HIGH POINT INDICATOR				TOKEN KEY
004	TUNJANG	108.75	67/7	HIGH POINT INDICATOR				TOKEN KEY
005	ALOR STAR	90.25	56/5	FULLY INTERLOCKED	BARRIER (NIWG)	56/18		TOKEN KEY
006	JUNUN	63.5	39/14	HIGH POINT INDICATOR				TOKEN KEY
007	GURUN	54.5	34/1	HIGH POINT INDICATOR	BARRIER (IWSB)	33/18		TOKEN KEY
008	BEDONG	43.5	27/6	HIGH POINT INDICATOR	SYM.GATE (IWG)	27/9		TOKEN KEY
009	SUNGAI PETANI	33.5	21/1	FULLY INTERLOCKED	SYM.GATE (IWG)	20/23		TOKEN KEY
010	PINANG TUNGGAL	23.5	14/21	HIGH POINT INDICATOR	BARRIER (NIWG)	14/15		TOKEN KEY
011	TASEK GLUGOR	15	9/12	HIGH POINT INDICATOR	SYM.GATE (IWG)	9/8		TOKEN KEY
012	PENATI	6.25	4/1	HIGH POINT INDICATOR	N0N-SYM. GATE (I)	4/1		TOKEN KEY
013	BUTTERWORTH	0	0/0	RELAY INTERLOCKING				TOKEN KEY
014	PRAI	1.9	0/15	RELAY INTERLOCKING				TOKEN KEY
015	BUKIT TENGAH	7.3	3/19	FULLY INTERLOCKED				TOKEN KEY
016	BUKIT MERTAJAM	11.5	6/11	FULLY INTERLOCKED	SYM.GATE (IWG)	6/4		TOKEN KEY
017	SIMPANG AMPAT	20.5	12/1	FULLY INTERLOCKED	SYM.GATE (IWG)	12/1		TOKEN KEY
018	NIBONG TEBAL	33.9	20/9	FULLY INTERLOCKED	N0N-SYM. GATE (I)	20/9		TOKEN KEY
019	PARIT BUNTAR	38.6	23/6	FULLY INTERLOCKED	SYM.GATE (IWG)	23/1		TOKEN KEY
020	BAGAN SERAI	51.8	31/11	FULLY INTERLOCKED	N0N-SYM. GATE (I)	32/3		TOKEN KEY
021	BUKIT MERAH	66.7	40/17	FULLY INTERLOCKED				TOKEN KEY
022	PONDOK TANJONG	76.8	47/1	FULLY INTERLOCKED	SYM.GATE (IWG)	47/1		TOKEN KEY
023	KAMUNTING	89.8	55/4	FULLY INTERLOCKED	SYM.GATE (IWG)	55/9		TOKEN KEY
024	TAIPING	95.3	59/5	FULLY INTERLOCKED	SYM.GATE (IWG)	59/15		TOKEN KEY
025	BUKIT BERAPIT	109.5	67/38	FULLY INTERLOCKED				TOKEN KEY
026	PADANG RENGAS	115.5	71/17	RELAY INTERLOCKING	SYM.GATE (IWG)			TOKEN KEY
					BARRIER (NIWG)			
027	KUALA KANGSAR	125.7	77/22	FULLY INTERLOCKED	NON-SYM.GATE (OC)	78/2		TOKEN KEY
028	SALAK NORTH	139.9	86/15	FULLY INTERLOCKED				TOKEN KEY
029	SUNGEI SIPUT	147.2	91/8	FULLY INTERLOCKED	SYM.GATE (IWG)	91/4-5		TOKEN KEY
030	CHEMOR	159.9	99/7	FULLY INTERLOCKED				TOKEN KEY
031	TANJONG RAMBUTAN	167.7	104/3	FULLY INTERLOCKED	N0N-SYM. GATE (I)	103/23	167.25	TOKEN KEY
032	TASEK	173.7	107/20	RELAY INTERLOCKING				
033	IPOH NORTH	181.1	112/12	FULLY INTERLOCKED				RELAY AUTO BLOCK
034	IPOH SOUTH	181.1	112/12	FULLY INTERLOCKED	SYM.GATE (IWG)	113/5		RELAY AUTO BLOCK
					SYM.GATE (IWG)	0/9		
035	LAHAT	187.6	116/13	FULLY INTERLOCKED				RELAY AUTO BLOCK
036	BATU GAJAH	195.4	121/8	FULLY INTERLOCKED	BARRIER (NIWG)	122/1		RELAY AUTO BLOCK
037	KOTA BAHRU	204.25	126/20	FULLY INTERLOCKED				RELAY AUTO BLOCK

KTMB STATION DRAWING LIST

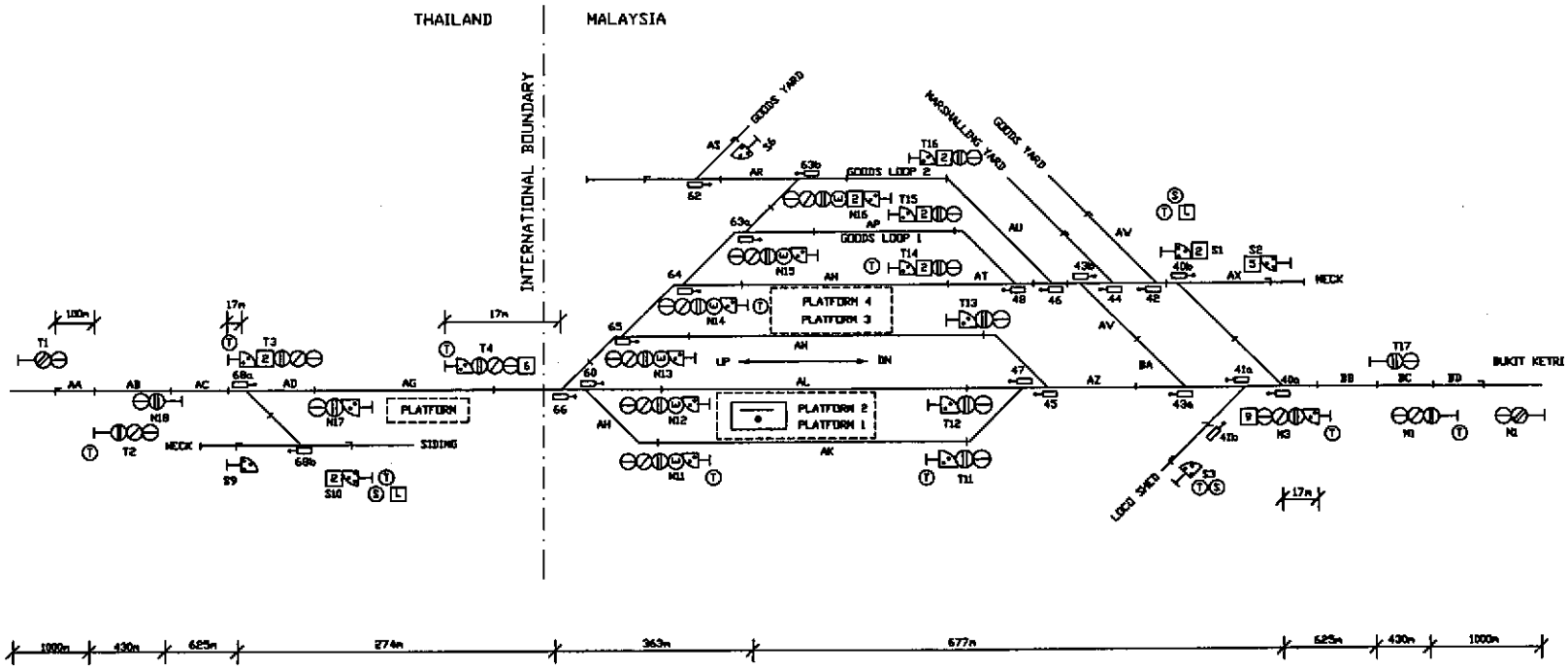
SHEET NO.	STATION	K.M. POST	T.T.	TYPE	CROSSING TYPE	XING T.T.	XING K.M.	SIGNAL SYS.
038	MALIM NAWAR	211.5	131/9	FULLY INTERLOCKED	SYM.GATE (IWG)	131/6		RELAY AUTO BLOCK
039	KAMPAR	218	135/12	FULLY INTERLOCKED				RELAY AUTO BLOCK
040	TAPAH ROAD	233.4	144/22	FULLY INTERLOCKED	BARRIER (IWSB)	145/3		RELAY AUTO BLOCK
041	BIDOR	245.4	152/9	FULLY INTERLOCKED				RELAY AUTO BLOCK
042	SUNGKAI	257.7	160/1	FULLY INTERLOCKED				RELAY AUTO BLOCK
043	TROLAK	273.5	169/17	FULLY INTERLOCKED				RELAY AUTO BLOCK
044	SLIM RIVER	282.75	174/23	FULLY INTERLOCKED				RELAY AUTO BLOCK
045	BEHRANG	293	181/21	FULLY INTERLOCKED				RELAY AUTO BLOCK
046	TANJONG MALIM	303.75	188/15	RELAY INTERLOCKING	SYM.GATE (IWG)	188/17		RELAY AUTO BLOCK
047	KALUMPANG	309	191/20	FULLY INTERLOCKED				RELAY AUTO BLOCK
048	KUALA KUBU ROAD	322.5	202/1	FULLY INTERLOCKED				RELAY AUTO BLOCK
049	ULU YAM	335.5	210/2	FULLY INTERLOCKED	BARRIER (IWG)	209/21		RELAY AUTO BLOCK
050	SERENDAH	347.1	217/6	FULLY INTERLOCKED				RELAY AUTO BLOCK
051	**RAWANG**	355.58		RELAY INTERLOCKING				RELAY AUTO BLOCK
052	**SEREMBAN**	460.98		RELAY INTERLOCKING				RELAY AUTO BLOCK
053	REMBAU	484.75		RELAY INTERLOCKING				RELAY AUTO BLOCK
054	KENDONG	497.25	311/6	RELAY INTERLOCKING				RELAY AUTO BLOCK
055	TAMPIN	508.75		RELAY INTERLOCKING	BARRIER (NIWG)	318/15		RELAY AUTO BLOCK
056	TEBONG	524.5		RELAY INTERLOCKING	BARRIER (NIWG)	327/18		RELAY AUTO BLOCK
057	BATANG MELAKA	535.5		RELAY INTERLOCKING	BARRIER (NIWG)	334/14		RELAY AUTO BLOCK
					BARRIER (NIWG)	334/12		
058	AIR KUNING SELATAN	544		RELAY INTERLOCKING	BARRIER (NIWG)	339/08		RELAY AUTO BLOCK
059	**GEMAS**	562.75	351/4	RELAY INTERLOCKING	BARRIER (NIWG)	351/10		RELAY AUTO BLOCK
				RELAY INTERLOCKING	BARRIER (NIWG)	0/17		
060	BATU ANAM	572.75	357/12	RELAY INTERLOCKING	BARRIER (NIWG)	357/19		RELAY AUTO BLOCK
061	SEGAMAT	588.25	367/3	RELAY INTERLOCKING	BARRIER (NIWG)	367/07		RELAY AUTO BLOCK
					BARRIER (NIWG)	368/02		
062	GENUANG	596.75	372/8	RELAY INTERLOCKING				RELAY AUTO BLOCK
063	TENANG	605.5	377/18	RELAY INTERLOCKING				RELAY AUTO BLOCK
064	LABIS	617.5	385/06	RELAY INTERLOCKING				RELAY AUTO BLOCK
065	LENEK	626	390/13	RELAY INTERLOCKING				RELAY AUTO BLOCK
066	BEKOK	633.5	395/4	RELAY INTERLOCKING				RELAY AUTO BLOCK
067	PALOH		404/2	RELAY INTERLOCKING	BARRIER (IWSB)	403/21		RELAY AUTO BLOCK
068	CHAMEK	655.25	408/16	ROUTE RELAY INTERLOCKING	NON-SYM. GATE (OC)			RELAY AUTO BLOCK
069	NIYOR	663	413/15	RELAY INTERLOCKING				RELAY AUTO BLOCK
070	KLUANG	671	418/11	ROUTE RELAY INTERLOCKING	BARRIER (NIWG)	418/19		RELAY AUTO BLOCK
071	MENGKIBOL	677.75	422/16	RELAY INTERLOCKING	NON-SYM. GATE (OC)			RELAY AUTO BLOCK
072	RENGAM	690.5	430/16	RELAY INTERLOCKING	SYM. GATE (IWG)	430/14		RELAY AUTO BLOCK
073	LAYANG LAYANG	703.1		RELAY INTERLOCKING				RELAY AUTO BLOCK

KTMB STATION DRAWING LIST

SHEET NO.	STATION	K.M. POST	T.T.	TYPE	CROSSING TYPE	XING T.T.	XING K.M.	SIGNAL SYS.
074	SEDENAK	716	446/11	RELAY INTERLOCKING				RELAY AUTO BLOCK
075	KULAI	725.75	452/15	RELAY INTERLOCKING				RELAY AUTO BLOCK
076	KEMPAS BARU	0(747.32)	465/15					RELAY AUTO BLOCK
077	PASIR GUDANG	29.2	22/1	RELAY INTERLOCKING				RELAY AUTO BLOCK
078	JOHOR BAHRU	757.97	472/3	FULLY INTERLOCKED				RELAY AUTO BLOCK
079	BAHAU	36.9	22/19	NON-INTERLOCKED	BARRIER (NIWG)	22/10	36.272	TOKEN KEY
					NON-SYM. (I)	22/18	36.78	
080	KEMAYAN	75.6	46/21	NON-INTERLOCKED				TOKEN KEY
081	TRIANG	89.8	55/16	NON-INTERLOCKED				TOKEN KEY
082	MENTAKAB	122	75/19	NON-INTERLOCKED	BARRIER (NIWG)	75/12		TOKEN KEY
083	KUALA KRAU	148.4	92/4	FULLY INTERLOCKED	BARRIER (NIWG)	91/19		TOKEN KEY
084	JERANTUT	174	108/3	NON-INTERLOCKED	BARRIER (NIWG)	107/18		TOKEN KEY
085	MELA	193.6	120/7	NON-INTERLOCKED				TOKEN KEY
086	KRAMBIT	204.3	127/1	NON-INTERLOCKED				TOKEN KEY
087	KUALA LIPIS	227.3	141/4	HIGH POINT INDICATOR	BARRIER (NIWG)	141/14		TOKEN KEY
088	PADANG TENGKU	236.2	146/19	NON-INTERLOCKED	BARRIER (NIWG)	147/9		TOKEN KEY
089	CHEGAR PERAH	263.3	163/19	NON-INTERLOCKED				TOKEN KEY
090	SUNGAI TEMAU	271.7	168/22	NON-INTERLOCKED				TOKEN KEY
091	MERAPOH	296.5	184/9	NON-INTERLOCKED				TOKEN KEY
092	GUA MUSANG	321.6	199/17	FULLY INTERLOCKED				TOKEN KEY
093	LIMAU KASTURI	348.1	216/14	NON-INTERLOCKED				TOKEN KEY
094	BERTAM BARU	356.6	221/21	NON-INTERLOCKED				TOKEN KEY
095	KEMUBU	378.6	235/13	NON-INTERLOCKED				TOKEN KEY
096	DABONG	388.1	241/1	NON-INTERLOCKED				TOKEN KEY
097	BUKIT ABU	399.2	248/8	NON-INTERLOCKED				TOKEN KEY
098	MANEK URAI	425.6	264/20	NON-INTERLOCKED				TOKEN KEY
099	KUALA KRAI	442.1	275/2	NON-INTERLOCKED	BARRIER (NIWG)	275/5		TOKEN KEY
100	TANAH MERAH	475.5	295/17	HIGH POINT INDICATOR	BARRIER (NIWG)	295/22	476.536	TOKEN KEY
101	PASIR MAS	502	312/8	FULLY INTERLOCKED	SYM. GATE (IWG)	312/12		TOKEN KEY
102	WAKAF BAHRU	513.7	318/20	HIGH POINT INDICATOR	SYM. GATE (IWG)	319/1-2		TOKEN KEY
103	TUMPAT	527.7	327/15	FULLY INTERLOCKED	BARRIER (IWG)	327/14		TOKEN KEY
					BARRIER (NIWG)	327/5		

PADANG BESAR

(RELAY INTERLOCKING)
KM 157.75
(T.T. 98/05)



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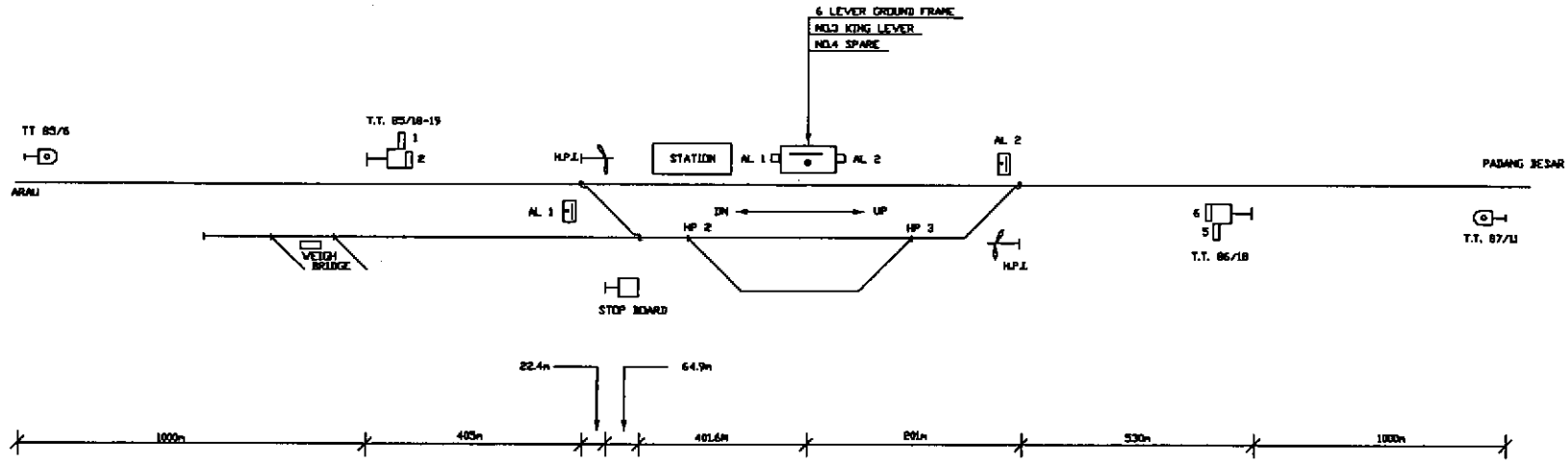
BUKIT KETRI

(HIGH POINT INDICATOR)

KM 138.75

(T.T. 86/8)



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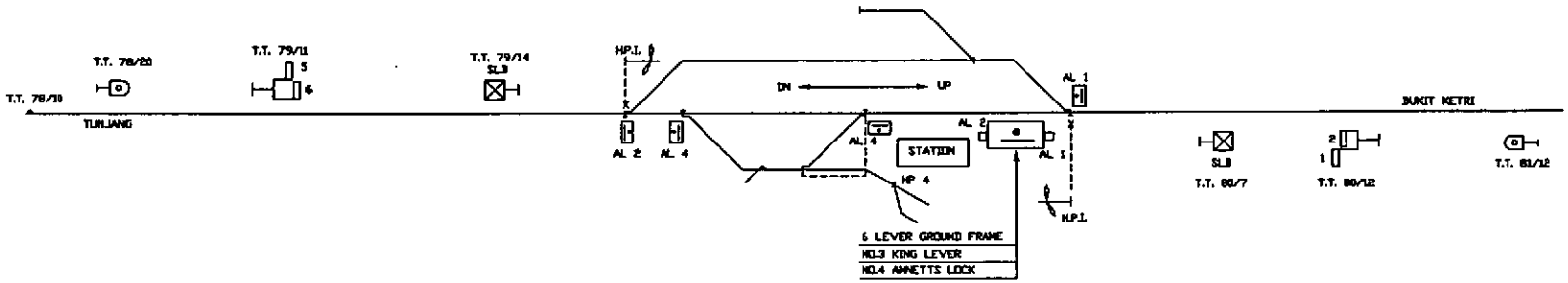
	REV. 0	SHEET NO. 002

ARAU

(HIGH POINT INDICATOR)

KM 128.5

(T.T. 80/1)



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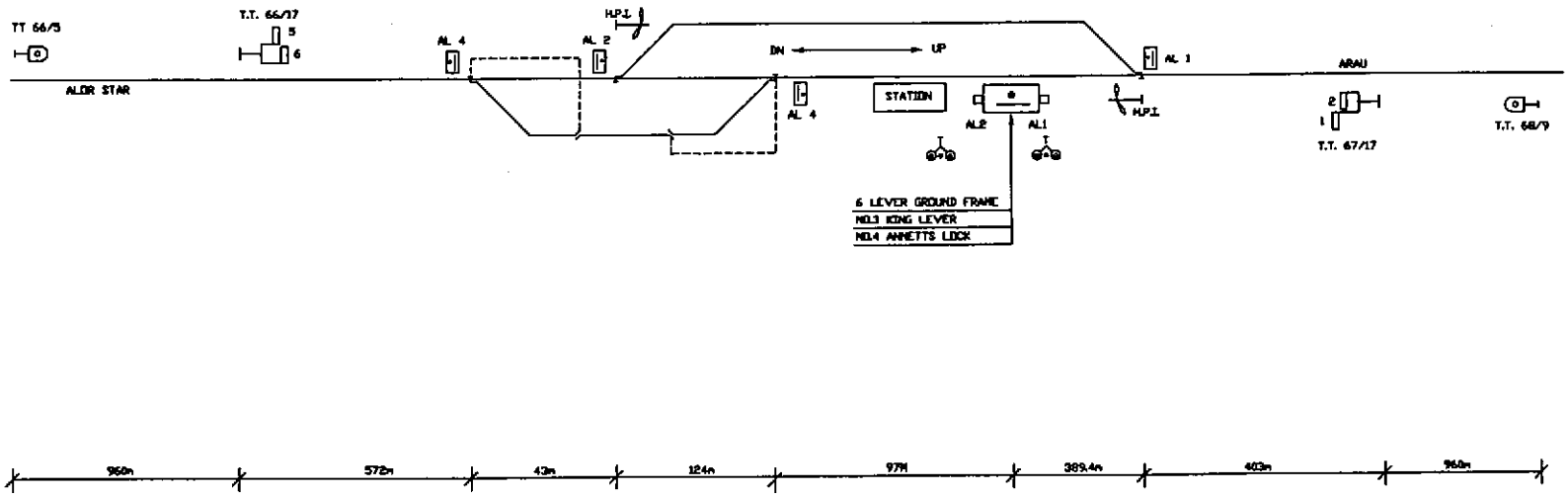
	DRAWING NO. KE 003	
	REV. 0	SHEET NO. 003

TUNJANG

(HIGH POINT INDICATOR)

KM 108.75

(T.T. 67/7)



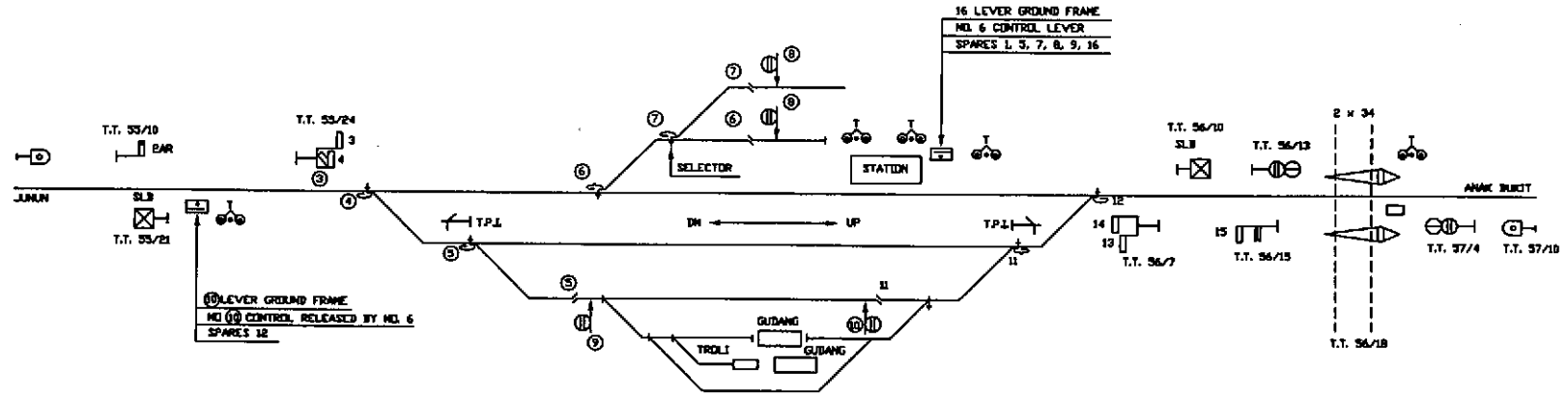
KTM / ICF KAISER	CAD FILE NO. TUNJANG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 004	
	REV. 0	SHEET NO. 004

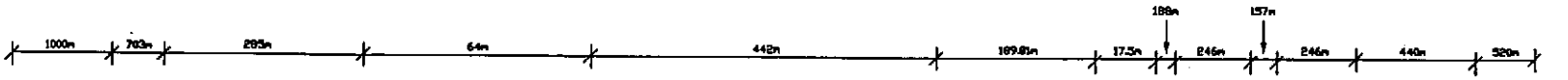
ALOR STAR

(FULLY INTERLOCKED)

KM 90.25

(T.T.56/5)

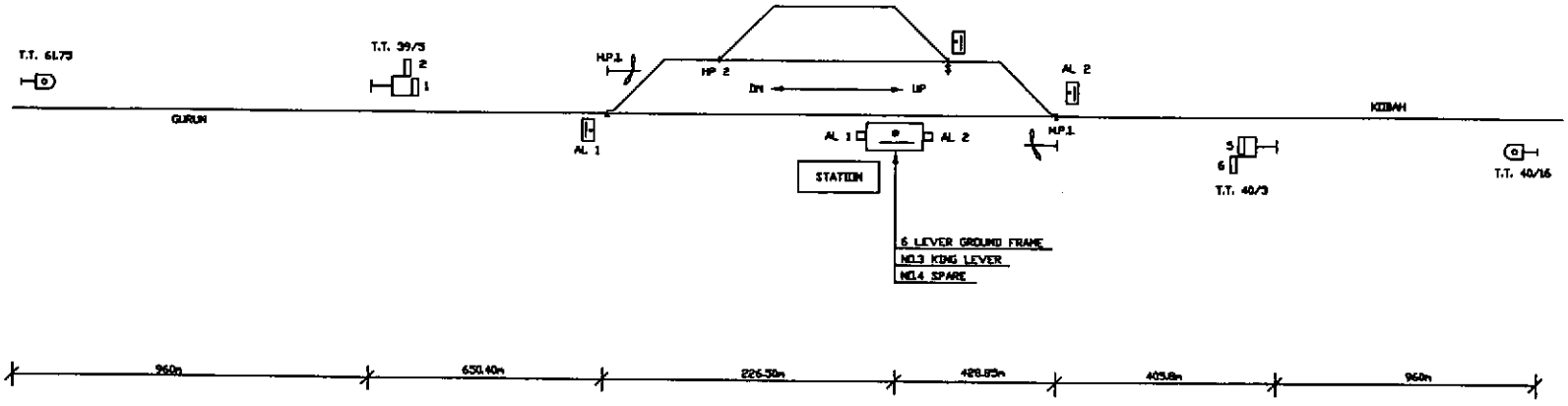




KTM / ICF KAISER	CAD FILE NO. ALORSTAR.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 005	
	REV. 0	SHEET NO. 005

JUNUN

(HIGH POINT INDICATOR)
KM 138.75
(T.T. 39/14)



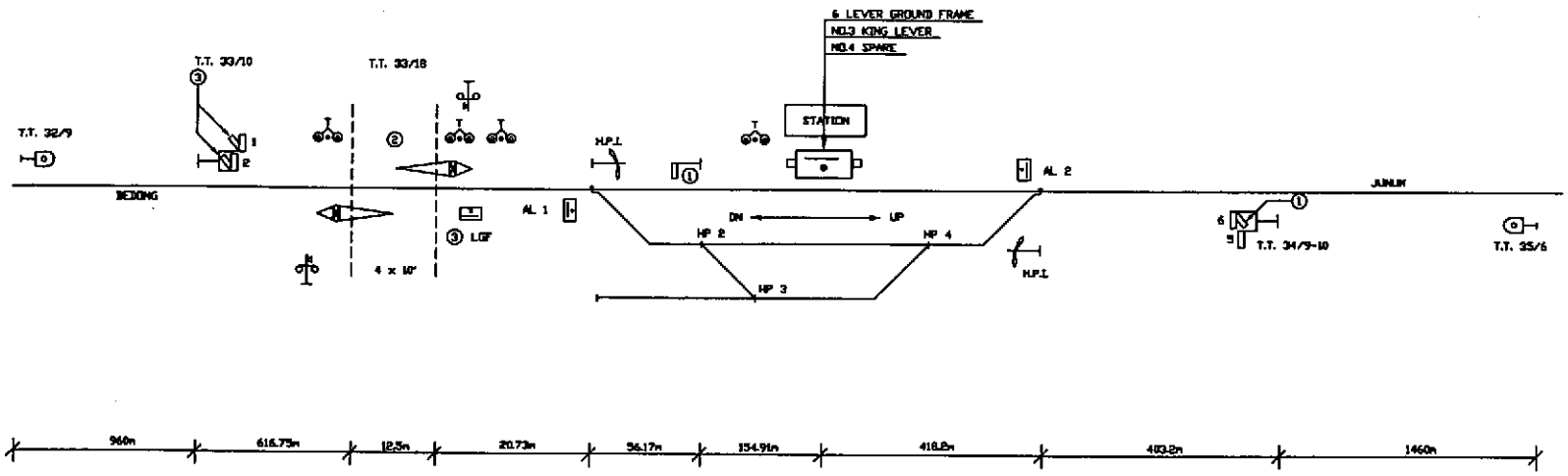
◆ ICF KAISER	CAD FILE NO. JUNUN.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 006	
	REV. 0	SHEET NO. 006

GURUN

(HIGH POINT INDICATOR)

KM 54.5

(T.T. 34/1)



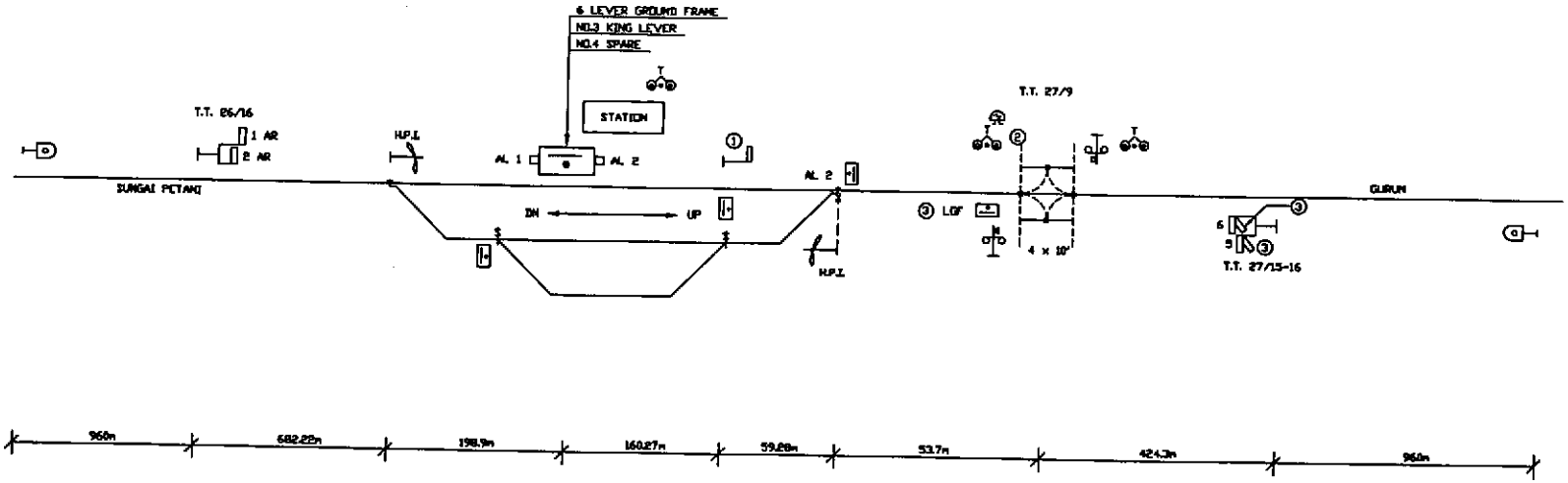
KTM / ICF KAISER	CAD FILE NO. GURUN.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 007	
	REV. 0	SHEET NO. 007

BEDONG

(HIGH POINT INDICATOR)

KM 43.5

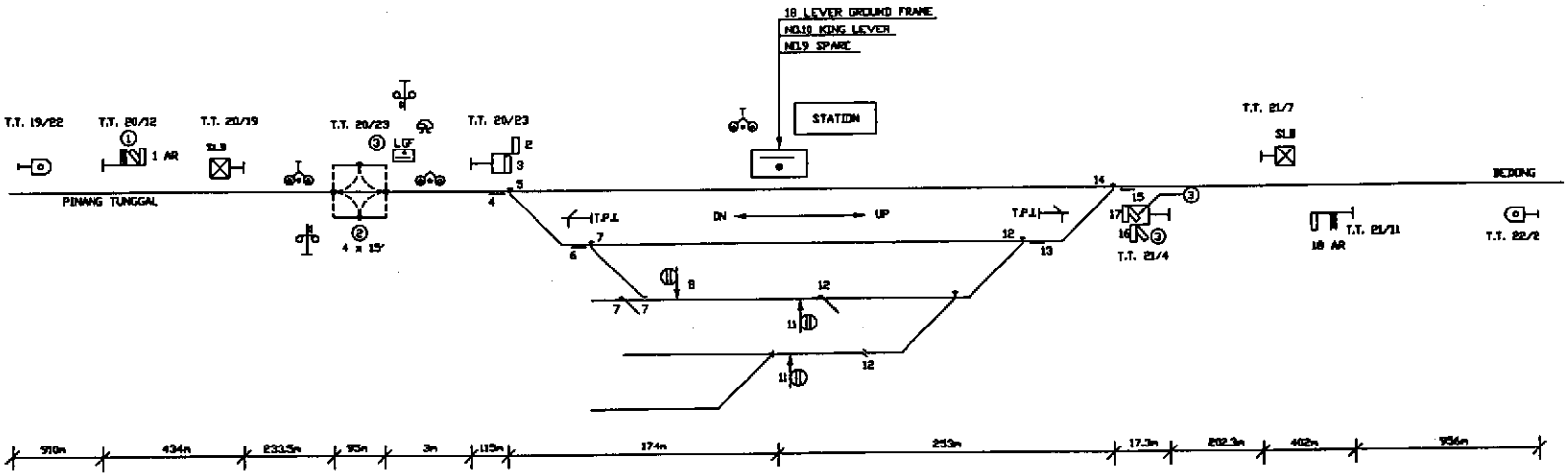
(T.T. 27/6)



KTM / ICF KAISER	CAD FILE NO. BEDONG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 008	
	REV. 0	SHEET NO. 008

SUNGAI PETANI

(FULLY INTERLOCKED)
KM 33.5
(T.T. 21/1)



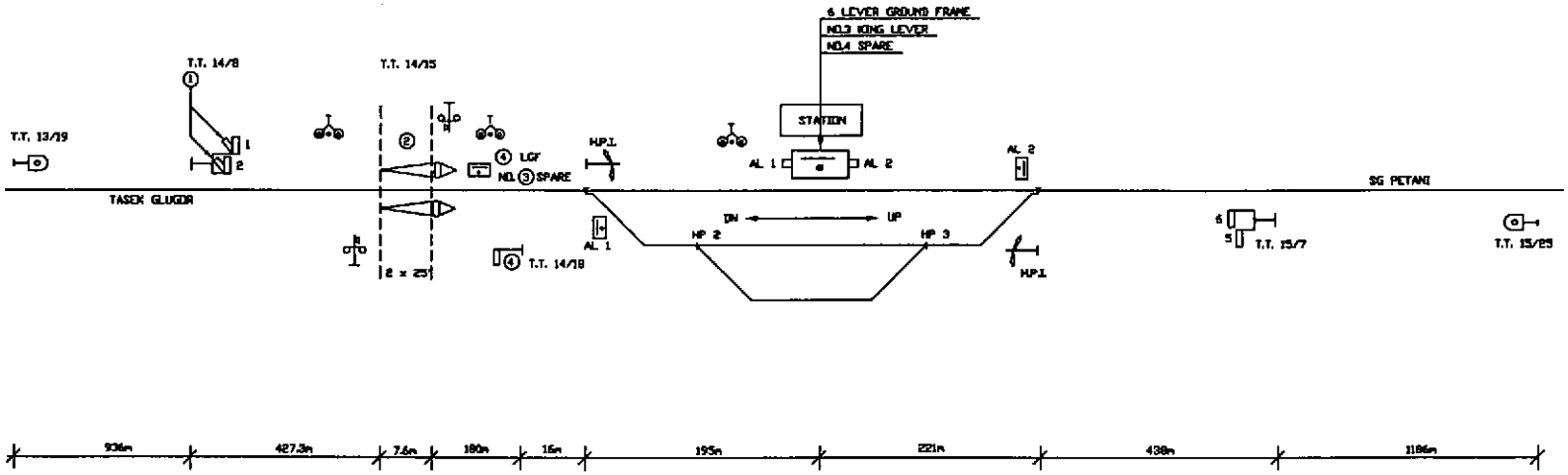
KTM / ICF KAISER	CAD FILE NO. SUNGAIPETANI.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 009	
	REV. 0	SHEET NO. 009

PINANG TUNGGAL

(HIGH POINT INDICATOR)

KM 23.5

(T.T. 14/21)



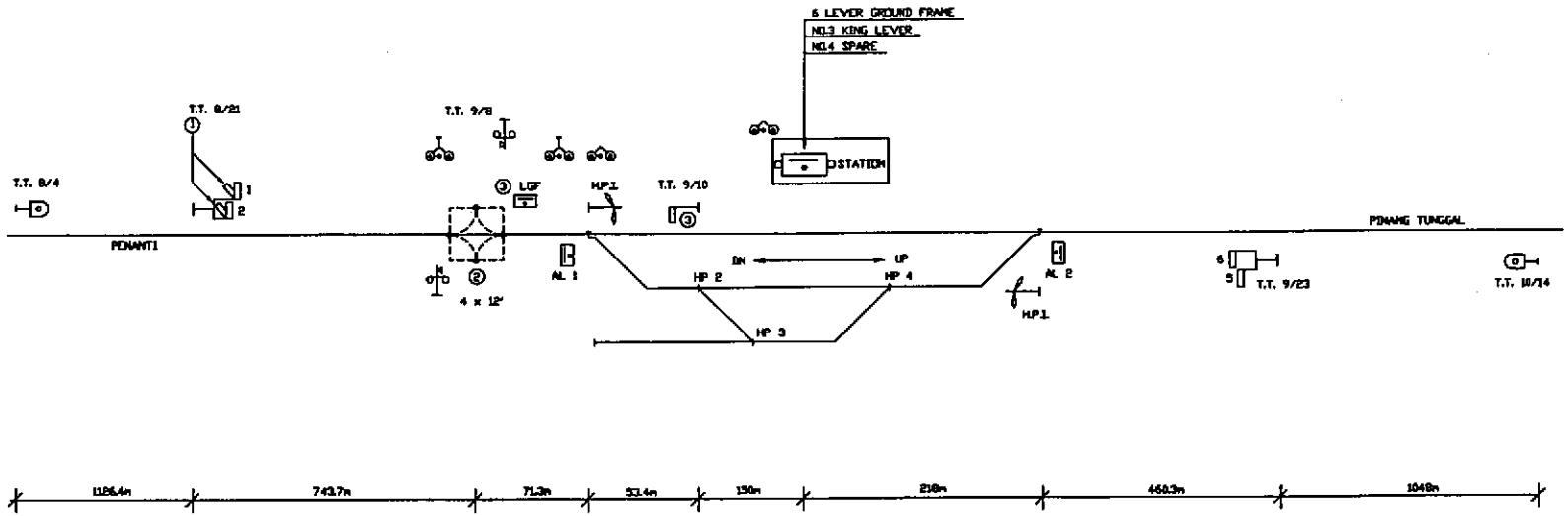
KTM / ICF KAISER	CAD FILE NO. PINANG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 010	
	REV. 0	SHEET NO. 010

TASEK GLUGOR

(HIGH POINT INDICATOR)

KM 15

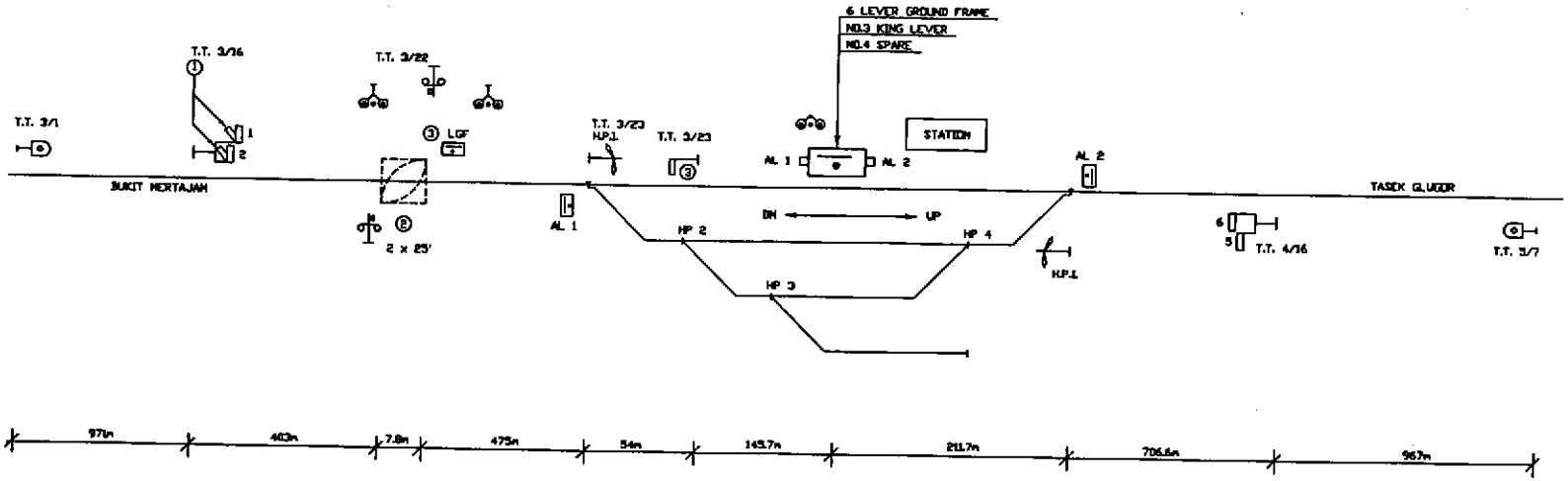
(T.T. 9/12)



KTM / ICF KAISER	CAD FILE NO. TASEKGLU.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 011	
	REV. 0	SHEET NO. 011

PENANTI

(HIGH POINT INDICATOR)
KM 6.25
(T.T. 4/1)



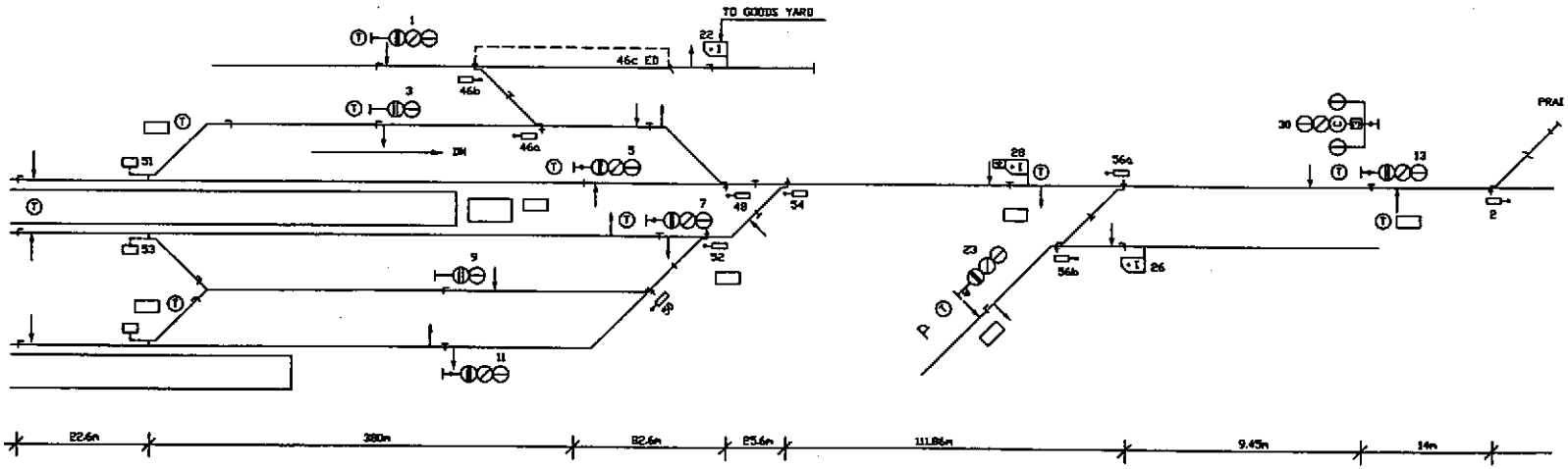
KTM / ICF KAISER	CAD FILE NO. PENANTI.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 012	
	REV. 0	SHEET NO. 012

BUTTERWORTH

(RELAY INTERLOCKING)

KM 0

(T.T. 0/0)



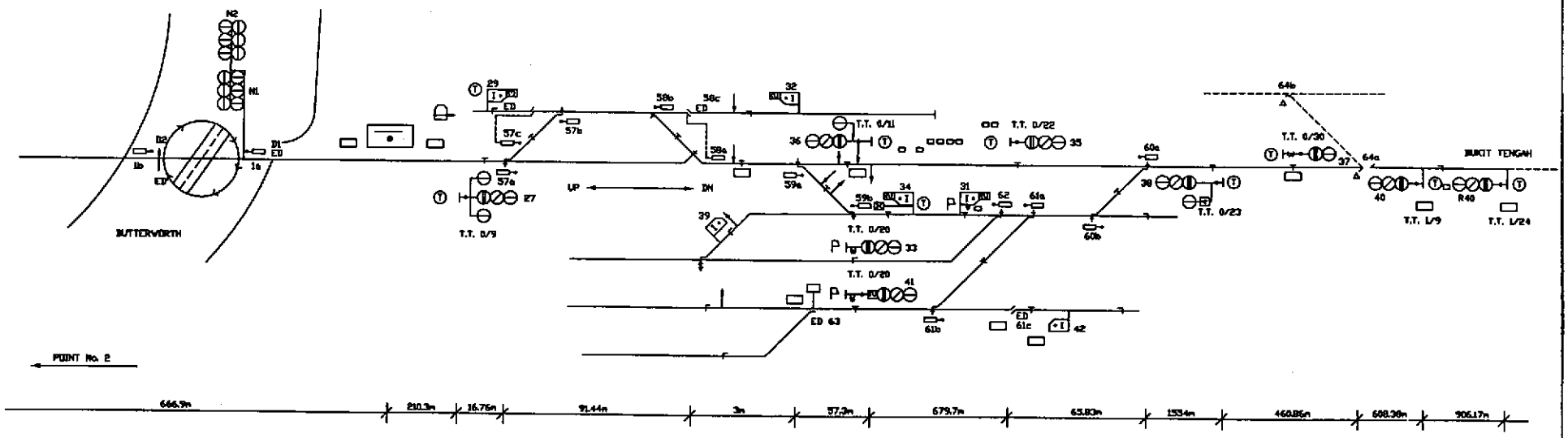
KTM / ICF KAISER	CAD FILE NO. BUTTERWORTH.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 013	
	REV. 0	SHEET NO. 013

PRAI

(RELAY INTERLOCKING)

KM 1.9

(T.T. 0/15)



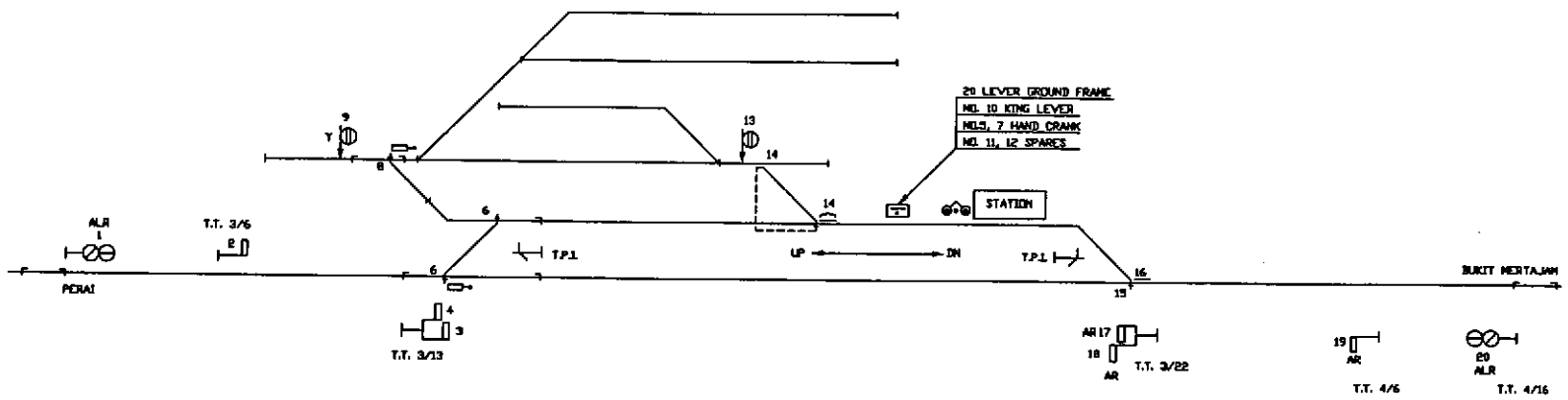
◆ ICF KAISER	CAD FILE NO. PRA.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 014	
	REV. 0	SHEET NO. 014

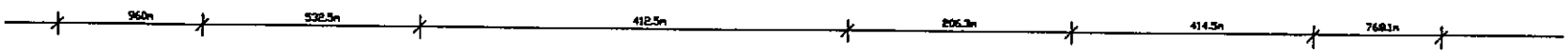
BUKIT TENGAH

(FULLY INTERLOCKED)

KM 7.3

(T.T. 3/19)





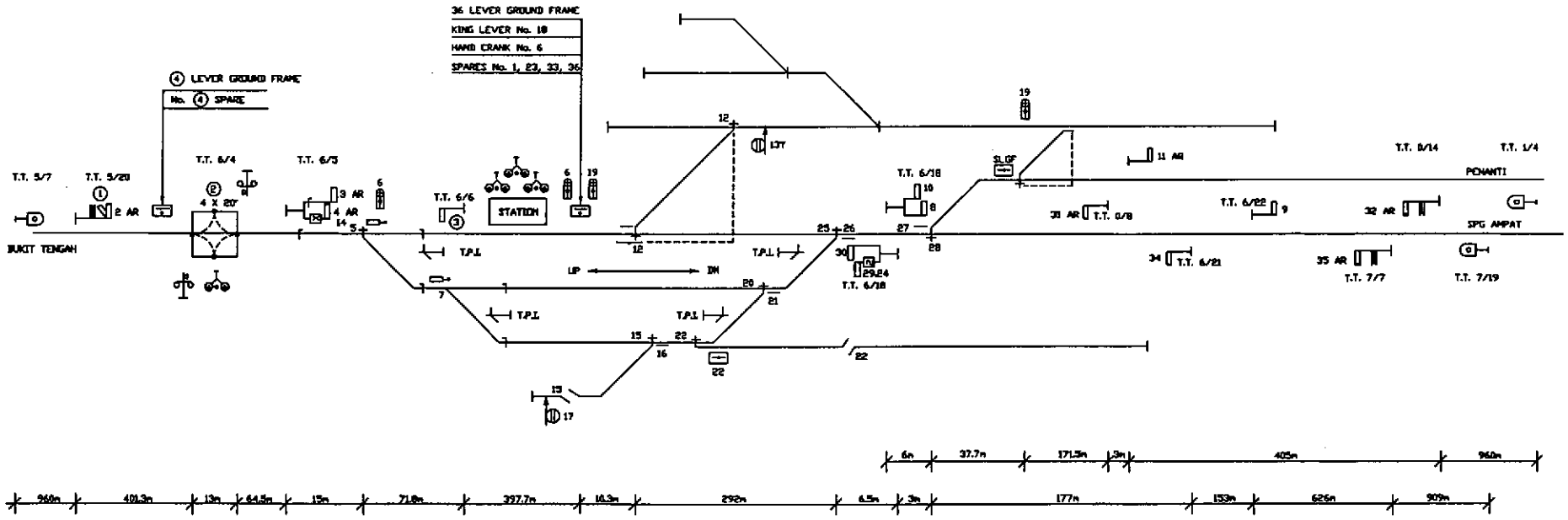
KTM / ICF KAISER	CAD FILE NO. BTENGAH.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 015	
	REV. 0	SHEET NO. 015

BUKIT MERTAJAM

(FULLY INTERLOCKED)

KM 11.5

(T.T. 6/11)



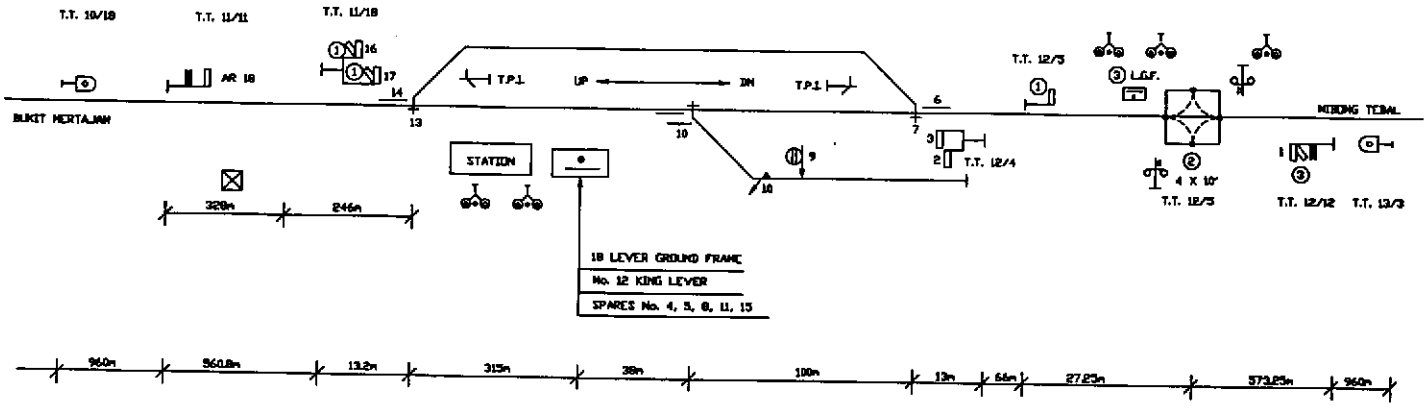
KTM / ICF KAISER	CAD FILE NO. BUKITMERTAJAM.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 016	
	REV. 0	SHEET NO. 016

SIMPANG AMPAT

(FULLY INTERLOCKED)

KM 20.5

(T.T. 12/1)



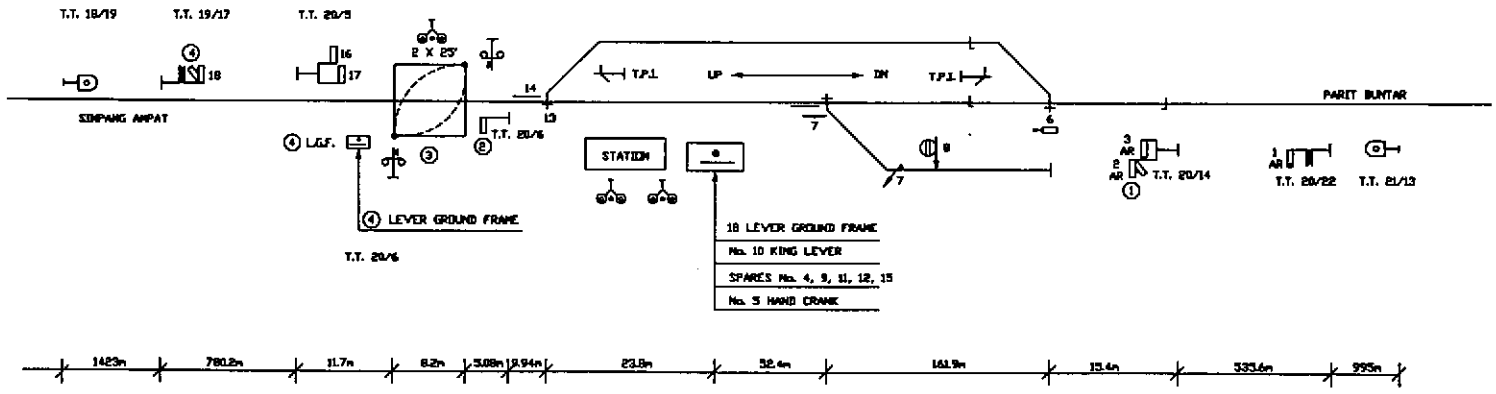
KTM / ICF KAISER	CAD FILE NO. SIMPANGAMPAT.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 017	
	REV. 0	SHEET NO. 017

NIBONG TEBAL

(FULLY INTERLOCKED)

KM 33.9

(T.T. 20/9)



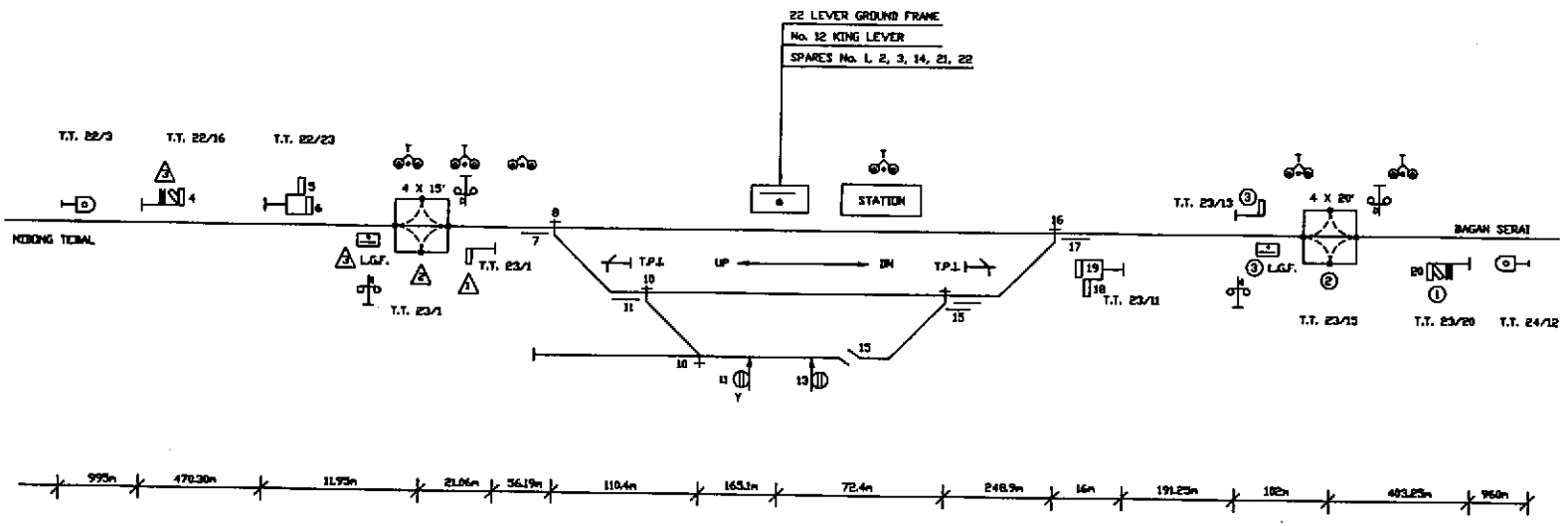
KTM / ICF KAISER	CAD FILE NO. NIBONGTEBAL.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 018	
	REV. 0	SHEET NO. 018

PARIT BUNTAR

(FULLY INTERLOCKED)

KM 38.6

(T.T. 23/6)



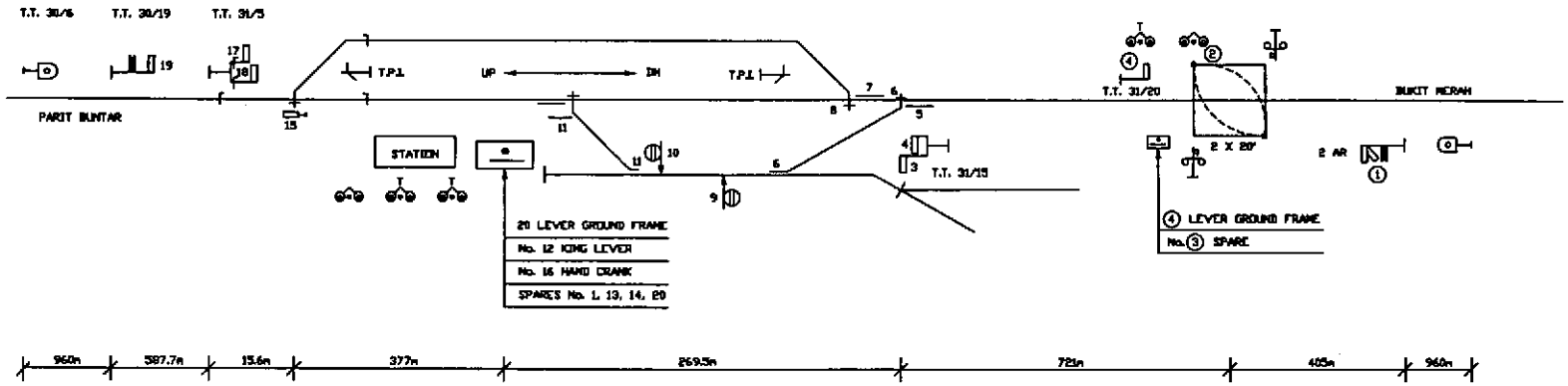
KTM / ICF KAISER	CAD FILE NO. PARITBUNTAR.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 019	
	REV. 0	SHEET NO. 019

BAGAN SERAI

(FULLY INTERLOCKED)

KM 51.8

(T.T. 31/11)



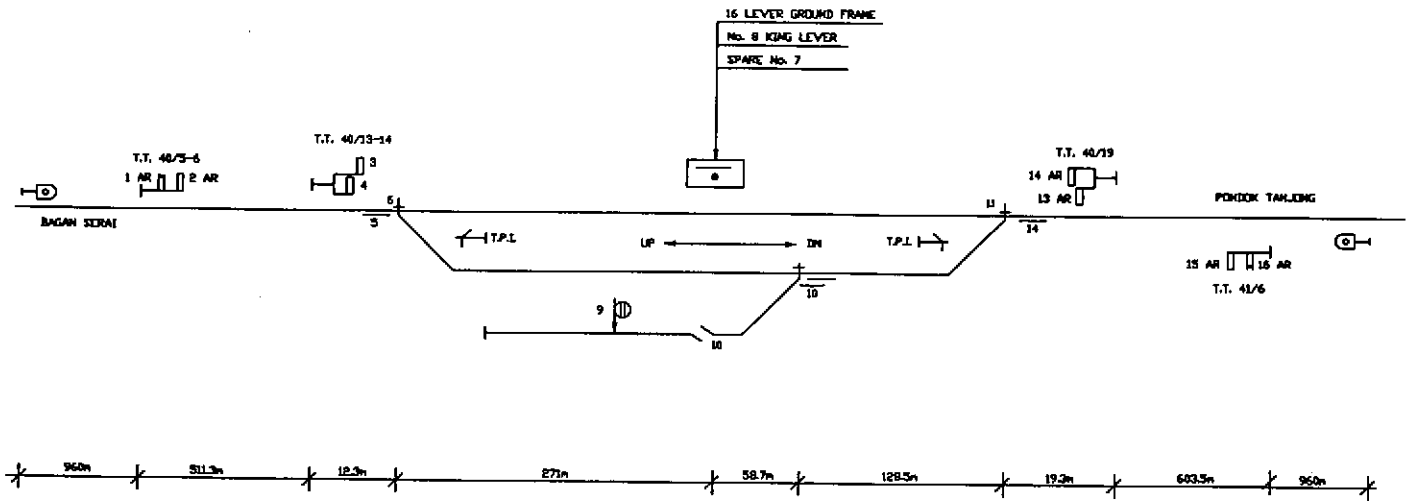
◆ ICF KAISER	CAD FILE NO. BAGANSERAI.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 020	
	REV. 0	SHEET NO. 020

BUKIT MERAH

(FULLY INTERLOCKED)

KM 66.7

(T.T. 40/17)



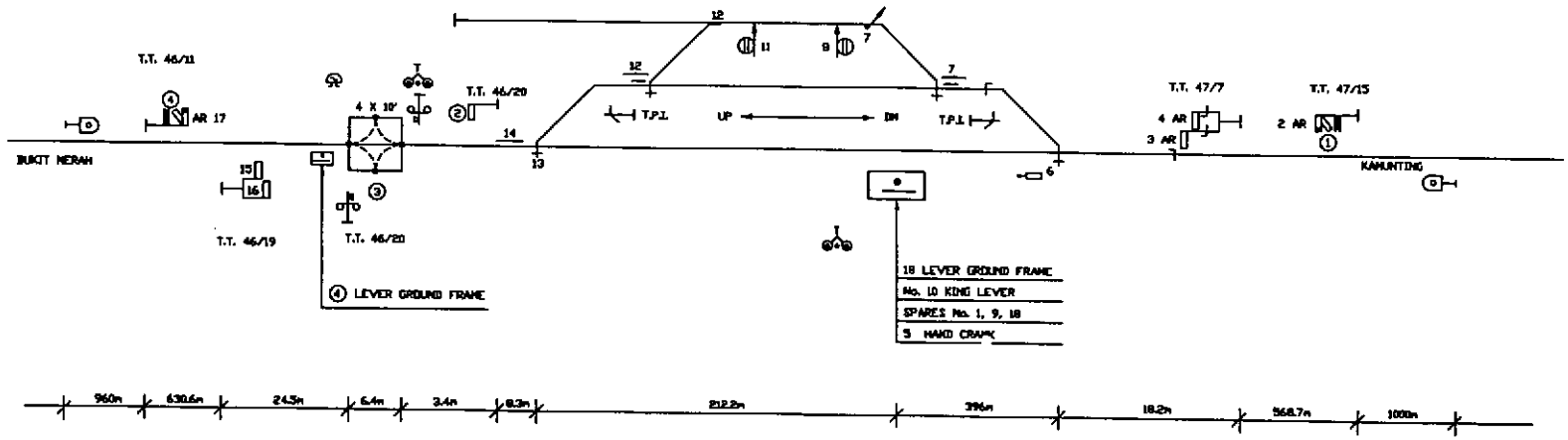
KTM / ICF KAISER	CAD FILE NO. BUKITMERAH.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 021	
	REV. 0	SHEET NO. 021

PONDOK TANJONG

(FULLY INTERLOCKED)

KM 76.8

(T.T. 47/1)



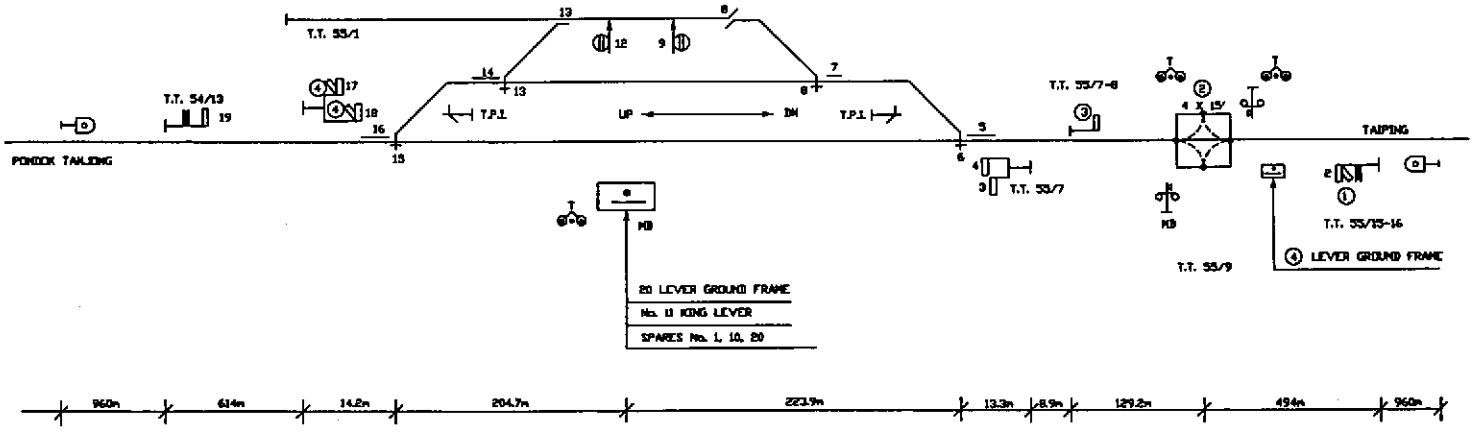
KTM / ICF KAISER	CAD FILE NO. PONDOKTANJONG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 022	
	REV. 0	SHEET NO. 022

KAMUNTING

(FULLY INTERLOCKED)

KM 89.8

(T.T. 55/4)



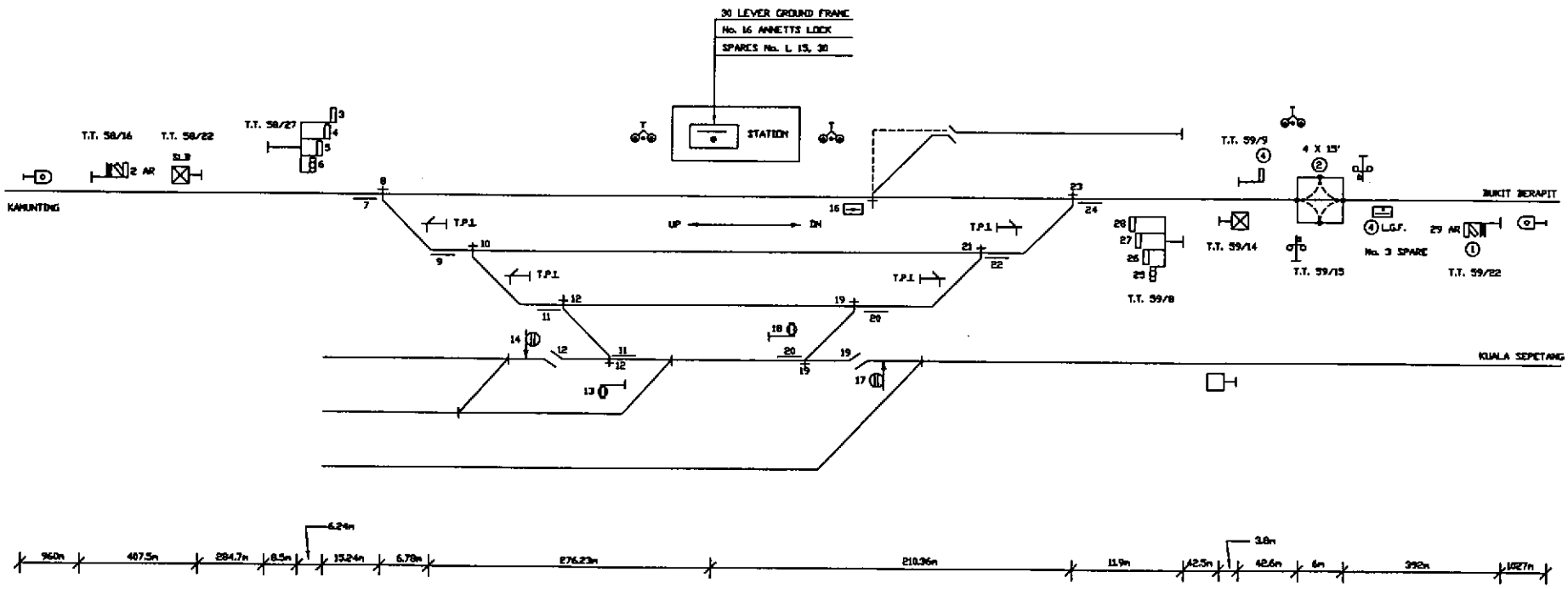
KTM / ICF KAISER	CAD FILE NO. KAMUNTING.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 023	
	REV. 0	SHEET NO. 023

TAIPING

(FULLY INTERLOCKED)

KM 95.3

(T.T. 59/5)



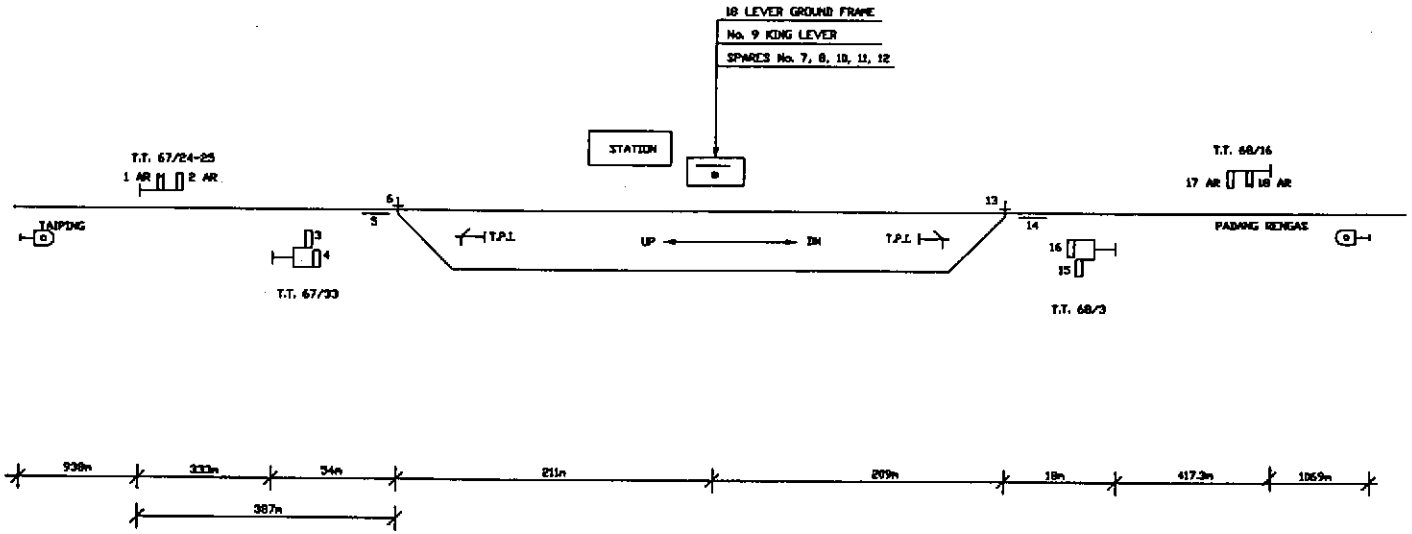
KTM / ICF KAISER	CAD FILE NO. TAIPING.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 024	
	REV. 0	SHEET NO. 024

BUKIT BERAPIT

(FULLY INTERLOCKED)

KM 109.5

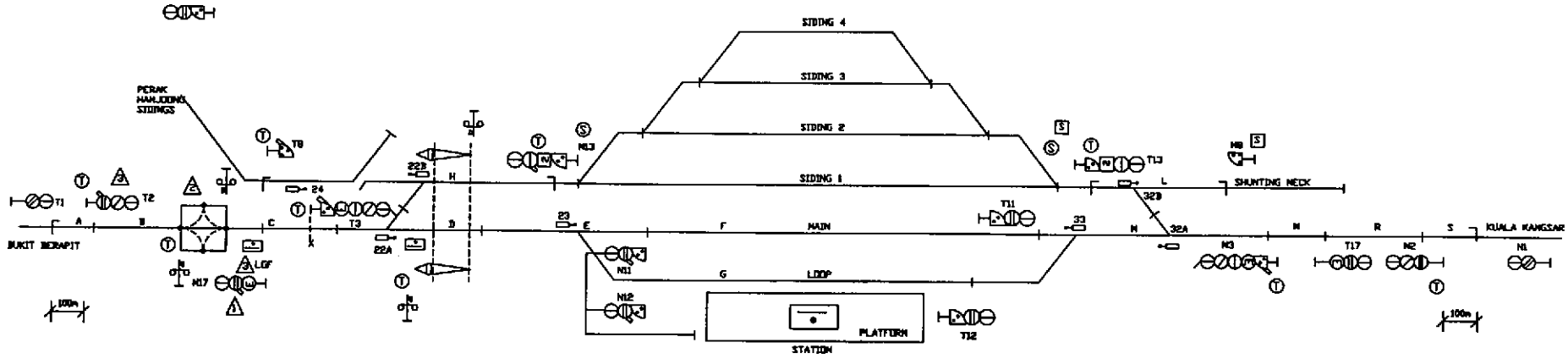
(T.T. 67/38)



◆ ICF KAISER	CAD FILE NO. BUKITBERAPIT.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 025	
	REV. 0	SHEET NO. 025

PADANG RENGAS

(RELAY INTERLOCKING)
KM 115.5
(T.T. 71/17)



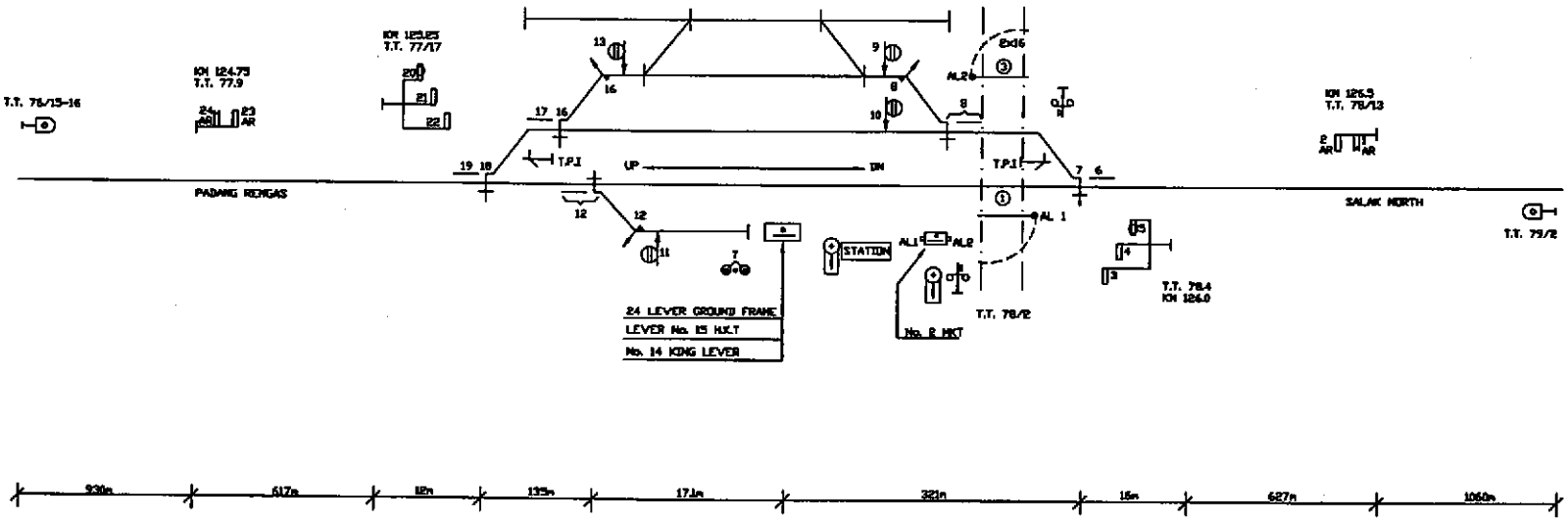
NOTE:

1. ALL DISTANCES ARE IN METERS.
2. TRACK LAYOUT ACCORDING TO DRG. H/3077
3. (S) SHUNTER'S ACCEPTANCE FOR SIGNALS T3, T8, N3 & N8 SHUNTING.
4. [S] LOCAL CONTROL
5. (T) SIGNAL POST TELEPHONE

KTM / ICF KAISER	CAD FILE NO. PADANGRENGAS.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 026	
	REV. 0	SHEET NO. 026

KUALA KANGSAR

(FULLY INTERLOCKED)
KM 125.7
(T.T. 77/22)



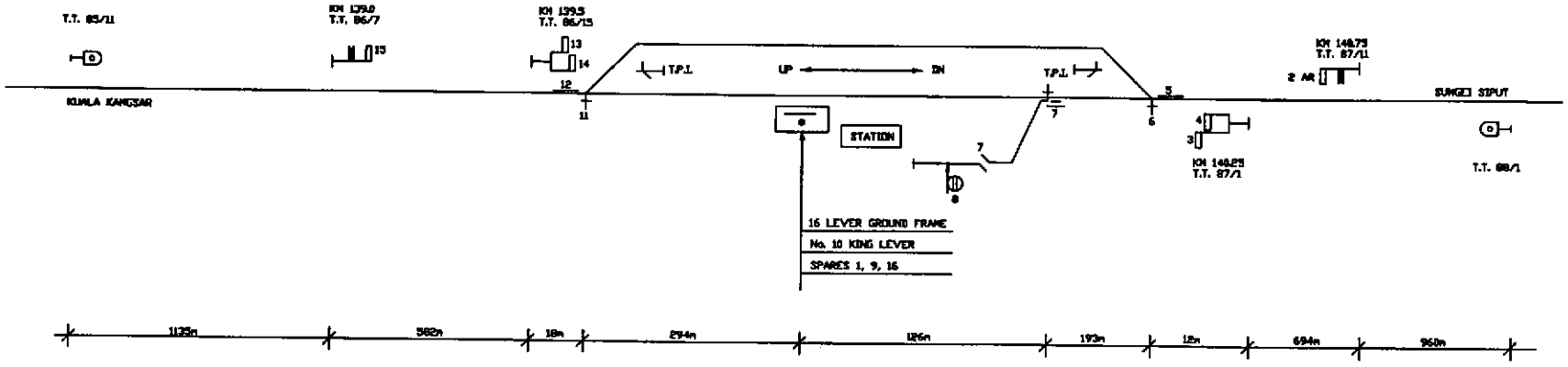
KTM / ICF KAISER	CAD FILE NO. KUALAKANGSAR.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 027	
	REV. 0	SHEET NO. 027

SALAK NORTH

(FULLY INTERLOCKED)

KM 139.9

(T.T. 86/15)



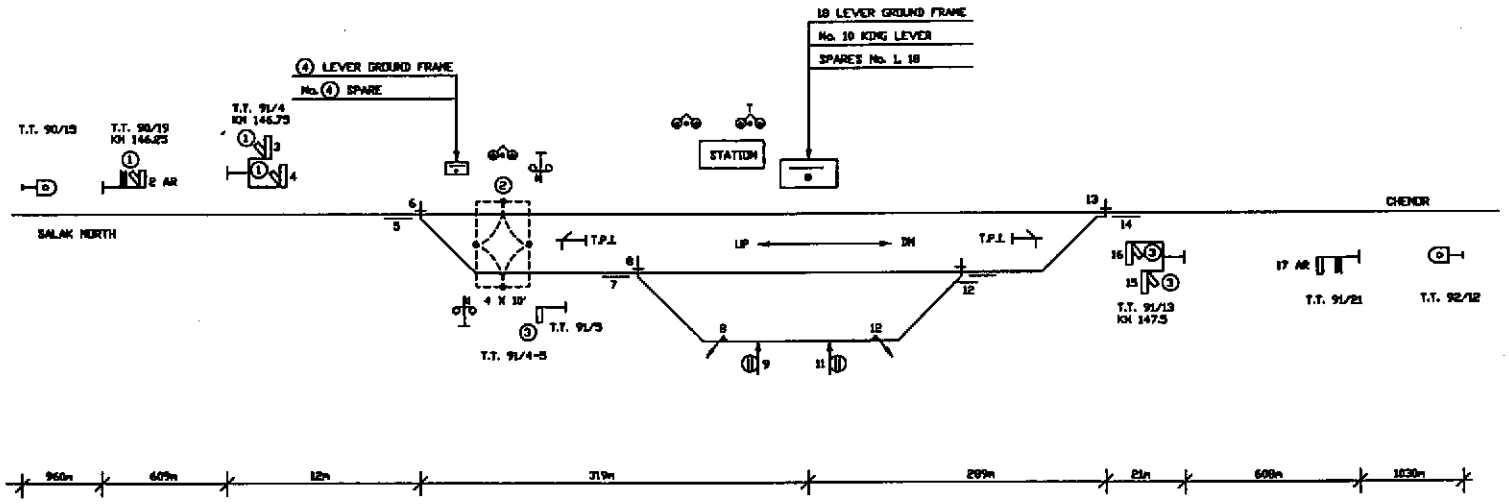
◆ ICF KAISER	CAD FILE NO. SALAKNORTH.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 028	
	REV. 0	SHEET NO. 028

SUNGEI SIPUT

(FULLY INTERLOCKED)

KM 147.2

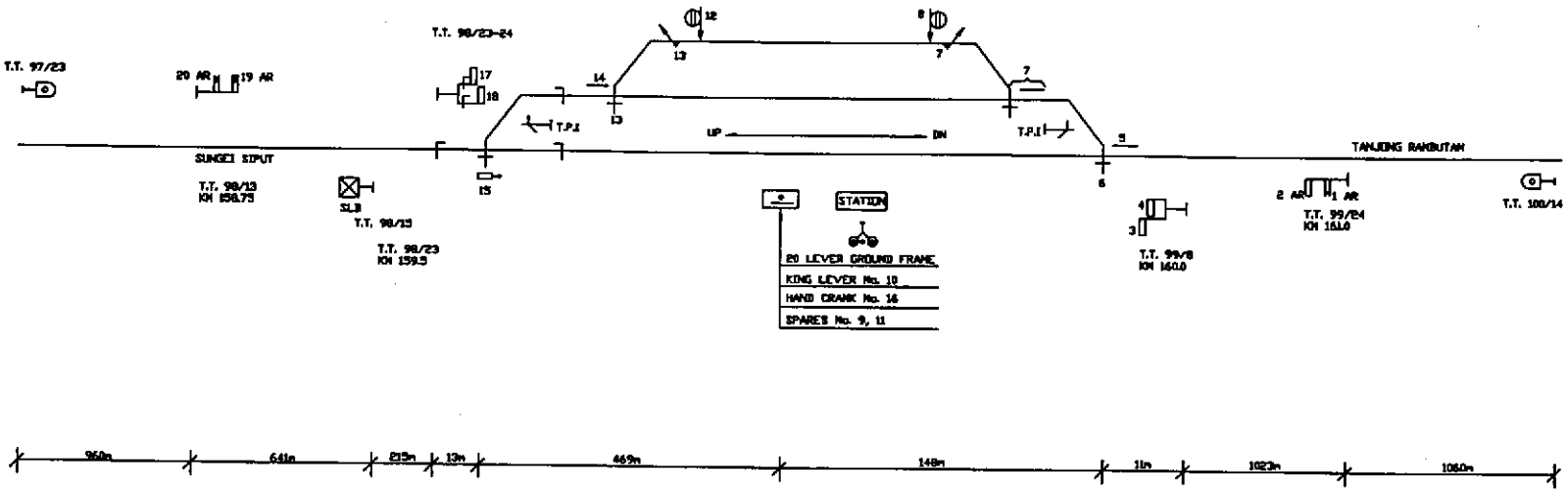
(T.T. 91/8)



KTM / ICF KAISER	CAD FILE NO. SUNGEISIPUT.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 029	
	REV. 0	SHEET NO. 029

CHEMOR

(FULLY INTERLOCKED)
KM 159.9
(T.T. 99/7)



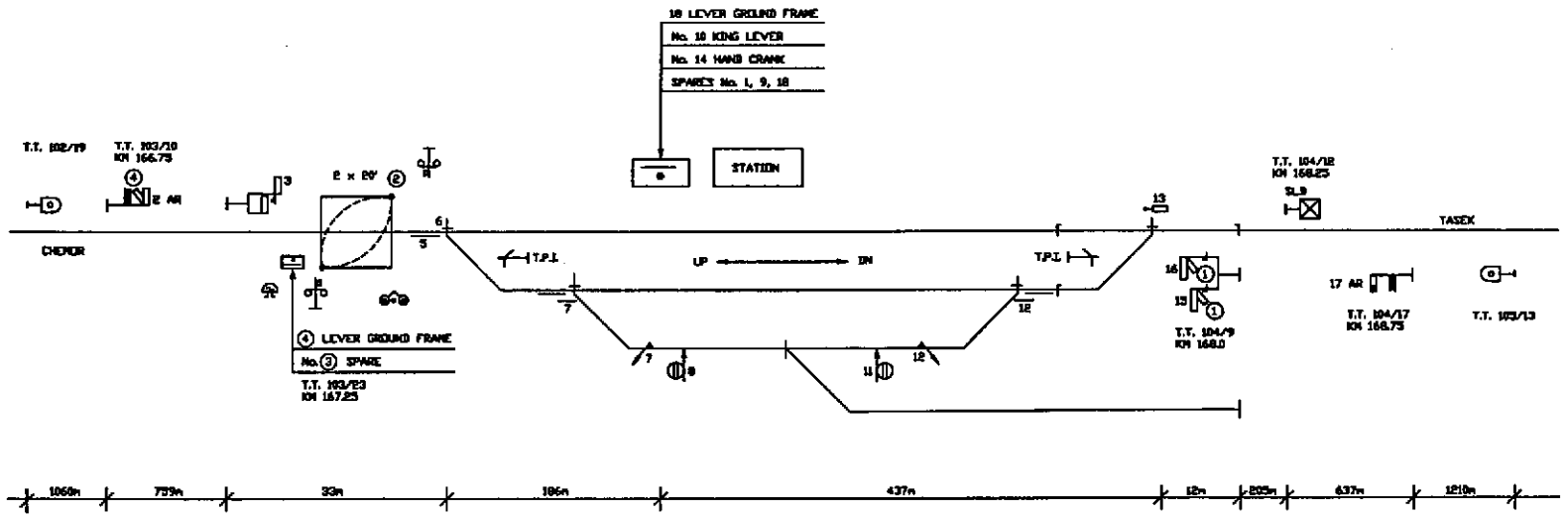
KTM / ICF KAISER	CAD FILE NO. CHEMOR.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 030	
	REV. 0	SHEET NO. 030

TANJONG RAMBUTAN

(FULLY INTERLOCKED)

KM 167.7

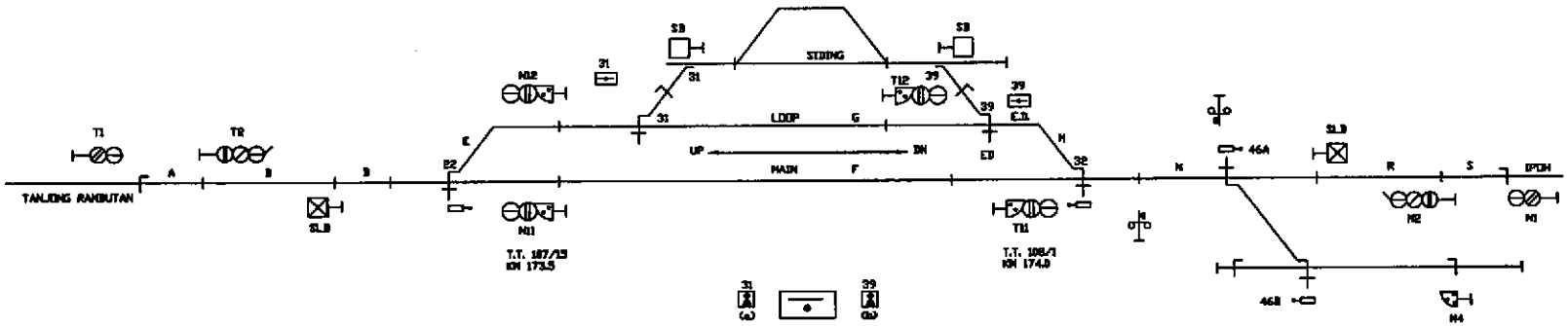
(T.T. 104/3)

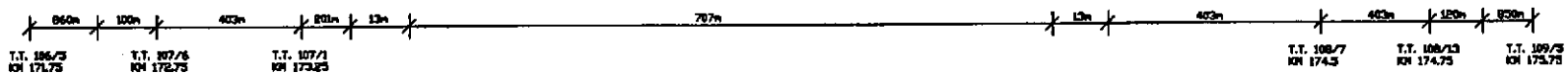


ICF KAISER	CAD FILE NO. TANJONGRAMBUTAN.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 031	
	REV. 0	SHEET NO. 031

TASEK

(RELAY INTERLOCKING)
KM 173.7
(T.T. 107/20)



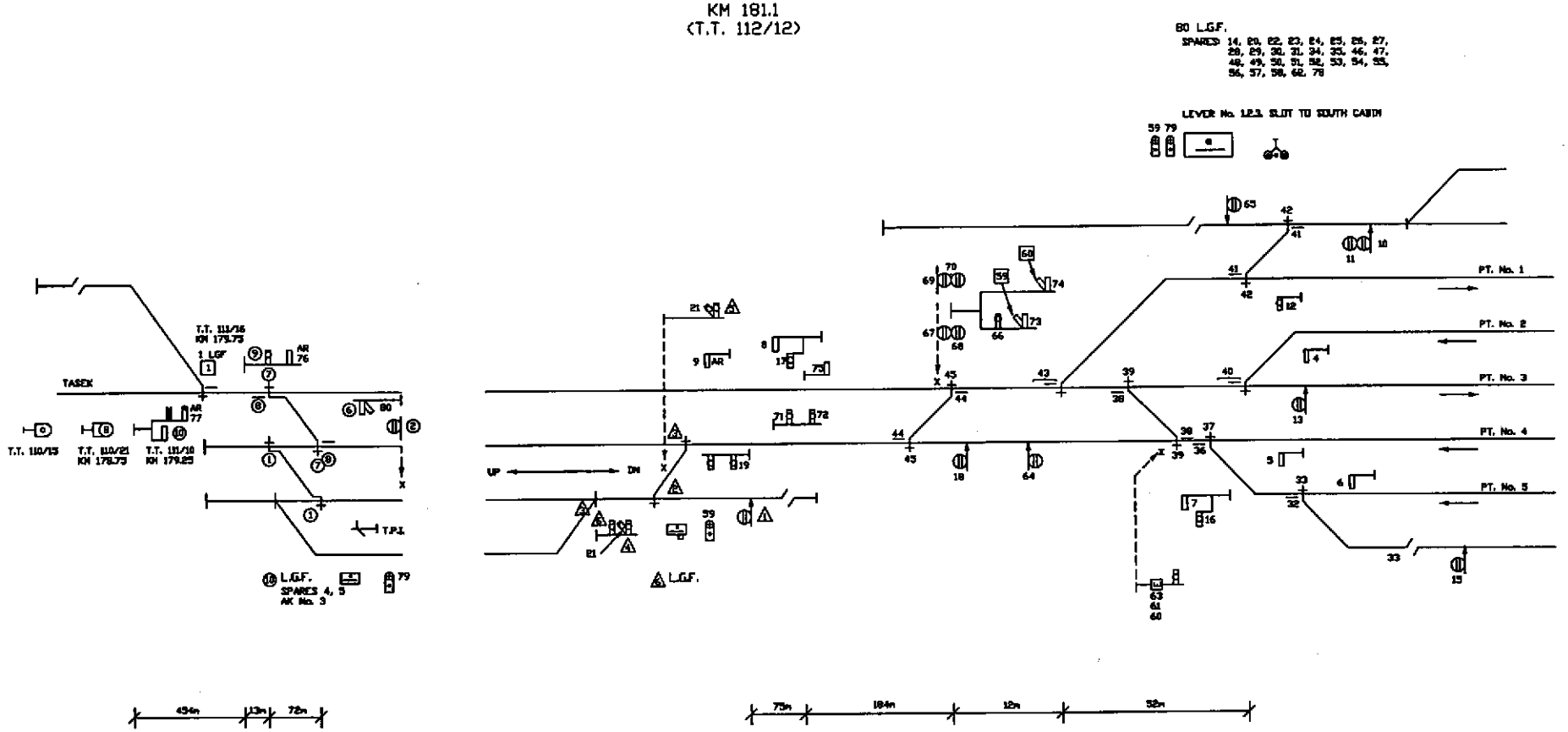


KTM
ICF KAISER

CAD FILE NO.	CAD DATE
TASEK.dwg	24/9/98
DRAWING NO.	
KE 032	
REV.	SHEET NO.
0	032

IPOH NORTH

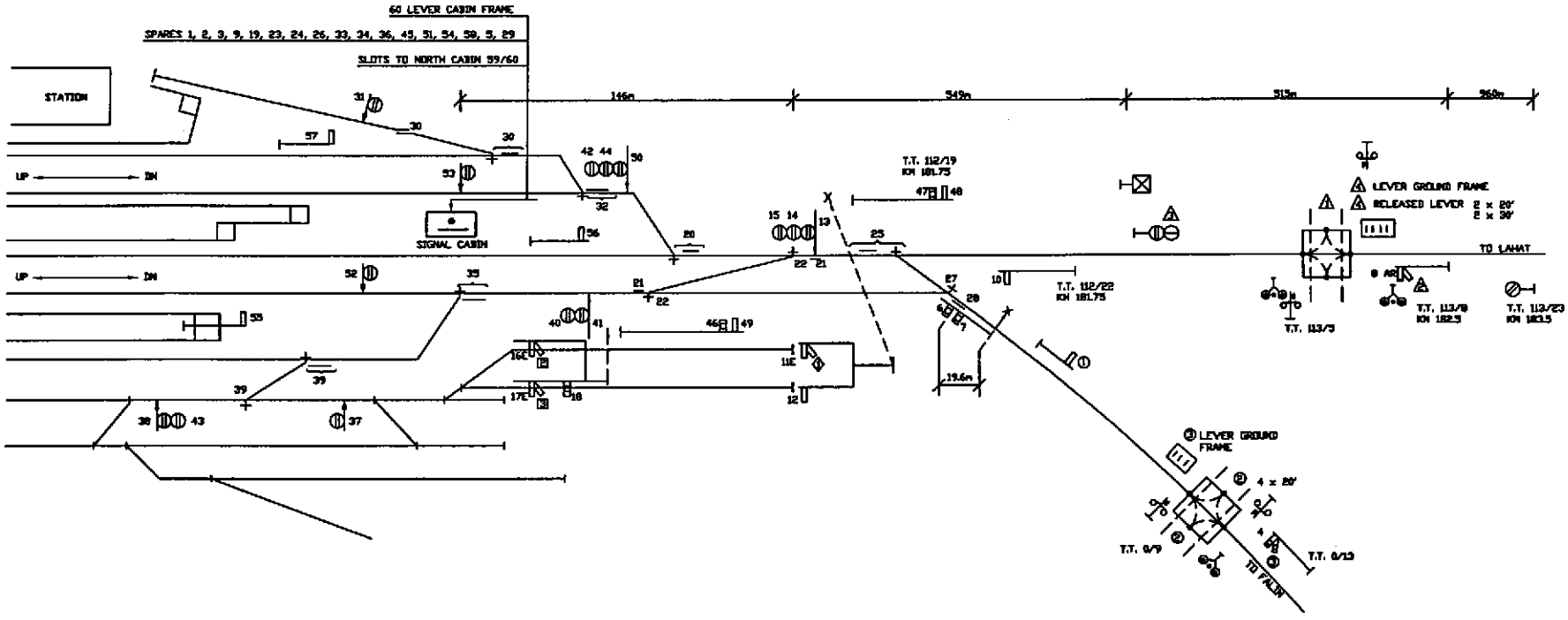
(FULLY INTERLOCKED)
KM 181.1
(T.T. 112/12)



KTM / ICF KAISER	CAD FILE NO. IPOHNORTH.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 033	
	REV. 0	SHEET NO. 033

IPOH SOUTH

(FULLY INTERLOCKED)
KM 181.1
(T.T. 112/12)



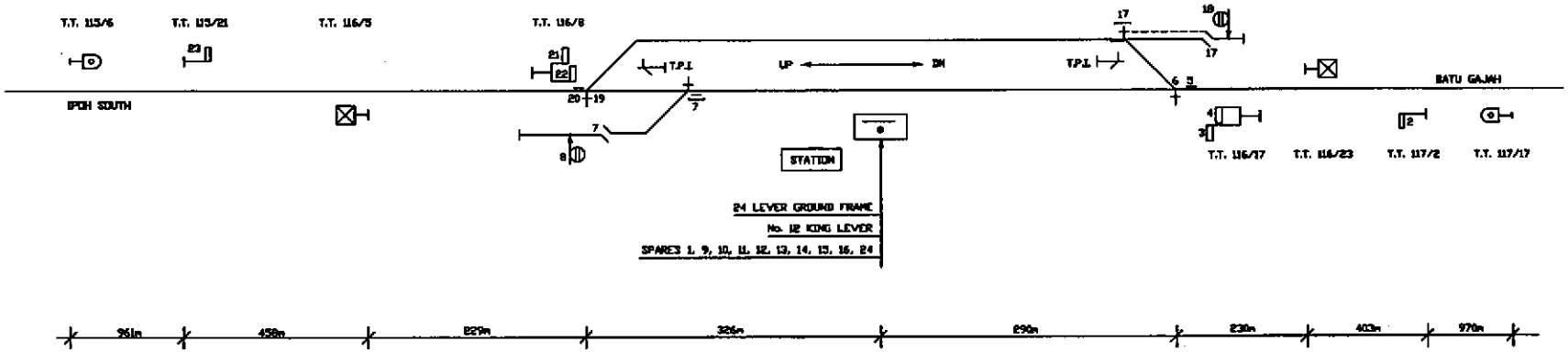
KTM / ICF KAISER	CAD FILE NO. IPOHSOUTH.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 034	
	REV. 0	SHEET NO. 034

LAHAT

(FULLY INTERLOCKED)

KM 187.6

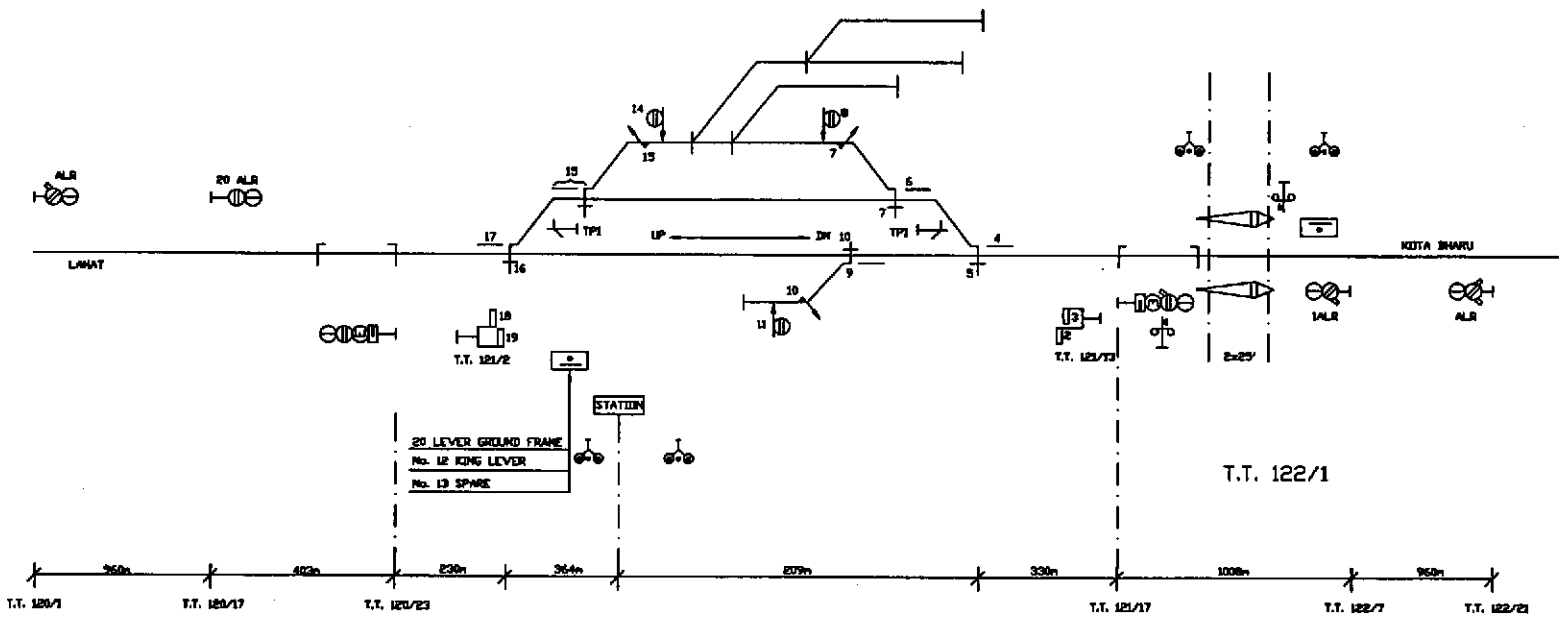
(T.T. 116/13)



KTM / ICF KAISER	CAD FILE NO. LAHAT.dwg	CAD DATE 24/9/88
	DRAWING NO. KE 035	
	REV. 0	SHEET NO. 035

BATU GAJAH

(FULLY INTERLOCKED)
KM 195.4
(T.T. 121/8)



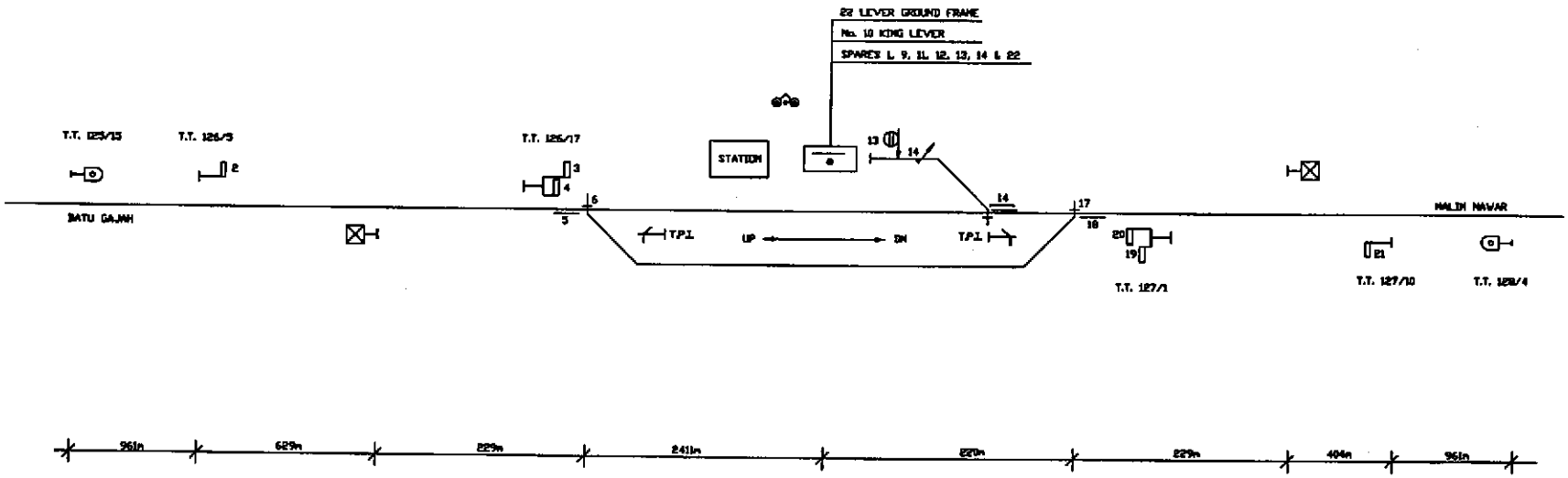
KTM / ICF KAISER	CAD FILE NO. BATUGAJAH.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 036	
	REV. 0	SHEET NO. 036

KOTA BAHRU

(FULLY INTERLOCKED)

KM 204.25

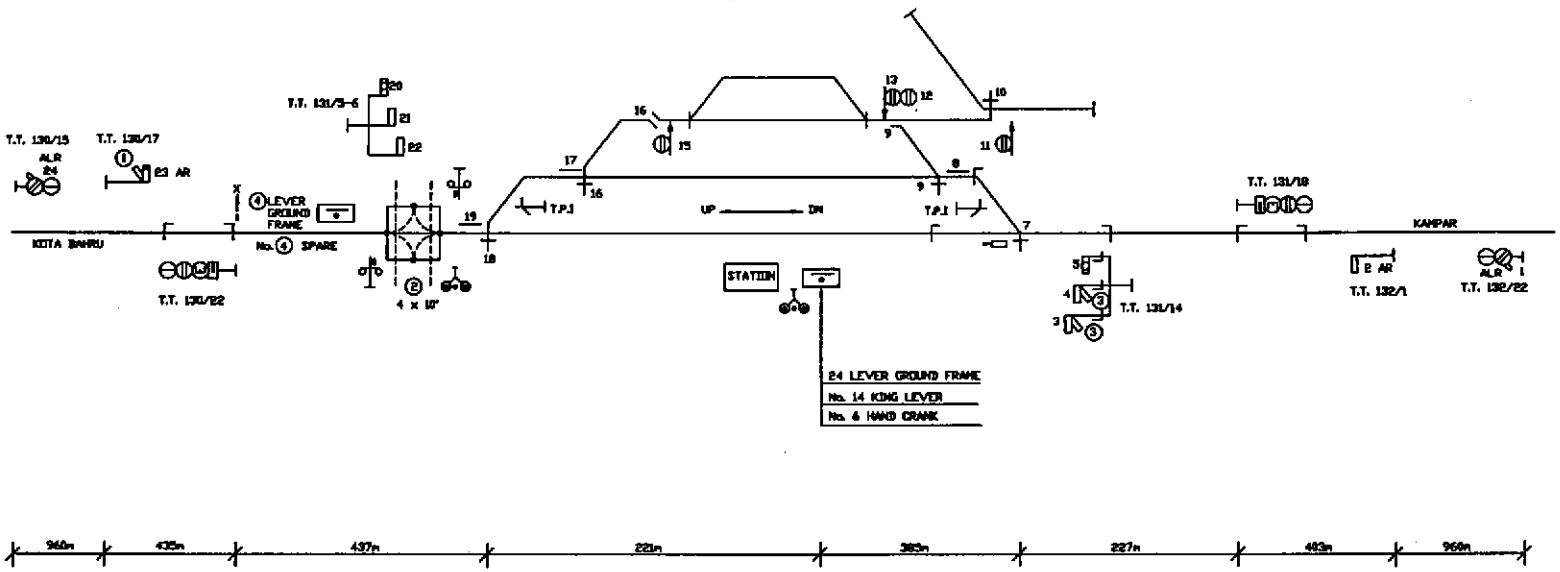
(T.T. 126/20)



KTM / ICF KAISER	CAD FILE NO. KOTABAHRU.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 037	
	REV. 0	SHEET NO. 037

MALIM NAWAR

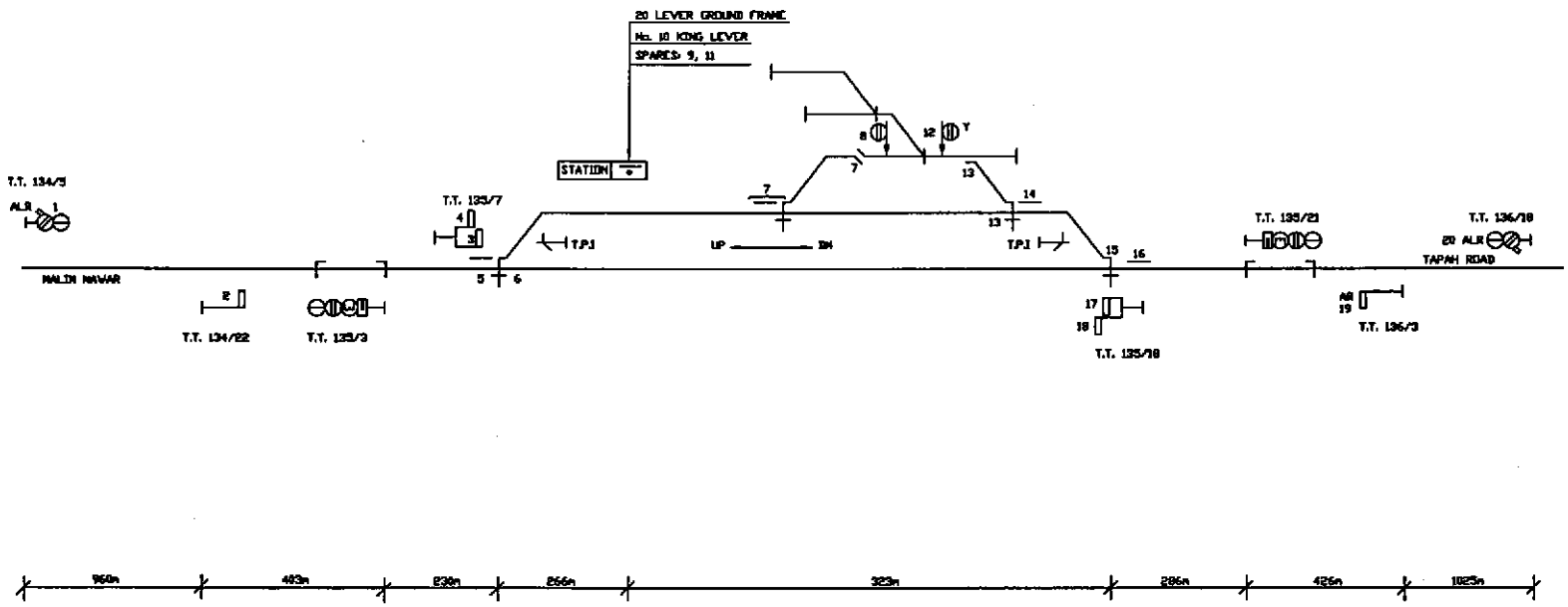
(FULLY INTERLOCKED)
KM 211.5
(T.T. 131/9)



KTM / ICF KAISER	CAD FILE NO. MALIMNAWAR.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 038	
	REV. 0	SHEET NO. 038

KAMPAR

(FULLY INTERLOCKED)
KM 218
(T.T. 135/12)



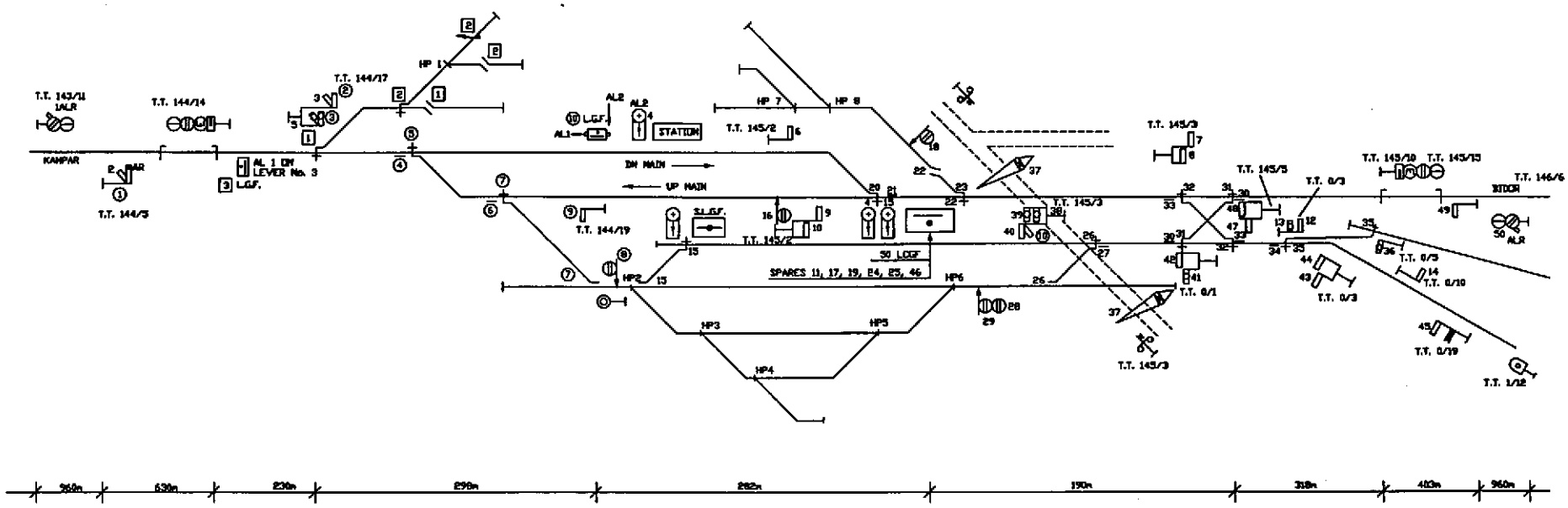
KTM / ICF KAISER	CAD FILE NO. KAMPAR.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 039	
	REV. 0	SHEET NO. 039

TAPAH ROAD

(FULLY INTERLOCKED)

KM 233.4

(T.T. 144/22)



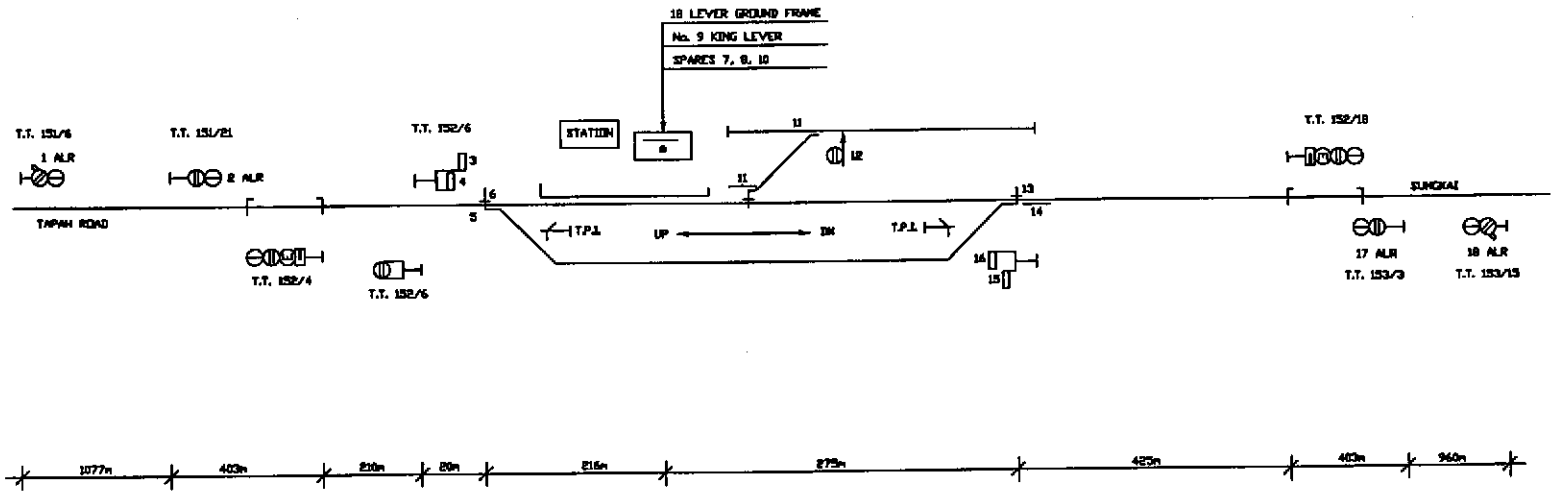
KTM / ICF KAISER	CAD FILE NO. TAPAHROAD.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 040	
	REV. 0	SHEET NO. 040

BIDOR

(FULLY INTERLOCKED)

KM 245.4

(T.T. 152/9)



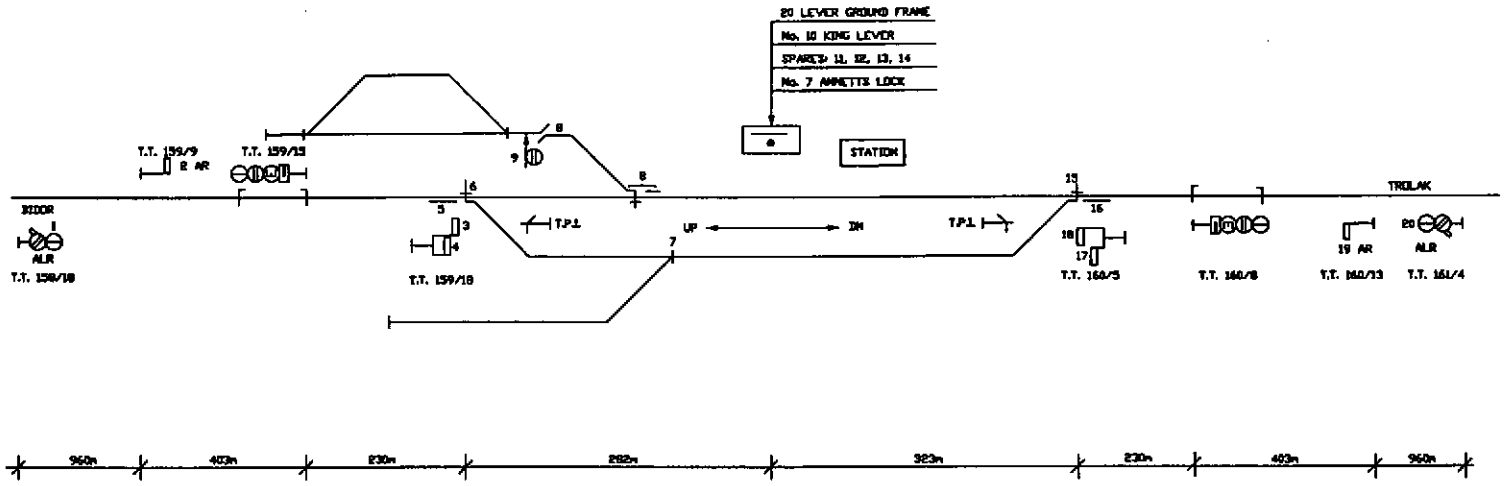
◆ ICF KAISER	CAD FILE NO. BIDOR.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 041	
	REV. 0	SHEET NO. 041

SUNGKAI

(FULLY INTERLOCKED)

KM 257.7

(T.T. 160/1)



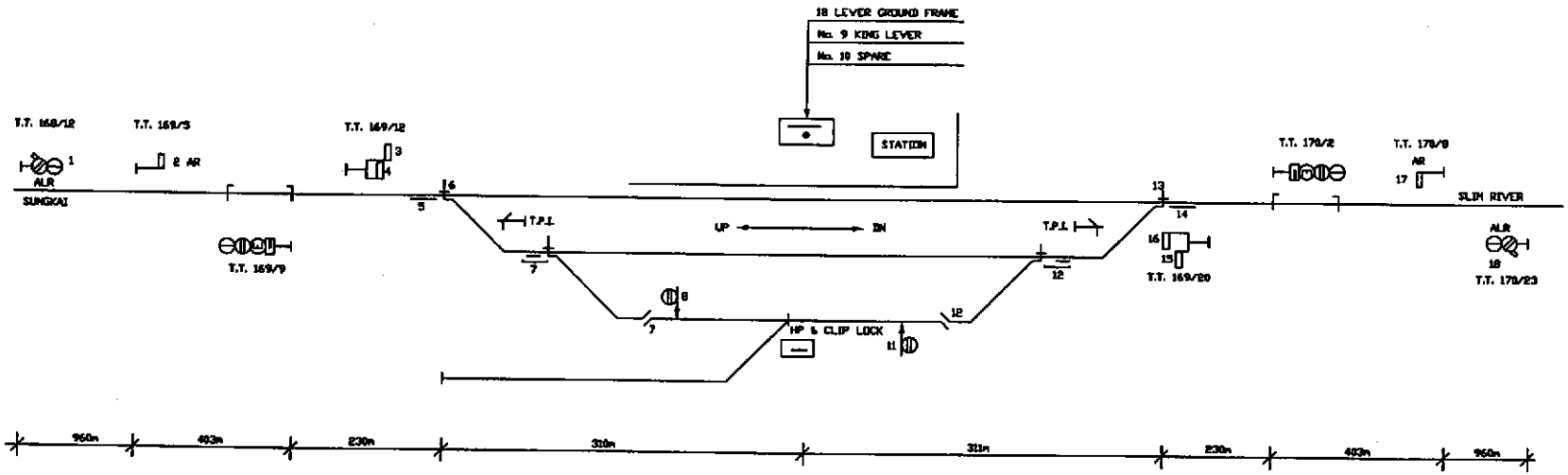
KTM / ICF KAISER	CAD FILE NO. SUNGKAI.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 042	
	REV. 0	SHEET NO. 042

TROLAK

(FULLY INTERLOCKED)

KM 273.5

(T.T. 169/17)



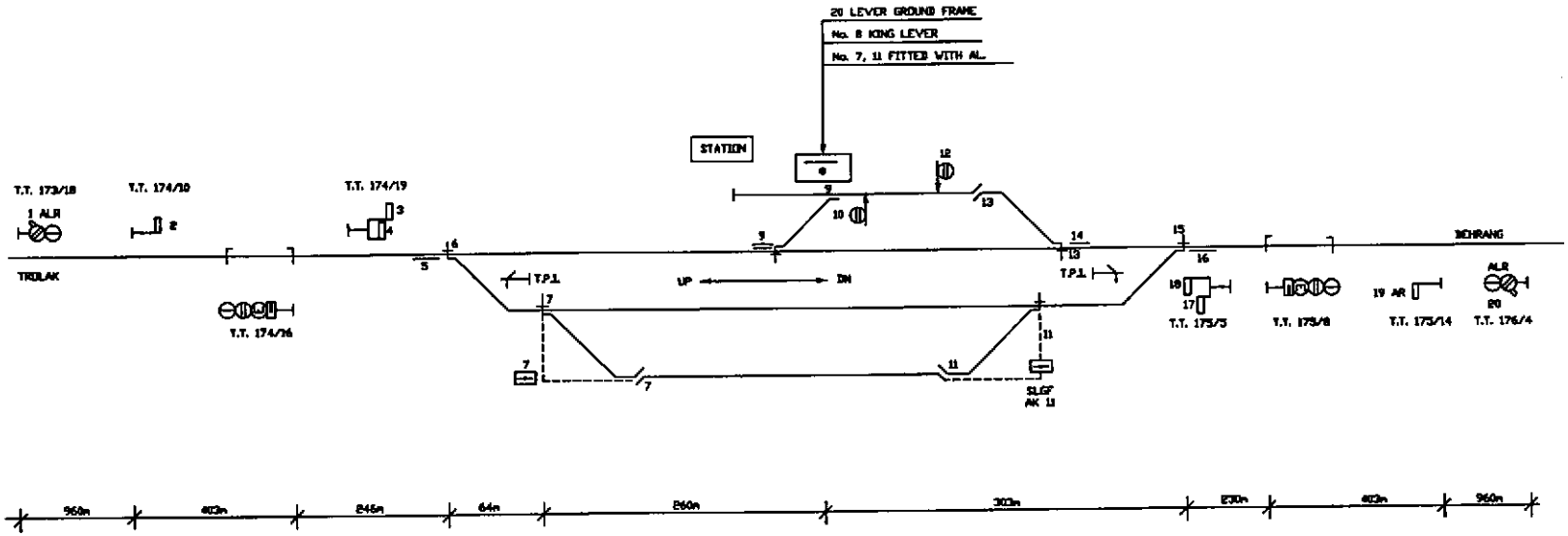
KTM / ICF KAISER	CAD FILE NO. TROLAK.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 043	
	REV. 0	SHEET NO. 043

SLIM RIVER

(FULLY INTERLOCKED)

KM 282.75

(T.T. 174/23)



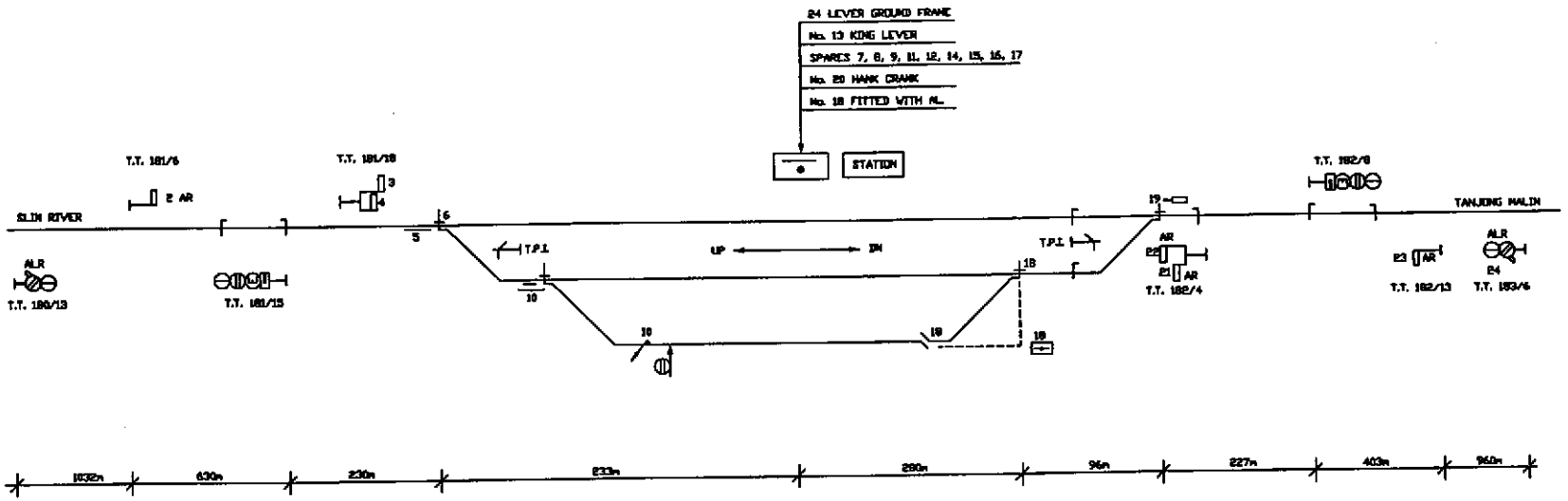
KTM / ICF KAISER	CAD FILE NO. SLIMRIVER.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 044	
	REV. 0	SHEET NO. 044

BEHRANG

(FULLY INTERLOCKED)

KM 293.0

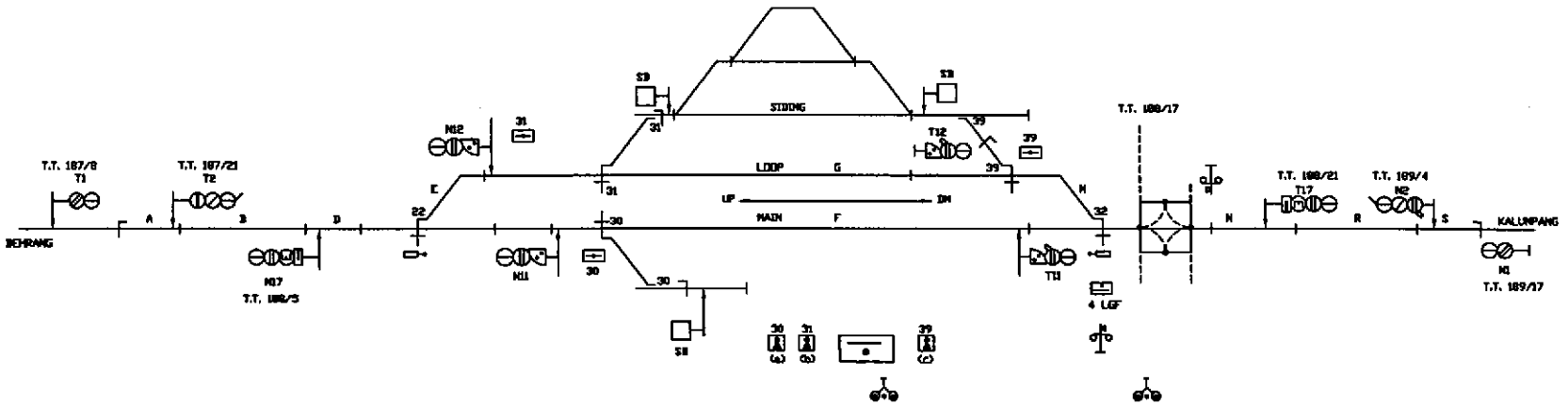
(T.T. 181/21)

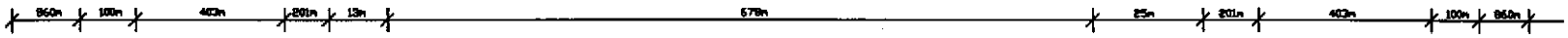


KTM / ICF KAISER	CAD FILE NO. BEHRANG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 045	
	REV. 0	SHEET NO. 045

TANJONG MALIM

(RELAY INTERLOCKING)
KM 303.75
(T.T. 188/15)





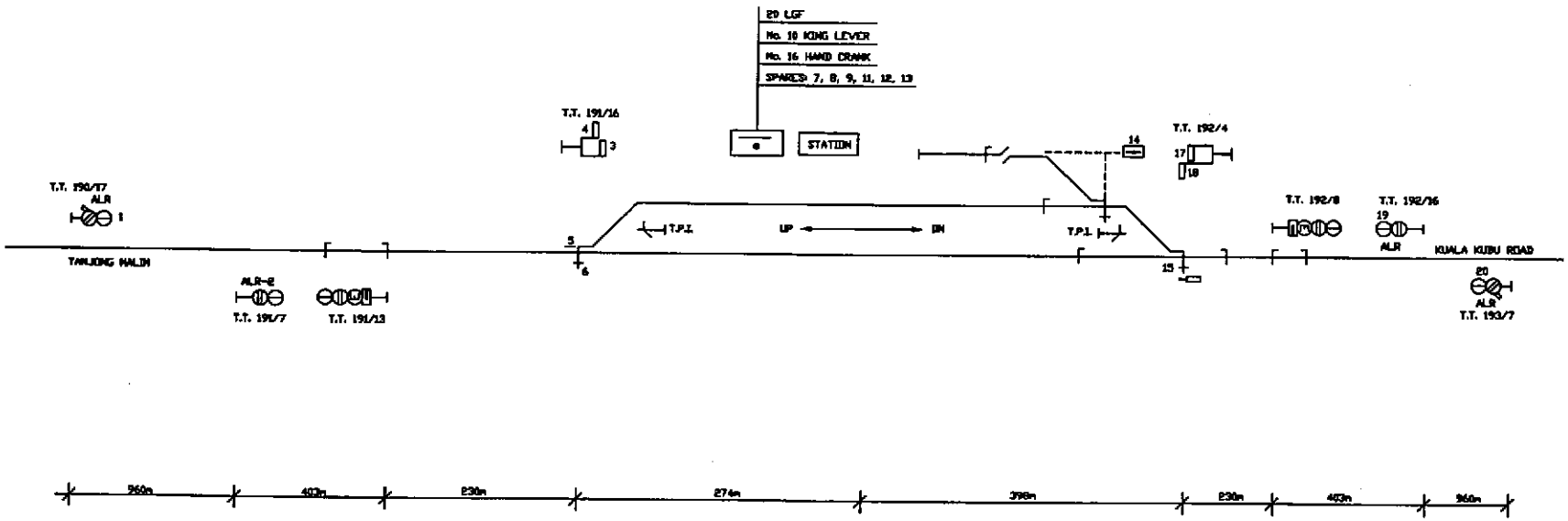
◆ ICF KAISER	CAD FILE NO. TANJONGMALIM.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 046	
	REV. 0	SHEET NO. 046

KALUMPANG

(FULLY INTERLOCKED)

KM 309

(T.T. 191/20)



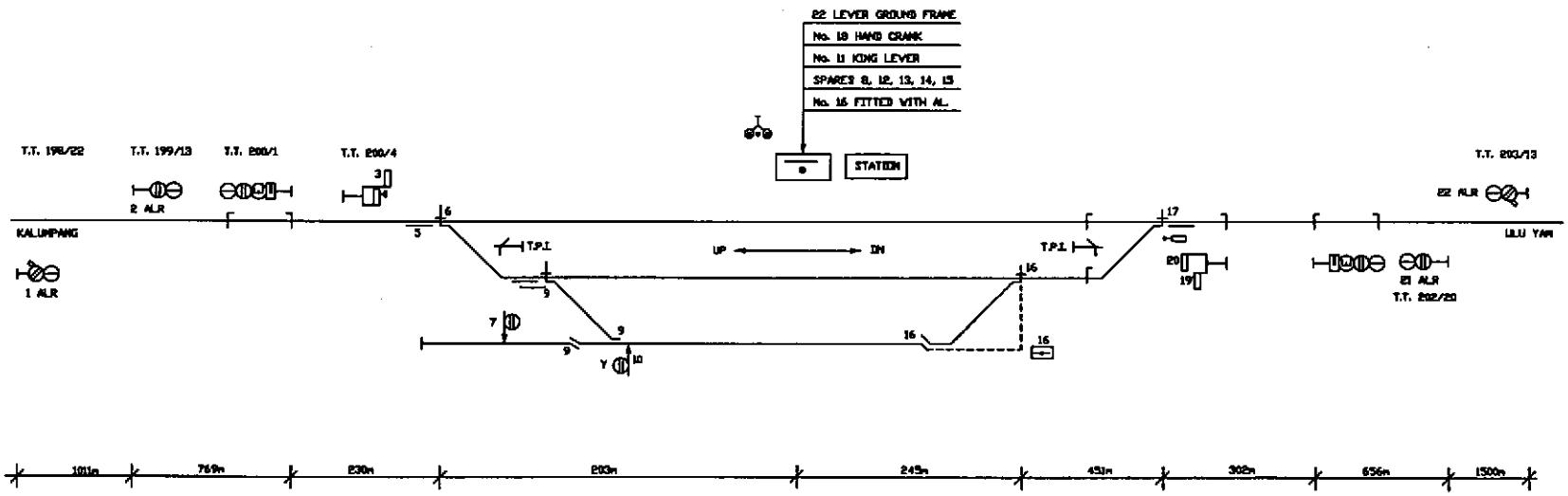
KTM / ICF KAISER	CAD FILE NO. KALUMPANG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 047	
	REV. 0	SHEET NO. 047

KUALA KUBU ROAD

(FULLY INTERLOCKED)

KM 322.5

(T.T. 202/1)



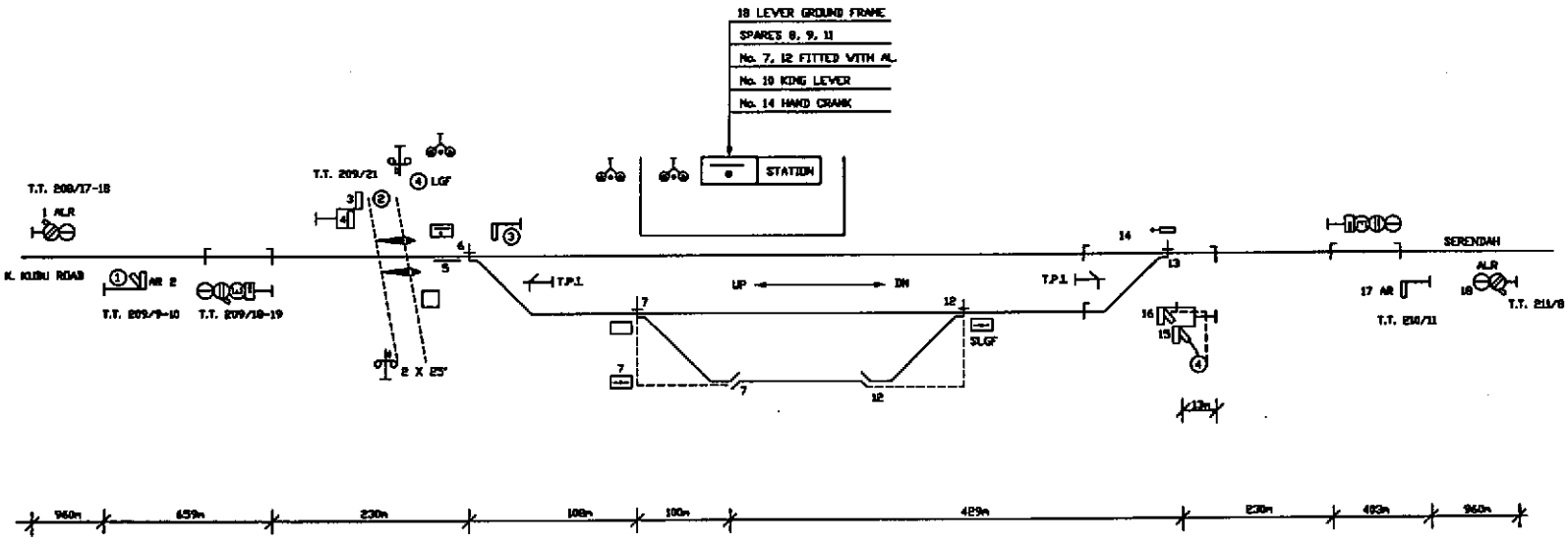
◆ ICF KAISER	CAD FILE NO. KUALAKUBU.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 048	
	REV. 0	SHEET NO. 048

ULU YAM

(FULLY INTERLOCKED)

KM 335.5

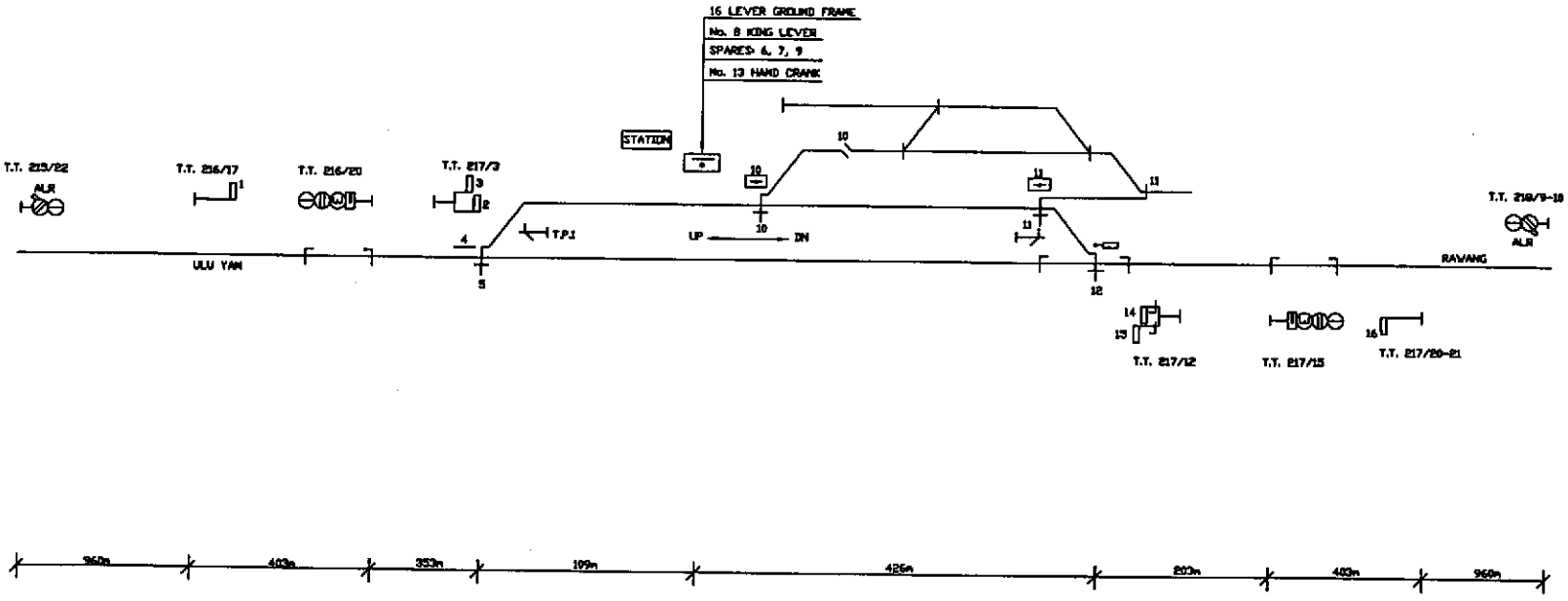
(T.T. 210/2)



KTM / ICF KAISER	CAD FILE NO. ULUYAM.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 049	
	REV. 0	SHEET NO. 049

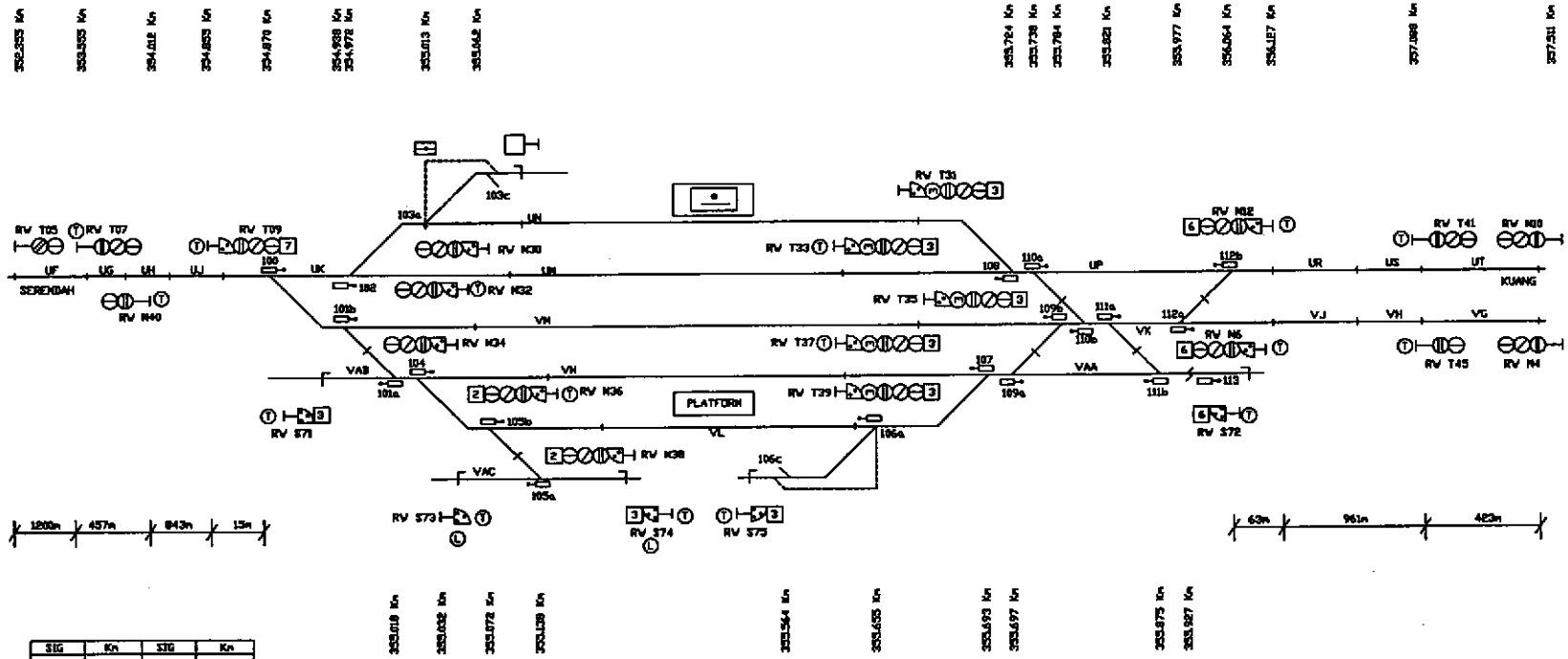
SERENDAH

(FULLY INTERLOCKED)
KM 347.1
(T.T. 217/6)



◆ ICF KAISER	CAD FILE NO. SERENDAH.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 050	
	REV. 0	SHEET NO. 050

RAWANG
(RELAY INTERLOCKING)
355.580 KM

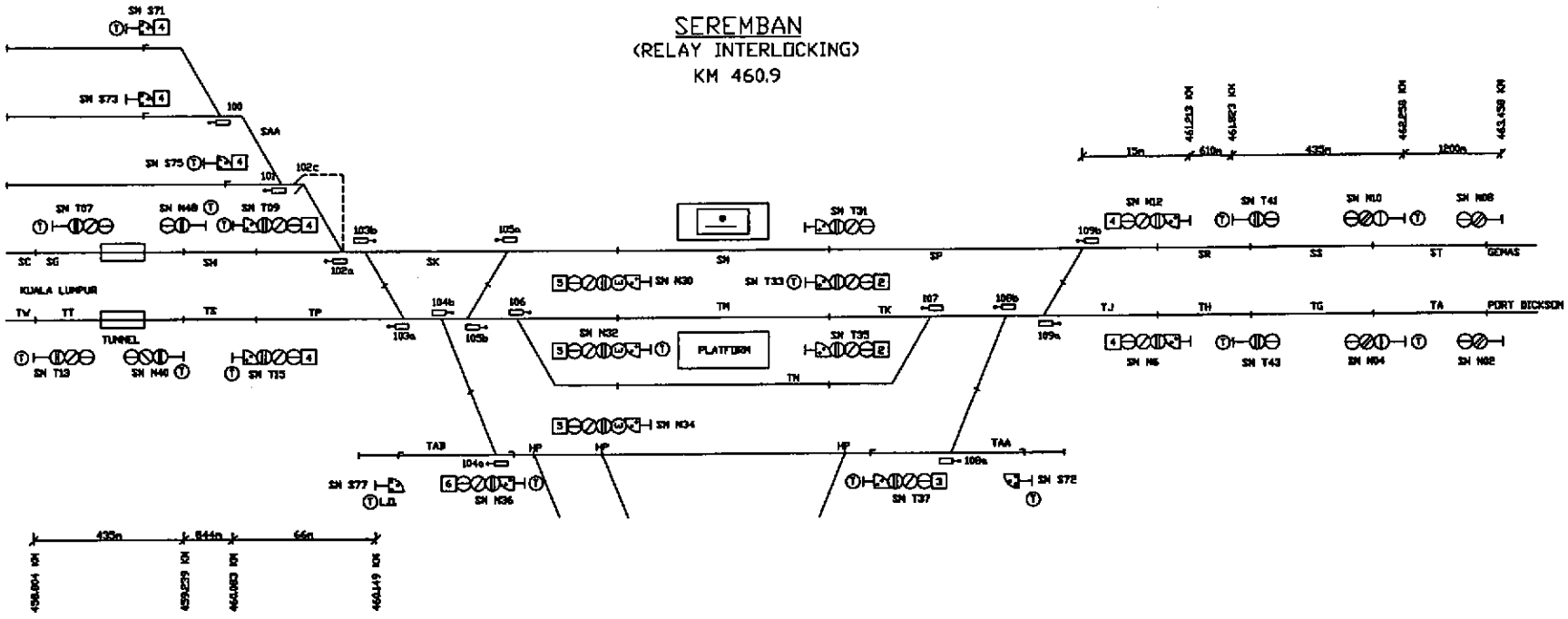


STG	Km	STG	Km
RV T31	355.663	RV N30	355.663
RV T33	355.636	RV N32	355.638
RV T35	355.663	RV N34	355.018
RV T37	355.636	RV N36	355.102
RV T39	355.593	RV N38	355.147
RV S71	354.953	RV S72	355.938
RV S73	355.067	RV S74	355.147
RV S75	355.560		

Ⓛ - LOCAL OPERATION

KTM / ICF KAISER	CAD FILE NO. RAWANG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 051	
	REV. 0	SHEET NO. 051

SEREMBAN
(RELAY INTERLOCKING)
KM 460.9



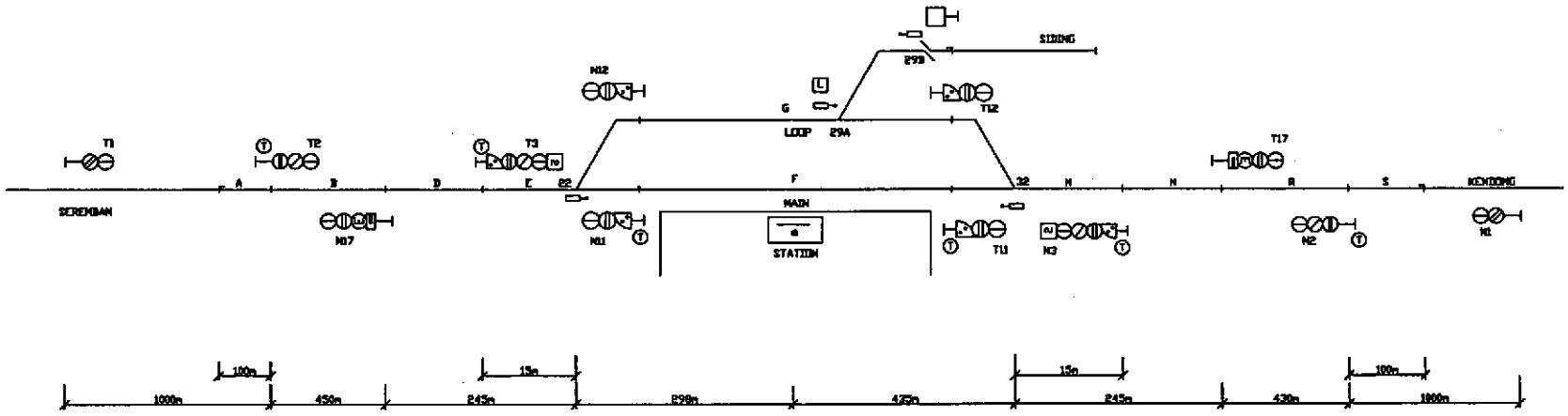
STG NO	KM	STG NO	KM
N 30	460.430	T 31	461.830
N 32	460.532	T 33	460.987
N 34	460.510	T 35	460.987
N 36	460.361	T 37	460.017
S 72	461.087	S 71	460.035
S 77	460.290	S 73	460.035
		S 75	460.055

KTM

ICF KAISER

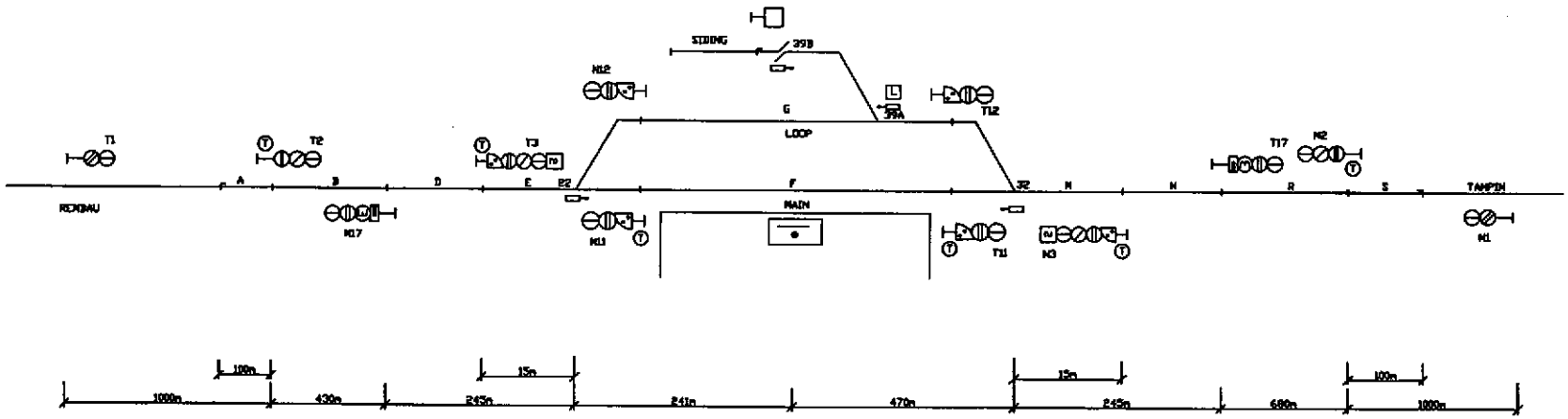
CAD FILE NO.	CAD DATE
SEREMBAN.dwg	24/9/98
DRAWING NO.	
KE 052	
REV.	SHEET NO.
0	052

REMBAU
(RELAY INTERLOCKING)
KM 484.75



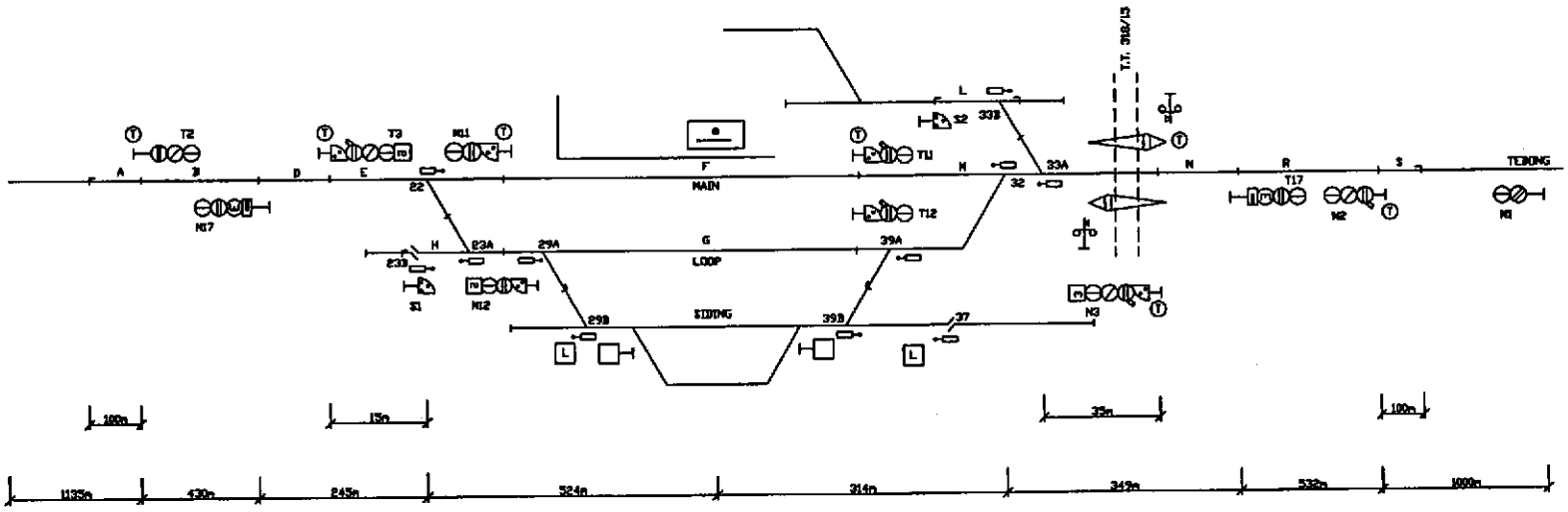
KTM / ICF KAISER	CAD FILE NO. REMBAU.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 053	
	REV. 0	SHEET NO. 053

KENDONG
(RELAY INTERLOCKING)
KM 497.25
(T.T. 311/6)



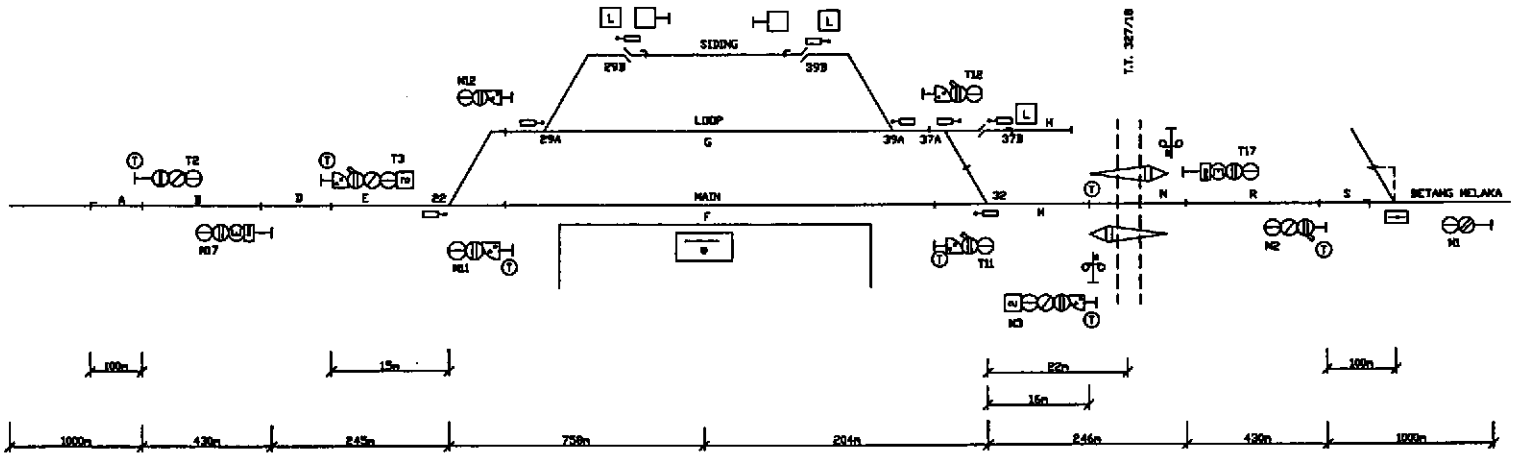
KTM / ICF KAISER	CAD FILE NO. KENDONG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 054	
	REV. 0	SHEET NO. 054

TAMPIN
(RELAY INTERLOCKING)
KM 508.75



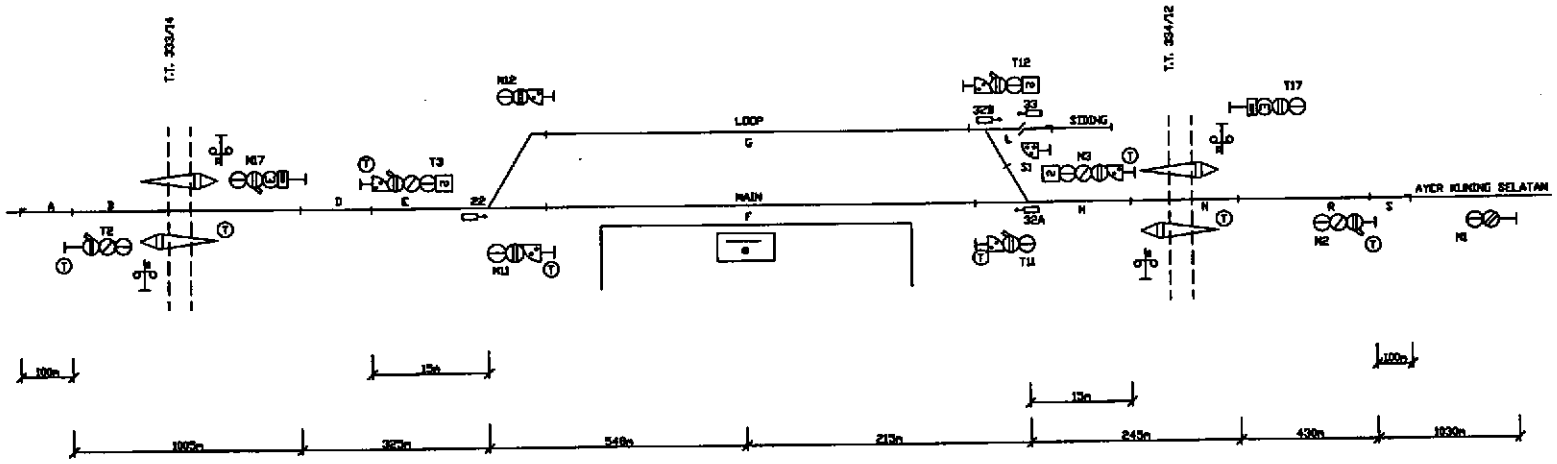
KTM / ◆ ICF KAISER	CAD FILE NO. TAMPIN.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 055	
	REV. 0	SHEET NO. 055

TEBONG
(RELAY INTERLOCKING)
KM 524.5



KTM / ICF KAISER	CAD FILE NO. TEBONG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 056	
	REV. 0	SHEET NO. 056

BATANG MELAKA
(RELAY INTERLOCKING)
KM 535.5

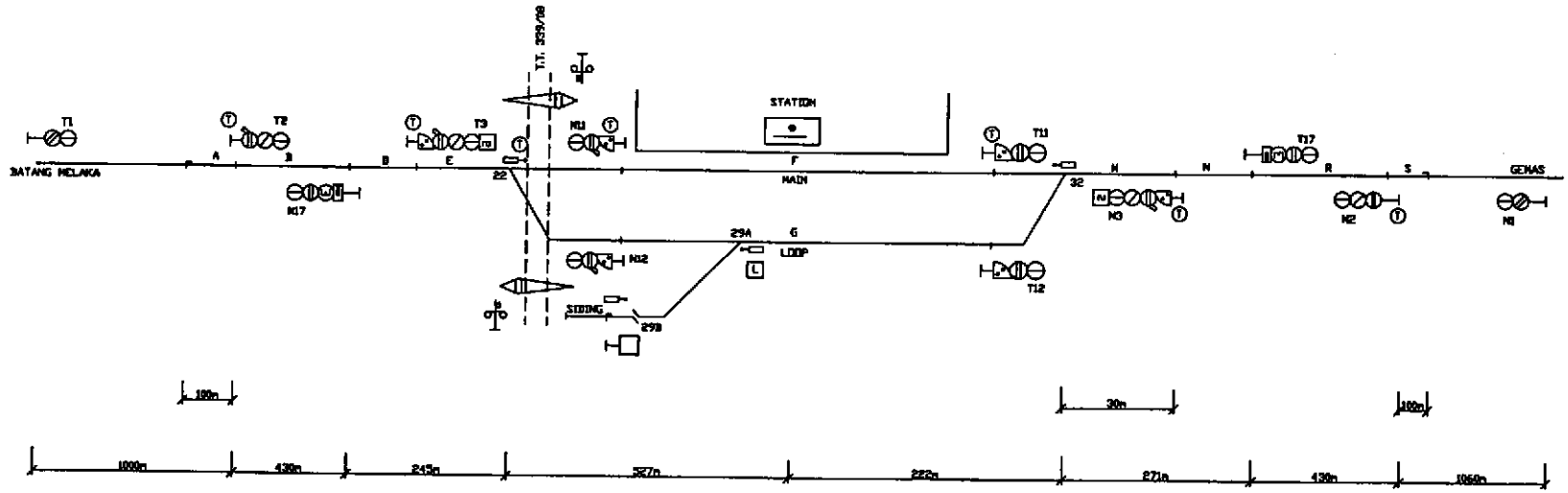


KTM / ICF KAISER	CAD FILE NO. BATANG_MELAKA.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 057	
	REV. 0	SHEET NO. 057

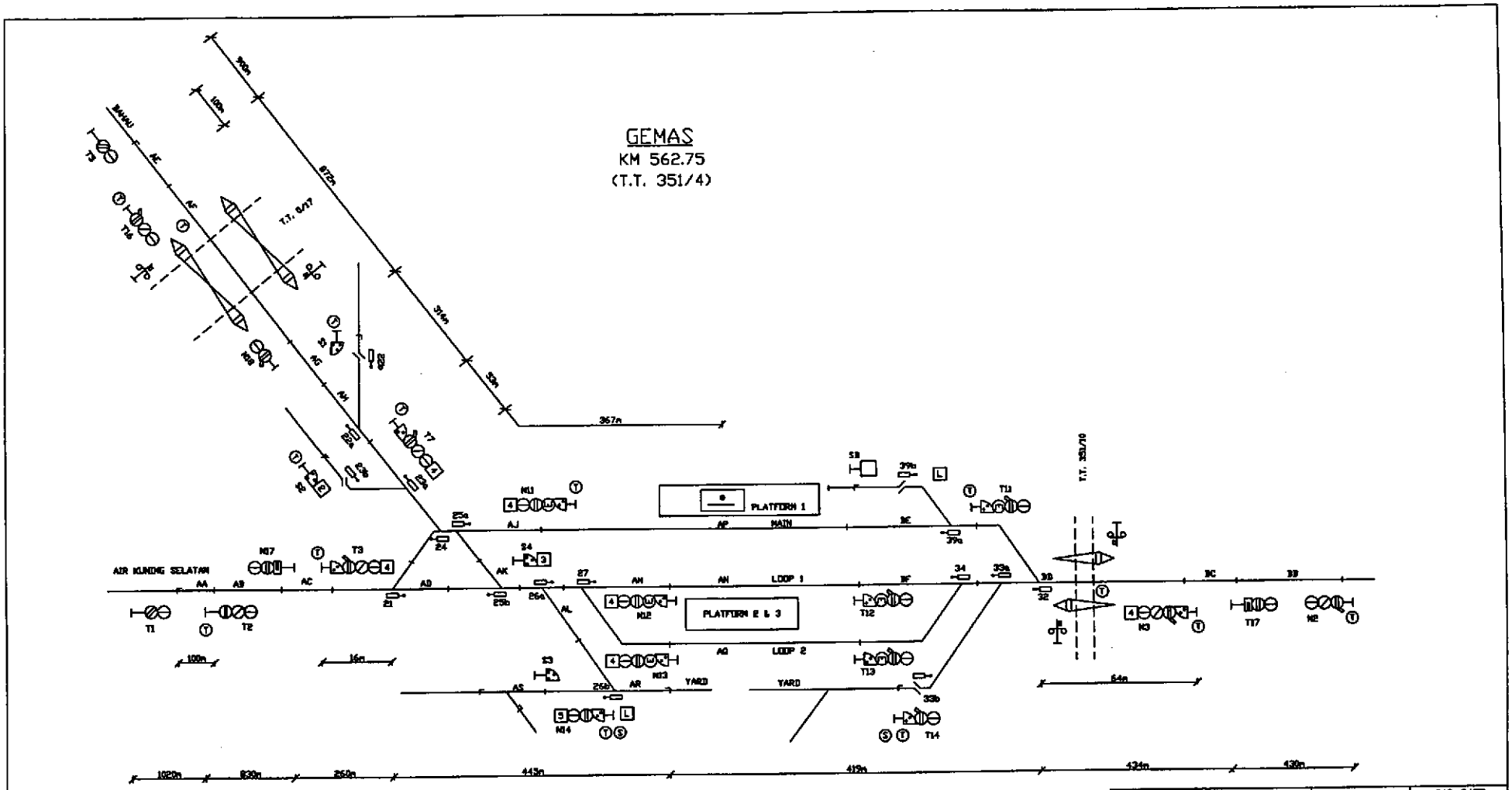
AIR KUNING SELATAN

(RELAY INTERLOCKING)

KM 544.0

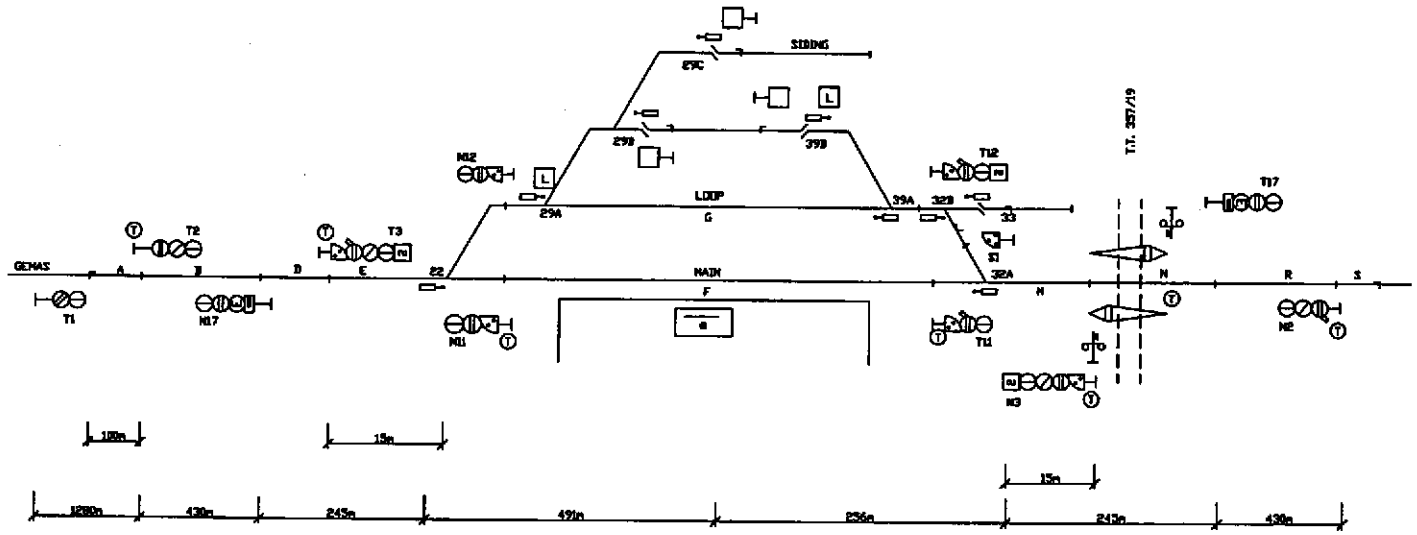


KTM / ICF KAISER	CAD FILE NO. AIR_KUNING_SELATAN.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 058	
	REV. 0	SHEET NO. 058



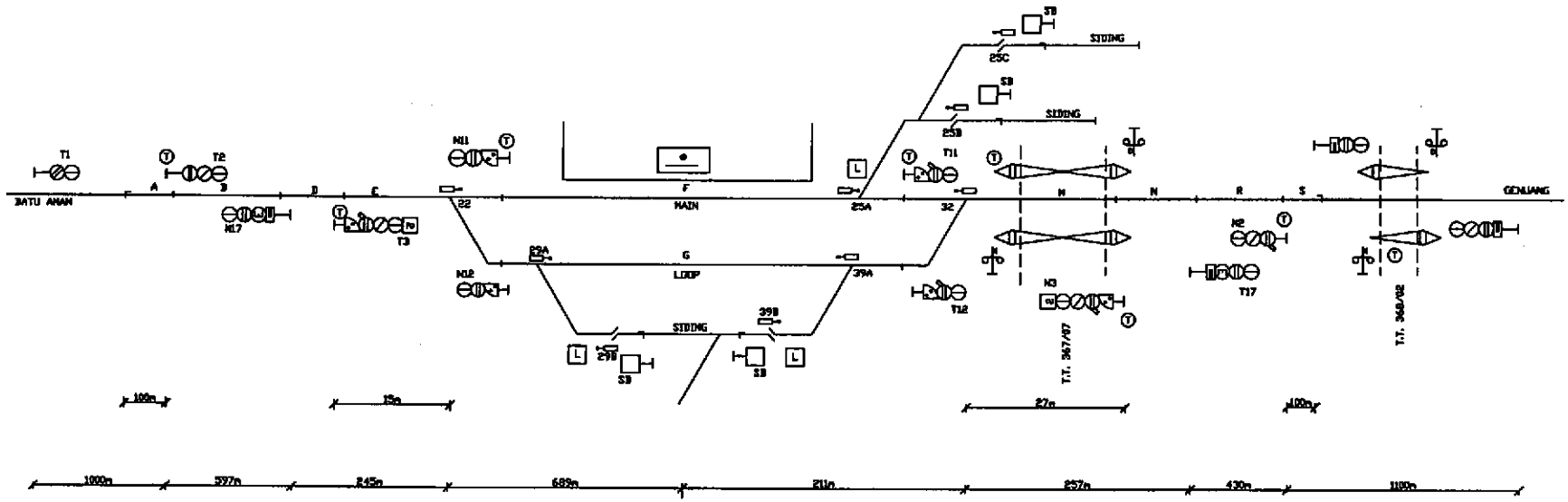
KTM / ICF KAISER	CAD FILE NO. GEMAS	CAD DATE 24/9/98
	DRAWING NO. KE 059	
	REV. 0	SHEET NO. 059

BATU ANAM
RELAY INTERLOCKING
KM 572.75
(T.T. 357/12)



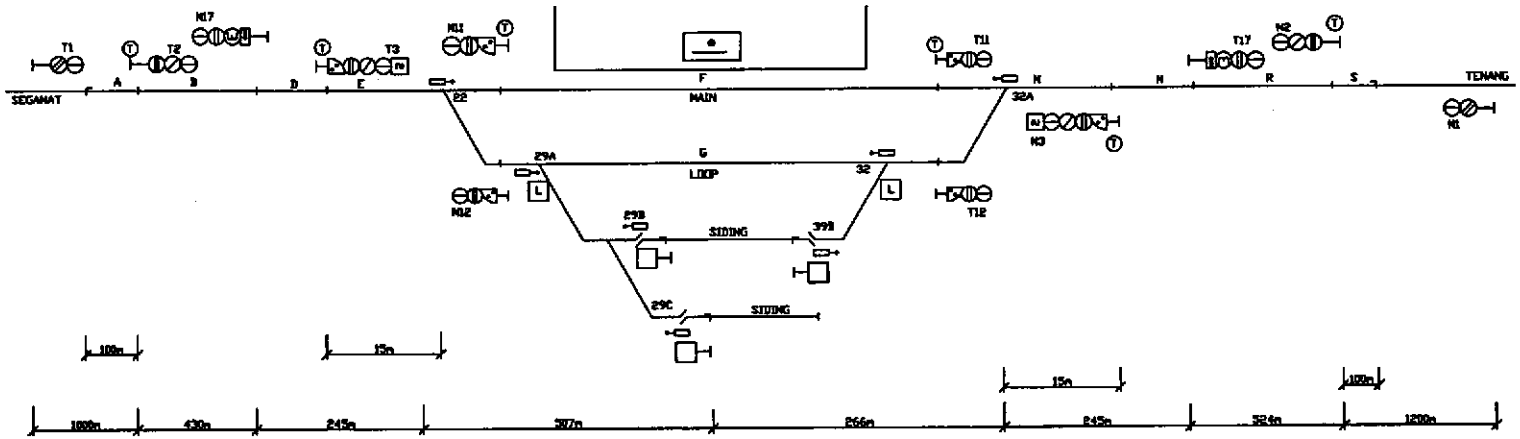
KTM / ICF KAISER	CAD FILE NO. BATU ANAM.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 060	
	REV. 0	SHEET NO. 060

SEGAMAT
(RELAY INTERLOCKING)
KM 588.25
(T.T. 367/3)



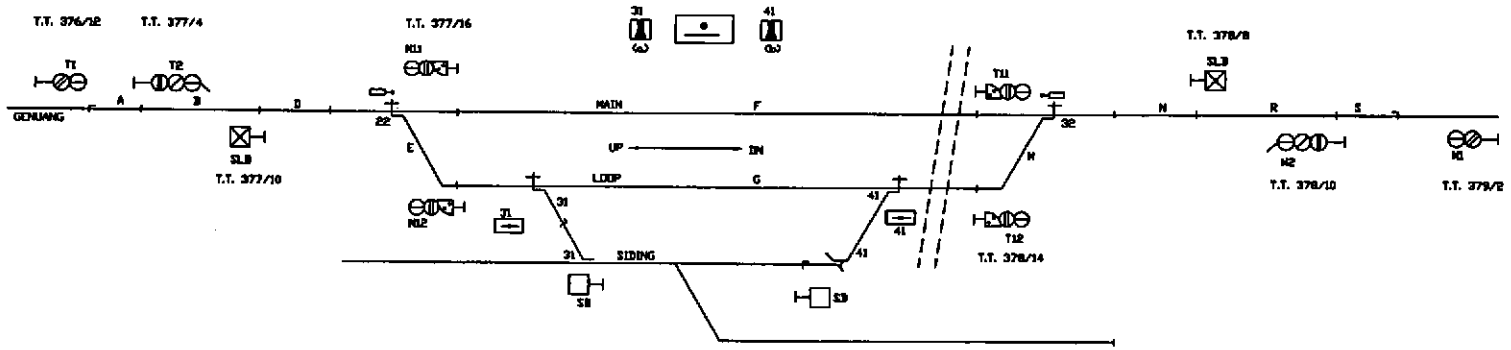
ICF KAISER	CAD FILE NO. SEGAMAT.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 061	
	REV. 0	SHEET NO. 061

GENUANG
(RELAY INTERLOCKING)
KM 596.75
(T.T. 372/8)



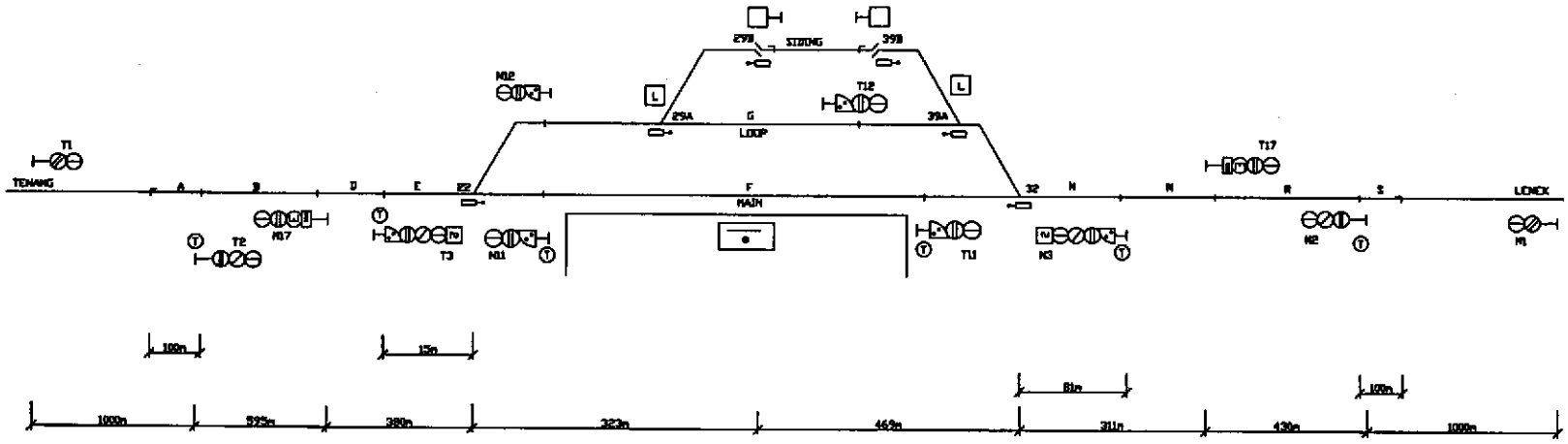
KTM / ICF KAISER	CAD FILE NO. GENUANG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 062	
	REV. 0	SHEET NO. 062

TENANG
(RELAY INTERLOCKING)
KM 605.5
(T.T. 377/18)



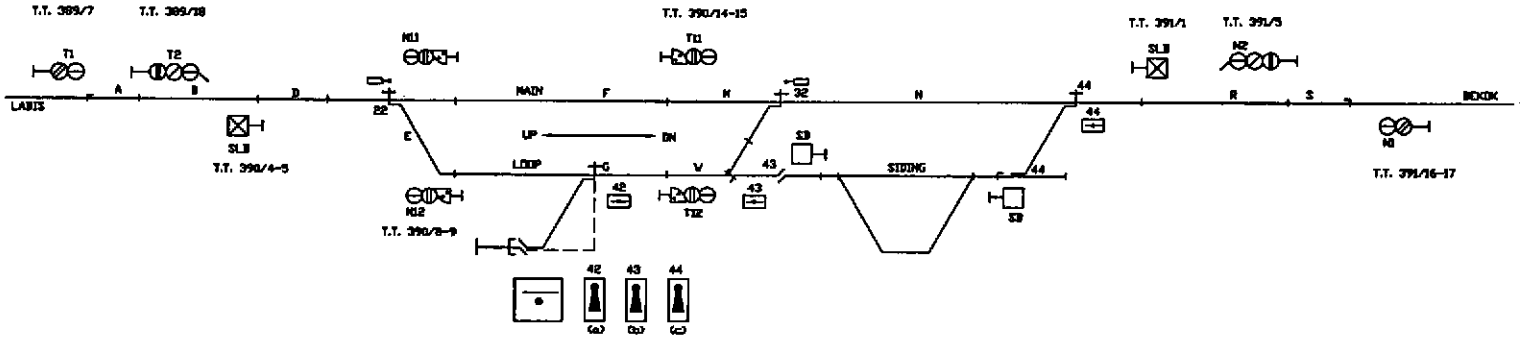
◆ ICF KAISER	CAD FILE NO. TENANG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 063	
	REV. 0	SHEET NO. 063

LABIS
(RELAY INTERLOCKING)
KM 617.5
(T.T. 385/06)



ICF KAISER	CAD FILE NO. LABIS.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 064	
	REV. 0	SHEET NO. 064

LENEK
(RELAY INTERLOCKING)
KM 626.0
(T.T. 390/13)



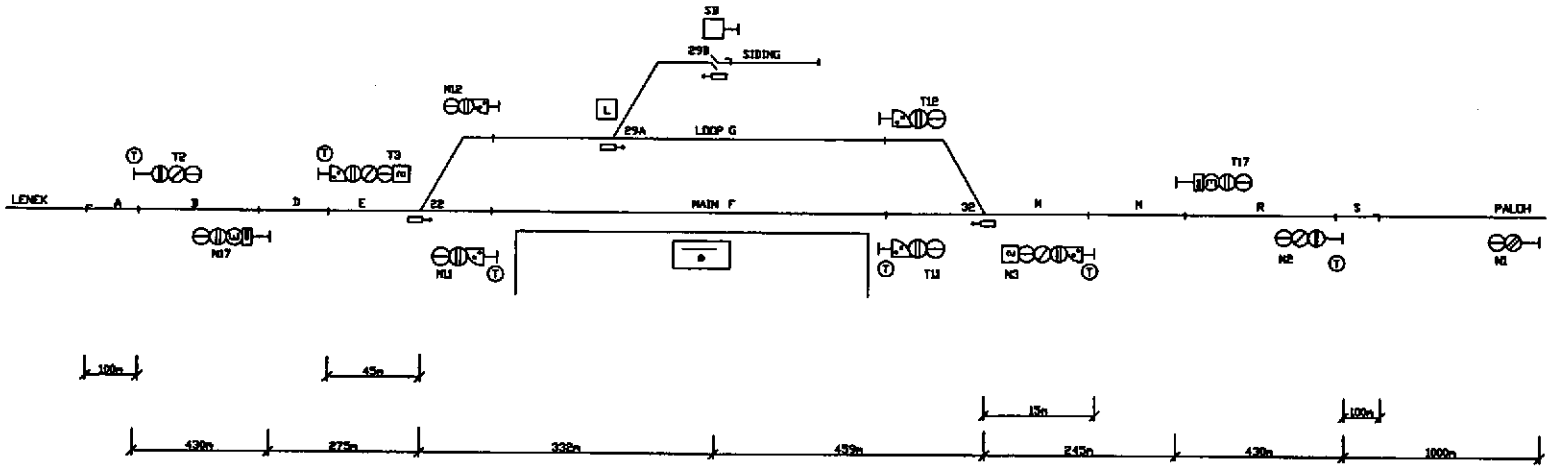
KTM / ICF KAISER	CAD FILE NO. LENEK.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 065	
	REV. 0	SHEET NO. 065

BEKOK

(RELAY INTERLOCKING)

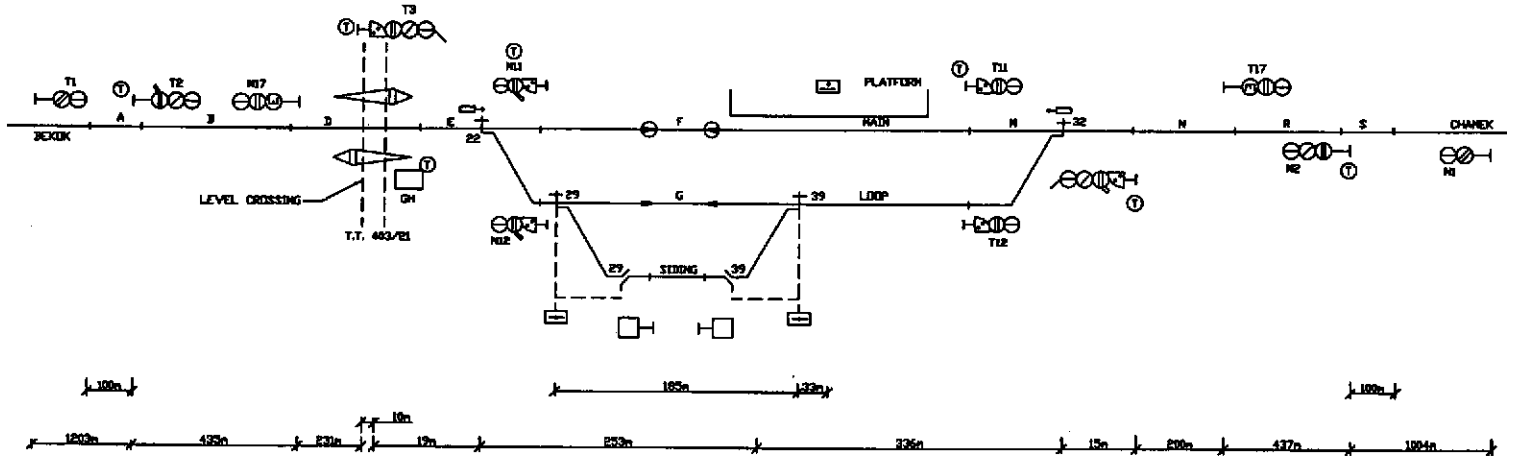
KM 633.5

(T.T. 395/4)



◆ ICF KAISER	CAD FILE NO. BEKOK.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 068	
	REV. 0	SHEET NO. 066

PALOH
(RELAY INTERLOCKING)
T.T. 404/2



NOTES:

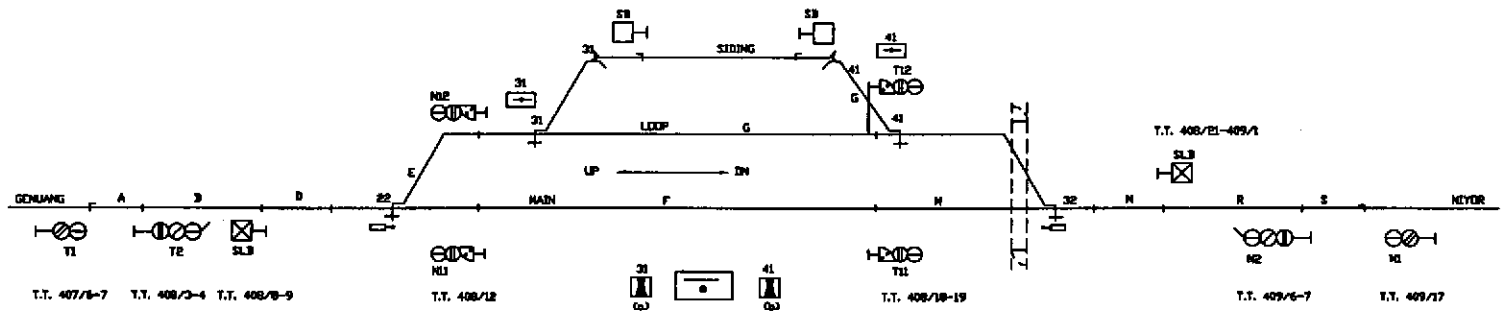
1. TRACK LAYOUT ACCORDING TO DWG. PKR H/3139.
2. LEVEL CROSSING CONTROLS SIGNALS T2, N3, N11, N12, T3.
3. KEY RELEASE FOR POINTS 29 AND 39.
4. (T) SIGNAL POST TELEPHONE,
   GH GATE HUT.

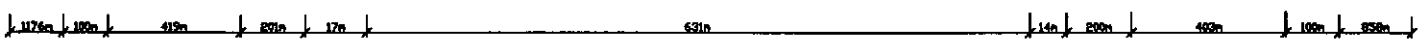
KTM

ICF KAISER

CAD FILE NO.	CAD DATE
PALOH.dwg	24/9/98
DRAWING NO.	
KE 057	
REV.	SHEET NO.
0	057

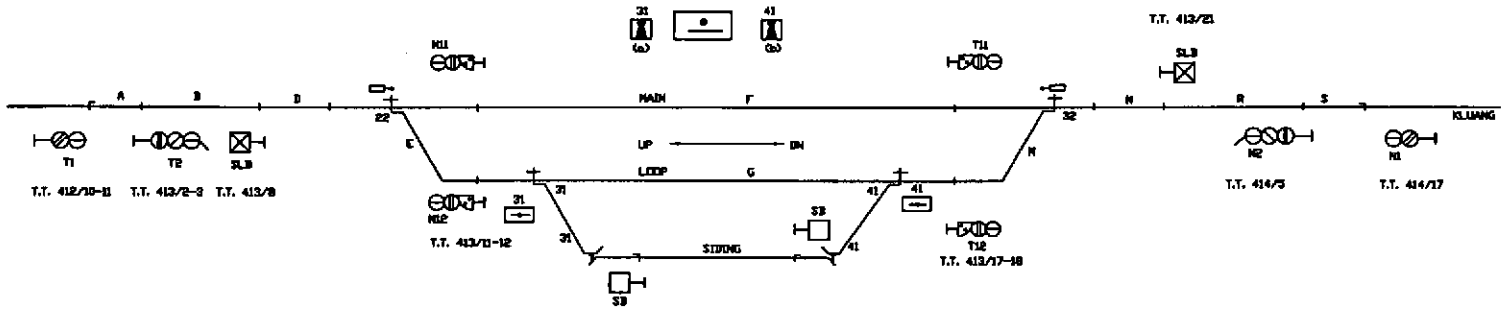
CHAMEK
(ROUTE RELAY INTERLOCKING)
KM 655.25
(T.T. 408/16)

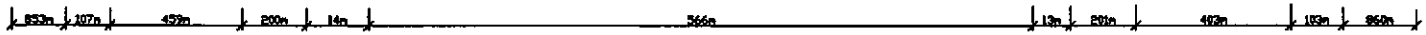




KTM / ICF KAISER	CAD FILE NO. CHAMEK.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 068	
	REV. 0	SHEET NO. 068

NIYOR
(RELAY INTERLOCKING)
KM 663.0
(T.T. 413/15)





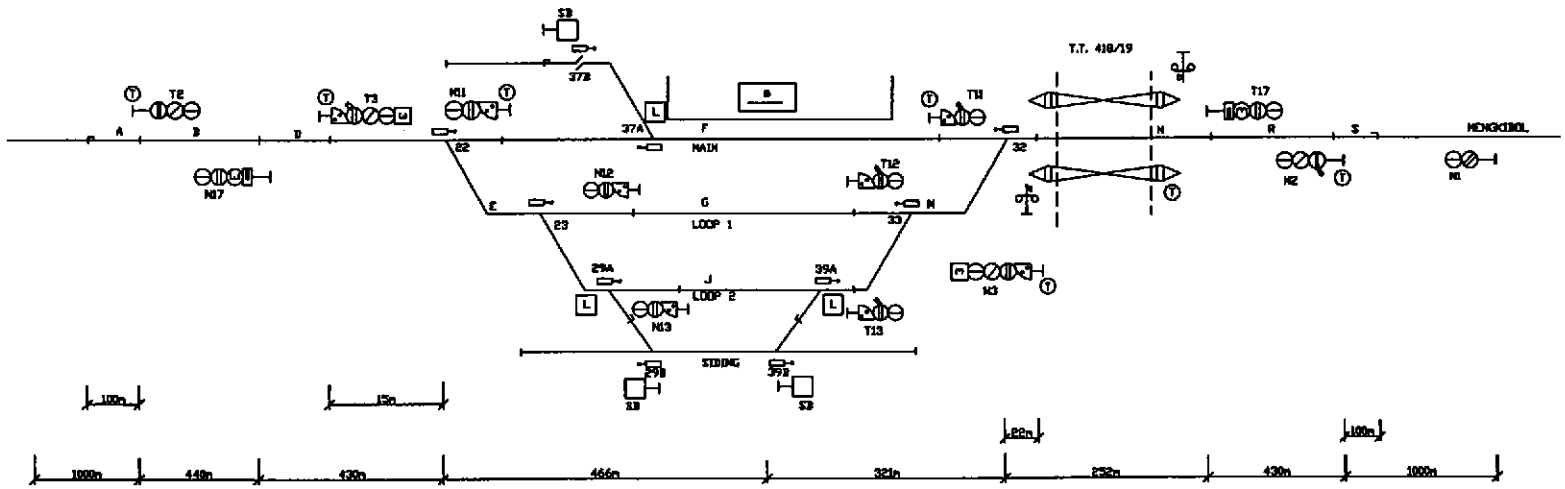
KTM / ICF KAISER	CAD FILE NO. NIYOR.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 069	
	REV. 0	SHEET NO. 069

KLUANG

(R.R.I.)

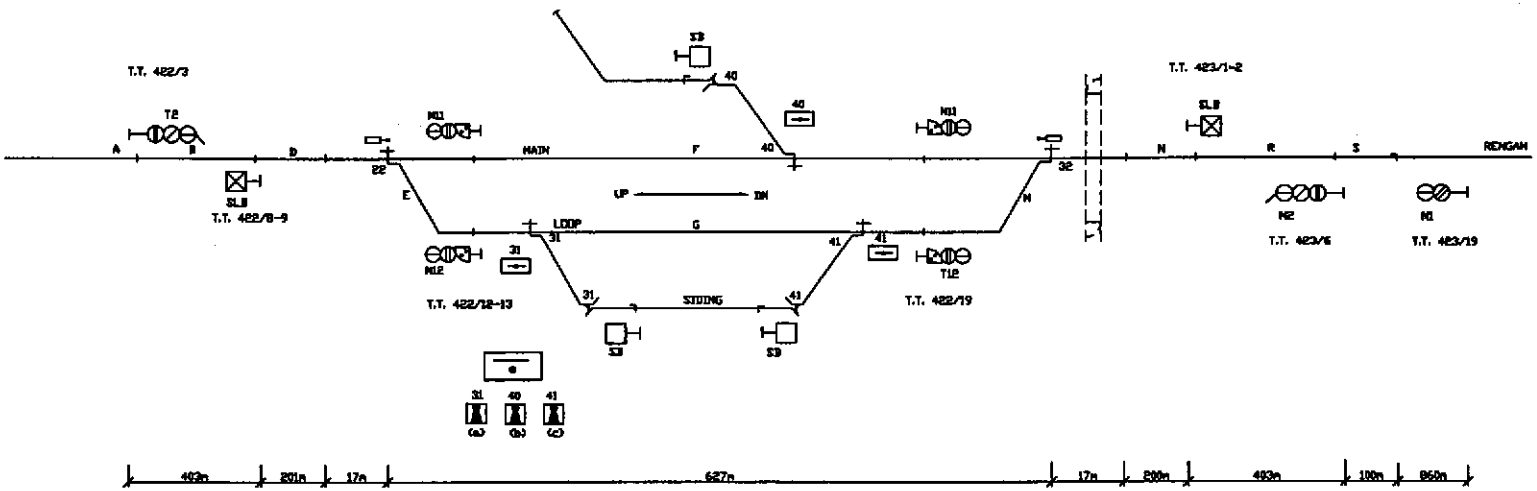
KM 671.0

(T.T. 418/11)



KTM / ICF KAISER	CAD FILE NO. KLUANG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 070	
	REV. 0	SHEET NO. 070

MENGKIBOL
(RELAY INTERLOCKING)
KM 677.75
(T.T. 422/16)



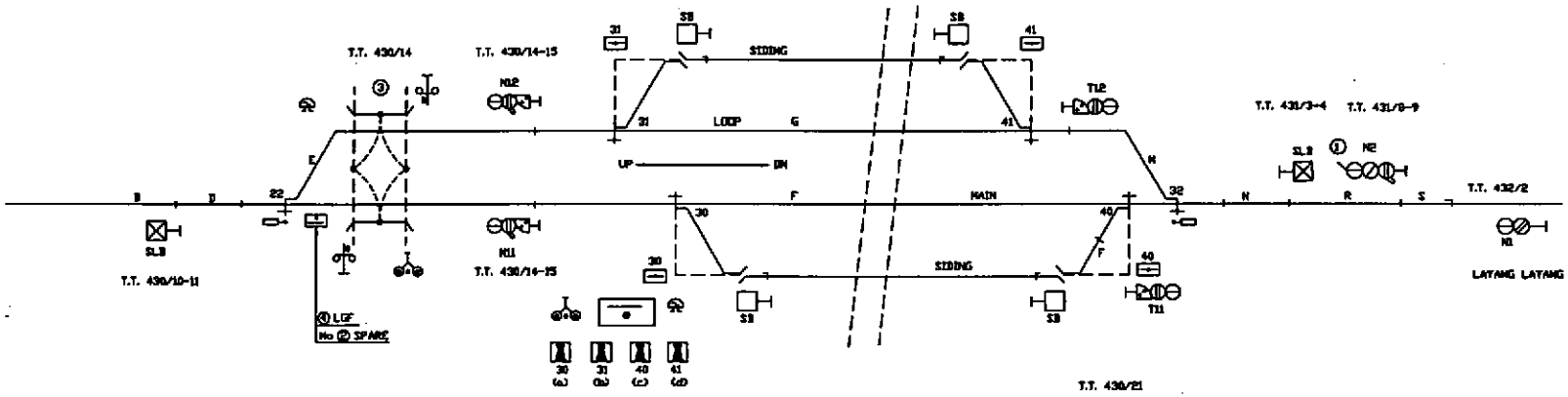
KTM / ICF KAISER	CAD FILE NO. MENGKIBOL.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 071	
	REV. 0	SHEET NO. 071

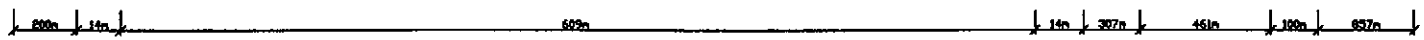
RENGAM

(RELAY INTERLOCKING)

KM 690.5

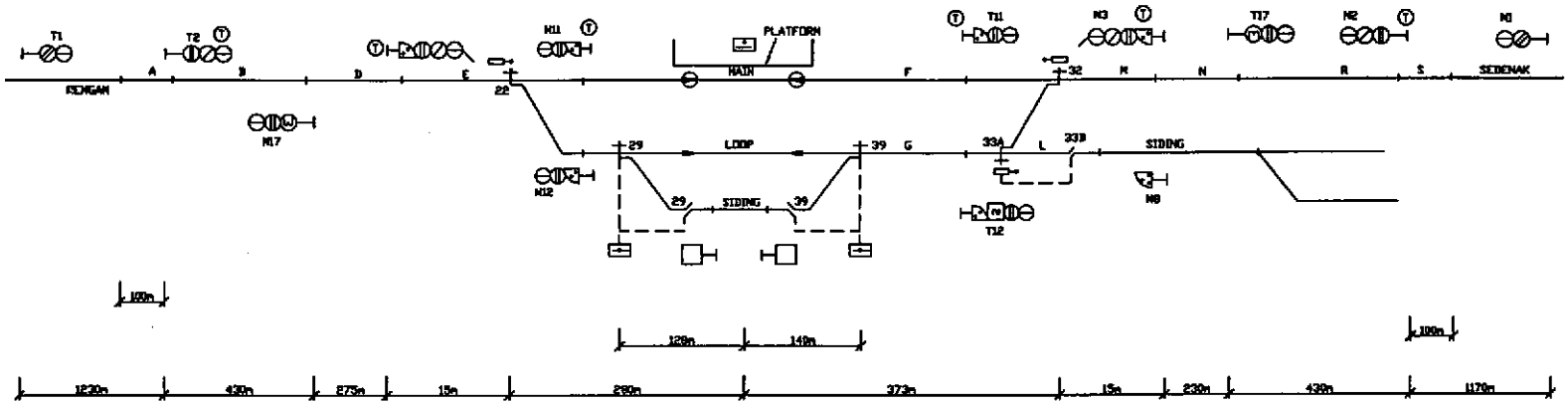
(T.T. 430/16)





◆ ICF KAISER	CAD FILE NO. RENGAM.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 072	
	REV. 0	SHEET NO. 072

LAYANG LAYANG
(RELAY INTERLOCKING)
KM 703.0



NOTES:

1. ALL DISTANCES ARE APPROXIMATE AND IN METERS.
2. FINAL DISTANCES FOR SIGNALS WILL BE CONFIRMED BY SIGHTING COMMITTEE.
3. TRACK LAYOUT ACCORDING TO DWG. IRCON/TR/2A.
4. KEY RELEASE FOR POINTS 29 AND 39.
5. Ⓣ SIGNAL POST TELEPHONE.

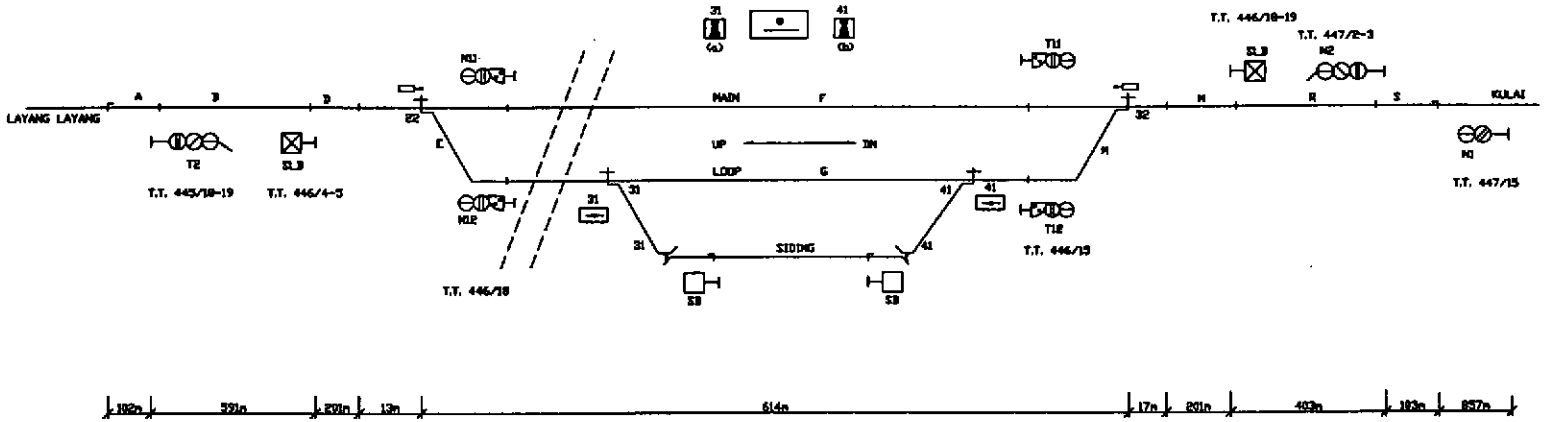
ALPHANUMERIC ROUTE INDICATIONS		
SIGNAL	ROUTE TO	INDICATION
T12	MAIN	M
	SIDING	S

KTM

ICF KAISER

CAD FILE NO.	CAD DATE
LAYANG_LAYANG.dwg	24/9/98
DRAWING NO.	
KE 073	
REV.	SHEET NO.
0	073

SEDENAK
(RELAY INTERLOCKING)
KM 716.0
(T.T. 446/11)



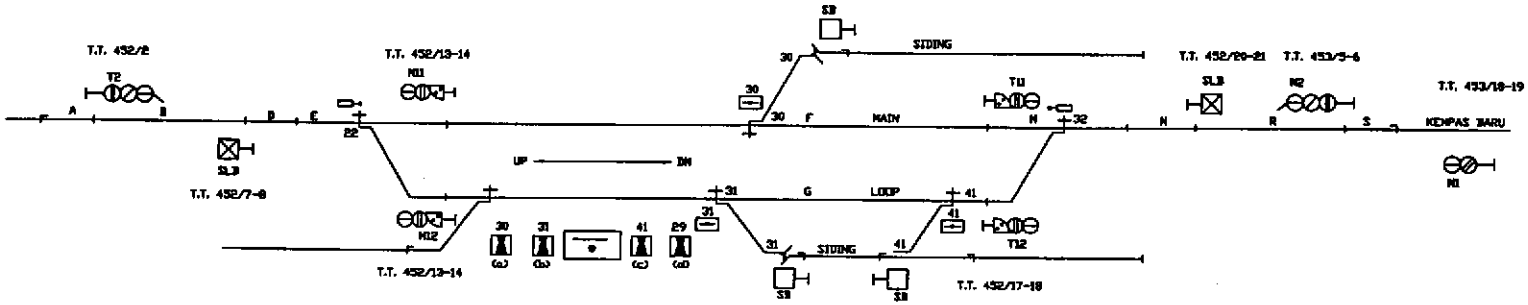
KTM / ICF KAISER	CAD FILE NO. SEDEN.W.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 074	
	REV. 0	SHEET NO. 074

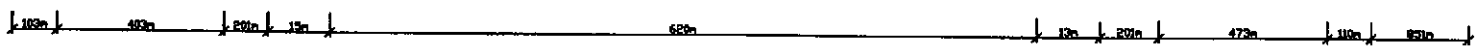
KULAI

(RELAY INTERLOCKING)

KM 725.75

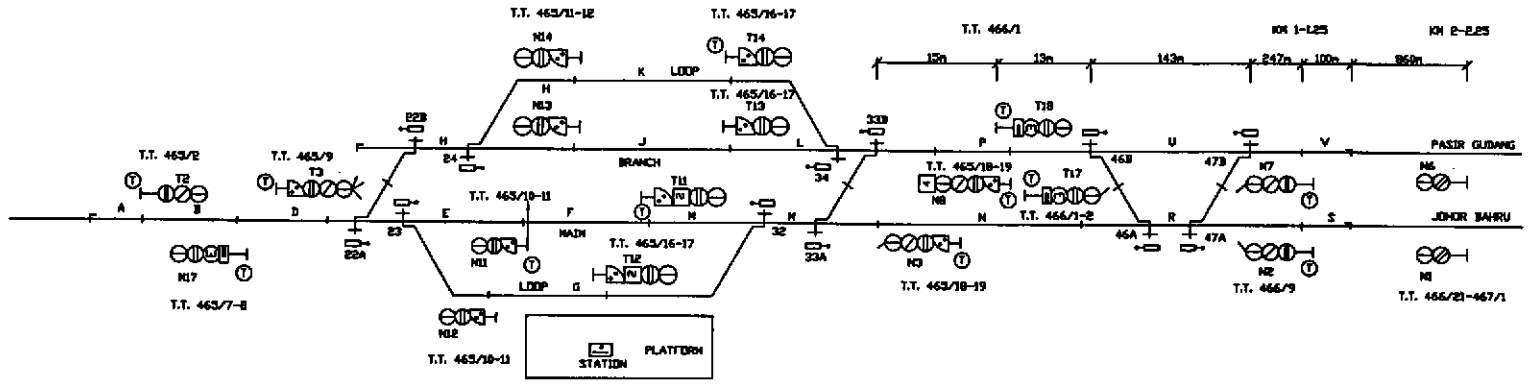
(T.T. 452/15)





KTM / ICF KAISER	CAD FILE NO. KULAI.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 075	
	REV. 0	SHEET NO. 075

KEMPAS BARU
(RELAY INTERLOCKING)
KM 747.32
(T.T. 465/15)



NOTES:

1. ALL DISTANCES ARE APPROXIMATE AND IN METERS.
2. FINAL DISTANCES FOR SIGNALS WILL BE CONFIRMED BY SIGHTING COMMITTEE.
3. Ⓣ SIGNAL POST TELEPHONE.

KTM

◆ ICF KAISER

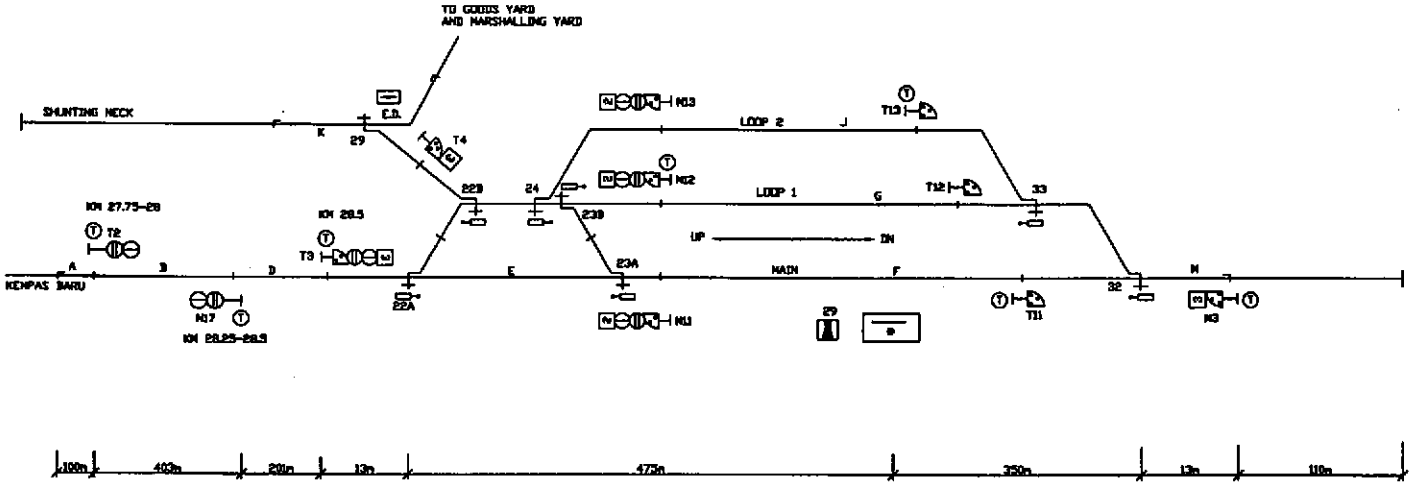
CAD FILE NO.	CAD DATE
KEMPAS_BARU.dwg	24/9/98
DRAWING NO.	
KE 078	
REV.	SHEET NO.
0	078

PASIR GUDANG

(RELAY INTERLOCKING)

KM 29.2

(T.T. 22/1)



NOTES:

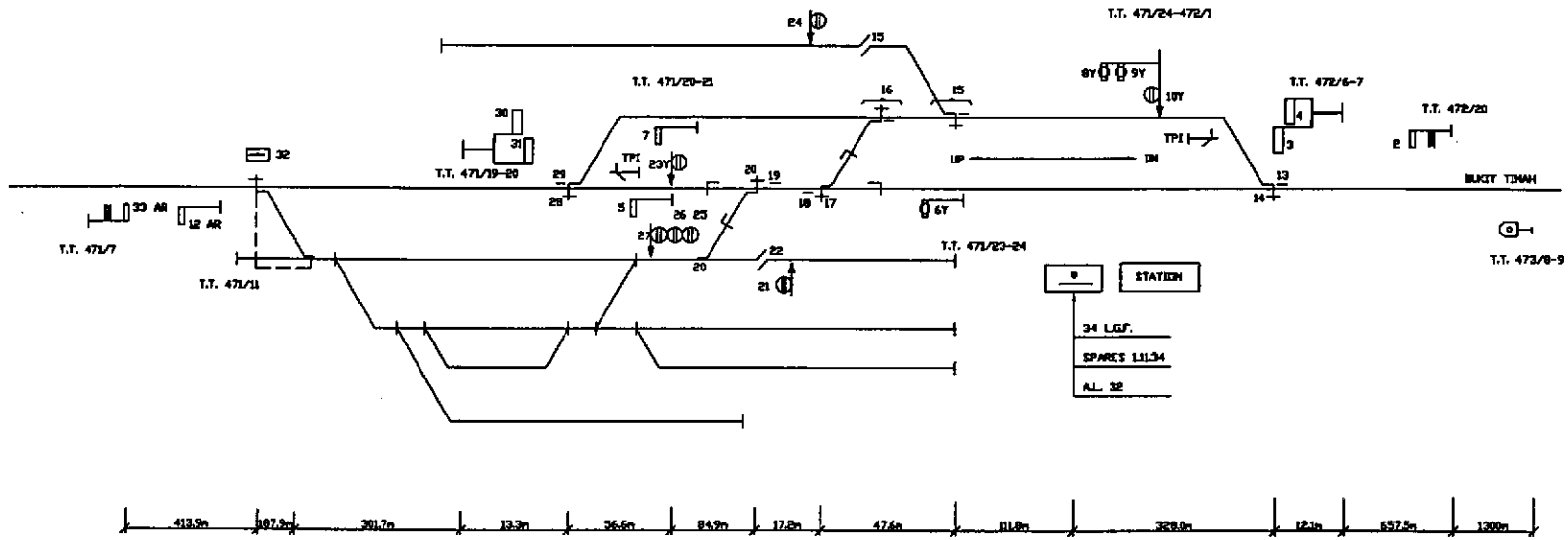
1. ALL DISTANCES ARE APPROXIMATE AND IN METERS.
2. FINAL DISTANCES FOR SIGNALS HAVE TO BE CONFIRMED BY THE SIGNAL SIGHTING COMMITTEE.
3. TRACK LAYOUT ACCORDING TO PNR DRG No. H/2942. SUPERSEDES DRG. No. S/K 10/79, S/K 94/81, S/K 102/81-L
4. POINT No. 27 HAND OPERATED BUT WITH ELECTRICAL DETECTION.
5. Ⓣ TELEPHONE.

KTM

ICF KAISER

CAD FILE NO.	CAD DATE
PASIR_GUDANG.dwg	24/9/98
DRAWING NO.	
KE 077	
REV.	SHEET NO.
0	077

JOHOR BAHRU
(FULLY INTERLOCKED)
KM 757.97
(T.T. 472/3)



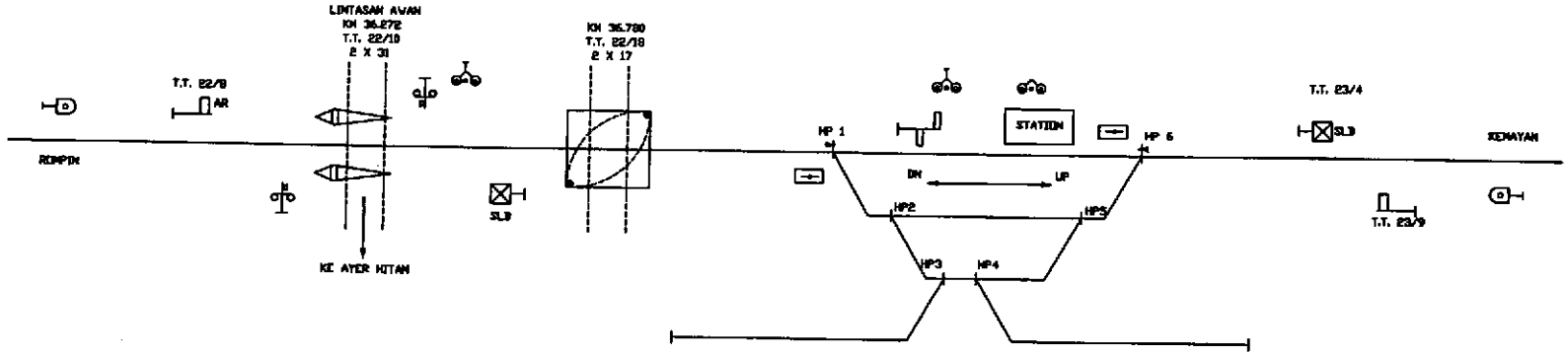
KTM / ICF KAISER	CAD FILE NO. JOHOR BAHRU.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 078	
	REV. 0	SHEET NO. 078

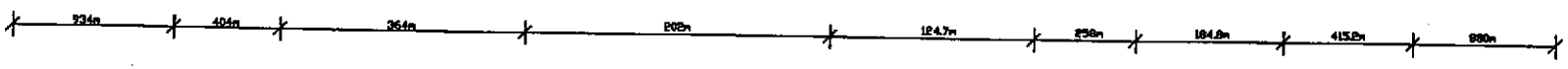
BAHAU

(NON-INTERLOCKED)

KM 36.9

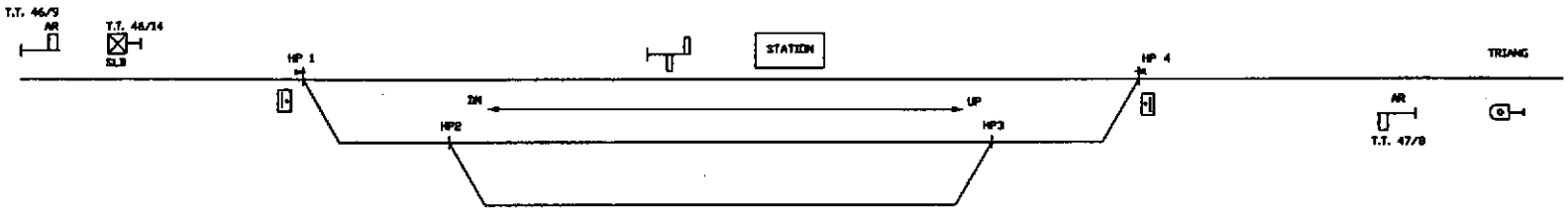
(T.T. 22/9)

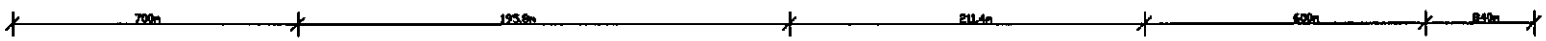




KTM / ICF KAISER	CAD FILE NO. BAHAU.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 079	
	REV. 0	SHEET NO. 079

KEMAYAN
(NON-INTERLOCKED)
KM 75.6
(T.T. 46/21)





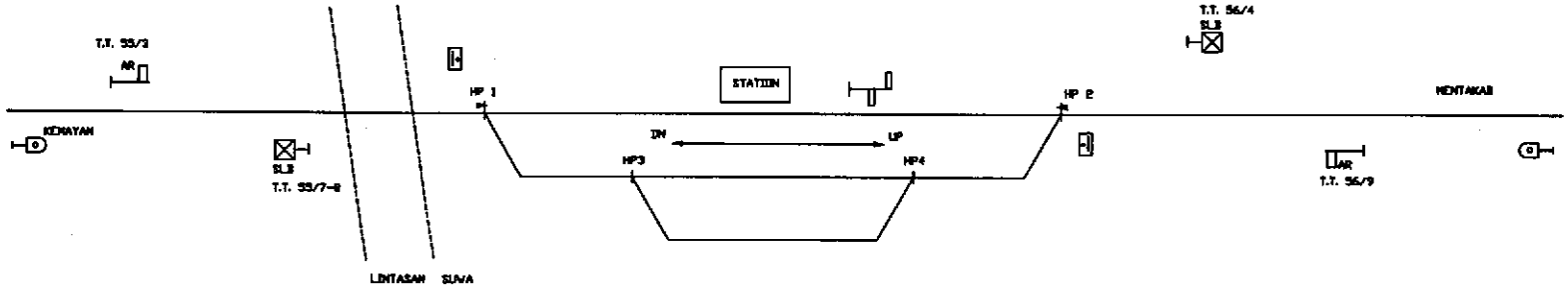
KTM / ICF KAISER	CAD FILE NO. KEMAYAN.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 080	
	REV. 0	SHEET NO. 080

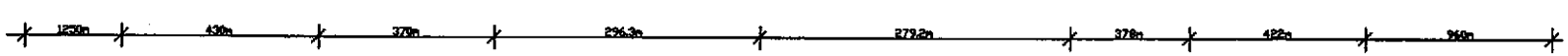
TRIANG

(NON-INTERLOCKED)

KM 89.8

(T.T. 55/16)





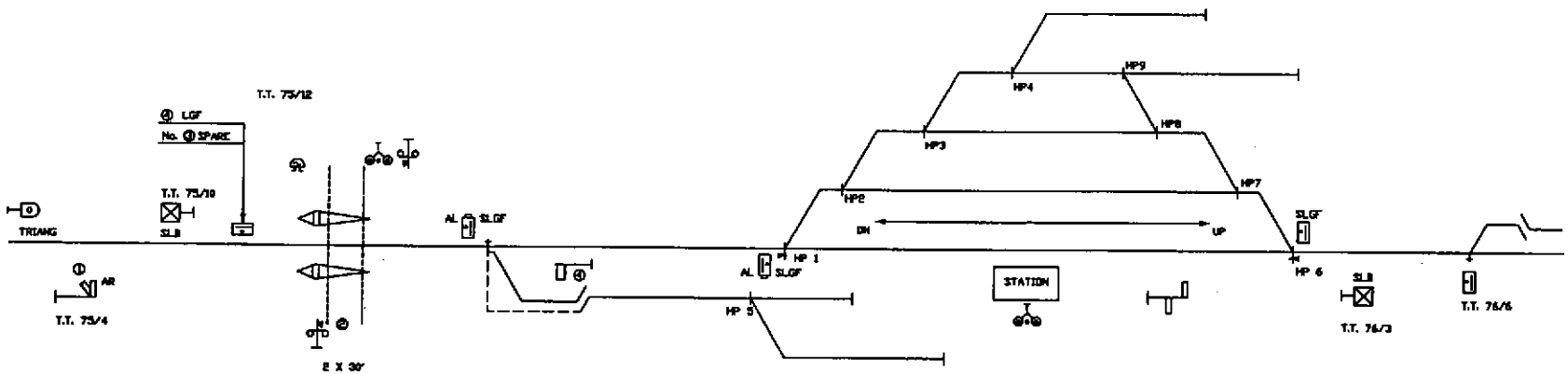
KTM / ICF KAISER	CAD FILE NO. TRIANG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 081	
	REV. 0	SHEET NO. 081

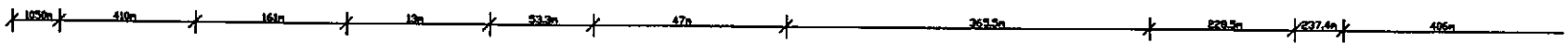
MENTAKAB

(NON-INTERLOCKED)

KM 122.0

(T.T. 75/19)





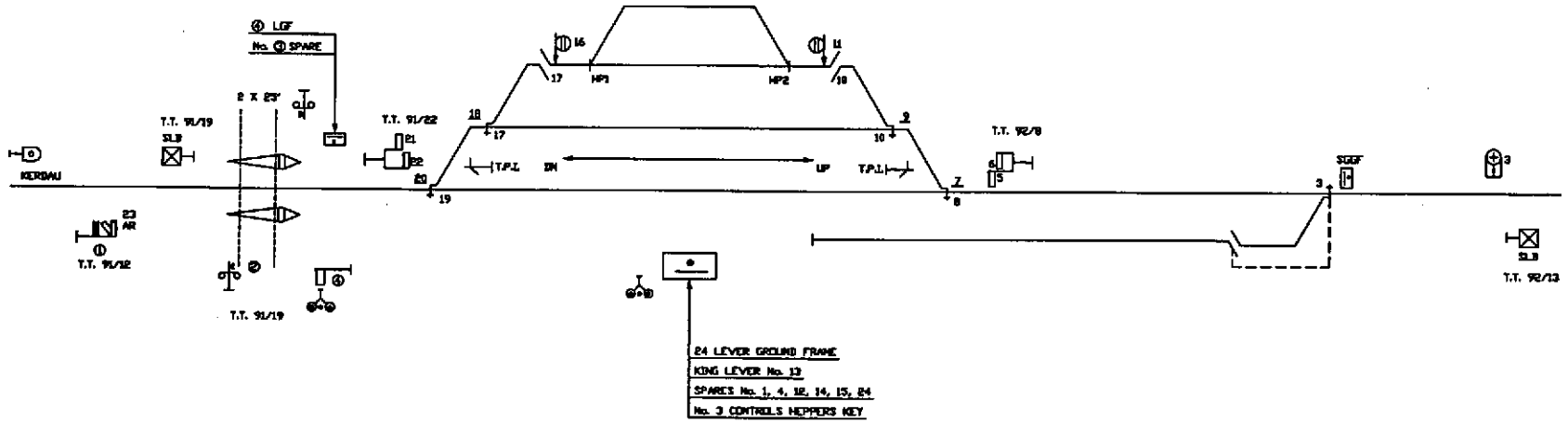
KTM / ICF KAISER	CAD FILE NO. MENTAKAB.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 082	
	REV. 0	SHEET NO. 082

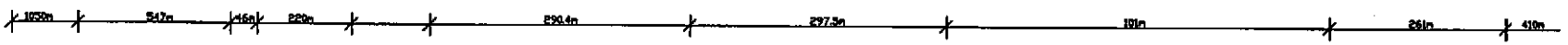
KUALA KRAU

(FULLY INTERLOCKED)

KM 148.4

(T.T. 92/4)





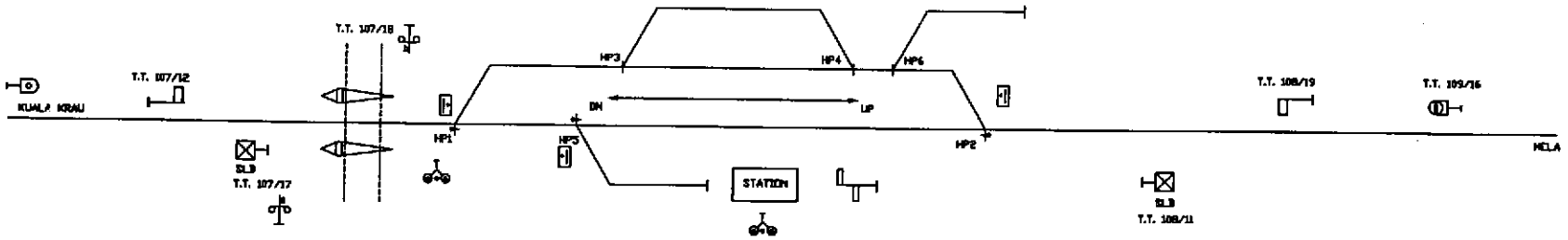
KTM / ICF KAISER	CAD FILE NO. KRAU.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 083	
	REV. 0	SHEET NO. 083

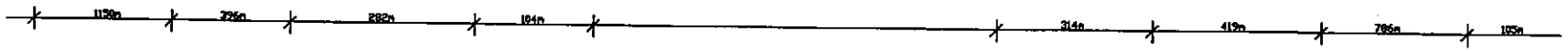
JERANTUT

(NON-INTERLOCKED)

KM 174.0

(T.T. 108/3)





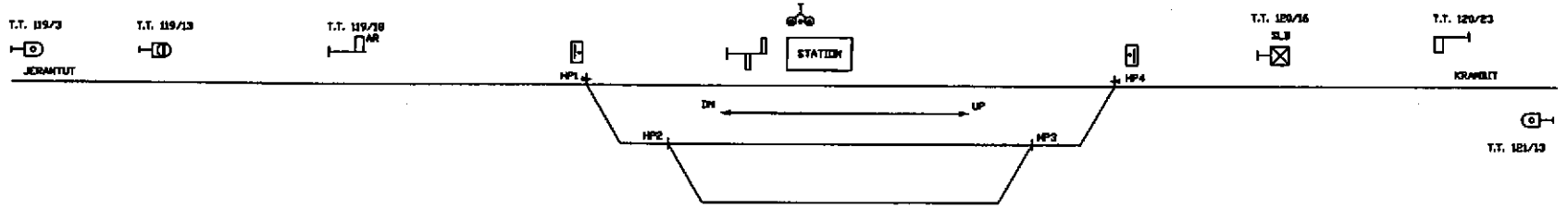
KTM / ICF KAISER	CAD FILE NO. JERANTUT.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 084	
	REV. 0	SHEET NO. 084

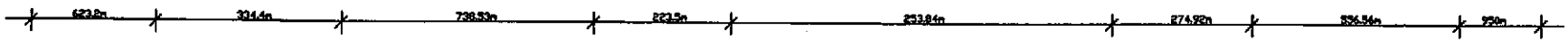
MELA

(NON-INTERLOCKED)

KM 193.6

(T.T. 120/7)





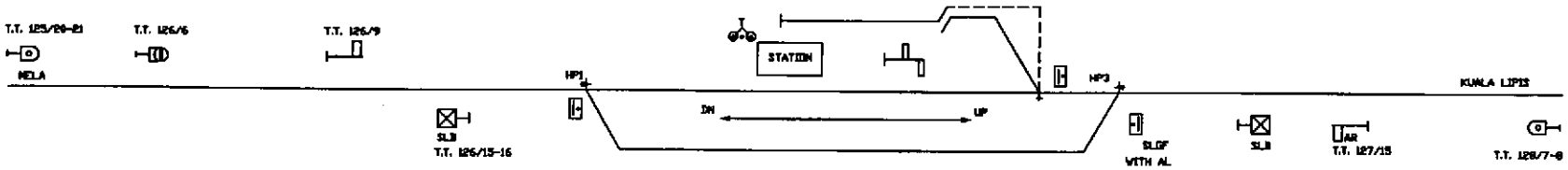
KTM / ICF KAISER	CAD FILE NO. MELA.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 085	
	REV. 0	SHEET NO. 085

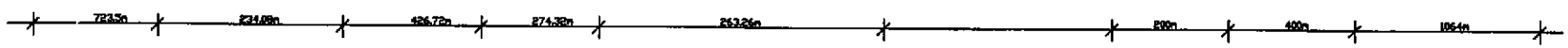
KRAMBIT

(NON-INTERLOCKED)

KM 204.3

(T.T. 127.1)

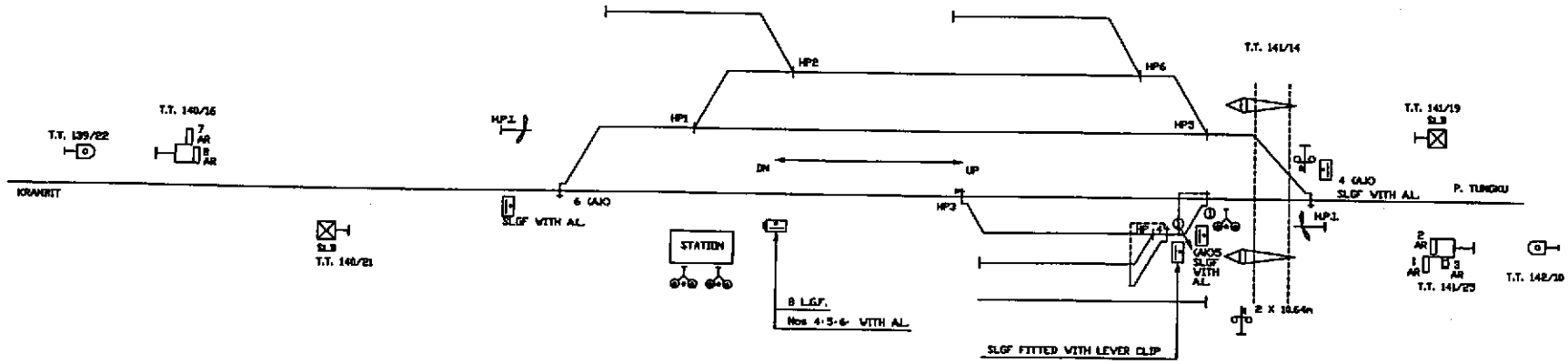


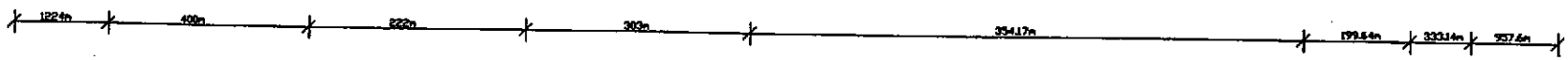


KTM / ICF KAISER	CAD FILE NO. KRAMBIT.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 086	
	REV. 0	SHEET NO. 086

KUALA LIPIS

(HIGH POINT INDICATOR)
KM 227.3
(T.T. 141/4)





KTM

◆ ICF KAISER

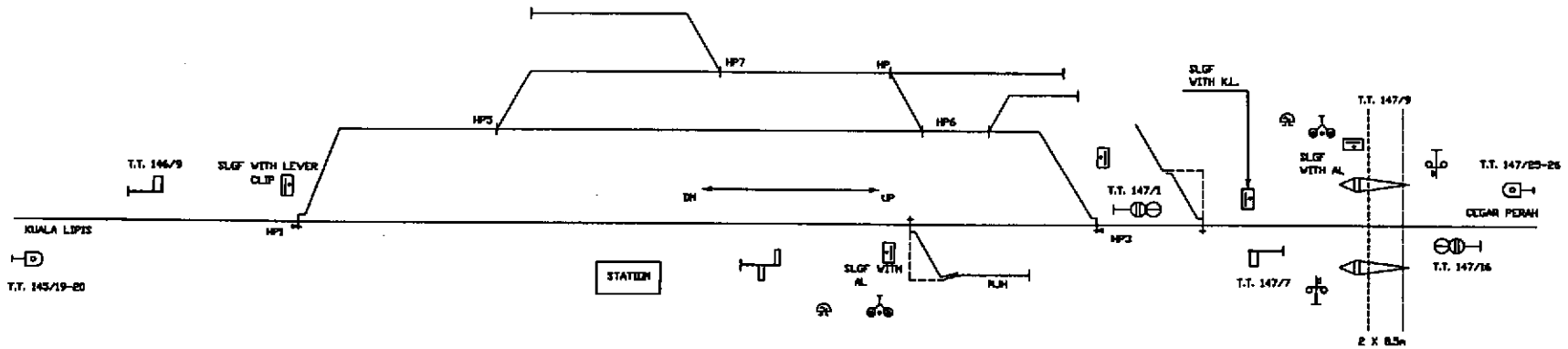
CAD FILE NO.	CAD DATE
LIPIS.dwg	24/9/98
DRAWING NO.	
KE 087	
REV.	SHEET NO.
0	087

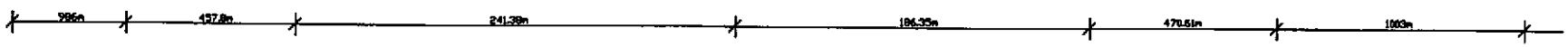
PADANG TENGKU

(NON-INTERLOCKED)

KM 236.2

(T.T. 146/19)





◆ ICF KAISER

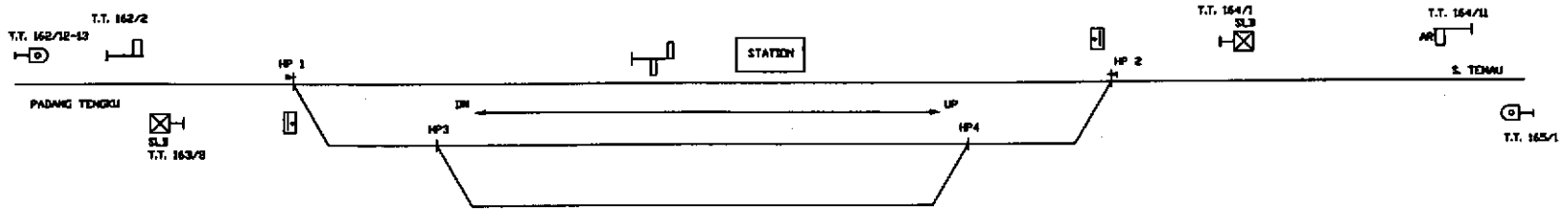
CAD FILE NO.	CAD DATE
TENGKU.dwg	24/9/98
DRAWING NO.	
KE 088	
REV.	SHEET NO.
0	088

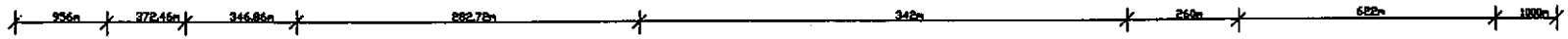
CHEGAR PERAH

(NON-INTERLOCKED)

KM 263.3

(T.T. 163/19)

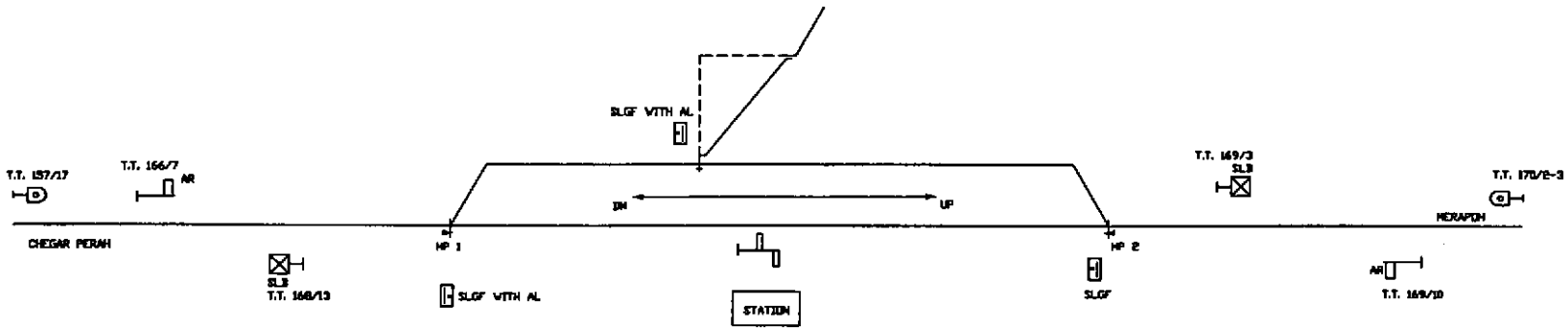


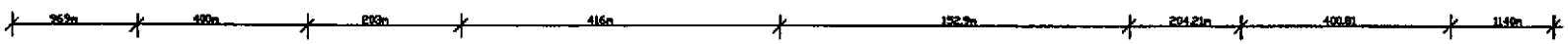


KTM / ICF KAISER	CAD FILE NO. PERAH.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 089	
	REV. 0	SHEET NO. 089

SUNGAI TEMAU

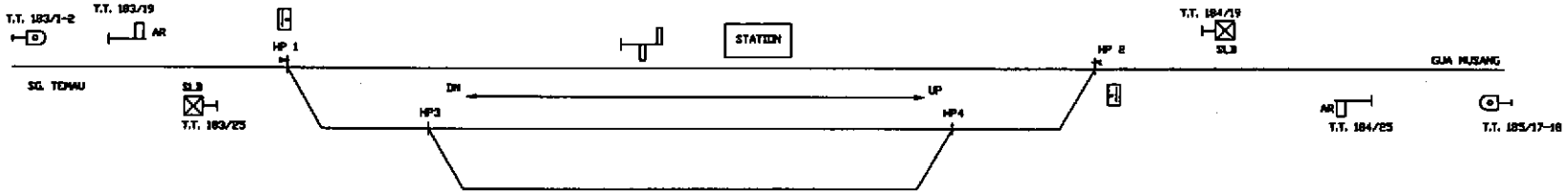
(NON-INTERLOCKED)
KM 271.7
(T.T. 168/22)

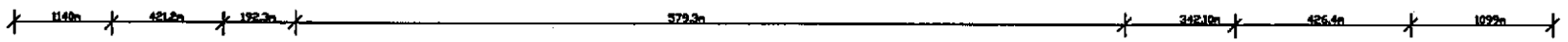




KTM / ICF KAISER	CAD FILE NO. TEMAU.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 090	
	REV. 0	SHEET NO. 090

MERAPOH
(NON-INTERLOCKED)
KM 296.5
(T.T. 184/9)





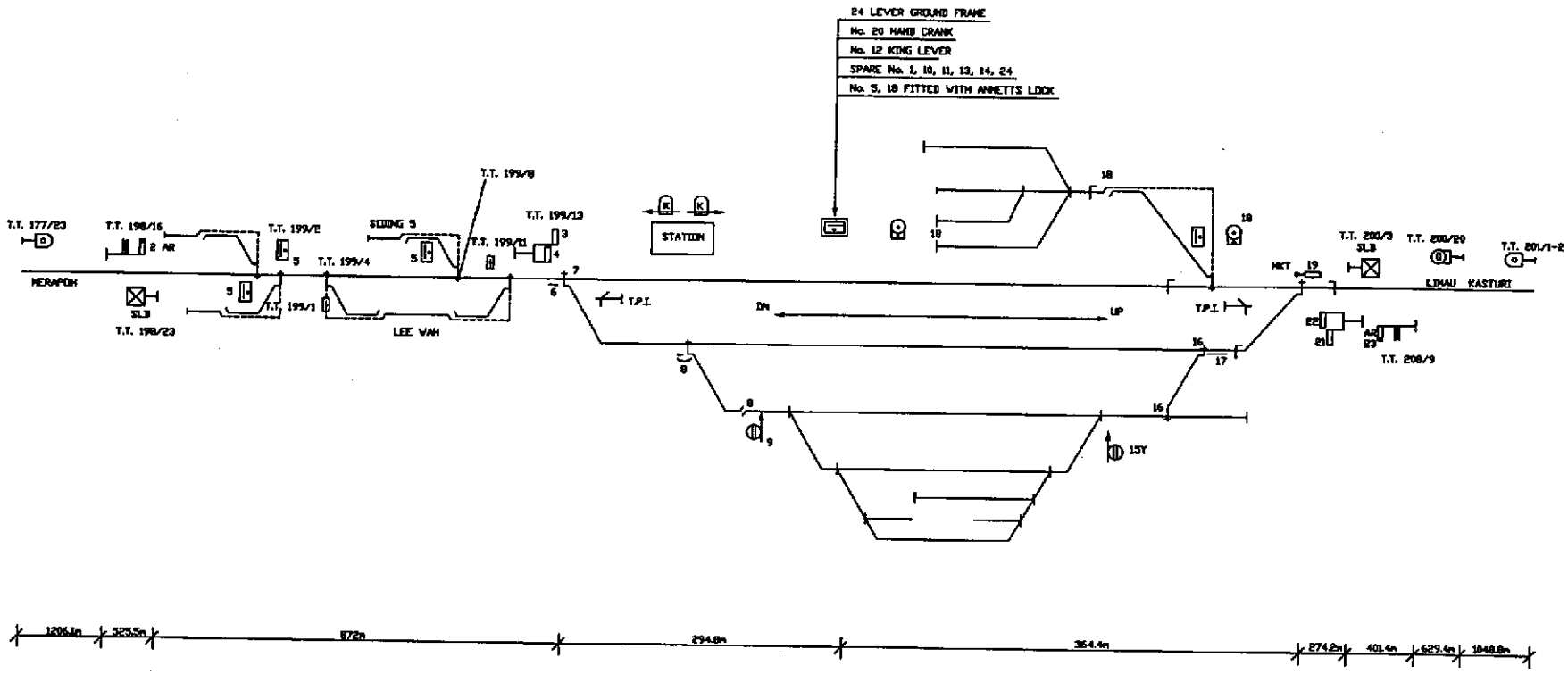
KTM / ICF KAISER	CAD FILE NO. MERAPOH.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 091	
	REV. 0	SHEET NO. 091

GUA MUSANG

(FULLY INTERLOCKED)

KM 321.6

(T.T. 199/17)



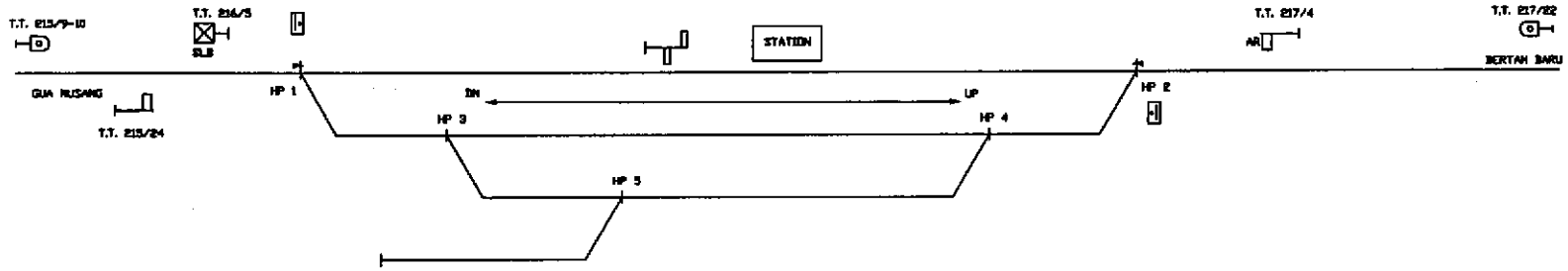
ICF KAISER	CAD FILE NO. MUSANG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 092	
	REV. 0	SHEET NO. 092

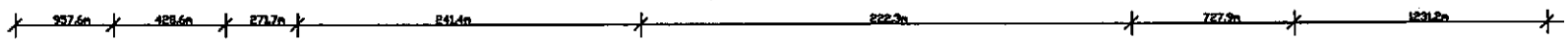
LIMAU KASTURI

(NON-INTERLOCKED)

KM 348.1

(T.T. 216/14)





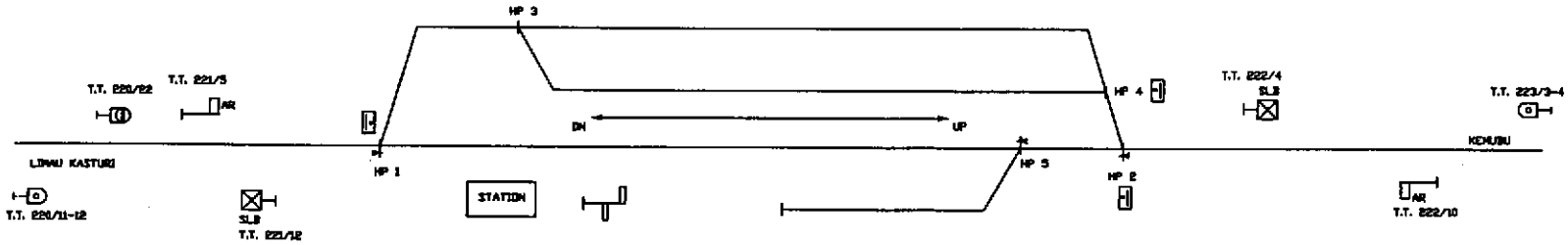
KTM / ICF KAISER	CAD FILE NO. KASTURI.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 093	
	REV. 0	SHEET NO. 093

BERTAM BARU

(NON-INTERLOCKED)

KM 356.6

(T.T. 221/21)



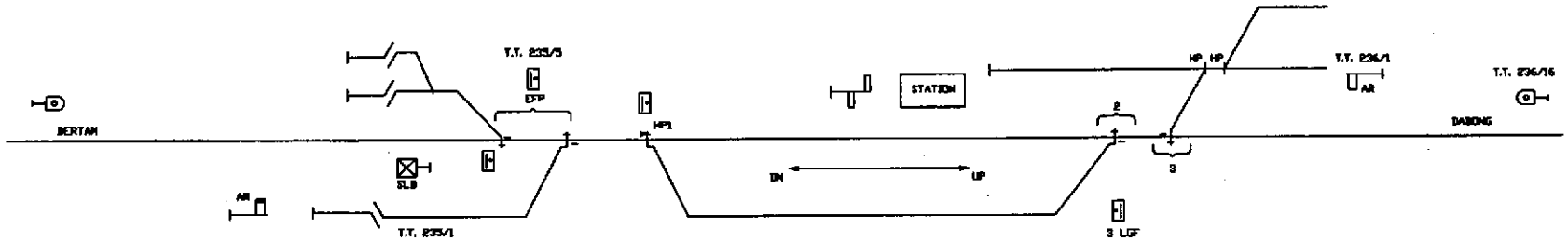
KTM / ICF KAISER	CAD FILE NO. BARU.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 094	
	REV. 0	SHEET NO. 094

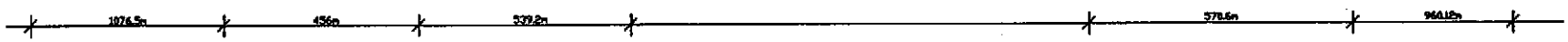
KEMUBU

(NON-INTERLOCKED)

KM 378.6

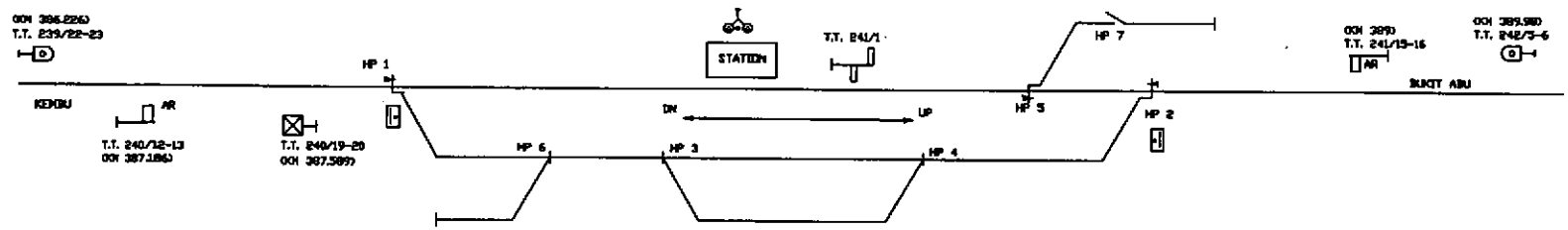
(T.T. 235/13)

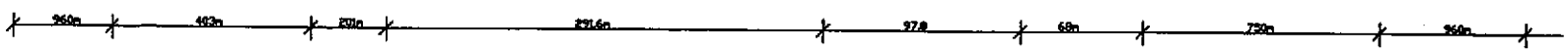




KTM / ICF KAISER	CAD FILE NO. KEMUBU.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 095	
	REV. 0	SHEET NO. 095

DABONG
(NON-INTERLOCKED)
KM 388.1
(T.T. 241/1)





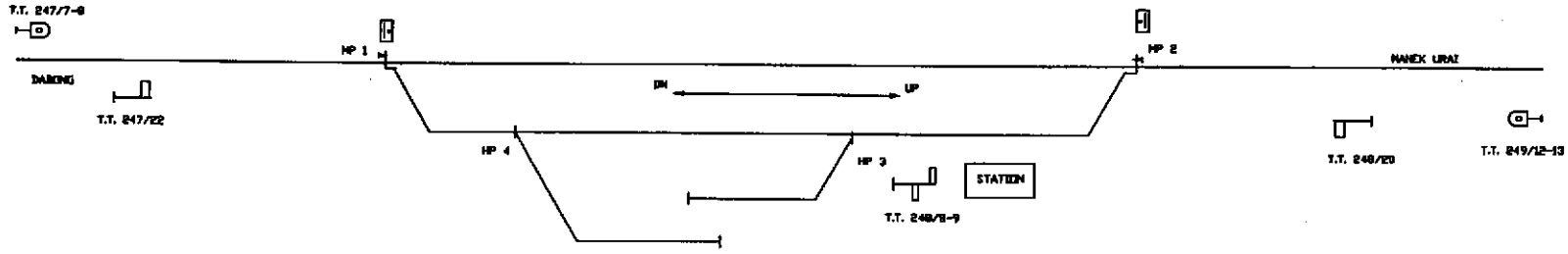
KTM / ICF KAISER	CAD FILE NO. DABONG.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 096	
	REV. 0	SHEET NO. 096

BUKIT ABU

(NON-INTERLOCKED)

KM 399.2

(T.T. 248.8)



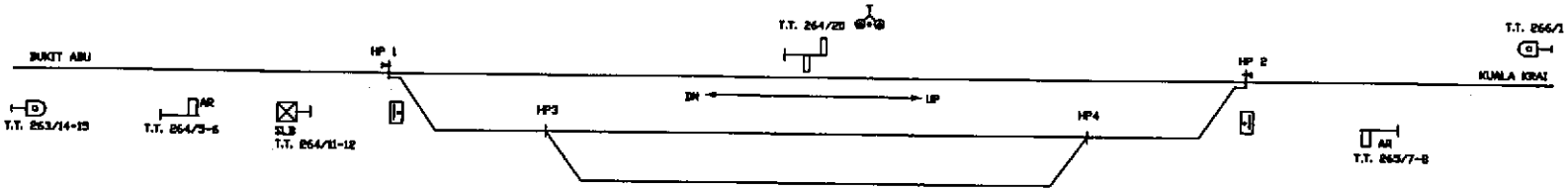
KTM / ICF KAISER	CAD FILE NO. ABU.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 097	
	REV. 0	SHEET NO. 097

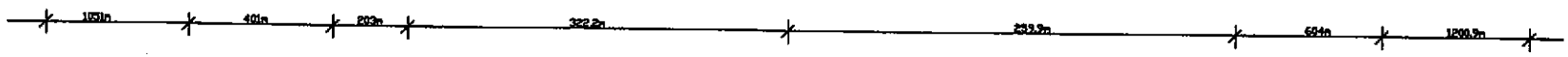
MANEK URAI

(NON-INTERLOCKED)

KM 425.6

(T.T. 264/20)

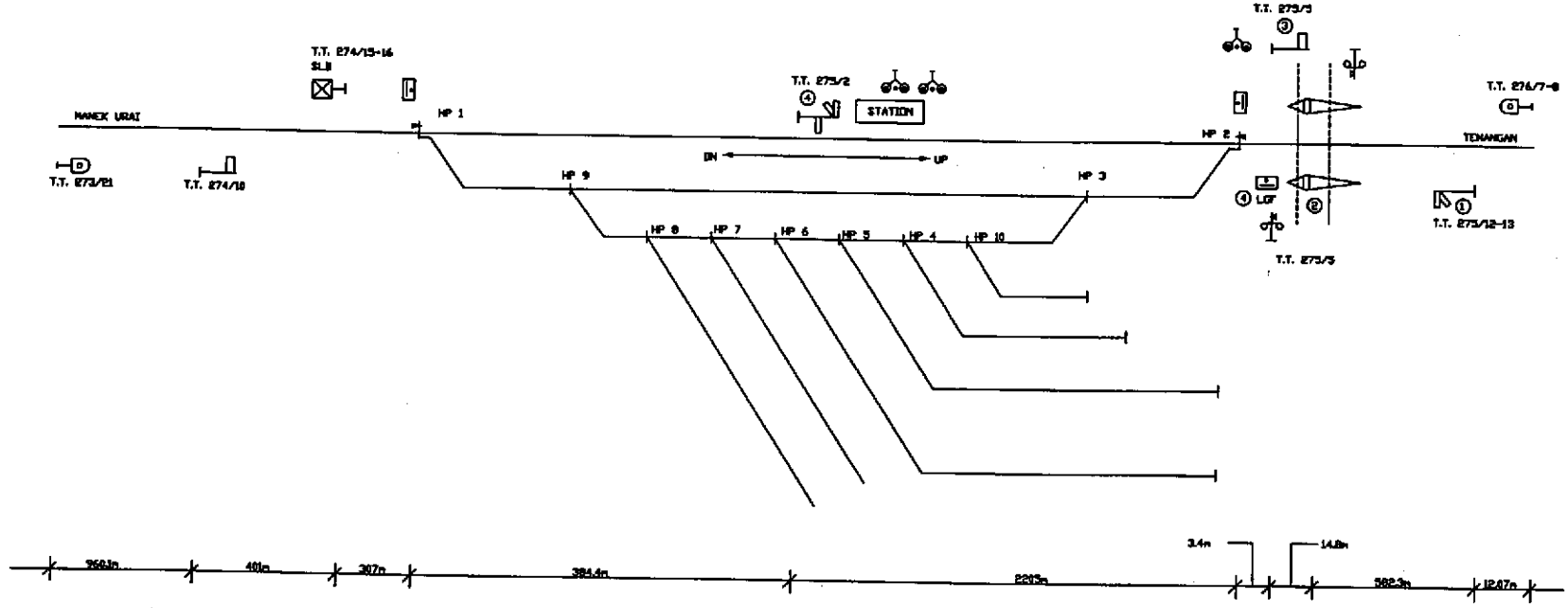




KTM / ICF KAISER	CAD FILE NO. URAI.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 098	
	REV. 0	SHEET NO. 098

KUALA KRAI

(NON-INTERLOCKED)
KM 442.1
(T.T. 275/2)



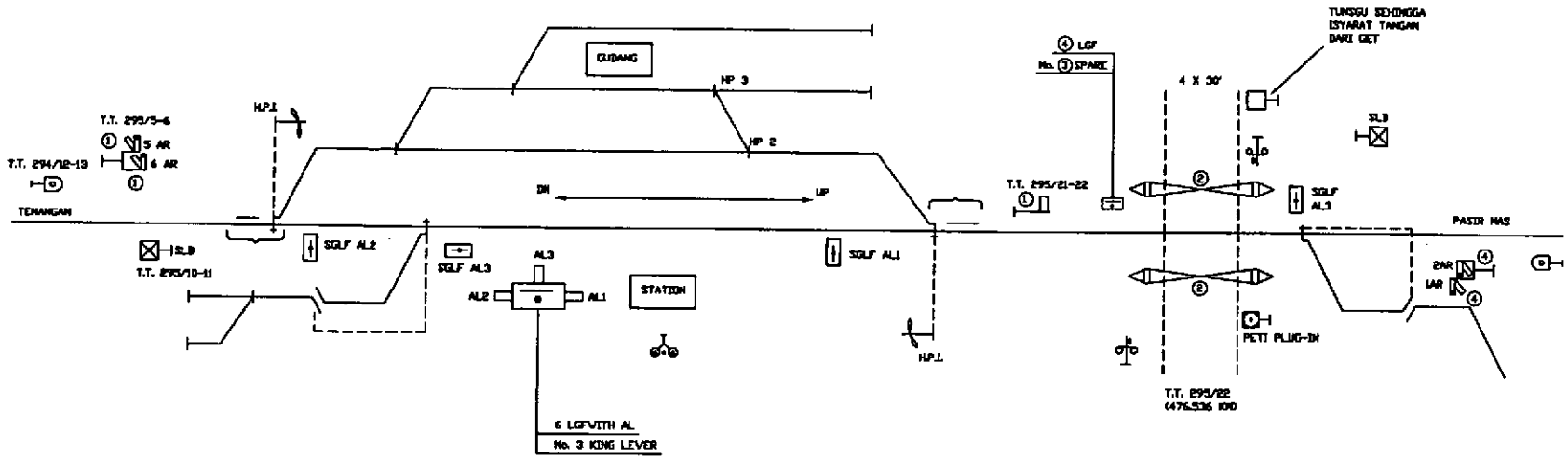
◆ ICF KAISER	CAD FILE NO. KRAI.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 099	
	REV. 0	SHEET NO. 099

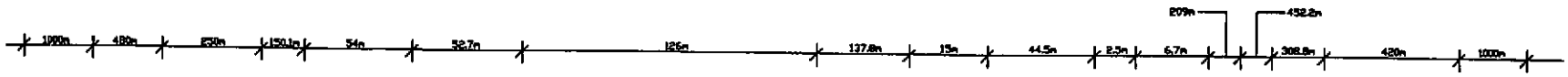
TANAH MERAH

(HIGH POINT INDICATOR)

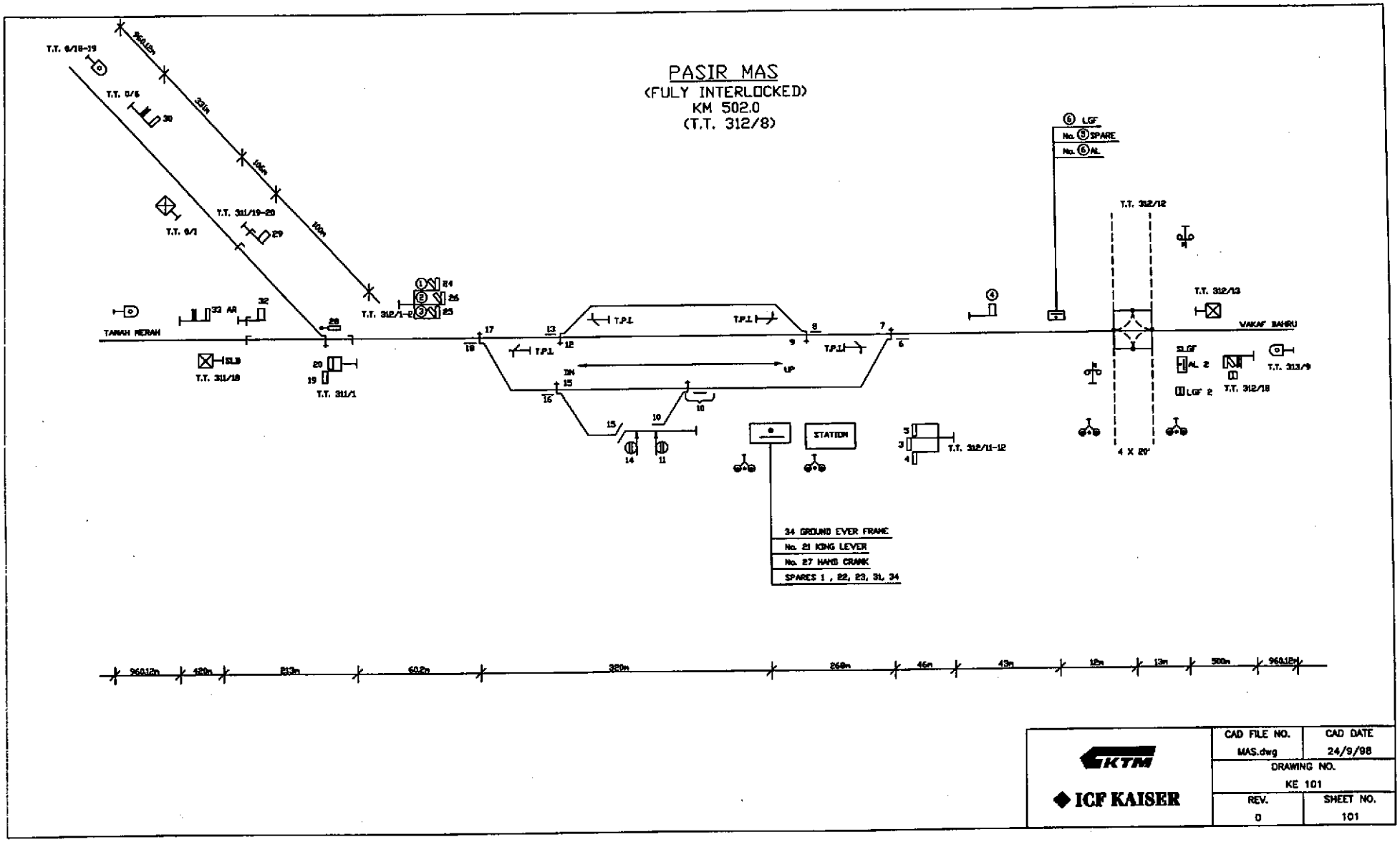
KM 475.5

(T.T. 295/17)





KTM / ICF KAISER	CAD FILE NO. MERAH.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 100	
	REV. 0	SHEET NO. 100



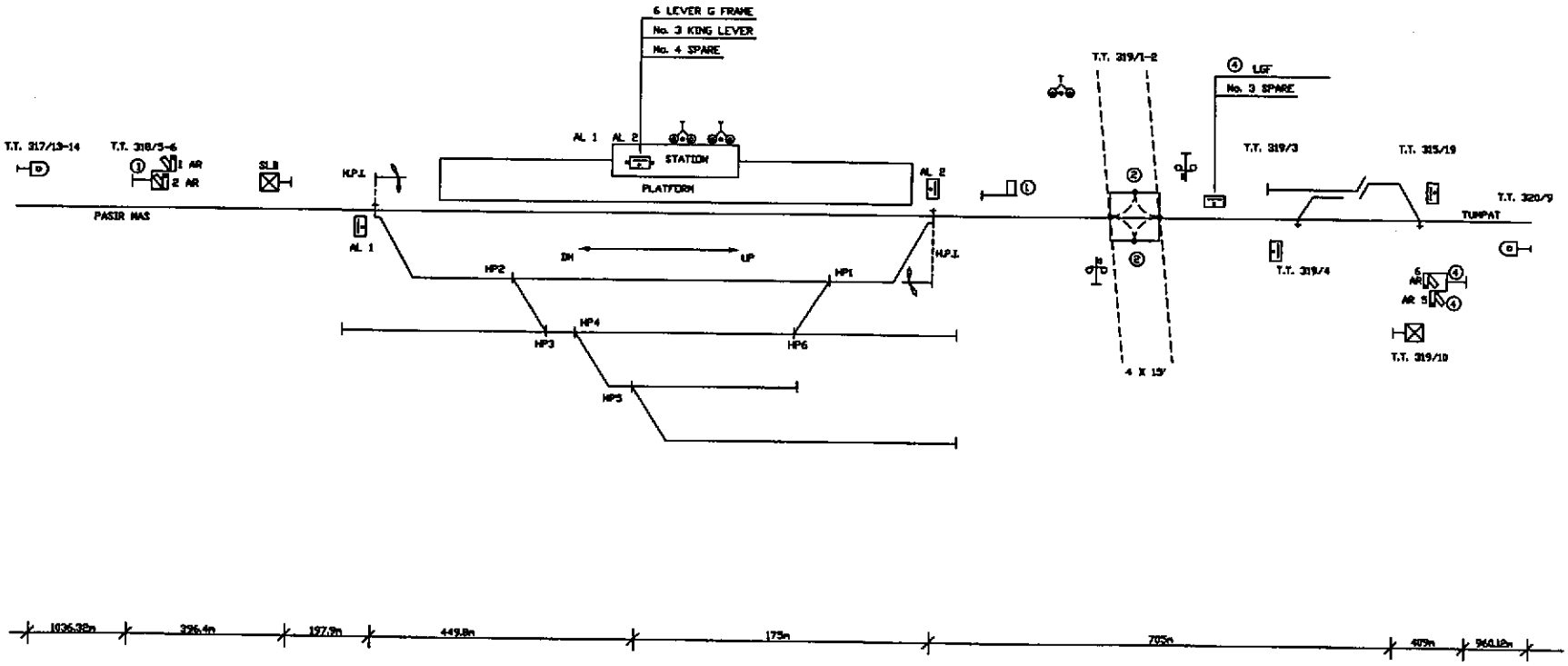
KTM / ICF KAISER	CAD FILE NO. MAS.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 101	
	REV. 0	SHEET NO. 101

WAKAF BAHRU

(HIGH POINT INDICATOR)

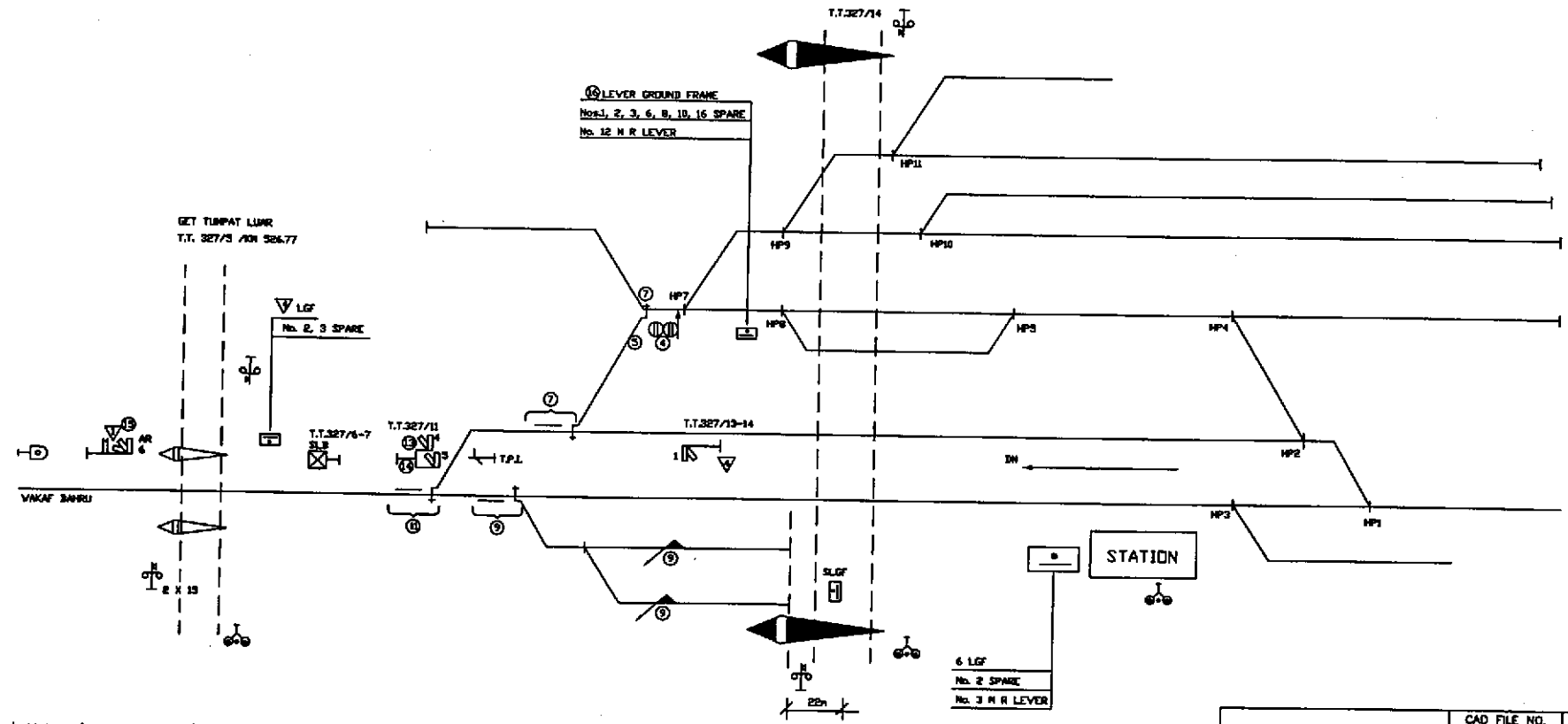
KM 513.7

(T.T. 318/20)



KTM / ICF KAISER	CAD FILE NO. BAHRU.dwg	CAD DATE 24/9/98
	DRAWING NO. KE 102	
	REV. 0	SHEET NO. 102

TUMPAT
(FULLY INTERLOCKED)
KM 527.7
(T.T. 327/15)



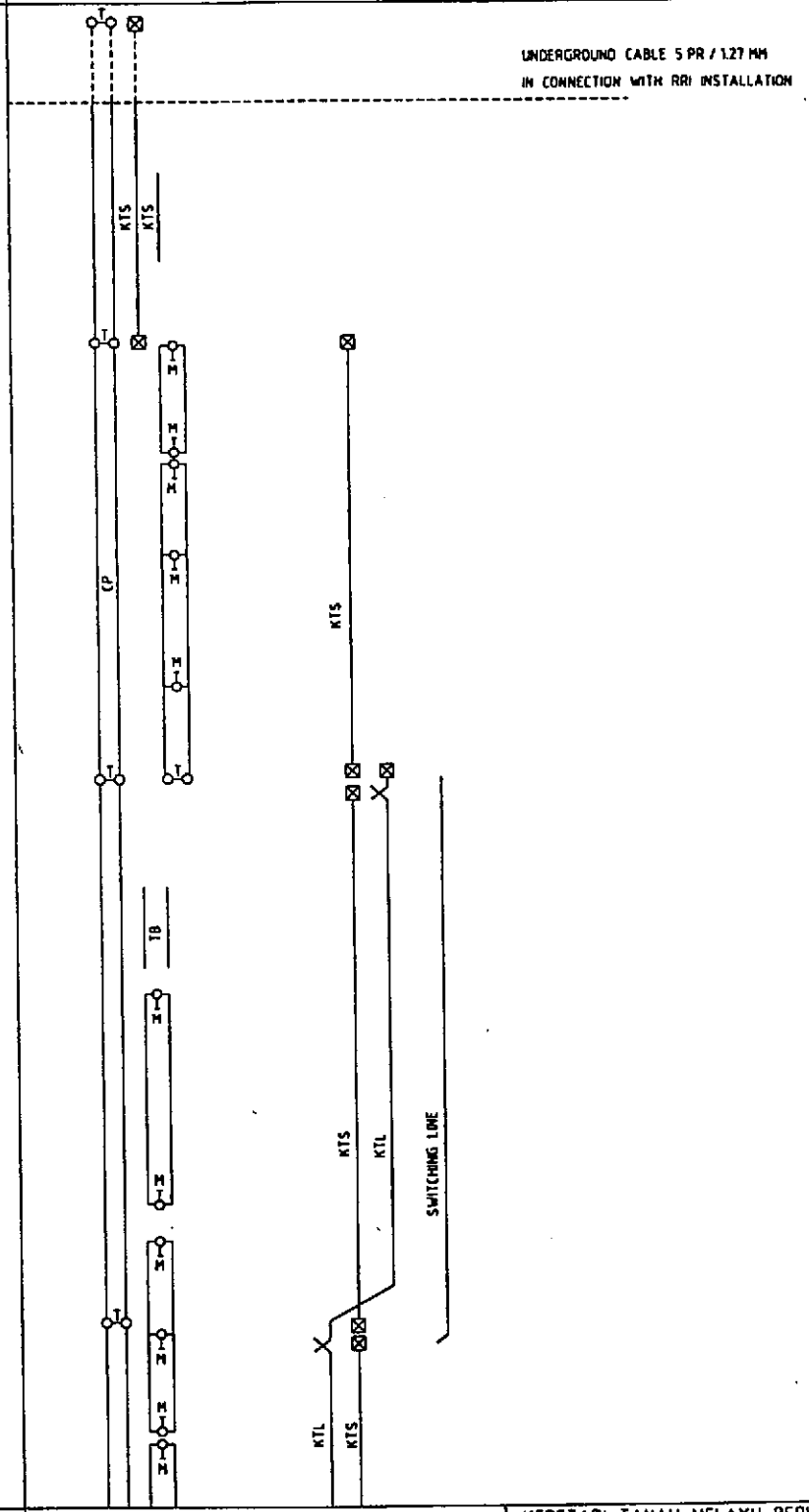
KTM

◆ ICF KAISER

CAD FILE NO.	CAD DATE
TUMPAT.dwg	24/9/98
DRAWING NO.	
KE 103	
REV.	SHEET NO.
0	103

Attachment B
Wire Line
Communications Inventory

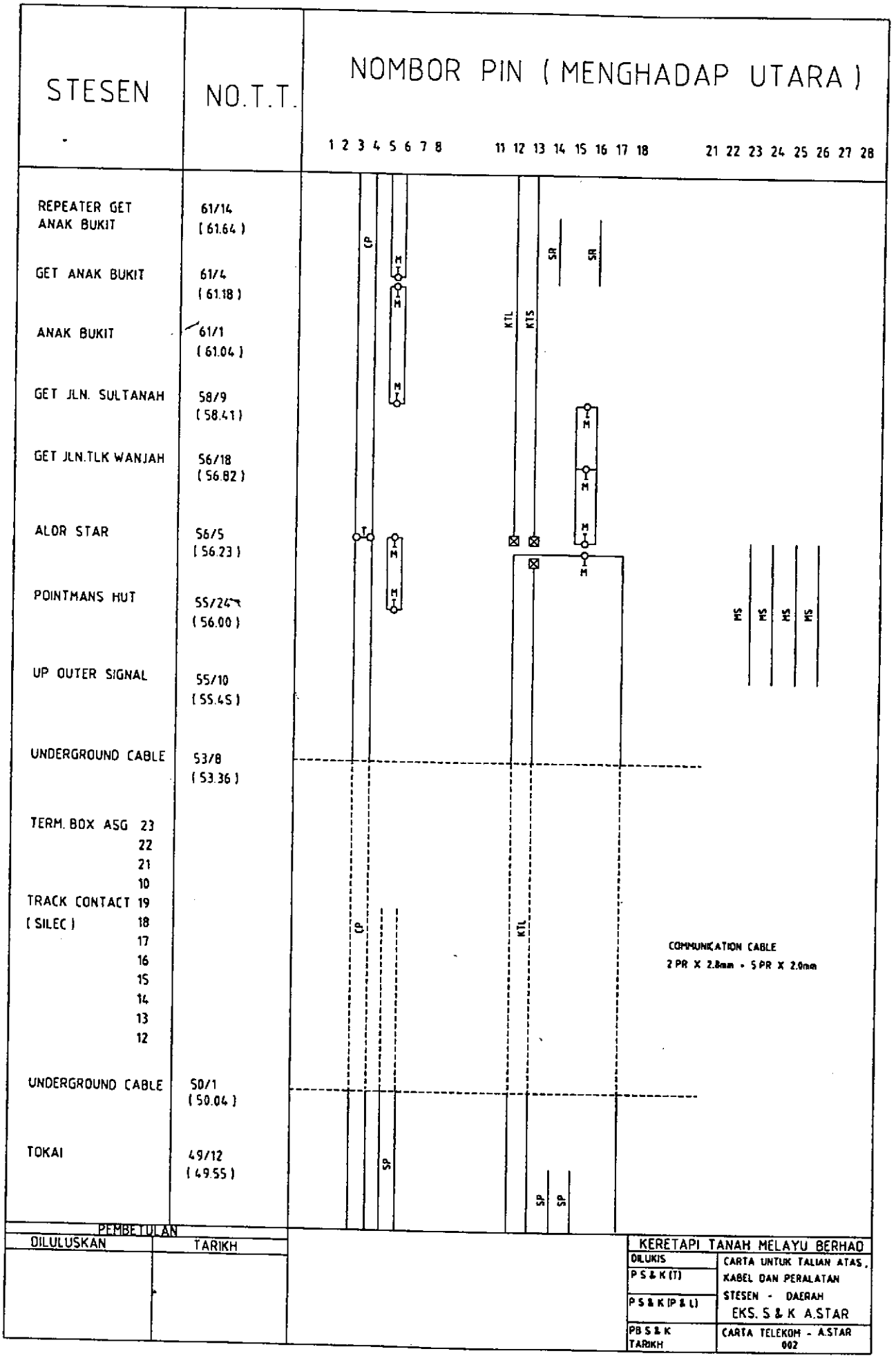
STESEN	NO.T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
PADANG BESAR	98/5 (98.23)	
DISTANT SIGNAL	96/13 (96.59)	
	95/12 (95.55)	
	90/1 (90.04)	
BUKIT KETRI	86/9 (86.41)	
GET TOKAYAMAN	83/15 (83.68)	
GET MATA AIR	82/17 (82.77)	
GET ARAU	81/3 (81.13)	
ARAU	80/1 (80.04)	
TRACK CONTACT (SILEC) GET KODIANG (U)	78/10 (78.45)	
GET KODIANG	75/10 (75.45)	
KODIANG	75/7 (75.32)	
GET AIR HITAM	68/14 (68.64)	
TUNJANG	67/7 (67.32)	
GET SG.KOROK	65/9 (65.4)	



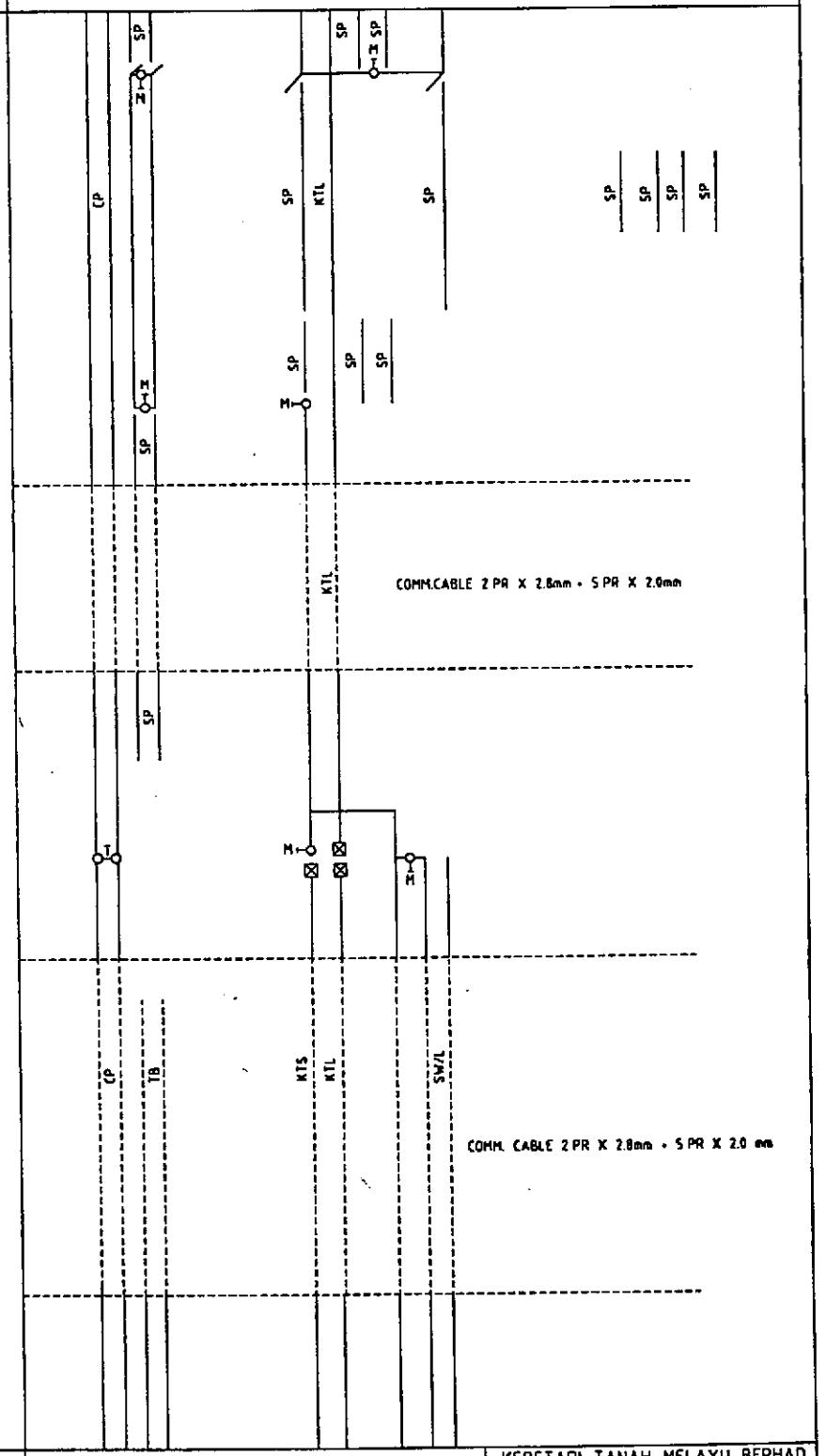
PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K A.STAR
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - A.STAR 001


STESEN
NO.T.T.
NOMBOR PIN (MENGHADAP UTARA)
1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
REPEATER GET ANAK BUKIT
61/14 (61.64)
GET ANAK BUKIT
61/4 (61.18)
ANAK BUKIT
61/1 (61.04)
GET JLN. SULTANAH
58/9 (58.41)
GET JLN.TLK WANJAH
56/18 (56.82)
ALOR STAR
56/5 (56.23)
POINTMANS HUT
55/24 (56.00)
UP OUTER SIGNAL
55/10 (55.45)
UNDERGROUND CABLE
53/8 (53.36)
TERM. BOX ASG 23
22
21
10
TRACK CONTACT 19
(SILEC) 18
17
16
15
14
13
12
UNDERGROUND CABLE
50/1 (50.04)
TOKAI
49/12 (49.55)
CP
KTL
KTS
SR
MS
SP
COMMUNICATION CABLE
2 PR X 2.8mm + 5 PR X 2.0mm
PEMBETULAN
DILULUSKAN
TARIKH
KERETAPI TANAH MELAYU BERHAD
DILUKIS
P S & K (T)
P S & K (P & L)
PB S & K
TARIKH
CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN
STESEN - DAERAH
EKS. S & K A.STAR
CARTA TELEKOM - A.STAR
002

STESEN	NO.T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
GET	49/8 (49.36)	
SEM. LUAR TURUN	45/18 (45.82)	
POIN UTARA	45/9 (45.41)	
KOBAH STATION	45/2 (45.09)	
GET	44/20 (44.91)	
UNDERGROUND CABLE	42/19 (42.86)	
TERMINAL BOX ASG 11 10 9		
UNDERGROUND CABLE	42/8 (42.36)	
TRACK CONTACT (SILEC)	41/20 (41.91)	
JUNUN	39/14 (39.64)	
UNDERGROUND CABLE TERMINAL BOX ASG 8 TRACK CONTACT (SILEC) ASG 7 ASG 6 ASG 5 ASG 4 ASG 3 ASG 2	39/5 (39.23)	
UNDERGROUND CABLE ASG 1	37/3 (37.14)	



PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD	
DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K A.STAR
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - A.STAR 003

STESEN	NO.T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
GET	36/8 (36.36)	
GURUN	34/1 (34.04)	
GET	33/18 (33.82)	
UNDERGROUND CABLE	30/21 (30.95)	COMM. CABLE 2 PR X 2.8 mm + 5 PR X 2.0 mm
UNDERGROUND CABLE	30/18 (30.82)	
GET	27/9 (27.41)	
BEDONG	27/6 (27.27)	
UP OUTER SIGNAL	26/16 (26.73)	
UNDERGROUND CABLE	26/5 (26.18)	5 PR / 1.27 mm U/G CABLE
UNDERGROUND CABLE	26/2 (26.09)	
DOWN OUTER SIGNAL	21/13 (21.59)	
SUNGAI PETANI.	21/1 (21.04)	
GET	20/23 (21.00)	

CP KTS KTL MP SP SW/L SR

TOTAL O/H WIRE

TYPE	LENGTH
CP	138.84
KTS	62.16
KTL	52.87
MP	105.07
MS	3.12
SR	3.10
SW/L	22.87
TB	7.56
	395.59

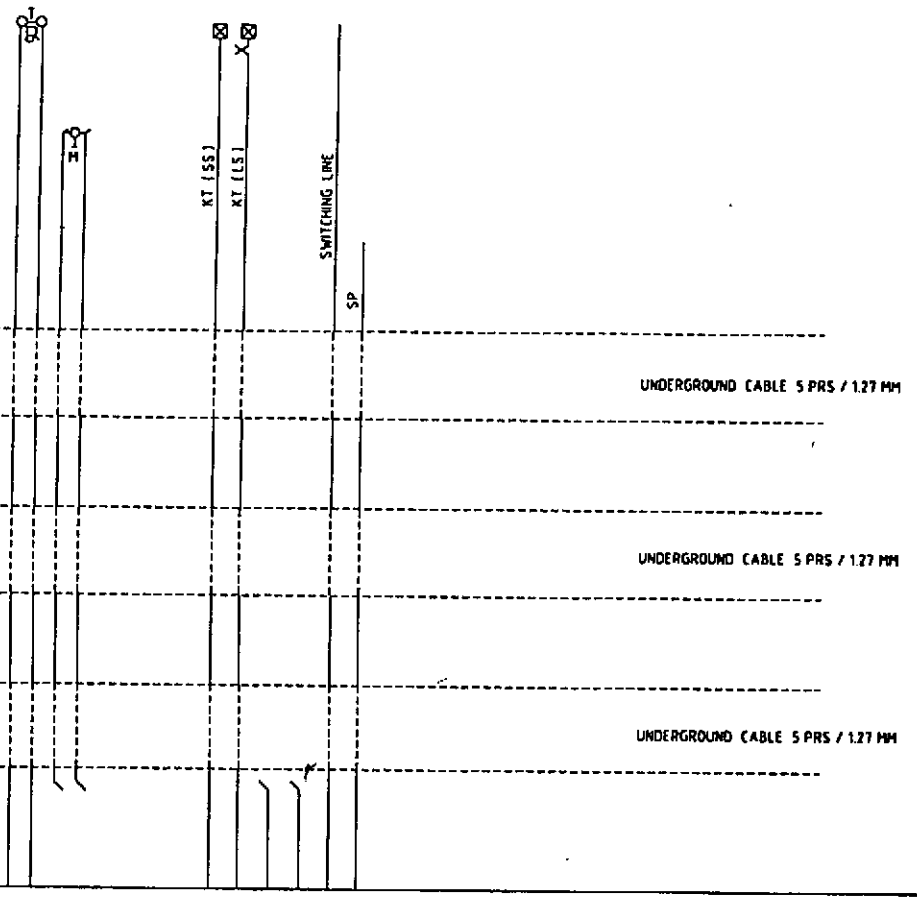
SINGLE - WIRE - MILE

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K A.STAR
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - A.STAR 004

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
SG.PETANI	21/1 (21.04)	
GATE AT L.C.	20/22 (21.00)	
UP OUTER SIGNAL	20/12 (20.55)	
	19/1 (19.04)	
	18/25 (19.00)	
	18/5 (18.20)	
	18/4 (18.16)	
	18/2 (18.08)	
	18/1 (18.04)	

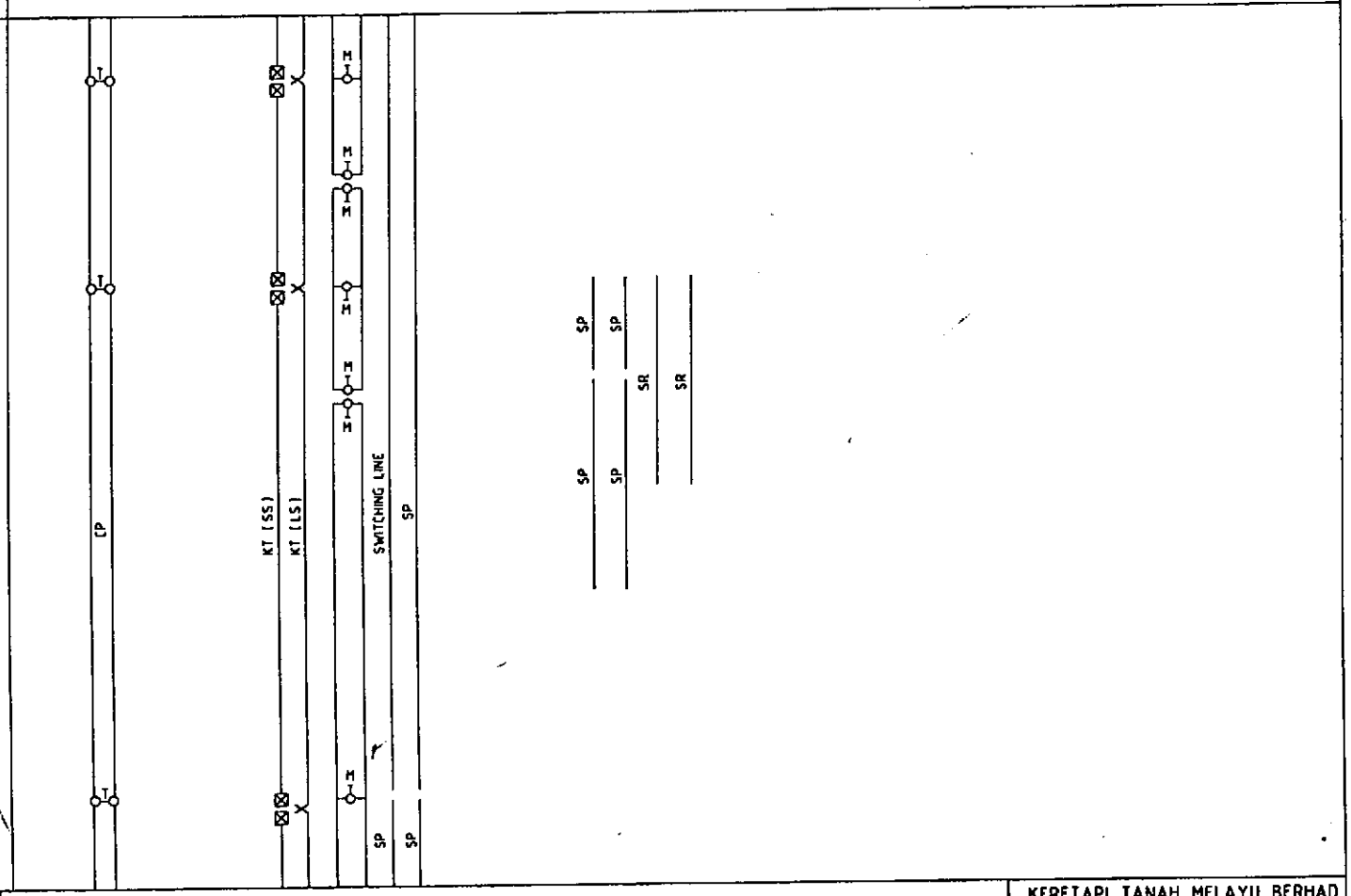


PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K B.MERTAJAM
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - B.MERTAJAM 001

STESEN	NO. T.T.
PINANG TUNGGAL	14/21 (14.95)
GATE AT L.C.	14/15 (14.68)
TASEK GLUGOR	9/12 (9.55)
GATE AT L.C.	9/8 (9.36)
SIGNAL POST	8/21 (8.95)
	7/8 (7.36)
GATE AT L.C.	6/24 (7.00)
PENANTI	4/1 (4.04)



PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS.
P S & K (T)	KABEL DAN PERALATAN
P S & K (P & L)	STESEN - DAERAH EKS. S & K B.MERTAJAM
PB S & K TARIKH	CARTA TELEKOM - B.MERTAJAM 002

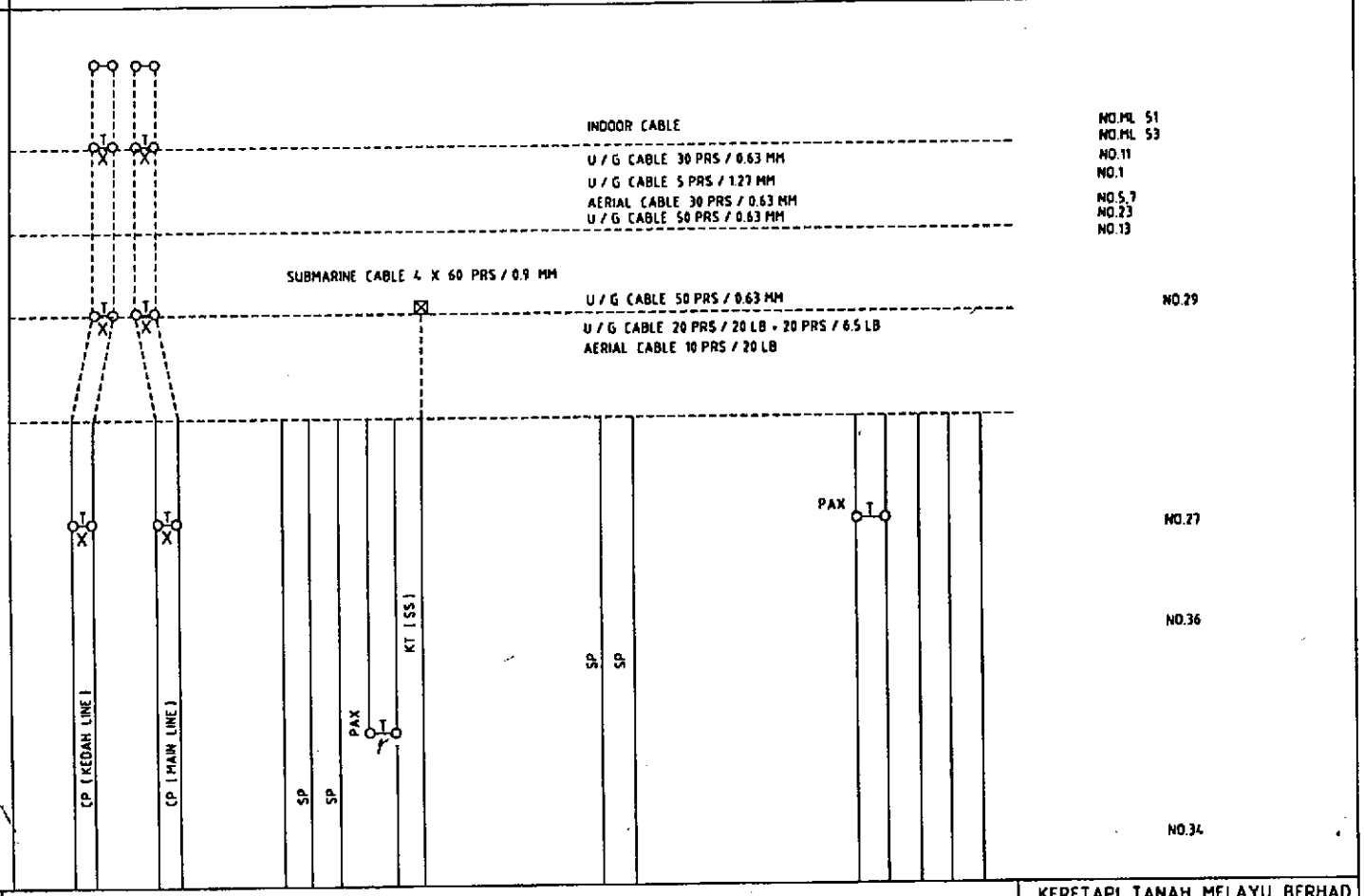
STLSEN	NO. T.T.
GATE AT L.C.	3/21 (3.95)
UP OUTER	3/16 (3.75)
	3/14 (3.64)
	3/12 (3.55)
GATE AT L.C.	2/12 (2.55)
GATE AT L.C.	1/15 (1.86)
DOWN BRANCH OUTER	0/14 (0.64)
ADVANCED STARTER	0/8 (0.38)
KEDAH BRANCH POLE	6/21 (6.95)

NOMBOR PIN (MENGHADAP UTARA)

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD	
DILUKIS 13/6	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH
P S & K (T) 13/6/98	
P S & K (P & L) 16/6/98	EKS. S & K B.MERTAJAM
PB S & K TARIKH 16/6	CARTA TELEKOM - B.MERTAJAM 003

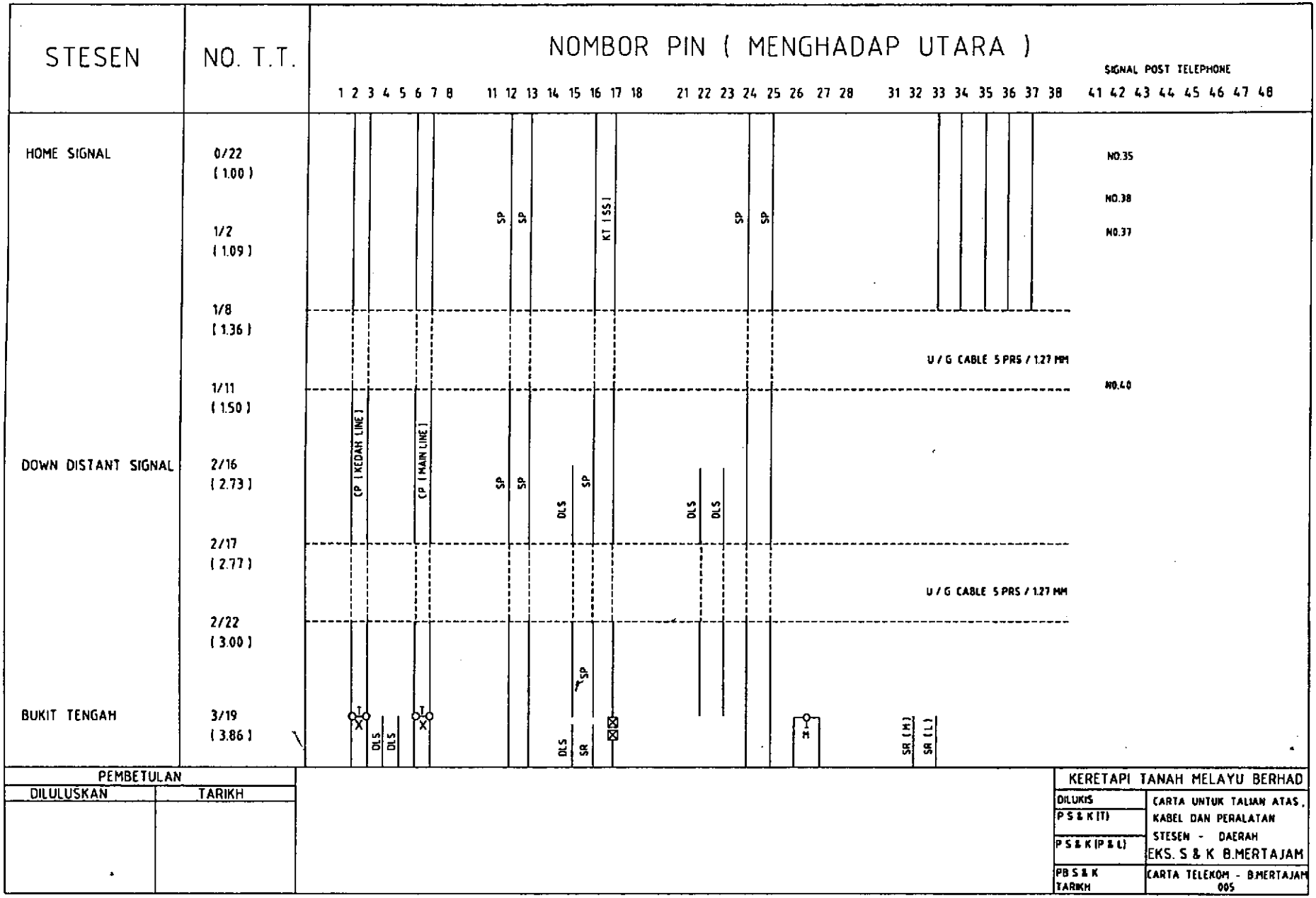
STESEN	NO. T.T.
B/W CONTROL OFFICE	
B/W DTS OFFICE	
B/W RLY. STATIDN	
B/W RELAY HUT	
B/W PIER	
PRAI PIER	
PRAI CABIN	0/3 (0.12)
OP POLE	0/7 (0.32)
PRAI YARD MASTER HUT	0/11 (0.50)
	0/12 (0.55)
CALTEX P'MANS HUT	0/15 (0.68)
	0/20 (0.91)



PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

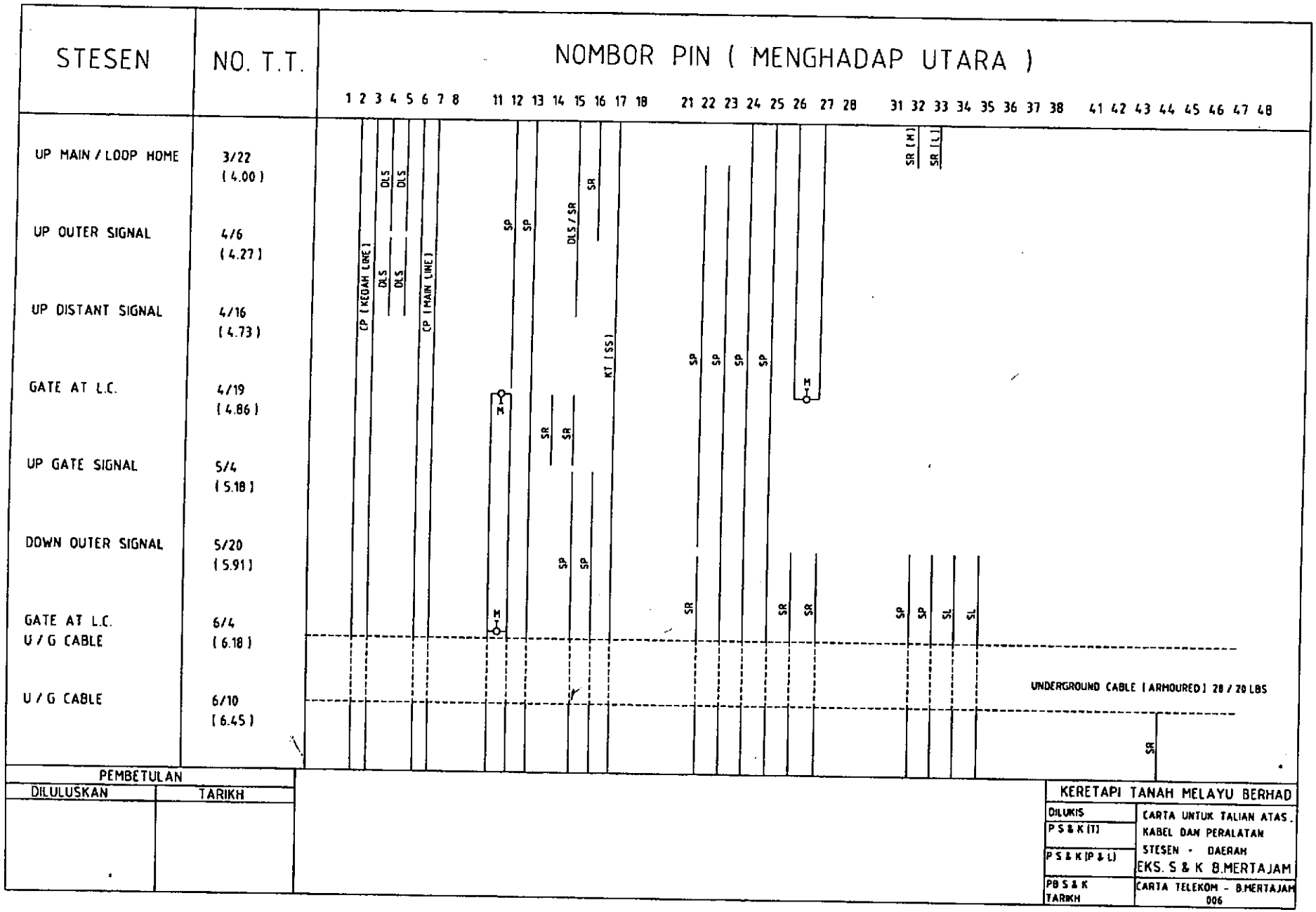
DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K B.MERTAJAM
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - B.MERTAJAM 004



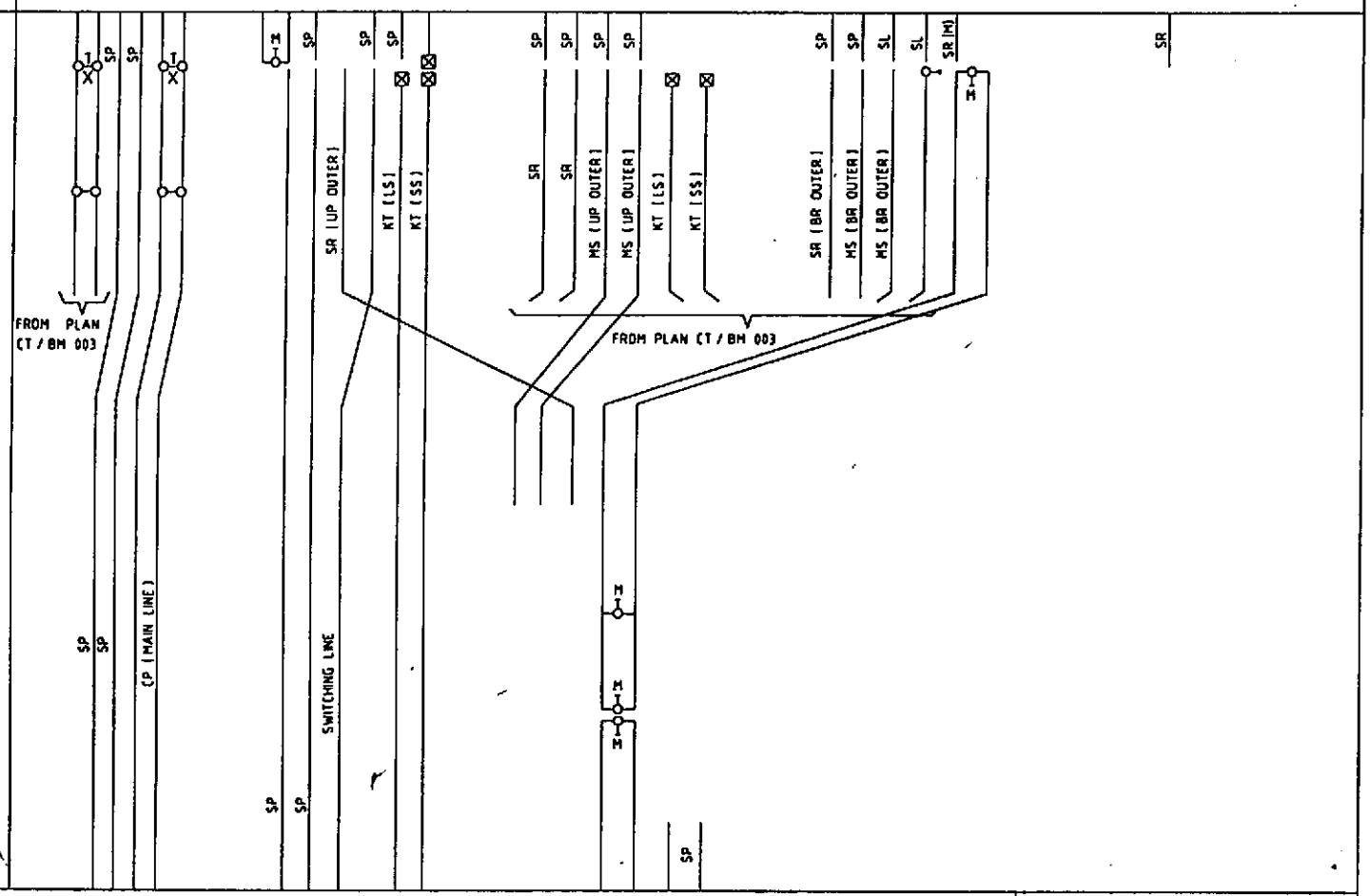
PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K B.MERTAJAM
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - B.MERTAJAM 005


STESEN
NO. T.T.
NOMBOR PIN (MENGHADAP UTARA)
1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
UP MAIN / LOOP HOME
3/22
(4.00)
UP OUTER SIGNAL
4/6
(4.27)
UP DISTANT SIGNAL
4/16
(4.73)
GATE AT L.C.
4/19
(4.86)
UP GATE SIGNAL
5/4
(5.18)
DOWN OUTER SIGNAL
5/20
(5.91)
GATE AT L.C.
U / G CABLE
6/4
(6.18)
U / G CABLE
6/10
(6.45)
CP (KEDAH LINE)
CP (MAIN LINE)
DLS
SP
SR
KT (SS)
SR (M)
SR (L)
SL
UNDERGROUND CABLE (ARMOURED) 28 / 20 LBS
PEMBETULAN
DILULUSKAN
TARIKH
KERETAPI TANAH MELAYU BERHAD
DILUKIS
P S & K (T)
P S & K (P & L)
PB S & K
TARIKH
CARTA UNTUK TALIAN ATAS.
KABEL DAN PERALATAN
STESEN - DAERAH
EKS. S & K B.MERTAJAM
CARTA TELEKOM - B.MERTAJAM
006

STESEN	NO. T.T.
BUKIT MERTAJAM	6/13 (6.59)
E S & K OFFICE	6/19 (6.77)
KEDAH BRANCH POLE	6/21 (6.95)
KEDAH BRANCH POLE	6/22 (7.00)
UP MAIN OUTER SIGNAL	7/7 (7.32)
GATE AT L.C.	7/20 (7.91)
GATE AT L.C.	8/12 (8.55)
	9/16 (9.73)

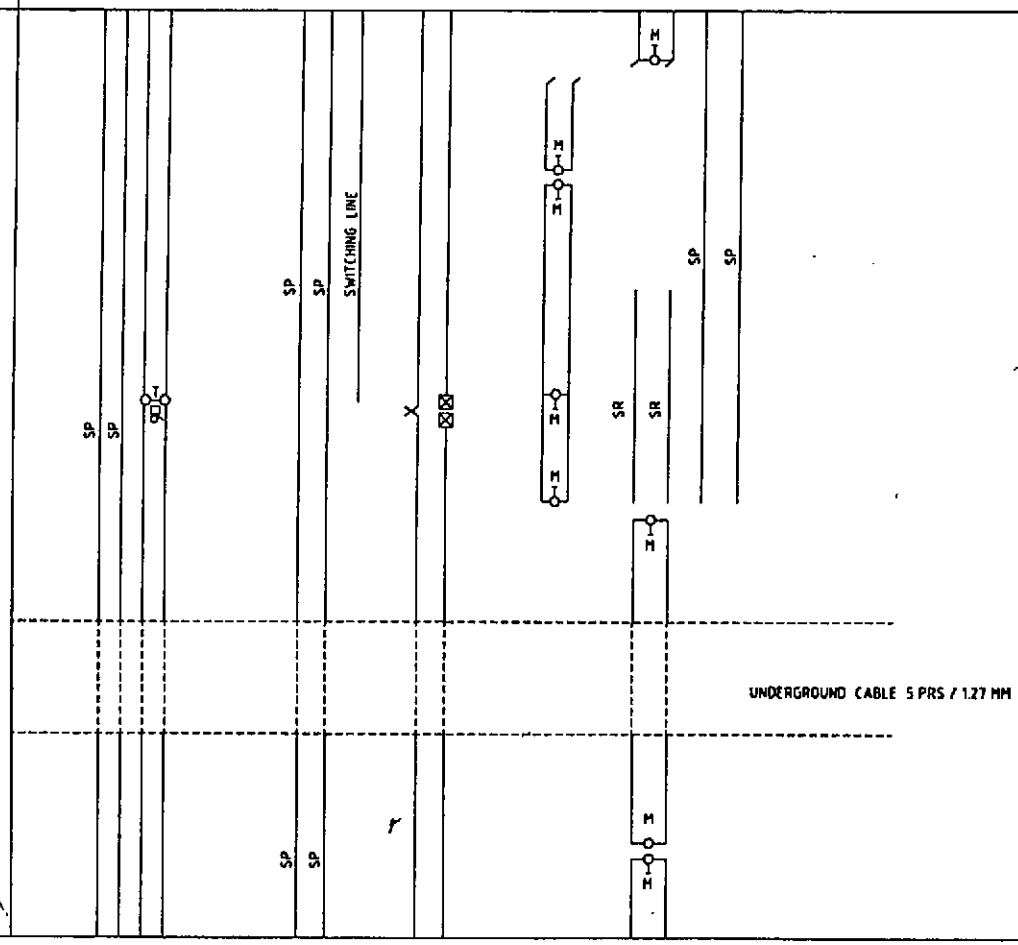


PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH
P S & K (T)	
P S & K (P & L)	EKS. S & K B.MERTAJAM
PB S & K TARIKH	CARTA TELEKOM - B.MERTAJAM 007

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
GATE AT L.C.	10/14 (10.64)	
GATE AT L.C. (N2)	11/9 (11.41)	
DOWN OUTER SIGNAL	11/11 (11.50)	
SIMPANG AMPAT	12/1 (12.04)	
GATE AT L.C.	12/5 (12.23)	
	14/1 (14.04)	
	14/2 (14.09)	
GATE AT L.C.	15/9 (15.41)	

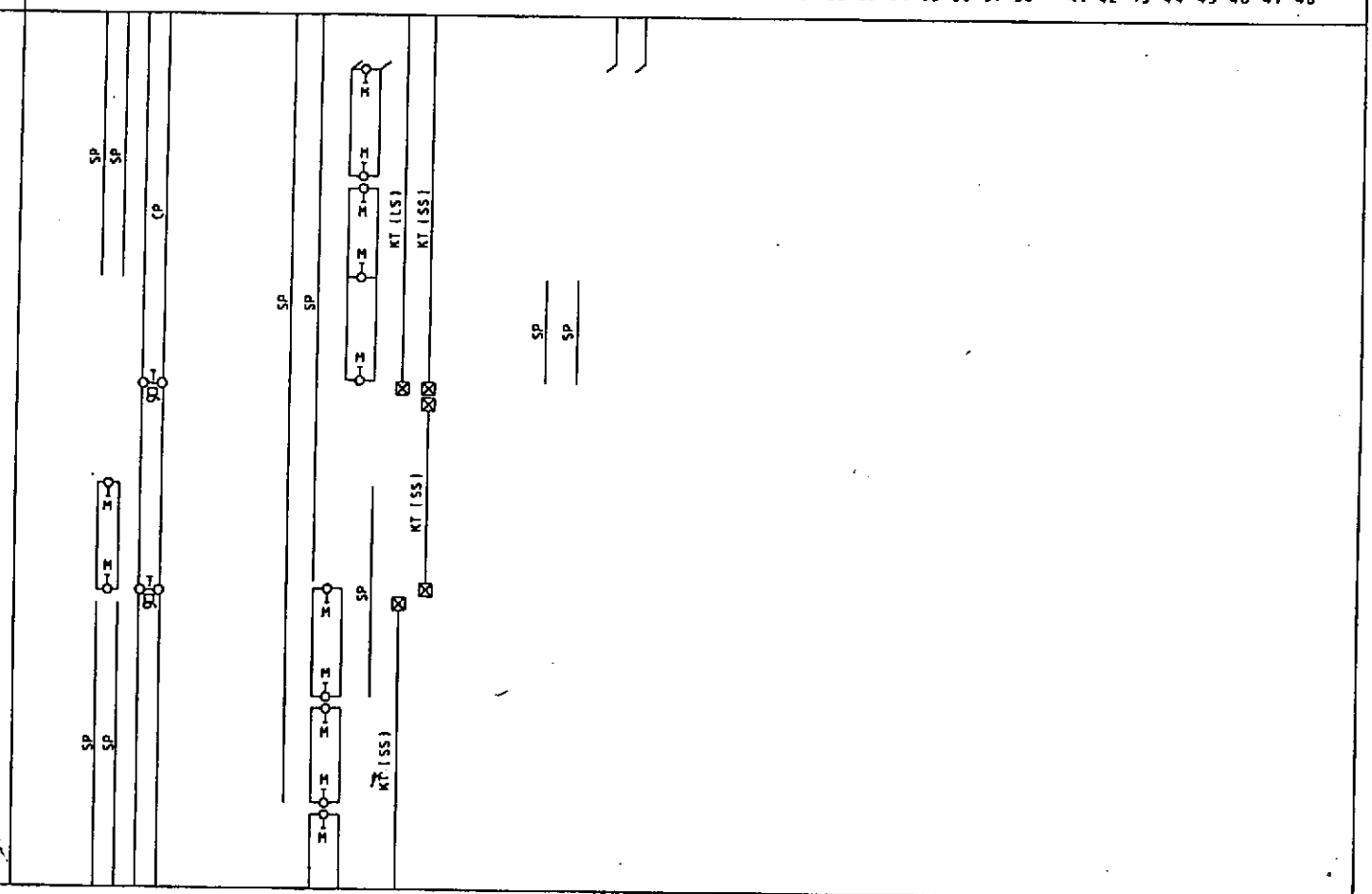


PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K B.MERTAJAM
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - B.MERTAJAM 008

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
GATE AT L.C.	16/13 (16.59)	
GATE AT L.C.	17/18 (17.82)	
GATE AT L.C.	20/6 (20.27)	
NIBONG TEBAL	20/10 (20.45)	
GATE AT L.C.	23/1 (23.04)	
PARIT BUNTAR	23/6 (23.27)	
GATE AT L.C.	23/16 (23.73)	
GATE AT L.C.	25/17 (25.77)	

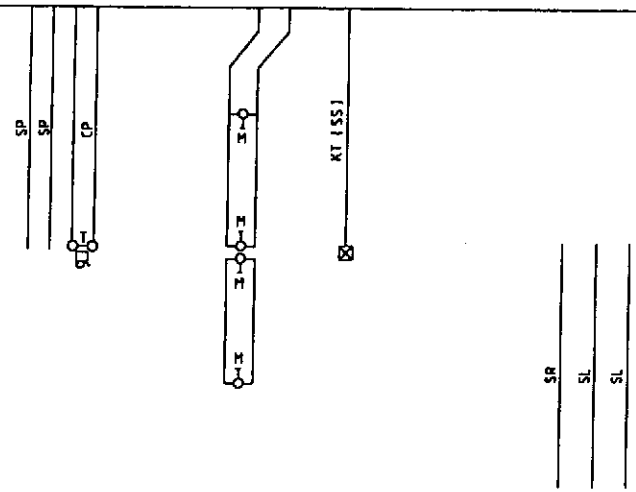


PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K B.MERTAJAM
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - B.MERTAJAM 009

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
GATE AT L.C.	28/19 (28.86)	
BAGAN SERAI	31/11 (31.50)	
GATE AT L.C.	32/3 (32.14)	
UP OUTER SIGNAL	32/9 (32.41)	



TOTAL O/H WIRE

TYPE	LENGTH
CP	115.06
DLS	5.19
KTS	51.72
KTL	34.72
MP	91.52
MS	1.92
SLOT	4.77
SR	6.90
SW/L	17.80
	329.60 SINGLE - WIRE - MILE

PEMBETULAN	
DILULUSKAN	TARIKH

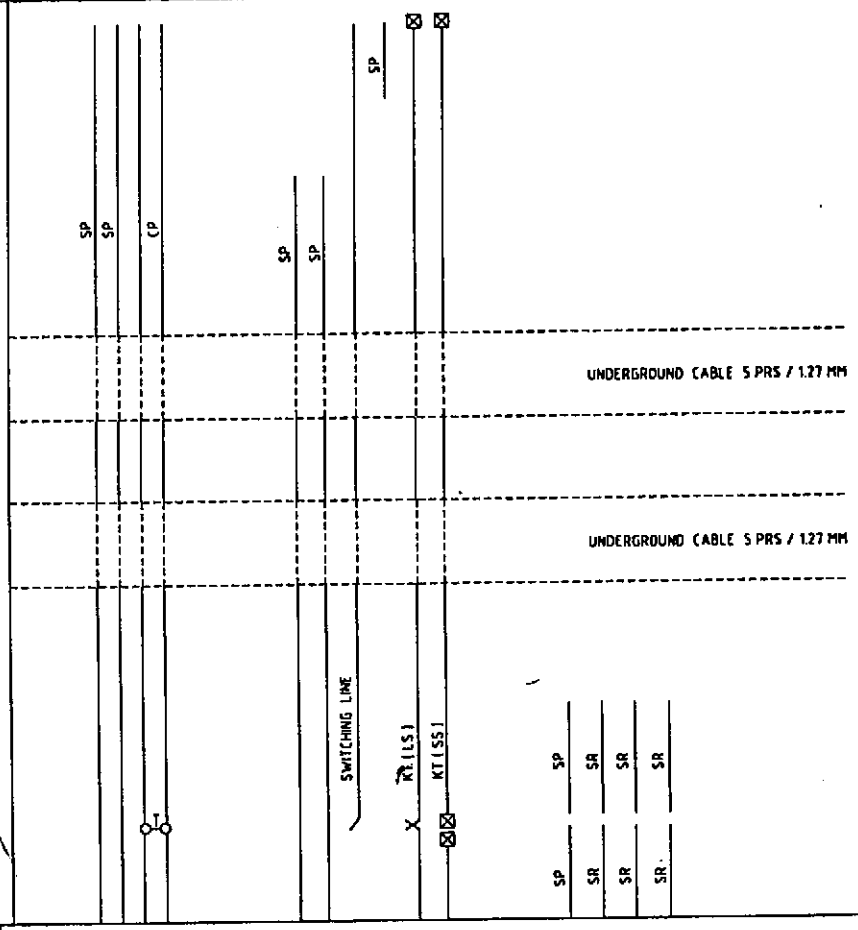
KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K B.MERTAJAM
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - B.MERTAJAM 010

STESEN	NO. T.T.
BAGAN SERAI	31/11 (31.50)
GATE AT L.C.	32/3 (32.14)
UP OUTER SIGNAL	32/9 (32.41)
ALOR PUNGSU	36/15 (36.68)
UNDERGROUND CABLE	36/19 (36.86)
UNDERGROUND CABLE	36/21 (36.95)
UNDERGROUND CABLE	37/7 (37.32)
UNDERGROUND CABLE	37/8 (37.36)
DOWN OUTER AND WARNER	40/5 (40.23)
BUKIT MERAH	40/17 (40.77)

NOMBOR PIN (MENGHADAP UTARA)

1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48

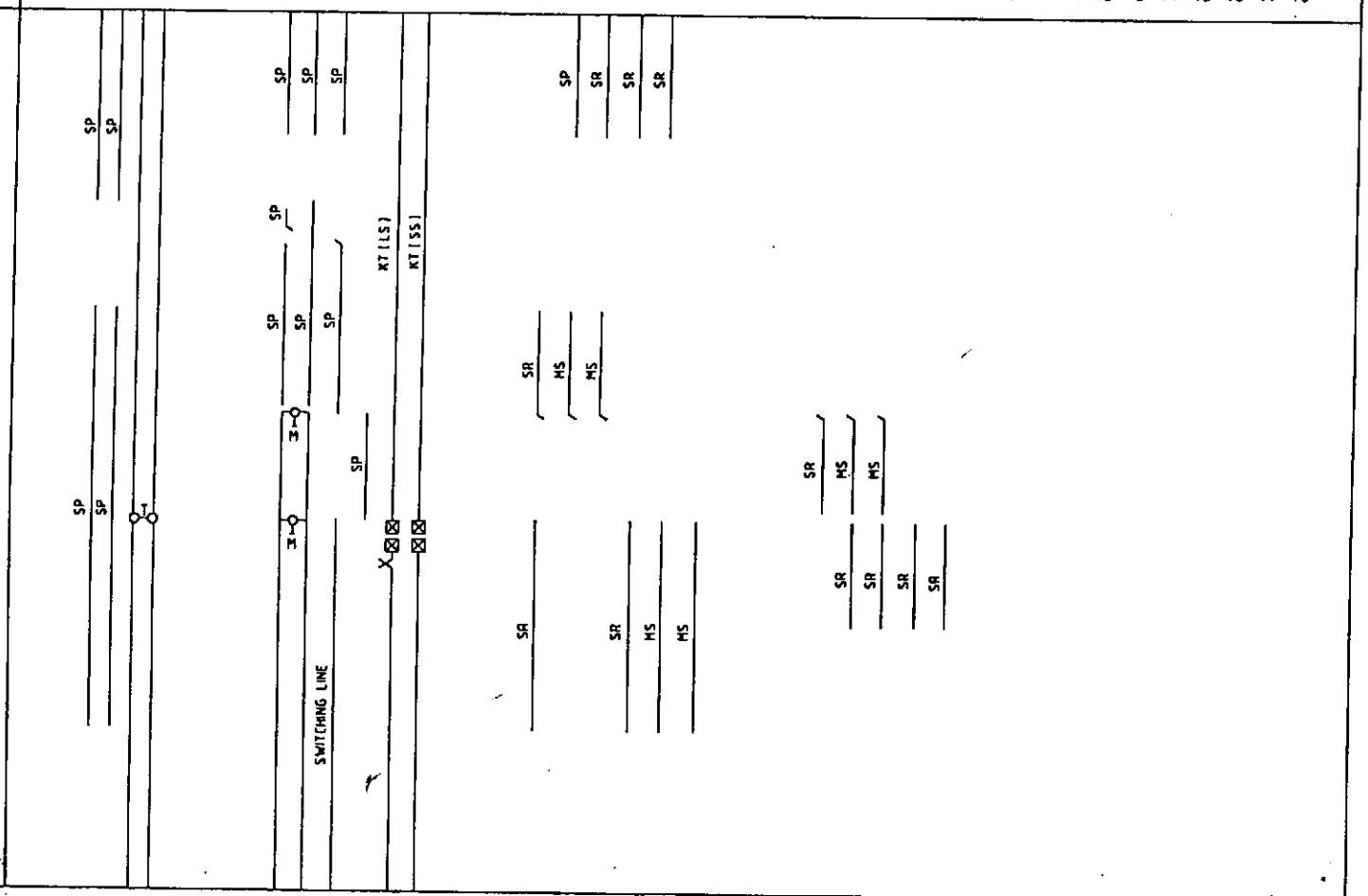


PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TAIPING
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TAIPING 001

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
OP BOX	40/19 (40.86)	
UP OUTER AND WARNER	41/6 (41.27)	
DOWN OUTER SIGNAL	46/13 (46.59)	
GATE AT L.C.	46/20 (46.91)	
PONDOK TANJUNG	47/1 (47.04)	
UP HOME SIGNAL	47/7 (47.32)	
UP OUTER SIGNAL	47/15 (47.68)	
OP BOX	48/12 (48.55)	

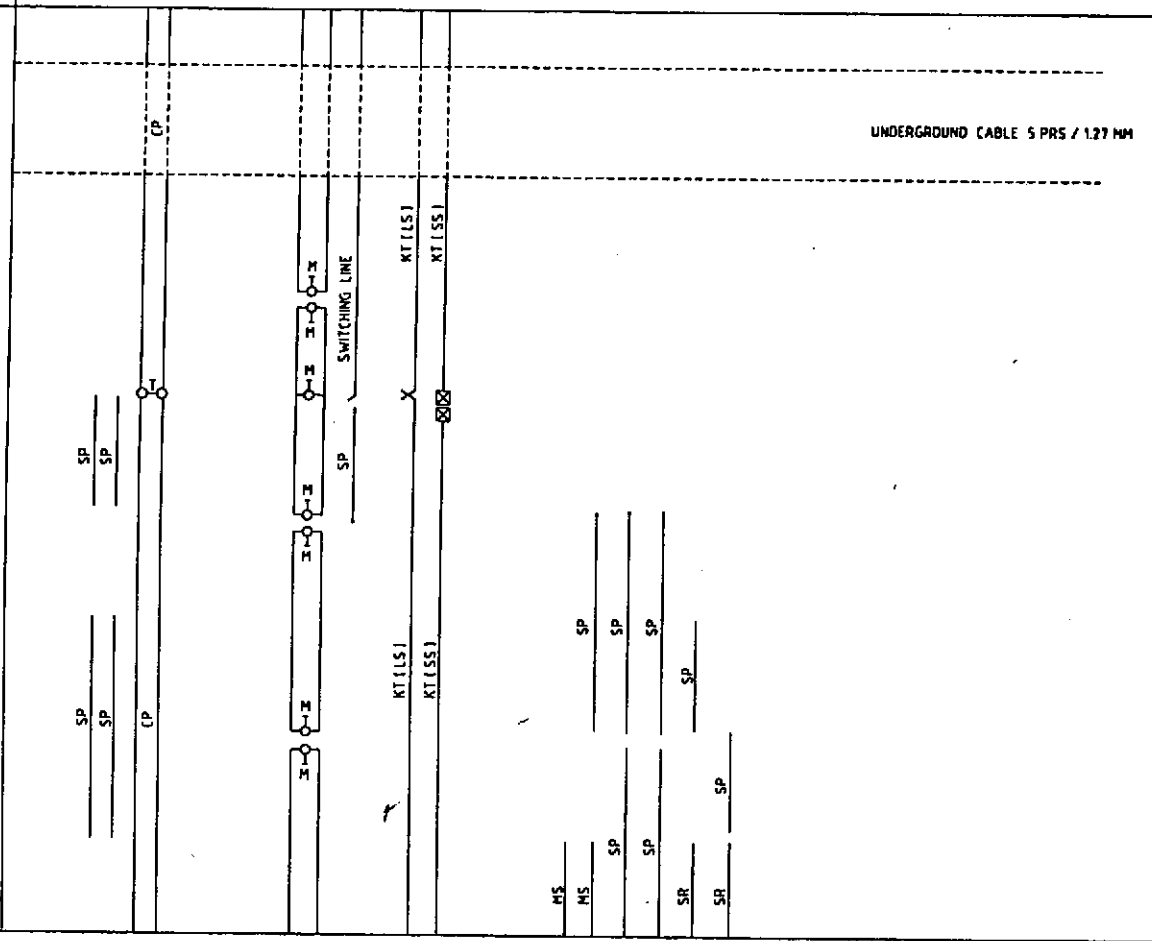


PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TAIPING
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TAIPING 002

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
	50/19 (50.86)	
DP BOX	50/20 (50.91)	
GATE AT L.C. DP BOX	52/13 (52.59)	
KAMUNTING	55/4 (55.18)	
GATE AT L.C.	55/9 (55.41)	
	57/19 (57.86)	
GATE AT L.C.	58/3 (58.14)	
DOWN OUTER SIGNAL	58/16 (58.73)	

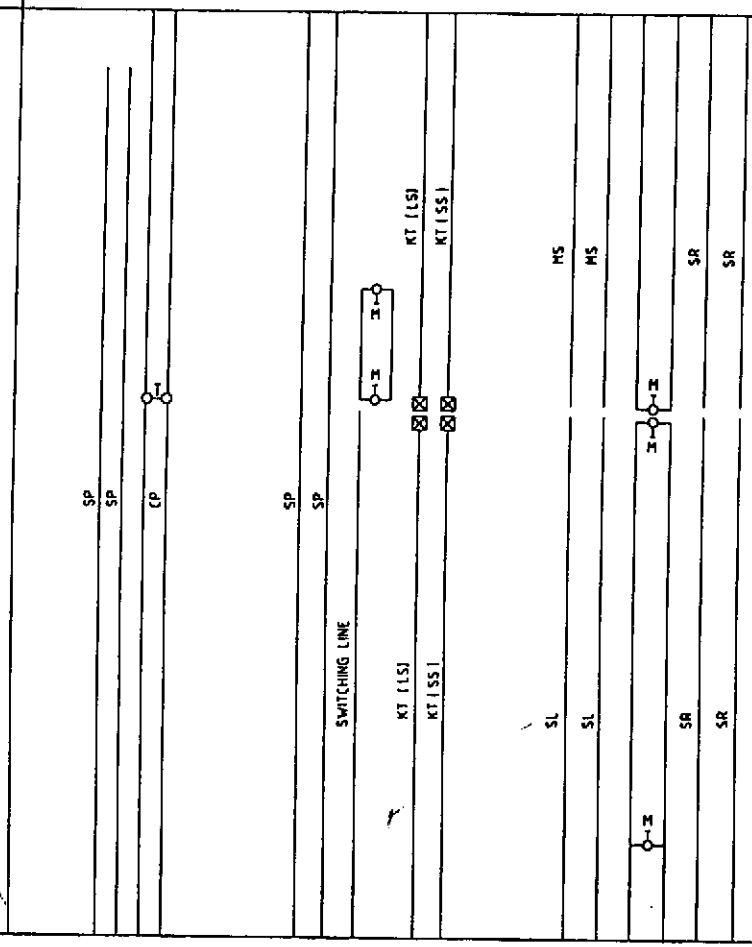


PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD	
DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TAIPING
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TAIPING 003

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
OP BOX	58/27 (58.23)	
GATE AT L.C.	58/28 (58.27)	
PWI'S OFFICE OP BOX	59/1 (59.04)	
TAIPING	59/5 (59.23)	
Y.F. OFFICE	59/5 (59.32)	
OP BOX	59/7 (59.32)	
LOCO	59/11 (59.50)	
GATE AT L.C.	59/15 (59.68)	

1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48



PEMBETULAN	
DILULUSKAN	TARIKH

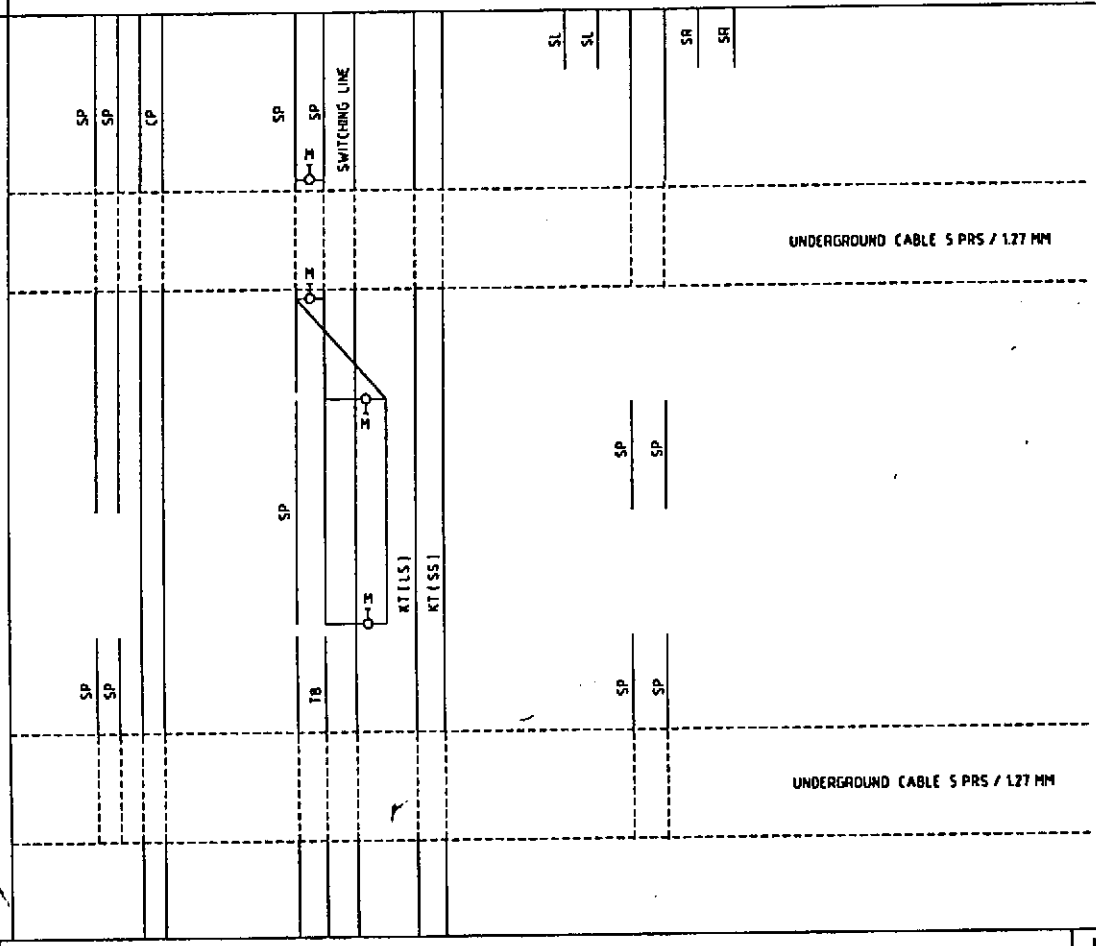
KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TAIPING
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TAIPING 004

STESEN	NO. T.T.
UP OUTER SIGNAL	59/17 (59.77)
GATE AT L.C.	59/28 (60.00)
	60/1 (60.04)
GATE AT L.C.	60/11 (60.50)
	60/21 (60.95)
GATE AT L.C. OP BOX	62/11 (62.50)
	63/16 (63.73)
	63/27 (64.00)

NOMBOR PIN (MENGHADAP UTARA)

1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48



PEMBETULAN	
DILULUSKAN	TARIKH

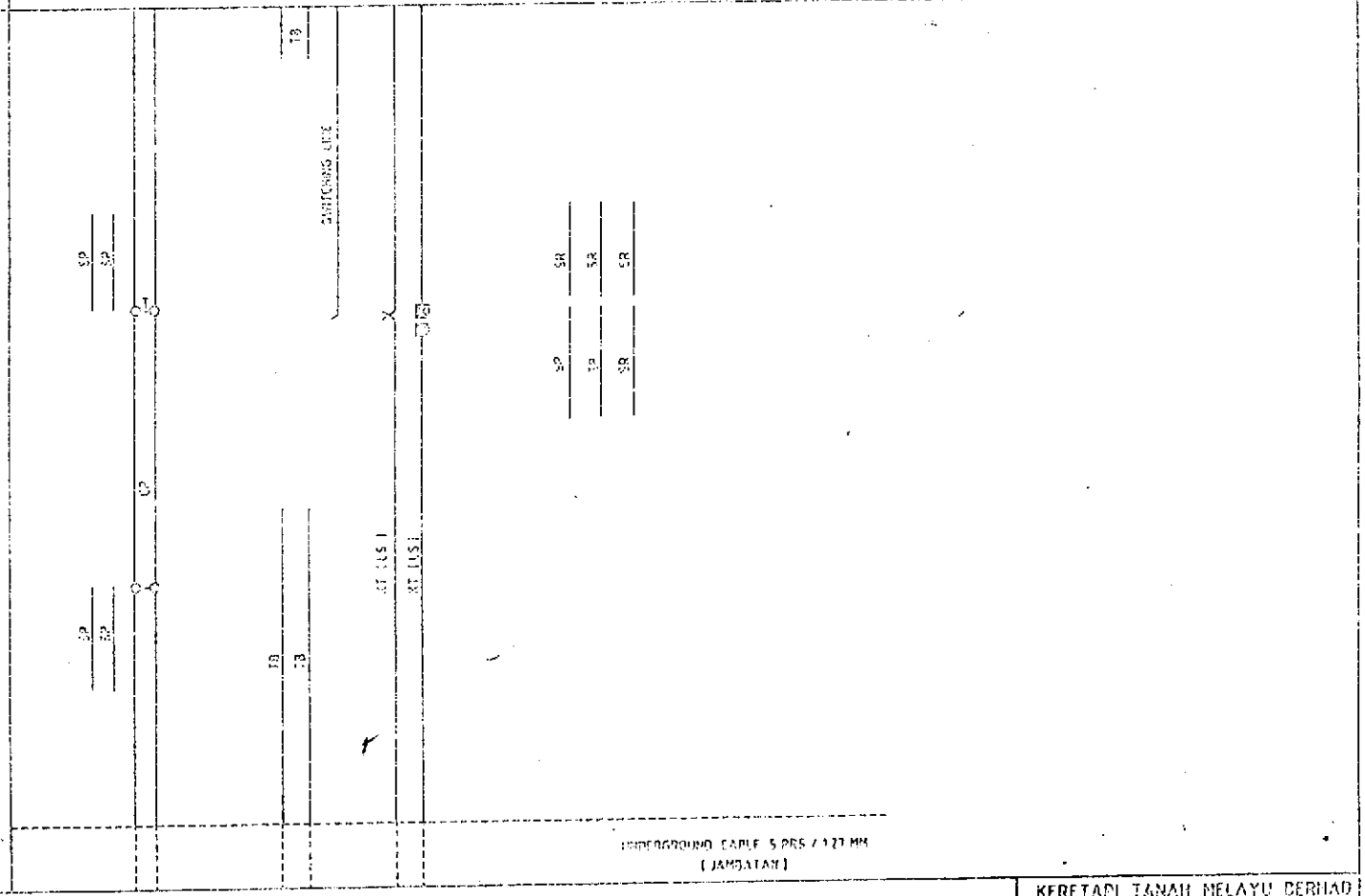
KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS. KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TAIPING
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TAIPING 005

STESEN	NO. T T.
TRACK CONTACT (SIL.CO)	55/11 (55.50)
DP BOX	55/27 (56.00)
DOWN OUTER SIGNAL	57/25 (58.14)
BUKIT BERAPIT	57/40 (58.00)
UP OUTER SIGNAL	60/16 (60.73)
TRACK CONTACT (SIL.CO)	60/21 (60.85)
DP BOX	59/1 (59.04)
	59/6 (59.27)
	70/20 (70.91)

NOMBOR PIN (MENGHADAP UTARA)

1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48



PEMBETULAN

DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN
P.S.& K (T)	STESEN - DAERAH
P.S.& K (P & L)	EKS. S & K. TAIPING
PB S & K TARIKH	CARTA TELEFON - TAIPING 006

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
	70/21 (70.96)	UNDERGROUND CABLE 5 PRS / 1.27 MM (JAMBATAN)
DOWN OUTER SIGNAL		SP SP CP TB TB KT (LS) KT (SS) SP SP SP SP SP SP
GATE AT L.C.	71/3 (71.14)	
GATE AT L.C.	71/15 (71.64)	
PADANG RENGAS	71/20 (71.91)	
UP OUTER SIGNAL	72/5 (72.23)	
DP BOX	74/2 (74.09)	
DP BOX	75/8 (75.36)	UNDERGROUND CABLE 5 PRS / 1.27 MM
DP BOX	75/10 (75.45)	SP SP TB TB

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS. KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TAIPING
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TAIPING 007

STESEN	NO T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
GATE AT L.C	77/1 (77.18)	
DOWN OUTER SIGNAL	77/9 (77.61)	
KUALA KANGSAR	77/23 (76.80)	
UP HOME 1,2,3	78/5 (78.23)	
UP OUTER AND WARNER SIGNAL	78/11 (78.64)	

TOTAL O/H WIRE

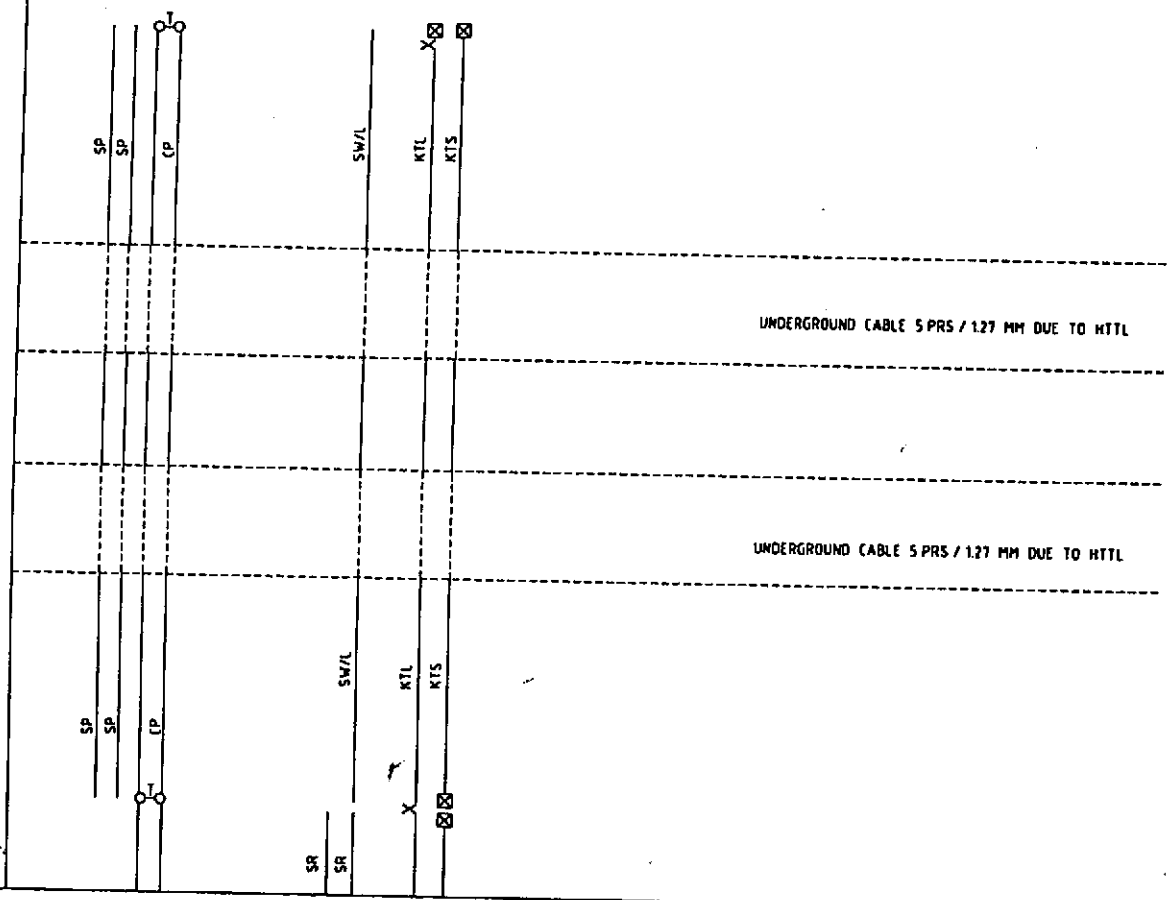
TYPE	LENGTH
CP	92.20
KTL	40.01
KTS	46.10
MP	32.82
MS	9.99
SR	11.87
SW/L	17.28
TB	6.46
	256.73 SINGLE - WIRE - MILE

PENYEDIAAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS, S & K TAIPING
P S & T (I)	
P S & K (P & L)	
P S & K TARIKH	CARTA TELEFON - TAIPING 093

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
KUALA KANGSAR	77/23 (78.00)	
UP OUTER AND WARNER SIGNAL	78/13 (78.59)	
	81/5 (81.23)	
	81/7 (81.32)	
	84/20 (84.91)	
	85/2 (85.09)	
RUMAH KETUA STESEN	86/18 (86.82)	
SALAK UTARA	86/20 (86.82)	

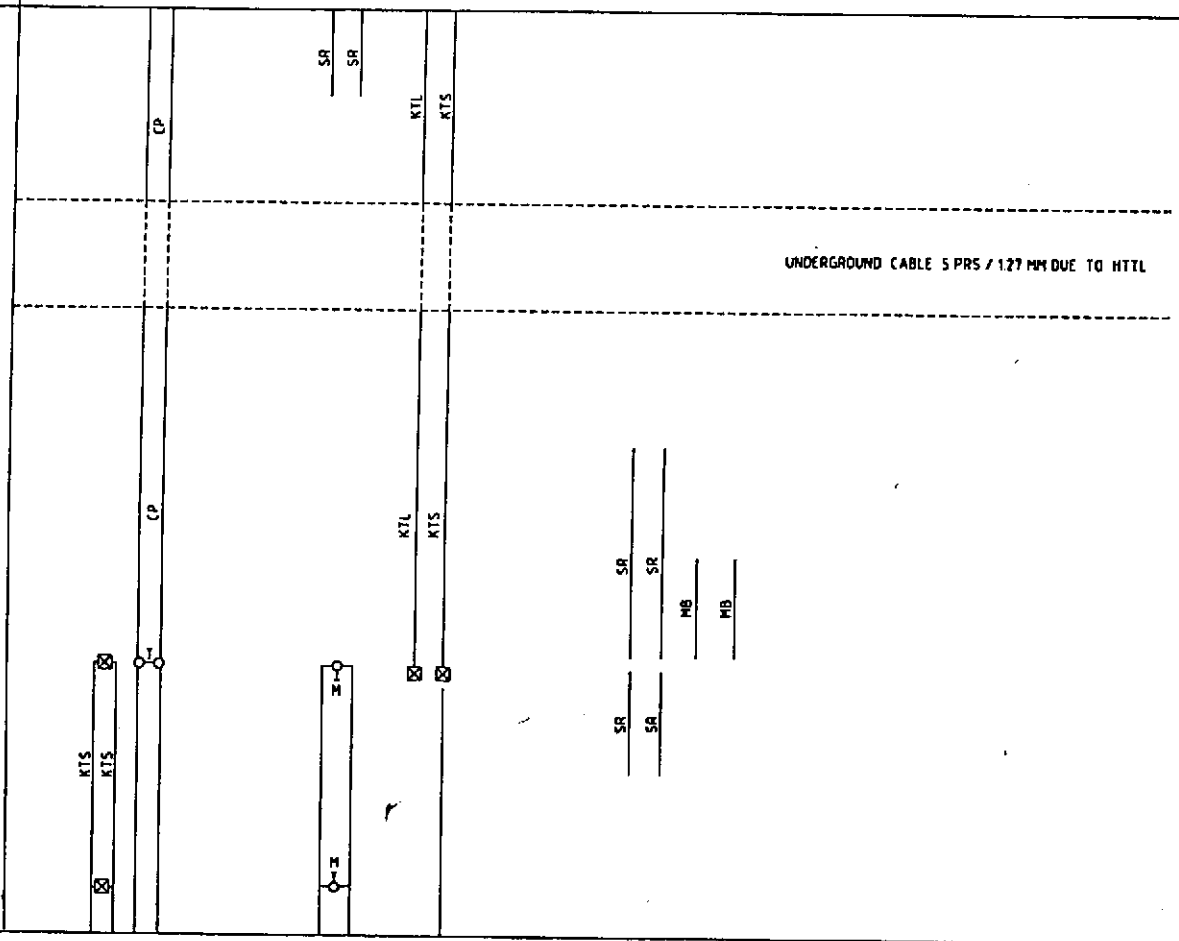


PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K IPOH (U)
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - IPOH (U) 001

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
UP OUTER AND WARNER SIGNAL	87/11 (87.50)	
	89/14 (89.64)	
	89/15 (89.68)	
DN OUTER SIG.RPTER	90/19 (90.86)	
GATE AT L.C.	91/5 (91.23)	
SUNGAI SIPUT	91/8 (91.36)	
UP OUTER SIGNAL REPEATER	92/3 (92.14)	
KANTHAN SIDING (POIN UTARA)	95/11 (92.55)	



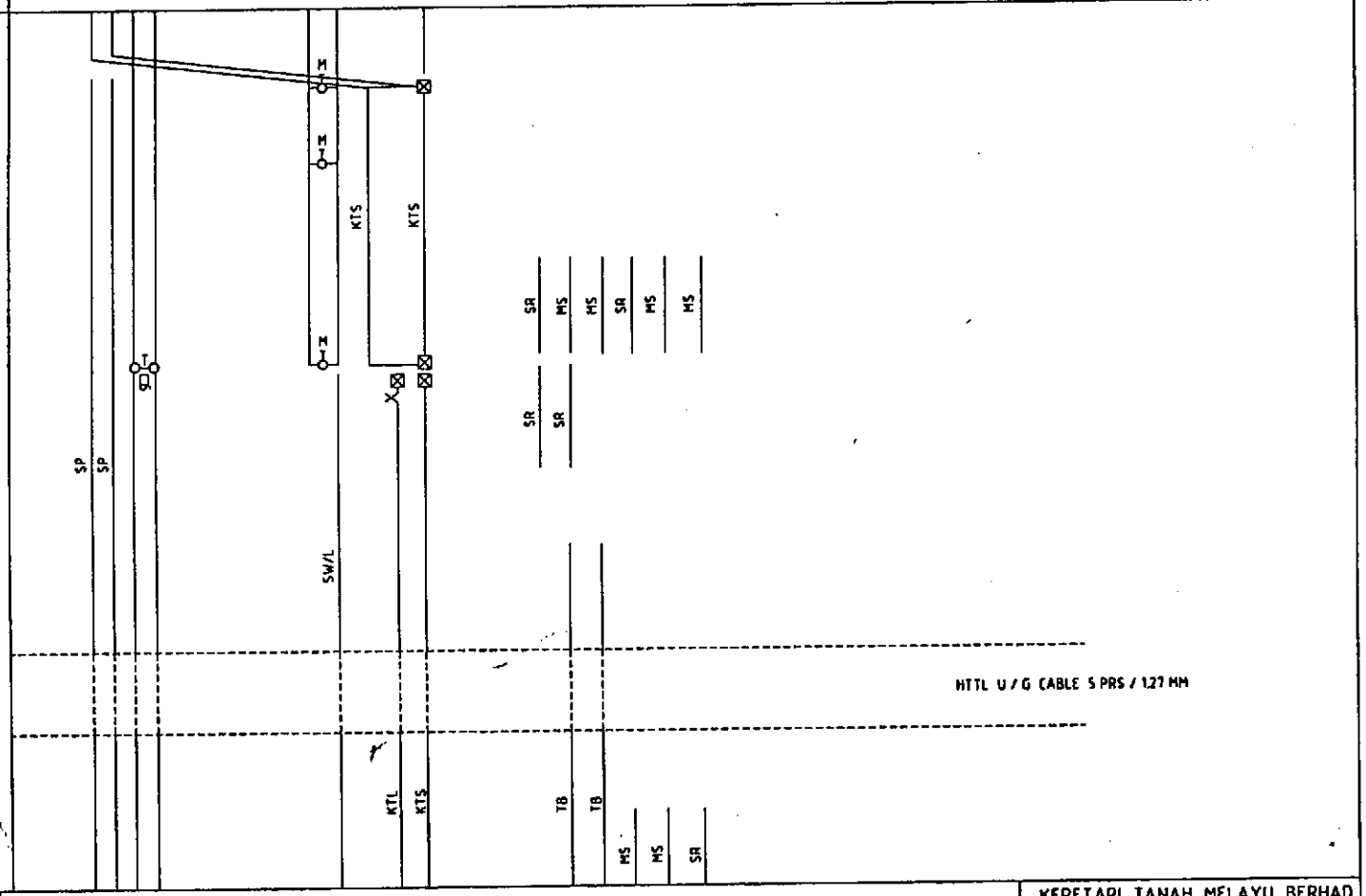
PEMBETULAN	
DILULUSKAN	TARIKH

HTTL = HIGH TENSION TRANSMISSION LINE

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K IPOH (U)
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - IPOH (U) 002

STESEN	NO. T.T.
KANTHAN SIDING [POIN SELATAN]	96/4 [96.18]
WEIGHING BRIDGE	96/4 [96.18]
DOWN OUTER AND WARNER SIGNAL	98/13 [98.59]
CHEMOR	99/7 [99.32]
UP OUTER SIGNAL	99/24 [100.00]
	101/1 [101.04]
	101/3 [101.14]
	101/4 [101.18]
DOWN OUTER SIGNAL	103/10 [103.45]



PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS. KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K IPOH (U)
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - IPOH (U) 003

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
GATE AT L.C.	103/23 (104.04)	
TG.RAMBUTAN	104/3 (104.14)	
UP OUTER SIGNAL	104/17 (104.77)	
	105/3 (105.14)	
	105/4 (105.18)	
	106/7 (106.32)	
	106/9 (106.41)	
TASEK	107/18 (107.82)	

SP SP CP KTL KTS TB TB MS MS SR MS MS SR M I

HTTL U/G CABLE 5 PRS / 1.27 MM

HTTL U/G CABLE 5 PRS / 1.27 MM

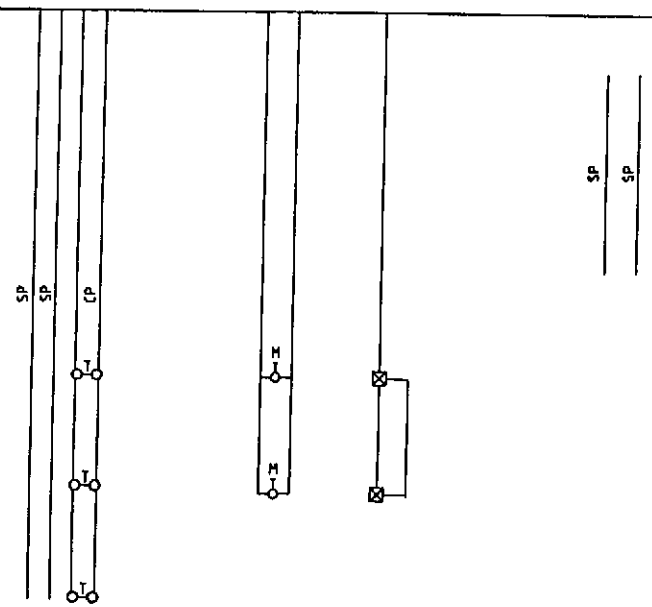
PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K IPOH (U)
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - IPOH (U) 004

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
	108/1 (108.04)	
TASEK CEMENT		
	110/19 (110.86)	
IPOH YARD FOREMAN	111/19 (111.86)	
NORTH CABIN	112/7 (112.32)	
IPOH	112/12 (112.55)	

1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48



TOTAL O/H WIRE

TYPE	LENGTH
CP	69.10
KTS	42.74
KTL	21.86
MP	24.52
MB	0.26
MS	8.34
SR	5.28
SW/L	13.64
TB	12.40
	198.14 SINGLE - WIRE - MILE

PEMBETULAN	
DILULUSKAN	TARIKH

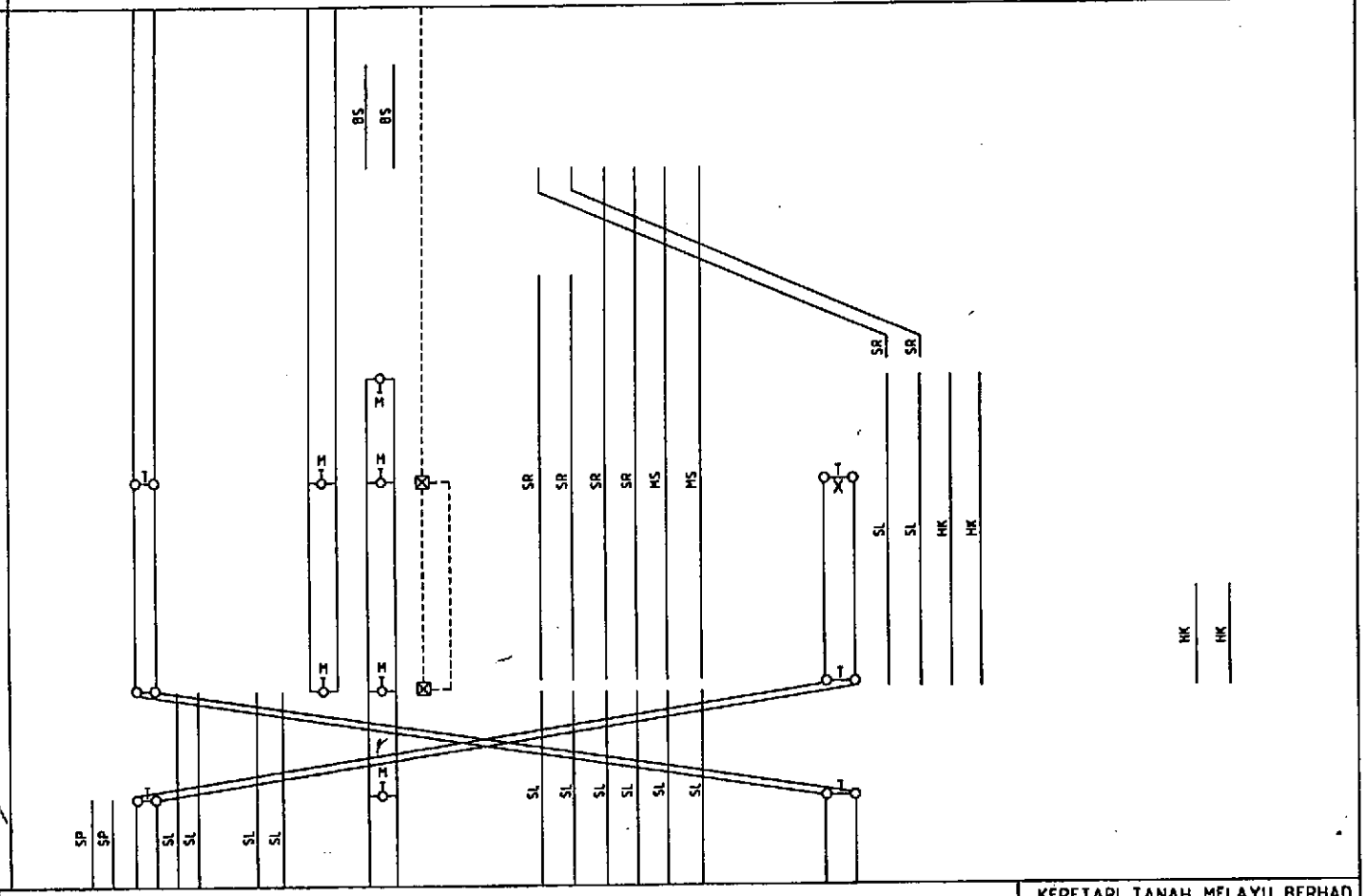
KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS.
P S & K (T)	KABEL DAN PERALATAN
P S & K (P & L)	STESEN - DAERAH
	EKS. S & K IPOH (U)
PB S & K TARIKH	CARTA TELEKOM - IPOH (U) 005

STESEN	NO. T.T.
BANNER SIGNAL	110/21 (110.15)
DOWN OUTER SIGNAL	111/10 (111.45)
OUTER HOME SIGNAL	111/16 (111.73)
LEVER FRAME HUT	111/17 (111.77)
IPOH YARD FOREMAN	111/19 (111.86)
POINT HUT	112/2 (112.09)
NORTH CABIN	112/7 (112.32)
IPOH	112/12 (112.55)

NOMBOR PIN (MENGHADAP UTARA)

1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48

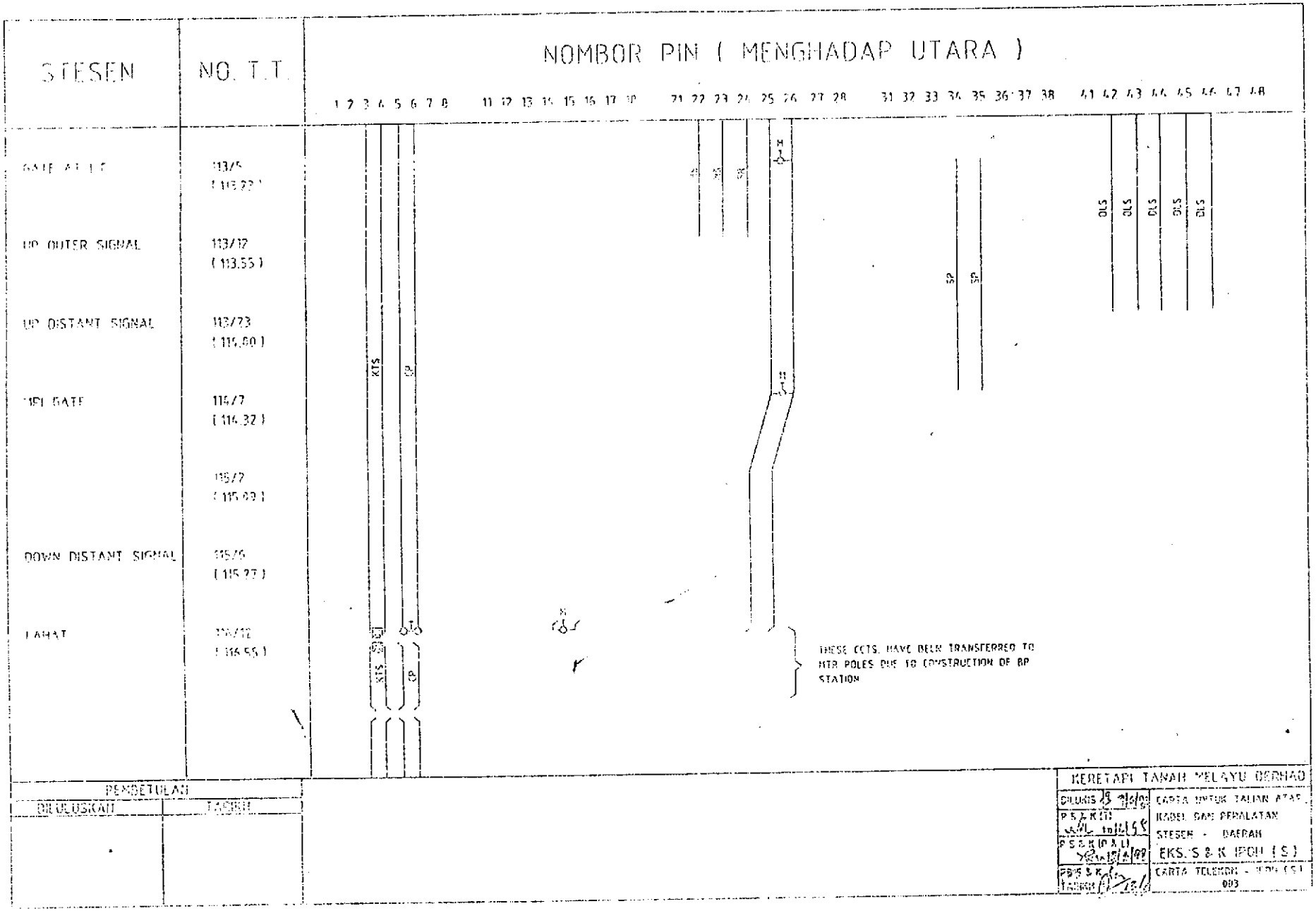


PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K IPOH (S)
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - IPOH (S) 001

STESEN
NO. T.T.
NOMBOR PIN (MENGHADAP UTARA)
1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
OTS OFFICE
IPOH SOUTH CABIN
112/15 (112.68)
E K & S OFFICE
OE OFFICE
GATE AT L.C.
0/9 (0.41)
UP BRANCH OUTER SIG.
0/13 (0.59)
IPOH LOCO UF FALIM
1/2 (1.09)
IPOH LOCO FALIM
1/5 (1.23)
SP
SL
KTS
SR
MS
DLS
TO PLAN
003 IPOH (S)
PEMBETULAN
DILULUSKAN
TARIKH
KERETAPI TANAH MELAYU BERHAD
DILUKIS
P S & K (T)
P S & K (P & L)
PB S & K
TARIKH
CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN
STESEN - DAERAH
EKS. S & K IPOH (S)
CARTA TELEKOM - IPOH (S)
002

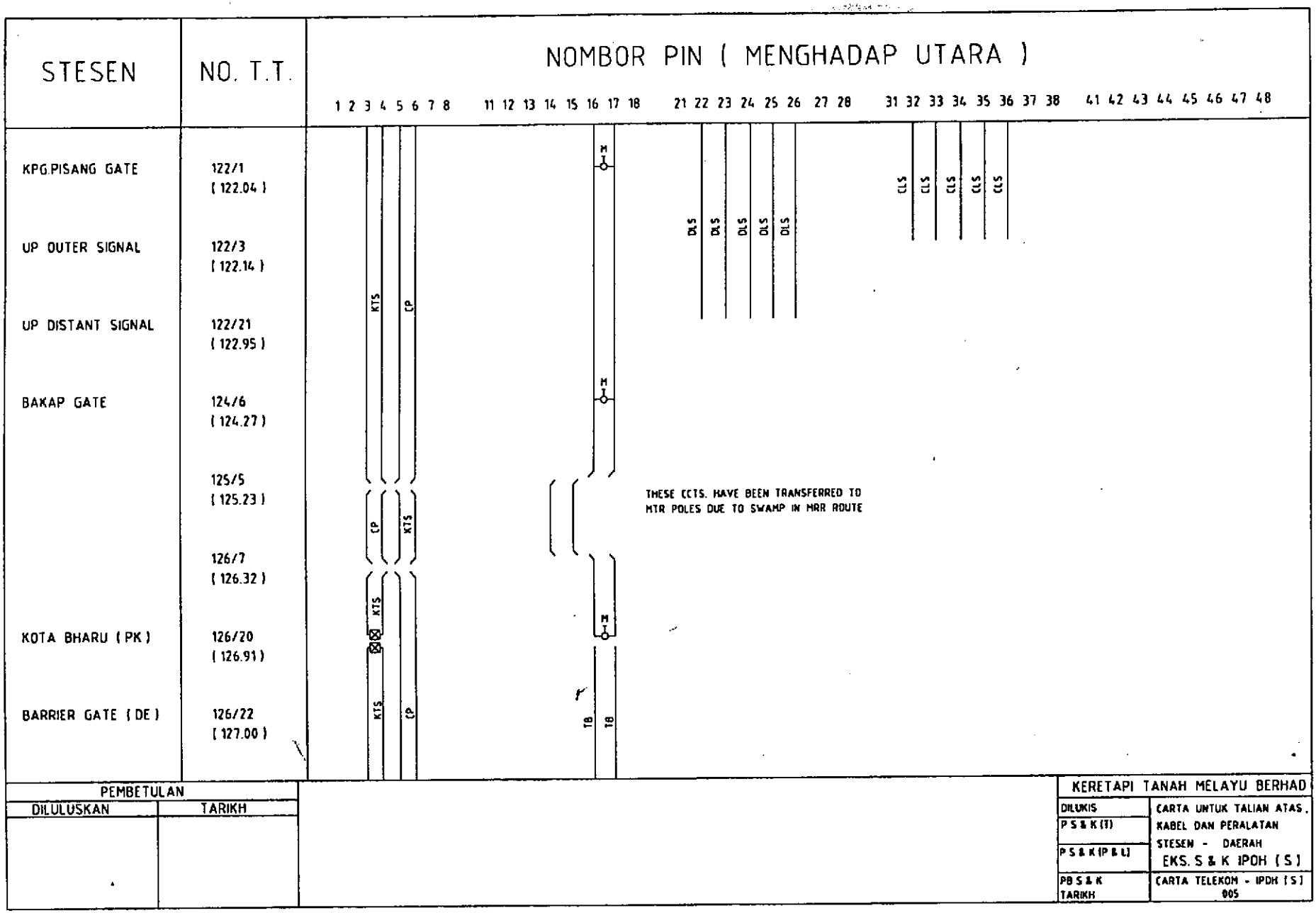

STESEN
NO. T.T.
NOMBOR PIN (MENGHADAP UTARA)
1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
GATE AT L.C.
113/5
(113.22)
UP OUTER SIGNAL
113/12
(113.55)
UP DISTANT SIGNAL
113/23
(114.00)
MPL GATE
114/7
(114.32)
115/2
(115.09)
DOWN DISTANT SIGNAL
115/6
(115.27)
LAHAT
116/12
(116.55)
KTS
CP
SP
OLS
THESE CCTS. HAVE BEEN TRANSFERRED TO MTR POLES DUE TO CONSTRUCTION OF BP STATION
PEMBETULAN
DILULUSKAN
TARIKH
KERETAPI TANAH MELAYU BERHAD
CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN
STESEN - DAERAH
EKS. S & K IPOH (S)
CARTA TELEKOM - IPOH (S)
003

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
UP DISTANT SIGNAL	117/17 (117.77)	
OOWN DISTANT SIGNAL	120/1 (120.05)	
OOWN OUTER SIGNAL	120/18 (120.82)	KTS CP
GATE AT L.C.	121/2 (121.09)	H
OOWN HOME SIGNAL	121/2 (121.09)	H
BATU GAJAH	121/8 (121.36)	KTS CP T
UP HOME SIGNAL	121/12 (121.55)	H
		DLS CLS IL

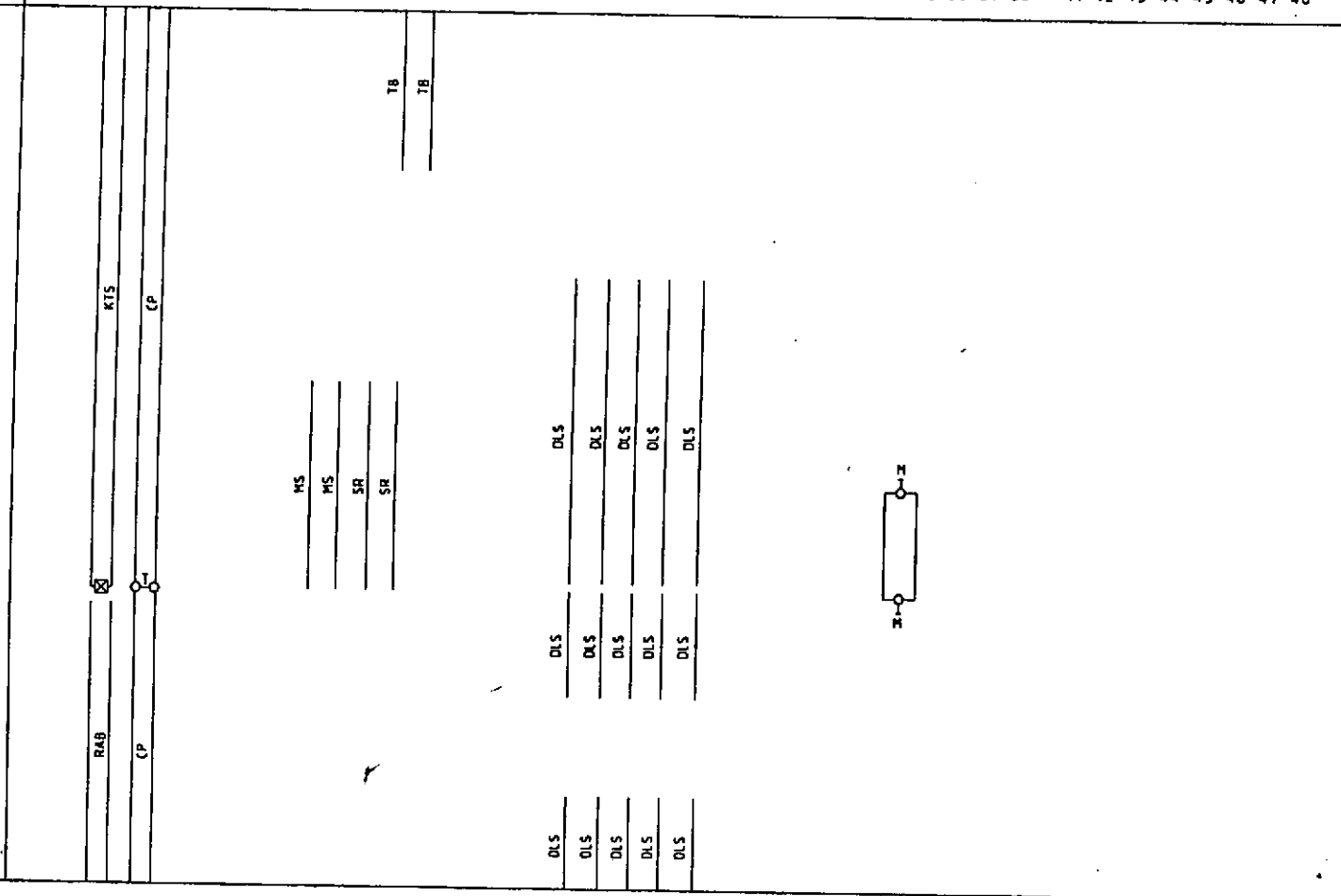
PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K IPOH (S)
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - IPOH (S) 004


STESEN
NO. T.T.
NOMBOR PIN (MENGHADAP UTARA)
1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
KPG.PISANG GATE
122/1
(122.04)
UP OUTER SIGNAL
122/3
(122.14)
UP DISTANT SIGNAL
122/21
(122.95)
BAKAP GATE
124/6
(124.27)
125/5
(125.23)
126/7
(126.32)
KOTA BHARU (PK)
126/20
(126.91)
BARRIER GATE (DE)
126/22
(127.00)
KTS
CP
DLS
CLS
M
TB
THESE CCTS. HAVE BEEN TRANSFERRED TO
MTR POLES DUE TO SWAMP IN MRR ROUTE
PEMBETULAN
DILULUSKAN
TARIKH
KERETAPI TANAH MELAYU BERHAD
DILUKIS
P S & K (T)
P S & K (P & L)
PB S & K
TARIKH
CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN
STESEN - DAERAH
EKS. S & K IPOH (S)
CARTA TELEKOM - IPOH (S)
005

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
UP DISTANT SIGNAL	128/4 (128.18)	
TRACK CONTACT (SILEC)	129/22 (130.00)	
DOWN DISTANT SIGNAL	130/2 (130.09)	
DOWN OUTER SIGNAL	130/17 (130.77)	
GATE AT L.C.	131/6 (131.27)	
MALIM NAWAR	131/9 (131.41)	
UP DISTANT SIGNAL	132/15 (132.68)	
DOWN DISTANT SIGNAL	134/5 (134.23)	

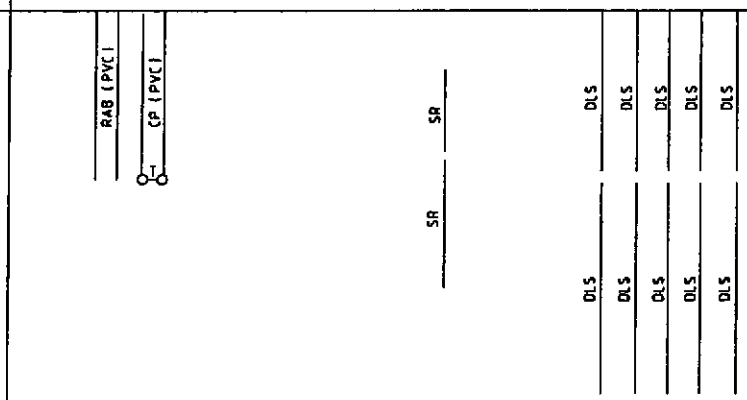


PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN
P S & K (T)	STESEN - DAERAH
P S & K (P & L)	EKS. S & K IPOH (S)
PB S & K TARIKH	CARTA TELEKOM - IPOH (S) 006

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
DOWN OUTER SIGNAL	134/22 (135.00)	
KAMPAR	135/13 (135.59)	
UP OUTER SIGNAL	136/3 (136.14)	
UP DISTANT SIGNAL	136/18 (136.82)	



TOTAL O/H WIRE

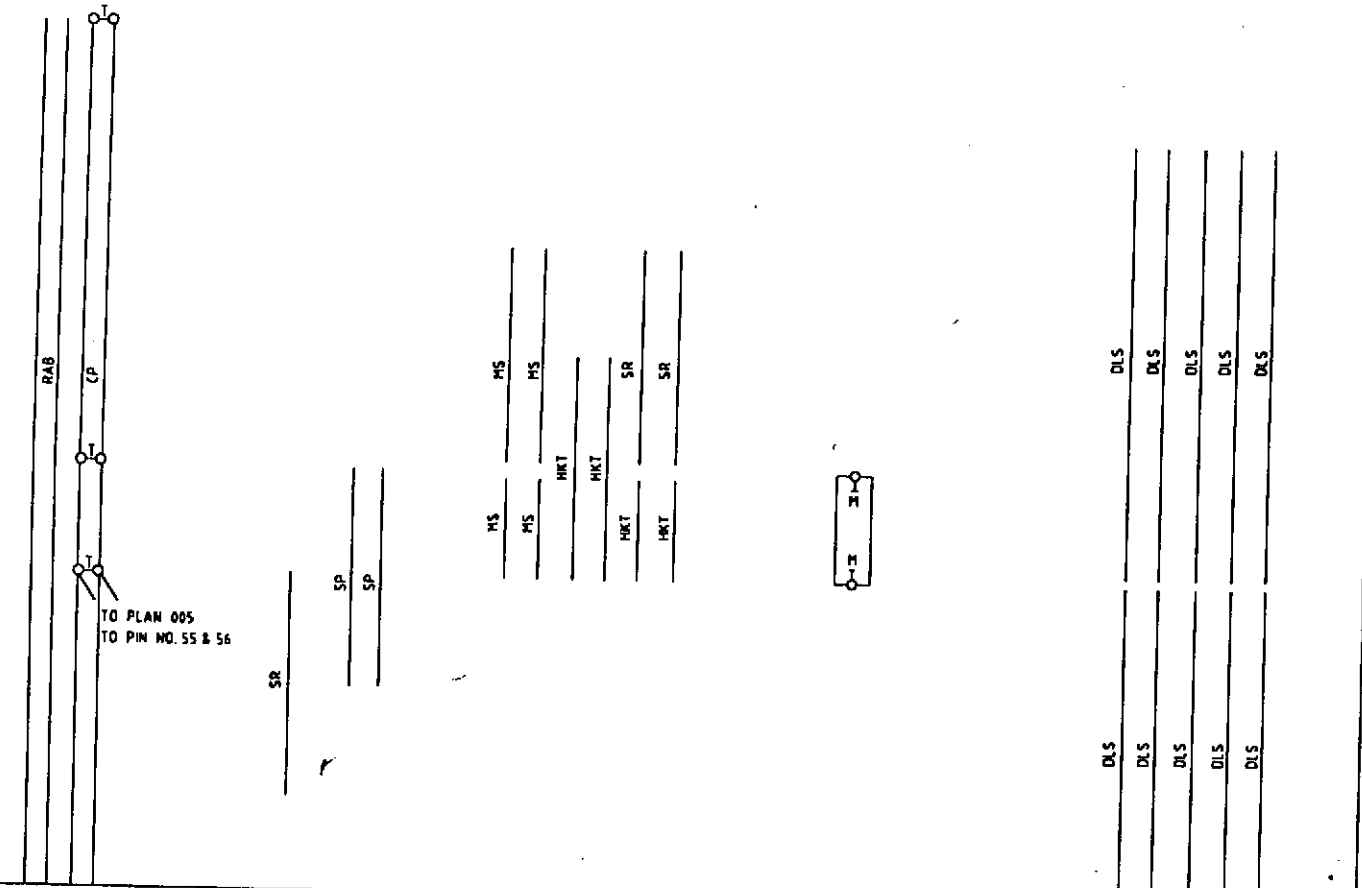
TYPE	LENGTH
CP	48.28
DLS	47.00
HK	1.56
IL	0.92
KTS	39.64
MP	28.84
MS	6.09
RAB	8.36
SLOT	4.7
SR	3.56
TB	6.18
	195.13 SINGLE - WIRE - MILE

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K IPOH (S)
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - IPOH (S) 007

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
KAMPAR	135/13 (135.59)	
DOWN DISTANT SIGNAL	143/11 (143.50)	
DOWN OUTER SIGNAL	144/5 (144.23)	
TAPAH ROAD YARD	144/21 (144.95)	
TAPAH ROAD STATION	144/23 (145.00)	
T.RD SOUTH CABIN	145/2 (145.09)	
UP OUTER SIGNAL	145/16 (145.54)	



PEMBETULAN	
DILULUSKAN	TARIKH

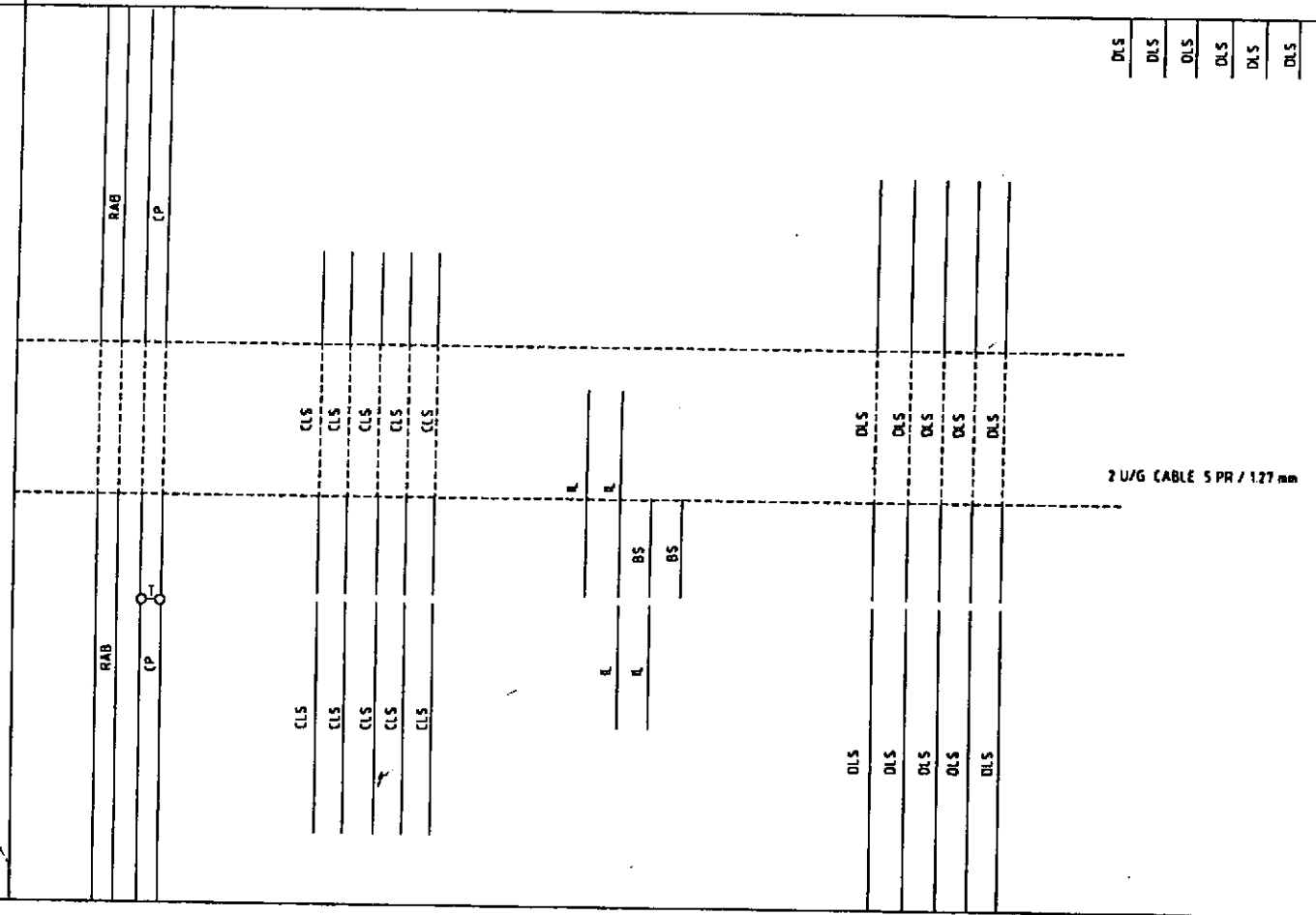
KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TAPAH RD.
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TAPAH RD. 001

STESEN	NO. T.T.
UP DISTANT SIGNAL	146/6 (146.27)
OOWN OISTANT SIGNAL	151/6 (151.27)
DOWN OUTER SIGNAL	151/21 (151.95)
	152/5 (152.23)
DOWN HOME SIGNAL	152/6 (152.27)
BANNER SIGNAL	152/7 (152.32)
BIOOR	152/9 (152.41)
UP HOME SIGNAL	152/13 (152.59)
UP OUTER SIGNAL	153/4 (153.18)

NOMBOR PIN (MENGHADAP UTARA)

1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48



PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TAPAH RD.
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TAPAH RD. 002

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
UP DISTANT SIGNAL	153/15 (153.68)	DLS DLS DLS DLS DLS
DOWN DISTANT SIGNAL	158/18 (158.82)	RAB CP DLS DLS DLS DLS DLS
DOWN OUTER SIGNAL	160/13 (160.59)	
SUNGKAI	160/1 (160.05)	
JAMBATAN BAWAH REL	160/11 (160.50)	SR SR DLS DLS DLS DLS DLS
UP OUTER SIGNAL	160/14 (160.64)	RAB CP
UP DISTANT SIGNAL	161/4 (161.18)	
DOWN DISTANT SIGNAL	168/10 (168.45)	DLS DLS DLS DLS DLS

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS. KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TAPAH RD.
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TAPAH RD. 003

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
DOWN OUTER SIGNAL	168/21 (168.95)	
S.M.'s QUARTERS	169/17 (169.77)	
TROLAK	169/17 (169.77)	
UP OUTER SIGNAL	170/8 (170.36)	
UP DISTANT SIGNAL	171/2 (171.09)	
DOWN DISTANT SIGNAL	173/18 (173.82)	
DOWN OUTER SIGNAL	174/10 (174.45)	
SLIM RIVER	174/23 (175.00)	

RAB CP SR DLS

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TAPAH RD.
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TAPAH RD. 004

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 51 52 53 54 55 56 57 58
UP OUTER SIGNAL	175/16 (175.73)	SR SR DLS DLS DLS DLS DLS
UP DISTANT SIGNAL	176/4 (176.18)	
T.RD SOUTH CABIN	145/2 (145.09)	

FROM PLAN NO. 001

SR SR

TOTAL O/H WIRE

TYPE	LENGTH
BS	0.18
CLS	6.15
CP	78.82
DLS	65.20
HK	0.46
IL	0.64
MP	0.18
MS	3.26
RAB	78.82
SR	11.09
	244.80

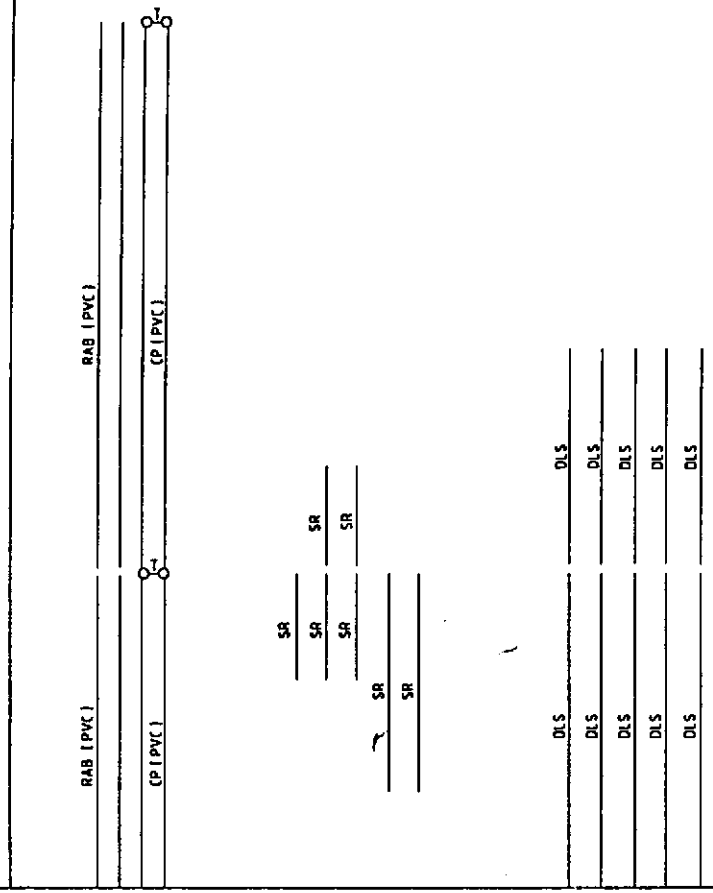
SINGLE - WIRE - MILE

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TAPAH RD.
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TAPAH RD. 005

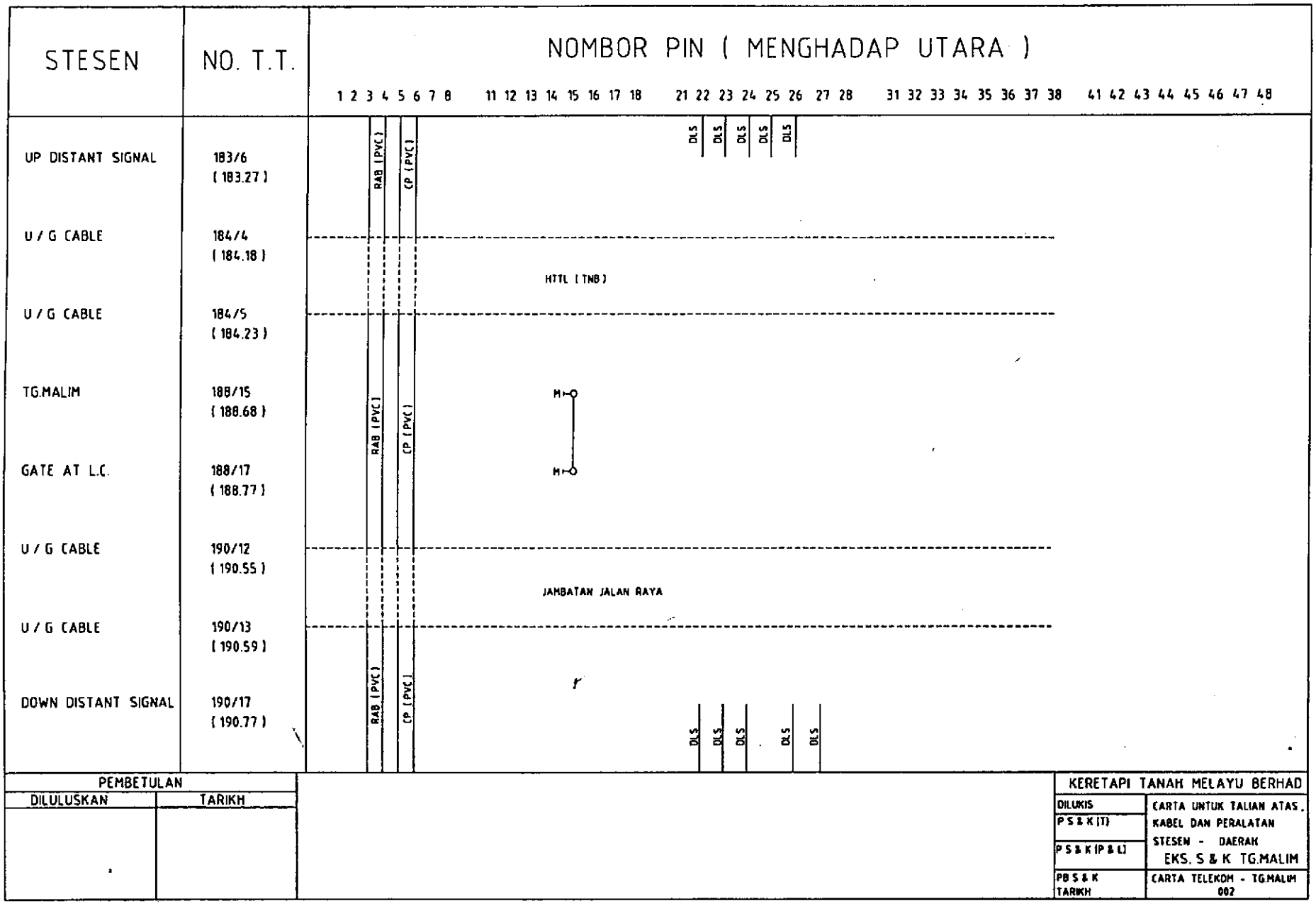
STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
SLIM RIVER	174/23 [175.00)	
UP OUTER SIGNAL	175/16 (175.73)	
UP DISTANT SIGNAL	176/4 (176.18)	
DOWN DISTANT SIGNAL	180/13 (180.59)	
DOWN OUTER SIGNAL	181/1 (181.05)	
BEHRANG RUMAH KETUA STESEN	181/21 (181.95)	
UP HOME SIGNAL	182/5 (182.23)	
UP OUTER SIGNAL	182/13 (182.59)	



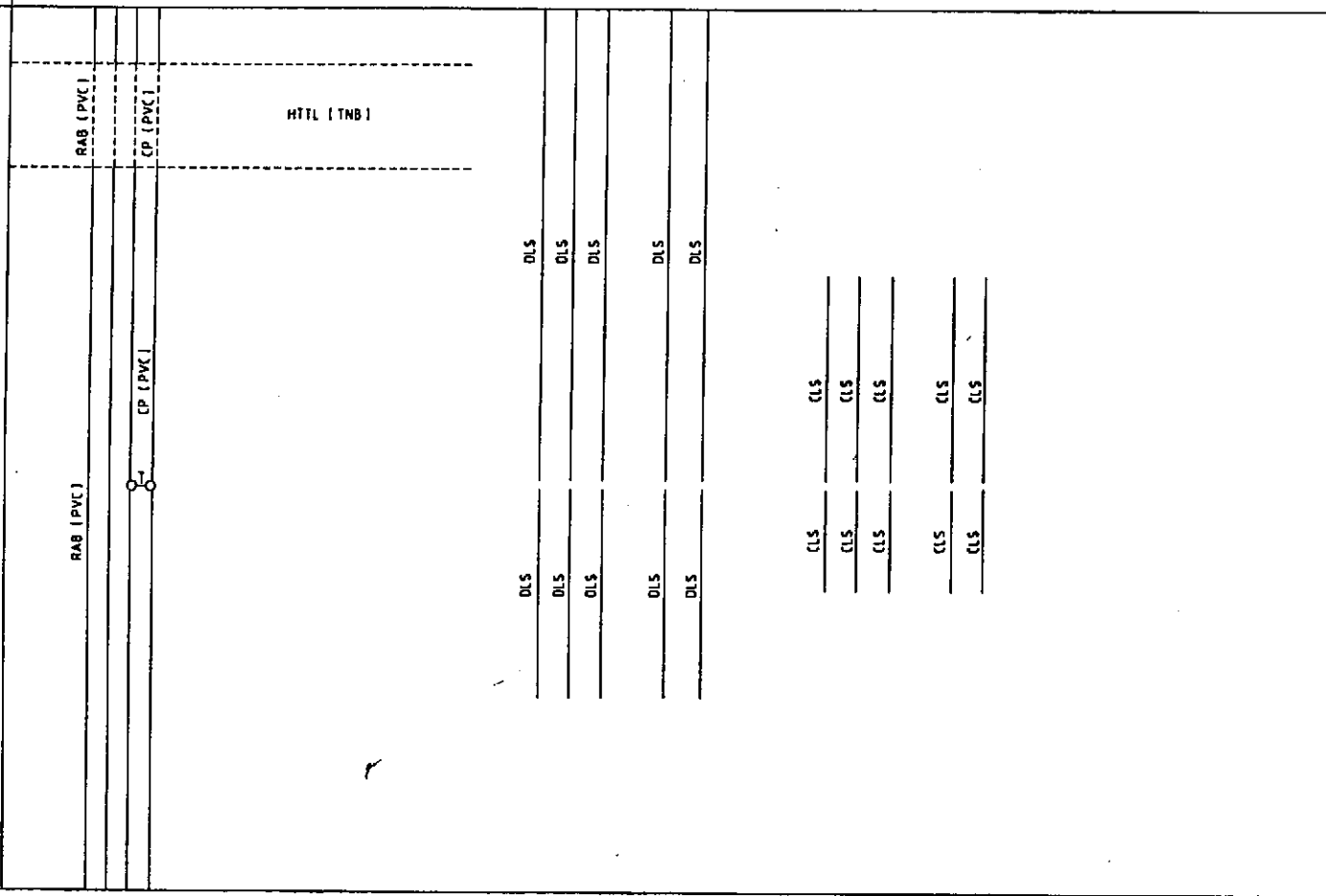
PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TG.MALIM
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TG.MALIM 001


STESEN
NO. T.T.
NOMBOR PIN (MENGHADAP UTARA)
1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
UP DISTANT SIGNAL
183/6
(183.27)
U / G CABLE
184/4
(184.18)
U / G CABLE
184/5
(184.23)
TG.MALIM
188/15
(188.68)
GATE AT L.C.
188/17
(188.77)
U / G CABLE
190/12
(190.55)
U / G CABLE
190/13
(190.59)
DOWN DISTANT SIGNAL
190/17
(190.77)
RAB (PVC)
CP (PVC)
DLS
HTTL (TNB)
JAMBATAN JALAN RAYA
PEMBETULAN
DILULUSKAN
TARIKH
KERETAPI TANAH MELAYU BERHAD
DILUKIS
P S & K (T)
P S & K (P & L)
PB S & K
TARIKH
CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN
STESEN - DAERAH
EKS. S & K TG.MALIM
CARTA TELEKOM - TG.MALIM
002

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
U / G CABLE	190/19 (190.86)	
U / G CABLE	190/20 (190.91)	
DOWN OUTER SIGNAL	191/7 (191.32)	
GATE AT L.C.	191/16 (191.73)	
KALUMPANG	191/20 (191.91)	
UP OUTER SIGNAL	192/16 (192.73)	
UP DISTANT SIGNAL	193/7 (193.32)	



PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN
P S & K (T)	STESEN - DAERAH
P S & K (P & L)	EKS. S & K TG.MALIM
PB S & K TARIKH	CARTA TELEKOM - TG.MALIM 003

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
U / G CABLE	194/4 (194.18)	
U / G CABLE TRACK CONTACT SILEC	194/6 (194.27)	JAMBATAN JALAN RAYA
U / G CABLE	196/16 (196.73)	TB
U / G CABLE	196/17 (196.77)	JAMBATAN JALAN RAYA
DOWN GATE SIGNAL	196/19 (196.86)	
GATE AT L.C. (KERLING)	197/5 (197.23)	RAB (PVC) CP (PVC) M
UP GATE SIGNAL	197/11 (197.50)	

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN
P S & K (T)	STESEN - DAERAH
P S & K (P & L)	EKS. S & K TG.MALIM
PB S & K TARIKH	CARTA TELEKOM - TG.MALIM 004

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
U / G CABLE	198/11 (198.50)	
U / G CABLE	198/12 (198.55)	
U / G CABLE	198/13 (198.59)	
U / G CABLE	198/14 (198.64)	
DOWN DISTANT SIGNAL	198/22 (199.00)	
TRACK CIRCUIT	199/6 (199.27)	
DOWN OUTER SIGNAL	199/13 (199.59)	
KUALA KUBU ROAD	202/1 (202.05)	

HTTL (TNB)

JAMBATAN JALAN RAYA

RAB (PVC)

CP (PVC)

T

M

DLS DLS DLS DLS DLS

DLS DLS DLS DLS DLS

CLS CLS CLS CLS CLS

CLS CLS CLS CLS CLS

PEMBETULAN	
DILULUSKAN	TARIKH

MISSING T.T. NUMBERS FROM 200/8 TO 201/22

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TG.MALIM
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TG.MALIM 005

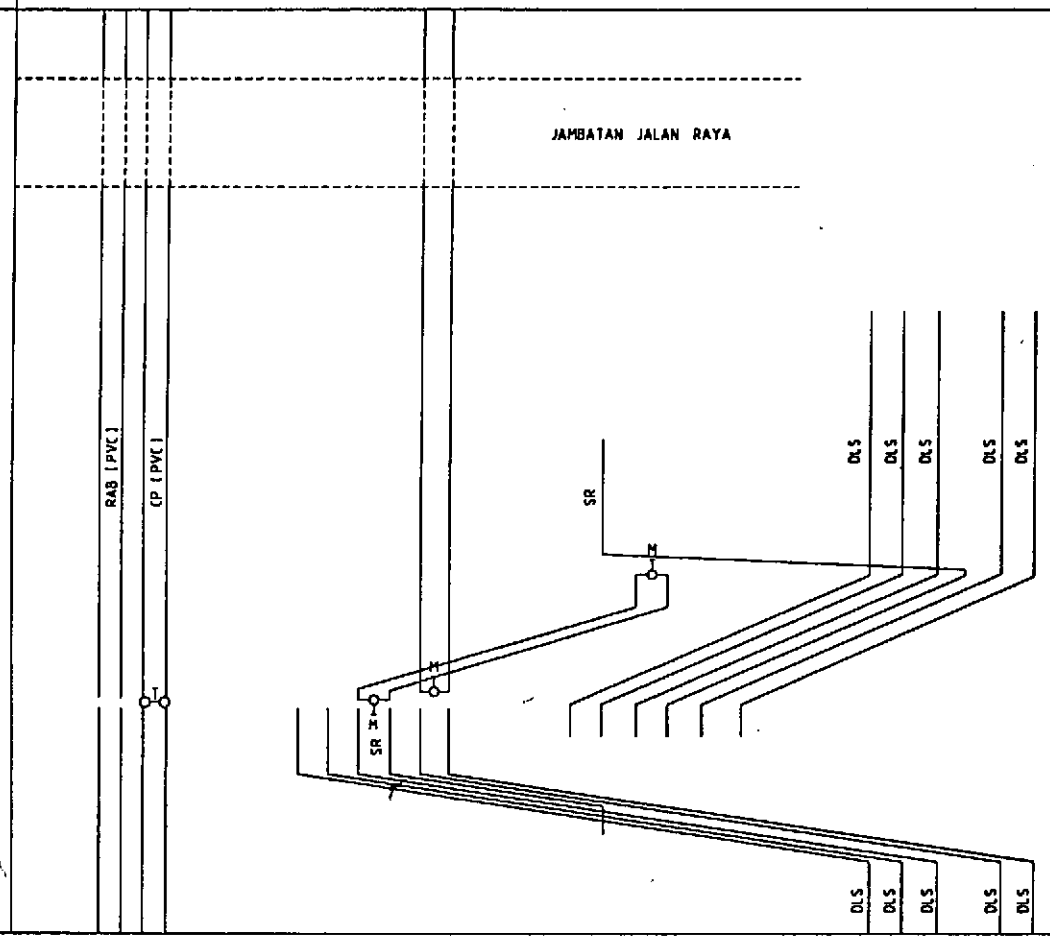
STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
UP OUTER SIGNAL	202/20 (202.91)	DLS DLS DLS DLS DLS CLS CLS CLS CLS CLS
UP DISTANT SIGNAL	203/13 (203.59)	RAB (PVC) CP (PVC)
TRACK CONTACT SILEC	204/3 (204.14)	TB TB
U / G CABLE	205/18 (205.82)	HTTL (TNB)
U / G CABLE	205/20 (205.91)	
GATE AT L.C. (RASA)	207/2 (207.09)	RAB (PVC) CP (PVC) M

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TG.MALIM
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TG.MALIM 006

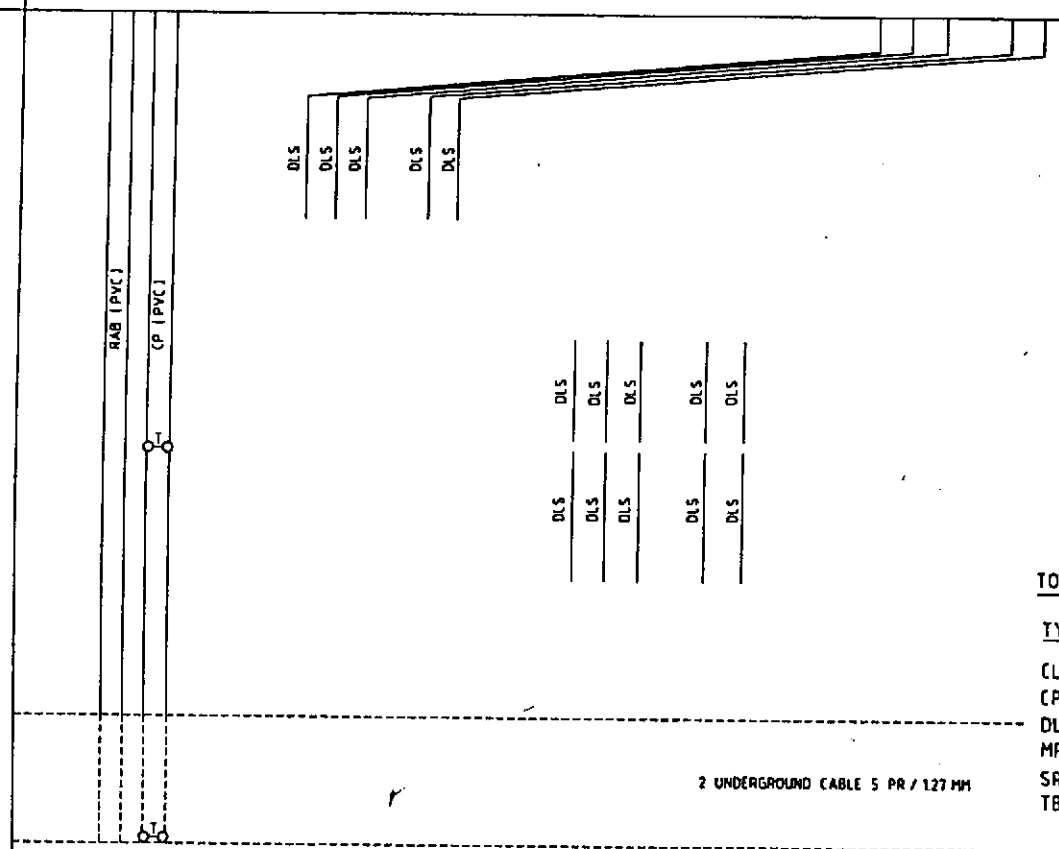
STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
U / G CABLE	208/1 (208.04)	
U / G CABLE	208/3 (208.14)	
DOWN DISTANT SIGNAL	208/18 (208.82)	
DOWN OUTER SIGNAL	209/16 (209.73)	
GATE AT L.C.	209/21 (209.95)	
ULU YAM	210/2 (210.09)	
UP OUTER SIGNAL	210/16 (210.73)	



PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD	
DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN
P S & K (T)	STESEN - DAERAH
P S & K (P & L)	EKS. S & K TG.MALIM
PB S & K TARIKH	CARTA TELEKOM - TG.MALIM 007

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
	211/2 (211.09)	
UP DISTANT SIGNAL	211/9 (211.41)	
DOWN DISTANT SIGNAL	215/22 (216.00)	
SERENDAH	217/6 (217.27)	
UP DISTANT SIGNAL	218/11 (218.50)	
U / G CABLE KM 315.00	219/13 (219.54)	
RAWANG	222/12 (222.55)	



TOTAL O/H WIRE

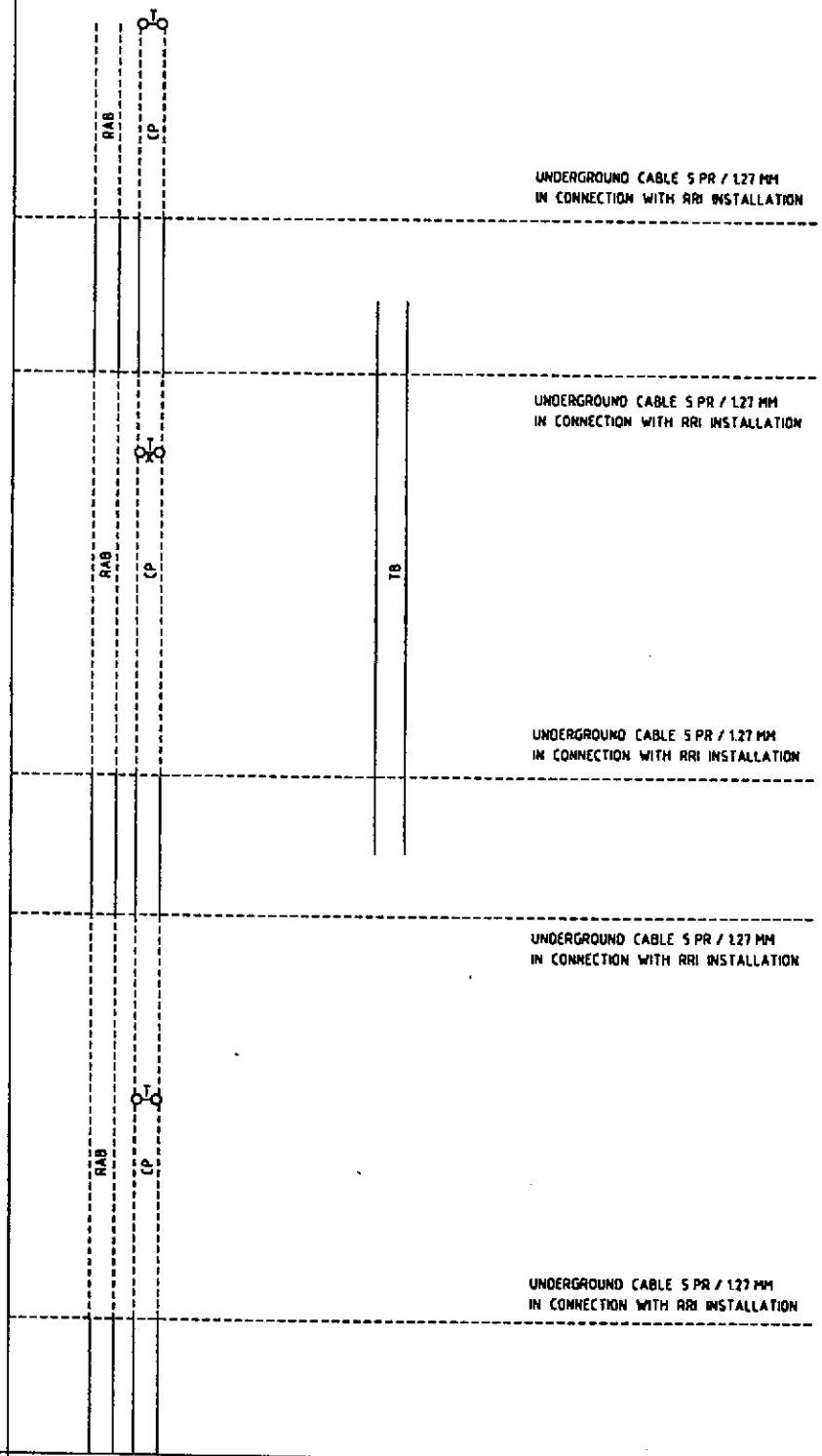
TYPE	LENGTH
CLS	23.65
CP	89.08
DLS	74.55
MP	16.01
SR	7.74
TB	11.82
	222.85 SINGLE - WIRE - MILE

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K TG.MALIM
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - TG.MALIM 008

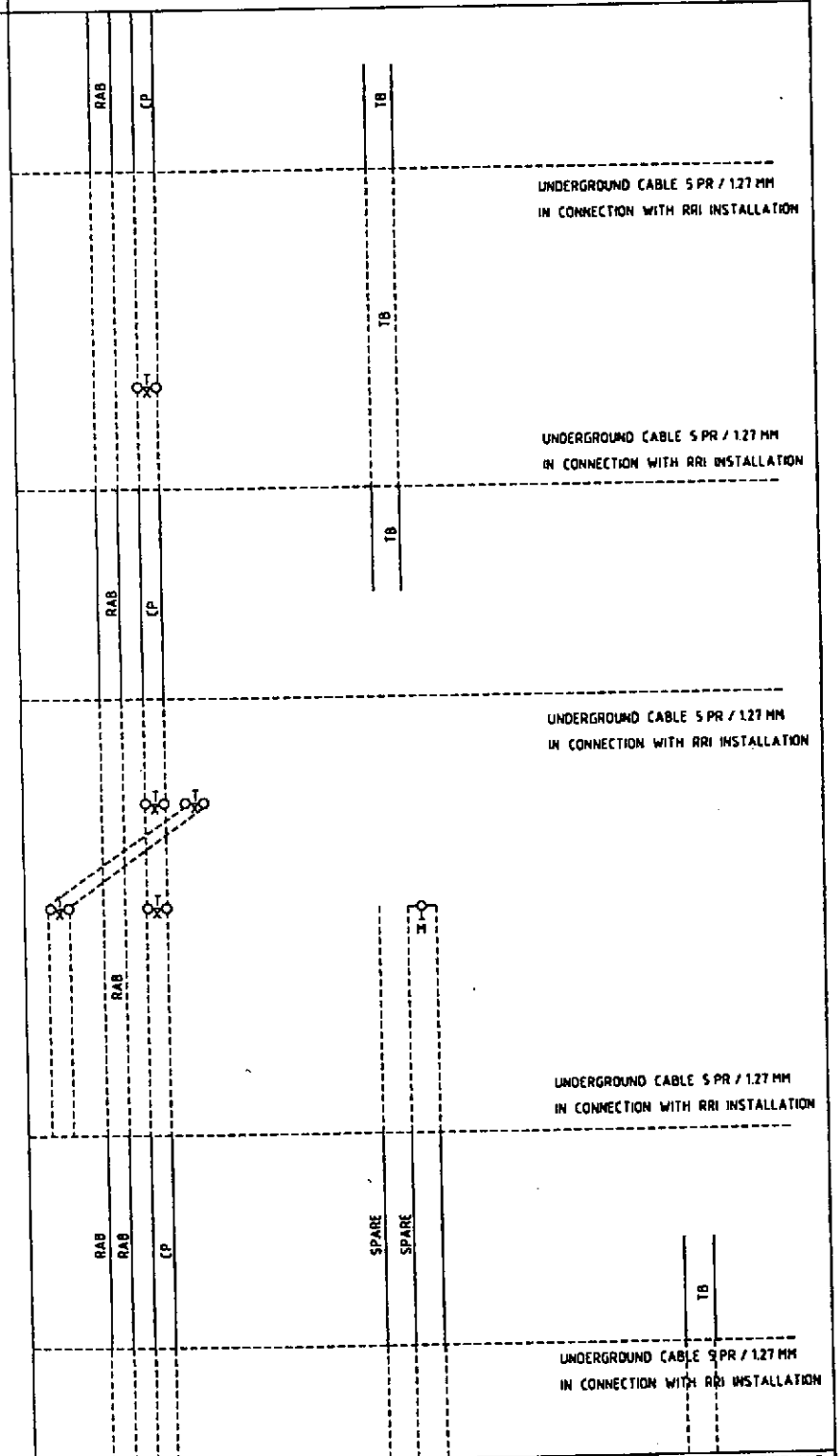
STESEN	NO.T.T.	NOMBOR PIN (MENGHADAP UTARA) 1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
TAMPIN	318/9 (318.41)	
GATE AT L.C.	318/15 (318.68)	
UP DISTANT SIGNAL	319/16 (319.73)	
TRACK CONTACT (SILEC)	324/12 (324.55)	
DOWN DISTANT SIGNAL	326/4 (326.18)	
TEBONG	327/14 (327.64)	
GATE AT L.C.	327/18 (327.82)	
SISIAN GUTHRIE	328/12 (328.55)	
UP DISTANT SIGNAL	328/19 (328.86)	
TRACK CONTACT (SILEC)	330/18 (330.82)	
DOWN DISTANT SIGNAL	332/13 (332.68)	
GATE AT L.C.	333/14 (333.64)	
BTG. MELAKA	334/8 (334.36)	
GATE AT L.C.	334/12 (334.55)	
UP DISTANT SIGNAL	335/13 (335.59)	



PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD	
DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K GEMAS
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - GEMAS 001

STESEN	NO.T.T.	NOMBOR PIN (MENGHADAP UTARA) 1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
TRACK CCT. (SILEC)	336/8 (336.36)	
DOWN DISTANT SIGNAL	338/4 (338.18)	UNDERGROUND CABLE 5 PR / 1.27 MM IN CONNECTION WITH RRI INSTALLATION
GATE AT L.C.	339/8 (339.36)	
AIR KUNING	339/13 (339.59)	
UP DISTANT SIGNAL	340/18 (340.82)	UNDERGROUND CABLE 5 PR / 1.27 MM IN CONNECTION WITH RRI INSTALLATION
TRACK CCT. (SILEC)	342/15 (342.68)	
DOWN DISTANT SIGNAL	349/12 (349.55)	UNDERGROUND CABLE 5 PR / 1.27 MM IN CONNECTION WITH RRI INSTALLATION
GEMAS LOCO	350/20 0/17	
GEMAS	351/7 (351.32)	
GATE NON INTERLOCKED	351/11 (351.50)	UNDERGROUND CABLE 5 PR / 1.27 MM IN CONNECTION WITH RRI INSTALLATION
UP DISTANT SIGNAL	352/15 (352.68)	
TRACK CCT. (SILEC)	355/4 (355.18)	
DOWN DISTANT SIGNAL	356/1 (356.05)	UNDERGROUND CABLE 5 PR / 1.27 MM IN CONNECTION WITH RRI INSTALLATION

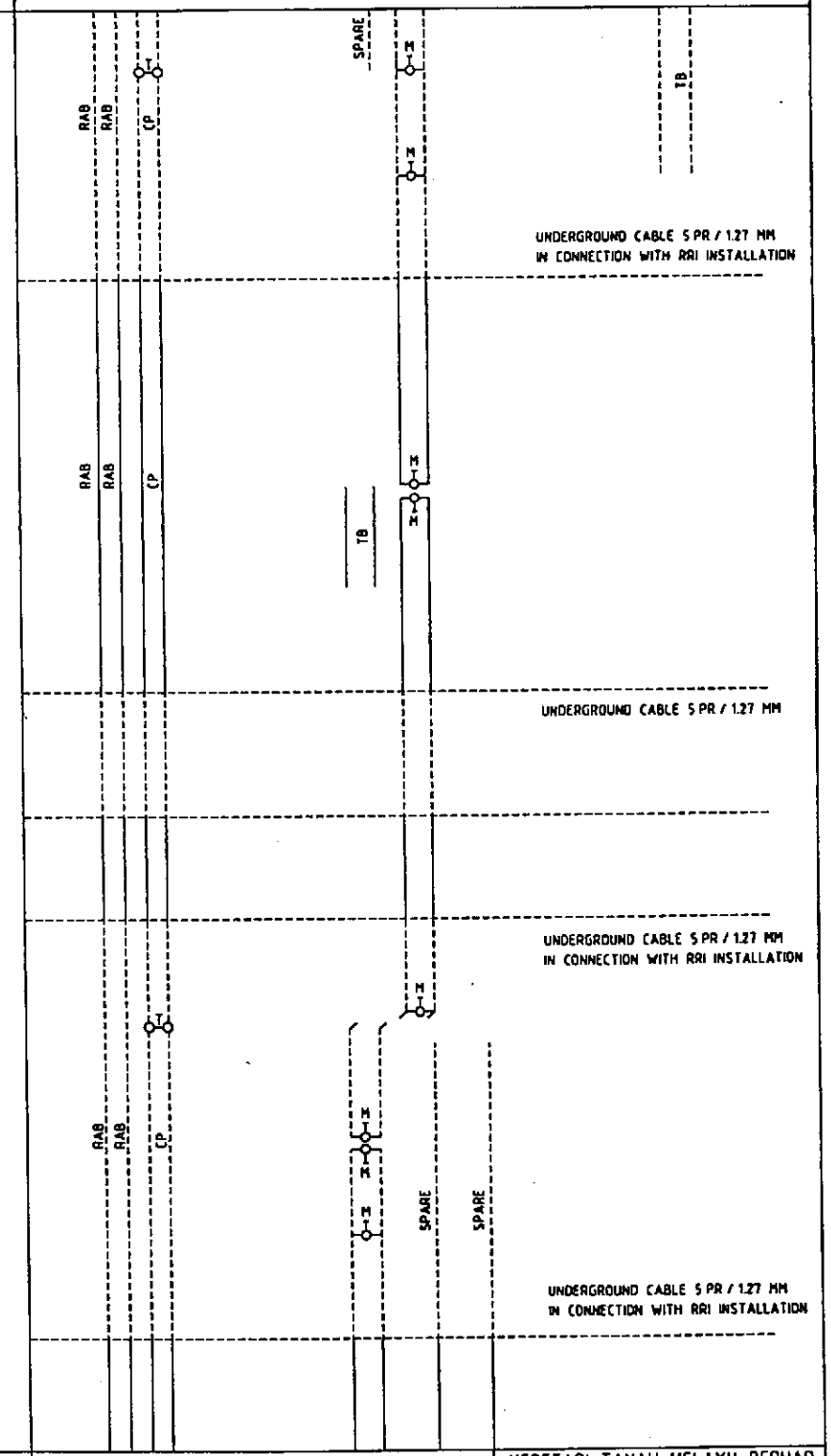


PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K GEMAS
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - GEMAS 002

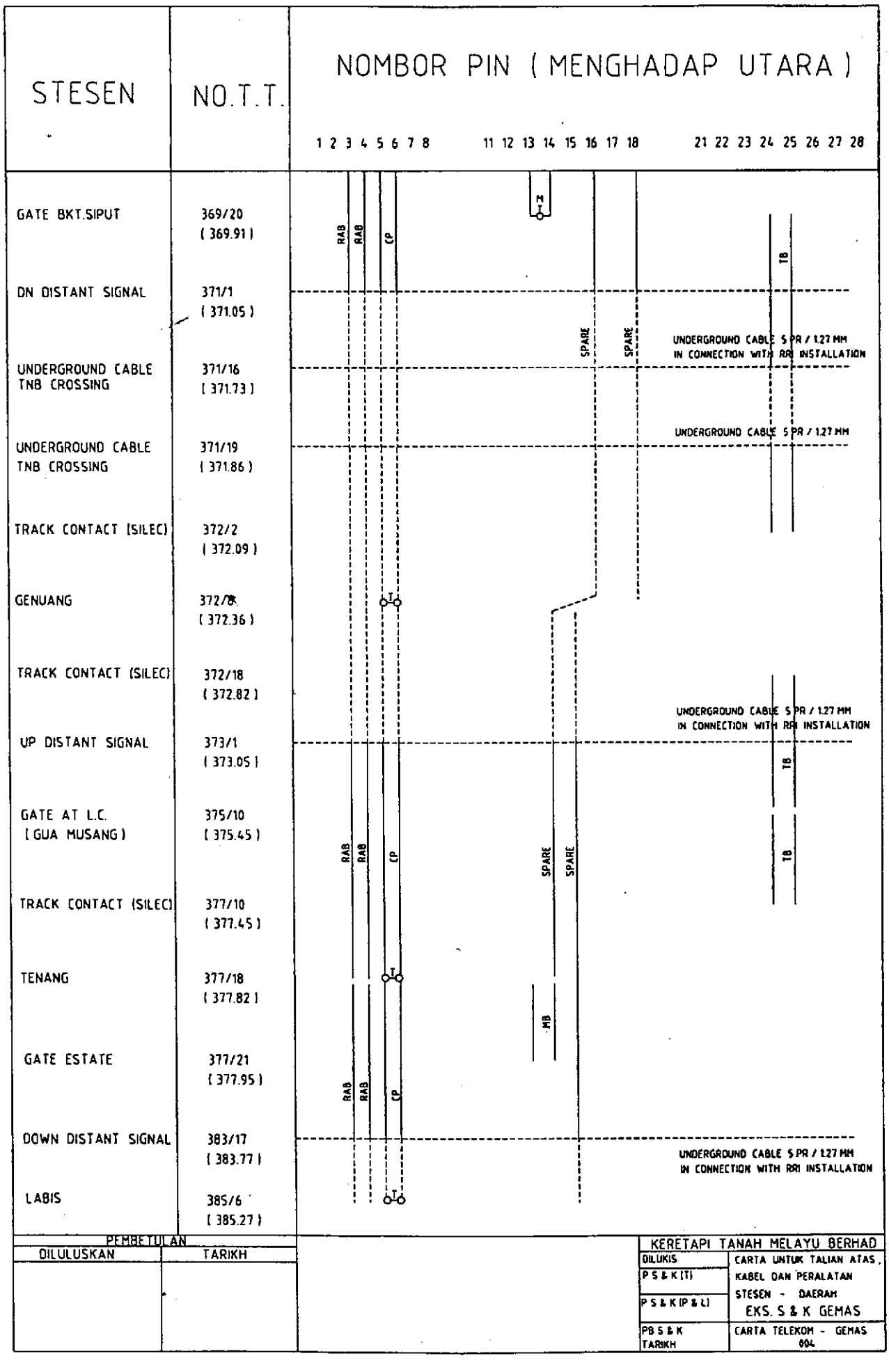
STESEN	NO.T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
BATU ANAM	357/12 (357.55)	
GATE BATU ANAM	357/17 (357.77)	
UP DISTANT SIGNAL	358/20 (358.91)	
GATE BULUH KASAP	361/5 (361.23)	
TRACK CONTACT (SILEC)	363/22 (364.00)	
UNDERGROUND CABLE TNB CROSSING	365/9 (365.41)	
UNDERGROUND CABLE TNB CROSSING	365/11 (365.50)	
DOWN DISTANT SIGNAL	365/12 (365.55)	
SEGAMAT	367/3 (367.14)	
GATE SEGAMAT	367/6 (367.27)	
GATE PAYA PULAI	368/2 (368.09)	
UP DISTANT SIGNAL	368/6 (368.27)	



PEMBETULAN	
DILULUSKAN	TARIKH

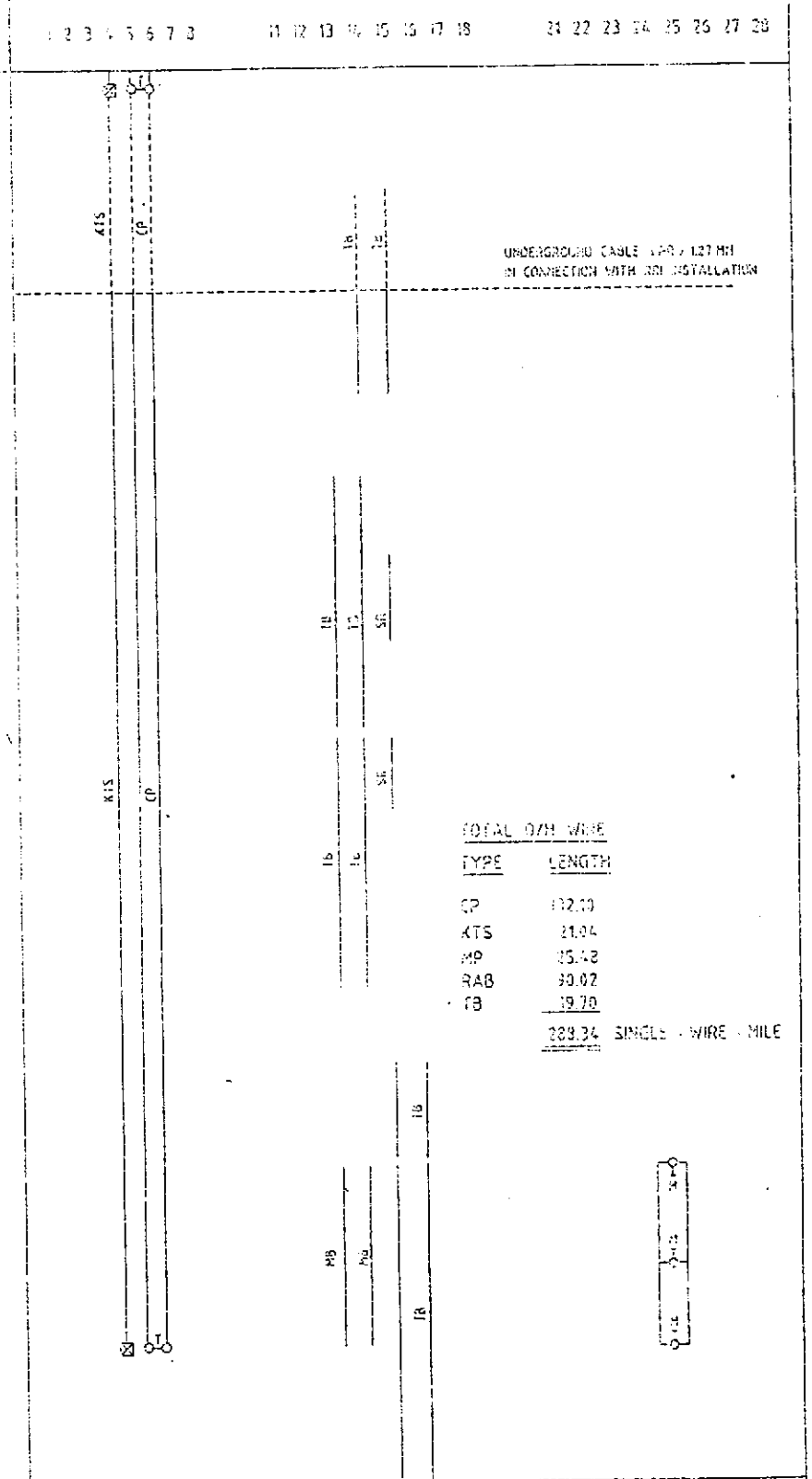
KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K GEMAS
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - GEMAS 003


STESEN
NO.T.T.
NOMBOR PIN (MENGHADAP UTARA)
1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
GATE BKT.SIPUT
369/20
(369.91)
DN DISTANT SIGNAL
371/1
(371.05)
UNDERGROUND CABLE
TNB CROSSING
371/16
(371.73)
UNDERGROUND CABLE
TNB CROSSING
371/19
(371.86)
TRACK CONTACT (SILEC)
372/2
(372.09)
GENUANG
372/8
(372.36)
TRACK CONTACT (SILEC)
372/18
(372.82)
UP DISTANT SIGNAL
373/1
(373.05)
GATE AT L.C.
(GUA MUSANG)
375/10
(375.45)
TRACK CONTACT (SILEC)
377/10
(377.45)
TENANG
377/18
(377.82)
GATE ESTATE
377/21
(377.95)
DOWN DISTANT SIGNAL
383/17
(383.77)
LABIS
385/6
(385.27)
RAB
RAB
CP
M
SPARE
SPARE
TB
MB
UNDERGROUND CABLE S PR / 1.27 MM
IN CONNECTION WITH RRI INSTALLATION
UNDERGROUND CABLE S PR / 1.27 MM
PEMBETULAN
DILULUSKAN
TARIKH
KERETAPI TANAH MELAYU BERHAD
DILUKIS
P S & K (T)
P S & K (P & L)
PB S & K
TARIKH
CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN
STESEN - DAERAH
EKS. S & K GEMAS
CARTA TELEKOM - GEMAS
004

STESEN	NO T T
GEMAS	351/7 0/0
GATE AT L.C.	5/17 (0.77)
DOWN DISTANT (ECL)	1/18 (1.82)
TRACK CONTACT (SILEC)	2/15 (2.68)
TRACK CONTACT (SILEC)	9/18 (10.82)
UP GATE SIGNAL	11/9 (11.82)
ROMPIN	12/10 (12.45)
GATE AT L.C.	12/14 (12.64)
GATE SIGNAL	[illegible]
TRACK CONTACT (SILEC)	15/3 (15.14)
TRACK CONTACT (SILEC)	19/18 (19.82)
GATE AT L.C.	21/15 (21.63)
GATE AT L.C.	22/10 (22.45)
BAHAU	22/19 (22.36)
TRACK CONTACT (SILEC)	24/19 (22.36)

NOMBOR PIN (MENGHADAP UTARA)



TOTAL O/H WIRE

TYPE	LENGTH
CP	132.10
KTS	21.04
MP	25.48
RAB	90.02
TB	19.70
	288.34 SINGLE - WIRE - MILE

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS S & K GEMAS
P S & K (T)	
P S & K (P & L)	
P S & K TARIKH	CARTA TELEKOM - GEMAS 005

STESEN	NO. T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
LENGEK	390/13 (390.50)	
[illegible] DISTANT SIGNAL	[illegible] (393.80)	
DEKOK	395/74 (395.10)	
[illegible] DISTANT SIGNAL	396/11 (396.50)	
TRACK CONTACT SILEC	401/3 (401.32)	
GATE	403/21 (403.95)	
PALOH	404/2 (404.99)	
TRACK CONTACT SILEC	406/18 (406.82)	

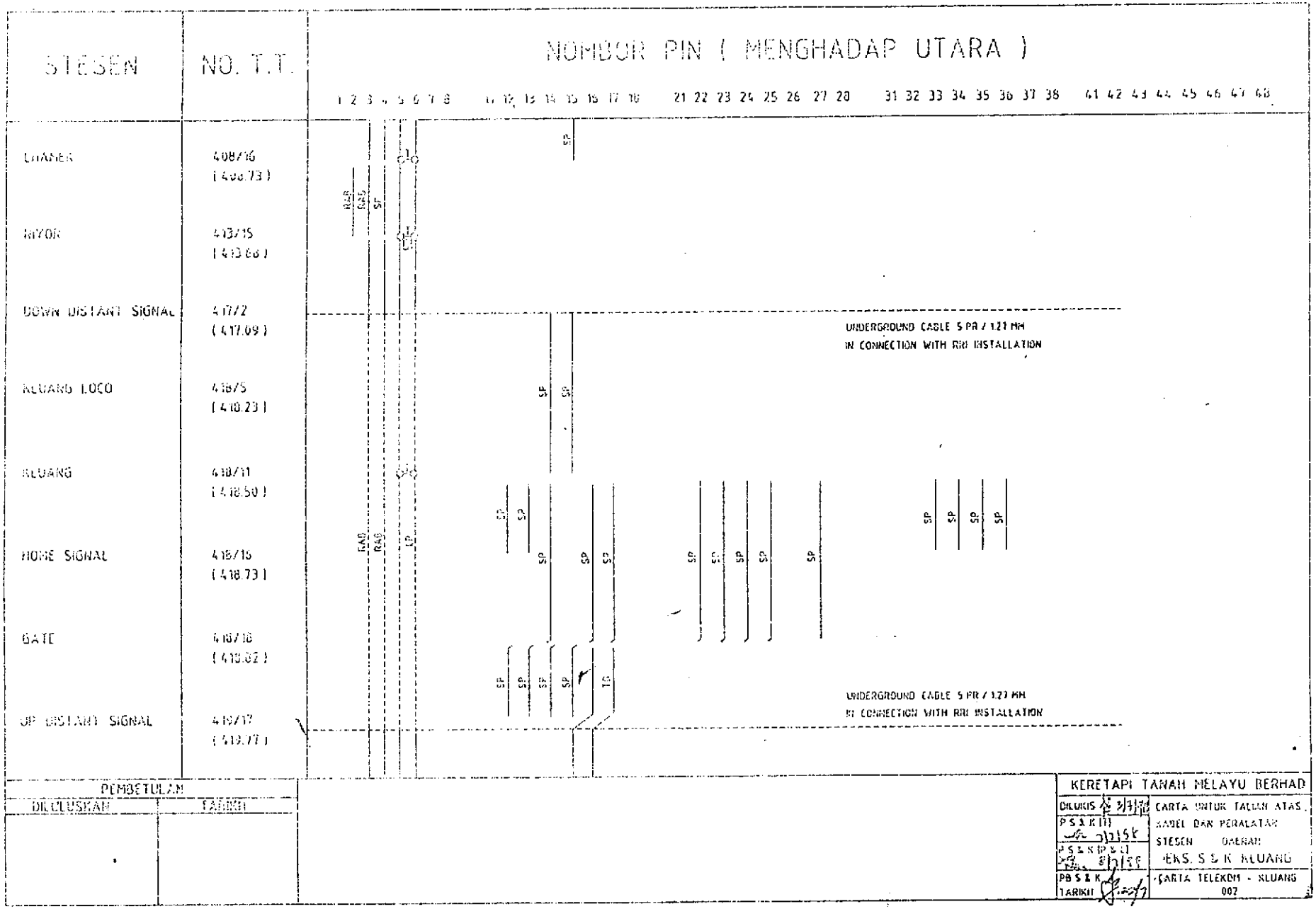
UNDERGROUND CABLE 5 PR / 1.27 MM
IN CONNECTION WITH RRI INSTALLATION

UNDERGROUND CABLE 5 PR / 1.27 MM
IN CONNECTION WITH RRI INSTALLATION

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

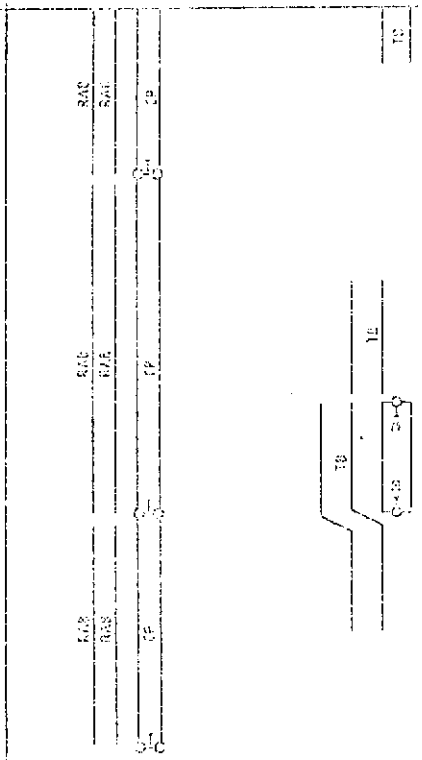
DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN
PS & K (T)	STESEN - DAERAH
PS & K (P & L)	EKS. S & K KUANG
PB S & K TARIKH	CARTA TELEKOM - KUANG 001


STESEN
NO. T.T.
NOMBOR PIN (MENGHADAP UTARA)
1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48
LUANAR
408/16
(408.73)
NYOR
413/15
(413.66)
DOWN DISTANT SIGNAL
417/2
(417.09)
KLUANG LOCO
418/5
(418.23)
KLUANG
418/11
(418.50)
HOME SIGNAL
418/15
(418.73)
GATE
418/18
(419.02)
UP DISTANT SIGNAL
419/17
(419.77)
RAB
GATE
SP
LP
TG
UNDERGROUND CABLE 5 PR / 1.27 MM
IN CONNECTION WITH RRI INSTALLATION
UNDERGROUND CABLE 5 PR / 1.27 MM
IN CONNECTION WITH RRI INSTALLATION
PEMBETULAN
DILULUSKAN
TARIKH
KERETAPI TANAH MELAYU BERHAD
DILUKIS
P S & K (T)
P S & K (P & T)
PB S & K
TARIKH
CARTA UNTUK TALIAN ATAS.
KABEL DAN PERALATAN
STESEN DAERAH
EKS. S & K KLUANG
CARTA TELEKOM - KLUANG
002

SILSEN	NO. T.T.
TRACK CONTACT SILEC	421/16 (421.73)
MENGKIBOL	422/16 (422.23)
TRACK CONTACT SILEC	427/17 (427.82)
GATE	430/14 (430.64)
KENGAH	430/16 (430.73)
TRACK CONTACT SILEC	433/16 (433.73)
LAYANG - LAYANG	438/4 (438.16)

NOMBOR PIN (MENGHADAP UTARA)

1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28 31 32 33 34 35 36 37 38 41 42 43 44 45 46 47 48



TOTAL O/H WIRE

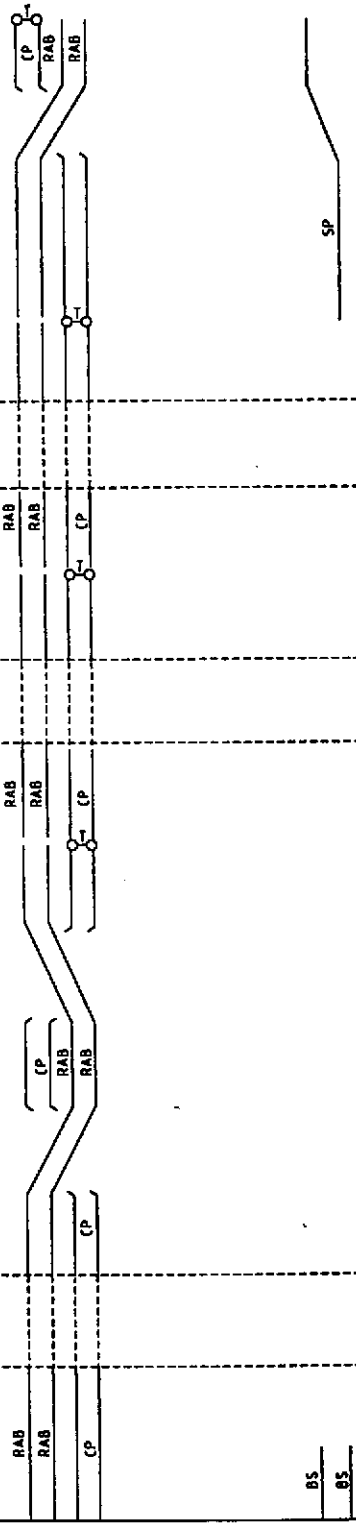
TYPE	LENGTH
CP	84.54
MP	0.46
RAB	84.54
TB	28.64
	198.18 SINGLE - WIRE - MILE

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN
P S & K (T)	STESEN - DAERAH
P S & K (P & L)	EKS. S & K KLUANG
P S & K TARIKH	CARTA TELEKOM - KLUANG 003

STESEN	NO.T.T.	NOMBOR PIN (MENGHADAP UTARA) 1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
LAYANG - LAYANG	438/4 (438.18)	
	439/2A (439.09)	
	439/2B (439.09)	
UP DISTANT SIGNAL	439/6 (439.27)	
SEDENAK	446/11 (446.50)	
	449/17 (449.77)	UNDERGROUND CABLE 5 PR / 1.27 MM IN CONNECTION WITH TNB CROSSING
	449/18 (449.82)	
KULAI	452/15 (452.68)	
	462/22 (463.00)	UNDERGROUND CABLE 5 PR / 1.27 MM IN CONNECTION WITH TNB CROSSING
	463/1 (463.05)	
KEMPAS BAHRU	465/13 (465.69)	
ZULLIG SIDING	468/1 (468.05)	
	468/1A (486.05)	
	468/8 (468.36)	
APMC SIDING	468/8A (468.36)	
	469/17 (469.77)	UNDERGROUND CABLE 5 PR / 1.27 MM IN CONNECTION WITH TNB CROSSING
	469/18 (469.82)	
BANNER SIGNAL	470/19 (470.86)	



PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

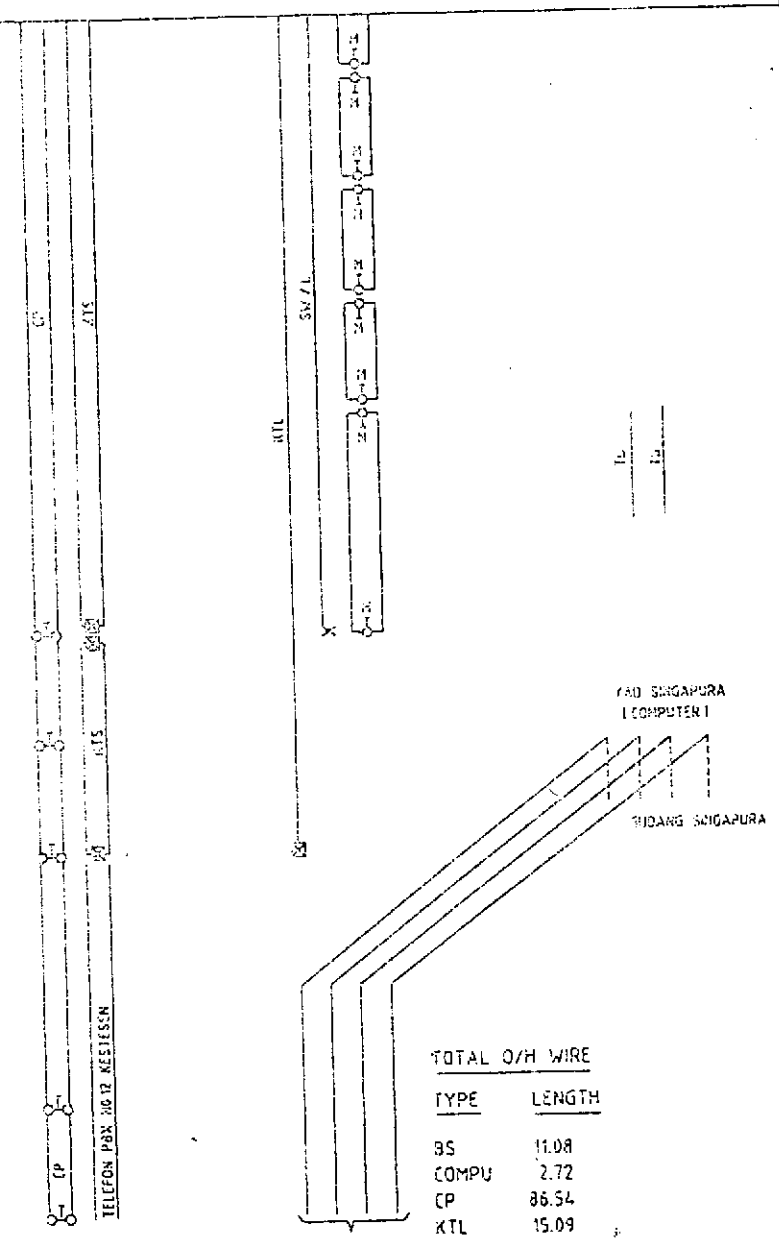
DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K J.BAHRU
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - J.BAHRU 001

STESEN	NO.T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
DOWN OUTER SIGNAL	471/7 (471.32)	RAB RAB CP MS MS SR SP SP SP BS BS
	471/10 (471.46)	UNDERGROUND CABLE 5 PR / 1.27 MM IN CONNECTION WITH O/H BRIDGE CONSTRUCTION
	471/11 (471.50)	
	471/11A (471.50A)	CP RAB RAB MS MS SR SP SP SP
	471/19 (471.86)	
PEJABAT E. S & K	471/19A (471.86A)	
JOHOR BAHRU	472/3 (472.14)	RAB RAB CP SR SR M M
UP OUTER SIGNAL	472/19 (472.86)	CP KTS KTL SW / L M
	472/33 (473.41)	
PEJ.IMEGRESEN (SINGAPURA)	473/7 (473.32)	
KABEL SEMENTARA PROJEK IMEG.S'PURA BARU	473/9 (473.41)	UNDERGROUND CABLE 5 PR / 1.27 MM
	474/6 (474.27)	
GATE AT L.C. (KRANJI)	474/15 (474.68)	CP KTS M M
UP GATE SIG. (KRANJI)	475/3 (475.18)	SR

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD	
DILUKIS	CARTA UNTUK TALIAN ATAS. KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K J.BAHRU
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - J.BAHRU 002

STESEN	NO T T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
GATE SG.KADUT	476/5 (476.25)	
GATE NANGA	477/5 (477.83)	
GATE CHUA CHU KANG BUKIT PANJANG	478/8 (478.34)	
GATE BUKIT TIMBAK	478/15 (478.91)	
TRACK CIRCUIT	481/4 (481.41)	
BUKIT TIMAH	481/8 (481.95)	
YAO SINGAPURA	488/6 (488.27)	
KADIN SINGAPURA	488/11 (488.50)	
	488/12 (488.65)	
LOKO SINGAPURA	488/13 (488.99)	
SINGAPURA	488/21 (488.95)	



TOTAL O/H WIRE

TYPE	LENGTH
BS	11.08
COMPU	2.72
CP	86.54
KTL	15.09
KTS	30.18
MP	21.98
MS	2.46
RAB	46.34
SR	0.50
SW/L	8.54
TB	5.00
	230.43 SINGLE - WIRE - MILE

PERSETUJUAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS [illegible] 2/3/82	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH SKS. S & K JOHORU
P S & K (T) [illegible] 2/3/82	
P S & K (P & L) [illegible] 2-3-82	
PB S & K TARIKH [illegible] 2/3/82	CARTA TELEKOM - JOHORU 303

STESEN	NO.T.T.	NOMBOR PIN (MENGHADAP UTARA) 1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
DOWN OUTER SIGNAL	236/1 (236.04)	
	235/13 (235.59)	
KEMUBU	235/12 (235.55)	
	235/11 (235.50)	
UP OUTER SIGNAL	234/26 (235.00)	
DOWN OUTER SIGNAL	222/10 (222.45)	
POINT NO.2 (UTARA)	222/4 (222.18)	
BERTAM BARU	221/21 (221.95)	
UP OUTER SIGNAL	221/5 (221.23)	
BANNER SIGNAL	220/22 (221.00)	
DOWN OUTER SIGNAL	217/3 (217.14)	
	216/14 (216.64)	
LIMAU KASTURI	216/13 (216.59)	
	216/12 (216.55)	

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD	
DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K K.LIPIS
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - K.LIPIS 001

STESEN	NO.T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
UP OUTER SIGNAL	216/1 (216.04)	SR SR
BANNER SIGNAL	200/19 (200.86)	BS BS
DOWN OUTER SIGNAL	200/9 (200.41)	
G.MUSANG S.M's HOUSE	199/17 (199.77)	SR SR MS MS
GUA MUSANG	199/16 (199.73)	
G.MUSANG POLICE STN.	199/M (199.50)	SR SR MS MS
UP OUTER SIGNAL	198/16 (198.73)	
DOWN OUTER SIGNAL	184/21 (184.95)	
MERAPOH POLICE STN.	184/14 (184.64)	SR SR
MERAPOH	184/9 (184.41)	SR SR
UP OUTER SIGNAL	183/11 (183.50)	
MERAPOH BAHRU	183/13 (183.59)	

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K K. LIPIS
P S & K (T)	
P S & K (P & LI)	
PB S & K TARIKH	CARTA TELEKOM - K.LIPIS 002

STESEN	NO.T.T.	NOMBOR PIN (MENGHADAP UTARA) 1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
TUNNEL NO. 1	171/17 (171.77)	SP SP
		SP SP SP
TUNNEL NO. 1	171/13 (171.59)	
DOWN OUTER SIGNAL (DILUCUT)	169/10 (169.45)	SP SP
SG.TEMAU (DITUTUP)	168/22 (169.00)	SP SP
	168/7 (168.32)	
DOWN OUTER SIGNAL	164/11 164.50)	SR SR
CHEGAR PERAH	163/19 (163.86)	
TRACK CCT. SILEC	149/20 (149.91)	
GATE AT L.C.	147/9 (147.41)	PR6 TB PR7 OF U/G CABLE 13 PRS
PADANG TUNKU	146/19 (146.86)	
EARTH	146/17 (146.77)	
TRACK CCT. SILEC	145/5 (145.23)	
DOWN OUTER SIGNAL.	141/27 (142.00)	SR SR SP SP SR SR
TELECOMS D.P.	141/15 (141.68)	

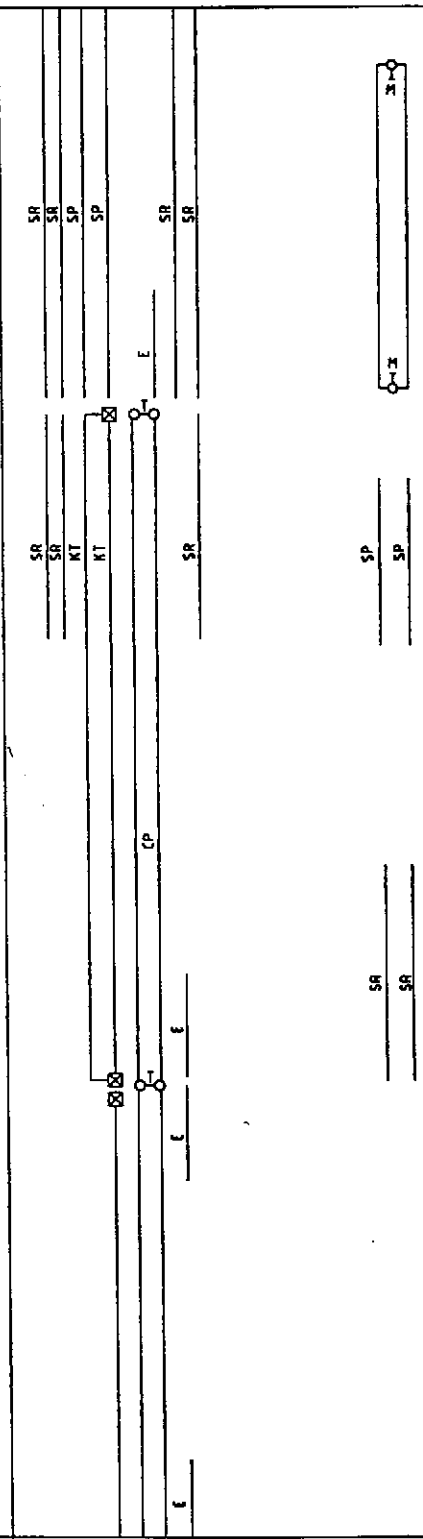
PEMBETULAN

DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K K.LIPIS
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - K.LIPIS 003

STESEN	NO.T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
GATE AT L.C.	141/14 (141.64)	
LOCO	141/12 (141.55)	
EARTH	141/11 (141.50)	
KUALA LIPIS	141/6 (141.27)	
	141/5 (141.23)	
GATE AT L.C.	141/2 (141.09)	
UP OUTER SIGNAL	140/15 (140.68)	
KUALA LANAR	139/1 (139.34)	
DOWN OUTER SIGNAL	127/15 (127.68)	
	127/4 (127.18)	
KRAMBIT	127/1 (127.04)	
	126/16 (126.73)	
UP OUTER SIGNAL	126/6 (126.32)	
DOWN OUTER SIGNAL	120/23 (120.55)	
	120/10 (120.45)	

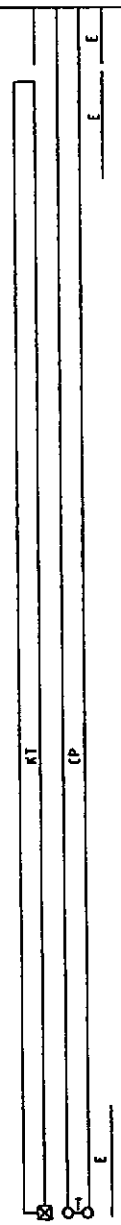


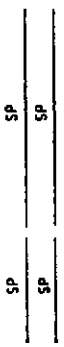
PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K K.LIPIS
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - K.LIPIS 004

STESEN	NO.T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
MELA (DITUTUP)	120/7 (120.55)	
	120/3 (120.14)	
UP OUTER SIGNAL	119/18 (119.82)	
BANNER SIG. (MELA)	119/13 (119.59)	
PADANG PIOL	113/19 (113.86)	
TEH HALT	109/22 (110.00)	
BANNER SIGNAL	109/9 (109.41)	
DN OUTER SIGNAL	108/19 (108.86)	
	108/6 (108.27)	
JERANTUT	108/3 (103.14)	





TOTAL O/H WIRE

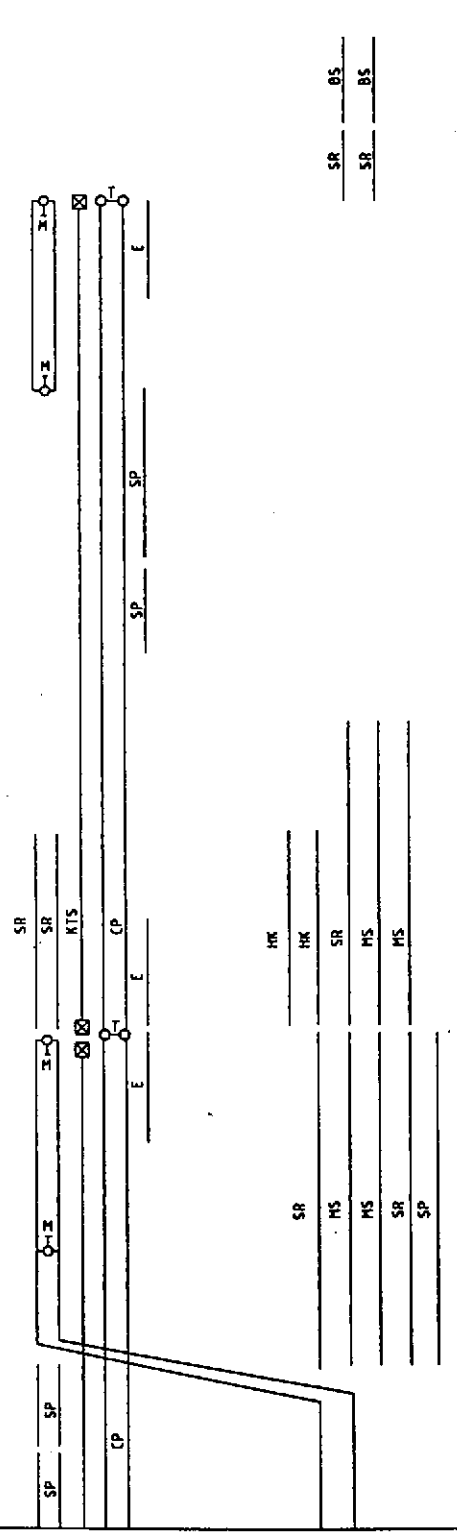
TYPE	LENGTH
BS	3.56
CP	66.26
E	1.12
KTS	59.77
MP	0.74
MS	8.92
SR	16.67
WK	0.28
	157.32 SINGLE - WIRE - MILE

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K K.LIPIS
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - K.LIPIS 005

STESEN	NO.T.T.	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
BANNER SIGNAL	109/9 (109.41)	
DOWN OUTER SIGNAL	108/19 (108.86)	
JERANTUT	108/3 (108.14)	
	108/1 (108.04)	
GATE AT L.C.	107/19 (107.86)	
	102/20 (102.91)	
	102/17 (102.77)	
	102/15 (102.68)	
DOWN OUTER SIGNAL	92/14 (92.64)	
DOWN HOME SIGNAL	92/8 (92.36)	
	92/7 (92.32)	
KUALA KRAU	92/3 (92.14)	
	91/23 (92.00)	
GATE AT L.C.	91/19 (91.86)	
UP OUTER SIGNAL	91/12 (91.55)	
	89/19 (89.86)	



PEMBETULAN	
DILULUSKAN	TARIKH

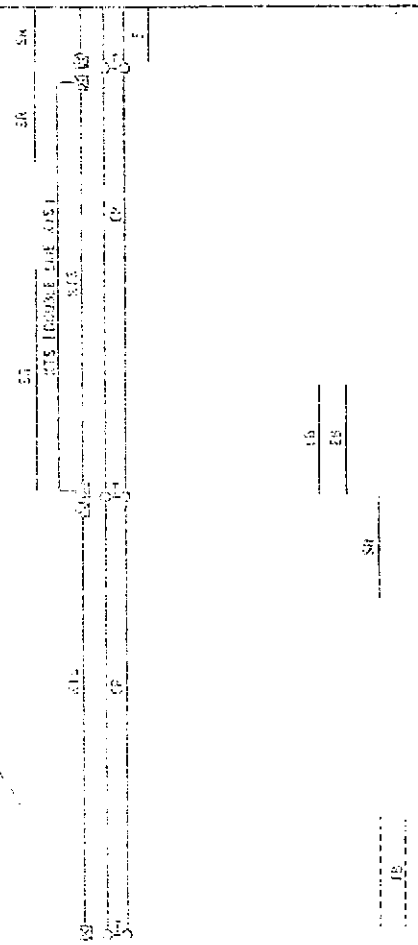
KERETAPI TANAH MELAYU BERHAD	
DILUKIS	CARTA UNTUK TALIAN ATAS.
P S & K (T)	KABEL DAN PERALATAN
P S & K (P & L)	STESEN - DAERAH EKS. S & K MENTAKAB
PB S & K TARIKH	CARTA TELEKOM - MENTAKAB 001

STESEN	NO T T	NOMBOR PIN (MENGHADAP UTARA)
GATE AT L.C.	88/3 (88.14)	
TRACK CONTACT (SILEC)	86/5 (86.14)	
NEW PLANTATION	84/1 (84.04)	
DOWN OUTER SIGNAL	76/0 (76.36)	
	76/1 (76.05)	
MENTAKAB	75/19 (75.36)	
	75/13 (75.82)	
GATE AT L.C.	[illegible]	
UP OUTER SIGNAL	75/[illegible] (75.27)	
TRACK CONTACT (SILEC)	73/13 (73.59)	
	62/3 (62.14)	
	61/21 (61.95)	
	61/12 (61.55)	
	55/21 (55.95)	
	55/19 (55.36)	

PEMBETULAN	
DILULUSKAN	TARIKH

KERETAPI TANAH MELAYU BERHAD	
DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K MENTAKAB
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - MENTAKAB 002

STESEN	NO T T	NOMBOR PIN (MENGHADAP UTARA)
		1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 21 22 23 24 25 26 27 28
TRIANG	55/16 (55.73)	
	55/4 (55.16)	
DOWN OUTER SIGNAL	47/12 (47.55)	
S.H. HOUSE	46/22 (47.00)	
KEMAYAN	46/20 (46.81)	
UP OUTER SIGNAL	46/8 (46.[illegible])	
AYER HITAM	45/5 (45.[illegible])	
TRACK CONTACT (SILEC)	34.10 (34.45)	
BANAU	22/19 (22.36)	



TOTAL O/H WIRE

TYPE	LENGTH
BS	1.1
CP	170.56
E	0.55
EB	0.18
HK	0.44
XTS	94.10
MP	9.18
MS	3.27
SR	4.60
TB	7.92
	291.90 SINGLE - WIRE - MILE

PEMERIKSAAN	
DILULUSKAN	TARIKH

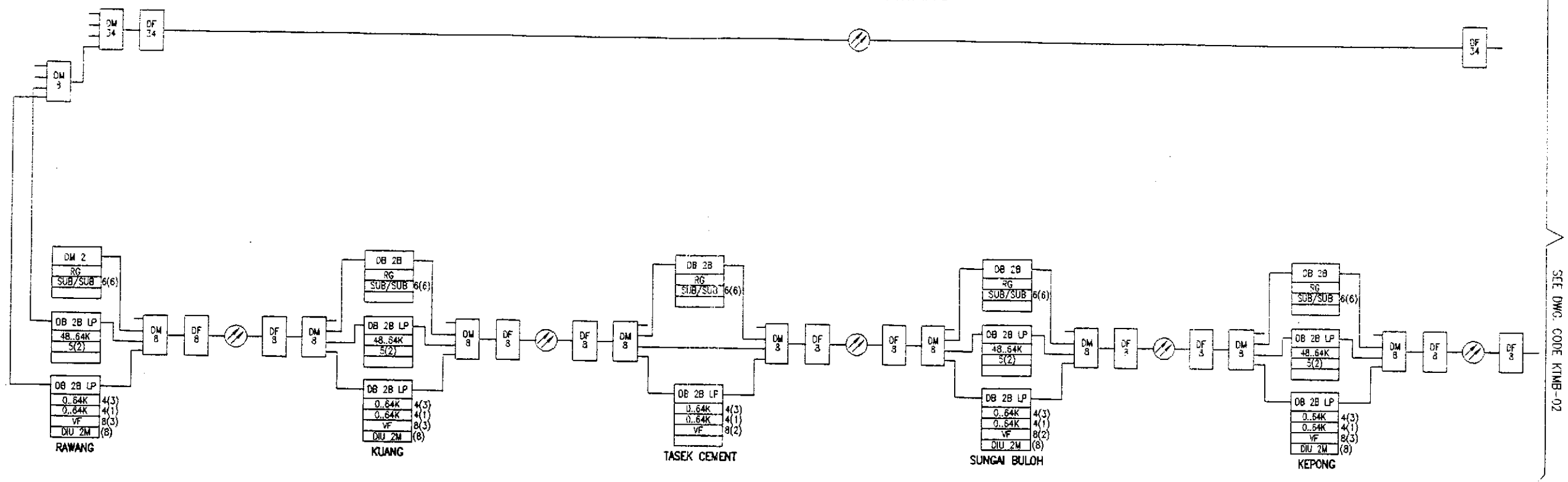
KERETAPI TANAH MELAYU BERHAD

DILUKIS	CARTA UNTUK TALIAN ATAS, KABEL DAN PERALATAN STESEN - DAERAH EKS. S & K MENTAKAB
P S & K (T)	
P S & K (P & L)	
PB S & K TARIKH	CARTA TELEKOM - MENTAKAB 093

Attachment C

KTM Fiber System Inventory

8 Mb/S
CHANNEL ALLOCATION
KUALA LUMPUR – RAWANG



LEGENDS :

DF 34	OPTICAL LINE TERMINAL EQUIPMENT
DM 34	THIRD ORDER MULTIPLEX EQUIPMENT
DF 8	OPTICAL LINE TERMINAL EQUIPMENT
DM 8	SECOND ORDER MULTIPLEX EQUIPMENT
DM	FIRST ORDER MULTIPLEX EQUIPMENT
DB 2B	2 MBIT/S BRANCHING EQUIPMENT
DB 2B LP	2 MBIT/S BRANCHING, LOOP PROTECTION
DIU 2M	DATA INTERFACE UNIT 2M FOR RADIO SYSTEM
0..64K	DATA INTERFACE UNIT FOR SPT. SIGNALLING (V.24/28)
48..64K	DATA INTERFACE UNIT FOR PASSENGER INFORMATION & TICKETING (V.35)
VF	E & M VOICE FREQUENCY FOR SPT, DESPATCH TELEPHONE AND SCADA
SUB/SUB	SUBSCRIBER CARD FOR PABX EXTENSION
SUB/EXCH	EXCHANGE CARD FOR PABX EXTENSION
RG	RING GENERATOR
X(Y)	X – CHANNEL PROVIDED Y – CHANNEL USED

3						
2						
1						
0						
CHY	DATE	AUTHOR	CHECKED	QA	APPROVED	DESCRIPTION

TITLE: 8Mb/s SIGNALLING & COMMUNICATION SYSTEM DRAWING

STATION: RAWANG–KUALA LUMPUR

ICF KAISER

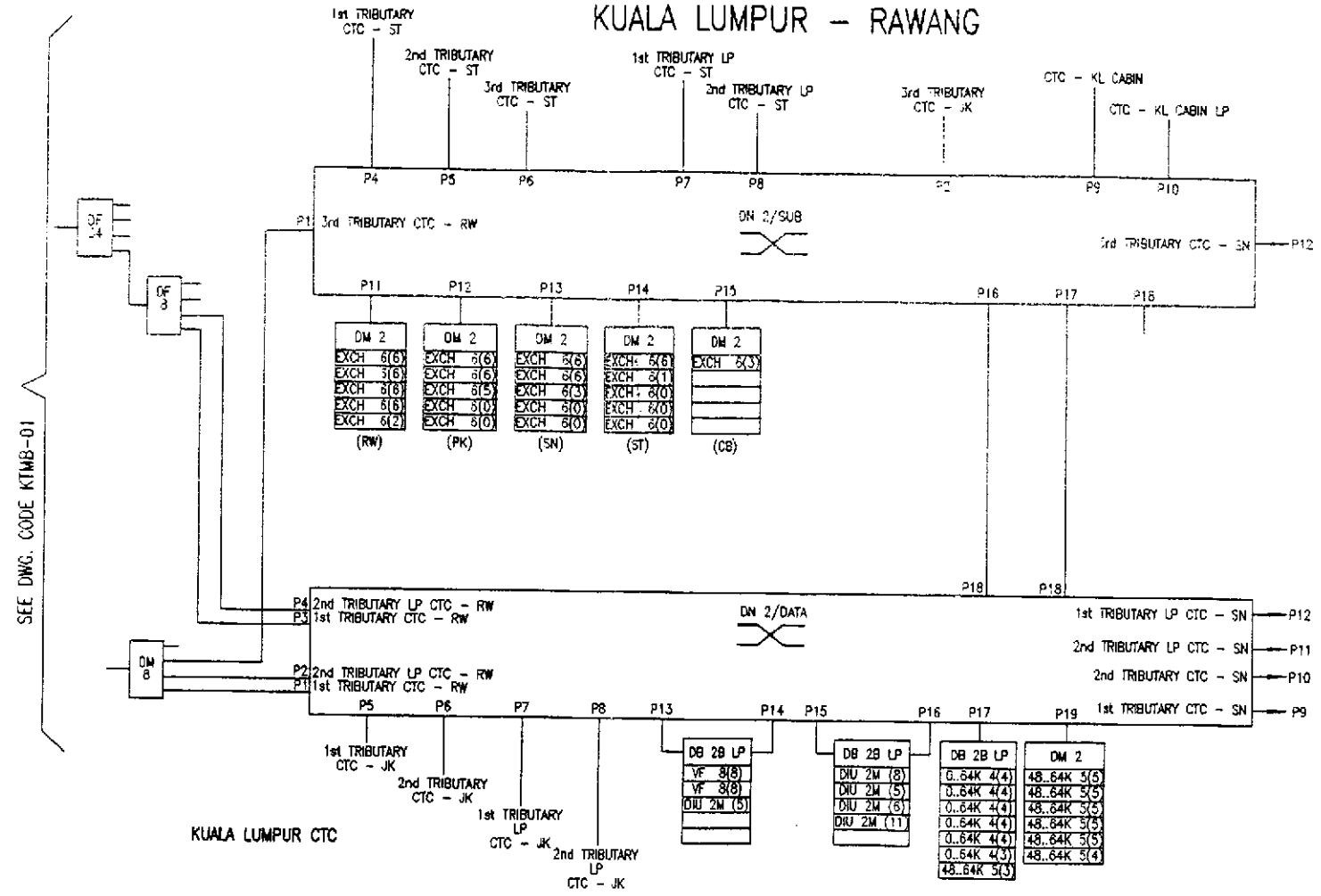
KERETAPI TANAH MELAYU BERHAD
BAHAGIAN SEMBOYAN DAN KOMUNIKASI

KTM

CODE FOR DOCUMENT	1.81	CODE FOR FUNCTION	DRAWING CODE :	SHEET NO.
			KTMB–01	1/2

CAD FILE : K–01.DWG
CAD BY: E Y BOON

8 Mb/S
CHANNEL ALLOCATION
KUALA LUMPUR – RAWANG



VF (P13/14)

1 – 3 : RW
4 – 5 : ST
6 : CB
7 – 8 : JK
9 – 12 : SN
13 – 15 : CB (DIU 2M)
17 – 18 : CB (DIU 2M)
19 : ST
20 : JK
21 : CB
22 : CB

DIU 2M (P15P16)

1 – 8 : RW
9 – 13 : ST
14 15 : JK
17 – 20 : JK
21 – 27 : SN
28 – 31 : SN

VF (P13/14)

1 – 4 : RW – 2
5 – 8 : ST – 3
9 – 12 : CB – 4
13 – 15 : JK – 5
17 : JK
18 – 21 : SN
22 – 24 : ST (48..64K)
25 : ST – 7
26 : JK
27 : SN

48..64K (P19)

1 – 6 : RW
17 – 15 : PK
17 –21 : PK
22 – 30 : SN

LEGENDS :

OF 34	OPTICAL LINE TERMINAL EQUIPMENT
DM 34	THIRD ORDER MULTIPLEX EQUIPMENT
OF 8	OPTICAL LINE TERMINAL EQUIPMENT
DM 8	SECOND ORDER MULTIPLEX EQUIPMENT
DM 2	FIRST ORDER MULTIPLEX EQUIPMENT
DB 2B	2 MBIT/S BRANCHING EQUIPMENT
DB 2B LP	2 MBIT/S BRANCHING, LOOP PROTECTION
DIU 2M	DATA INTERFACE UNIT 2M FOR RADIO SYSTEM
0..64K	DATA INTERFACE UNIT FOR SPT, SIGNALLING (V.24/28)
48..64K	DATA INTERFACE UNIT FOR PASSENGER INFORMATION & TICKETING (V.35)
VF	E & M VOICE FREQUENCY FOR SPT, DESPATCH TELEPHONE AND SCADA
SUB/SUB	SUBSCRIBER CARD FOR PABX EXTENSION
SUB/EXCH	EXCHANGE CARD FOR PABX EXTENSION
RG	RING GENERATOR
X(Y)	X – CHANNEL PROVIDED Y – CHANNEL USED

EDIT	DATE	AUTHOR	CHECKED	QA	APPROVED	DESCRIPTION

TITLE: 8Mb/s SIGNALLING & COMMUNICATION SYSTEM DRAWING

STATION: RAWANG–K.LUMPUR

ICF KAISER

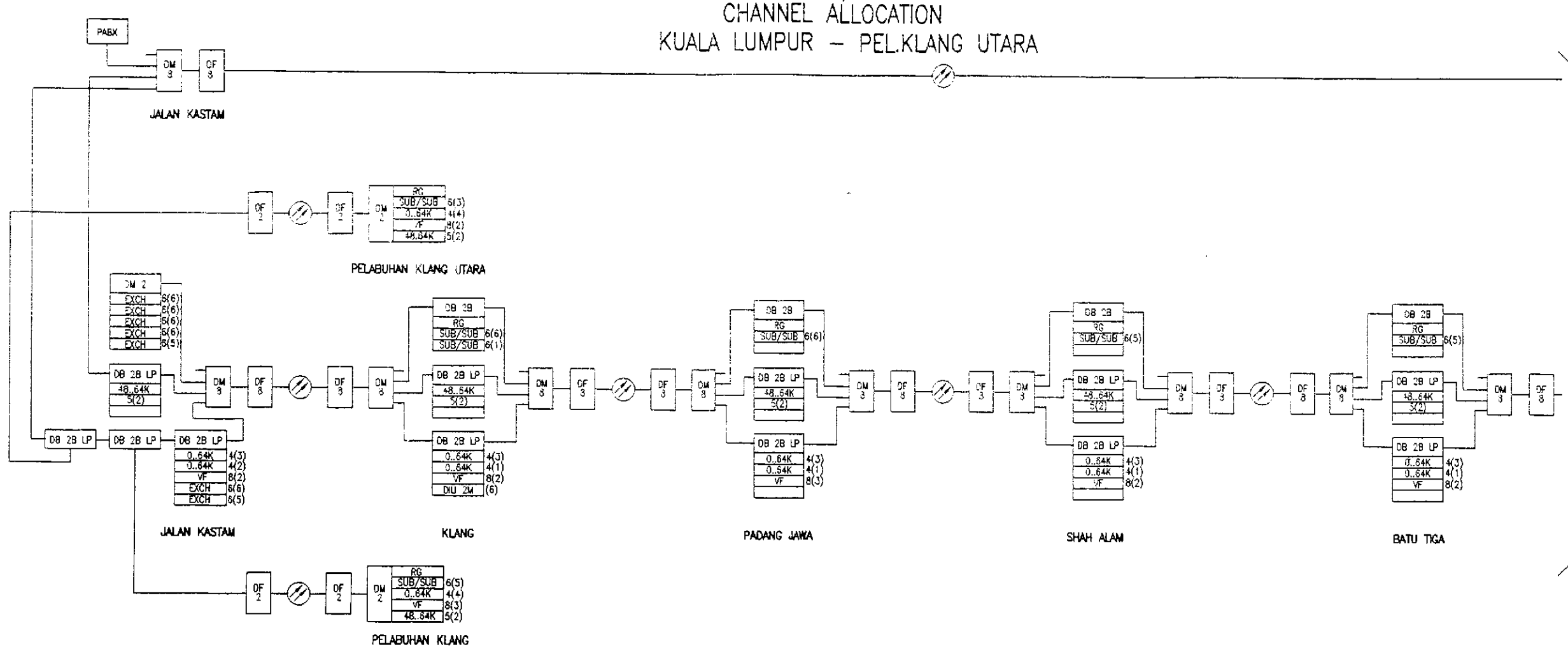
KERETAPI TANAH MELAYU BERHAD
BAHAGIAN SEMBOYAN DAN KOMUNIKASI

KTM

CODE FOR DOCUMENT	T.R.I	CODE FOR FUNCTION	DRAWING CODE :	SHEET NO.
			KTMB–02	2/2

CAD FILE : X–02.DWG
CAD BY: E Y BOON

8 Mb/S
CHANNEL ALLOCATION
KUALA LUMPUR – PEL.KLANG UTARA



LEGENDS :

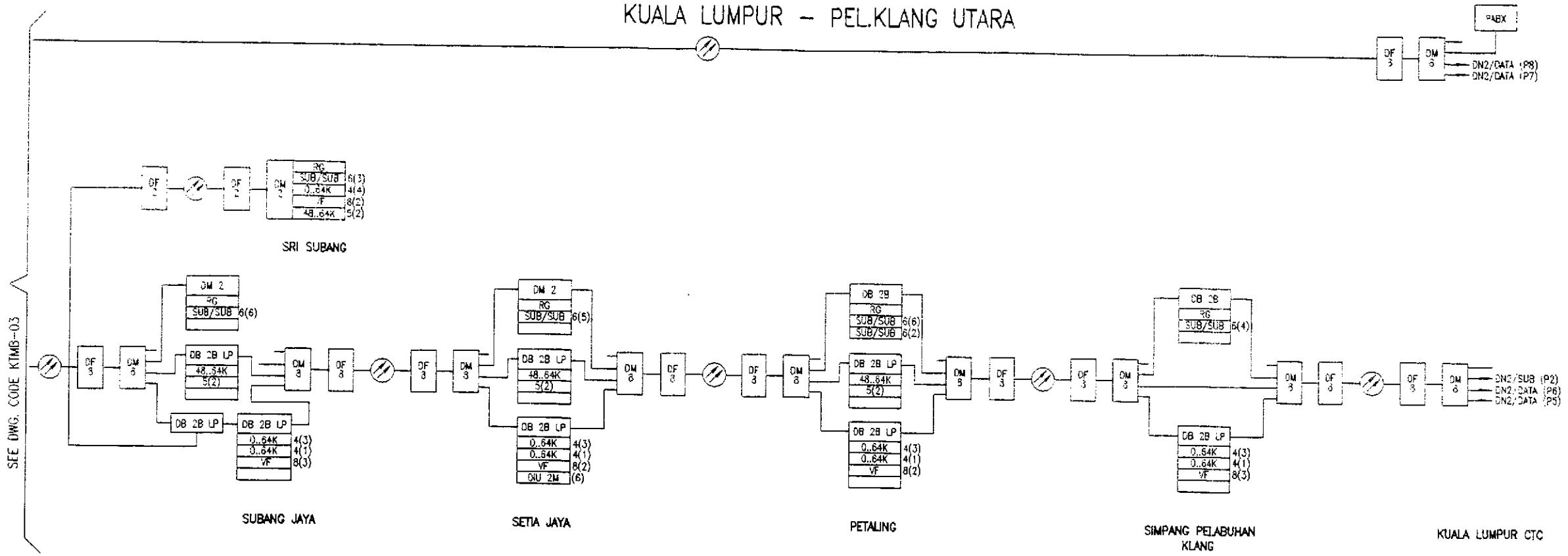
DF 8	8 Mbit/s OPTICAL LINE TERMINAL EQUIPMENT
DM 8	SECOND ORDER MULTIPLEX EQUIPMENT
DM 2	FIRST ORDER MULTIPLEX EQUIPMENT
DB 2B	2 MBIT/S BRANCHING EQUIPMENT
DB 2B LP	2 MBIT/S BRANCHING, LOOP PROTECTION
DIU 2M	DATA INTERFACE UNIT 2M FOR RADIO SYSTEM
0..64K	DATA INTERFACE UNIT FOR SPT, SIGNALLING (V.24/28)
48..64K	DATA INTERFACE UNIT FOR PASSENGER INFORMATION & TICKETING (V.35)
VF	E & M VOICE FREQUENCY FOR SPT, DESPATCH TELEPHONE AND SCADA
SUB/SUB	SUBSCRIBER CARD FOR PABX EXTENSION
SUB/EXCH	EXCHANGE CARD FOR PABX EXTENSION
RG	RING GENERATOR
X(Y)	X – CHANNEL PROVIDED Y – CHANNEL USED

EDIT	DATE	AUTHOR	CHECKED	QA	APPROVED	DESCRIPTION

TITLE: 8Mb/s SIGNALLING & COMMUNICATION SYSTEM DRAWING	STATION: K.LUMPUR–PEL.KLANG UTARA
ICF KAISER	KERETAPI TANAH MELAYU BERHAD BAHAGIAN SEMBOYAN DAN KOMUNIKASI
CODE FOR DOCUMENT: T.R.I. CODE FOR FUNCTION	KTMB
	DRAWING CODE : KTMB–03
	SHEET NO. 1/2

CAD FILE : K-03.DWG
CAD BY: E Y BOCO

8 Mb/S
CHANNEL ALLOCATION
KUALA LUMPUR – PEL.KLANG UTARA



LEGENDS :

DF 8	8 Mbit/s OPTICAL LINE TERMINAL EQUIPMENT
DM 8	SECOND ORDER MULTIPLEX EQUIPMENT
DM 2	FIRST ORDER MULTIPLEX EQUIPMENT
DB 2B	2 MBIT/S BRANCHING EQUIPMENT
DB 2B LP	2 MBIT/S BRANCHING, LOOP PROTECTION
DIU 2M	DATA INTERFACE UNIT 2M FOR RADIO SYSTEM
0..64K	DATA INTERFACE UNIT FOR SPT, SIGNALLING (V.24/28)
48..64K	DATA INTERFACE UNIT FOR PASSENGER INFORMATION & TICKETING (V.35)
VF	E & M VOICE FREQUENCY FOR SPT, DESPATCH TELEPHONE AND SCADA
SUB/SUB	SUBSCRIBER CARD FOR PABX EXTENSION
SUB/EXCH	EXCHANGE CARD FOR PABX EXTENSION
RG	RING GENERATOR
X(Y)	X – CHANNEL PROVIDED Y – CHANNEL USED

EDIT	DATE	AUTHOR	CHECKED	QA	APPROVED	DESCRIPTION
4						
3						
2						
1						

TITLE: 8Mb/s SIGNALLING & COMMUNICATION SYSTEM DRAWING

STATION: K.LUMPUR-PEL.KLANG UTARA

ICF KAISER

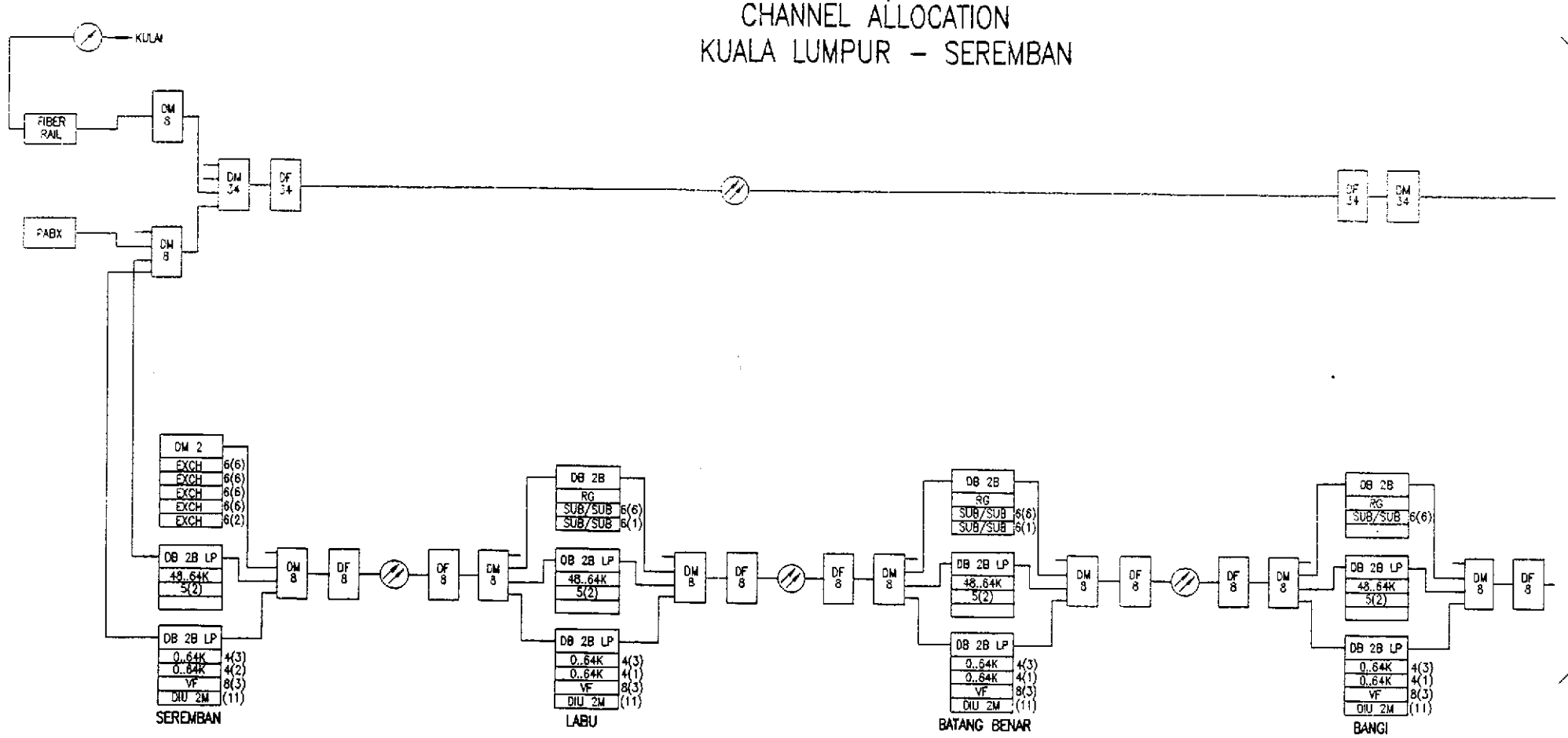
KERETAPI TANAH MELAYU BERHAD
BAHAGIAN SEMBOYAN DAN KOMUNIKASI

KTM

CODE FOR DOCUMENT	T.R.I	CODE FOR FUNCTION	DRAWING CODE :	SHEET NO.
			KTMB-04	2/2

CAD FILE : K-04.DWG
CAD BY: E Y BOCO

8 Mb/S
CHANNEL ALLOCATION
KUALA LUMPUR – SEREMBAN



SEE DWG. CODE KTMB-06

LEGENDS :

DF 34	34 Mbit/s OPTICAL LINE TERMINAL EQUIPMENT
DM 34	THIRD ORDER MULTIPLEX EQUIPMENT
DF 8	8 Mbit/s OPTICAL LINE TERMINAL EQUIPMENT
DM 8	SECOND ORDER MULTIPLEX EQUIPMENT
DM 2	FIRST ORDER MULTIPLEX EQUIPMENT
DB 2B	2 MBIT/S BRANCHING EQUIPMENT
DB 2B LP	2 MBIT/S BRANCHING, LOOP PROTECTION
DIU 2M	DATA INTERFACE UNIT 2M FOR RADIO SYSTEM
0..64K	DATA INTERFACE UNIT FOR SPT, SIGNALLING (V.24/28)
48..64K	DATA INTERFACE UNIT FOR PASSENGER INFORMATION & TICKETING (V.35)
VF	E & M VOICE FREQUENCY FOR SPT, DESPATCH TELEPHONE AND SCADA
SUB/SUB	SUBSCRIBER CARD FOR PABX EXTENSION
SUB/EXCH	EXCHANGE CARD FOR PABX EXTENSION
RG	RING GENERATOR
X(Y)	X – CHANNEL PROVIDED Y – CHANNEL USED

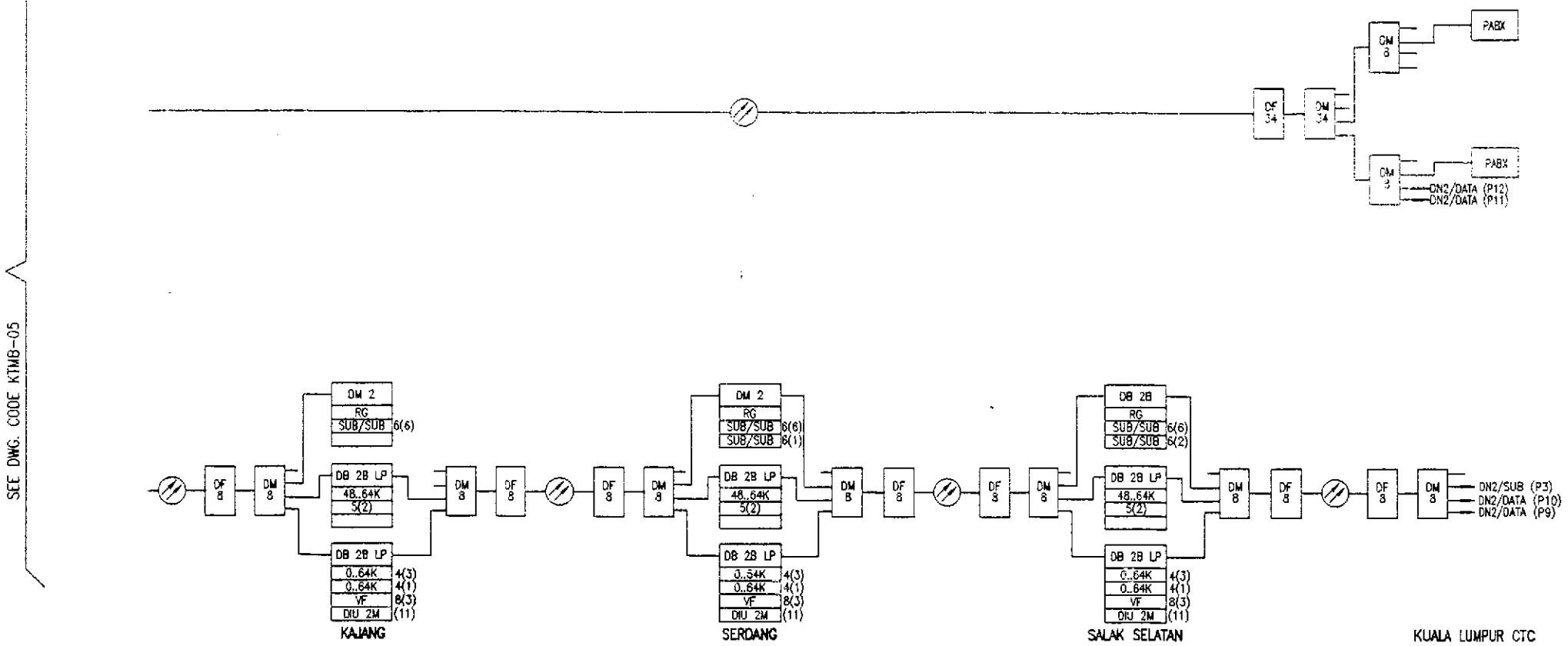
EDIT	DATE	AUTHOR	CHECKED	QA	APPROVED	DESCRIPTION
4						
3						
2						
1						

TITLE: 8Mb/s SIGNALLING & COMMUNICATION SYSTEM DRAWING		STATION: K.LUMPUR SEREMBAN
ICF KAISER	KERETAPI TANAH MELAYU BERHAD BAHAGIAN SEMBOYAN DAN KOMUNIKASI	
CODE FOR DOCUMENT: T.R.I / CODE FOR FUNCTION	KTM	DRAWING CODE : KTMB-05 / SHEET NO. 1/2

CAD FILE : K-05.DWG
CAD BY: E Y BOOD

8 Mb/S
CHANNEL ALLOCATION
KUALA LUMPUR – SEREMBAN

SEE DWG. CODE KTMB-05



LEGENDS :

DF 34	34 Mbit/s OPTICAL LINE TERMINAL EQUIPMENT
DM 34	THIRD ORDER MULTIPLEX EQUIPMENT
DF 8	8 Mbit/s OPTICAL LINE TERMINAL EQUIPMENT
DM 8	SECOND ORDER MULTIPLEX EQUIPMENT
DM 2	FIRST ORDER MULTIPLEX EQUIPMENT
DB 2B	2 MBIT/S BRANCHING EQUIPMENT
DB 2B LP	2 MBIT/S BRANCHING, LOOP PROTECTION
DIU 2M	DATA INTERFACE UNIT 2M FOR RADIO SYSTEM
0..64K	DATA INTERFACE UNIT FOR SPT, SIGNALLING (V.24/28)
48..64K	DATA INTERFACE UNIT FOR PASSENGER INFORMATION & TICKETING (V.35)
VF	E & M VOICE FREQUENCY FOR SPT, DESPATCH TELEPHONE AND SCADA
SUB/SUB	SUBSCRIBER CARD FOR PABX EXTENSION
SUB/EXCH	EXCHANGE CARD FOR PABX EXTENSION
RG	RING GENERATOR
X(Y)	X – CHANNEL PROVIDED Y – CHANNEL USED

EDIT	DATE	AUTHOR	CHECKED	QA	APPROVED	DESCRIPTION
4						
3						
2						
1						

TITLE: 8Mb/s SIGNALLING & COMMUNICATION SYSTEM DRAWING

STATION: K.LUMPUR SEREMBAN

ICF KAISER

KERETAPI TANAH MELAYU BERHAD
BAHAGIAN SEMBOYAN DAN KOMUNIKASI

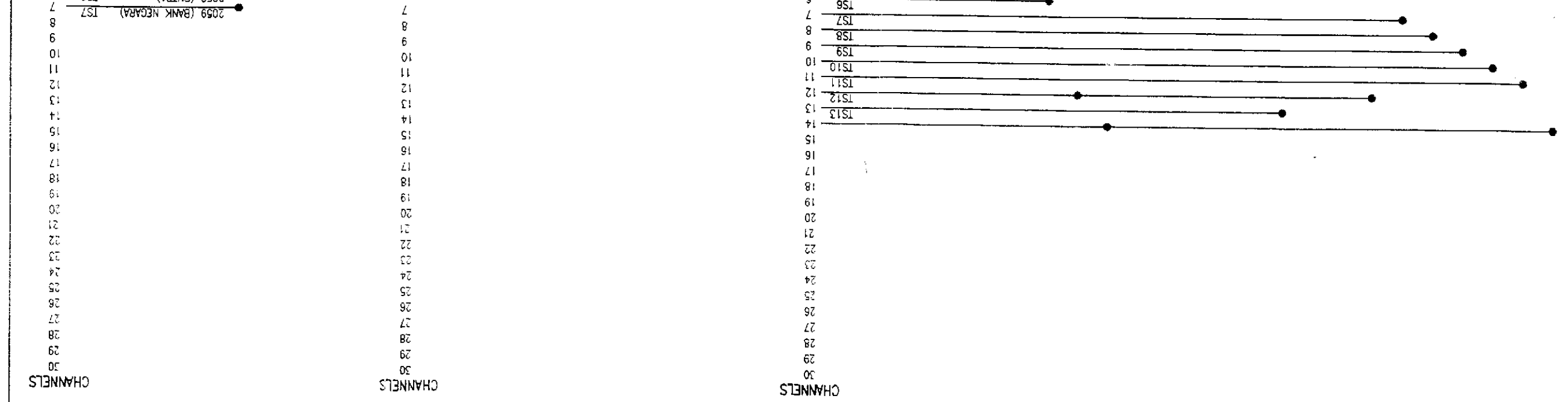
CODE FOR DOCUMENT: T.R.I | CODE FOR FUNCTION

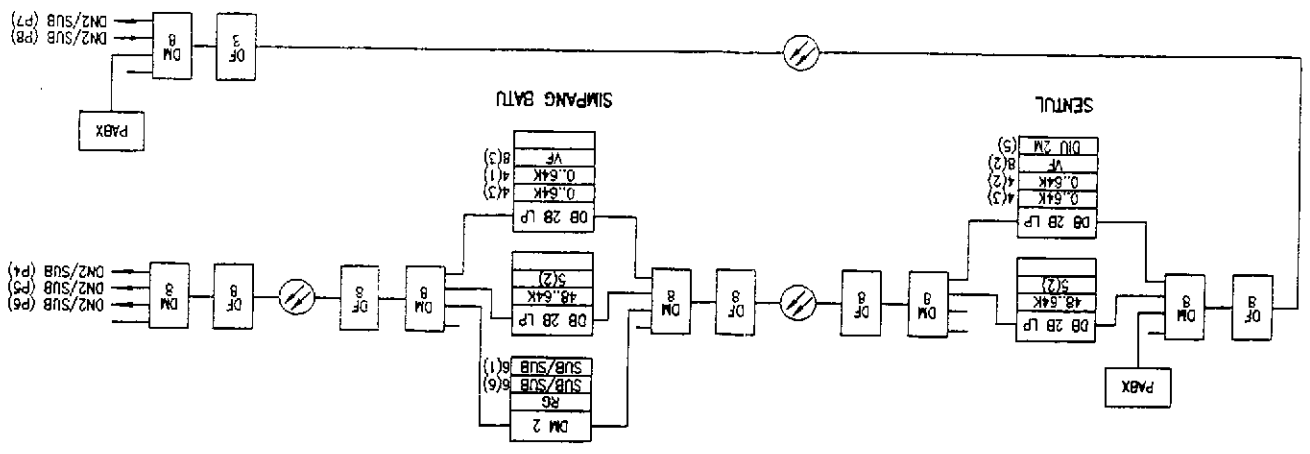
DRAWING CODE : KTMB-06

SHEET NO. 2/2

CAD FILE : K-06.DWG
CAD BY: E Y BOON

8 Mb/S
CHANNEL ALLOCATION
KUALA LUMPUR – SENTUL





LEGENDS :

CI	RADIO CONTROL CHANNEL (INBOUND)
CO	RADIO CONTROL CHANNEL (OUTBOUND)
TC	RADIO TRAFFIC CHANNEL (VOICE)
SC	RADIO STANDBY CHANNEL
SR	RADIO SERVICE RADIO CHANNEL (VOICE)
A	SIGNAL POST TELEPHONE (DATA)
B	SIGNAL POST TELEPHONE (VOICE)
BS	BILLING SYSTEM (DATA)
C	DESPATCH TELEPHONE (VOICE)
J	TICKETING (DATA)
K	PASSENGER INFORMATION (DATA)
S	SCADA (DATA)
D1	SIGNALLING 9600 bits/s
D2	SIGNALLING 9600 bits/s
D3	SIGNALLING 2400 bits/s
H	PABX EXTENSION (VOICE)
HS	SCADA PABX EXTENSION (VOICE)

ITEM	DATE	REMARK	D'SCRIPTION	QA	APPROVED	DESCRIPTION
1						
2						
3						
4						
5						

TITLE: BMS/S SIGNALING & COMMUNICATION SYSTEM DRAWING

STATION: KUALA LUMPUR SENTUL

ICF KAISER

KERETAPI TANAH MELAYU BERHAD
BAHAGIAN SEMBOYAN DAN KOMUNIKASI

DRAWING CODE : KTM9-07 SHEET NO. 1/1

ISSUE DATE 2003/AUG | ISSUE TYPE T.S.I | ISSUE TYPE TENDER

KTM

CAD FILE : K-07.DWG
CAD BY: E Y BOON

Attachment D
Leased Circuit Inventory

		Report of Data Line at KTM Berhad Dated 1994				
No	**Agreement**	**Location**	**Address Agreement**	**Date Valid Until**	**Yearly Rental**	**Status**
1	DABRF-BW1510	KL-BW(STAR)	PEJ. TIKET STESEN BUTTERWOTH	31/12 /94	RM 18,960	
2	DABW-KMP1267	BW-KOMSTAR	PEJ. TIKET PENANG		RM 1,260	
3	DAAS-BW1693	BW-A/STAR	PEJ. TIKET STESEN A. STAR		RM5,460	
4	DAAU-BW1956	BW-ARAU	PEJ. TIKET STESEN ARAU		RM7,440	
5	DABTH-BW4251	BW-B.TGH	PEJ. KETUA STESEN BUKIT TENGAH		RM1,920.00	
6	DABRF-BW2420	KL-BW(SPOT)	PEJ. KONTROL BUTTERWORTH		RM19,080	
7	DABW-PZ1866	BW-P/BESAR	PEJ. KETUA STESEN PDG. BESAR		RM9,240	
8	DABES-BW1959	BW-B/KETRI	PEJ. KETUA STESEN BKT KETRI		RM7,680	
9	DABW-PB1957	BW-P/BUNTAR	PEJ TIKET STESEN PARIT BUNTAR		RM2,940	
10	DABW-SP2013	BW/S/PETANI	PEJ TIKET STESEN SUNGAI PETANI		RM2,220	
11	DABRF-IP1561	KL-IPOH 9STAR)	PEJ TIKET STESEN IPOH		RM11,340	
12	DAIP-KK1286	IPH-K/KANGSAR	PEJ TIKET STESENKUALA KANGSAR		RM2,160	
13	DAIP-TP1287	IPH-TAIPING	PEJ TIKET STESEN TAIPING		RM3,660	
14		IPH-TAPAH ROAD	PEJ TIKET STESEN TAPAH ROAD		RM0.00	RM 3360
15	DAIP-KR4004	IPH-KAMPAR	PEJ TIKET STESEN KAMPAR		RM2,580	
16	DABG-IP4079	IPH-B/GAJAH	PEJ TIKET STESEN BATU GAJAH		RM1,500	
17	DAIP-PGS2404	IPH-P/RENGAS	PEJ. KETUA STESEN PDG RENGAS		RM2,520	
18	DABRF-IP2423	KL-IPOH(SPOT)	PEJ. KETUA STESEN IPOH		RM11,400	
19	DAIP-TSK4093	IPH-TASEK	PEJ. KETUA STESEN TASEK		RM1,440	
20	DAIP-CMR4094	IPH-CEMOR	PEJ. KETUA STESEN CEMOR		RM1,500	

No	Agreement	Location	Address Agreement	Date Valid Until	Yearly Rental	
21						
22	DABRF-KL2830	KL-K/LIPIS	PEJ. KETUA KUALA LIPIS		RM0.00	RM7680
23	DABRF-TAR281	KL-SENTUL	PEJ. KETUA STESEN SENTUL		RM1,380	
24	DATAR-A272	KL-SENTUL (SPIK)	PEJ. SETOR SENTUL		RM1,800	
25	DABRF-SBJG298	KL-SBG/JAYA (STAR)	PEJ. TIKET STESEN SUBANG JAYA		RM1,800	
26	DABIN-BRFM889	KL-SG/WANG	LOT 10, BUKIT BINTANG PLAZA		RM1,050	
27	DABRF-PJCP52A	KL-PJ	JAYA SUPERMARKIT, SECTION 14 PJ		RM0.00	RM1500
28	DAPKG-SBJJ644	SBG/JAYA-KLANG U	PEJ. KETUA YAD PEL. LANG UTARA		RM2,640	
29	DKLG-SBJJ721	SBG/JAYA-KLANG(B)	PEJ. TIKET STESEN KLANG (BANDAR)		RM0.00	RM1080
30	DABRF-SN1019	KL-SEREMBAN	PEJ TIKET STESEN SEREMBAN		RM4,140	
31	DASN-TN146	SEREMBAN TAMPIN	PEJ TIKET STESEN TAMPIN		RM3,180	
32	DASN-SGT493	SEREMBAN SEGAMAT	PEJ TIKET STESEN SEGAMAT		RM6,540	
33	DAPD-SN314	SEREMBAN T/MINYAK	PEJ KETUA STESEN TAPIS MINYAK		RM1,800	
34	DABRF-GS2421	KL-GEMAS (SPOT)	PEJ KONTROL GEMAS		RM7,980	
35	DAG-MEN2831	GEMAS-MENTAKAB	PEJ KETUA STESEN MENTAKAB		RM0.00	RM6300
36	DABRF-JB1551	KL-J/BHARU (STAR)	PEJ TIKET STESEN JOHOR BHARU		RM18,540	
37	DAJB-KU496	JB-KLUANG	PEJ TIKET STESEN KLUANG		RM5,280	
38	DAJB-TMP237	JB-KEMPAS BHARU	PEJ KETUA STESEN KEMPAS BHARU		RM1,560	
39	DAJB-PGD238	JB-PASIR GUDANG	PEJ KETUA STESEN PASIR GUDANG		RM1,980	
40	DAKLR-SE421	KL-SINGAPORE(1) (SPOT)	PEJ KETUA STESEN SINGAPORE		RM38,232	
41	KLR-SDP421	SINGAPORE(1)-STN	PEJ KETUA STESEN SINGAPORE		RM	RM3672
42	DABRF-KQ2422	KL-KUALA KRAI (SPOT)	PEJ KONTROL KUALA KRAI		RM17,160	

No	Agreement	Location	Address Agreement	Date Valid Until	Yearly Rental	Status
43	DAKQ-TU713	KRAI-TUMPAT	PEJ KETUA STESEN TUMPAT		RM4,980	
44	DAKQ-GMU720	KRAI-G/MUSANG	PEJ KETUA STESEN GUA MUSANG		RM5,280	
45	DAKQ-RTP714	KRAI-R/PANJANG	PEJ KETUA STESEN RANTAU PJG.		RM4,140	
46	DAKQ-WB721	KRAI-W/BHARU	PEJ KETUA STESEN WAKAF BHARU		RM4,620	
47	DAKQ-PM786	KRAI-PASIR MAS	PEJ KETUA STESEN PASIR MAS		RM0.00	RM 3780
48	DAKQ-GGGJJ	KRAI-TANAH MERAH	PEJ KETUA STESEN TANAH MERAH		RM0.00	RM2280
49	DAPKG-011	KLANG(O/P)-KONTENA	PEJ OPERASI PEL. KLANG KTMB		RM690	
50	DABRF-R378	KL-RAWANG(SPOT)	KETUA STESEN RAWANG			RM1980
51	DAR379	RAWANG-TJG/MALIM	KETUA STESEN TANJUNG MALIM			RM2880
52	DABRF-R379	KL-KAJANG	KETUA STESEN KAJANG			RM1680
53	KTMB LINE	BW-PRAI	STESEN PRAI			
54						
55	DAPKG-SBJJ643	S/JAYA-P/KLANG(S)	PEJ KETUA STESEN PEL. KLANG(S)			RM1680
56	DAILUP 2747459	DAILUP TIKET	BILIK COMPUTER K.LUMPUR		RM252	
57	DAILUP27 38755	DAILUP LAN	BILIK COMPUTER K.LUMPUR		RM252	
58	DAILUP 2747739	DAILUP IBM	BILIK COMPUTER K.LUMPUR		RM252	
59	DABM-BW 4135	B.MERTAJAM-B/WORTH				RM1080
60						

REMOTE SITES FOR KUALA LUMPUR HQ LAN

KUALA LUMPUR HEADQUARTER LAN

JAYA SUPERMARKET
SENTUL (2)
KUALA LIPIS
KAJANG
SG. WANG
SENTUL (1)
CISCO ROUTER 2501
UNIX SERVER
SINGAPURA
CISCO ROUTER 2501
UNIX SERVER
MENTAKAB
CISCO 2501
CISCO ROUTER 2501
UNIX SERVER
GEMAS
KCT
CISCO 2501
CISCO ROUTER 2501
UNIX SERVER
KLANG
SEGAMAT
CISCO 2501
CISCO 2511 DIAL-UP
UNIX SERVER
CISCO ROUTER 7000
64Kbps
64Kbps
64Kbps
64Kbps
64Kbps
CISCO 2501
CISCO ROUTER 2501
UNIX SERVER
RAWANG
WAKAL BARU
CISCO 2501
GUA MUSANG
CISCO 2501
KRAI CISCO 2522
CISCO 2501
CISCO 2501
CISCO 2501
TUMPAT
RANTAU PAJANG
TANAH MERAH
KRAI SATELLITE LAN
YARD KLANG
CISCO 2501
SUNGIL WAY
CISCO 2501
SUBANG CISCO 2522
SUBANG JAYA SATELLITE LAN
TAPIS MINYAK
CISCO 2501
SEREMBAN CISCO 2522
UNIX SERVER
TAMPIN
CISCO 2501
SEREMBAN SATELLITE LAN
CISCO 2501
CISCO 2501
PORT KLANG
BANDAR KLANG
SUNGEL PELANI
CISCO 2501
ALOR STAR
CISCO 2501
BUKIT MERLAJAM
CISCO 2501
BUKIT KETRI
CISCO 2501
PENANG
CISCO 2501
PEDANG BESAR
CISCO 2501
PARIT BUNTAR
CISCO 2501
ARAU
CISCO 2501
BUKIT TANGAH
CISCO 2501
CISCO 2522
UNIX SERVER
BUTTERWORTH SATELLITE LAN
CISCO 2501
PRAI
TASEK
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CHEMOR
CISCO 2501
IPOH CISCO 2522
UNIX SERVER
IPOH SATELLITE LAN
FAHIM
CISCO 2501
TAPAH
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KUMPAR
CISCO 2501
TAIPING
CISCO 2501
BATU GAJAH
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KUALA KANGSAR
CISCO 2501
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PEDANG RENGAS
KLUANG
CISCO 2501
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JOHOR BAHRU SATELLITE LAN
PASIR GUDANG
CISCO 2501

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ISSUE	DATE	ISSUED	CHECKED	QA	APPROVED	DESCRIPTION

REMOTE SITES FOR KUALA LUMPUR HQ LAN — DRAWING NO. -

ICF KAISER

KERETAPI TANAH MELAYU BERHAD
BAHAGIAN SEMBOYAN DAN KOMUNIKASI

DRAWING CODE :	SHEET NO.
-	1

CAD FILE : KC-01.DWG
CAD BY : CY WONG

C:\temp\KC-01.DWG Fri Nov 13 11:21:24 1998

Attachment E

Iridium Marketing Material

MOTOROLA

The Iridium Satellite Network

21st Century Technology in the palm of your hand

***ONE Phone *ONE Number *ONE Bill *ONE Currency *ONE Service Provider**

MONTHLY SERVICE

WORLD	$ 69.95
U.S.A	$ 64.95
World Messaging (phone with pager)	$ 109.90
World Paging Only	$ 199.00

EQUIPMENT

Motorola 9500 Series phone	$2795.00
Cellular Cassette GSM	$ 495.00
Cellular Cassette CDMA	$ 695.00
Phone and Cassette package discount	$3295.00
Phone and Cassette and Pager	$3795.00
Phone and Pager package discount	$3295.00
Pager – 32 DB gain antenna	$ 695.00

ALL EQUIPMENT PRICES ARE PRESALE PROMOTION PRICES Expires 10/30/98

Activation Fee $99.95 Waived Free satellite to satellite calls through December 1998 Expires 10/30/98

CELLULAR ROAMING *available in countries with cellular service*

South America	$ 1.98 per minute
Europe / Eurasia	$ 1.50 per minute
Africa	$ 1.33 per minute
South Pacific	$ 1.43 per minute
Australia	$ 1.25 per minute

WORLD SATELLITE *for remote or poor coverage areas* Voice mail & L.D. included

South America to U.S.A.	$ 5.46 per minute
Europe to U.S.A.	$ 5.19 per minute
Southeast Asia to U.S.A.	$ 6.43 per minute
International Waters North America	$ 6.39 per minute

COMPLETE CALLING PARTY PAYS ON WORLD SATELLITE

THE EMBASSY PROGRAM

GSM Countries only / non-satellite	$ 1.05 per minute

All prices subject to change 10/05/98

Shiree Rose Trozera
Account Manager / Motorola Satellite and Personal Communications Services
(619) 481-4455 Fax (619) 481-6212

MOTOROLA

PRESALE PROMOTION
ENDS
FRIDAY OCTOBER 30, 1998

MOTOROLA 9500 SERIES SATELLITE
DUAL MODE PHONE

CURRENTLY PRICED AT $2795.00
EFFECTIVE MONDAY NOVEMBER 2, 1998 $3395.00

CURRENT PROMOTIONAL EQUIPMENT PACKAGES
WILL NOT BE AT OUR CURRENT PRICE.

ORDER TODAY AND SAVE $600.00
EQUIPMENT IS LIMITED & WILL BE DELIVERED ON A FIRST COME BASIS

Shiree Rose Trozera
Account Manager / Motorola Satellite and Personal Communication services
(619) 481-4455 FAX (619) 481-6212

Iridium Satellite Service

Plan	Access	Usage Minutes
World Satellite	$69.95	See Attached Maps/Charts: • Iridium International Satellite Zones • International Satellite Usage Rates • In-Country Satellite Usage Rates • MCSI Terrestrial Roaming Rates
U.S. Satellite	$64.95	See Attached Chart: • Iridium International Satellite Zones • U.S. Satellite Usage Rates
World Paging	$199.95	Not Applicable

Calling Features (cost per month)

World Message	$39.95
Voice Mail (World Satellite)	Included
Voice Mail (U.S. Satellite)	$14.95
Call Forwarding	Included
Call Barring	Included
Enhanced Call Completion	Included

Long Distance and other charges may apply for terrestrial roaming calls placed on using Iridium service. Other calling features may be available. Please contact MCSI for details.

Non-Recurring Charges

Voice Activation	$99.95
Pager Activation	$75.00
SIM Replacement	$50.00
Service Charge	$25.00

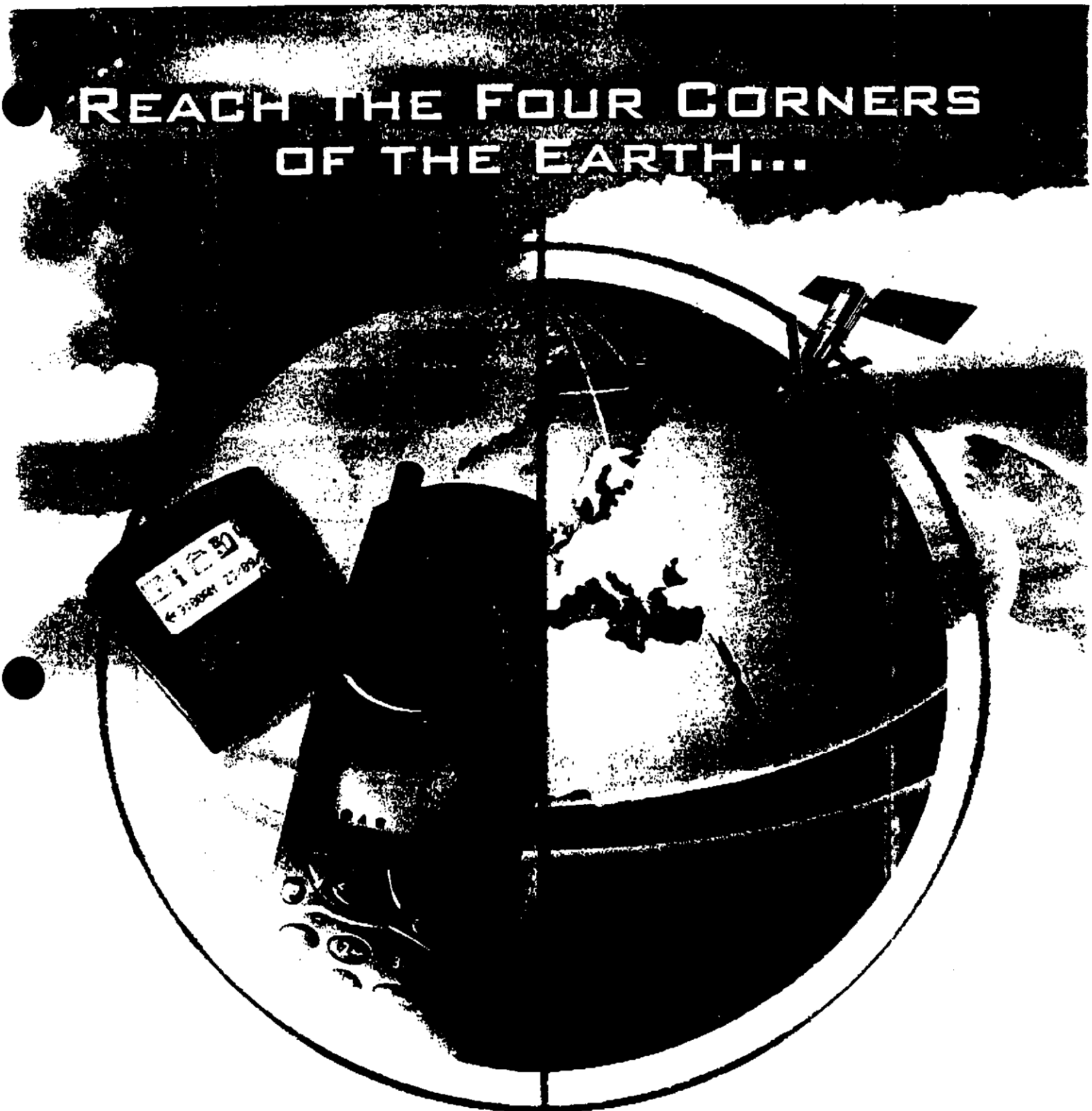
Timing of Calls

Minimum Length of Call = 1 minute
Calls Rounded To One minute
Incomplete Calls = No charge
Calls in 2 Rate Periods are Prorated

Issue: 8/27/98
Replaces: 7/17/98

Prices subject to change. (877) 355-MCSI.

REACH THE FOUR CORNERS OF THE EARTH...



Satellite Series™ 9500 Portable Phone
Satellite Series™ 9501 Wearable Pager

Motorola's very first suite of wireless products specifically offered in tandem – introducing the Satellite Series 9500 Portable Phone and Satellite Series 9501 Pager. Both products are designed to be used on the Iridium® system, where satellites orbit the Earth to keep you in constant communication, including in some of the most remote areas of the world!

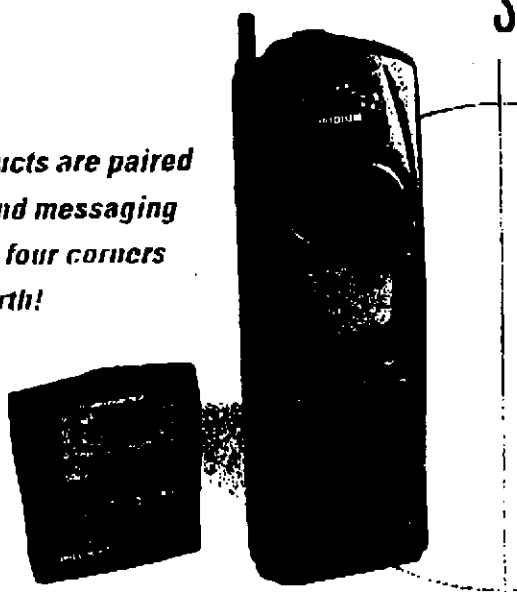
MOTOROLA

WINGS

satellite SERIES

PHONE & PAGER

Together these products are paired to optimize voice and messaging capabilities to the four corners of the earth!



Satellite Series™ 9500 Portable Phone

Is the very first portable phone for the Iridium® System. Specifically designed to work either as a single mode satellite phone or a dual mode satellite/wireless phone with the optional Cellular Cassettes.

Features include:

- Weighs less than 454 g (16 oz.) with standard battery
- Gives you up to 5.5 hrs. of continuous talk time or 2 days of standby time (with optional ultra high capacity battery in Satellite mode only)
- Convenient 100 memory locations to store your most frequently used names and numbers
- VibraCall™ alert feature gently notifies you of incoming calls
- One-Touch dialing allows the important numbers you store to be automatically dialed
- Business traveler benefits of dual time zone settings, battery meters, and 10 selectable ringer tones
- Features a large 4 X 16 character LCD display

Satellite Series™ 9501 Wearable Pager

Is the first belt-worn alphanumeric one-way personal messaging device with global capabilities. Its unique features are specifically designed to be used on the Iridium® satellite system. Some of these features include:

- Large storage capacity—up to 99 messages
- Supports multiple language options
- Personal message folder
- Information services folder
- Easy to use phone directory links numeric pages to display stored information
- User friendly icons for ease of operation
- Business traveler benefits of dual time zone settings, battery meters, quiet time, and convenient alarm clocks

Motorola provides an array of powerful original accessories designed to help you take off and take your world with you. With Motorola, your phone is more than a handset, it is a versatile and powerful communications medium. To spread your wings and optimize your phone's potential, look for Motorola Original Accessories.

This device has not been authorized as required by the rules of the Federal Communications Commission. This device is not, and may not be, offered for sale or lease, or sold or leased, until authorization is obtained.

Product information is accurate at the time of printing. All specifications are subject to change.

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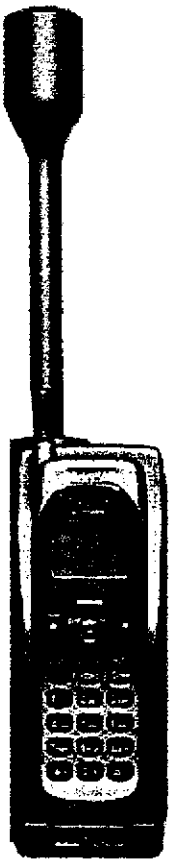
MOTOROLA GIVES YOU WINGS.
WINGS SET YOU FREE.

MOTOROLA
WINGS

Go | Select a Product



KYOCERA MULTI-MODE TELEPHONE

The Kyocera Multi-Mode Phone gives you the versatility of terrestrial wireless services and access to the global coverage of the Iridium satellite network. Within cellular coverage areas, you can use your Kyocera Iridium telephone on the local network. Outside the cellular coverage area, snap your Kyocera Iridium phone into the Iridium satellite attachment unit and you are instantly connected to the largest, most comprehensive satellite network in the world.

Graphic LCD Display
Multiple language choices for prompts
Selectable ringer alerts
World Alarm Timer
One key operation
Battery Gauge

	Iridium-ready GSM cellular phone*	**Satellite Attachment unit**
Dimensions	W41 x H130 x D22 mm	W57 x H146 x D 63mm
Weight	100g	400g
Continuous Talk Time	Up to 2 hours	~ 100 min. (4-5.5 hours with optional battery)
Continuous Standby Time	70 - 160 hours	Up to 24 hours (48 hours with optional battery)
Power	0.645W (average)	0.64 W (average)
Data speed	9,600bps	2,400bps (available 1999)
Display	LCD 64 x 112 pixels	---

* Iridium-ready cellular phones by Kyocera will also be available in AMPS, CDMA and PDC standards.

Go | Select a Product

MOTOROLA DUAL-MODE TELEPHONE

Weighing less than half a kilogram, the Iridium telephone by Motorola doubles as a satellite and a cellular (terrestrial) wireless phone. With the dual-mode phone, moving between local networks is as easy as inserting a different radio cassette - each one compatible with a different local cellular standard. For Iridium system access, the unit also includes a Subscriber Identity Module (SIM) card.The key to enhanced personalized telephone features and security, your SIM card prevents anyone from using your phone without proper authorization.

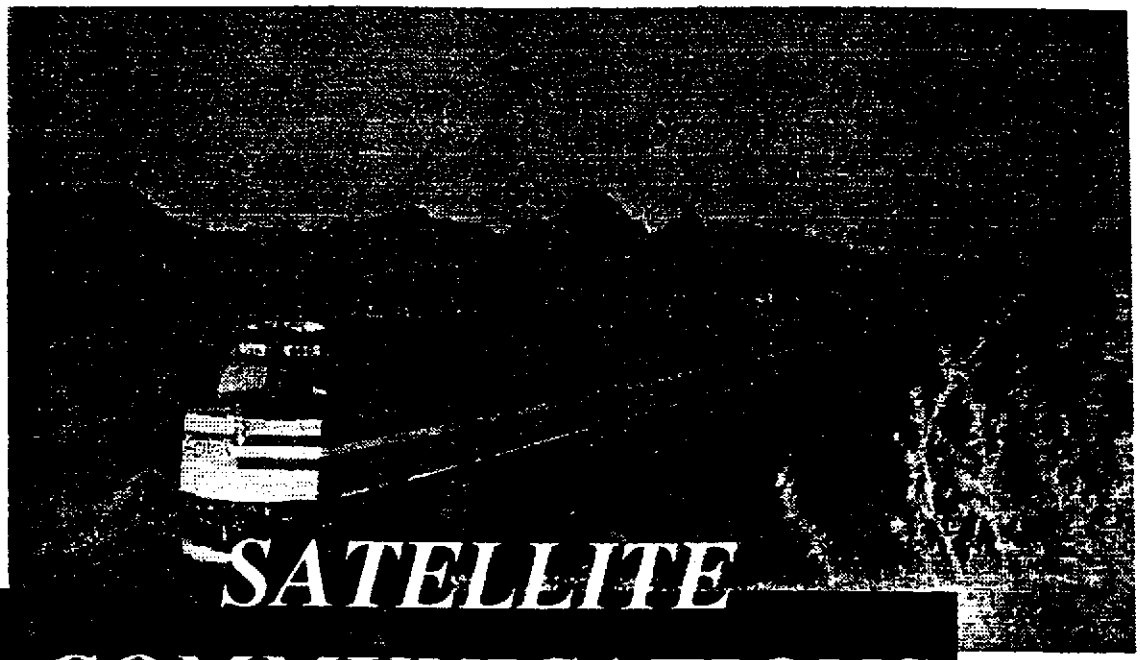
Similar in design to Motorola's popular cellular phones, Iridium telephones use digital facilities for maximum clarity and signal quality.

*Motorola cellular cassettes will be available in GSM 900 or CDMA/AMPS/NAMS 800 standards.

Illuminated Holographic Display
Illuminated Keypad
Multiple language choices for prompts
10 dedicated control keys
Selectable ringer alerts
Phone book memory
Battery Gauge
Dual time clock (home and local time)
Removable Satellite Antenna

Size:	less than 490 cc
Weight:	380g or 432g with cellular cassette
Continuous Talk Time:	Up to 2 hours (4 - 5. 5 with optional battery)
Continuous Standby Time:	Up to 24 hours (48 with optional battery)
Power:	0.645W (average)
Data speed:	2,400 bps (available 1999)
Display:	4x16 characters

Attachment F
Bill Stroud,
Amtrak Article Copy



SATELLITE COMMUNICATIONS FOR AMTRAK LONG DISTANCE TRAINS

Bill Stroud
Manager Radio Engineering
Amtrak

Satellite Communications
for Amtrak Long Distance Trains

BACKGROUND

The National Railroad Passenger Corporation (Amtrak) was created on October 30, 1970 by the United States Congress with the passage of the Rail Passenger Service Act to provide a modern, efficient, inter-city rail passenger service and to strive for operation on a "for profit" basis. Today, Amtrak operates it's inter-city trains over a 24,000 mile route system in 45 states across the USA including approximately 535 station stops.

Amtrak's mission is to provide a superior "world class" quality national rail passenger service as a competitive alternative to other inter-city transportation modes. This mission will be achieved only through a commitment to the continuous improvement of products and services at every level of the company, and by fostering a productive working environment that encourages growth and satisfaction for all employees, and where safety and exceeding the expectations of the customer are primary.

THE NEED

By January 1994, Amtrak identified several area where customer needs were not being adequately addressed. Amtrak had no means to reliably communicate information to the long distance trains, that would help address these customer needs. This vital function is particularly difficult as Amtrak's trains operate over the rights-of-way of the various freight railroads. Two-way voice radio is the primary means by which crew members talk with each other, and with the operating railroad dispatcher, but this is usually not accessible to Amtrak. With the more recent availability of cellular telephone communications, Amtrak is utilizing this technology as an effective tool to support passenger services. However, cellular services are unreliable in less populated regions of the country and inefficient for many communications requirements.

Amtrak's most pressing need was for a reliable communications system to link passenger trains with various corporate functions. This system would enable Amtrak's Train Operations, Customer Services, Commissaries and Mechanical forces to communicate on an as needed, but uninterrupted basis with all Amtrak trains operating throughout it's national rail passenger network. This system would enable Amtrak to effectively communicate data with it's trains in support of activities including:

- Train location and schedule variances
- Passenger emergency and safety related information
- Resale of unclaimed space
- Locomotive performance and status monitoring
- Consumable requisitioning

AVAILABLE TECHNOLOGIES

Wireless technology is one of America's fastest growing technology sectors. Exciting new technologies, just around the corner, promise to provide an almost perfect solution to Amtrak's need for communication to our long distance trains. These promises of future advances were interesting and exciting, but Amtrak's needs could not wait. Existing technologies had to be evaluated, selected and modified to fit the peculiarities of Amtrak's unique requirements.

GPS, or Global Positioning System, although not a communications system, does offer the ability to determine the location of Amtrak's trains. Our first requirement. Unfortunately this position determination is made at the mobile unit. The challenge for Amtrak to successfully employ this technology would be to transfer this information from the train to a central data repository where the information could be accessed by interested users, including the traveling public. GPS, if employed would have to be utilized in conjunction with some wireless data communications technology that offered coverage throughout the 24,000 miles of Amtrak's route network. In the end, GPS was not utilized to provide position information over the satellite system. It was however an interest in GPS that brought the spark of life to the Satellite Communications Project at Amtrak.

Prior to making any decisions to employ a satellite based data communications system. wireless data technologies were divided into three subsets for preliminary evaluation:

- Terrestrial based data radio networks
- Cellular telephone networks
- Satellite communications systems.

Terrestrial Data Systems

Ardis, originally a joint venture between Motorola and IBM. was the pioneer in the terrestrial based data systems. Ardis was joined more recently by RAM Mobile Data. Both of these services claim particular distinctions but generally utilize a similar network of multi-channel cells deployed in major metropolitan areas, and along major interstate highways.

Typical data rates are up to 19.6 kbps. Forward error correction and error detection are utilized to keep data reliability high. These systems utilize packet switching to deliver a data message to it's intended user.

Packet Switched

In a packet switched data network. the information to be transmitted is "stuffed" into an electronic "envelope" or packet. An "address" and a "return address" are placed on the header of this envelope along with information that will allow the receiver to check the message contents for errors. and correct minor errors. The envelope with it's message contents are then transmitted to an available base station. The network will check the contents of the packet for data integrity as the packet is being relayed through the network. If an unrecoverable error is detected the network will ask for a re-transmission of the packet before that data is passed to the application. Packet size limitation vary between service providers. but will typically be in the 500 to 2000 character range. Longer message must be broken down into multiple packets.

Once the message content has been assembled. the originator need only send the message into the network. The network assumes responsibility for steering the message through the network to the message receiver. based on the "address" on the message header. The connection through the network is up only as long as the single packet is being transmitted. Once the packet has been delivered the network segments. over which the message was sent, are made available for the transmission of other packets.

Billing, is usually based on the number of packets. and the total number of characters sent over the network. For instance a service provider might charge a customer two cent per packet and five cent per one hundred characters. There is no consideration for distances.

Terrestrial wireless packet data networks are not efficient systems for the transmission of large volumes of data. They are engineered to provide coverage to areas with high business and population concentrations. Since most of Amtrak's inter-city long distance passenger trains often operate in areas of the country that have a very low population density. these wireless networks do not adequately meet the current needs of Amtrak's Inter-City trains.

ATCS

ATCS, which stands for Advanced Train Control System. is a data radio system designed specifically for the rail industry, not a wireless data service. Although intended more for controlling train movement. the design of this system also allows for the transmission of business related data such as that in which Amtrak has an interest. The ATCS network concept foresaw the need to interconnect the ATCS infrastructures of the various railroads so that trains from one road could be tracked by and communicate with their home railroad while operating on the rights-of-way of another railroads. Deployment of ATCS base stations has been at a measured pace. It will most likely be some years before any ATCS networks are interconnected between railroads and

longer still before enough ATCS base stations are deployed to provide seamless coast to coast data coverage on Americas rail links.

Cellular

Circuit switched data transmission generally refers to the use of a modem on a dial telephone line to transmit data. In the context of this evaluation that includes a cellular connection into the telephone network. The connection through the network is established prior to the data transmission. This connection stays in place for the length of the session, not just one transmission. If the connections fails at some time during the session, the user must reestablish the connection. Error detection, correction and re-transmission are not an integral part of the network, and must be handled by the application.

Billing is based on distance and length (in time) of connection, and often, time of day and day of week. Fractions of a minute are rounded up. If the circuit switched connection include a cellular link, the billing will probably include a roaming charge. Minimum billing for a connection with roaming will be in excess of $1 dollar.

Cellular circuit switched data transmission for mobile applications is efficient and cost effective only when large amounts of data are being transmitted.

Satellite Data Services

Satellite communications services promise to be one of the fastest growing segments of the wireless industry. With LEOs (Low Earth Orbit), Little LEOs (data only LEOs), MEOs (medium Earth Orbit) in various stages of planing for launch by the end of the decade, there should be no shortage of services available to every level of potential data user. At the time of Amtrak's evaluation there were only two companies that offered commercial service - AMSC (American Mobile Satellite Company) and Qualcomm.

The Choice

Although satellite service ranked behind terrestrial service in some areas of the selection criteria, these areas were not given the same weight as coverage. Applications that were determined to be most important to Amtrak did not necessarily require the larger data handling capabilities that were available with terrestrial services. Only satellite service could provide the seamless, coast to coast coverage that Amtrak required.

System Evaluation

In late July 1994 Amtrak leased 11 Omnitracs mobile satellite units from the Qualcomm Corporation of San Diego, CA. for evaluation. Nine of those units were installed in diesel locomotives normally used in long distance service. One unit was installed at a fixed location at 30th street station in Philadelphia, and one unit was held in reserve. Experience gained during this evaluation would prove invaluable during later phases of the satellite project.

The mobile components of the Omnitracs system, collectively referred to as the Mobile Communications Terminal, or MCT includes three major hardware components. These are the "black box", the antenna, and the display/keyboard. This system was originally designed for use primarily in the over-the-road trucking industry. Since the design of the equipment anticipated a harsh environment no modifications were required to adapt this equipment to locomotive service other than the addition of a 72 VDC to 12 VDC isolated converter.

Latency

One concern had to be relieved before Amtrak could comfortably proceed with the purchase of a satellite communications system for Amtrak trains. Messages sent over a satellite system are "stored" in the system and "forwarded" to the addressee when a path over the satellite is available (Store and Forward). The availability of this path over the satellite varies depending on the number of users attempting to use the system at any one time. Amtrak needed to be certain that the maximum delay imposed by the satellite network would not excessively delay the delivery of messages between the fixed and mobile user. It was determined that a 60 second delay in the delivery of a message would be acceptable. During the on line evaluation of the Qualcomm satellite system tests were performed to measure this delay at various times during the business day. The system consistently delivered messages in 30 to 45 seconds. The baud rate is actually very low, but is of little consequence. Amtrak needed a system that could consistently deliver a 1000 character message in less than 60 seconds.

Mobile Installation

Considerable thought was given to the placement of the MCT installation on the train. Installation in the locomotive has several benefits. The locomotive crew are the only employees on the train that do not routinely move about. The Engineer will always be in his, or her, seat. The installation could be accomplished in such a way that the Engineer can easily be notified, with a light and buzzer, of the arrival of a message on his train and the Assistant Engineer, or another member of the crew can retrieve the message. For safety reason, Amtrak does not want the Engineer to attempt to send or retrieve a text message while the train is in motion.

Locating the MCT on the locomotive do result in one significant problem. Much of the information generated on the train comes, not from the locomotive, but from the body of the train. While the train is in motion, there is no access to the locomotive. At best messages would have to be relayed to the locomotive to be entered into the MCT. Amtrak needed a way to do this efficiently

The Portable Terminal

Amtrak's Radio Engineering department was already involved in the evaluation of the Qualcomm satellite system, and had some experience with wireless data systems. Could a wireless system extend the display terminal to any location in the body of the train? The Qualcomm MCT is equipped with a serial port that is intended to allow the customer to use an On-Board Computer (OBC) in addition to, or in place of, the keyboard/display unit that Qualcomm provides as the input devise to the MCT. A fairly straightforward solution appeared obvious. An RF modem connected to the serial port on the MCT and a portable PC equipped with a companion RF modem, carried anywhere in the train.

With most of the components of this proposed solution already on hand, Radio Engineering and the Philadelphia Radio Shop went to work building a mock-up portable satellite terminal. Two Spread Spectrum modems left over from a previous project, and a pair of laptop computer were set up on the bench. Messages were sent between the PCs by way of the spread spectrum modems. The RF modems interfaced to the PC without any problems. Next the laptop was connected to the MCT without the RF modem. Only after the MCT-PC interface was worked out, would the RF modems be placed back into the link.

The MCT's serial port communication protocol was proprietary. No finished software packages are available interface a PC to this port. Qualcomm had included this port on the MCT for those users who desired to customize the installation of the MCT by adding data storage or processing capability in the form of an On-Board Computer (OBC). Since Qualcomm could not predict what form of customization this OBC might be required to add to the MCT installation, only a collection of high level routines that could be called by a customer written software application are offered. Qualcomm did offer a "demonstration" program for the

"proof of concept". This program came with a warning that some irregularities in it's performance could be expected. and Qualcomm would not be able to offer any support for this software package as a product.

The first over-the-air tests of the portable satellite terminal concept took place on the 8th floor at 30th Street Station. After a number of modifications to the software and hardware configurations where completed the first message was sent from the "portable terminal". This message originated on the laptop. was transmitted by spread spectrum across the room to the MCT. relayed to the Qualcomm earth station in San Diego via satellite. carried by phone line from San Diego back to Philadelphia. up to the 8th floor at 30th Street Station. and displayed on a PC sitting next to the laptop that originated the message.

Next. the laptop and spread spectrum modem where taken to the room next door for a more ambitious test. The over-the-air connection was lost. and could not be re-established from the next room. If spread spectrum coverage could be so easily effected by the gypsum walls at 30th Street Station. how would it ever be able to penetrate the stainless steel bodies of our passenger cars? Spread spectrum would not be a part of this solution.

If spread spectrum would not work. what was available that would? Frequencies typically used by the railroad industry for voice communications are between 160.215 to 161.565 MHz VHF. These frequencies are routinely used for voice communications between the locomotive and points throughout the train but. Amtrak does not have access to any one VHF frequency that can be used everywhere our satellite equipped trains would operate. Amtrak does however, have access to one UHF (450 MHz) frequency in all the areas of interest.

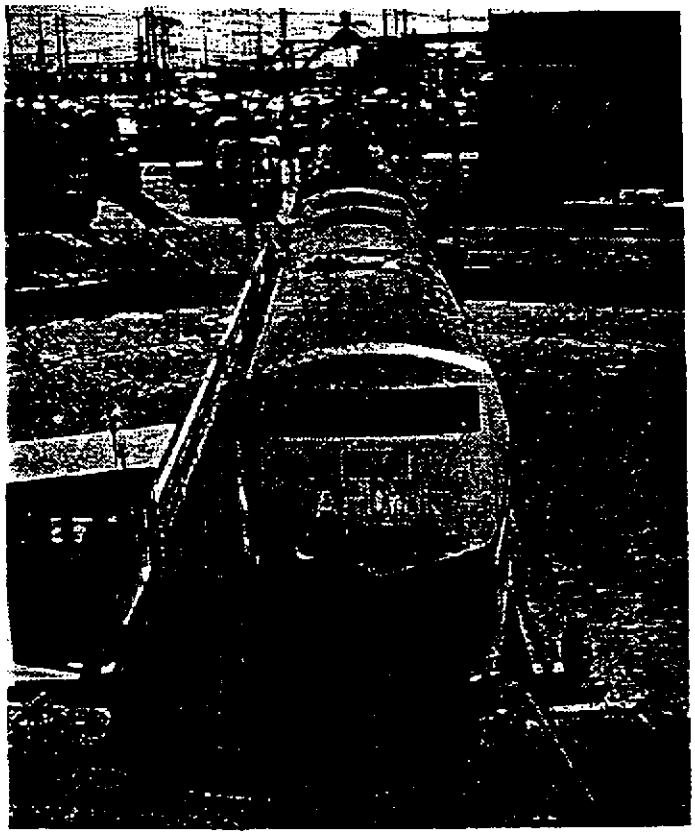
Before any further resources were invested in building an operational prototype Amtrak had to have some assurance that this UHF frequency would provide adequate coverage throughout the length of a train. To find out, two members of the Radio Engineering group took a pair of two watt UHF portables for a ride on the Silver Meteor, one of the few long distance trains that run between Philadelphia and Trenton. The performance was flawless over the entire length of the consist. The Radio Engineering Group now had the confidence to request funds for the development of a prototype portable satellite terminal using 450 MHz UHF RF modems.

The first prototype, the **transportable** satellite terminal. was built into an inexpensive briefcase. An aluminum "shelf" was installed as a false bottom in this brief case. Under this false bottom was installed the RF modem with a 12 Volt gel cell and the laptop PC power supply. The PC was installed on top of the false bottom. and a flexible antenna took advantage of the aluminum false bottom as a ground plane. Though not especially pretty, it worked. All that had to be done now was convince the train crews that by carrying around this 26 pound package their job would be made easier. Or, put the portable satellite terminal on a serious diet.

By the time the prototype was completed. Amtrak was confident that satellite data communications could play an important roll in improving the quality of service Amtrak could offer to it's passengers. Funds were being allocated to equip 80 locomotives with mobile satellite units. Each of the 80 locomotives was also be equipped with an RF modem to support the portable satellite terminal. Radio Engineering committed to build the portable terminal with the capability to operate on battery for 8 hours. and weighing not more than five pounds. To meet the weight and battery life goals. a complete overhaul of the software that operated the portable terminal would be required.

System Implementation

After a competitive procurement Amtrak selected Qualcomm to provide the 80 mobile satellite units with the UHF RF modem, mainframe software to process the messages on the fixed side of the system and software tools to develop more useful software for the portable terminal. A rigorous implementation schedule was adopted.



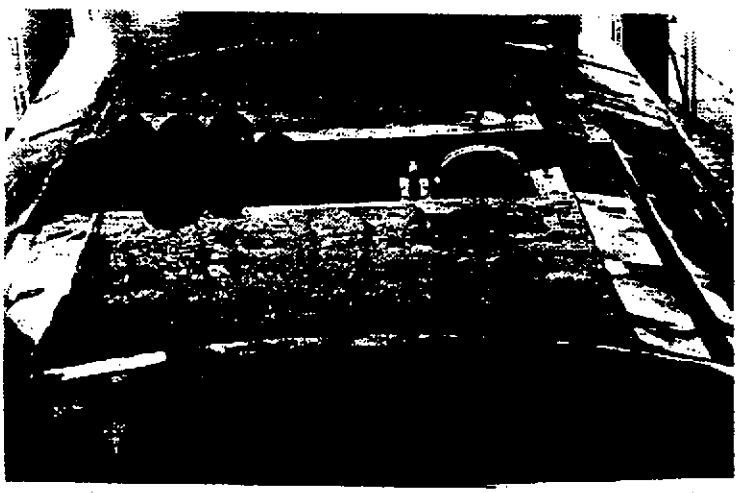
General Electric Genesis Locomotive with Qualcomm antenna mounted in horn pan.

APST Software

Negotiating a firm fixed price contract to write the communications software package for the portable satellite terminal would require a carefully written specification that Amtrak did not have, nor were the resources available to develop this specification within the time-frame available. As an alternative approach Amtrak hired Cone Software Corporation to modify the Qualcomm demonstration software package on a time and material basis. Having received Qualcomm's commitment of support, and agreeing on terms and conditions with both Qualcomm and Cone, Amtrak provided a list of changes to be incorporated in the demonstration package. As these changes were incorporated into the demonstration program Amtrak had the flexibility to easily add or subtract features as the need or the budget dictated while Cone and Qualcomm had the flexibility to offer suggestion on changes to the package.

RF Modem

The RFM 96 radio packet modem manufactured by Pacific Crest Corporation of Santa Clara, CA was used to provide the wireless connection between the MCT on the locomotive and the portable terminal. Packets sent from the RFM 96 can be addressed for reception by a correspondingly addressed receiving modem, or the packets can be broadcast to all modems within range. During proof of concept testing the RF modem was always set up to "broadcast". As portable satellite terminals would be deployed, two systems would very seldom be in the same area. When this did happen, perhaps while waiting in the originating terminal, the portable satellite



RF modem antenna sites between the horn assembly and the Qualcomm antenna.

terminal would be inoperative. The alternative was a very unmanageable system requiring the "marriage" of the portable terminal to the locomotive.

TRIP.EXE

Qualcomm and Cone suggested a better alternative. Add a software program to the portable terminal that would re-address the portable modem to match the address of the locomotive modem. By executing this program prior to each trip, the portable terminal could be configured to communicate only with the MCT on the appropriate locomotive. This software program became TRIP.EXE. Features of TRIP.EXE include:

- accept input from the user to assemble into a data message to be sent, via satellite, to the mainframe. This input will include:
  - User's name
  - Train identification
  - RF modem property number
  - palmtop serial number
- Accept a date and time to set the incoming message "book mark"
- Accept the lead locomotive number

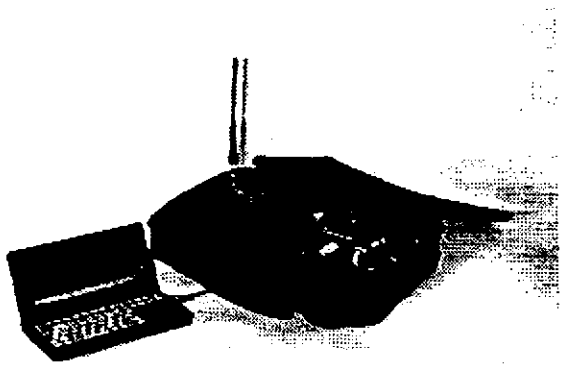
The users name, train identification, property number, and serial number become a message that is sent via the MCT to the mainframe computer. This information is archived and can be used to reconstruct a custody trail of the portable terminal.

The date and time are used to tell TRIP.EXE which messages stored in the MCT to download to the portable terminal. The MCT stores the last 99 messages in a buffer. Rather than download all 99 messages, most of which are too old to be of interest, the MCT will only download stored messages that have been received after the bookmark date and time. This would greatly decrease battery consumption.

The lead locomotive number is used to address the portable RF modem to match the address of the locomotive RF modem. The RF modem installed in each locomotive is programmed with a unique address. Each portable terminal carries a software file with all of Amtrak's locomotive numbers and the corresponding RF modem addresses. TRIP.EXE cross references the locomotive number to the modem address, send a break command to the attached portable RF modem and sets the address in that modem to match the address in the locomotive modem.

APST.EXE

Many of the modification to the demonstration program were changes to the appearance. Other changes were much deeper. One of the more significant changes involved the polling duty cycle. The original demonstration software assumed a wired connection between the MCT and the OBC. The OBC constantly polled the MCT for new data. In a battery operated wireless environment this means a shortened battery life. To extend battery life, the polling routine was modified to allow for a variable length dormant period between periods of polling. Now, once the OBC has downloaded all new data from the MCT, it "goes to sleep" for a period of time. If a



Amtrak Portable Satellite Terminal (APST)

message arrives at the MCT during this time the Engineering on the locomotive is alerted. He. or she can notify the crew via voice radio to retrieve the message manually. This involves overriding of the dormant period on the OBC software. another feature that was added to the demo program.

As the program changes neared completion the program name "demo.exe" had to be changed. The abbreviation for Amtrak Portable Satellite Terminal was used and the program became apst.exe. As users began to work with the system in the field the hardware would also become known by the same name. the APST.

The Host

During the evaluation of the Qualcomm system the interface with Qualcomm was through a single PC terminal located at Amtrak's National Operations Center in Philadelphia. Information such as on time performance or messages to a down-line station had to be manually relayed to the interested party. This was accomplished with a dedicated clerk. Once a system was fully turned up these messages had to be routed to the appropriate party automatically, or with existing staff. The clerical position was temporary. and would not be made permanent.

Amtrak's reservations and ticket system. Arrow. runs on a mainframe computer in Manassas VA. Almost every ticket office. every supervisor. and every manager has access to the mainframe. During implementation the PC terminal was replaced by Qtracs. a Qualcomm IBM mainframe program that was installed in Amtrak's mainframe. By using Qtracs on the mainframe the existing network of mainframe terminals was exploited to provide access to the satellite system for almost every potential user of the system.

The on-time performance of trains not equipped with the satellite system, is posted in the Arrow application by the station agent at the last station from which the train departed. If that train is delayed between stations. there is no consistent way to report that delay into the Arrow system until the train finally does reach it's next station. This on-time performance information in Arrow is used to keep passengers informed of train status at downline stations. This same information is automatically posted once an hour for trains equipped with the satellite system. Additionally, an agent at a downline station can receive the current location of that train on demand.

Message Notification

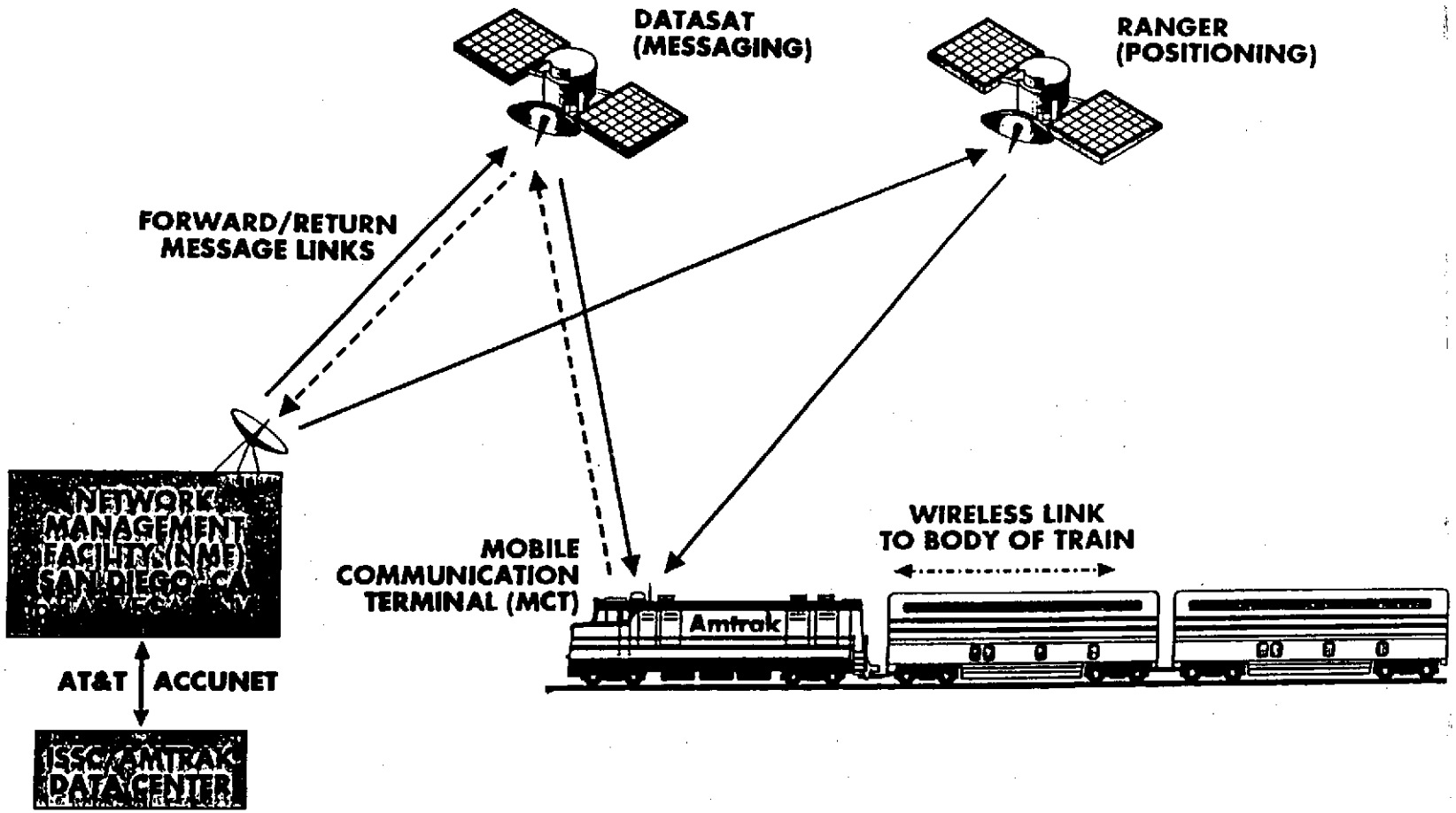
Qtracs works very much like email. The message recipient at the fixed end is not notified of the receipt of a message. He or she must enter the application and check for the presence of a message. Amtrak uses a macro running in a PC terminal emulation program under Window NT to automate the process of checking for new messages. When a new message appears in Qtracs. this macro will detect that message. and place the contents of that message in a pop-up window on the PC screen.

Amtrak is also having a system installed to automate the process of delivering messages to location not equipped to run Windows NT. This will be a PC based voice response system emulating a 3270 terminal on the mainframe. A message originator will have the option to insert. at any location in the text of the message, a unique character sequence followed by an address code. The voice response system will check every incoming message for this unique character sequence. When that sequence is found the voice response system will cross reference the address code to a telephone number. or list of numbers. This list will also contain special instruction on how the message is to be handled (voice announce or fax delivery).

Summary

It's customer satisfaction. Nothing else counts if the customer is not satisfied. Will the implementation of satellite data communications on Amtrak's long distance trains made a difference? Yes, without a doubt it has, and it will continue to do so. Passengers waiting for a train are given more accurate and timely information regarding their train. Passengers already on board are given information regarding connecting trains. Employees have a tool that empowers them to do their jobs better

During the Qualcomm evaluation, a diabetic passenger boarded a train without realizing he had forgotten to pack his Insulin. The train crew sent a satellite message to Philadelphia with the passenger's doctor's telephone number. A prescription was called in to a pharmacy near the next station. The pharmacy delivered the Insulin to the station attendant who in turn delivered the insulin to our passenger when his train arrived at that station. A potential problem was quickly resolved, and one passenger was very impressed by the service that he got while riding on Amtrak. That one passenger was not the only one who was impressed. Amtrak's management was very impressed by the ingenuity and resourcefulness of the employees who went out of their way to keep a passenger a happy customer. Management was also very impressed with the role that satellite communications could played in a situation such as this.


DATASAT
(MESSAGING)
RANGER
(POSITIONING)
FORWARD/RETURN
MESSAGE LINKS
NETWORK
MANAGEMENT
FACILITY (NMF)
SAN DIEGO, CA
MOBILE
COMMUNICATION
TERMINAL (MCT)
WIRELESS LINK
TO BODY OF TRAIN
Amtrak
AT&T
ACCUNET
ISSC/AMTRAK
DATA CENTER

Attachment G
Trains Magazine Article on Amtrak

TWO PHOTOS: DAVID C. WARNER

Under one roof

Amtrak opens its high-tech Consolidated National Operations Center

BY BOB JOHNSTON

COACH PASSENGER on No. 4 at Gallup (N.Mex.) wants a standard bedroom to Kansas City. Can I sell it?" At one time, the conductor of the eastbound *Southwest Chief* would have had no idea whether an agent down the line at, say, Albuquerque or Lamy, N.Mex., had just booked a room designated as vacant on the manifest printed at Los Angeles the previous evening. It certainly isn't the kind of weighty issue the Burlington Northern Santa Fe dispatcher would investigate.

Now the message, typed en route into a computer located in the *Chief*'s crew dormitory lounge, is forwarded to the locomotive, beamed up to a satellite over Texas, down to San Diego, then cross-country to Amtrak's new Consolidated National Operations Center (CNOC) in a renovated warehouse along the banks of the Christina River in Wilmington, Del. The request pops up on a screen at the desk of the Intercity inventory manager, who blocks out room 12 in car 0431 in the Arrow reservation system and gives the green light to No. 4's conductor.

A century-old warehouse was the shell for Amtrak's CNOC. The first floor has an engineering and mechanical service center, plus design and operations support offices. The top floor houses direct operating functions.

Keeping track of space on all Amtrak trains is just one of the operating functions centralized at CNOC, which officially opened March 30. Sharing the facility's top floor with inventory management are locomotive deployment (the "power desk"); equipment distribution and car management; train, engine, and on-board service crew calling; assignment and payroll verification; and mail and express tracking. One flight down in the Engineering and Mechanical Service Center, engineering, operating rules and standards, procurement, and maintenance support staffs stand ready to lend a hand.

Previously, many departments were scattered between the second and eighth floors above Philadelphia's 30th Street Station; engineering design was at 20th and Arch Streets in Philly, on-board crew dispatching was in Balti-

ALL PHOTOS THIS PAGE: BOB JOHNSTON

Ben Cornelius zeroes in on a 700-foot section of CSX main line near Lucama, N.C., where the northbound *Carolinian* has just passed.

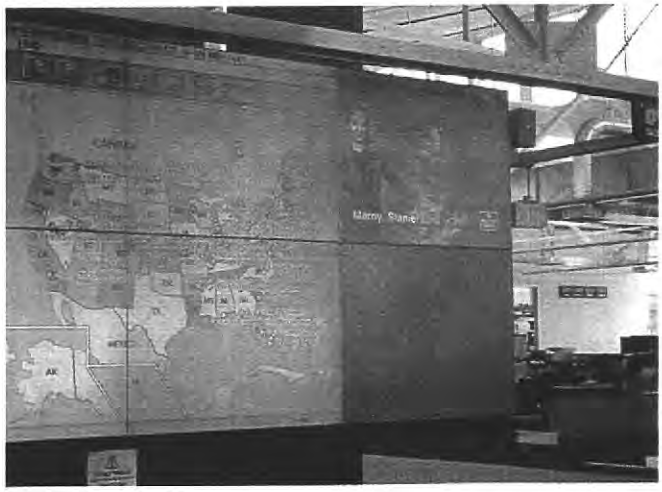
more, and operating rules people were in Wilmington. "We always used to communicate with each other by conference call and fax," recalls Mike Frazier, director of Intercity and West service. "Now we're face to face, with paper going back and forth across the table." Favorable lease terms with the Riverfront Development Corporation of Delaware, which financed the building's renovation, brought 230 jobs to the formerly blighted area across a parking lot from the Amtrak station.

On a tour of the state-of-the-art, 50,000-square-foot facility, Frazier's Northeast Corridor counterpart, Jim Walls, shows off the lime green and periwinkle blue curving interior corridors and conference rooms on the first floor that had been built new around the old warehouse's brick shell. Interior glass-walled managers' offices "encourage an open, team-building spirit," observes Walls. Indirect lighting bounces off a maze of shiny ductwork and wiring clinging to the tall ceiling above 136 cubicles and 21 offices. Also included are a "collaboration pit" for impromptu meetings, an informal dining area with vending machines, and a complete exercise room and changing area with showers. Union and non-union employees from the various disciplines all wear "business casual" attire at the 24-hour nerve center.

Though men and women are grouped by function—"t&e" (train and engine crew) dispatchers in the center, on-board service crew callers on the side of the room facing Wilmington's station, and Intercity/West and Northeast Corridor operating personnel on the other—a lack of visible hierarchy between the groups theoretically helps engender mutual respect and interdependence.

The focal point of this jack-of-all-trades complex, though, is the "status screen" video wall that dominates the airy top-floor work area. The same system that relayed a simple query from the *Southwest Chief*'s conductor also shows the location of every Amtrak diesel road locomotive on a full-size U.S. map. Yellow diamonds (on top of each other if more than one unit sends a signal) denote engine numbers and the date and time reported. A video feed from the Atlanta-based Weather Channel plays constantly in the upper right-hand corner, giving managers responsible for each aspect of train operation an inkling of what road crews are up against.

Qualcomm's Star Trak utilizes two satellites to triangulate locations. "It's not really a global positioning system, which would require three birds for moving pinpoint accuracy," points out Mike Sherlock, director of project management and technical support. "But once a train is identified, anyone on the floor can zoom in to an eighth of a mile of the last reported location on his desktop computer." Intercity service manager Ben Cornelius spotted



A giant status screen pinpoints diesel road units across the system, plus a Weather Channel feed. In photos taken on separate occasions, *City of New Orleans* engineer Scotty Wright inputs a departure time on his Star Trak on-board computer; status screen shows his engine at New Orleans.

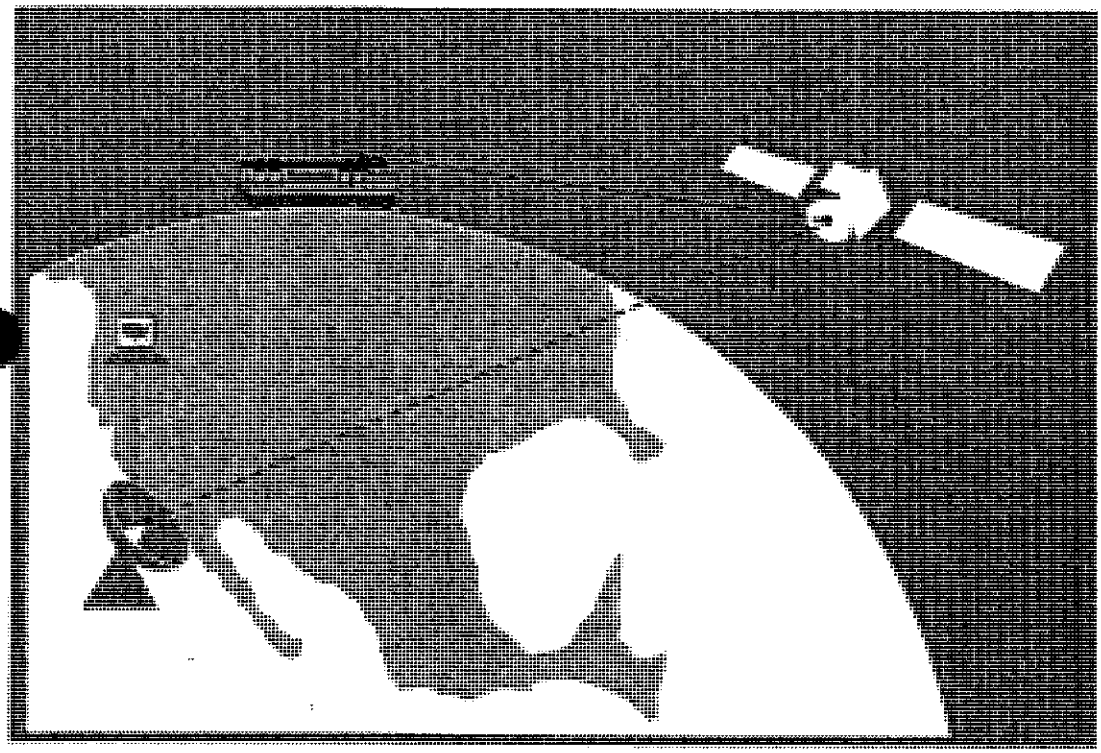
the northbound *Carolinian* rolling alongside U.S. Highway 301 through Lucama, N.C., between Selma and Wilson. "If a passenger has a medical emergency or a car is struck at a crossing, we can notify local authorities and give them directions to the scene," says Cornelius. "Crews always know where they are milepost-wise, but they may not know street names." One mouse click displays emergency phone numbers; another shows hospital locations in the Lucama area.

Star Trak communication with the locomotives began going on-line in June 1996, when operations were based in Philadelphia. Now all 47 Superliner transition dorm cars and 25 single-level cars are being equipped with satellite computers so the engineer never has to relay a conductor's message. In fact, personnel at CNOC often don't intercede either. "An interactive voice response unit sends messages to a printer at their intended destination, then dials the phone and tells the person who answers, 'You have an inbound message. Press 1 to hear it,'" explains Sherlock.

With the Northeast Corridor's Centralized Electrification and Traffic Control (CETC) dispatching centers in Philadelphia, New York, and Boston keeping split-second tabs on NEC trains, Amtrak chose to limit Star Trak's initial roll-out to its routes that are dispatched by the freight carriers. "We're now looking to equip all trains in the NEC for messaging capability as soon as funding allows," says Sherlock. "The system is more reliable than cell phones and answers questions without a middleman getting involved." With Star Trak and the opening of CNOC, Amtrak has joined the ranks of freight railroads who have harnessed satellite technology and centralization to improve operating efficiency. And now even the most mundane message—"Engine 13. Please have the chief on No. 3 set off as many menus as he can at Lamy for No. 4"—will go through Wilmington to get where it's going. ■

Attachment H
OmniTRACS' Marketing Brochure

OmniTRACS Locomotive Crew User Manual



OmniTRACS

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October 1995
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1
General Information

Introduction

This manual is your guide to the OmniTRACS® Mobile Communications Terminal (MCT). The MCT consists of the outdoor unit (antenna), the communications unit (the black box) and the display unit (keyboard and screen). The MCT allows you to send messages to and receive messages from your operations center. This manual contains all the information you need to operate your MCT.

Note

Your MCT is easy to operate, and using your equipment is the best way to get familiar with it. Don't hesitate to practice on the display unit. You cannot damage your unit or lose information by simply pressing the keys. In many cases, instructions appear on the screen to help you along.

Chapter 1 provides general information on the MCT's features. It also tells you how to use the display unit to check the status of your MCT.

Chapter 2 explains how to read messages. You can read messages you have just received and re-read messages you received or sent in the past.

Chapter 3 explains how to send messages via your MCT and describes the kinds of messages you can send.

Chapter 4 explains the MCT option screens available.

Appendix A provides a quick-reference guide for reading messages you have received and for sending messages to the operations center.

Appendix B gives detailed information about the keys on the display unit keyboard.

Appendix C explains how your MCT actually stores both the messages it receives and those you create.

Appendix D tells you how to handle "password" messages. Check with your operations center to see if your MCT is equipped to receive these messages. If it is not, skip this appendix.

Appendix E explains the canned message field types that are included in software version 700 or later of the MCT. Check with your operations center to see what version you have, or check your Software Version Screen. (See Chapter 4.) If you have an earlier version, skip this appendix.

The OmniTRACS System

Your MCT operates on OmniTRACS, a *messaging system* that allows messages to be sent between you and your operations center.

Your MCT receives messages even if you are not actually operating it. The OmniTRACS system automatically receives and stores messages in your MCT for later use. In addition, your MCT transmits and receives messages whether your locomotive is stopped or in motion.

The keyboard on your MCT display unit is designed so that you can press any key *at any time* without damaging OmniTRACS or losing typed information. If you press a key that the system cannot act on at that point (for example,

if you press **READ NEXT** when there are no more messages to be read), the display unit beeps twice.

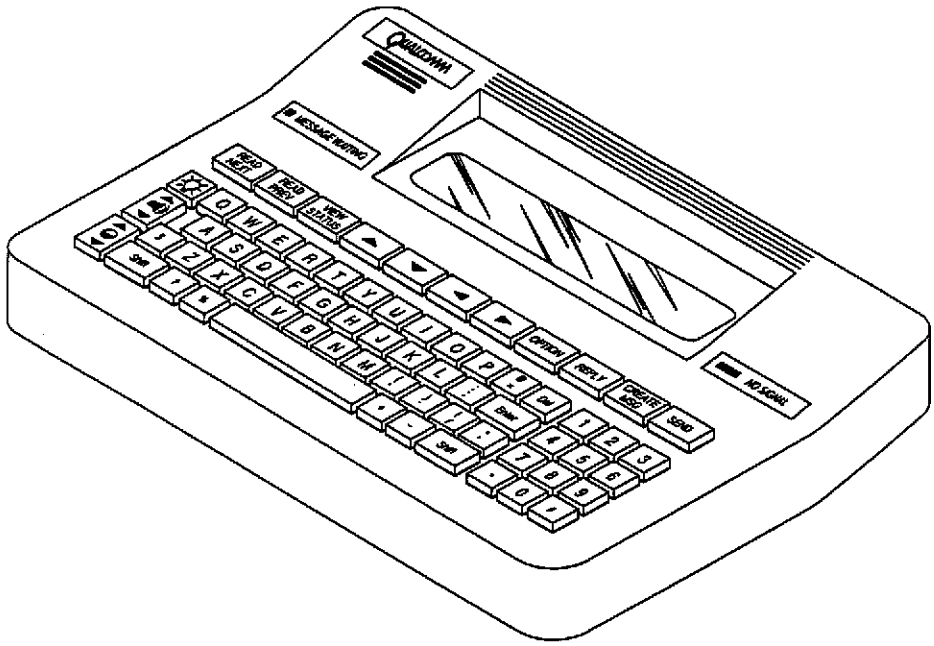
Many features can be added to future versions of the OmniTRACS system. We welcome your input and suggestions regarding the system.

WARNING

Never use your MCT while the locomotive is moving. This will divert your attention from the track and could lead to a serious accident.

The MCT Display Unit

The OmniTRACS MCT is operated via the display unit, which is shown in the following illustration. The layout of the letter keys on the display unit keyboard match the key layout of a typewriter. Messages are read and sent using the function keys at the top of the keyboard. These function keys are described in detail in Appendix B.



Display Unit Features

At the top center of the display unit is a 4-line by 40-character liquid crystal display (LCD) screen where messages and status information are displayed. Messages can be as long as 50 lines, but no more than 4 lines will be on the screen at one time. Long messages can be read by pressing the ↑ and ↓ keys.

The display unit also has three control keys located on the left side of the keyboard. These control keys can be used as described below.

Backlight Control The backlight control turns the display unit backlight on and off. The backlight should be turned on when the display unit is used at night.

Audio Control The audio control adjusts the volume of the display unit message waiting beeper. Press the top of this control to increase the volume or the bottom of the control to decrease the volume.

Contrast Control The contrast control adjusts the contrast of the display unit LCD. Press the top of this control to brighten the contrast or the bottom of this control to darken the contrast.

Note

The MCT may appear to be malfunctioning if these controls are not adjusted properly. If the display screen is blank, try adjusting these three controls first.

MESSAGE WAITING Light

On	This indicates that one or more unread messages are waiting to be read.
Off	This indicates that no messages are waiting to be read.
Flashing	This indicates that a priority message is waiting to be read.

Note

The optional remote message waiting light works like the MESSAGE WAITING light.. The remote light indicates messages intended for the on-board services chief.

MESSAGE WAITING Beep

One Beep	This indicates that your MCT has received a message.
Multiple Beeps	This indicates that your MCT has received a priority message. The display unit is set at the factory to emit three short beeps every minute until the priority message is read; this setting can be changed by your operations center.
Periodic Beeps	This indicates that your MCT contains messages that you have not yet read. The display unit is set at the factory to emit one beep (or three beeps for a priority message) every five minutes until the message or messages are read; this setting can be changed by your operations center.

NO SIGNAL Light

On	This indicates that your MCT is searching for the satellite. For example, this light might go on if you are in a long tunnel or train shed. In such cases, the light goes off within one minute. It can take your MCT between 10 seconds and 10 minutes to find the satellite once it is in clear view of the satellite.
Off	This indicates that your MCT can see the satellite and is receiving the satellite signal.

Checking the Status of Your MCT

Shortly after power up or whenever you press **VIEW STATUS**, the MCT Status Screen appears on the display unit. This screen shows you the status of the system and indicates how many messages are currently unread or are being sent to the operations center. A sample MCT Status Screen is shown below and explained in the following paragraphs.

```
OmniTRACS-200          1/15/91 15:00:00 PST
-------------------------------------------
                       UNREAD MESSAGES:   0
STATUS: GOOD           MSGS BEING SENT:   0
```

The Date and Time Field

When your MCT powers on for the very first time, the MCT Status Screen does not display the date and time. After the MCT first acquires the satellite signal, it displays the current date and time, as well as the time zone that is currently selected, whenever the MCT is powered on and the MCT Status Screen is displayed. See Chapter 4 for information on changing the time zone.

The STATUS Field

The STATUS field indicates the operational status of the MCT and tells you either that the MCT is operating properly or that there is a problem. The field displays one of the following:

- GOOD is displayed if the MCT is operating properly.
- A numerical error code (e.g., 1000) is displayed if the MCT detects a problem. Make a note of any error code that is displayed in the STATUS field and report it to your operations center.

The UNREAD MESSAGES Field

The UNREAD MESSAGES field indicates the number of messages the MCT has received but that you have not read. This number increases as the MCT receives new messages, and decreases as you read the messages you receive.

The MSGS BEING SENT Field

The MSGS BEING SENT field indicates the number of messages your MCT is currently sending to the operations center. This number increases as you enter new messages and decreases as your messages are acknowledged.

Note

When the MSGS BEING SENT field shows a value of 3, you cannot create more messages until one of the messages you previously sent is acknowledged by the receiving station. This generally happens if you try to send a message when your MCT is out of view of the satellite. In this case, the notice "TRANSMIT BUFFER FULL" appears on the display unit screen, and the MCT beeps twice if you press ***CREATE MSG****. Wait until the MSGS BEING SENT field is less than 3 before creating another message.*

If you send a message when your locomotive cannot "see" the satellite, the MCT remembers the message and keeps sending it to the receiving station until it receives an acknowledgment.

Re-displaying the MCT Status Screen

The MCT Status Screen is displayed as long as you do not press any of the function keys on your keyboard. Once you press a function key, you can re-display the Status Screen *at any time* by pressing **VIEW STATUS**. No typed information is ever lost by pressing **VIEW STATUS** or any other function key.

2
How to Read Messages

Introduction

When the MCT first receives a message from the operations center, it stores the message for you to read. Once you have read the received message on your display unit, the message is stored in memory as a "read" message. This chapter explains how to read new messages that you have not yet read and messages that you have already read but want to look at again. In addition, this chapter explains how messages are shown on your display unit screen, how to read long messages and how to delete messages stored in the MCT.

Remember—the best way to get accustomed to your MCT is to use it. Don't hesitate to practice on the display unit. You cannot damage it or lose information by pressing the wrong key.

When your MCT receives and stores a message from the operations center, it notifies you as follows:

1. The display unit beeps. If you have a Remote Message Waiting Light option, that light goes on.

2. The MESSAGE WAITING light goes on.

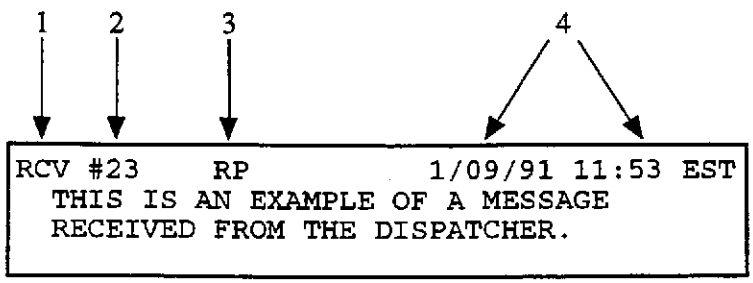
3. If the message is a *priority* message, the display unit beeps three times, and the MESSAGE WAITING light flashes on and off.

How Your MCT Displays Messages

Your MCT display unit shows messages you *send* and messages you *receive* in slightly different formats. These formats are explained below.

Received Message Display

Messages received by your MCT from the operations center are displayed in capital letters on your display unit in the format shown below.



A message received from the operations center contains several items of information:

- **A message header line.** This is the first line of the message. It consists of the following:

  1. The type of message ("RCV" for Receive)
  2. The message number ("23" in the example)
  3. The return receipt status indicator. This is an optional field and is blank for most messages. If the operations center asks to be notified automatically via a "receipt" when you have displayed the message on your MCT, two possible status indicators are shown. Initially, "RP" is shown while the receipt is being transmitted to the Network Management Computer (NMC). When the

NMC acknowledges that it has received the receipt, RA is displayed. These status indicators are defined as follows:

RP Receipt Pending

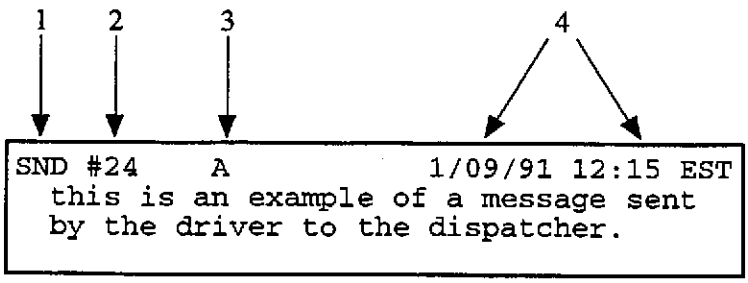
RA Receipt Acknowledged

4. The date and time that the message was received

- **The message text.** This is displayed on the next three lines of the screen. (In the message display shown above, the message text consists of only two lines, so the third message line is blank.) Because the message shown above was *received from* the operations center, it is displayed in capital letters.

Sent Message Display

Messages sent from your MCT to the operations center are displayed in lowercase letters on your display unit in the format shown below.



A message that you have sent to the operations center contains several items of information when you look at it again on your display unit:

- **A message header line.** This is the first line of the displayed message. It consists of the following:

1. The type of message ("SND" for Send)

2. The message number ("24" in the example)

3. An acknowledgment indicator (the "A" in the example). This indicates that the message has been sent and acknowledged, and is available for the operations center to read. The "A" does not appear *immediately* after the message has been sent, but after the entire message has been transmitted and an automatic acknowledgment has been received by the MCT. Typically, it appears *soon after* the message is sent.

Note

If your MCT is unable to transmit a send message, "XXX" may appear in the message header instead of the "A." This indicates that your MCT is broken; contact your operations center.

4. The date and time that the message was sent

Note

If you created the send message before the NO SIGNAL light on your MCT went off, the message "NO TIME AVAILABLE" would be displayed instead of the date and time. Your message would still be sent with no problem.

- **The message text.** This is displayed on the next three lines of the screen. (In the message display shown above, the message text consists of only two lines, so the third message line is blank.) Because the message shown above was *sent to* the operations center, it is displayed in lowercase letters.

Reading New Messages

To read a message that has just been received (indicated by the MESSAGE WAITING light being on), do the following:

1. Press **READ NEXT**. This causes the message text to be displayed on the screen. If you were reading an old message when the message waiting light came on, hold down **READ NEXT** until the new message is displayed. Or, press any other function key and then **READ NEXT;** the message immediately appears.

2. If more than one message is waiting to be read (the MESSAGE WAITING light is still on), read the next one by pressing **READ NEXT** again.

3. Continue to press **READ NEXT** until all unread messages have been read. When the last unread message has been displayed, the MESSAGE WAITING light goes off. The display unit beeps twice if you press **READ NEXT** while the last stored message is displayed. This is simply to notify you that there are no more unread messages.

Reading Stored Messages

To read messages stored in the memory of your MCT, press **READ NEXT** then press **READ PREV** ("read previous"). Using these keys is like "paging" through a book. To read a message that is in an "earlier" place in MCT memory, press **READ PREV**.

When you press **READ PREV**, the next lower numbered message is displayed. The MCT beeps twice if you press **READ PREV** while the oldest stored message is displayed, to notify you that there is no stored message *older* than the one displayed.

To read a more recent message, press **READ NEXT**. The display unit beeps twice if you press **READ NEXT** while the newest stored message is displayed. This is to notify you that there is no stored message *newer* than the one displayed.

Note

As your MCT stores messages, it numbers them 1 through 99. The number of messages stored in the memory of your MCT depends on the length of the messages (long messages mean that fewer can be stored). The MCT cycles through the numbers 1-99 as it stores messages and deletes old messages to make room for new ones.

Moving Rapidly through Stored Messages

To move rapidly through the messages stored in MCT memory, press and hold down either **READ PREV** or **READ NEXT**, and do not release the key until you reach the desired message. Holding either of these keys down causes the display unit to display messages rapidly, with a slight pause at each message. When you release the key, the message currently displayed stays on the screen.

If you are looking through old messages and a new message is received, you can hold down **READ NEXT** until the new message is displayed on the screen. To more quickly display the new message, press **VIEW STATUS** or any other function key first, then **READ NEXT**.

Note

*You may hold down **READ NEXT** to move rapidly through previously read messages. The display unit beeps, and the screen holds the display when it comes to the first unread message. These messages must be read one at a time.*

Interrupting an MCT Task to Read a Message

Whenever you are using your MCT, even if you are in the process of creating a message, you can press **READ NEXT** or **READ PREV** to interrupt the process and read a new or stored message. Once you have read the message, you can easily return to what you were doing.

If you press **READ PREV** while you are using the MCT for another function, the message most recently displayed on the screen is displayed again.

Reading Long Messages

Your display unit screen can show up to 4 lines of text. A message can contain up to 50 lines, so you may not be able to see the entire message on the screen at one time. Since the message header is displayed on the screen, any message with more than three lines of text cannot fit on one screen. This chapter explains how to read these long messages.

When a message cannot be displayed entirely on one screen, an arrow pointing down appears in the lower left corner of the screen. This arrow indicates that the message contains additional text. By pressing ↓ and ↑, you can move through the lines of a long message. This is called scrolling through a message.

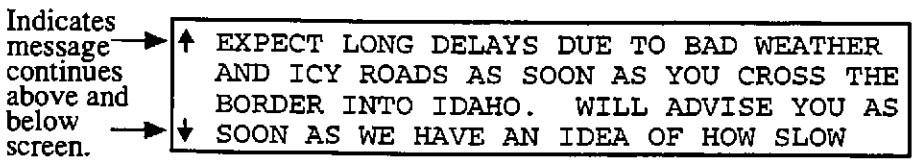
An example of a long message is shown below.

Indicates message continues below screen. →

```
RCV #26                    1/09/91 12:25 EST
  EXPECT LONG DELAYS DUE TO BAD WEATHER
  AND ICY ROADS AS SOON AS YOU CROSS THE
↓ BORDER INTO IDAHO.  WILL ADVISE YOU AS
```

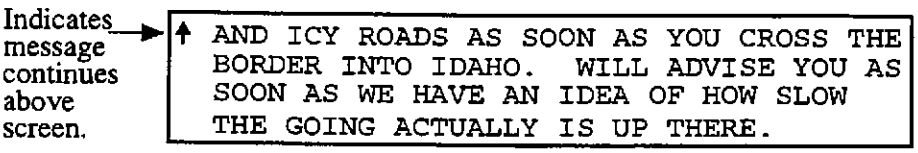
The arrow at the lower left of the screen, indicates that the text of the message continues beyond what is currently displayed. Press ↓ to see the next line of the message.

When you do this, the top line that had been displayed disappears, and the next line of text appears at the bottom of the screen, as shown on the next page.



As the example shows, an arrow pointing up appears at the upper left of the screen to indicate that the message continues above what can be seen on the screen. The arrow pointing down still appears in the bottom left of the screen in the figure, indicating that there is still more message text below what you can now see.

You can use ↓ and ↑ to scroll through the entire message. The end of the example message appears on the screen as shown below.



If you press ↓ when the last line of message text is currently displayed (i.e., when no down arrow appears in the lower left of the screen), the display unit beeps twice to indicate that you have reached the end of the message. If you press ↑ when the first line of the message is currently displayed (i.e., when no up arrow appears in the upper left of the screen), the display unit beeps twice to indicate that you have reached the beginning of the message.

Moving Rapidly through a Long Message

To move faster through a long message, press *and hold* the ↑ or ↓ key. This causes the lines of the message to scroll rapidly, with a slight pause as lines move up or down the screen. When you release the key, the message lines currently appearing stay on the screen.

You can press any function key (i.e., **VIEW STATUS, READ NEXT, READ PREV, CREATE MSG, REPLY**) in the middle of scrolling through a long message.

Deleting Stored Messages

Occasionally, you may want to delete a message stored in your MCT. To delete a message, do the following:

1. Press **READ NEXT** or **READ PREV** until the correct message appears on the display unit screen.

2. Press **Del** (located on the upper right side of the letter keys on the display unit keyboard). This causes the Delete Stored Message Screen to be displayed. An example of this screen is shown below.

```
ARE YOU SURE YOU WANT TO DELETE MSG #26

        YES - TYPE "Y" TO DELETE
        NO  - TYPE "N" TO CANCEL
```

3. Press either **Y** or **N**. If you press **Y**, the notice "MESSAGE #XX IS DELETED" is displayed on the screen for a few seconds ("XX" is the message number for the selected message). If you press **N**, the selected message reappears on the display unit screen as it was before you pressed **Del**.

Note

When you delete a send message from your MCT, you simply delete it from the display memory. This means that the message is still sent to the operations center even though it cannot be seen on your MCT.

3
How to Send Messages

Introduction

Sending a message to the operations center involves the following two steps:

- Creating the message (either "free-form" or "canned"). This step involves typing the text and making any necessary changes or corrections to what you typed.

- Sending the message. Once you have completed the message text, you transmit it to your operations center.

This chapter explains in detail how to create and send messages. It also tells you how to reply to a specific message, how to resume creating a message when you have been interrupted, and how to cancel a message you have started to create.

Note

The best way to get accustomed to your MCT is to use it. Don't hesitate to practice on the display unit. You cannot damage it or lose information by simply pressing the keys. In addition, you cannot actually send a message until you confirm that you want it sent.

Free-Form and Canned Messages

The messages that you send and receive on your MCT can be either free-form or canned. Free-form messages are messages made up entirely of text that is freely typed (like typing on a blank piece of paper). Canned messages, which are the type most commonly sent and received, are pre-formatted messages that are either in fill-in-the-blank format or are completely filled out for you to send immediately. These messages are also sometimes called "macro" messages.

Creating a Free-Form Message

To create a free-form message, do the following:

1. Press **CREATE MSG** to display the Create Message Screen, as shown below.

```
** SELECT CANNED MESSAGE (0-63): _
** USE "+"/"-" TO VIEW CANNED MESSAGE.
```

2. Press **Enter**. This causes the cursor to move down to the start of the message text area, as shown below. A zero (0) automatically appears in the SELECT CANNED MESSAGE input field. (This indicates that canned message number 0 is used for free-form messages.)

```
** SELECT CANNED MESSAGE (0-63): 0_
** USE "+"/"-" TO VIEW CANNED MESSAGE.
```

3. Type the text of your message. You can use all the keys below the function keys on the keyboard, *except* **Del**.

Note

When the MSGS BEING SENT field on the MCT Status Screen shows a value of 3, you cannot create any more messages until at least one of the messages you previously sent has been acknowledged by the receiving station. This generally happens only if you enter messages when your MCT is out of view of the satellite. In this case, the notice TRANSMIT BUFFER FULL appears on the display unit screen. The MCT beeps twice if you press ***CREATE MSG*** *to create another message. Wait until the MSGS BEING SENT field is less than 3 before creating another message. (See chapter 1 for more information on the MSGS BEING SENT field.)*

Hints for Creating a Free-Form Message

Keep the following points in mind when you create a free-form message:

- The words that you type appear on the screen exactly as you type them. If a word does not fit on the end of a line, it is automatically moved to the next line. This word wrap feature allows you to type a message without worrying about whether a word will fit on a line.

- While typing a message, you can press **Enter** at any time to start a new line in the message. When you press **Enter** before the end of a line, the cursor moves to the left margin on the next line, where you can then continue typing.

- You can insert a blank line in the message by pressing **Enter** twice.

- A message to be sent to the operations center can be up to 50 lines long. As you type, the first lines of the message move off the top of the screen one by one to make room for additional lines of text. An arrow also appears in the upper left of the screen, to indicate that part of the message is no longer displayed on the screen. You can use the ↑ and ↓ keys to re-display lines of text that have moved off the screen.

Correcting Errors in Free-Form Message Text

Before you actually send a message, review it for mistakes or omissions and make any necessary corrections. To correct errors, do the following:

1. Use the arrow keys (↑, ↓, ←, and →) to move the cursor (the "■" symbol) to the point where you need to make a correction.

2. To *remove* one or more characters from the message, use the arrow keys to position the cursor just to the *right* of the character(s) to be removed, and press **Del** once for each character to be removed.

3. To *add* one or more characters to the message, use the arrow keys to position the cursor to the point where characters are to be added, then type them.

4. Once you have edited your message, it is ready to be sent to the operations center. Press **SEND** and then **Y** to send the message. See the later section *Sending a Message to the Operations Center* for the final steps in sending the message to the operations center.

Preparing a Canned Message

Your MCT stores up to 63 canned or pre-formatted messages.. Each canned message has a number between 1 and 63 assigned to it. (Canned message number 0 is used for free-form messages.) Because many of these canned messages are in a fill-in-the-blank format, you can only fill in the dashed lines on the screen. You cannot change the form of the message itself.

Displaying a Canned Message

To display a canned message in preparing to send it, do the following:

1. Press **CREATE MSG** to display the Create Message Screen, as shown below.

```
** SELECT CANNED MESSAGE (0-63): _
** USE "+"/"-" TO VIEW CANNED MESSAGE.
```

2. If you know the number of the canned message you wish to send, type the number at the end of the SELECT CANNED MESSAGE (0-63): line and press **Enter**. Type in the appropriate number. If you do not know the number of the message you need to send, follow the next three steps.

3. Press + or – to begin reviewing the available canned messages. When you press +, a canned message is displayed on the screen. Its message number is shown at the end of the SELECT CANNED MESSAGE (0-63): line.

4. Continue to press + until the message you need is displayed on the screen. Each time you press +, the next sequential canned message is displayed.

5. If necessary, press – to move back through the canned messages you have already checked. Each time you press –, the previous (in numerical order) canned message is displayed.

6. Press **Enter** when the canned message you need is displayed on the screen. You are now ready to fill in the blanks in the message.

Hints for Displaying a Canned Message

Keep the following points in mind when searching for the appropriate canned message.

- When you type in a canned message number or press the + key at the Create Message Screen, the screen might appear as shown below. In this example, the first two lines of the canned message are displayed on the screen. The LOAD and DESTINATION CONTACT fields are pre-written text that you cannot alter, and the underlined areas are where you fill in information.

```
** SELECT CANNED MESSAGE (0-63): _
** USE "+"/"-" TO VIEW CANNED MESSAGE.
  LOAD:________
↓ DESTINATION CONTACT:________
```

- If you mistakenly type a canned message number that is not currently in the system, the message "** INVALID MSG #; USE 0 FOR FREEFORM" appears at the bottom of the screen. Type the correct number or press + or – to get to the canned message that you want.

- As you use the + and – keys to review the canned messages in your system, canned message number 0 may be displayed on your screen. Because this message number is used for free-form messages, it will have no text on the screen.

- When a canned message is displayed for review, you can press **Del** to delete the message number displayed in the SELECT CANNED MESSAGE (0-63) field and then type in another number. The canned message associated with the new number is then displayed on the screen.

Filling in the Text of a Canned Message

When the appropriate canned message is displayed on the screen and you have pressed **Enter**, the cursor moves to the beginning of the first input field in the canned message. For example, after you press **Enter** for the screen shown on the previous page, the screen appears as shown below.

```
** SELECT CANNED MESSAGE (0-63): 1_
** USE "+"/"-" TO VIEW CANNED MESSAGE.
  LOAD:_______
↓ DESTINATION CONTACT:________
```

Note

Some canned messages are already completely filled out. You cannot add any information to these messages, but simply need to display them on the screen and then send them.

To fill in the fields of a canned message. Do the following:

1. Use the letter and number keys on the keyboard to fill in the first field. Use → and ← to move the cursor around in a field. The number of dashed lines displayed in the field indicates the maximum number of

characters you can enter in the field. For example, you could type up to 8 characters in the LOAD: field shown above. If you try to type in more characters for a field than are allowed, the additional characters are ignored and the display unit beeps twice. (Press **Del** to remove any incorrect characters in the field before typing new ones.

2. Press **Enter** or ↑ and ↓ to move among the input fields of the canned message. These keys can be used as follows:

   - Pressing **Enter** moves the cursor to the next field.
   - Pressing ↑ moves the cursor to the first field in the current line or, if the cursor is already in this field, to the first field in the line above.
   - Pressing ↓ moves the cursor to the first field on the next line.

Hints for Filling in a Canned Message

Keep the following points in mind when you fill in canned messages:

- Some lines of a canned message may have more than one field for you to fill in. Press **Enter** to move from one field to the next and from one line to the next.
- Canned messages can be up to 50 lines long. As you fill in longer canned messages, the first lines of the message scroll off the top of the screen one by one to make room for new lines of text. When this happens, an arrow appears in the upper left of the screen to indicate that part of the message is not displayed on the screen. (This scrolling of message text is described in the earlier Chapter 2 section *Reading Long Messages*.) You can

press ↑ and ↓ to display different lines of the message on the screen. As you press these keys, lines of text move on and off the screen, and the cursor moves from field to field in the canned message. If the canned message has blank lines or lines with no fields, the cursor moves to the far left of the line.

- Your operations center will supply instructions on the specific requirements for the canned messages that you use.

- You can stop work on a particular canned message and select a different one at any time. To accomplish this, do the following:

  1. Press ↑ until the cursor appears in the SELECT CANNED MESSAGE (0-63): field.

  2. Press + or – or type a different canned message number to display a different message.

  3. Press **Enter** and start filling in the fields of the new canned message.

Note

The information that you typed for the first message will be lost once you enter a different canned message.

Correcting Errors in Canned Message Text

Before you actually send a canned message, review it for mistakes or omissions and make any necessary corrections. To correct the errors, do the following:

1. Use the arrow keys to move the cursor to the point where you need to make a correction. The ↑ and ↓ keys move the cursor from field to field and from line to line in the message; the → and ← keys move the cursor

around within a field. **Enter** can also be used to move from one field to the next.

2. To *remove* one or more characters from a field, use the arrow keys to position the cursor just to the *right* of the character(s) to be removed, and press **Del** once for each character to be removed.

Note

If the character you need to delete is at the end of a field, position the cursor on top *of the character and then press* **Del**.

3. To *add* one or more characters to a field, use the arrow keys to position the cursor to the point where characters are to be added. Once the cursor is positioned, type the necessary character(s). The display unit beeps twice if you try to add characters to a field that is already filled with the maximum number of characters. If you need to add characters, you must first press **Del** to delete existing characters in the field.

4. Once you have edited your message, it is ready to be sent to the operations center. Refer to the next section for instructions on sending the message to the operations center.

Sending a Message to the Operations Center

Once a free-form or canned message has been created and you are satisfied with its contents, you are ready to send it to the operations center. To send a message to the operations center, do the following:

1. Press **SEND** while the created message is shown on the display unit screen. Pressing this key causes the Send Message Screen, shown below, to be displayed.

```
TYPE "Y" TO SEND THIS MESSAGE.
TYPE "N" TO NOT SEND THIS MESSAGE.
TYPE "P" TO SEND A PRIORITY MESSAGE.
```

Note

Some operations centers disable the priority message capability. If this has been done on your system, only the first two lines of the above screen are displayed.

2. Select one of the three options on the Send Message Screen. These options are as follows:

   - Press **Y** to send the message. If you press **Y**, the notice "RETURN MESSAGE HAS BEEN QUEUED" appears on the display unit screen for a few seconds. This message confirms that **Y** was pressed and notifies you that the message has been stored for transmission. Soon after this confirmation, the MCT Status Screen is displayed. The number count in the MSGS BEING SENT field is changed to indicate that the message is waiting to be sent. Once you press **Y**, the MCT sends the message to your operations center. You cannot subsequently cancel the sending of the message.

- Press **N** to cancel the sending of the message. If you press **N**, the selected message reappears on the display unit screen. You can then make corrections or additions to the message or simply go on to another function and cancel the message completely. The message is still in MCT memory, so you can return to it. To delete the message completely from MCT memory, press **CREATE MSG** or **REPLY**. Then type **N** in the Continue Message Creation Screen (discussed later).

- Press **P** to send the message to the operations center as a *priority* message. Priority messages are sent ahead of any regular messages already waiting in your MCT to be sent to the operations center. Priority messages are also sent more quickly. After you press **P**, "PRIORITY MESSAGE HAS BEEN QUEUED" appears on the screen for a few seconds. This message confirms that **P** was pressed and that the priority message is stored for transmission. Soon after this confirmation, the MCT Status Screen is displayed. The number count in the MSGS BEING SENT field is changed to indicate that the priority message is waiting to be sent.

Replying to Received Messages

To reply to a specific message received from the operations center, you need to use the **REPLY** key. First, display the operations center's message on the screen. This is important for the following reasons:

- Your operations center will automatically know which message you are answering. For example, if your reply message is a simple "Yes," the operations center can check to which message you are responding.

- The operations center's message may be a canned message that calls for a specific canned message in reply. If it is, your MCT contains an Associated Canned Message Number corresponding to the operations center's message. In this case, when you press **REPLY**, the MCT automatically displays the correct canned message. (You do not have to use this associated canned message if you want to send a different message). This automatic feature works only if you first display the operations center's message on the screen and then press **REPLY**.

To reply to a specific message received from the operations center, do the following:

1. Press **READ PREV** or **READ NEXT** to display the operations center's message.

2. Press **REPLY**. This causes the operations center's message to be replaced on the screen by the Create Message Screen shown below.

```
** SELECT CANNED MESSAGE (0-63): _
** USE "+"/"-" TO VIEW CANNED MESSAGE.
```

3. If the message from the operations center has an Associated Canned Message Number, the corresponding canned message *automatically* appears on the display unit screen. In this case, do one of the following:

   a) If the displayed canned message is the one that you want to fill out and send as a reply, press **Enter** and begin filling out the message as described earlier in this chapter.

   b) If the displayed canned message is *not* the reply that you want to send, press + and – to get to the canned message that you want, or type the number of the canned message that you want. Press **Enter**.

The **REPLY** function key works exactly like the **CREATE MSG** function key except for two additional features.

- When you later read a message that you already sent with the **REPLY** key, the number of the message to which you responded is displayed on the message header line. See the later section entitled *The Reply Message Number*.

- If you press **REPLY**, a specific canned message may be automatically displayed for you to fill out. If the received message that is displayed when you press **REPLY** does not have an Associated Canned Message, no canned message is displayed. Instead, the Create Message Screen appears.

Re-displaying the Operations Center's Message

As you create your reply message in response to a message from the operations center, you may find it helpful to re-display and re-read the operations center's message.

This can be easily done, as follows:

1. Press **READ PREV**. This causes the operations center's message that had been displayed to reappear.

2. Once you have finished checking the operations center's message and are ready to resume creation of your reply message, press **REPLY**. This causes the Continue Message Creation Screen, shown below, to be re-displayed. The Continue Message Creation Screen offers you two options and also shows the first line of the message you were creating.

```
TYPE "Y" TO CONTINUE WITH PREVIOUS MSG
TYPE "N" TO BEGIN NEW MSG CREATION

LOAD:17A-4897
```

3. Select one of the two options on the Continue Message Creation Screen. These options are as follows:

   a) Press **Y** to continue creating the message you started. If you press **Y**, the message that you had been working on before you pressed **READ PREV** is re-displayed in exactly the same format and with exactly the same contents as when you left it. The cursor also appears at the position it was when you pressed **READ PREV**, so you can continue creating your reply exactly where you left off.

   b) Press **N** to begin a new reply message. If you press **N**, either the Create Message Screen is displayed or,

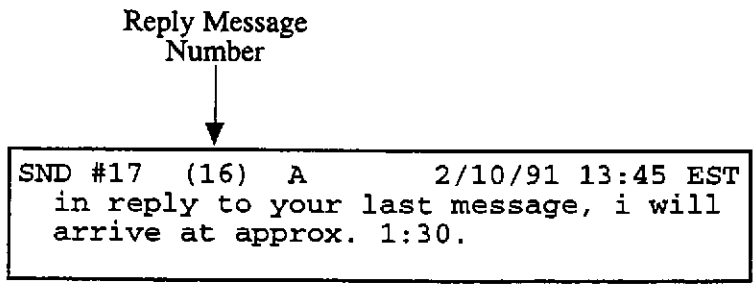
if the operations center's message had an Automatic Canned Message Number, the appropriate canned message is re-displayed. You can then create a new reply message to send to the operations center.

Note

Pressing N causes your original reply message to be lost. Therefore, this is one way to cancel a created message without *sending it to the operations center.*

The Reply Message Number

If you press **REPLY** to create a reply to a message received from the operations center, a Reply Message Number will show in the Message Header (the first line of the message) when the message is later displayed on the screen. For example, a message sent in reply to a received message would be displayed as shown below.



The Reply Message Number is displayed in parentheses in the Message Header. In the example above, your sent (SND) message number 17 was sent in reply to received message number 16.

Note

If message 16 is deleted, the Reply Message Number will not appear in the above display.

Interrupting Message Creation

The MCT allows you to interrupt message creation or perform other functions (such as reading a new message), and then return to where you left off in creating a message. You can do this without having to create the message from the beginning again.

When you are creating a message, you can stop anywhere in the middle of message composition and press any function key (*other than* **REPLY** or **CREATE MSG**) to perform another function. When you do this, the MCT stores the contents of the message you were creating so you can continue it later. The next time you press either **CREATE MSG** or **REPLY**, the Continue Message Creation Screen is displayed. Follow the instructions contained in step 3 of the earlier section, *Re-displaying the Operations Center's Message,* for selecting options on the Continue Message Creation Screen.

Interrupting Reply Message Creation

Once you have displayed the operations center's message to which you want to respond and then pressed **REPLY** to initiate reply message creation, **READ PREV** will always take you back to the operations center's message. This is true even if you interrupt reply message creation by pressing **READ NEXT** to read a message that has just come in on your MCT.

The sequence below shows how **REPLY**, **READ PREV**, and **READ NEXT** operate when you are replying to a specific message:

1. You have read message 17 from the operations center and pressed **REPLY** to create a response to the message.

2. While you are composing your reply, new messages (messages 18, 19, and 20) come in, and you press **READ NEXT** to read them.

3. After you have read the new messages, you press **REPLY** again, and the Continue Message Creation Screen is displayed.

4. You press **Y**, and the message you had been composing is re-displayed.

5. You press **READ PREV**.

6. Message *17* (rather than message *20*, which had been on the screen when you last pressed **REPLY**) is now re-displayed, because that is the message to which you are replying.

Canceling Message Creation

If you have begun to create a message and decide not to send it to the operations center, you can easily cancel the message by doing the following:

1. Press any function key other than **REPLY** or **CREATE MSG**. This causes the message that you had been creating to be removed from the screen.

2. Press **REPLY** or **CREATE MSG**. The Continue Message Creation Screen, shown below, is then displayed.

```
TYPE "Y" TO CONTINUE WITH PREVIOUS MSG
TYPE "N" TO BEGIN NEW MSG CREATION

LOAD:17A-4897
```

3. Type **N** in response to the options on the screen. This cancels the message.

4
The MCT Option Screens

Introduction

This chapter describes the various MCT option screens. The more commonly used option screens are the Select Time Zone Screen and the MCT Positioning Status Screen. The other option screens can be used to help you and your operations center diagnose problems that may occur with your MCT.

The Select Time Zone Screen

The Select Time Zone Screen allows you to select the time zone that the MCT uses to display the current time and the times at which messages are received and sent. The current time zone is also displayed on the View Status Screen. The selection that you make affects *all* times displayed on your MCT, including those for previously sent and received messages. The MCT remembers the time zone that you select even when power is turned off. To select a time zone, do the following:

1. Press **OPTION** on the display unit keyboard. This causes the Select Time Zone Screen, shown below, to be displayed. The currently selected time zone appears at the bottom of the Select Time Zone Screen (in the example, PST for Pacific Standard Time).

```
USE ↑ (↓) TO MOVE TO PREV (NEXT) SCREEN

TYPE "Z" TO CHANGE TIME ZONE: PST
```

2. To select a different time zone, press **Z**. This causes a different time zone to appear at the bottom of the screen, and this new time zone becomes the currently selected time zone.

3. Continue pressing **Z** until the desired time zone appears.

If you press and hold down **Z**, the MCT displays the eleven available time zones sequentially, beginning at the current setting. Pressing **Z** after GMT is displayed starts the display over again at PST. The available time zones are as follows:

PST	Pacific Standard Time
PDT	Pacific Daylight Time
MST	Mountain Standard Time
MDT	Mountain Daylight Time
CST	Central Standard Time
CDT	Central Daylight Time
EST	Eastern Standard Time
EDT	Eastern Daylight Time
AST	Atlantic Standard Time
ADT	Atlantic Daylight Time
GMT	Greenwich Mean Time

Other Option Screens

If you experience a problem with your MCT, the other option screens can help you and the operations center determine the cause of the problem.

To view the option screens other than the Select Time Zone Screen, do the following:

1. Press **OPTION**. This causes the Select Time Zone Screen to be displayed. (If you are already viewing an option screen, this step is not necessary.)

2. Press ↓ to display the next option screen.

3. Press ↓ and ↑ to move around among the option screens. Pressing ↓ causes the next option screen to appear; pressing ↑ causes the previous option screen to appear.

When you are viewing an option screen and then press a function key other than **OPTION** (i.e, **VIEW STATUS** or **READ NEXT**), the Select Time Zone Screen is displayed the next time you press **OPTION**.

The MCT Addresses Screen

Pressing ↓ while the Select Time Zone Screen is displayed causes the MCT Addresses Screen to be displayed. A sample MCT Addresses Screen is shown below.

```
USE ↑ (↓) TO MOVE TO PREV (NEXT) SCREEN

UNIT ADDRESS:      12528
GROUP ADDRESSES: 523424,       0,       0
```

The MCT Addresses Screen shows the MCT Unit Address (12528 in the example) and Group Addresses (523424, 0, and 0 in the example).

The Unit Address is your "mailbox address." It allows your operations center to send messages to your locomotive. Your operations center may request this number. If your MCT is replaced, the new MCT will display a different address here.

The Group Addresses section of the screen shows your fleet or group number (or address). It may also show the number of other groups of which you are a member. These numbers are defined and used by your operations center to address the fleet/group.

The MCT Diagnostic Screen

Pressing ↓ while the MCT Addresses Screen is displayed causes the MCT Diagnostic Screen to be displayed. A sample MCT Diagnostic Screen is shown below.

```
USE ↑ (↓) TO MOVE TO PREV (NEXT) SCREEN
MODE: Receiving
M0:  19 M1:   1 M2:4000 M3:031A M4:0783
M5:  42 M6:2089 M7:7412 M8:0693 M9: 166
```

The MCT Diagnostic Screen shows ten diagnostic fields labeled M0 through M9. The information in these fields can be used to help diagnose problems. For example, if your MCT cannot find the satellite for a long time (the NO SIGNAL light on your display unit stays on), your operations center may ask for your M4 number to help determine why the problem is occurring. In the above example, diagnostic field M4 has a value of 0783.

The MCT Positioning Status Screen

Pressing ↓ while the MCT Diagnostic Screen is displayed causes the MCT Positioning Status Screen to be displayed. A sample MCT Positioning Status Screen is shown below.

```
USE ↑ (↓) TO MOVE TO PREV (NEXT) SCREEN

POSITIONING STATUS : ACTIVE
R1: + 8 R2: 0023
```

The MCT Positioning Status Screen shows the status of your MCT satellite positioning. The screen will display one of the following status:

1. ACTIVE. This indicates that your MCT is able to report its position.

2. SEARCHING. This indicates that your MCT is still trying to determine its position.

3. INACTIVE. This indicates that the positioning feature of the network has been temporarily disabled. This is displayed for your information only; you can still send and receive messages normally in this status.

A
Quick-Reference Guide

Introduction

This appendix is a brief guide to using the display unit shown in Chapter 1.

Your MCT is easy to operate and the best way to learn about the equipment is to use it. Your MCT is specifically designed so that you cannot damage it by simply typing information on the display unit or by pressing the keys on the keyboard.

Reading Messages from the Operations Center

When a new message is received from the operations center, the MCT beeps and the red MESSAGE WAITING light to the left of the message screen turns on. To read the new message, do the following:

1. Press **READ NEXT**. (If you were last reading an old message, hold down **READ NEXT** until the new message is displayed.)

2. After you have read the new message, press **READ NEXT** again to read any remaining new messages. The display unit beeps twice when there are no more messages to be read.

3. To read previously received messages stored in the memory of your MCT, press **READ PREV**. (The MCT can store up to 98 messages.)

Sending Messages to the Operations Center

To send messages to the operations center, do the following:

1. Press **CREATE MSG**.

2. Do *one* of the next three steps:

   a) Press **Enter** to create a "free-form" message (one in which you type in the entire text.

   b) Press + or – to find the appropriate "canned" message (one in which you type in certain requested information, like filling in a form) and press **Enter**.

   c) Type the number of the appropriate canned message, if you know it, and press **Enter**.

3. Type the text of the free-form message, or fill in the blanks of the selected canned message. Use the arrow keys to move around in the text. If you are typing a canned message, press **Enter** to advance from one field to the next. If necessary, move the cursor with the ← or → key and press **Del** to correct any mistakes you make.

4. Press **SEND**.

5. Press **Y** to confirm that you want the message to be sent.

The MCT Status Screen

When the MCT first switches on, or when you send a message to the operations center, the MCT Status Screen, shown below, appears on the display unit. This screen gives you information on the operating status of the MCT. It can also be seen at any time by pressing **VIEW STATUS** on the display unit.

```
OmniTRACS-200          1/15/91 15:00:00 PST
-----------------------------------------
                       UNREAD MESSAGES:  0
STATUS: GOOD           MSGS BEING SENT:  0
```

The NO SIGNAL Light

If the red NO SIGNAL light to the right of the message screen is on, it means that the antenna on your locomotive cannot "see" the satellite. The NO SIGNAL light should go out when your locomotive moves to a location with a clear view to the south. (The satellite is in orbit around the earth, south of the United States, in the general direction of western Texas.)

The MESSAGE WAITING Light

If the red MESSAGE WAITING light to the left of the message screen is on, it means that at least one message from the operations center is waiting to be read. If the MESSAGE WAITING light is blinking, it means that at least one of those messages is a priority message. To read any unread messages, press **READ NEXT**.

B
The Display Unit Keyboard

Introduction

The keyboard on your display unit contains function keys, arrow keys, special operation keys and standard typewriter (alphabetic and numeric) keys.

Function and Arrow Keys

The function and arrow keys are located at the top of the display unit keyboard and are used to perform specific tasks on the display unit. They are illustrated below and explained in the following paragraphs.

READ NEXT This key is used to read either the next new message or the message with the next higher message number when you are reading through a series of messages.

READ PREV This key is used to read either the message that was last displayed on the screen or the message with the next lower number when you are reading through a series of messages.

VIEW STATUS	This key is used to check the status of your MCT and causes the MCT Status Screen to be displayed.
ARROW	These keys (↑, ↓, ←, and →) are used to move around within the display unit screen.
OPTION	This key is used to view MCT option screens (see chapter 4).
REPLY	This key is used to reply to a message that you have just viewed on your MCT. The **REPLY** key functions the same as the **CREATE MSG** key, except that when you use it, the operations center knows you are replying to a specific message.
CREATE MSG	This key is used to initiate the creation of a message (canned or free-form) to send to the operations center.
SEND	This key is used to send a created message to the operations center. When you press this key, the MCT asks if you are sure you want to send the message. You respond by pressing **Y** to send the message, **N** to not send the message or **P** to send the message as a priority message (if that is an option for your system).

Special Operation Keys

These keys are located on the right side of the display unit keyboard. They are used to perform specific operations on the display unit, as described below.

Enter	This key is used to move to the next field in a canned or free-form message or to add a blank line to a free-form message.
Del	This key is used to delete the character that you typed immediately to the left of the cursor. (The cursor is the "■" symbol on the screen.)
+	This key is used to move through canned messages in the memory of your MCT. Press this key after the **CREATE MSG** or **REPLY** function key to display the *next* canned message.
–	This key is used to move through canned messages in the memory of your MCT. Press this key after the **CREATE MSG** or **REPLY** function key to display the *previous* canned message.

Alphanumeric Keys

These are the standard typewriter alphabet and number keys, arranged in the traditional format. They are located directly below the function and arrow keys on the display unit.

C
How Your MCT Stores Messages

Introduction

Your MCT stores the messages it receives and sends in its internal memory. When the MCT stores a message, it assigns the message a number between 1 and 99. This helps you find the message after it has been stored. After the MCT assigns the number 99 to a message, it begins again at number 1, and the old message 1 is deleted. Therefore, a message with a lower number may actually be a more recent one. Because messages are assigned numbers *as* they are stored, the messages are kept in chronological order.

Note

The number of messages actually in the memory of your MCT depends on the length of the messages. Long messages mean that fewer can be stored. The MCT stores messages and deletes old messages as necessary to make room for new ones.

The messages that you send and receive on your MCT can be either "free-form" or "canned." These two types are explained below.

Free-Form Messages

Free-form messages are messages made up entirely of text that you type. These messages can be used in situations not covered by canned messages.

Canned Messages

The messages that you will more commonly send and receive are canned messages. These are pre-formatted, usually fill-in-the-blank messages to which you or the operations center add specific information.

To find out what kind of information is included in any canned message, do the following:

1. Press **CREATE MSG**.
2. Type in the appropriate canned message number or use the + and – keys to find the desired message.
3. Press **Enter**.

Canned messages are custom-designed by operations centers and/or locomotive crews to cover *most* messaging needs. Operations centers can add new canned messages to the system or modify or delete existing messages at any time.

D
Password Messages

Introduction

Some MCTs are equipped with a feature that requires you to type a password to read the complete text of certain messages you have received. This appendix explains how to read these "password messages." If your system is not equipped with this feature, or if your operations center does not use password messages, you can skip this appendix.

The password feature allows your operations center to send you messages that only you can read. Passwords are assigned by your operations center.

Note

Passwords may only be used with MCT Version 700 or higher. If you do not know your password, ask your operations center for it.

Reading Password Messages

When you receive a password message from your operations center and display it on your screen, it looks similar to the example below.

```
RCV #39                    3/15/91 13:55 EST
  ENTER YOUR PASSWORD TO READ THE REST
  OF THIS MESSAGE [_______]
↓
```

The cursor (the " ■ " symbol on the screen) is already on the first space for the password. The dashes, bound by brackets, indicate the maximum number of characters that you can type in for your password. Type your password and press **Enter**.

As you type your password, asterisks (*) fill the spaces; the letters of your password do not appear on the screen. Even if your password is not as long as the spaces provided, asterisks fill all the spaces once you press **Enter.**

If you make a typing mistake and press **Enter**, the display unit beeps twice and the cursor returns to the first space in the password area. Re-type your password and press **Enter** again.

When you type your password correctly and press **Enter**, the text of the message is displayed on the screen.

A message may require more than one password. Type each password and press **Enter** as you encounter the place for the password. It will be apparent from the text of the message which password you need to enter at a given location.

If you want to re-read a password message at a later time and retrieve the message with the **READ PREV** or **READ NEXT** key, it is displayed exactly as when you first read it. You must type in the correct password each time you want to read the message.

E
Fixed Canned Message Fields

Introduction

In the discussion of canned message creation in Chapter 3, it was stated that you could type any character into a field. But if your MCT contains software version 700 or later, some of the canned messages in your system may contain "fixed" fields. These fields are preset to accept only certain typed input and, in some cases, *must* be filled in. If you type incorrect information, the system informs you of any mistake and tells you how to correct it. The system also informs you if you skip a mandatory field.

These fixed canned message fields make it much easier for you to ensure the accuracy of your messages. As you'll see, in some fields you don't even have to type any information at all; you just use the + and – keys to have the correct information inserted automatically.

Entering Data in Fixed Canned Message Fields

Fixed canned message fields are used for information whose format is standardized (e.g., time, days of the week, months of the year) but whose exact content may vary according to the message you need to send. Suppose, for example, that you need to send the canned message shown below and that its fields are fixed.

```
** SELECT CANNED MESSAGE (0-63): 17
** USE "+"/"-" TO VIEW CANNED MESSAGE.
  ETA:__:__
↓ DAY:___
```

The first field is for estimated time of arrival (ETA). If you mistakenly typed an alphabet character in the first space, the screen shown below might be displayed.

```
*     INCORRECT ENTRY FOR THIS FIELD     *
*----------------------------------------*
* HH:MM (24-HOUR TIME CLOCK)             *
* HH: HOUR (00-24)  MM: MINUTE (00-59)   *
```

This "help" screen is displayed for about five seconds to tell you that the ETA must be in the format of hour, colon (the ":" is already filled in for you) and minutes. It also tells you that this field expects time to be entered based on a 24-hour clock. The hour value must be between 00 and 24. The minute value must be between 00 and 59.

If the hour value that you enter in the ETA field is less than 10, you can enter the value in several ways. If, for example, the hour value you want to enter is "1" and the minute value is "23," you could enter the values in any of the following ways:

1. Type **1**, press the Space Bar on the keyboard, and then type **23**.

2. Type **1**, then **:**, and then **23**.

3. Type **01** and then **23**.

In the 3-space DAY field, you are expected to enter one of the standard 3-letter abbreviations for the days of the week (i.e., MON, THU).

If you type your entry incorrectly, the help screen shown below is displayed.

```
*     INCORRECT ENTRY FOR THIS FIELD     *
*----------------------------------------*
* DAY OF WEEK: (SUN..SAT)                *
* YOU MAY USE '+' OR '-' TO FIND IT.     *
```

The screen tells you that you must use one of the standard 3-letter abbreviations for the day of the week. You can use this as a guide to type your entry correctly. But for this field, the screen also tells you that you don't have to actually type in the information at all. Instead, you can press the + and - keys, and the abbreviations appear sequentially in the field. Stop pressing the key when the correct day is displayed, and press **Enter** to move to the next field.

Note

*To return quickly from a help screen to the canned message that you were working on, press **Del**. This causes the canned message to be re-displayed, with the cursor in the first space of the field that you had been entering.*

Mandatory Fields

Some fields are assigned by your operations center as mandatory; this means that the message cannot be sent unless you fill in the fields. A canned message may have several such fields. If the DAY field in the first "ETA" message shown in this appendix is mandatory and you try to send the message without filling in that field, the help screen shown below is displayed.

```
*      NEED TO COMPLETE THIS FIELD      *
*---------------------------------------*
* DAY OF WEEK: (SUN..SAT)               *
* YOU MAY USE '+' OR '-' TO FIND IT.    *
```

Type your entry correctly or use the + and - keys until you find the correct day. When the help screen is replaced by the screen display of the message, the cursor is located at the field that you need to fill in.

Hints for Filling in Fixed Canned Message Fields

Keep the following points in mind when filling in fixed canned message fields:

- When you reach a particular fixed field for which you want information, you can have the help screen for that field displayed immediately by pressing the ? key.
- To keep the help screen from disappearing, press the ? key. This causes the help screen to remain displayed an additional five seconds.
- The display unit beeps twice if you reach the end of a fixed field and try to type in more information.

Fixed Canned Message Field Types

The following table lists the possible fixed field types that the operations center may specify in a canned message. This information is provided for your reference only. For help in completing the canned message, press the ? key. The characters that may be input in the specified field are shown in parentheses. This information is also given in the help screens.

Field Type	Description
Free-Form	Accepts any alphabetic, numeric, or special character.
Alphabetic	Accepts only alphabetic characters (A-Z or blank).
Unsigned Integer	Accepts numbers (0-9), but you may not specify a positive or a negative sign.
Full-Width Integer	Accepts only numbers (0-9) without positive or negative signs. The entire field must be filled in.
Signed Integer	Accepts numbers with positive and negative signs (0-9,+,–).
Alphanumeric	Accepts a combination of alphabetic and numeric characters (A-Z, 0-9 or blank).
Real Numbers	Accepts numbers with decimal points and positive and negative signs (0-9, +, –, .). The decimal point is optional.
Monetary	Accepts dollar amounts. The dollar sign is inserted automatically as the first character; the last three characters are the decimal point and the cents digits (0-9).
Date (mm/dd/yy)	Accepts a date in the following month, day, and year format: mm:01-12; dd:01-31; yy:00-99.
Date (mm/dd)	Accepts a date in the following month and day format: mm:01-12; dd:01-31.
Time (12hr)	Accepts a time in the 12-hour cycle in the following format: MMA:AM; MMP:PM; HH:01-12; MM:00-59.
Time (24hr)	Accepts a time in the 24-hour cycle in the following format: HH:00-24; MM:00-59.
Phone #	Accepts phone # (0-9) without area code.

Field Type	Description
Phone # (Area Code)	Accepts the phone number; an area code is required (0-9).
Zip Code	Accepts a zip code (0-9).
Extended Zip Code	Accepts a zip code with a 4-digit extension (0-9).
Yes/No	Accepts only a "Y" or "N" response. The valid options may be selected using the + or – key (Y:YES, N:NO).
Weekdays	Accepts 3-letter abbreviations for the days of the week: "SUN," "MON," "TUE," "WED," "THU," "FRI," and "SAT." The valid options may be selected using the + or – key to scroll through the list.
Months	Accepts 3-letter abbreviations for the months of the year: "JAN," "FEB," "MAR," "APR," "MAY," "JUN," "JUL," "AUG," "SEP," "OCT," "NOV," and "DEC." The valid options may be selected using the + or – key to scroll through the list.
States	Accepts 2-letter abbreviations for state names. The valid options may be selected using the + or – key to scroll through the list.
Item List	Provides a list of items from which to choose.
Integer Range	Provides a range of integers from which to choose.
Social Security	Accepts a social security number (0-9).

Glossary

Associated Canned Message Number

When you press **REPLY** to create a message in reply to a received canned message with an Associated Canned Message Number, the canned message stored in the MCT corresponding to the Associated Canned Message Number is automatically displayed on the screen for you to fill in. Refer to the section *Replying to Received Messages* in Chapter 3 for more information on Associated Canned Message Numbers.

Canned Message

A message made up of pre-written text and fields that are filled in. Canned messages (also sometimes called "macro" messages) correspond to filling out a form.

Cursor

The "■" symbol on your screen that indicates where you are in the message.

Display Unit

The part of the MCT that contains the keyboard and screen. See Chapter 1 for an overview of the display unit.

Fields

The separate items in canned messages that you must fill in before sending the message. The number of blanks in the field indicates the number of characters that you can type in the field.

Forward Message

A message sent from the operations center to a locomotive crew. This is the same as a receive message (see below).

Free-Form Message

A message made up of text that is freely typed. Free-form messages are similar to typing on a blank piece of paper.

Message Header

The first line displayed when a stored message is viewed. The message header shows different information about the message, including the message type (SND for sent messages, RCV for received messages), the message number, and the date and time the message was stored.

MCT

Mobile Communications Terminal. This is all the equipment installed on a locomotive to support the OmniTRACS system. It consists of the outdoor unit (antenna), the communications unit (the black box), and the display unit (keyboard and screen).

Receive Message

A message sent from the operations center to the locomotive crew. This is the same as a forward message (see above).

Reply Message

A message sent by the locomotive crew to the operations center in reply to a specific message sent by the operations center.

Return Message

A message sent from the locomotive crew to the operations center. This is the same as a send message.

Send Message

A message sent from the locomotive crew to the operations center. This is the same as a return message.

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September 17th, 1998

Charles Fisher
27805 Naranjo
Mission Viejo, CA 90017

Dear Mr. Fisher:

With regard to your interest in OmniTRACS railroad applications I am pleased to inform you we have enjoyed good success in this area. Railroad companies too have come to recognize the value of OmniTRACS in meeting their logistics and communications requirements. In the United States there are OmniTRACS units on AMTRAK passenger trains as well a pilot with Southern Pacific Railways. AMTRAK (America's Passenger Railroad Company) uses the OmniTRACS system to communicate with its fleet in the western United States operating on railroad tracks own by others. AMTRAK also uses the system to notify destination stations of sleeper berth changes/availability, and to maintain adequate supplies in café cars. In Brazil there are over 800 OmniTRACS units employed by railroad cargo companies Ferrovia Atlantico Sul (Atlantic South Railroad), and Ferrovia Centro Atlantico (Atlantic Central Railroad) for the following:

1. "Licenciamento"- The authorization of one train to move from one station to the next. This is required because all tracks are "single tracks". In order to avoid collisions one train needs to wait in the station while another approaches, then passes in the same station. Then, the waiting train can move forward. OmniTRACS Macro messages are used for this purpose.

2. Maintenance- Maintenance crews use a portable version of the MCT to communicate while out in the field (where there are no other communications). The MCT is actually mounted on a portable container that can be moved from car to car as needed.

3. General Purpose- There is a small number of units on different types of vehicles serving the railroad company and stand alone systems at train stations where there is no other means of communications.

Furthermore, through a few conversations with some QUALCOMM employees who worked on AMTRAK account, I am able to gather the following information for you.

- Satellite Communications For AMTRAK Long Distance Trains
- A system diagram of OmniTRACS application for trains
- OMNITRACS Outdoor Unit Mount Installation Guide
- OmniTRACS Locomotive Crew User Manual

Please let me know if you have further questions regarding OmniTRACS' applications on trains.

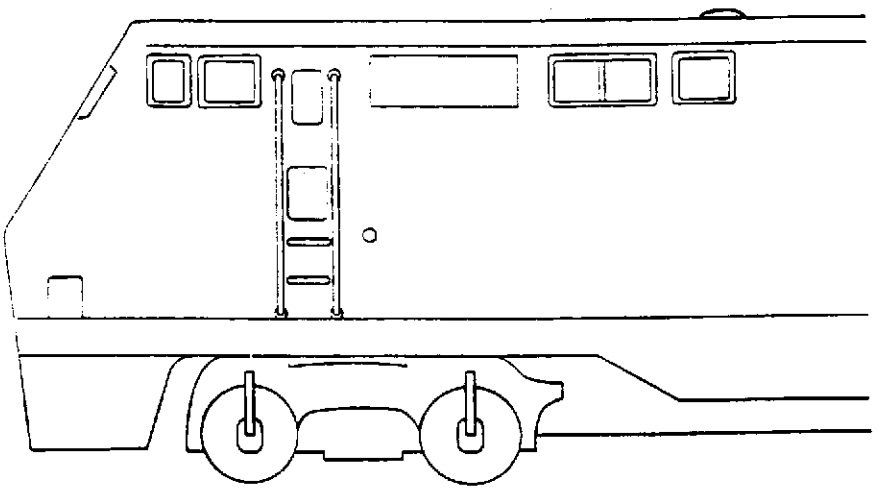
Thank you very much.

Sincerely,

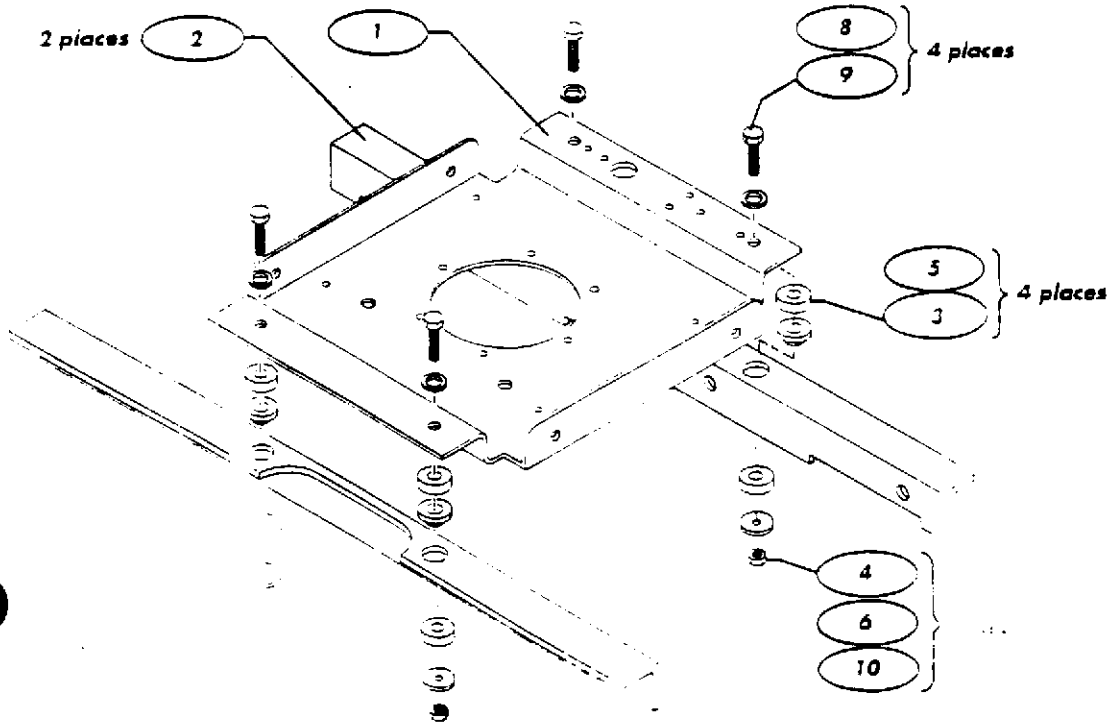
Dandan Pan
Program Manager
OmniTRACS International

AMA-501

Designed for AMTRAK P-40 GE (Genesis)



Side View



Omni

Introduction

This document provides the guidelines and an installation procedure to follow when you install the AMA-501 Outdoor Unit mount (P/N 0-30100-1) on the AMTRAK P-40 GE (Gensis) locomotive. An assembly drawing of the AMA-501 and an accompanying parts list are provided in these instructions.

Installation Guidelines

1. Unpack the mount hardware and verify that all the parts listed on the parts list included in this document are present. If a part is missing, call the Customer Service Hotline.

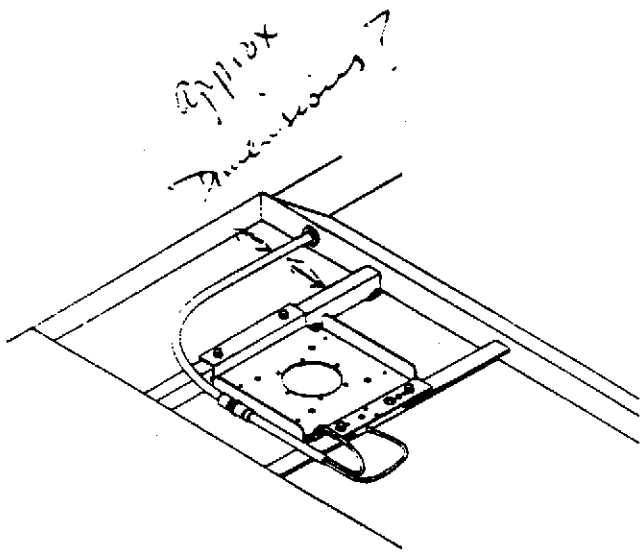
2. Because of FRA clearance issues, be sure the assembled antenna and mount do not excede the height of the airhorns.

   If the AMA-501 is used on a different locomotive than the GE P40, be aware of any height restrictions that may impact route useage.

3. Install the mount so that the Outdoor Unit is level. This ensures the best possible overall performance.

4. The AMA-501 mount has a built in jig feature that does two functions. One, it pre-aligns the angle brackets for proper spacing for final assembly. When configured in the jig configuration, the welder only needs to place the mount and weld. This automatically ensures that the angle brackets will be properly spaced. Two, it allows the angle brackets to be welded without risk of heat damage to the rubber vibration isolators.

Installation Procedure



The following steps apply to the AMA-501 installation. Perform these steps in the order listed below. Installation of the AMA-501 is divided into the following groups:

1. Identify Mounting Location (Horn Pan - Recessed Area)
2. Use the Rail Spacing Jig Method to Connect ODU Bracket
3. Weld Assembled Mount to Roof
4. Remove the ODU Bracket and Attach ODU
5. Attach ODU and ODU Bracket to Angle Brackets

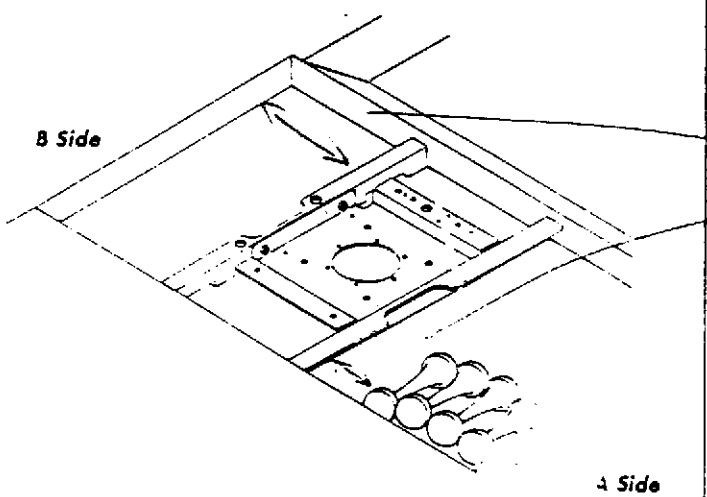
Help

For help during installation, call the OmniTRACS Customer Service Hotline for assistance. The toll-free telephone number is (800) 541-7490, and the Hotline is staffed 24 hours a day, 7 days a week (including holidays).

Note

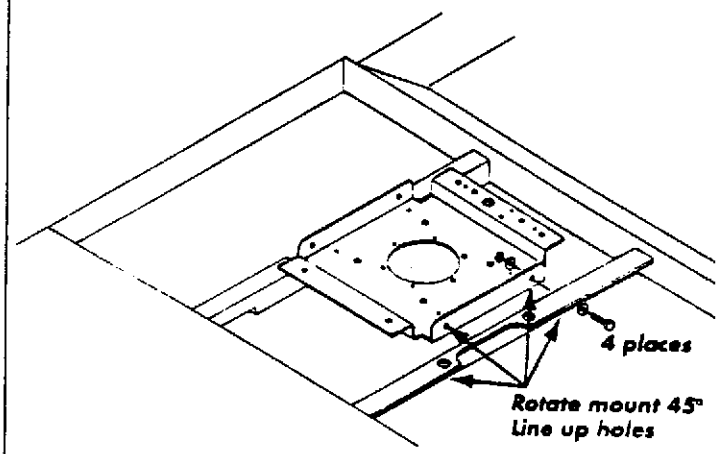
Before installing the AMA-501, be sure to review the Installation Guidelines provided on page 2.

Step 1. Identify Mounting Location (Horn Pan - Recessed Area)



1. The AMA-501 should be mounted on the roof of the locomotive, in the "recessed" area, next to the horns. on the B side of the locomotive.

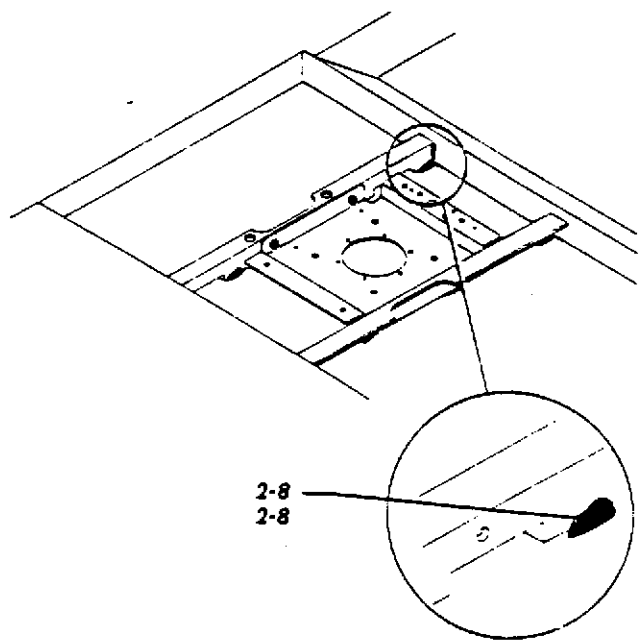
Step 2. Use the Rail Spacing Jig Method to Connect the ODU Bracket



1. Connect the ODU Bracket (item 1 from the parts list) to the Angle Brackets (item 2) using the 3/8" bolts, washers, and nuts.
2. Make sure the ODU Bracket is sitting flush against the sides of the Angle Brackets and not on top (see picture).

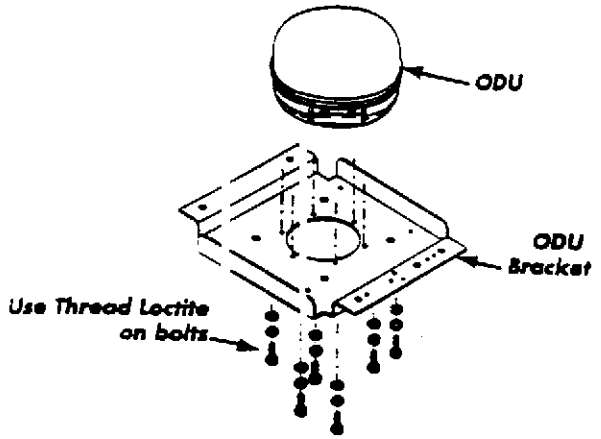
Note:
The Rail Spacing Jig Method pre-aligns the angle brackets for proper spacing and prevents heat damage to the rubber vibration isolators.

Step 3. Weld Assembled Mount to Roof



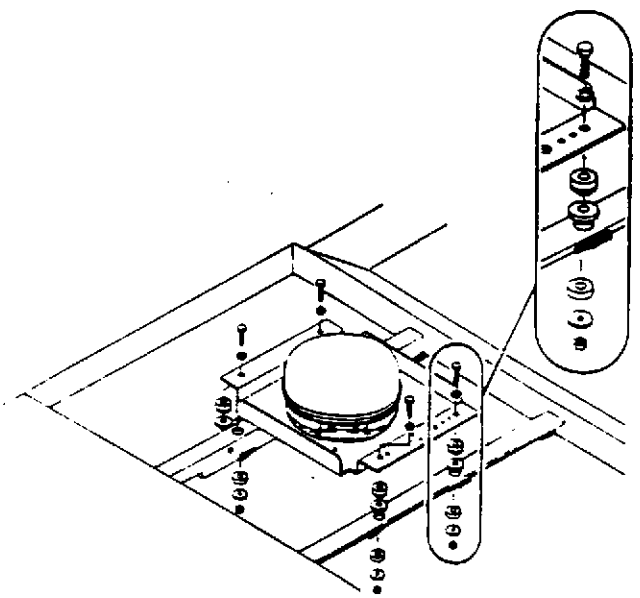
1. Place the asembled mount on the roof.
2. Ensure the mount is level and secure.
3. Weld both Angle Brackets to the roof.

Step 4. Remove the ODU Bracket and Attach ODU



1. Remove the ODU Bracket from the Angle Brackets.
2. Attach the ODU to the ODU Bracket using the hardware provided.
3. Use Thread Loctite on the bolts.

Step 5. Attach ODU and ODU Bracket to Angle Brackets



1. Attach the ODU and ODU Bracket to the Angle Brackets.
2. Ensure that you place the Isolation Vibration Mount hardware between the ODU Bracket and the Angle Brackets.

Note:
For a detail listing of all parts, see the first page of this document.

Item No.	Part No. (MCN)	Qty.	Item	Size	PL Ref
1	50-30002-1	1	Train ODU Bracket		4
2	50-30101-1	2	Angle Bracket		6
3	50-2832-1	4	Isolator Mount Shoulder Washer		14
4	50-2777-1	4	Isolation Mount		15
5	50-2777-2	4	Isolation Mount		16
6	50-2851-1	4	Vibration Mount Washer		17
7	556-02218-0000	Alt	Head Washer	1.25X.40X.125	17a
8	552-02069-2250	5	Hex Head Bolt	3/8-16UNC	19
9	556-01879-0375	4	Flat Washer	.375 (.875X.375X.083)	21
10	554-02072-0375	4	Nylon Lock Nut	3/8-16UNC	23
11	552-02069-1000	5	Hex Head Bolt	3/8-16UNC-2AX1.00	16
12	556-02074-0375	5	Flat Washer	3/8 (1 X 7/16 X 5)	25
13	554-01172-0375	5	Mach Plain Hex Cres Nut	.375-16UNC-2B	28
14	552-01171-1000	5	Mach Pan Head Cres Screw	10-32X1.00	31
15	554-02072-1032	5	Nylon Lock Nut	10-32 Reg Hex	34
16	556-01879-0250	5	Flat Cres Washer	.250 (.562X.250X.065)	40
17	755-01778-0002	1	Thread Loctite		43

Note: Items 3 through 10 are contained in isolation hardware kit 65-6686-1.
Items 11 through 17 are contained in antenna mounting kit 65-2910-501.
Items 11 through 13 are used only when welding mount to train.
Items 14 through 16 are used to mount the fax modem (not inlcuded in this kit) to mount.
Each hardware item includes spare parts.

QUALCOMM Incorporated, 6455 Lusk Boulevard, San Diego, CA 92121-2779

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Attachment I

IEEE Communications Magazine, IMT-2000 Article

The Cellular Phone Industry in Malaysia: Toward IMT-2000

Tharek A. Rahman, Universiti Teknologi Malaysia

Hamzah Burok, Ministry of Energy, Telecommunications, and Post

Tan Kim Geok, Universiti Teknologi Malaysia

ABSTRACT Explosive growth of the cellular phone industry in Malaysia has been witnessed over the past decade. Eight nationwide cellular phone operators with different technology bases exist in a single market. This article intends to provide an overview of the telecommunications industry, especially the cellular phone sector, and also the activities on IMT-2000 in Malaysia.

At present most available cellular systems, such as NMT, AMPS/DAMPS, TACS, GSM900, and GSM1800, have been used in Malaysia since the introduction of the first cellular system in the mid-1980s. These systems are designed to different and incompatible standards, making interworking difficult and leading to unnecessary cost. The emergence of the concept of International Mobile Telecommunications in the year 2000 (IMT-2000) is likely to be the alternative to resolve this problem. IMT-2000 activities in Malaysia were started in 1996. The initial objective was to increase awareness and understanding of the concept of IMT-2000 within the local telecommunications industry. Due to the strong support and active participation of local industry, efforts have been taken to conduct research and study on technologies related to IMT-2000 such as a wideband code-division multiple access (W-CDMA) field trial.

The Status of the Fixed Network

The telecommunications industry in Malaysia has grown steadily since the past decade. At present, it is probably one of the most active markets in the region of Southeast Asia. The fixed telephone penetration rate in Malaysia increased rapidly, as shown in Fig. 1. In 1997 there were about 4,236,347 residential and business subscribers in a country with a population of about 21 million. This makes the overall penetration rate about 20 telephone lines per 100 people [1, 2]. The PSTN infrastructure with a capacity of 7,306,000 access lines is offering various types of services such as voice, data leased circuits, message and text services (e.g., telegram, facsimile, etc.), Internet, and so on.

The Status of the Cellular Network

The success of fixed network does not mean the local telecommunications industry has reached its limit. The cellular networks introduced in the early '80s are experiencing explosive growth, as shown in Fig. 2. By the year 2000 the cellular penetration rate is expected to reach about 17/100 inhabitants according to the ITU database source.

The cellular market in Malaysia is shared by seven cellular operators providing eight different cellular services nationwide: the leading operator Celcom providing ART900 and Celcom GSM services based on TACS and GSM900 systems; Mobikom offering Mobifon800 services using AMPS technology; Telekom Malaysia's ATUR450, based on NMT technology; Maxis Mobile services offered by Binariang, based on GSM900; and three other cellular operators operating GSM1800 systems — ADAM from Sapura Digital, DiGi1800 from Muatiara, and TMTouch from TMcellular. Figure 3 compares the number of subscribers to each cellular service provider at the end of 1996 and 1997, while Fig. 4 indicates the market share of each cellular system at the end of 1997. The allocated frequency bands for cellular services are shown in Table 1.

Out of these eight cellular service providers only ATUR450 and ART900 have achieved nationwide coverage of at least 80 percent. The others only have nationwide coverage less than 60 percent, especially GSM1800 service providers with only 25 percent on-street coverage. Figure 5 indicates the number of radio base stations (RBSs) already installed by each service provider at the end of 1997. More RBSs are expected to be installed in the near future in order to meet the minimum quality standards.

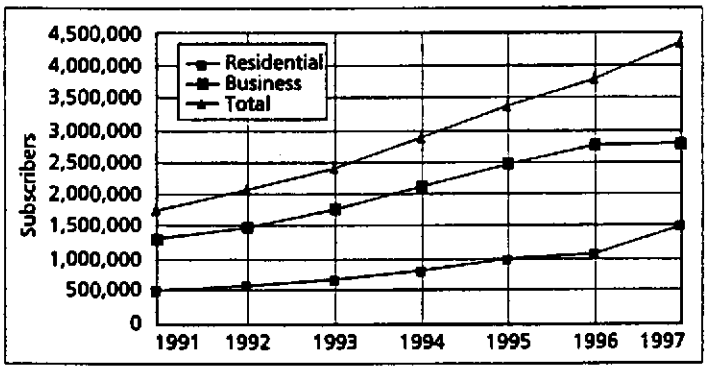


Figure 1. *Fixed telephone subscribers in Malaysia.*

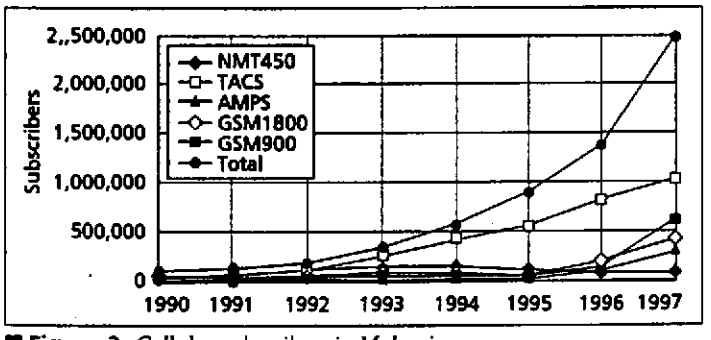
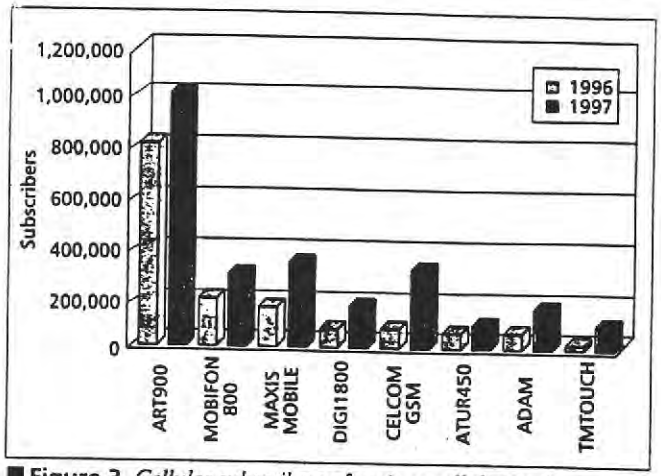


Figure 2. *Cellular subscribers in Malaysia.*

0163-6804/98/$10.00 © 1998 IEEE



■ **Figure 3.** *Cellular subscribers of various cellular service providers in 1996 and 1997.*

Systems	Frequency Bands (MHz)	Bandwidth (MHz)
NMT450	452–456.5/462–466.5	4.5
AMPS	824–835/869–880	11
TACS	888–900/933–945	12
GSM900	900–915/945–960	15
GSM1800	1710–1785/1805–1880	75

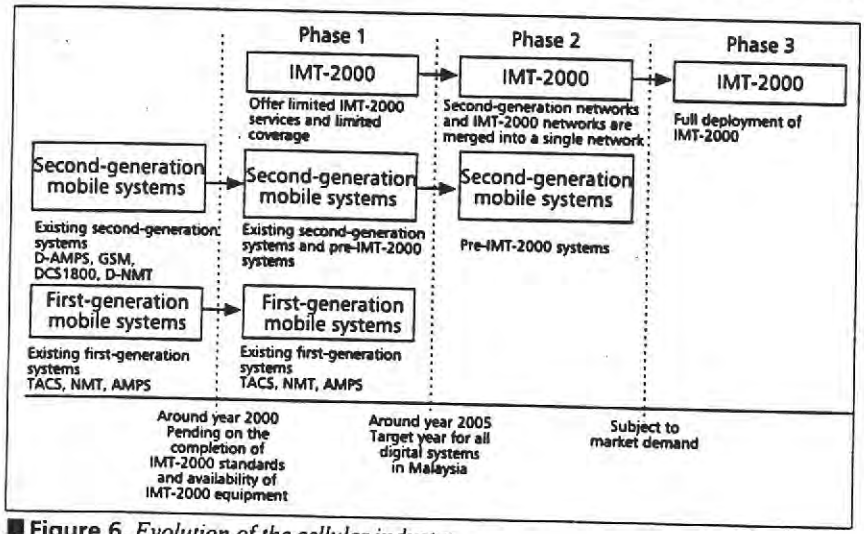
■ **Table 1.** *Frequency bands allocated.*

IMT-2000

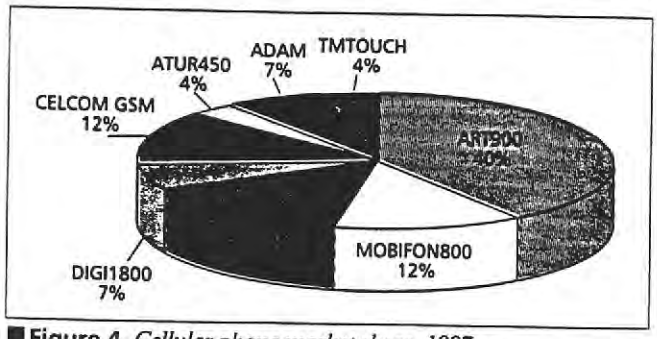
At present most available systems being used in Malaysia have been mainly designed and installed by the large manufacturing organizations from Europe, the United States, and Japan. The systems' incompatibility together with pressure from market for more frequency bands and advanced services lead to the wish for a single standard capable of offering a wide range of services in different operating environments. The preferable future mobile system must be able to provide highly effective, economic, and advanced telecommunications services to anyone, at any time, anywhere, and in any form. The emergence of IMT-2000 is considered the ultimate solution to ease the present cellular market scenario in Malaysia.

The special needs of developing countries have been described by the International Telecommunication Union–Radiocommunication Standardization Sector (ITU-R) in Recommendation M.819-1 [3]. This Recommendation states that IMT-2000 should provide, in both urban and rural areas, economical services of high quality and integrity comparable to the fixed network. The systems must be capable of serving a wide range of user densities and coverage areas as well as remote regions.

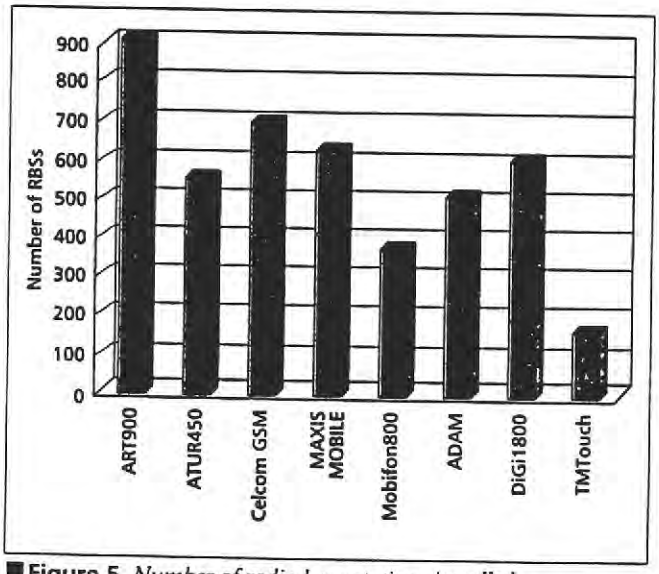
IMT-2000 also should be able to provide a fixed wireless access (FWA) application. This is important because it is a potentially large application in the developing countries. FWA can be economically implemented within a relatively short period to provide telecommunication services to under-served areas, especially rural and newly developed areas. Therefore, developing countries will largely rely on FWA to extend their telecommunications services nationwide.



■ **Figure 6.** *Evolution of the cellular industry.*



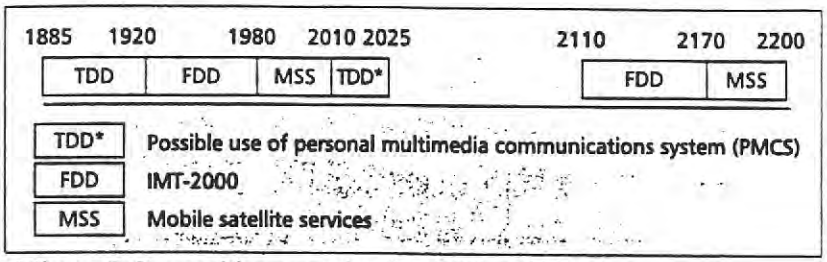
■ **Figure 4.** *Cellular phone market share, 1997.*



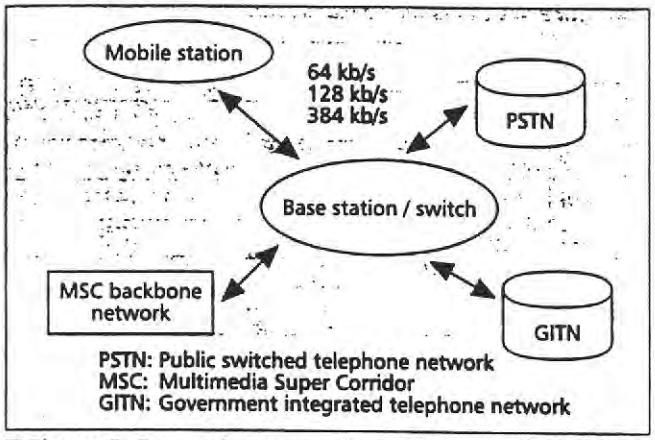
■ **Figure 5.** *Number of radio base stations installed.*

Evolution Toward IMT-2000

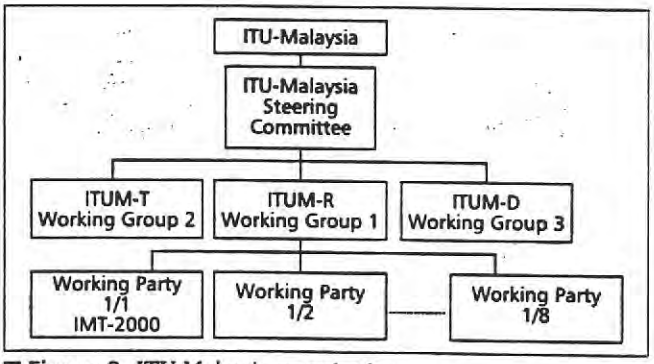
Studies on the feasibility of introducing IMT-2000 in Malaysia are currently being conducted, especially the aspect of migration and evolution from the existing cellular systems: the interworking scenario between IMT-2000 and existing systems, service portability across multiple net-



■ **Figure 7.** *Proposed frequency planning of IMT-2000 band.*



■ **Figure 8.** *Proposed system configuration for the W-CDMA field trial.*



■ **Figure 9.** *ITU Malaysia organization.*

works, and the application of FWA. The introduction of IMT-2000 in Malaysia will be between 2000 and 2005, depending on factors such as the IMT-2000 standardization progress, availability of equipment, and market considerations.

Factors such as existing infrastructure, technological, and regulatory development have been given special attention in considering evolution toward IMT-2000. The phased evolution approach has been recognized as the most cost-effective way of introducing IMT-2000 due to the minimum initial cost and possible reuse of existing infrastructure. Figure 6 shows the possible evolution path of the local cellular industry. Meanwhile, the regulator has taken the initiative to make the frequency band available for IMT-2000. Figure 7 shows the frequency planning of IMT-2000 band.

W-CDMA Field Trial

A W-CDMA field trial will be conducted by a local operator with the support of NTT DoCoMo by the end of 1998. The W-CDMA test system will operate at 2 GHz IMT-2000 band, and 5 MHz each for up- and downlinks at 1920–1940 and 2110–2130 MHz based on DS-CDMA/frequency-division duplex (FDD) radio access technology. One proposed site is the Multimedia Super Corridor (MSC). The proposed system configuration is shown in Fig. 8.

Organization of ITU Malaysia

Working Party 1/1 (WP 1/1) was established in January 1996 under ITU-Malaysia. The organization of ITU-Malaysia is shown in Fig. 9. WP 1/1 is playing an important role in promoting IMT-2000 in Malaysia. The primary objectives in this work are [4]:

- To accelerate IMT-2000 studies from both the technical and regulatory aspects
- To explore international standardization in ASEAN and the Asian region with the aim of providing cost-effective and flexible access to mobile communications
- To establish a firm base of expertise for the manufacture and introduction of future mobile communications systems
- To cooperate with standardization bodies in other countries

WP 1/1 consists of a chair, vice chair, and members from the telecommunications industry, network operators, and government agencies. In general, WP 1/1 has responsibility for [5]:

- Formulating policy and strategy
- Approving an action plan
- Evaluating the progress of the project
- Making recommendations for national and international standardization

Conclusions

Despite the current economic turmoil in the Asian region and strong competition within the local cellular phone industry, there is still room for growth in the future, especially in wireless multimedia services stimulated by the Multimedia Super Corridor project. On the other hand, steps have been taken in order to prolong the IMT-2000 activities in Malaysia through proper planning which is important since Malaysia has registered with ITU-R as an IMT-2000 radio transmission technologies evaluation center.

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[1] Telecommun. Dept.,. Malaysia, "Statistics Telecommunications Industry Malaysia 1996," 1997.
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[5] F. C. Nantha, "Beefing Up Cellular Phone Services," *New Strait Times*, 1998, p. 15.
[3] ITU-R Rec. M.819-1, "Future Public Land Mobile Telecommunication Systems (FPLMTS) for Developing Countries, 1994.
[4] ITU-Malaysia, WP 1/1, "Concept Paper: FPLMTS Studies in Malaysia," Project Mgmt. Team, WP1-1(96)/AD/1, 1996.

Biographies

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Attachment J
Trains Magazine Article on Hydra-Switch

Hydra-switch

By W. Hugh Moomaw
Photos by the author

Solar panels rise above Hydra-Switch model 3000 equipment boxes in NPB's Berkley Yard.

One gray day in late November 1996, conductor Ray Stafford and engineer Norman B. Myers III of the Norfolk & Portsmouth Belt Line Railroad (NPB) brought into Berkley Yard a train of 24 hi-cube boxcars. Norfolk Southern, NPB's majority owner, handled the cars from Detroit. The Belt Line's job was to block and spot them at the precisely designated places and times among the 132 locations in Ford's truck assembly plant in Norfolk, Va.

The train stopped at the first switch of the 20-track yard. Stafford was the ground crew. He dismounted but did not touch a single switch lever. Instead, he took a few steps to one of three control panels strategically located by the two parallel leads. He pushed three buttons, which actuated as many switches, setting up the desired path for his train. The 24 x 36-inch panels contain a track plan of the leads, and have two control buttons for each of the 15 third-generation Hydra-Switches, model 3000, and their red and green lights.

NPB had just completed this installation, which replaced 12 second-generation units. Hydra-Switch manufacturer Mike Wyatt, president of Railway Technology, Inc., Paducah, Ky., says NPB's integration of this technology into a complete system for flat switching work using the remote-control feature of this self-contained switchstand is "the first in the country."

This dramatic advance in switch technology offers immense advantages. Apart from the relatively few centrally controlled hump yards, switching is generally performed on level track with hand-operated switches. Traditional switch technology, little changed for a century, requires trainmen to dismount, walk to the switch, align it by lifting the solid, 40-pound switch lever, and then return to the train. In fact, an Association of American Railroads study shows that to overcome friction within the switch mechanism, crews actually handle 67 pounds per throw. The Hydra-Switch eliminates this muscle work.

"The job of aligning switches will never be the same."

It is also safer. From 1984 to 1987, 39 percent of all NPB trainmen's injuries were caused by dismounting from the train, throwing the switch, and remounting. There have been no such injuries in the Hydra-Switch era.

Also, second- and third-generation Hydra-Switches have reduced derailments in Berkley to zero, from an annual average of six, by delivering 2000 pounds of pressure to keep the switch rail tightly pushed against the stock rail. (The first generation only locked the switch.) Also, the Hydra-Switch, unlike the traditional switchstand, possesses the big advantage of not derailing cars inadvertently "run-through"; it automatically "flops over" with no damage to itself or the rolling stock.

It is very cost-effective. Major savings accrue from the remote-control capability of the third generation. NPB President and General Manager Dennis A. Walker declares "the job of aligning switches will never be the same."

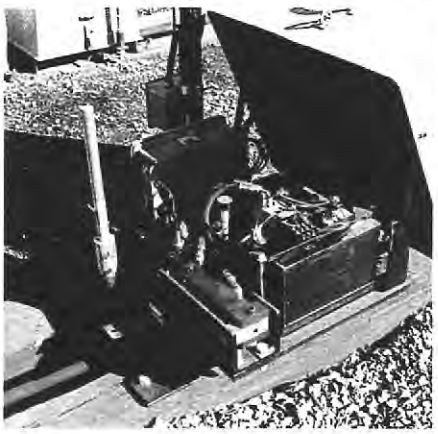
Following NPB's agreement with the United Transportation Union for conductor-only crews, Walker perceived some form of automatic switch was needed to make the job safer, quicker, and less physically taxing. NPB is a Class 3 switching and terminal road, whose employees are paid on Class 1 rates. Walker understandably sought a "poor boy's option." CSX is the minority owner of the Belt Line, and invited Walker to Jacksonville, Fla., to see some first-generation Hydra-Switches.

The Hydra-Switch concept belongs to former CSX Chief Engineer Jerry Epting, who retired in May 1996 after 43 years' service. He had been thinking for some time of an improved switchstand to reduce both back injuries and

derailments, often caused by switches being out of adjustment. He wanted greater productivity without using "man-made power." This meant hydraulic power which the trains themselves could generate. He brought in Wyatt, who had been manufacturing hydraulic and other railroad equipment for years.

Actually, Wyatt had already looked at solar power, but that technology was not then sufficiently advanced. He comprehended that wheel treads, depressing the plunger of a rail-mounted hydraulic pump, could provide energy to be stored in a reservoir for release on demand to align the switch. CSX installed the first Hydra-Switch in Nashville, Tenn., in November 1993. The Belt Line installed the eighth in July 1994.

The first generation didn't last long.



From left: Interior of a model 3000 unit; conductor Stafford at the Berkley Yard panel; a worker applies lubricant to a model 2000.

Epting recalls that railroaders were not educated about it, and neglected to recharge it, so the reservoir became exhausted. The second-generation mechanism was enlarged and improved. In December 1994, the Belt Line ordered 12 to test in Berkley. CSX and Burlington Northern ordered 130 and 300, respectively, of the first two generations.

But the hydraulic mechanism required high maintenance. The main difficulty lay in the high temperatures and pressures that built up in the many feet of tubing between plunger and switchstand on hot summer days. And crews still had to dismount from the train and walk to the switch. Major savings could accrue only from remote control, developed in the third generation.

For this, Epting and Wyatt produced a significantly different design. Epting had been involved with radio to control the unloading of ballast hopper cars. This led him to the idea of remote radio control with power derived from solar cells. Wyatt contributed to the concept and produced the hardware.

The resulting third-generation Hydra-Switch, model 3000, features a new, airplane-type hydraulic system. Electrical power (12-volt D.C.) is generated by a solar panel, placed on a pole at each switch. Solar power charges a battery, with 90 amp-hour capacity, which can power 800-900 throws per charge. The self-contained switch mechanism—30 inches long, 24 wide, by 19 high—develops 6000 lbs. to move the switch rail, and 2000 lbs. for holding and locking.

Remote control is exercised either through two push buttons per switch on a local panel through a low-voltage wire as in Berkley, or from a central control panel, or by radio signal. Two buttons are also placed at the switch for local operation. In NPB's application of Hydra-Switches, Walker involved his trainmen from the outset discussing it with the local UTU. The men helped select the first site—the switch which they liked least to throw, at one of the busiest locations. They provided feedback and kept records of lifting not performed. In its first year, the first-generation switch saved the lifting of about 1 million pounds. Walker suggested modifications to Wyatt based on the men's reports and his own engineering training.

The Belt Line installed the first third-generation Hydra-Switch in January 1996. Located at Huntsman Chemical, in Chesapeake City, Va., the switch is thrown up to 50 times daily. During a severe winter with fewer sunny days than normal, the switch performed flawlessly—until April. Shipped back to Paducah for repairs, it was test-operated 100,000 times before reinstallation. Its success led Walker to automate both Berkley leads at the office end.

NPB Facilities Manager Leon Rodgers calls them a "tremendous breakthrough, taking only about an hour each to install. They're effortless in operation." Trainmen, he reported, are very pleased: "They can stand in one spot and throw all 15 switches." Furthermore, involving the men led to their "buying into" this new technology with resulting pride of ownership and of use: "We're pioneers!"

In December 1997, NPB placed in-service four Hydra-Switches with radio remote control to automate operations at the Ford assembly plant. The road has thus entered the next era of wireless communication using Motorola handset radios with Dial Tone Frequency Modulation Pads to activate switches. The conductor can operate a switch with his radio at the location most convenient. The system confirms that the switch points are married to the stock rail and transmits this information.

As for other roads, the BNSF is installing 120 Hydra-Switches, model 3000, in its large Argentine Yard in Kansas City. The road ran a test on the 3000 in its West Yard; a crossover was thrown up to 90 times a day with no problems. CSX has installed its second-generation switches in several locations.

The model 3000 Hydra-Switch is probably the most promising advance in 20th-century switchstand technology. Labor costs are minimized for flat-switching operations, even as throughput is increased. Crews and equipment need now be placed in a yard only when and where needed, a major economy. Operations are safer through reductions in crews' lifting, riding equipment, walking, as well as derailments. NPB President Walker probably speaks for railroaders everywhere when he says, "We will never miss the old way. The technology of tomorrow is here today." 1

W. HUGH MOOMAW is a retired historian who lives in Virginia Beach, Va. His book, "Hampton Roads Connector: The N&P Belt Line," will be published shortly. This is his first TRAINS byline.

Attachment K

Copy of Ad For Hydra-Switch

INTRODUCING THE WORLD'S FIRST STAND-ALONE SOLAR-POWERED CHIROPRACTOR

SAVE MILLIONS OF DOLLARS ANNUALLY WITH THE NEW HYDRA-SWITCH 3000 SOLAR-POWERED SWITCH STAND–DESIGNED AND MANUFACTURED BY RAILWAY TECHNOLOGY INC.– AVAILABLE ONLY THROUGH L. B. FOSTER COMPANY

It's a hard fact. Rail and industrial companies worldwide spend millions of dollars annually in personal injury claims for switch stand-related back injuries. Now you can dramatically reduce those costs with a simple push of a button.

The Hydra-Switch 3000, designed and manufactured by Railway Technology Inc., is a stand-alone solar-powered automatic switch stand designed to meet your specific operational requirements. The unit can be operated manually by radio control, from a central control panel or from remote button locations. Not only does the unit dramatically reduce the cost of personal injury claims due to manually operated switch stand-related back injuries, it provides exceptional ease of operation, increases productivity and reduces manpower requirements.

The Hydra-Switch 3000 features:

- Self-contained power source–no outside power required.
- Switch points automatically "flop over" during a run-through, with no damage to the switch stand.
- Self-adjusting throw length. Eliminates derailments caused by out-of-adjustment switches.
- Easy installation–little or no maintenance.
- Point held to stock rail with 2,000 lb. of force.
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November 23, 1999

Encik Abdul Radzak b. Abd. Malek
General Manager (Freight)
KTM Berhad
Jalan Sultan Hishamuddin
50621 Kuala Lumpur
Malaysia

Subject: **Transmittal of Milestone #4 Remaining Deliverables**
Signaling & Communications Task – Deliverable #2 and Radio Propagation Study
Intermodal Task - Interim Report #3
KTMB Railway Modernization Project

Dear Sir:

Attached please find three copies of the subject deliverables for KTM's review. The designated KTM responsible person for the Signaling and Communications Task is Mr. Lee Heng Cheong, and for the Intermodal Task, yourself. I would greatly appreciate it if you could forward the two submittals entitled "Phase II Signaling & Communications Improvement Study" and "Radio Coverage Simulation for KTMB Malaysia" to Mr. Lee for his review. The Radio Coverage Study was part of the scope for the initial task, but we had difficulty in arranging with Motorola to provide the simulation, so we are submitting their report with this submittal. The other deliverable that is included in this Milestone, the Concept Design Report for the Depot Task – was transmitted to you in April 1999 for Mike Shaman's review.

These three deliverables for Tasks 1,2 and 3 comprise Milestone 4 under the contract, and are associated with Invoice #5 under the Contract Payment Schedule. Our Invoice #5 is attached to this letter. As with previous invoices, if these deliverables are acceptable to KTM, please approve the invoice and forward it to USTDA for processing and payment at your earliest convenience.

The remaining submittal under our contract's scope of work is a final report that covers all three of the study tasks. We intend to complete that report in the next month and submit it to you, along with the final invoice.

Very truly yours,

John H. Bergerson
Project Manager and Senior Vice President
Attachments

cc: Mike Uremovich, Ron Rypinski

KTMB RAILWAY
MODERNIZATION PROJECT

Signal, Communications, and Dispatch Project

Phase II
Signaling and Communications Improvement Study

October 1999

ICF Kaiser Engineers, Inc. 2101 Webster Street, Suite 1000 Oakland, California 94612

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E - Adtranz Balise

F - Railway Technology

KTMB Railway
Modernization Project

PHASE 2

Signaling and Communication
Improvement Study

1.0 Introduction

The following submittal is the second portion of a modernization study conducted for the KTMB Railway of Malaysia and sponsored by the U.S. Trade and Development Agency.

Through the use of the first portion of the study (submitted, November 1998) and previous work such as the Definitional Mission (March 1998) this report provides a comparative review of various solutions the KTMB could decide to implement to modernize railway operation and increase revenue.

The report's recommendations outline the prioritized capitalization improvements first for the implementation of system-wide train to wayside communication, and second, the upgrade of the railroad's signaling capability to various levels (CTC, balise, remote switch) as a function of traffic density.

2.0 Scope of Study

The Signal, Communications and Dispatch Project

The goal of the work to be performed in the Signal, Communications, and Dispatch Project are to:

Identify and quantify the productivity improvements that can be achieved for KTMB through improvements in signaling, communications and dispatch; identify the costs and benefits involved in using improvements in signaling and communications to expand KTMB capacity, especially in the most heavily utilized sections of the railway such as the segment between Rawang and IPOH; and determine the cost of taking the necessary first step in using improvements in signaling and communications to expand KTMB capacity. That first step is the creation of a backbone for a KTMB communications network by linking the railroad to the fiber-optic network installed along the entire KTMB right-of-way; and to quantify, for each segment of the railroad, (1) the minimum cost for installing signal and communications systems to facilitate remote control of train operations and (2) the expected reduction in operating expenses that will occur.

3.0 Previous Work

This Phase 2 report has used information provided in the following references to benchmark some of the data contained in the cost analysis found later in the submittal.

3.1 Definitional Mission

A report was submitted to the U.S. Trade and Development Agency dated March 1998. This report is a definitional mission for KTM Berhad railway modernization project. The study outlined an approach in three areas to improve the Malaysian Railway operation and revenue. One area was the signalling, communication and dispatch, which recommended a phased study to further detail the modernization program.

3.2 Radio Communication Improvement Proposal

A proposal for radio communication upgrade was submitted by Motorola in August 1998 to provide a system-wide train to wayside voice and (optional) data radio link to a centralized dispatching facility.

4.0 Phase 1. Data Collection & Assembly

4.1 Field Site Survey & Inventory of Existing S & C Systems

The Phase I work involved a comprehensive inventory and site survey of KTMB's existing signal and communication systems generally in accordance with the following:

4.1.1 Signal System Line Segments & Inventory

Padang Besar to IPOH
IPOH to Rawang
Seremban to Gemas
Gemas to Johor Bahru
Tumpat to Gemas

This signal inventory did not show, in detail, the double-track CTC portion of KTMB between Rawang and Seremban.

Schematic Signal Layout Drawings were developed and prepared to include track and signal schematic layout drawings showing the existing track and signal operating system layouts, by stations, for each of the single line KTMB segments listed above.

These drawings were prepared on AutoCAD system and submitted in the Phase 1 report.

4.1.2 Communication System Inventory

A comprehensive description, including schematic line diagrams, as necessary, of the existing KTMB-owned communication facilities was prepared. These documents included radio, fiber-optic cable, telephone dispatcher circuits, pole lines, voice and or data truck circuits wholly owned and maintained by KTMB.

Also developed was a listing, along with schematic drawings of all railroad long-haul circuits currently leased by KTMB. Such circuits included, but are not limited to, ticket and reservation system, advance consists, voice trunk lines, data truck lines, etc.

4.1.3 Propagation Tests

A Propagation test was commissioned to include site coverage and equipment recommendation. The results of this study have been documented and have been submitted to KTMB in Nov. 1999.

4.2 Output - Preliminary Recommendations

At the conclusion of Phase I, the data was assembled in an S&C inventory data and drawings report. This report included descriptions of the existing systems studied, together with preliminary recommendations as to which of the promising system upgrades should be studied.

5.0 Phase 2. Feasibility Analysis/Evaluation

Upon KTMB's approval of the Phase I Interim Report, and the recommendations of subsystems to be studied, the Phase 2 Study was performed.

5.1 S & C Study Criteria

In preparing the Phase 2 S&C Feasibility Study, the study criteria was set forth. In addition to cost effectiveness this criteria recognized weighting factors in such areas as:

Existing train traffic densities, by segments.
Potential future changes in rail traffic.
Comparative capital costs.
Increase/decrease in operating and maintenance costs.
Comparative reliability.
Comparative maintainability.
Comparative safety assessment.

5.1.1 Technical Descriptions

The Phase 2 Report contains concise technical descriptions of the alternatives studied.

5.1.2 Cost/Benefit Analyses

A cost/benefit analysis is presented for each system and subsystem studied. It is realized that certain systems may not show quantitative cost savings, especially in communication systems. However, the inherent advantage of any recommended systems was explained.

5.1.3 Conclusions and Recommendations

The Phase 2 Report includes:

- Priorities, by segments, of recommended signal system upgrades.
- Costs, by line segments, of the recommended signal system upgrades.
- Costs by system and/or subsystem of recommended communication system upgrades.
- Implementation plan for each recommended signal or communication upgrade.

5.2 How the Study Achieved the Goal

The study of the communication system was performed on a system-wide basis. It was determined that the implementation of the solutions can be phased but the technical solution should be uniform for the entire railroad.

The signalling, work was performed on a territorial basis whereby various technological solutions were studied in relation to the traffic density data as known, and the existing level of signalling on a per segment basis.

Cost estimates were developed using various sources, i.e. previous work, supplier's quotes and/or proposals, the consultant's estimators, historical data and market values.

Comparative life cycle costs including operations, maintenance and replacements cost for a ten-year period were estimated for the communications portion to complete the decision making and recommendation process.

A recommended implementation plan to optimize the railroad improvements and increase revenue was prepared in outline form.

6.0 Communications Improvements

In providing communications capability between the Control Centers and the trains, two types of communications media are required, voice and data.

6.1 Voice Communication

Two system-wide solutions were studied:

1. A land-based radio system providing system-wide coverage, e.g. Motorola or the Fiberail Network as the carrier.

2. A wireless solution using Iridium satellite telephones and roaming on local cellular networks when possible.

Land-based Radio – The following is a brief outline of the pros and cons for the Motorola Train Radio Technology.

- More traditional approach with wayside antenna towers and radios, and the use of the Fiberail Network as the land carrier.
- Heavy-duty locomotive adapted equipment.
- Makes Central Control operation more efficient with instant communication, no dialing nor waiting.
- Approximately 80 antennas needed.
- Fiberail has at least 12 antennas available.
- Easier maintenance, including Fiberail tech support.

In our opinion this provides for a more reliable network that is not difficult to design based on existing applications. This choice would take more time to implement than the satellite alternative. This radio solution can expand to forward technologies such as data transmission. The voice

channel could be used for remote switch control keying. Higher implementation cost, no airtime, Fiberail lease is long term and should be reasonable.

Satellite – Based on the Iridium System; the following is a brief outline of the pros and cons of satellite technology.

- Stand-alone telephone unit would require adaptation to the locomotive environment.
- High cost of airtime even when roaming to locally available cellular.
- Sophisticated maintenance.
- Can be implemented fast.
- Claims complete coverage, but can be affected by weather.
- Readily expandable by adding telephones.
- Operation would be awkward with dial ups required and time delay to connect.
- No data transmission at this time, voice only.
- Relatively lower implementation cost because of lower land-based equipment requirements.

Cellular - It was determined that the conventional cellular service does not provide the complete system coverage necessary. Even the future IMT-2000 upgrade will focus the coverage first in the population centers then the main roads. Cellular coverage is a function of demand and usage. To guarantee complete railroad network coverage by cellular would require costly cell towers with a closer spacing than the Land-based Radio explained above. Therefore, the cellular system is not recommended for this application.

6.1.1 Land-based Radio, System-wide

Based on Motorola train radios with wayside repeater antennas and the use of the Fiberail network as the land carrier.

6.1.1.1 Assumptions

- Equipment for 80 Locomotives and for 100 maintenance crews plus connection to the Fiberail network.

- The equipment is based on the proven train radio equipment as used on many railroads and hand-held devices also of current use.

A preliminary estimate was provided by Motorola in August of 1998. This system would provide a wide area coverage of voice communication for the 1600km of KTMB rail, an integration into the Kuala Lumpur CAD office (dispatch) and included enhancement capabilities.

This approach assumes 80 sites, which require antenna, towers, repeater radio, fiber optic interface and Central Control equipment.

The Fiberail system already has 12 towers which could be used. Also, it is assumed that another 20 sites have cellular or other communication towers that would be usable. The balance of 48 sites assumed would require construction of required towers. It is also assumed because KTMB is part owner of the Fiberail network that the use of the fiber link will be available at a very attractive rate.

Using the data provided by Motorola as referenced above, the estimate for this study was revised as follows:

	Quantity	Unit Price	Cost
Towers, antennas	48 sites	15,000	$720,00
RF site equipment	80 sites	20,000	1,600,00
Fiber optic to RF equipment	160 units	5,000	800,00
Fiber optic multiplexer and connect to the fiber carrier	80 sets	18,000	640,00
Installation	80 sites	5,000	400,00
Mobile train radios	80 units	10,000	800,00
Installation on Locomotive	80 units	1,000	80,00
Portable radios	100 units	2,500	250,00
Central Control Office (3 positions)	Lot	750,000	750,00
Fiber optic interface MPX, DMPX installation for 80 TX and RX and network management	Lot	140,000	140,00
Engineering, system integration, procurement		700,000	700,00
Project, Management, installation supervision commissioning		700,000	700,00
			$7,580,00

6.1.1.2 Operation and Maintenance for Land-based Radio

Cost to maintain the system	$400,000/year
Cost for Fiberail Network use estimated at no airtime, it is a lease cost	600,000/year
System operation management	100,000/year
Total operating cost per year	$1,100,000/year

6.1.1.3 10 Year Life Cycle Cost, Motorola Solution

One time Implementation		$7,580,000
Maintenance and operation including Fiberail network =	1,100,000/year	
(no escalation)	x 10 years	11,000,000
Radio-based Voice Total Life Cycle Cost		**$18,580,000**

Expected life of the equipment is estimated at 10 years.

6.1.2 Satellite Wireless Solution – Based on the Iridium System – Cost Estimate

6.1.2.1 Assumptions

- Equipment for 80 Locomotives and for 40 Maintenance Crews for the Most Remote Locations
- The phones would be provided with remote antennas and "docking station" in order to reduce theft and maintain continuous operation from the locomotive power.
- The equipment is not hardened for severe environment use.
- All costs in 1999 U.S. dollars.

Cost for the telephone, docking, remote antenna and custom installation (per locomotive)	$9,000 x 80	= 720,000
Cost for the maintenance crew telephone	$4,500 x 40	= 180,000
For central control – main dispatch set up	allowance	= 120,000
Remote dispatch set up for 3	allowance	= 300,000
System integration engineering		= 350,000
Miscellaneous		= 150,000
		$1,820,000

6.1.2.2 Airtime Cost Estimate

- 120 telephones activated at $70/month excluding taxes $8,400
- The cost per minute of airtime was quoted at $1.50 which can vary depending on roaming and qnantity discounts.
- The railroad has approximately 195 trains daily, estimated air time per train at 20 minutes per trip= 3900 min/day
- The maintenance crew air time per day estimated 30 min x 40 1200 min/day

Airtime cost per month: $1.50/min x 5100 min/day = $7,650/day x 30 days = $229,500

Yearly O&M Cost Estimate:

Cost to maintain the system of 120 phones/Central Control per year estimate:		$200,000
Monthly connection fee	$8,400 x 12 mo.	$100,800
Cost of airtime for 120 telephones is estimated at	$7,650 x 365 days	$2,792.250
Yearly O&M Cost Estimate		$3,093,050

6.1.2.3 10-year Life Cycle Cost Iridium Solution

- One time implementation Capital Cost	1,820,000
- 200,000 x 10y maintenance cost (no escalation included)	2,000,000
- Airtime cost $7,650/day, assume 20% discount due to high usage = $6,048 per day x 365 day/year x 10 year	22,075,200
- monthly fee for 120 phone/month $8,400,00 x 12 mo. x 10 years less 20%	806,400

Estimated total 10-year life cycle cost for voice only communication, i.e. Iridium. $26,701,600

Includes 20% discount on airtime and replacement phones.

- For the maintenance crews that are close to locations where regular cellular service is usable
  ---estimate 60 cellular phones at $250 each = $15,000 (one time)
- airtime $25 monthly fee per unit x 60 = $1,500/monthly
- cost per minute estimated at 20¢ x 30 minute per day x 60 = $360/day
- $360/day x 365 day x 10 years air time = 1,314,000
- $1,500/mo. x 12 mos. x 10 years = 180,000

Additional recurring costs, the telephones will not last the 10 years. Estimate telephone replacement every 4 years at $4,000 per unit (discounted value).

120 units x $4000 ea. = 480,000 every 4 years
for 10 years = 1,200,000

Irridium Total Life Cycle Cost = $29,410,600

Table 6.1 Comparative Capital and O&M Estimates for 10-years

	Iridium Satellite Phone	Motorola Land-based Radio
Capital	1,835,000 – one time	7,580,000 – one time
Operation and Maintenance	2,000,000 – 10 years	5,000,000 – 10 years
Airtime & Monthly Fees	24,375,600 – 10 years (includes 20% discount)	6,000,000 (Fiberail) – 10 years
Added Recurring Cost	Telephone Replacement 1,200,000 – 10 years	N/A
Total Estimated Cost For 10-years	29,410,600	18,580,000
Difference	+10,830,600	

Note: To bring the Iridium total cost close to Motorola the air time cost would have to be discounted a further 44% or the Motorola capital cost would have to double.

6.2 Data Communication

Two system-wide solutions were studied:

1. Land-based radio system providing data and location on a system-wide coverage basis, e.g. Motorola GPS and the Fiberail Network as the carrier.

2. Wireless solution by the use of a satellite-based on a data and location transmission system, e.g. Qualcomm.

Land-based Radio – The following is a brief outline of the pros and cons for the Motorola GPS/data radio technology.

- More traditional approach.
- Expands the land-based voice network to include a data/location channel
- Can be integrated with the voice system to optimize use and cost.

- Provides GPS location and can transmit remote control codes to remote switch sites.
- Instant real-time communication
- Train location display more reliable.
- Can expand to forward technologies.
- Easy maintenance with Fiberail tech support.
- This application is straight forward to implement and would follow land-based voice subsystem.
- Higher implementation cost although there would be big savings if integrated with voice
- No airtime cost.
- Fiberail lease is long term.

Satellite – The following is a brief outline of the pros and cons for the Qualcomm Omnitracs System.

- Terminal adaptation to locomotive.
- Data send, receive and relative positioning (GPS) rely on the satellite Control Center to relay messages within packet transmission = time delay.
- Qualcomm system is in operation in Malaysia.
- Coverage can be affected by weather.
- Sophisticated maintenance.
- Central Control operation is delayed but can display train approximate location.
- Land-based terminals could be used to control the switches at remote sites (equipment may be in development).
- No voice.
- Stand-alone.
- Lower implementation cost.
- High airtime cost.
- Wayside terminal requires integration design.

6.2.1 Land-based Radio Data Transmission Using Motorola Data and Train Location System

This estimate is based on information provided by Motorola in a preliminary proposal submitted in August 1998, which included an automatic train location (ATL) system (add-on phase).

Base Stations	80 units	at $10,000 ea.	$800,000
Antennas/towers already provided in the voice option discussed earlier.			
Fiber Optic linking equipment	80 sets	at $5,000	400,000
Installation cost	80 units	at $7,000	560,000
Mobile train equipment for data and GPS	80 units	at $10,000	800,000
Installation cost on Locomotive	80 units	at $1,000	80,000
Central Control equipment Voting equipment	1 Lot		250,000
Fiber Optic MPX UMDX	1 Lot		250,000
ATL system w/software interfacing to the computer aided dispatch	1 Lot		500,000
Installation	Lot		250,000
Project Management, QC. Commissioning, Motorola			500,000
Implementation and design engineering and training			400,000
Total Capital Cost			**$4,790,000**

6.2.1.1 O&M Estimated Cost: Motorola Land-based Data Radio with ATL

Estimated annual maintenance cost	$200,000

Airtime (not applicable)
- Fiberail usage is included in voice radio estimate

6.2.1.2 10 Year Life Cycle Cost

Capital cost one time	4,790,000
Maintenance 200,000/year x 10	2,000,000
10-year life Total Cost	$6,790,000

6.2.2 Satellite-based Data Transmission

Using Ommitracs supplied by Qualcomm.
- Qualcomm has a hub located in Malaysia, which enables a direct data transfer to the KTMB Control Center via dedicated phone line.

The latest version of the Qualcomm mobile terminal uses GPS to enhance train location data.

Terminal equipment for 80 locomotives	
- customized for each Locomotive $3,500/unit	$280,000
- plus installation $800/unit	64,000
	$344,000
Dispatcher Center multiple work stations	
- Work Stations	116,000
- Implementation Engineering	180,000
- Training & Miscellaneous	60,000
Total Estimated Capital Cost	**$700,000**

These cost are based on information provided by Qualcomm sales rep in the U.S.A. The costs may vary on the international market.

6.2.2.1 O&M Estimated Cost: Qualcomm Satellite-based Data Transmission

Estimated annual maintenance cost	$160,000
Airtime Cost	
▪ $35 per month for each terminal connect fee rental annual x 80 x 12	33,600
▪ Cost per message at 5¢ per message plus .2¢ per character = 10¢ per message, assume an average of 25 characters per message. 195 trains are scheduled every day, estimating 25 messages per trip including train location polling at a low rate = 4875 messages per day at 10¢ per message x 365 days = message cost/year	178,000

- Central control link to Qualcomm hub est. 2,400

Total Annual Operating Cost **$374,000**

6.2.2.2 10 Year Life Cycle Cost

- 160,000 annual maintenance x 10y $1,600,000
- 214,000 annual estimated airtime x 10y 2,140,000
- Cost of terminal replacement every 6 years at 3,200 per unit x 80 unit x 1.6 in 10y 410,000
- Initial capital cost to implement 700,000

Total 10-year life cycle cost $4,850,000

Table 6.2 Comparison of Data Transmission Solutions

	Qualcomm	Motorola
Technology	Satellite-based data transmission no voice, stand alone	Land-based radio using the voice carrier on Fiberail
Capital Cost	$700,000 /one time	$4,790,000/one time
Maintenance	$160,000/year – 10 years	$200,000/year – 10 years
Airtime	$213,938/year – 10 years	None
10 Year Replacement Cost	6-year $410,000	N.A
10 Year Life Cycle Cost	$4,850,000	$6,790,000
Difference		+$1,940,000
Other Factors	The number of messages could be significantly larger than 25 per train trip per day. Increase in airtime cost could be as much as 30%, which equals +$641,000	This Motorola option could have significant saving in capital cost if integrated with the voice radio system and installed at the same time. Saving could be close to $1,000,000
Revised Difference		+$300,620

The cost difference between the satellite-based and land-based data transmission systems could be from zero to 2 million dollars over 10 years in favor of the satellite-based system.

Later in the report a cost comparison for the transmission of the remote control feature for the switches is studied (see signals section).

6.3 Wayside Data Transmission for Control of Remote Switches

This section evaluates the cost of wayside data transmission for control of remote switches. CTC Territories are covered in signaling, Section 7.0.

A total of 76 remote sites would require the installation of a switch control module. Twenty-three are relay interlocked and 53 are GLF or manual locations.

6.3.1 Estimated Cost of Remote Switch Control Modules

Each module includes a programmable remote control (PRC) unit and a data transmission terminal, which will interface with the relay interlocking at each site

The PRC unit and the data transmission cost estimates are as follows:

Qualcomm - $3200 (data) + 5000 (PRC) + 4800 install = $13,000 per site	
Total for 76 sites	$988,000
Motorola - 6000 (data) + 5000 (PRC) + 5000 install = $16,000 per site	
Total for 76 sites	$1,216,000

Each site will be integrated into the Central Control display system. Estimated costs for both systems are similar.

Central control work stations	$105,000
Software integration	200,000
Engineering (excludes signaling)	255,000
Total Estimated Cost	$620,000

6.3.2 O&M Estimated Cost

Motorola:
Airtime: No cost, already integrated with the ATL radio data system.

Qualcomm:
Airtime is a function of the number of terminals required or added.

76-land terminals - Connection Fee at $35/month x 12	$31,920/year

Messages at 5¢ per message .2¢ per character, control message at 25 characters = 10¢ per message.

IPOH to Bukit Mertajam: 52 trains, 15 loops each loop:	
4 messages per train per day,	
3120 message/day x .1 x 365	$113,880/year
Bukit Mertajam to Padang Besar: 17 trains, 13 loops at	
4 messages per train per day	
884 message/day x .1 x 365	$32,266/year
Gemas to Johor Bahru: 34 trains, 26 loops each loop	
4 messages per train per day	
2176 message/day x .1 x 365	$79,424

Gemas to Tumpat: 12 trains, 23 loops each loop
4 messages per train per day
1104 message/day x .1 x 365 $40,296

Qualcomm Airtime/year $297,786
say, $300,000

6.3.3 10 Year Life Cycle Cost

Qualcomm satellite-based remote control for switches
Maintenance of the remote control modules
$150,000/per year x 10 years = $1,500,000

Air time as estimated above:
$300,000/per year x 10 years = $3,000,000

This equipment is stationary and will not manipulated as much as the locomotive unit, therefore replacement should not be necessary in the 10-year estimate.

Capital Cost, units one time 988,000
Central Control 620,000
10-Year Life Cycle Qualcomm est. cost $6,108,000

Motorola land-based radio remote control for switches
Maintenance of remote control modules
$150,000/per year x 10 years = $1,500,000

Air time – none applicable
See above for replacement life
Capital cost units – one time 1,216,000
Central Control 620,000
10-Year Life Cycle Motorola est. cost $3,336,000

Table 6.3 Wayside Remote Control for Switches Data Transmission

	Qualcomm	Motorola
Technology	Satellite-based	Land-based Radio
Capital Cost for 76 units	988,000	1,216,000
Central Control	620,000	620,000
Maintenance	150,000/year	150,000/year
for 10-Years	1,500,000	1,500,000
Air time	297,786/year	None Applicable
for 10-Years	2,977.860	
Total – 10-Year	**6,085,860**	**3,336,000**
Difference	+2,749,860	

By including the total costs of both train data transmissions and wayside remote control data, the Motorola option is lower than the Qualcomm option over a 10-year period.

7.0 Signaling Improvements

There are a number of types of systems that are viable for implementation

Option 1- CTC along the wayside

A CTC wayside-based system is what is in use in the Kuala Lumpur rail territory. This type of conventional "hard wired" system is usually more costly to implement. However, this type of system is reliable and the railroad already knows how to maintain and operate it. These systems can be equipped with on board ATP/cab signals or just a trip stop device or no on-board equipment. The operating mode envisaged here is with wayside signals and no on-board equipment. This provides significantly improved railroad operation without the costly on-board equipment and the wayside facilities needed to support it.

Option 2 - Balise

The balise-based signaling subsystem requires on-board equipment. This can be used as a train location information method as well as providing segment ahead operating instructions, all linked via landlines and/or radio. The radio system to our knowledge would have to be a dedicated type of link. This system would be recommended for high-density operation making the cost close to the CTC option above.

Option 3 – Relay Interlocking w/Remote Control

A relay interlocking with remote control is conventional wayside-based, passing loop, block signaling with a remote control feature for the switches. The remote control data can be carried via landlines and/or radio. The radio link would be provided via either land-based or satellite-based technology. What makes this system very attractive is the train location feature that both data transmission options above provide. The relay interlocking provides the block protection and the train location feature brings traffic efficiency to a high level.

The data system on-board (either land-based radio or satellite-based) described in the communication system section also provides a train location feature which enables Central Control to display the location of trains on the entire network. This approach provides information close to the balise system and CTC in train location, which enhances traffic management and at a fraction of the cost of signaling technology. This approach is useful for low to medium density traffic territories.

7.1 Implementing Signaling Improvements

The following determines, by railroad segment, the level of existing signaling i.e. manual, ground lever frame, relay interlocking, etc, and the improvements to be provided.

For the CTC Territories:

IPOH to Rawang	2 loops are Relay Interlocking (RI) 17 loops are Ground Lever Frame (GLP)

The 2 RIs require integrating to the CTC.

The 17 GLFs require the installation of switch machines, relay interlocking and the integration to the CTC.

Seremban to Gemas	8 loops are Relay Interlocking.

The 8 RIs require integrating to the CTC.

For the switch remote control with relay interlocking territories.

Bahru Anam (Gemas) to Johor Bahru	17 loops are Relay Interlocking 1 loop is Ground Lever Frame

The 17 RIs require integrating the remote control
The 1 GLF requires the installation of switch machines, relay interlocking and the integration of the remote control.

Gemas to Tumpat

All 25 passing loops require the installation of switch machines, relay interlocking and the integration of the remote control feature. Of the 25 stations, 18 are non-interlocked manual loops, and 7 are GLF or high-point indicator loops.

Padang Besar to IPOH	5 loops are RIs and 27 loops are GLF

The 5 RIs require integration of the remote control.
The 27 GLFs require the switch machines relay interlocking and integration of the remote control.

Summary of Signaling Inventory:

For CTC:	
Total Relay Interlocked Locations	10
GLF locations	17
For Switch Remote Control:	
Relay interlocking	22
GLF and/or manual locations	53
Total Relay Interlockings	32
Total Ground Lever Frames/Manual	70

7.1.1 **Highest Traffic Territories**

Phase 1A - Rawang to IPOH 174.75 km
Phase 1B - IPOH to Bukit Mertajam 169.5 km

These two segments, based on the drawings from the Phase 1 report, total 344.25 km with 32 stations equipped with ground lever frame, and 3 stations equipped with relay interlockings.

The level of effort and capital expenditure required for these segments will be the highest of the project. A total of 32 out of 35 stations will require the installation of relay interlocking with switch machines and wayside data transmission back to the Control Center. The three stations that already have relay interlocking will require an upgrade to the wayside data transmission back to the Control Center for CTC.

7.1.1.1 Cost of a Typical Relay Interlocking

Unit prices for typical signaling components are:

- The cost of a typical CTC-based relay interlocking with switch machines installed with preempting signals is estimated at $1,132,000
- Cost of an expanded relay interlocking with switch machines for small yards installed with preempting signals and mainline blocks is estimated at $1,650,000
- Cost per kilometer of mainline block signals with wayside communication trunk lines for single track is estimated at $283,000
- Cost of a typical upgrade to CTC of a relay interlocking is estimated at $530,000

The estimated costs for the Phase 1 area, broken down into Phase 1A and 1B are:

Phase 1A Rawang to IPOH North	
175km x cost per km	$48,393,000
17 station x cost per relay interlocking	$19,244,000
1 station with RI x cost per upgrade	$ 530,000
Engineering, Design, CM, Safety	$21,813,00
Total CTC	$89,980,000
Phase 1B Tasek to Bukit Mertajam	
170 km x cost per km	$45,846,000
15 station x cost per relay interlocking	$16,980,000
2 stations with RI x cost per upgrade	$ 1,060,000
Engineering, Design,CM, Safety	$20,443,000
Total CTC	$84,329,000
Total CTC Capital Cost	$174,309,000

7.2 Implementing Remote Switch Control

Where relay interlocking is exiting.

Phase 2A Seremban to Gemas 101.6km

A total of seven (7) stations will require the upgrade to remote switch control via wayside/radio data transmission from the Central Control.

Phase 2B (Batu Anam) Gemas to Johor Bahru 195km

A total of 17 stations will require the upgrade to remote switch control via radio data transmission to the Central Control.

One station will require the installation of a relay interlocking with switch machines and the upgrade to remote switch Control.

7.2.1 Cost of a Typical Upgrade to Remote Switch Control is Estimated at $400,000

Cost per kilometer for the wayside trunk line communication is estimated at $50,000.

The estimated costs for Phase 2 are:

Phase 2A Seremban to Gemas	
107km x cost per kilometer of wayside trunk line	$5,350,000
7 stations with RI x cost of upgrade to remote switch control	$2,800,000
Engineering, Design, CM, Safety	$2,608,000
Total	$10,758,000
Phase 2B Cost Gemas to Johor Bahru	
195km x cost per km to Radio Remote Switch Control	$9,750,000
17 stations with RI x cost to update	$6,800,000
1 station to install an expanded RI	$3,000,000
Engineering, Design, CM, Safety	$6,256,000
Cost of switch remote upgrade	$25,806,000
Total Capital Estimated Cost for this segment	$36,564,000

7.2.2 Implementing Radio Switch Control Where There is No Relay Interlocking

Phase 3A Bukit Mertajam to Padang Besar 158km

This segment includes a total of 14 station passing loops of which only one is equipped with relay interlocking - the terminal at the Thailand border (Padang Besar).

Phase 3B Gemas to Tumpat 528km

This segment is considered "dark" with all stations operated in manual. A total of 25 stations would require upgrading.

7.2.3 Estimated Cost of the Hydra-Switch 3000 Application

For the above two segments, the traffic densities are not as high as the previous ones.

A basic approach was evaluated to improve the efficiency at minimal cost.

On the assumption that KTM will implement the voice and data/location improvements recommended, the following approach will provide radio controlled switches.

Implementing The Model 3000 Hydra-Switch Machine As Manufactured By Railway Technology Inc.:

These machines are self-contained self-powered (solar and battery) modules that replace directly the manual switch stand. This device includes switch point safety, train occupancy protection, run through protection, radio DXMF control and status back features. In the "dark" territories this switch machine can be installed in a few days (including approach circuits installation). It is controlled via the locomotive radio or a hand held unit equipped with a "touch-tone" capability. Each switch has its own ID code for safety.

For a pair of these switches, equipped as described above, with solar panel, battery and radio installed along the Phase 3A and 3B segments the cost is estimated at $27,000 per pair.

For Bukit Mertajam to Padang Besar, a total of 13 stations are manual and one has a relay interlocking configuration. There are a total of 14 sets of mainline switch pairs and a total of 47 local "yard" switches that could be automated as described above.

14 x 2 + 47 =	75 switch machines =	1,012,500
	Engineering Est.	320,000
	Total Estimated Cost for this Segment is	1,332,500

For Gemas to Tumpat, a total of 25 stations are manual. There are a total of 29 sets of mainline switch pairs and a total of 91 local "yard" switches that could be automated as described above.

29 x 2 + 91 =	149 Switch Machines =	1,329,000
	Estimated Engineering Cost.	470,000
	Total Estimated Cost for this Segment is	1,799,000

The total capital cost for the Bukit to Mertajaim and the Gemas to Tumpat segments is estimated at US $3,131,500 for a total of 686km of railroad.

This approach provides radio remote control of all of the switches (224) for these territories. The train crews will not need wayside personnel to manage the passing loops nor will they need to jump off the trains and walk back to restore or set the switches. American, Canadian and Brazilian railroads, to name a few, have found these switches very cost efficient and reliable.

8.0 Implementation Plan – Phasing Plan

There are many ways to implement the improvements that are suggested. We recommend a phased approach, which will spread the costs over time while offering significant benefits to the most crucial areas in the short term.

8.1 Communication Upgrade

Now that the Fiberail network is implemented, the remote segments of the railroad are poised to receive a modern communication system at a reasonable cost. As funds are made available and based on preliminary estimates, the land-based voice and data communication system seems to be the most cost effective system the railway can implement, even before implementing any signaling improvements. With a cost in the range of 9 to 11 million US dollars, the radio voice and data network for the entire railroad is "cheap" compared to a signaling cost that could reach

350 million US dollars for an all CTC option. Even if the improvements to signaling were only remote control, the cost could be more than 100 million US dollars.

The key benefit of implementing the voice and data/location communication system first is the global system visibility the Control Center will have of the entire railroad operation.

8.1.1 Train to Wayside Voice Communication

To enable the increase in railroad revenue it is suggested that train to wayside communication be the first and foremost area of investment for KTMB.

The benefits cannot be emphasized enough of communication between Central Control and the train crews for optimal train movement coordination.

The study outlined an initial investment in the range of $7,580,000 for a land-based train to wayside radio communication system. With the introduction of a computer aided dispatch function and strict updated operating rules and procedures, this investment would provide for a significant improvement in railroad efficiency.

8.1.2 Train to Wayside Data Communication

To compliment the voice communication, a train to wayside data transmission is considered the next appropriate step in the modernization program. The study outlined an initial investment in the range of $4,790,000 (us) for a land-based train to wayside data and GPS-based train position transmission system. This system would compliment the computer aided dispatch mentioned above and enable complete visibility of the entire railroad.

With the implementation of updated operating rules and procedures, the potential savings are estimated at a 50% reduction in the field (station) staffing. These updated procedures would change the operation from the old token key mode to a time separation operation, thus enabling significantly higher safe train traffic.

8.1.3 Integrated Communication

The study also outlined possible investment savings by implementing the voice and data/GPS land-based radio transmission system in one phase. The estimated capital cost would be in the range of $10,300,000 complete, a saving of $2,070,000 for the entire railroad.

8.2 Signals Improvement Inventory by Segment

The CTC-based signaling expansion maintains a known operation mode and does not (if it is wayside-based with no cab signals) require locomotive added equipment.

8.2.1 First Priority

From Rawang to IPOH all the equipment shown on the drawings are "Lever Ground Frame Interlockings" of various sizes. These devices would not be usable for a CTC application. Therefore, this segment requires a complete set of CTC equipment. This is a 175-Km segment with 18 passing loop stations.

From Seremban to Gemas, all the equipment shown on the drawings is "Relay Interlocking" of various sizes. This equipment would be upgradable to a CTC level application requiring less equipment. This is a 102-KM segment with 7 passing loop stations.

8.2.2 Second Priority

From Gemas to Johor Bahru, all the equipment shown on the drawings is "Relay Interlocking" of various sizes. (Except for Johor Bahru LGF). This equipment would be upgradable to a remote control type of operation using either landlines and/or radio. This is a 224-KM segment with 19 passing loop stations.

From IPOH to Padang Besar, most of the equipment shown on the drawings are "Lever Ground Frame Interlocking" of various sizes, except for five stations with relay interlocking. These devices would not be usable for remote controlled passing block interlock except for the five existing relay interlocked stations. Therefore, this segment requires a complete set of equipment for the remote control relay interlocking upgrade. This is a 338-KM segment with 32 passing loop stations.

8.2.3 Third Priority

From Gemas to Tumpat, of the 24 stations listed in the drawings seven stations use the "Lever ground frame interlockings" and the balance of 17 are non-interlocked manual operation. This whole segment would require a complete set of equipment for the remote control relay interlocking implementation. This is a 528-KM segment with 24 passing loop stations.

8.3 Remote Control Data Communication Options for the Second and Third Phases

In the Phase 2B and Phase 3 (A & B) portions of the project, the voice and data options selected in the first phase will have a significant impact in the implementation of the remote control feature of the passing track functions.

8.3.1 Option 1

If a land-based radio system is selected for the voice communication over the entire system, then it is logical to include the data/location feature that this system can support. This would provide for the implementation of an integrated network where locations with remote immediate access to the Fiberail network would allow radio-based control of the switches. The switch status could also be transmitted to the Control Center via wayside data collection radios.

The cost of this approach is mainly in the hardware as there is no airtime cost, only Fiberail network cost.

8.3.2 Option 2

If a satellite-based voice communication system is selected, the data transmission would not be integrated. A different satellite-based communication system, i.e. Qualcomm, would have to be implemented. The system includes train relative positioning with two-way data transmission and possible wayside data acquisition equipment that could provide switch remote control and switch status to the Control Center.

The cost of these satellite-based systems, both voice (Iridium) and data (Qualcomm) are not as high because the carrier does not have to be installed. Each location requires a voice terminal (telephone) and a data terminal. Both are implemented by separate entities and the major cost will be the airtime for these two independent networks.

Implementation of the remote control feature for both data options can take place once the data network is implemented (either of the two). Then the improvement of the signaling system can take place on a site by site basis. The choice will be one of front-end cost (land base) versus long term operating cost (satellite base).

8.4 Signaling Upgrades

8.4.1 First Priority

For the IPOH segment to the north and the Gemas segment to the southeast: The best solution is to expand the existing CTC used in the Kuala Lumpur area for both segments. This may not be the cheapest way but it is the most effective way to provide a significant increase in system throughput and capacity increase capability. By using known technology, on-hand spare parts and pre-trained maintenance staff this would reduce the operating costs, streamline the implementation cost and probably assure a smooth and timely service integration.

8.4.2 Second Priority

The second priority is the improvement of traffic management for the west line north of IPOH and for the south line from Gemas to Jahor Bahru (Singapore).

This upgrade can be accomplished in various ways.

1. Conventional CTC type of land-based signaling with a "hard wired" type system and land line communication.
2. Use of the Balise-based (almost CTC) type of signaling with landline-radio-based communication.
3. Use of a remote control passing track block (relay interlocking) signaling through the use of the data transmission system explained above.

    - Motorola land-based data radio to provide location of trains and remote control of the passing tracks (with the safety of the blocks).
    - Qualcomm data system to achieve about the same function.
      ** Some of the track block (relay interlocking) is already in place

8.4.3 Third Priority

The third priority is the improvement of the East line from Gemas north to Tumpat. This line is the segment with the least amount of automation installed. The majority of the passing tracks are completely manual (no lever ground frames or track blocks).

The recommended solution is the use of remote controlled passing track block signaling using one of three options.

1. Using a land-based balise style system with radio communication.
2. Using the Motorola land-based data radio to provide location and remote control of the passing tracks.
3. Qualcomm satellite-based data system to achieve about the same function.

9.0 Recommendation

Although the new technologies in satellite communication are appealing, the application involved here would be half served. The initial capital investment would certainly be lower than the land-based radio but the operation cost over ten years would make it more expensive due to the high airtime cost.

For the Railroad, the use of the Fiberail network with a land-based radio system is the recommended solution. As Fiberail already covers the entire rail system, an integrated, KTMB dedicated communications network would probably pay for itself. The savings in wayside dispatcher, wire maintenance, the manned track loop stations, and the land lines that are leased for the ticketing and other company activities, could add up to the cost of implementing the Fiberail application. This would make the KTM communications cost independent and sheltered from price increases, stabilizing the long-term life cycle cost.

In light of the above, it is recommended that a three-phase railroad operation improvement be adopted.

Phase One – implement voice and data/location communication system-wide through the procurement of a land-based radio link system carried on the Fiberail network, i.e. Motorola voice and data/GPS.

Phase Two – improved signaling in the higher traffic density segments.

2.1 IPOH to Rawang would be converted to full wayside CTC
2.2 Seremban to Gemas would be upgraded to full wayside CTC
2.3 Gemas to Johor Bahru would be upgraded to a radio-based remote controlled segment.

Phase Three – Implement relay interlocking with radio-based remote control for the other railroad segments.

3.1 IPOH to Padang Besar would be equipped with radio-based remote control relay interlocking
3.2 Gemas to Tumpat would be equipped with radio-based remote control relay interlocking.

Phase One and Phase 2.1 and 2.2 could be implemented in parallel followed by 2.3, 3.1 and 3.2.

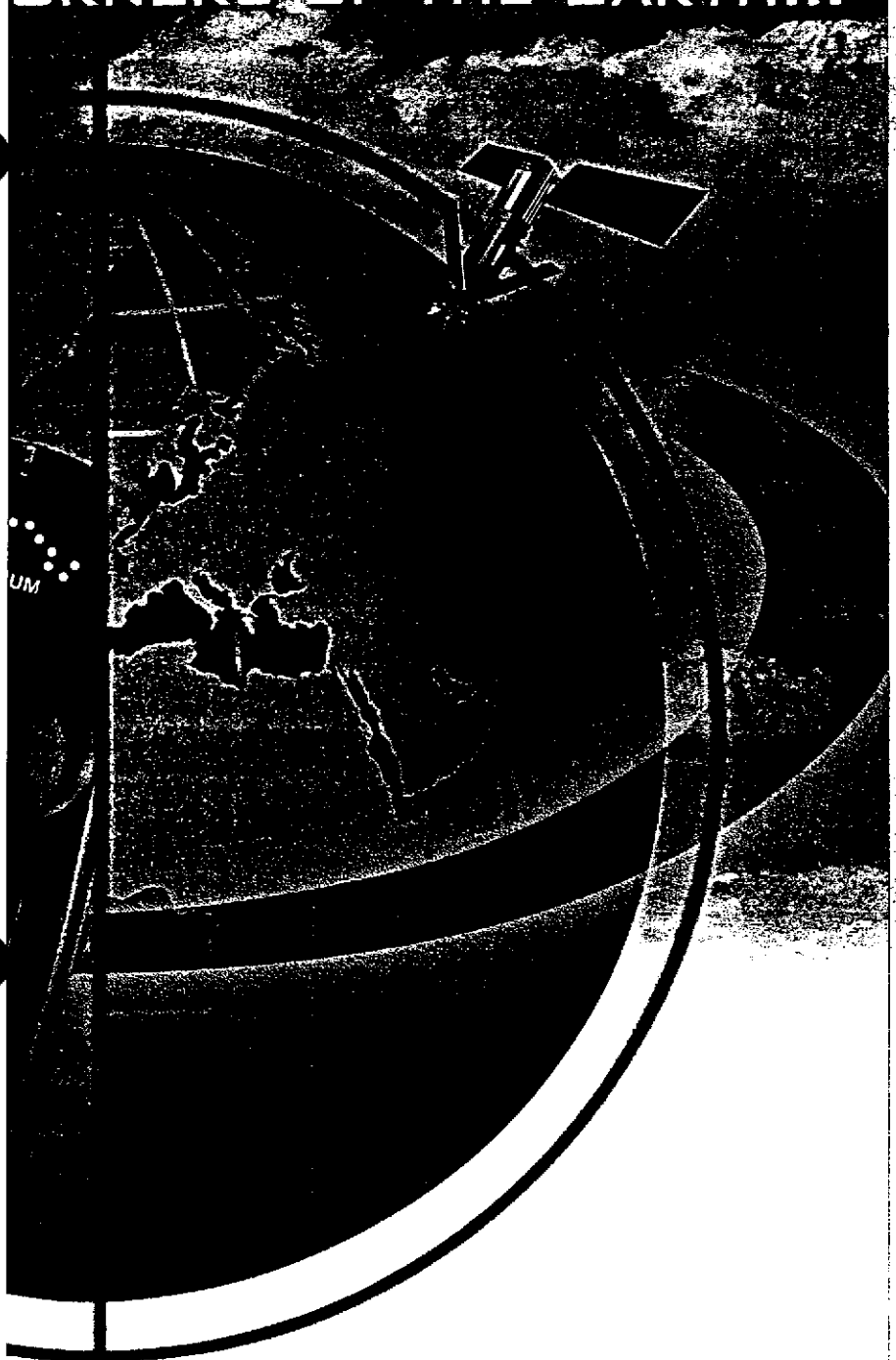
If the railroad cannot capitalize the parallel approach above, then Phase One with both voice and data is the first step that should be taken.

Attachments

A	-	Iridium
B	-	Qualcomm
C	-	Fiberail
D	-	Adtranz CTC
E	-	Adtranz Balise
F	-	Railway Technology

Attachment A
Iridium
Satellite Based Telephone Communication

ORNERS OF THE EARTH...



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Motorola Satellite Series 9501 Pager

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IRIDIUM World Service

STRATOS

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Iridium World Satellite Service – Iridium users who live and work in areas outside cellular coverage or in places with poor landline service benefit from the direct links Stratos offers through its Iridium World Satellite Service. Through a handheld phone registered to the Iridium satellite network, customers can make and receive calls around the world. For people already owning a cellular phone, it's worth registering with Stratos for their satellite service for lower rates and the comfort of dealing with a leader in the mobile satellite business.

Iridium World Roaming Service – Ideal for international travelers with terrestrial wireless coverage, this service allows users to roam between previously incompatible cellular networks while keeping a single telephone number and one consolidated phone bill. Customers simply turn on their Iridium multi-mode phones, equipped with cellular compatible hardware, and are automatically registered with participating local cellular networks to make and receive calls.

Iridium World Page Service – Allowing customers to always stay in touch, this global paging service delivers messages to customers when voice communications may not be possible (e.g. phone is turned off or out of reach). As a stand-alone service or to complement Iridium voice services, Iridium World Page Service allows customers to receive messages of up to 120 alphanumeric characters virtually anywhere in the world. With optional Voice Mail service, customers receive notification of new messages on their pagers.

Service Feature	Iridium World Satellite Service	Iridium World Roaming Service (Iridium homed)	Iridium World Page Service
Coverage	Global	Partners' service area[1]	Global[2]
Complete Calling Party Pays	Yes	Yes	Flat subscription charge
Call Forwarding	Yes	Yes	N/A
Call Barring	Yes	Yes	N/A
SIM Card	Yes	Yes	N/A
Voice Mail	Optional	Optional	Optional
Personal Mail Box	Yes	Yes	Yes

[1] See service map for Iridium World Roaming coverage area [2] Subscriber must pre-select their message delivery areas (except with Follow Me Paging)

Benefits of Voice Services

Complete Calling Party Pays – All calls to and from Stratos customers with an Iridium phone are billed directly to the caller. Fixed-to-mobile calls are therefore free to the mobile user.

Ease of use – Callers simply power on their phone, insert a SIM card and extend their antenna to make and receive calls.

Multiple users – SIM (Subscriber Identity Module) cards inserted into all Iridium phones (satellite and cellular) contain all customer identification and account information — allowing shared use of phones with individual bills.

Cost-effective rates – Iridium World Satellite Service has two tiers of rates: International and Domestic. Domestic or In-country callers receive lower rates as their calls require fewer transfers between satellites. Domestic rates are charged when an Iridium World Satellite user situated within a specific country code calls a terrestrial number with the same country code. Callers from fixed phones to 8817 Iridium North America mobile numbers within the United States also receive lower rates when using AT&T and Sprint.

No missed calls – Voice customers are always available with Call Forwarding and optional Voice Mail services. Subscribers can have calls to their Iridium phone forwarded unconditionally or only when they are unavailable (e.g. phone is turned off). Subscribers are notified on their phone and/or Iridium pager when messages are deposited in their personal mailbox, which they can access via satellite or terrestrial communications.

No unwanted calls – All voice service subscribers can have certain incoming or outgoing numbers barred from their phone — useful when lending out the phone.

Full cellular compatibility – Iridium World Roaming bridges compatibility issues between IS-41 (AMPS, CDMA, TDMA) networks predominant in the Americas and GSM networks found in Europe, the Middle East, Africa and parts of Asia.

Benefits of Paging Service

Low flat rate – Stratos customers can receive up to 120 messages per month for one low, flat monthly rate.

Messaging in urban areas – Iridium pagers can receive messages in areas not always accessible to satellite communications, e.g. inside buildings.

Never miss a page – All Iridium pages are number sequenced so they can be traced and retransmitted if necessary.

Many ways to send a page – Messages can be sent to Stratos customers of Iridium World Page service by direct dialing the subscriber's pager, filling in an online web form or sending an e-mail.

Complete Global Coverage – Bundled with other Iridium voice services, Iridium World Page offers Stratos customers a complete global solution. And with Follow Me Paging, customers that have registered for Iridium voice services have their message delivery areas automatically updated when they power on their phone.

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Origin of Call Zones	Termination of Call Zones				
	NA/Europe/ Japan/Korea	Africa	Central America	China	Eurasia
NA/Europe/Japan/Korea	$ 5.52	$ 6.30	$ 6.15	$ 6.15	$ 6.15
Africa	$ 5.52	$ 6.46	$ 5.52	$ 5.52	$ 5.52
Central America	$ 5.52	$ 7.41	$ 5.20	$ 7.72	$ 6.62
China	$ 9.03	$ 7.92	$ 7.21	$ 5.23	$ 8.96
Eurasia	$ 5.52	$ 5.99	$ 5.83	$ 5.67	$ 5.20
India	$ 5.52	$ 7.41	$ 7.25	$ 7.72	$ 6.78
Middle East	$ 5.52	$ 7.41	$ 7.56	$ 7.41	$ 6.15
South Pacific/SE Asia	$ 5.52	$ 6.93	$ 7.09	$ 6.93	$ 6.61
Sud America	$ 5.52	$ 7.72	$ 6.62	$ 7.72	$ 6.93
Int'l Waters	$ 3.78	$ 3.78	$ 3.78	$ 3.78	$ 3.78

Origin of Call Zones	Termination of Call Zones					
	India	Middle East	South Pacific/SE Asia	Sud America	ISU to ISU	ISU to Inmarsat
NA/Europe/Japan/Korea	$ 6.30	$ 6.15	$ 5.52	$ 5.83	$ 3.15	$ 7.91
Africa	$ 5.52	$ 5.52	$ 5.52	$ 5.52	$ 3.15	$ 7.91
Central America	$ 6.46	$ 7.72	$ 7.41	$ 6.78	$ 3.15	$ 7.91
China	$ 8.42	$ 8.91	$ 7.65	$ 8.58	$ 4.89	$ 7.91
Eurasia	$ 5.52	$ 5.67	$ 6.15	$ 5.52	$ 3.15	$ 7.91
India	$ 5.52	$ 6.93	$ 6.15	$ 6.62	$ 3.15	$ 7.91
Middle East	$ 6.46	$ 5.52	$ 6.30	$ 6.30	$ 3.15	$ 7.91
South Pacific/SE Asia	$ 6.30	$ 6.30	$ 5.52	$ 6.30	$ 3.15	$ 7.91
Sud America	$ 7.72	$ 7.72	$ 7.09	$ 5.83	$ 3.15	$ 7.91
Int'l Waters	$ 3.78	$ 3.78	$ 3.78	$ 3.78	$ 3.15	$ 7.91

NOTE:
1. Calls billed at 1 minute minimum and 1 minute increments.
2. These rates include all land-line and satellite charges.
3. Taxes are not included.

International Calling (Country-to-Country) Zones

Africa

Algeria	Central African Republic	Eritrea	Kenya	Mauritius	Senegal	Togo
Angola	Chad	Ethiopia	Lesotho	Mozambique	Seychelles	Tunisia
Benin	Comoros	Gabon	Liberia	Namibia	Sierra Leone	Turkey
Botswana	Congo	Gambia	Libya	Niger	Somalia	Uganda
Burkina Faso	Cyprus	Ghana	Madagascar	Nigeria	South Africa	Zaire
Burundi	Djibouti	Guinea	Malawi	Reunion	Sudan	Zambia
Cameroon	Equatorial Guinea	Guinea-Bissau	Mali	Rwanda	Swaziland	Zimbabwe
Cape Verde		Ivory Coast	Mauritania	Sao Tome & Principe	Tanzania	

Central America

Belize	El Salvador	Honduras	Nicaragua
Costa Rico	Guatemala	Mexico	Panama

China

China	Hong Kong	Macao	Mongolia

Eurasia

Belarus	Georgia	Latvia	Moldavia	Uzbekistan
Estoria	Kazakhstan	Lithuania	Russia	

Europe

Albania	Czech Republic	Golan Heights	Luxembourg	Portugal	Sweden
Andorra	Denmark	Greece	Macedonia	Romania	Switzerland
Austria	Falkland Islands	Greenland	Malta	Saint Helena	Ukraine
Belgium	Faroe Islands	Hungary	Mayotte	San Marino	Vatican City
Bosnia & Herzegovina	Finland	Iceland	Monaco	Slovakia	Wake Island
	France	Ireland	Netherlands	Slovenia	West Bank
Britain	Gaza Strip	Israel	Norfolk Island	Spain	Yugoslavia
Bulgaria	Germany	Italy	Norway	Svalbard & Jan Mayen	
Croatia	Gibraltar	Liechtenstein	Poland		

India

Bangladesh	Bhutan	India	Maldives	Napal	Sri Lanka

Japan

Japan

Korea

North Korea	South Korea

Middle East

Afghanistan	Iraq	Oman	Turkmenistan
Armenia	Jordan	Pakistan	United Arab Emirates
Azerbaijan	Kuwait	Qatar	
Bahrain	Kyrgyztan	Saudi Arabia	Yemen
Egypt	Lebanon	Syria	
Iran	Morocco	Tajikistan	

North America

Bahamas	Cayman Islands	Johnston Atoll	Saint Lucia	Turks & Caicos Islands
Baker Island	Dominica	Midway Islands	Saint Pierre & Miquelon	U.S. Virgin Islands
Barbados	Dominican Republic	Montserrat Marianas		
Bermuda	Grenada	Northern Puerto Rico	Saint Vincent & the Grenadines	United States
British Virgin Islands	Jamaica	Saint Kitts & Nevis	Trinidad & Tobago	
Canada	Jarvis Island			

South Pacific

American Samoa	Cook Islands	Marshall Islands	Palau	Taiwan	Western Samoa
Australia	Fiji	Micronesia	Palmyra Atoll	Tokelau	
Brunei	French Polynesia	Nauru	Papua New Guinea	Tonga	
Christmas Island	Guam	New Caledonia	Philippines	Tuvalu	
Cocos (Keeling) Islands	Indonesia	New Zealand	Pitcalm Islands	Vanuatu	
	Kiribati	Niue	Solomon Islands	Wallis & Futuna	

South America

Anguilla	Aruba	Chile	Ecuador	Guyana	Netherlands Antilles	Surinam
Antigua & Barbuda	Bolivia	Columbia	French Guiana	Haiti	Paraguay	Uruguay
Argentina	Brazil	Cuba	Guadeloupe	Martinique	Peru	Venezuela

South East Asia

Burma	Cambodia	Laos	Malaysia	Singapore	Thailand	Vietnam

Iridium World Satellite Service (In-country/Domestic Voice Services)

Rates for satellite calls placed in the same country code as the second party. (For example, an Iridium caller located within Germany (country code 49) will receive domestic/in-country rates for all calls to numbers prefixed with the same country code (49). As Germany is a Domestic Zone 2 country, these calls would cost $2.99 per minute).

Zone (For country references, see attached pages.)	**Price**
Dom 1	$1.79
Dom 2	$2.99
Dom 3	$3.99
Dom 4	$4.99
Dom 5	$5.99
Dom 6	$6.99
Usage Fee (flat rate per month)	$70.00

Iridium World Roaming Service

With a dual–mode Iridium Phone you can take advantage of local cellular / terrestrial networks around the world, which include GSM (900, 1800, 1900), AMPS, TDMA (800, 1900) and CDMA (800, 1900). The rates below apply to calls made over these networks.

Zone (For country references, see attached pages)	**Price***
World 1	$1.49
World 2	$1.99

* Excludes long distance charge from customers cellular network to final call destination. If applicable, terrestrial long distance charges will appear on your bill.

Additional Services

Pager works in conjunction with Phone

Follow Me Paging (Pager works in conjunction with Phone)	**Price**
One-time Activation	$ 40.00
Usage	$ 40.00/mth

Other Services	**Fee/Month**
Voice Mail (available for all Iridium Services)	$ 19.95/mth

NOTES:

1. Call is automatically billed as in -country satellite when the satellite call origination country code is the same as the call termination country code.
2. Calls billed at 1 minute minimum and 1 minute increments.
3. Unlimited number of pages per month up to 120 characters per page (includes header information if sent via e-mail).
4. 200-message limit for pages sent via Internet (e-mail and web page).
5. Pages are broadcast to 3 message delivery areas (MDAs) selected by the customer.
6. Taxes are not included.

For more information on our rates please call:

- **INSIDE NORTH AMERICA** **1-888-766-1313**
- **OUTSIDE NORTH AMERICA** **+1 (709) 748-4233**
- **INTERNET** **info@stratos.ca**
- **WEBSITE** **www.stratos.ca**

Iridium World Satellite Service In-country/Domestic Zones

Dom 1

Anguilla	Canada	Japan	Puerto Rico	Trinidad and Tobago
Antigua and Barbuda	Cayman Islands	Jarvis Island	Saint Kitts and Nevis	Turks and Caicos Islands
Bahamas	China	Latvia	Saint Lucia	U.S. Virgin Islands
Barbados	Dominica	Midway Islands	Saint Pierre and Miquelon	United States
Belarus	Dominican Republic	Moldavia	Saint Vincent and the Grenadines	Wake Island
Bermuda	Grenada	Montserrat	South Korea	
British Virgin Islands	Guam	North Korea		
	Jamaica	Northern Marianas		

Dom 2

Albania	Bulgaria	French Guyana	Italy	Netherlands Antilles	Slovenia	Vatican City
Algeria	Burundi	Gabon	Jordan	New Caledonia	Spain	Venezuela
Andorra	Chile	Gambia	Kazakhstan	Nicaragua	Sri Lanka	West Bank
Argentina	Christmas Island	Gaza Strip	Kenya	Norway	Surinam	Yemen
Aruba	Cocos (Keeling) Islands	Georgia	Kuwait	Oman	Svalbard and Jan Mayen	Yugoslavia
Australia	Colombia	Germany	Lebanon	Panama	Swaziland	Zambia
Austria	Costa Rica	Gibraltar	Lesotho	Paraguay	Sweden	
Bahrain	Cyprus	Golan Heights	Liberia	Peru	Switzerland	
Bangladesh	Czech Republic	Greece	Libya	Poland	Taiwan	
Belgium	Denmark	Greenland	Liechtenstein	Portugal	Tanzania	
Belize	Djibouti	Guadeloupe	Lithuania	Qatar	Thailand	
Bhutan	Ecuador	Guatemala	Luxembourg	Romania	Turkey	
Bolivia	El Salvador	Guyana	Malta	Russia	Ukraine	
Bosnia and Herzegovina	Estonia	Honduras	Martinique	Saint Helena	United Arab Emirates	
Botswana	Faroe Islands	Hungary	Mexico	San Marino	Uruguay	
Brazil	Finland	Iceland	Monaco	Saudi Arabia	Uzbekistan	
Britain	France	Ireland	Mongolia	Slovakia		
		Israel	Netherlands			

Dom3

Angola	Fiji	Macedonia	Namibia	Philippines	Syria
Baker Island	French Polynesia	Madagascar	Nauru	Pitcalm Islands	Tokelau
Brunei	Ghana	Malawi	Nepal	Reunion	Tonga
Burkina Faso	Hong Kong	Malaysia	New Zealand	Sao Tome and Principe	Tuvalu
Cape Verde	India	Maldives	Niger	Senegal	Uganda
Croatia	Indonesia	Marshall Islands	Nigeria	Singapore	Vanuatu
Egypt	Ivory Coast	Mauritius	Niue	South Africa	Western Samoa
Eritrea	Johnston Atoll	Morocco	Palau	Sudan	Zimbabwe
Ethiopia	Macao	Mozambique	Papua New Guinea		

Dom 4

Benin	Cook Islands	Kiribati	Seychelles	Tunisia
Burma (Myanmar)	Guinea	Mauritania	Solomon Islands	Wallis and Futuna
Central African Republic	Haiti	Micronesia	Tajikistan	Zaire
	Iran	Pakistan	Togo	

Dom 5

American Samoa	Cambodia	Congo	Iraq	Mali	Sierra Leone
Armenia	Cameroon	Falkland Islands	Kyrgyztan	Norfolk Island	Turkmenistan
Azerbaijan	Comoros	Guinea-Bissau	Laos	Rwanda	Vietnam

Dom 6

Afghanistan	Chad	Cuba	Equatorial Guinea	Mayotte	Somalia

Iridium World Roaming Service

World 1

American Samoa	Cocos (Keeling) Islands	Gaza Strip	Kazakhstan	Mongolia	Romania	Tokelau
Australia	Cameroon	Ghana	Kiribati	Montserrat	Russia	Tajikistan
Azerbaijan	Cape Verde	Golan Hights	Kyrgyztan	Malta	San Marino	Turkmenistan
Afghanistan	Central African Republic	Guinea	Kenya	Malaysia	Switzerland	Tanzania
Algeria	Chad	Guinea-Bissau	Latvia	New Caledonia	Seychelles	Togo
Angola	Comoros	Germany	Liechtenstein	New Zealand	Singapore	Tunisia
Albania	Congo	Georgia	Lithuania	Norfolk Island	Sri Lanka	Turkey
Armenia	Cyprus	Gibraltar	Lebanon	Namibia	Slovakia	Taiwan
Andorra	China	Guam	Lesotho	Niger	Slovenia	Tonga
Austria	Cook Islands	Greece	Liberia	Netherlands	Sao Tom & Principe	Tuvalu
Baker Island	Croatia	Greenland	Libya	Norway	Saudi Arabia	Ukraine
Bangladesh	Czech Republic	Hungary	Luxembourg	Nauru	Senegal	Uganda
Bhutan	Denmark	Hong Kong	Laos	Niue	Sierra Leone	United Arab Emerates
Burma	Egypt	India	Maldives	Napal	Somalia	Uzbekistan
Belgium	Equatorial Guinea	Indonesia	Mauritius	North Korea	Spain	Vatican City
Bahrain	Eritrea	Iceland	Mayotte	Oman	South Africa	Vietnam
Benin	Ethiopia	Iran	Moldavia	Pitcalm Islands	Sudan	Vanuatu
Botswana	Estonia	Iraq	Monaco	Poland	Swaziland	Wake Island
Burkina Faso	France	Israel	Madagascar	Portugal	Syria	Wallis and Futuna
Burundi	Fiji	Ivory Coast	Malawi	Pakistan	Svalbard & Jan Mayen	Western Samoa
Belarus	French Polynesia	Italy	Mali	Palau	Solomon Islands	Yugoslavia
Bosnia & Herzegovina	Finland	Ireland	Mauritania	Philippines	South Korea	Yemen
Britain	Faroe Islands	Jarvis Islands	Morocco	Palmyra Atoll	Saint Helena	Zaire
Bulgaria	Gabon	Johnston Atoll	Mozambique	Papua New Guinea	Sweden	Zambia
Cambodia	Gambia	Japan	Macao	Qatar	Thailand	Zimbabwe
Christmas Island		Jordan	Marshall Islands	Reunion		
		Kuwait	Micronesia	Rwanda		

World 2

Argentina	British Virgin Islands	Ecuador	Jamaica	Panama	Turks & Caicos Islands
Antigua & Barbuda	Chile	El Salvador	Martinique	Puerto Rica	Urugay
Aruba	Colombia	Falkland Islands	Mexico	Surinam	U.S. Virgin Islands
Bolivia	Canada	French Guiana	Midway Islands	Saint Kitts & Nevis	United States
Brazil	Cayman Islands	Guyana	Netherlands Antilles	Saint Lucia	Venezuela
Bahamas	Costa Rica	Grenada	Nicaragua	Saint Pierre & Miquelon	
Barbados	Cuba	Guadeloupe	Northern Marianas	Saint Vincent & the Grenadines	
Belize	Dominica	Guatemala	Paraguay	Trinidad & Tobago	
Bermuda	Dominican Republic	Haiti	West Bank		
		Honduras			

STRATOS

PRICE LIST

IRIDIUM® EQUIPMENT
Motorola Phones, Pagers & Accessories

Effective April 1, 1999 - All prices in US dollars

Stratos provides its Motorola phones and pager as part of complete hardware and standard accessory packages. Cellular cassettes for the Motorola Satellite Series 9500 Portable Telephone and accessories for all of the equipment are also available separately.

Satellite Series 9500 Portable Telephone **$2,995.00**

- Satellite Portable Telephone
- Standard Battery
- Auto Accessory Adapter
- AC Charger w/ Inf Plug Kit
- Leather Holster with Lanyard
- SIM Card

Satellite Series 9520 Mobile Telephone **$2,995.00**

- Satellite Mobile Telephone
- Cabling & Hardware
- Hang-Up Cup w/ SIM Card Reader
- Microphone
- Speaker
- SIM Card

Satellite Series 9551 Cellular Cassette CDMA/AMPS at 800 MHz **$ 595.00**

Satellite Series 9550 Cellular Cassette GSM at 900 MHz **$ 495.00**

Satellite Series 9501 System Pager **$ 695.00**

- Pager
- AA Battery
- Holster with Lanyard

Accessories

• Leather Holster w/ Lanyard	$ 99.95	• Battery Ultra High Capacity LI ION	$ 339.95
• Antenna Adapter	$ 119.95	• Satellite Portable Spare Antenna	$ 374.95
• StarTAC Adapter Plug	$ 74.95	• Portable Auxiliary Antenna	$ 267.95
• Satellite Series 9570 Portable Dock	$ 944.95	• Solar Charger	$ 964.95
• Desktop Charger	$ 264.95	• Fixed Mount Antenna	$ 399.95
• AC Travel Charger w/ Inf Plug Kit	$ 139.95	• Mobile Magnetic Mount Antenna	$ 267.95
• Auto Accessory Adapter	$ 99.95	• Additional SIM Card	$ 19.95
• Battery Standard Cap LI ION	$ 184.95	• Mobile Permanent Mount Antenna	$ 267.95
• Battery High Capacity LI ION	$ 234.95	• 10m Cable for Fixed Mast Antenna	$ 399.85

Stratos reserves the right to alter pricing.

Revised: April999 P.IRMP&P.0019E.220499

NOTES:

1. All prices are FOB Fort Lauderdale, Florida, U.S.
2. All taxes, duties, customs/license charges and any other governmental fees shall be over and above the Stratos quoted price.

For more information on our equipment pricing please call:

• **INSIDE NORTH AMERICA**	**1-888-766-1313**
• **OUTSIDE NORTH AMERICA**	**+1 (709) 748-4233**
• **INTERNET**	**info@stratos.ca**
• **WEBSITE**	**www.stratos.ca**

STRATOS

SERVICE RATES

IRIDIUM® AIRTIME RATES

Effective June 1, 1999- All Prices in US Dollars

Plan A

A one-time activation fee of $99.95 will apply.

Service	Monthly Fee
Access	$ 34.95
Voice Mail	$ 19.95
Follow Me Paging	N/C

Pricing Per Minute	Rate
Country Code (CC-1 to CC-1)/ISU-ISU	$ 1.89
Int'l Waters to any PSTN (except Inmarsat)	$ 2.99
All Other Satellite	$ 3.99
Usage Pricing – Iridium World Roaming Service	$ 1.59

Plan B

A one-time activation fee of $199.95 will apply.

Service	Monthly Fee
Access	N/C
Voice Mail	$ 19.95
Follow Me Paging	N/C

Pricing Per Minute	Rate
Alaska to North America	$ 1.59
Country Code (CC-1 to CC-1)/ISU-ISU	$ 1.99
Int'l Waters to CC-1	$ 2.99
All Other Satellite	$ 4.49
Usage Pricing – Iridium World Roaming Service	$ 2.19

Paging Service

A one-time activation fee of $119.95 will apply (includes SIM card).

Service	Monthly Fee
Access	$ 34.95
Voice Mail	$ 19.95

NOTES:

1. CC-1 includes: Anguilla, Antigua and Barbuda, Bahamas, Barbados, Bermuda, British Virgin Islands, Canada, Cayman Islands, Dominica, Dominican Republic, Grenada, Jamaica, Montserrat, Northern Marianas, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, United States Virgin Islands, Trinidad and Tobago, Turks and Caicos Islands, and United States.
2. ISU-ISU is a call from an Iridium terminal to another Iridium terminal.
3. Calls billed at 1 minute minimum and 1 minute increments.
4. Unlimited number of pages per month up to 120 characters per page (includes header information if sent via e-mail).
5. 200-message limit for pages sent via Internet (e-mail and web page).
6. Pages are broadcast to 3 message delivery areas (MDAs) selected by the customer.

For more information on our rates please call:

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- **WEBSITE** **www.stratos.ca**

Attachment B
Qualcomm
Satellite Based Data/Position
Communication

Brunet, Pierre FL12

From: Dandan Pan
Sent: Thursday, July 08, 1999 5:27 PM
To: pbrunet@icfkaiser.com
Subject: railroad info.

Dear Pierre:

Here is the information regardingOmniTRACS' Railroad implementations around the world.

We have enjoyed good success in this area. Railroad companies too have come to recognize the value of OmniTRACS in meeting their logistics and communications requirements.

A.) Railroad implementation in the United States

In the United States there are OmniTRACS units on AMTRAK passenger trains as well a pilot with Southern Pacific Railways. AMTRAK (America's Passenger Railroad Company) uses the OmniTRACS system to communicate with its fleet in the western United States operating on railroad tracks own by others. AMTRAK also uses the system to notify destination stations of sleeper berth changes/availability, and to maintain adequate supplies in café cars.

We have recently decided to pursue the US railroad industry more vigorously and are talking with a number of existing suppliers to railroad companies about collaborative efforts.

B.) Railroad implementation in Brazil

In Brazil there are over 1,000 OmniTRACS units employed by railroad cargo companies Ferrovia Atlantico Sul (Atlantic South Railroad), and Ferrovia Centro Atlantico (Atlantic Central Railroad) for the following:

1. "Licenciamento"- The authorization of one train to move from one station to the next. This is required because all tracks are "single tracks". In order to avoid collisions one train needs to wait in the station while another approaches, then passes in the same station. Then, the waiting train can move forward. OmniTRACS Macro messages are used for this purpose.

2. Maintenance- Maintenance crews use a portable version of the MCT to communicate while out in the field (where there are no other communications). The MCT is actually mounted on a portable container that can be moved from car to car as needed.

3. General Purpose- There is a small number of units on different types of vehicles serving the railroad company and stand alone systems at train stations where there is no other means of communications.

C.) Railroad implementation in Japan

In Japan, there are currently 230 OmniTRACS units installed on Japan Rail Freight (which deal with cargo only). JRF uses OmniTRACS for position tracking and limited communication from JRF control center to the driver/engineer. Though JRF has its own private voice communications network which is still used for day to day voice communications, OmniTRACS is

used to send (a) Driver log on/log off macros to the control center and (b) emergency communication when trains are in areas where there is no radio coverage for voice.

Our Japan Partner has developed a patented technology called "Freight Train Position Detection System"(also referred to as "signpost") which functions as follows:

(a) OBC(On Board Computer) unit's data card holds information about the pre-programmed routes and signpost information corresponding to that route.
(b) Along a pre-determined route, train stations are designated as the signpost area's focal point. Each focal point has assigned to it an "inner radius" and an "outer radius" which is used to determine when a train has entered or exited the signpost area.
(c) The OBC is programmed to obtain GPS position data every 5 minutes. It calculates the distance between its actual position and the preprogrammed signpost focal point. It also detects when the train has entered the inner radius and when it has exited. This info is sent back to the JRF control center via the NMC and used to monitor where and when the train has actually travelled.

I also looked around. There is not much latest brochures in this area. The information I have are those I sent to Charles Fisher a while ago.

- □□□□□□□Satellite Communications For AMTRAK Long Distance Trains
- □□□□□□□A system diagram of OmniTRACS application for trains
- □□□□□□□OMNITRACS Outdoor Unit Mount Installation Guide (AMA-501)
- □□□□□□□OmniTRACS Locomotive Crew User Manual

Do you still need them? Could you please send your address once again? Thanks.

Please don't hesitate to contact me directly if you require additional information.

Best Regards,

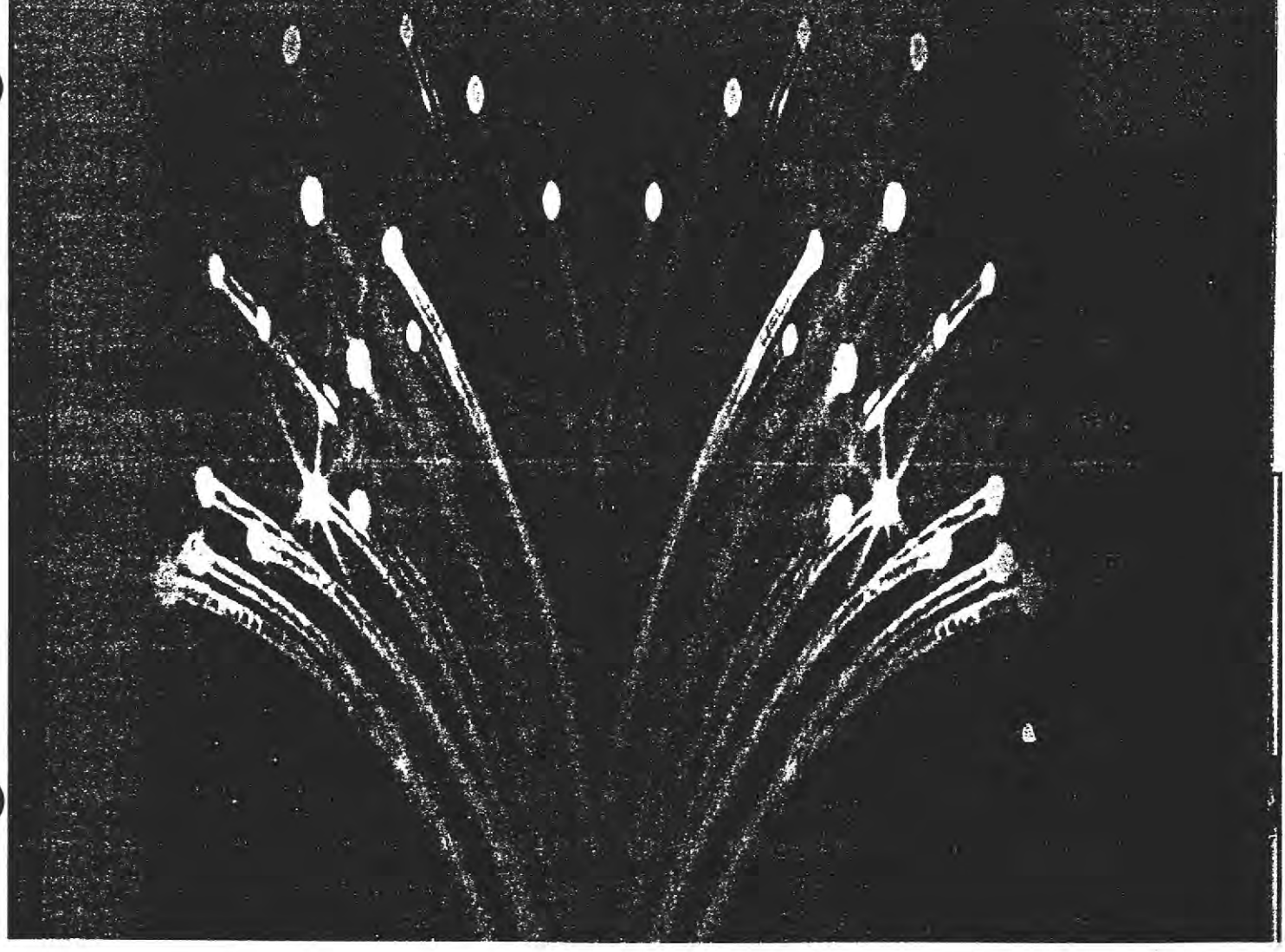
Dandan

Dandan Pan
Program Manager
QUALCOMM Wireless Business Solutions
Phone: 619-658-3558
Fax: 619-658-5061
Office: O-252G

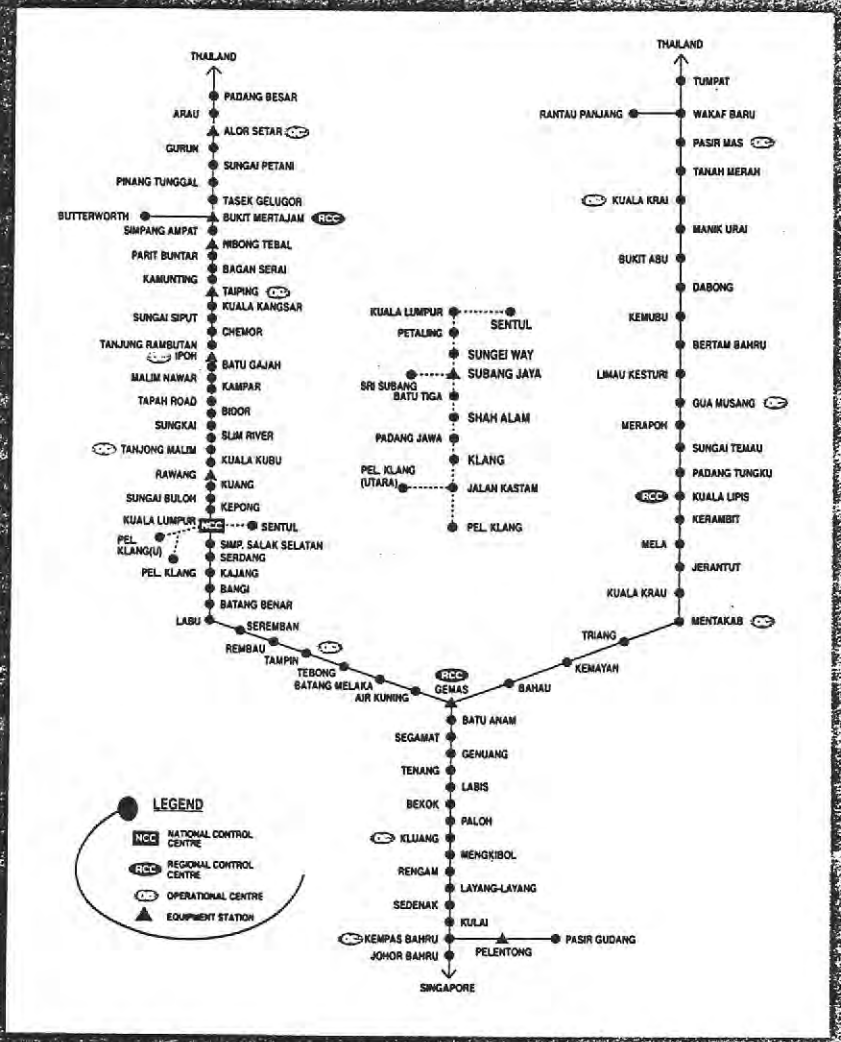
Attachment C
Fiberail
Fiber Optic Land Based Communication

Fiberail

The Network Highway



Fiberail's Fibre Optic Network Support Centres



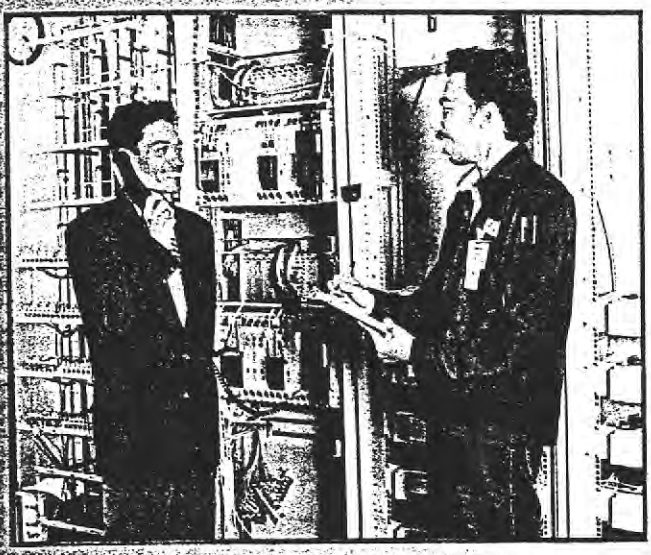
Products and Services

- Lease of Dark Fibre Optic Core
- Digitaline Services (2 / 34 Mbps)
- Lease of Broadband Services
  - STM-1 (155 Mbps), STM-4 (620 Mbps), STM-16 (2.5 Gbps)
- Ancillary Services
  - Telecommunications Tower
  - Telecommunications Equipment Cabin Space
- Turnkey Network Solution

Target Market

- Telecommunications Operators
- Information Technology Industry
- Broadcasting Organisations
- IT Multimedia Service Providers
- Multinational Corporations

Customer Support Services



NATIONAL CONTROL CENTRE (NCC)

- Located in KL and fully computerized with Network Management System (NMS)
- Operates 24 hours

REGIONAL CONTROL CENTRE (RCC)

- Strategically located at major towns
- Network restoration and fault rectification

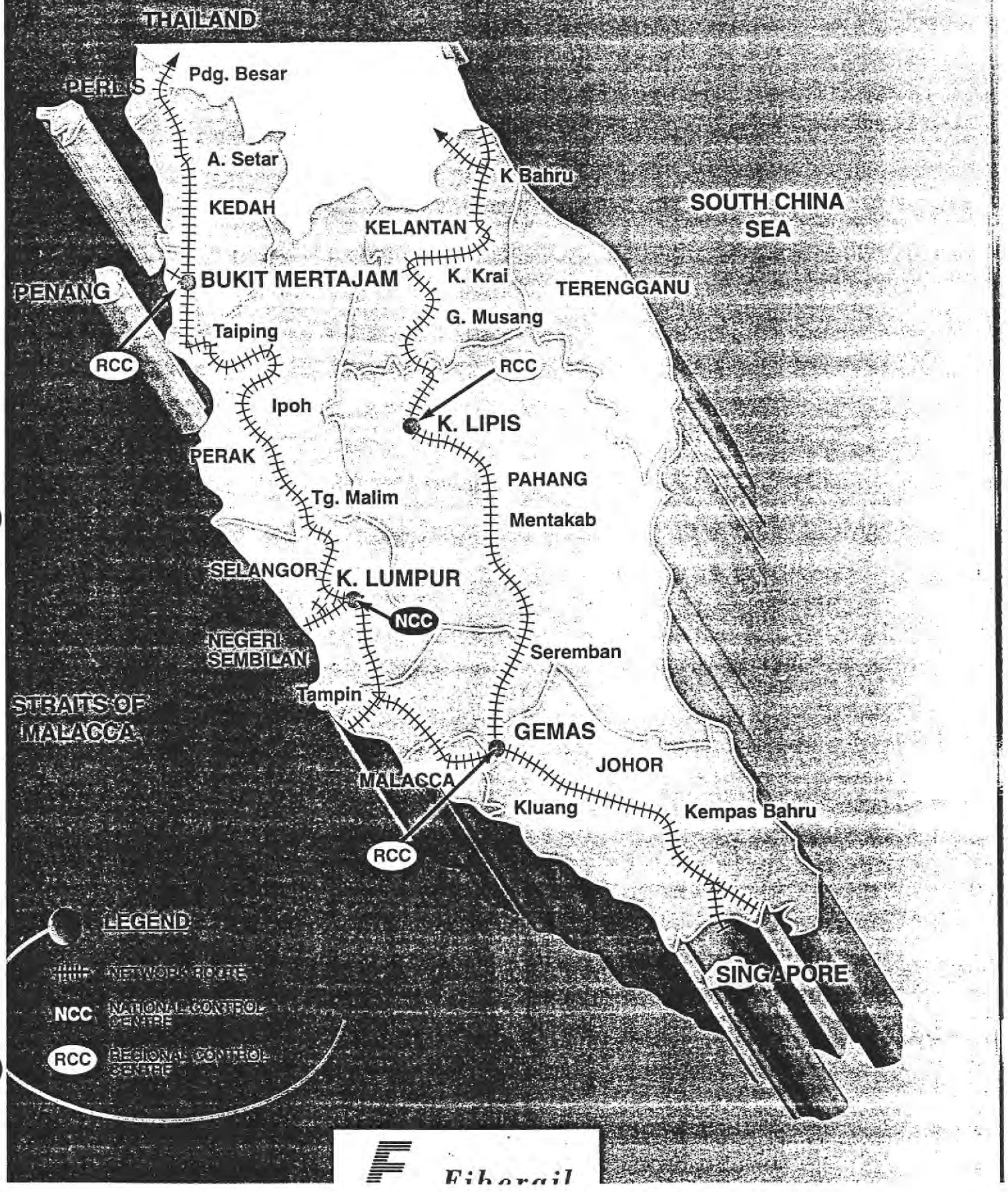
OPERATION CENTRE (OC)

- Located at major towns throughout Peninsular Malaysia
- Urgent fault restoration services

Professional Bussiness Support Services

TIBERAIL shall provide personalised services with expertise to develop a competitive and excellent business communications network for your organization.

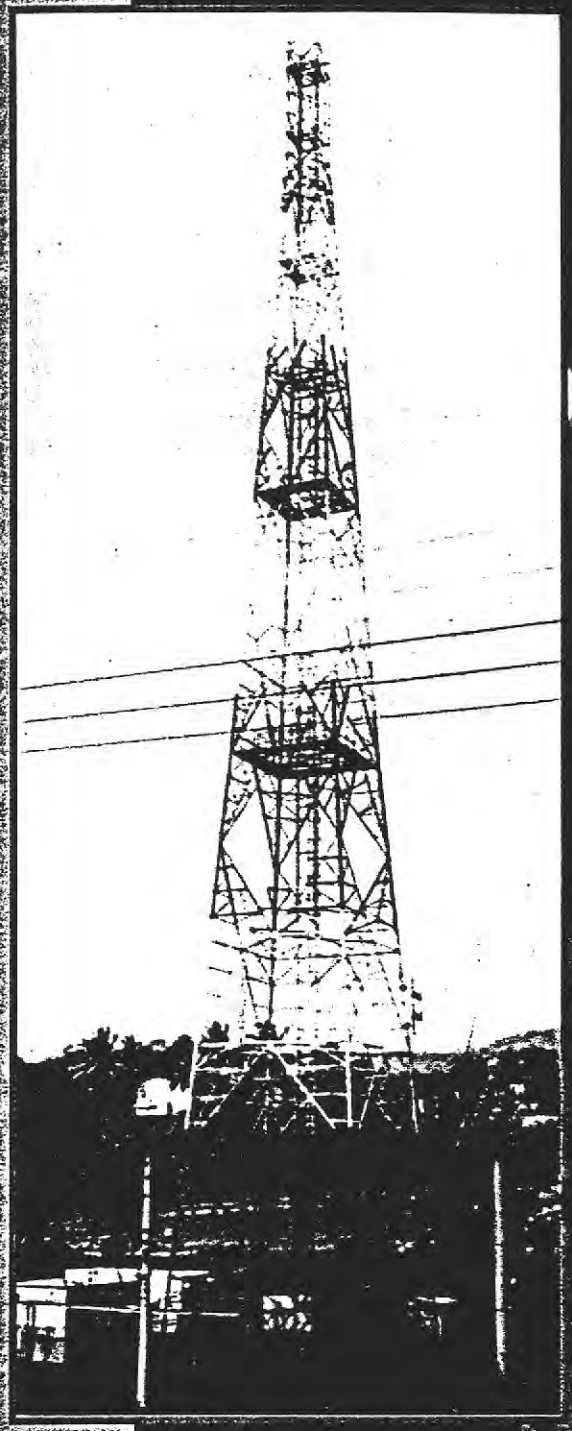
Fiberail's Fibre Optic Network Route



Fiberail

Ancillary Services
Telecommunications Tower

- FIBERAILS telecommunications tower can be constructed throughout our terminating stations which covers all the major towns in Peninsular Malaysia.
- It can accomodate a wide range of antennas for microwave transmission, broadcasting & repeaters.



Telecommunications Tower Location

Locations	Height
Alor Setar	250'
B. Merlajam	300'
Taiping	200'
Ipoh	150'
Tanjung Malim	200'
Bayang	250'
Padang Jawa	300'
Seremban	250'
Tampin	300'
Semas	300'
Pelentong	200'
Pasir Gudang	200'

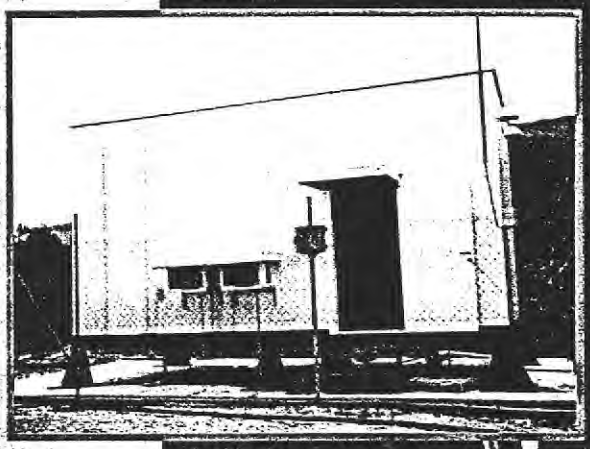
Telecommunications Tower Specifications

- A legged or monopole
- Made of structural steel using angles, gusset plates, high tensile nuts and bolts.
- Tower height varies between 150 feet to 300 feet
- Resting and working platforms are provided at certain height levels of the tower
- All steel work are hot dipped galvanize and have a minimum life span of 50 years
- Lightning arrester and aviation warning lights are provided
- Tower is designed to withstand wind load up to 150 kph

For more information, Please call **603 - 780 9696**

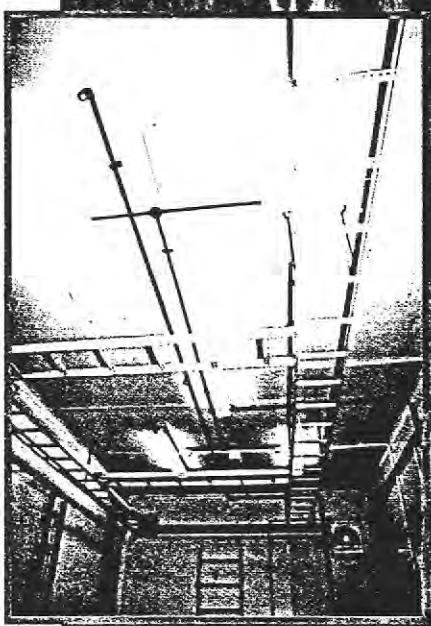
Ancillary Services
Telecommunications Equipment Cabin

- **FIBERAIL'S** telecommunications equipment cabin can be constructed throughout our terminating stations which cover all the major towns in Peninsular Malaysia.
- Usage of the telecommunications equipment cabin is to install transmission and switching equipments and to link from one site to the other.



Telecommunication Equipments Cabin Location

- Padang Besar
- Arau
- Alor Setar
- Gurun
- Sg. Petani
- Bukit Mertajam
- Nibong Tebal
- Parit Buntar
- Bagan Serai
- Taiping
- Kuala Kangsar
- Sg. Siput
- Ipoh
- Kampar
- Sungkai
- Tg. Malim
- Rawang
- Padang Jawa
- Kajang
- Batang Benar
- Tampin
- Gemas
- Segamat
- Labis
- Bekok
- Kluang
- Renggam
- Sedenak
- Pasir Gudang
- Pelentong
- Kemayan
- Mentakab
- Jerantut
- Kerambit
- Chegar Perah
- Sg. Temau
- Gua Musang
- Kemubu
- Kuala Krai
- Tanah Merah



Telecommunications Equipment Cabin Specifications

- Custom made
- Insulation material used is polyurethane- provides good insulation up to 6 hours during air-cond breakdown
- Good insulation allows savings on electricity consumption for air-cond unit
- Material used is 100% rust proof and durable against all weather conditions
- Roof sheet is specially designed as cliplock thus being 100% leak proof
- Cabin can be transported to site as CBU or CKD
- Fire detection and fire fighting equipment will be provided

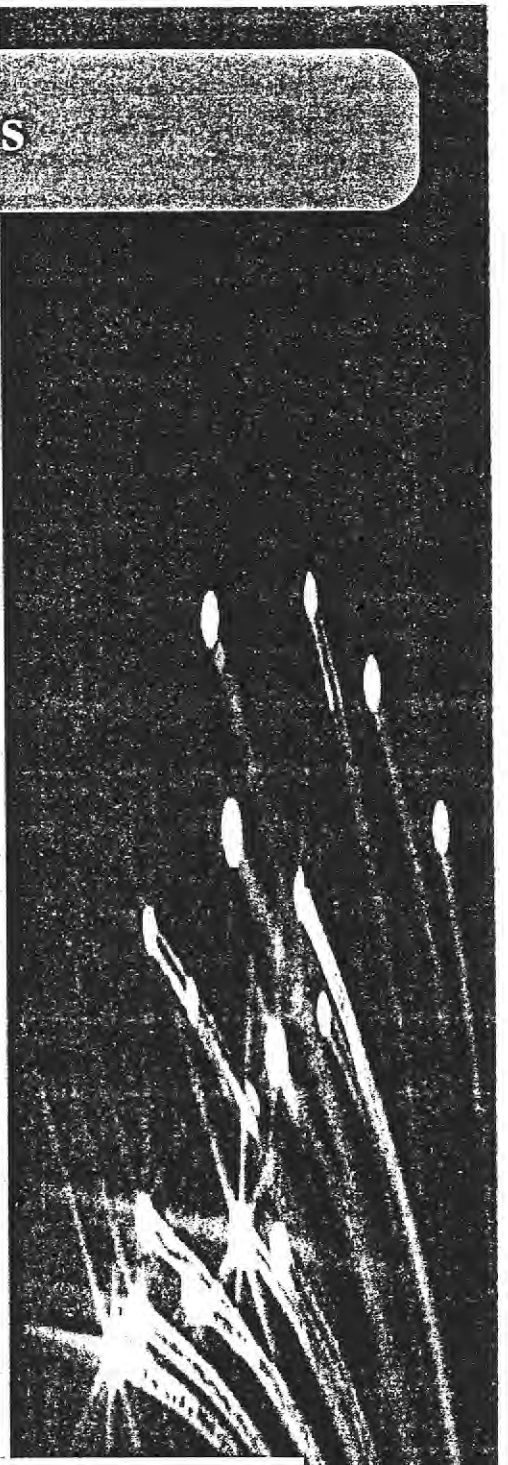
For more information Please call **603 - 780 9696**

Digitaline Services

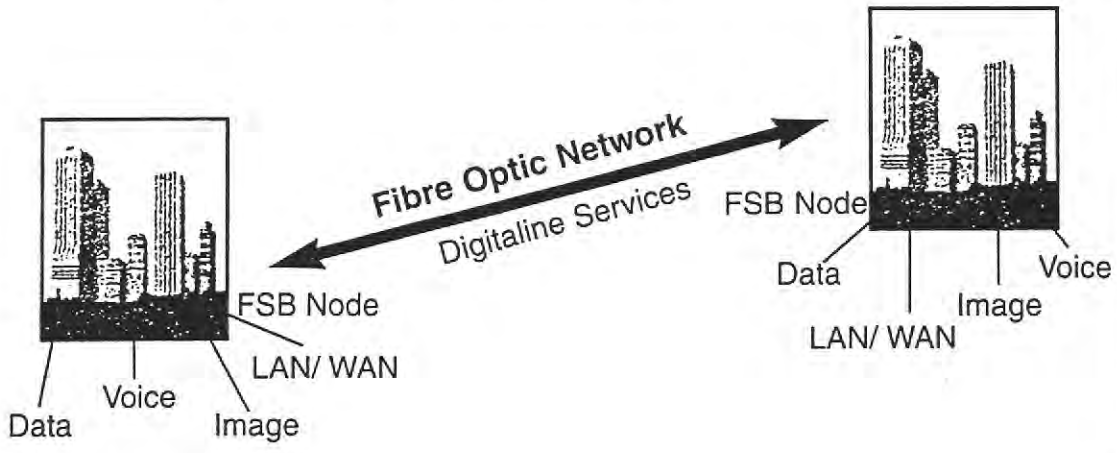
Leased Digitaline Services (2 / 34 Mbps)

The convergence of **data**, **voice** and **image** technologies are causing a dramatic shift in the information transmission paradigm. **FIBERAIL'S** leased digitaline services can ensure quality of information transmission on our fibre optic trunk network. This digitaline services enhances business potential including **Telcos, LANs, WANs, IT network suppliers** and overall broadcasting industry that will be the primary providers.

FIBERAIL'S digitaline services shall provide the connectivity and transmission from point-to-point dedicated lines to the customer's premises. Our team of dedicated technical engineers will ensure the feasibility of the connection to allow the transmission to be established.



Digitaline Point-to-Point Connectivity



Exclusivity of Service Specifications

- 100% fibre optic network transmission
- High transmission capacity of large volume of information (i.e. voice, data, image and video transmission)
- Point-to-point fibre optic connection and transmission
- Improved quality of transmission, no cross line or interference
- Flexibility in future upgrade on network capacity

Benefits to Our Customers

- Flexible payment terms
- Cost savings on investment for long term contract
- After-sales support and maintenance services
- Loyalty incentives and attractive tariff for volume and long term of service contract
- Fast turn around response on request for digitaline services
- No installation fee for point-to-point connectivity

Usage of Digitaline Services

- Cellular and Mobile Services
- Fixed line Networks
- High Speed Network Transmission (Voice, Data, Image or Video)
- Tele - Video Conferencing
- Multimedia IT Applications
- Private Network
- Broadcasting Transmission

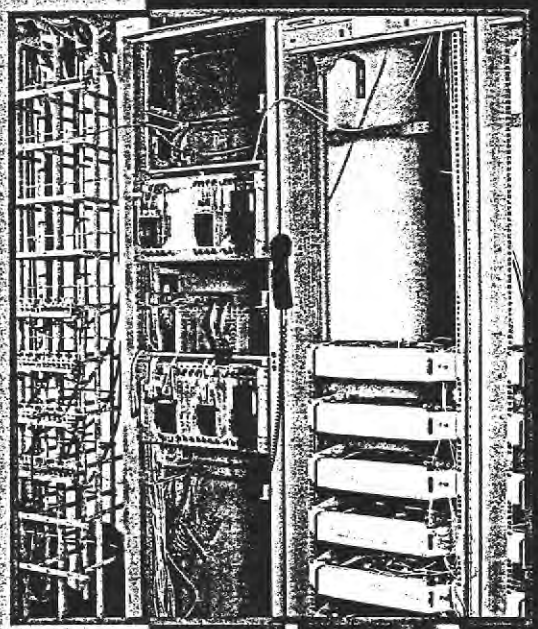
For more information, Please call **603 - 780 9696**

Fibre Optic Core Network

Here's your opportunity for a new choice in communications. **FIBERAIL** connects you from local, regional to global, allowing you to achieve business competitiveness and excellence.

Our established 100% fibre optic network provides you with the benefits of superior service, expertise, excellent resources, high quality and competitive rates.

FIBERAIL will meet all your business communications requirements for speedy and excellent connectivity service to stretch your business potential.



Service Packages

SERVICE PACKAGE	FROM	TO	REGION	DISTANCE (KM)
Optical Fibre Core Package 1	P. Besar B. Mertajam	Kuala Lumpur Butterworth	Northern Northern	545 12
Optical Fibre Core Package 2	Sentul	Pelabuhan Klang	Central	59
Optical Fibre Core Package 3	K. Lumpur Kempas Baru	Johor Bahru Pasir Gudang	Southern Southern	370 29
Optical Fibre Core Package 4	Seremban	Port Dickson	Southern	36
Optical Fibre Core Package 5	Gemas	Kuala Lipis	Eastern	228
Optical Fibre Core Package 6	Kuala Lipis Pasir Mas	Wakaf Baru R. Panjang	Eastern Eastern	286 19
			GRAND TOTAL	**1,584**

Exclusivity Of Product Specifications

- 100% Fibre Optic Network
- Fibre Optic Core in compliance to CCITT Recommendation Series G.652
- Synchoronous Digital Hierarchy (SDH) transmission consists of Add Drop Multiplexer (ADM) and Terminating Multiplexer (TM) in compliance to CCITT Recommendation Series G.7xx, G.8xx, G.9xx.
- Network Management System (NMS) for monitoring, controlling and performance management of Fibre Optic Network
- Scaleability and upgradibility on network capacity

Benefits to Our Customers

- Competitive tariff
- Fully managed network
- Reliable 24 hour support centre
- Customised Total Solution
- Loyalty incentive for long term contract

Usage Of Fibre Optic Network

- Cellular and Mobile Services
- Fixed line Networks
- High Speed Network Transmission (Voice, Data, Image or Video)
- Tele - Video Conferencing
- Multimedia IT Applications
- Private Network
- Broadcasting Transmission

For more information Please call **603 - 780 9696**

Attachment D
Adtranz CTC
CTC Signaling

Computer systems for effective traffic management

Train movements over a wide geographical area can be controlled and supervised effectively at the traffic control centre. Traffic controllers follow train movements on computer screens, which show current train routes, point positions, signal aspects, and train position.

The computerised traffic management system controls all types of trains in mixed traffic environments – high-speed trains as well as freight and express trains.

The traffic management system automatically sets train routes, in other words, it determines the route a train takes from A to B. This relieves traffic controllers of routine tasks. The routes are laid out with the help of time-tabled route plans for trains within a

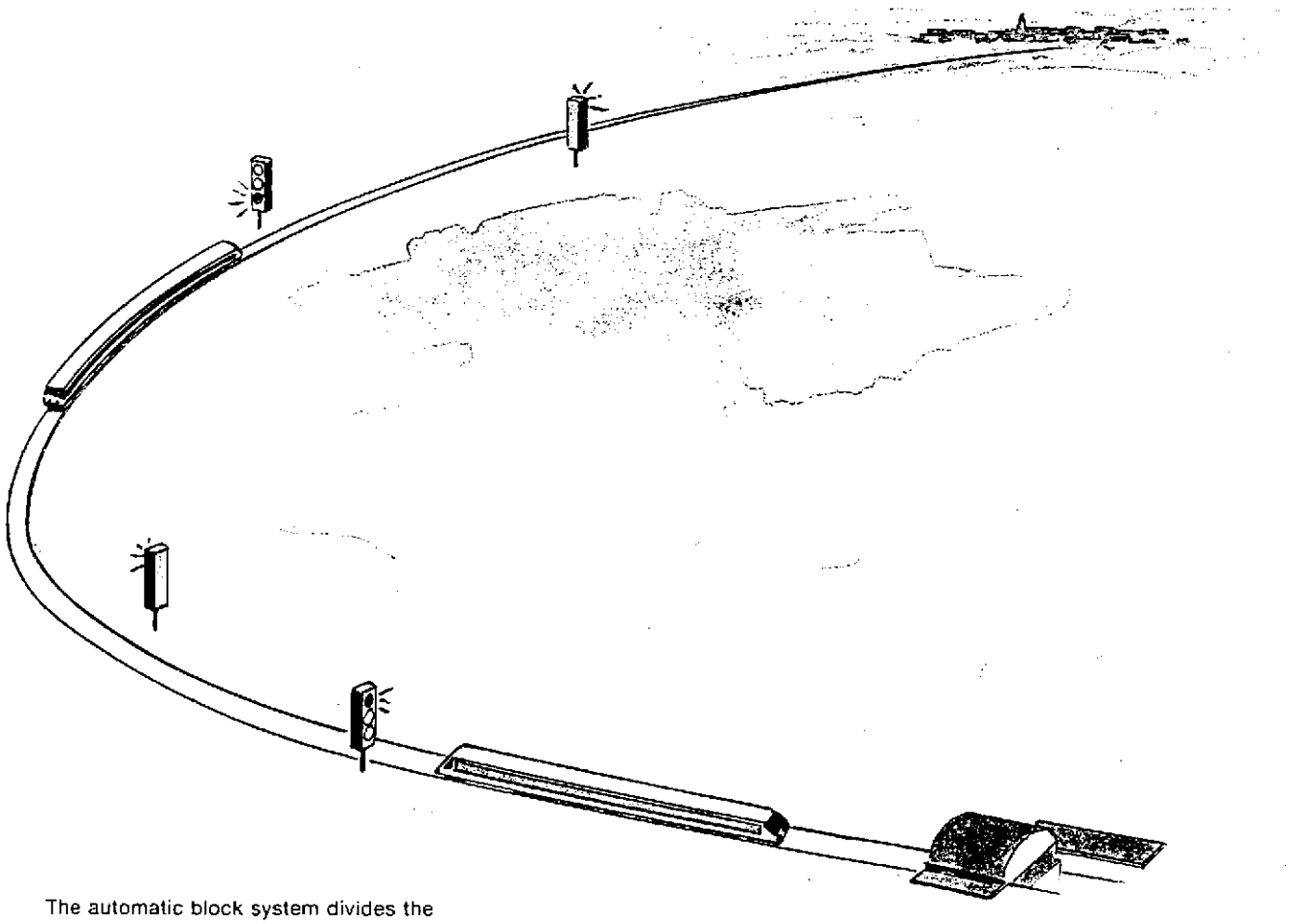
Traffic controllers at the control centre can easily supervise train traffic. Each workstation has its own computer display which shows train routes in detail, along with information about current train location and destination. The control centre also features a wall panel showing the current traffic situation on all tracks.

specific area. They can also be set manually by traffic controllers.

When a route is established, the relevant command is sent to the interlocking system, which automatically executes the operation safely. Information between traffic control centres, interlocking systems, and trains is conveyed by radio, cables and equipment installed in the track.

Modern traffic management systems can be integrated with power supply control systems, SCADA. This makes it possible for operators to regulate the power distribution on the traffic network, i e traction power control. The power supply voltage can be increased or decreased during high or low traffic.

Positioning of trains on the line

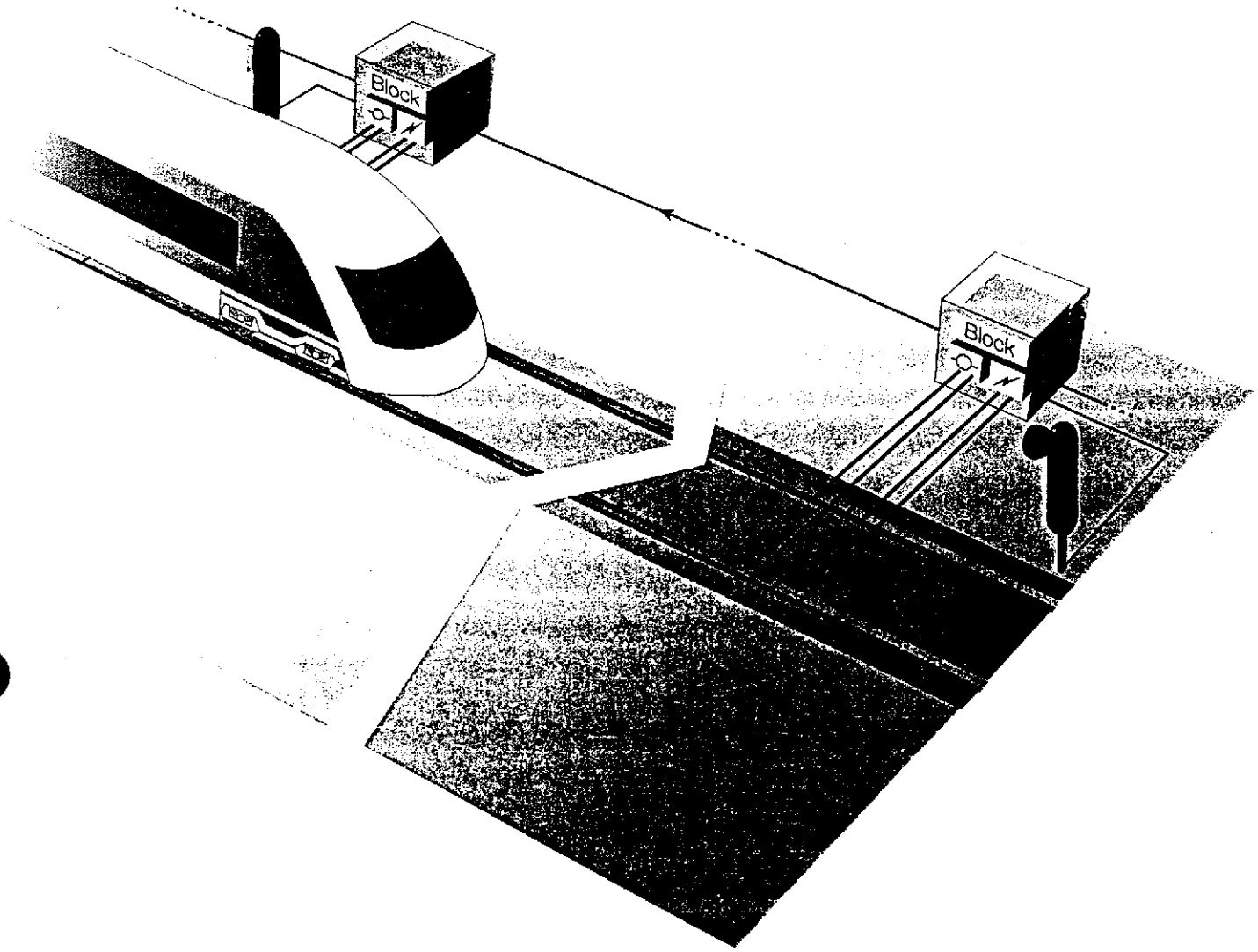


The automatic block system divides the line into a number of isolated sections. One train is allowed to occupy each section. This means that two trains can operate a line divided into two sections, and three trains can occupy a line that is divided into three sections. The number of, and the length of these sections are decided by considering the traffic capacity and speed.

An automatic block system will detect traffic on a line between stations and indicates the position of any train to the traffic control centre. The system enables several trains to use the line simultaneously, while ensuring maximum safety.

Before the train dispatcher can clear the starter signal at the first block section to green and allow a train to exit the station, the block system detects that the block is free and that there are no trains on the line coming from the opposite direction.

When the train occupies the first block section the starter signal is set to red. No other train is allowed to enter the block section until the first train has left that section. The starter signal then returns to green.

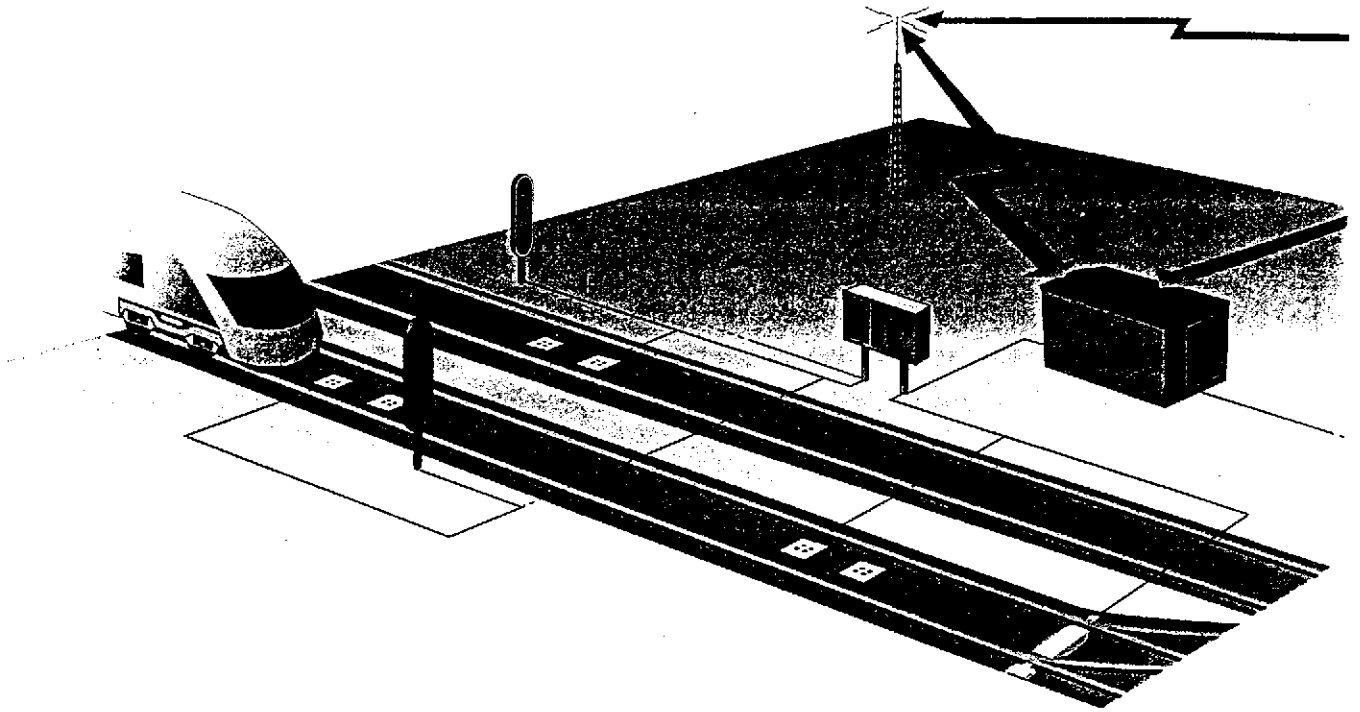


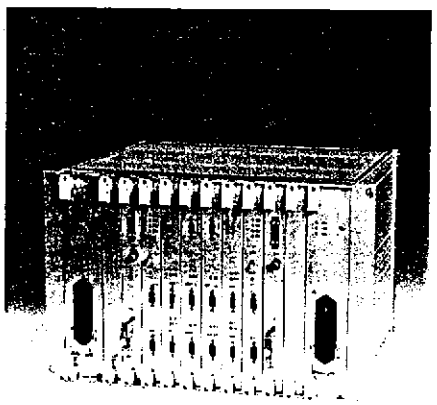
At one end of each block section there is a voltage source, a battery. A relay is positioned at the other end. The battery feeds the rails, forming a track circuit, with current. This activates the relay.

When a train enters a track circuit or section, the power circuit is short-circuited and the relay losing power switches to an off or safe position. This action is detected by the automatic block system which, via the interlocking, informs the traffic control centre that the section is occupied.

The block system automatically controls signals at the remaining sections according to the same principle, i.e. when the section in front of the train is unoccupied the block system sets the signal to green, and when a train occupies the section the signal is set to red.

Computerised interlocking systems for stations and lines





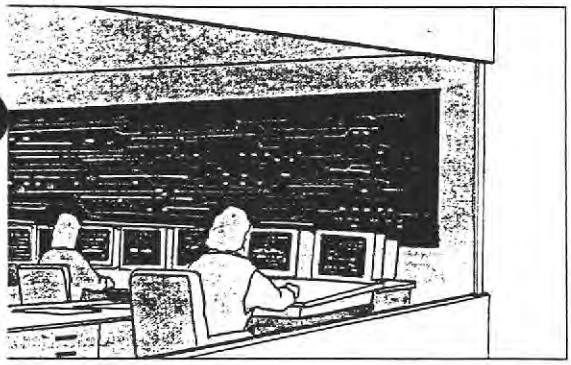
The central interlocking computer is very compact.

The interlocking system supervises and controls wayside objects such as signals, point machines, derailers, and level crossing protection, in such a manner that trains can run safely. Before the interlocking system allows a signal aspect to display green it checks that the train route after the signal is clear of trains and that all points are locked in the correct positions. By default the interlocking system will ensure that no other route can be selected using the same length of track.

The interlocking system can be controlled remotely from the traffic control centre or locally from a terminal directly connected to the interlocking. It receives commands about train routes to be set, and then directs track objects along these routes.

The computerised interlocking system has a modular structure and can control stations with any number of track objects, as well as sections of track between stations (lines). Geographical coverage is increased with the addition of more modules.

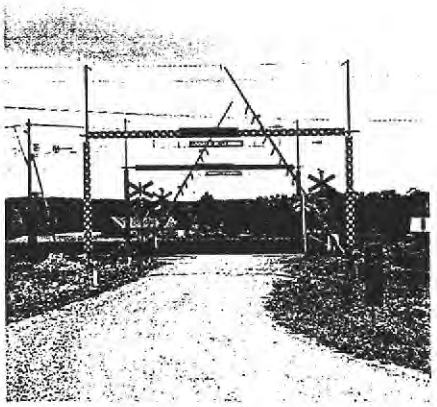
The interlocking system consists of an interlocking computer and



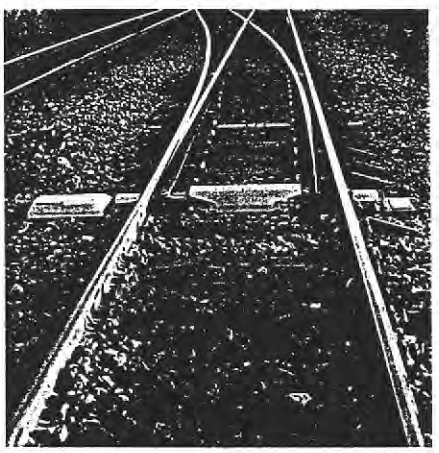
The interlocking computer is installed in a small building while the object controllers can be distributed in cabinets close to wayside objects.

object controllers with microcomputers. The central interlocking computer checks that all the safety conditions necessary for a train route are fulfilled, while the object controllers directly control and supervise the wayside objects.

The object controllers can be placed centrally with the interlocking computer, or in the vicinity of the wayside objects. Communication between object controllers and the interlocking computer takes place via a transmission loop.

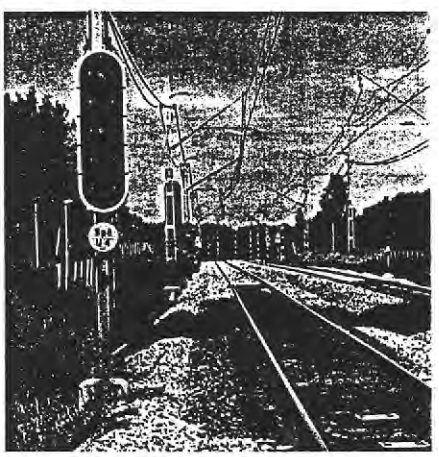


Fully automatic level crossing protection
Level crossing protection warns and protects road users from crossing the tracks when trains are approaching. The equipment can comprise barriers with light and sound signals, or simply signals and bells.



Point machines
Point machines are used for the switching, locking, and control of points in the track. A single machine is used in short points, while longer points often require several machines.

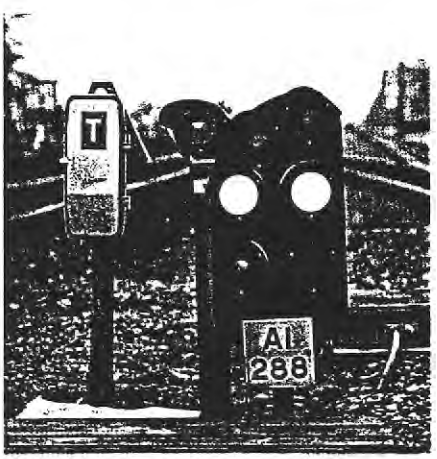
The modern point machine is integrated into a sleeper. This means that automatic track maintenance can operate through the whole turnout without any difficulty. The point machine is made of modules than can easily be changed during maintenance.



Signals
The main signal is used at stations and on lines for signalling train routes. The lamps have double lens systems with a long range, and they are visible even in bright sunlight.

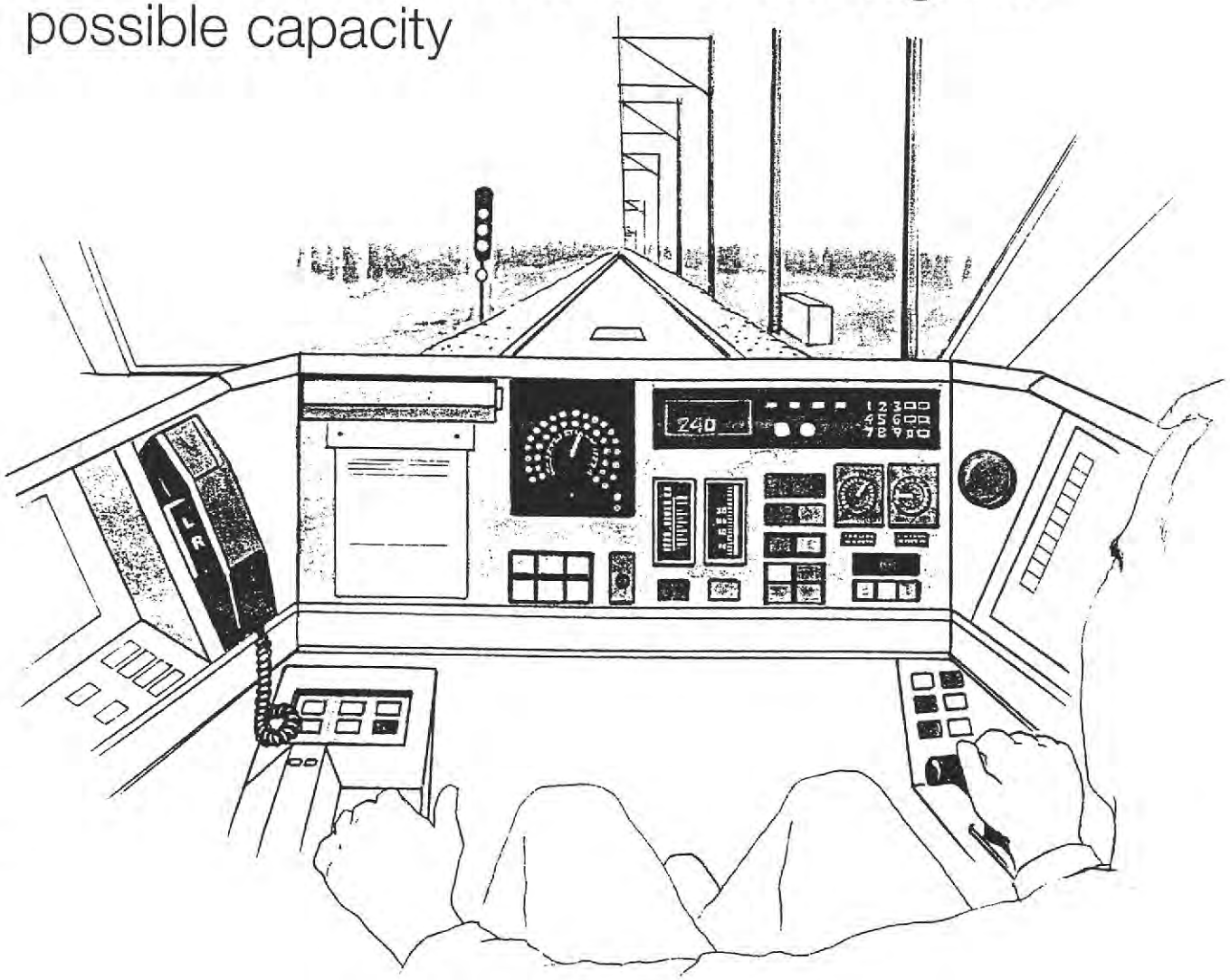
The signals comprise lamp units each with its own light opening, and separate optical systems.

Dwarf signals are normally used at stations for the signalling of shunting routes.



Attachment E
Adtranz Balise
Train to Wayside Balise Signaling

Automatic train protection for the highest possible capacity

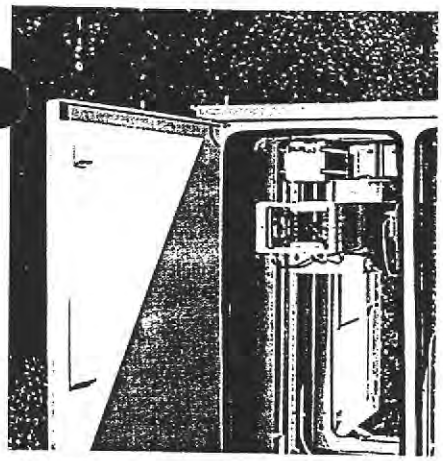


The driver's panel displays information about maximum permitted speed, target speed, target distance, and type of target point. The panel can also warn the driver with lights or audible signals, for example, if the train exceeds the maximum permitted speed.

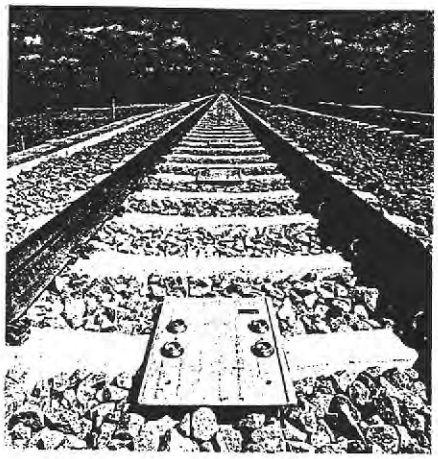
Automatic train protection systems support and supervise modern railway traffic. Drivers receive information about maximum permitted speeds, speed limits further along the line, and objects such as signals, signs, level crossings, and points. All relevant route information is displayed clearly on a panel in the driver's cab.

Prior to the target point, the driver receives information to help him brake effectively, so that the train can maintain a high average speed right up to its target. Automatic train protection also warns the driver when the maximum permitted speed has been exceeded, and activates the brakes automatically if there is any risk. Train transport is thus made more efficient and safer.

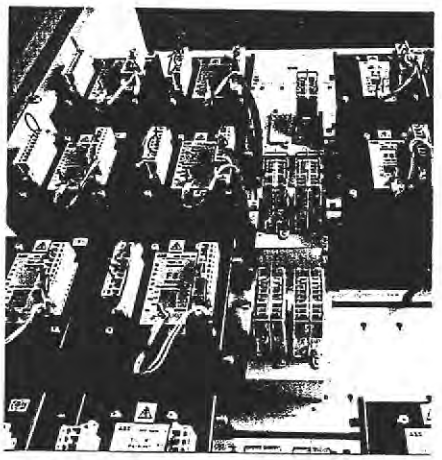
In conventional traffic networks, the driver receives operating information via optical signals along the track. At high speeds, the driver may have difficulty in discerning all the signal information. Automatic train protection solves this problem by providing the information directly on the driver's panel. This, together with the continuously provided and more exact information, makes it possible to run high-speed trains on tracks with mixed traffic.



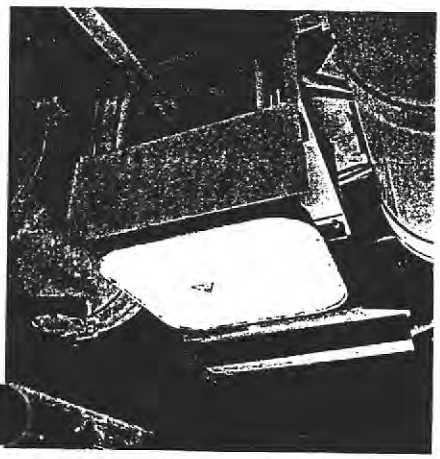
Encoder



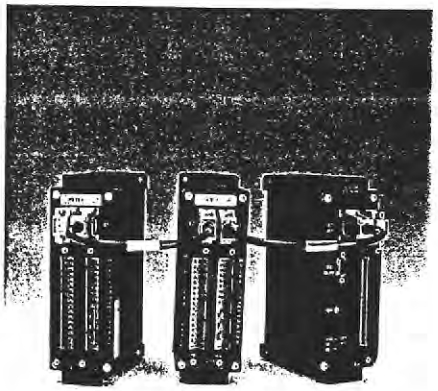
Balise



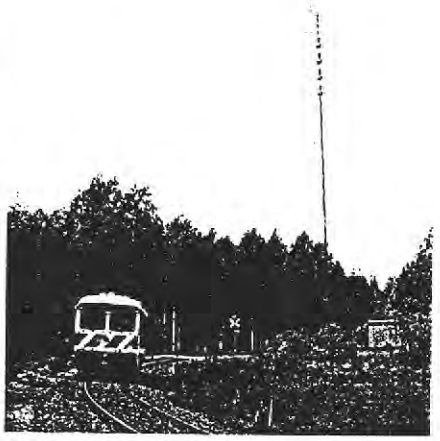
Track circuit



Antenna



Computer



Radio base station

Encoders
The encoder sends continuous information to balises or encoded track circuits. It controls up to four balises, with a maximum distance between encoders of 3000 metres. The encoder is equipped with its own supervision system that guarantees fail-safe information.

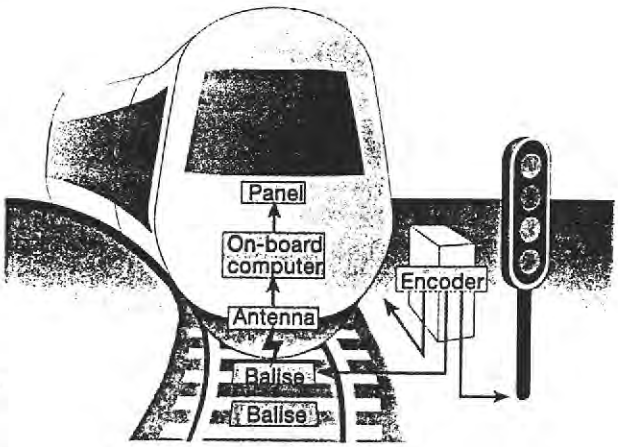
Balises
Balises convey information to trains at various points along the track. They are supplied with information directly from the interlocking system, or via encoders linked to signals, level crossings, and interlocking systems. They can also be preprogrammed with information. Balises need no power supply themselves – they receive the necessary power from the antenna of passing trains – and because they are installed in the middle of the track, normal track maintenance can be conducted as usual. Two balises are often positioned one after the other for redundancy and to indicate the direction of travel.

Encoded track circuits
Encoded track circuits provide continuous information to trains. The track circuits are either jointless or insulated section of track or a cable loop in the track. It is supplied with serial telegrams directly from the interlocking system or via an encoder.

Antenna
An antenna is installed underneath rail vehicles, and have separate transmitter and receiver circuits. When the train passes a balise at speeds of up to 500 km/h, the antenna can receive at least two complete messages.

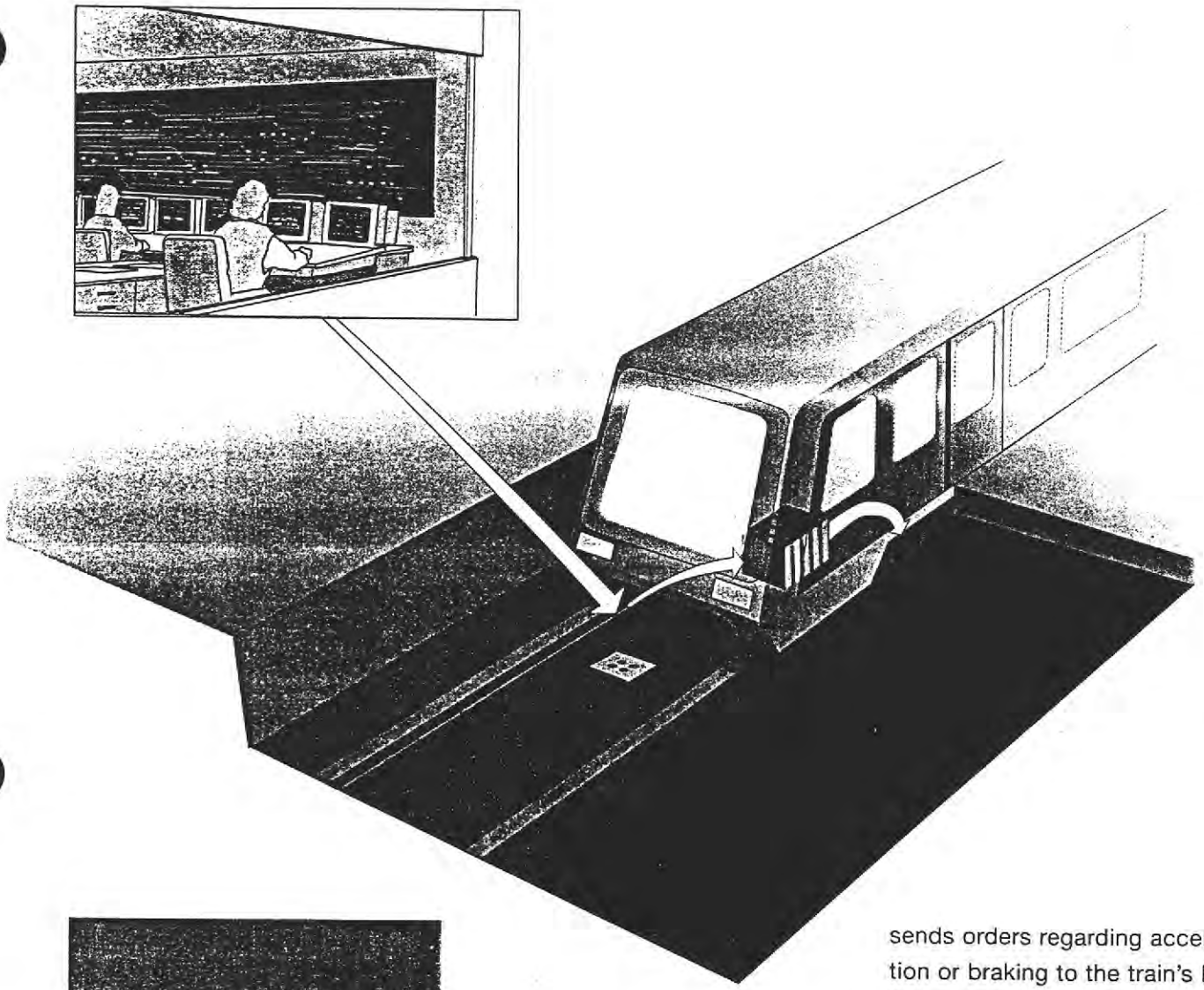
On-board computer
The on-board computer continuously calculates braking curves and highest permitted speeds for the train, using information from balises and pre-programmed train data such as train length, braking capacity, and maximum train speed. New or modified train data can be loaded by the driver via the driver's panel.

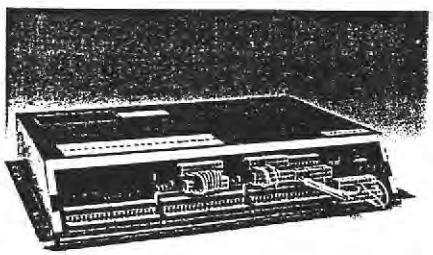
Radio base stations
Telegrams from interlocking systems and traffic control centres can be sent directly to the train's on-board equipment via radio. Radio towers (known as radio base stations), transmit the telegrams to trains.



Information for the driver is sent to balises or encoded track circuits in the track, and is then transmitted to passing trains via the antenna under the locomotive. Information can also be sent directly to the train from the interlocking system via radio. The information received is decoded by the train's on-board computer and displayed on the driver's panel.

Traffic is operated automatically





The onboard computer can receive operating information from, for example, encoded track circuits mounted in the track. The computer receives information about the train's position from preprogrammed balises.

Trains can be operated without drivers by using a computer onboard the locomotive, a so called autopilot. The whole train fleet is controlled directly from the traffic control centre where controllers input route plans for each train. The computer drives the train in accordance with the timetable.

Safe automatic operation of traffic network requires that each vehicle is supervised by systems for automatic train protection. The onboard computer receives instructions from the automatic train protection system and then sends orders regarding acceleration or braking to the train's braking system.

With automatic train operation, speeds are always kept within permitted limits, and are regulated according to the train's status in relation to the timetable. When the train approaches the station, speed and braking are adjusted to suit the remaining distance. The system ensures that the train always stops at the same place on the platform, and it opens doors and changes the direction of travel at termini. Railway traffic is in this way made more efficient and drivers and train attendants are relieved of routine work.

Track-to-train transmission

Information from signals, level crossings and interlockings is translated by encoders into safety telegrams that are continuously sent to the balises in the track. Balises can also be permanently programmed with information or controlled directly from the interlocking.

Passing trains power the balises and pick up the telegrams by means of an antenna positioned under the train. The telegrams are first decoded and processed by a computer on board the train, and then presented on the train driver's panel.

Fail-safe encoder

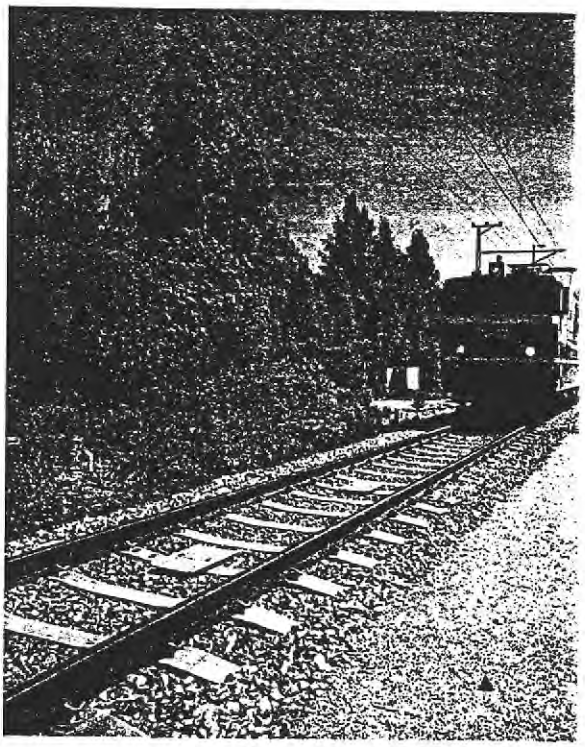
The encoder translates all types of information from interlockings, level crossings and signals into safety telegrams that are sent continuously to the balises. Cross-checking each section of the telegram, the encoders ensures that a transmitted telegram is correct. The telegrams are sent by serial links that have a very high resistance to interference.

Encoders and balises can be positioned up to 3000 metres apart. The encoder has twelve ports that detect control signals and signal lamps. It can control up to four balises and provide 95 different telegrams to each balise.

Balise for fast transmission

The balises are installed in pairs to indicate, among other things, the direction in which a train is travelling. The first balise sends all the relevant information to the train, and the second balise repeats that information. Transmission takes place very quickly, and a balise can transmit 450 data bits to trains passing at speeds of up to 300 km/h. The telegram is formatted in a modified cyclic block code.

The balises are powered by passing trains and do not require a costly, continuous power supply. Fault-free operation is ensured at ambient temperatures of between -40°C and +70°C, even when the balises are covered by ice, water, snow, mud, iron-ore slime or ballast.



Positioned in the track, balises can send 450 data bits to trains passing at speeds of up to 300 km/h. The first balise sends all the relevant information, and the second balise repeats that information.

Compact on-board computer

A small, compact computer on board the train decodes the telegrams from the balises. The computer carries out a redundancy check as soon as it has received 255 data bits. When the computer has checked that the bits received are correct, the 180 bits of vital information is decoded.

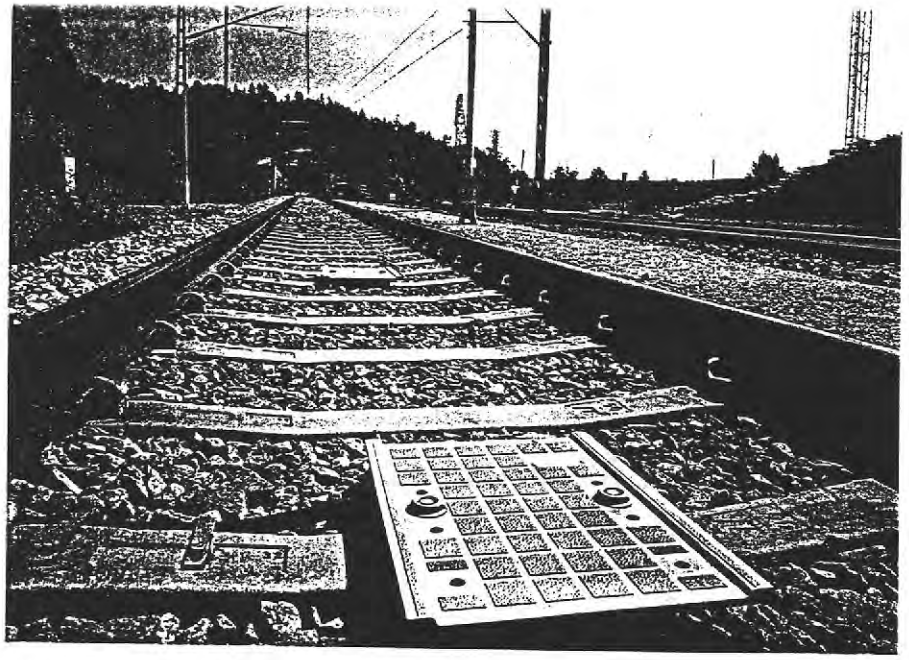
Using the decoded information and pre-programmed train data, such as the train length, the braking capacity and the maximum train speed, the computer continuously calculates the brake curves and the maximum permissible speed of the train. Train data can be pre-programmed in the computer or put in by the driver prior to departure.

When the computer has processed the telegrams from the balises, it presents information on track, traffic conditions and targets directly on the driver's panel. During a journey, the computer is also able to store in a recording unit all information sent to the driver as well as the driver's operational instructions and the train's speed. The recording unit is mounted in a shockproof, protecting box. The on-board computer is connected directly to a tachometer and the brake system. If the train exceeds the maximum permissible speed, the computer automatically activates the brakes. The on-board computer is built up of modules and its software can be adapted to the safety regulations of any country. The software consists of two different programs that work in parallel. The programs are designed to do exactly the same tasks and must produce the same result for a function to be carried out.

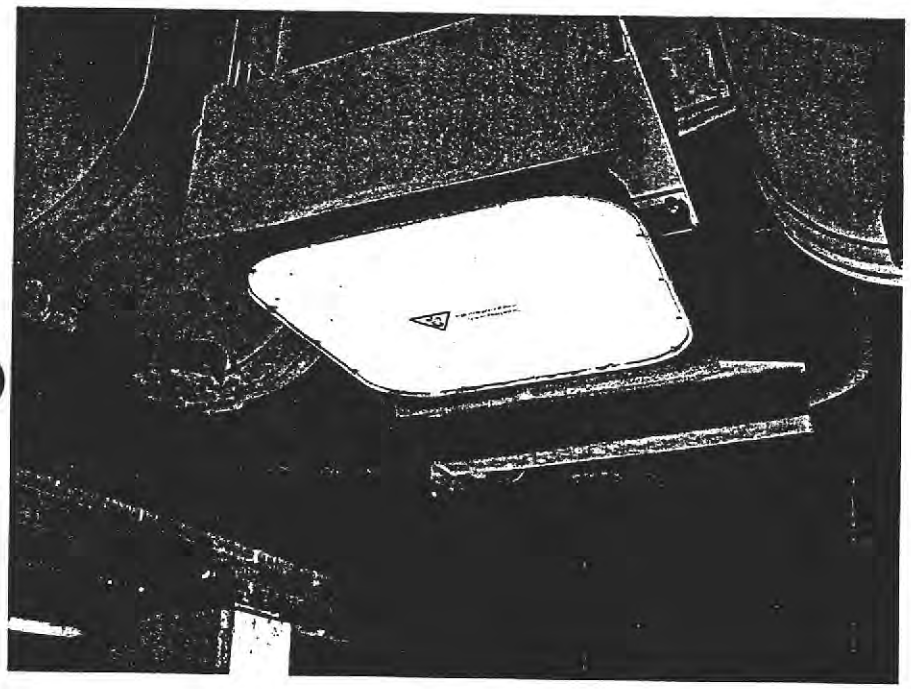
A panel that helps and warns

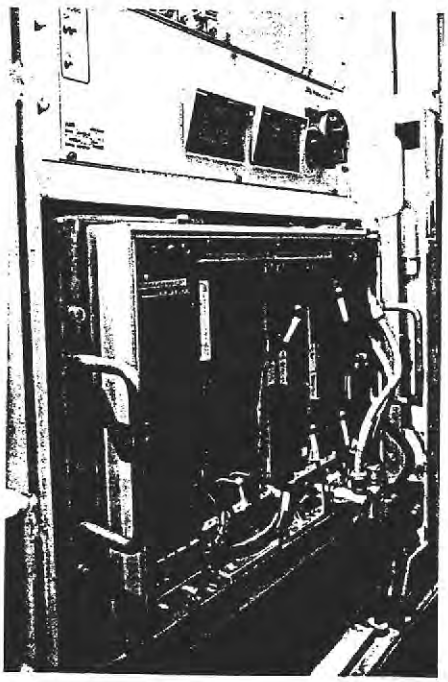
Ebicab 900 presents the maximum permissible speed on the driver's panel continuously. En route to new targets, the system provides information on the type of target, the target speed and the decreasing distance to that target.

If a driver exceeds the maximum permissible speed, Ebicab issues a warning and the word "brake" is displayed on the panel. If the driver does not brake after the warning, the display starts flashing and an audible alarm is issued. If the driver ignores the warning, Ebicab will automatically apply the service brake.



Telegrams from encoders or interlockings are received by the balises. The balises can also be permanently programmed with information. Passing trains pick up the telegrams by means of an antenna positioned under the train. The telegrams are first decoded and processed by a computer onboard the train, and then presented on the train driver's panel.

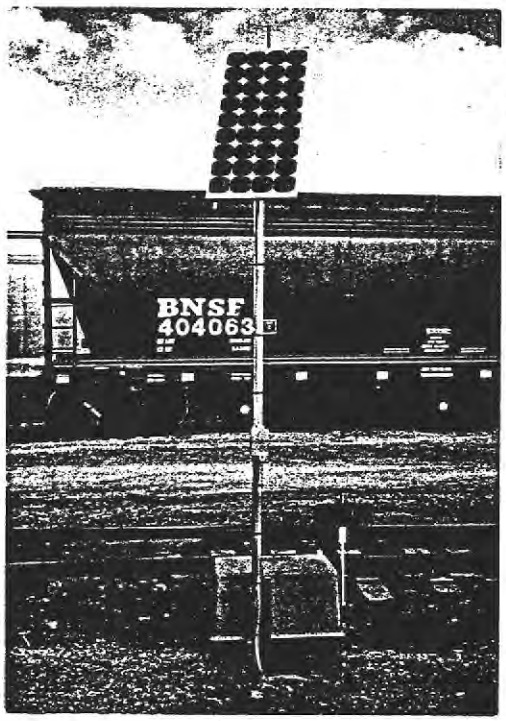




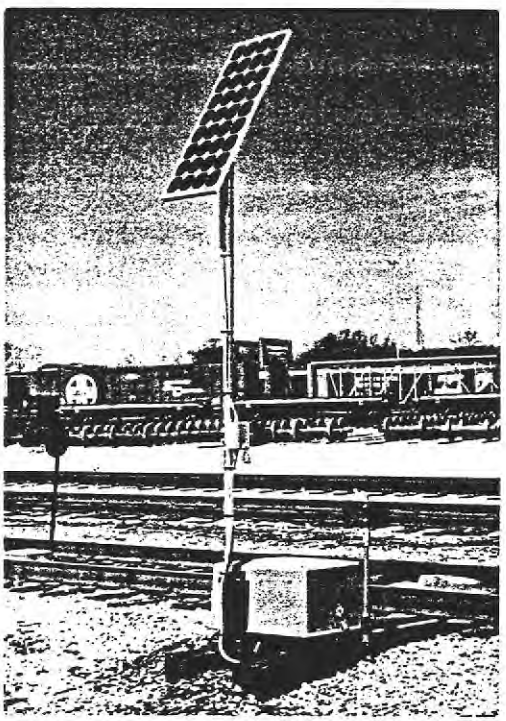
Attachment F
Railway Technology
Radio Remote Control
Switch Machine

Railway TECHNOLOGY INC.

Versatility by Design



Model 3000
Hydra-Switch
with 75 watt solar panel
and remote radio control.



Model 4000
Derail/Blue Flag
Hydra-Switch
with 75 watt solar panel
and remote radio control.

Railway Technologies' Model 3000 Hydra-Switch is a solar powered hydraulically operated automatic switch stand. The Model 3000 Hydra-Switch can be installed anywhere that manual or conventional electrically operated switches are required. The Hydra-Switch is designed to provide the user with an extremely reliable and low maintenance switch operator. Productivity is greatly increased due to the ease of operation and options such as remote radio control and the self restoring function.

An operator injury, as the result of switch stand operation, is essentially eliminated with the Hydra-Switch machine. Operation of the switch requires nothing more than the push of a button. All moving parts are completely enclosed under a polyethylene cover.

The entire electrical system operates on 12-volts D.C. Electrical power for operation of the Hydra-Switch is provided through the use of a solar panel. The switch can be installed literally anywhere without the necessity of providing an external power source. An electrocution hazard does not exist with this type of power source and 12-volt D.C. operation.

The Model 3000 Hydra-Switch can also be used to operate de-rails with the same ease of operation and reliability. Productivity can be further increased with the addition of remote Radio Control.

Features of the Hydra-Switch 3000:

- Years of proven reliable service on American Class I Railroads
- Local pushbutton operation, remote push-button control, or remote radio control
- Self contained solar power source
- Self adjusting throw length, no shimming required
- Undamaged by "trailing" or "running through" switch
- Easy installation with little or no maintenance required. (allow 1 hour for installation)
- Operating temperature range from - 70 to +160° Fahrenheit
- Standard solar charging system sized for 125 operations per day with a battery reserve of approximately 1,000 throws.
- Options: 120 vac operation, high usage solar panel, hand throw, cycle counter, radio frequency control, strobe light, self-restoring, protection circuit.

SPECIFICATIONS:

Dimensions	30"Lx24"Wx19"H (76.2x60.9x48.3mm)
Weight	550 Lbs. (248 Kg)
Force at Closure	6000 Lbs. (2702 Kg)
Throw Length (self-adjusting)	4.74" to 6.5" (12 to 16.5mm)
Throw Time	1.5 seconds average
Operating Temperature Range	-70 to +160° F (-56 to +71° C)
Maximum Hydraulic Pressure	1000 psi (69 bar)
Reservoir Capacity	90 cubic inches (1.52 Liters)
Hydraulic Fluid Type	Exxon J-13 or Equivalent
Electrical	12 Volt DC (Optional 120 Vac)
Battery	90 Amp Hour sealed lead acid

Railway TECHNOLOGY INC.

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Tel: (270) 442-5090
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www.railtech.net

Railway Technology Inc.

Model 3000 Hydra-Switch standard equipment package.

Electrical

- 90-amp hour sealed lead acid battery.
- 35 watt solar panel.
- Totally encapsulated microprocessor electronic controller.
- Fuse block for the solar panel, microprocessor, and the hydraulic power unit.
- 1-pushbutton local control and enclosure.
- 12-volts electrical components with the pushbutton and the microprocessor mounted in nema-4 enclosures.
- 10'-0 solar mast.
- Solid state voltage regulator.
- The wiring between the local pushbutton and the microprocessor is installed in flexible conduit.

Hydraulic

- 12-volts D.C. hydraulic power unit with a 90 cubic inch reservoir.
- Hydraulic pressure switch.
- Cartridge solenoid valve and an integrated manifold.
- Integral relief valve.
- Hydraulic cylinder capable of 9800 pounds of linear thrust and 7340 pounds of linear pull.
- The reservoir is filled with a high viscosity index, low pour point hydraulic fluid.

Mechanical

- Infinite life, high strength locking spring.
- Extreme duty spherical roller bearings used for the spindle support.
- Stiffeners and braces as required for the ultimate in reliable operation.
- Target mast.
- Mounting feet integral with the baseplate.
- Polyethylene case and a lockable hasp.
- 50" or 62" connecting rod is furnished with the base machine. (customer to specify the length required)
- Clevis with 1" or 1-1/8" bolt provided for connection to the #1 rod. (customer to specify the bolt size required)

The Model 3000 is wired, hosed, lubricated, and filled with hydraulic fluid from the factory. Installation requires spiking down the Switch machine to the headblocks and connection of the connecting rod to the # 1 rod to be made operational.

Railway Technology Inc.
Options Defined

01-Hand Throw

The hand throw option provides a method to throw the switch in the event electrical operation is not functional. The hand throw option includes a hand pump assembly, pump handle, valve and pump manifold, and interconnecting hosing necessary for the manual operation of the switch. This method of operation is recommended only for intermittent or emergency operation.

02-Protection Circuit

The protection circuit prevents operation of the switch machine while there is traffic on the switch. This circuit interrupts electrical power to the switch machine in effect making the switch "dead". This option is normally used if the operator cannot see the switch he is throwing. Examples of this would be operation of the switch from a remote location or operation by radio control. This option requires the addition of an inductive current loop sensor. This sensor is located just before the switch and senses the presence of an engine or railcar on the switch. ***It is recommended that option 22 be used with this option to assure a complete point movement once initiated.***

03-Radio Frequency Operation

This option allows operation of the switch by "wireless remote control". The acceptable distance for operation by this option is limited only by the power of the transmitting radio. With the appropriate transmitter, operation can occur from several miles away. The frequency used can normally be the frequency already licensed by the customer. This advantage allows the use of existing locomotive or hand held radios.

03V-Radio Frequency with Voice

The 03V option is the same as the 03 option with the addition of electronic voice confirmation of switch operation. The electronic voice confirmation can be any message with duration of up to 20 seconds. A typical message could be "switch number 101, normal".

04-Crossover Option

This option provides the simultaneous operation of both switches on a crossover. This eliminates the necessity for an operator to walk between the switches in order to throw them. This option also allows a train to move through both switches with only one stop. ***It is recommended that option 22 be used with this option in order to assure a complete point movement once initiated.***

05-Self Restore Option

The self-restore or "line back" option automatically lines or moves the switch back to the main line after a train has pulled to the end of a passing track. This allows the approaching train on the main line to maintain it's speed and eliminates the need to "line" the switch relative to it's direction of travel. This option is primarily used in "Dark Territories". "Dark Territories" are sections or "Blocks" of the track where-in train travel and switch positions are not controlled by C.T.C. (Centralized Train Control). Control of the switches and movement of the trains is controlled by personal located in the relative section or "Block" of track.

06-Cycle Counter

The cycle counter records and displays the number of switch throws that has occurred. The counter is electronic and cannot be reset. Each throw of the switch will increment the counter a value of one.

07-Remote Button Assembly

This option provides an operator's pushbutton station that can be installed remote from the switch. This option is used when it is not safe for the operator to stand at the switch when it is thrown or when a second point of operation is required.

08-Strobe Light

The strobe light provides a visual warning of gapped points. The strobe light will flash anytime the points are not tightly fitted to the stock rail. The strobe light can be furnished in amber, red, blue, or green.

09-Indicating Lights

The indicating light package provides visual confirmation of a good point. It also provides visual indication of switch position. This option is not recommended for use with solar powered machines due to the amount of energy required to operate the lights. Standard light colors are:

Green	Normal
Amber	Gapped points
Red	Reverse

10-Autoline

The Autoline option is used to prevent a run-through of the switch points. An inductive detection loop (option 02) is located prior to the trailing side of a switch. A train traveling over this loop is detected and the switch machine will automatically throw the points to the appropriate position to prevent a run-through from occurring. This prevents unnecessary abuse of the switch and maintains compliance with "No Run-through" guidelines established by most railroads.

11-Blue Flag Operator and Strobe

The Blue Flag Operator and Blue Strobe are offered to allow the customer to comply with the FRA requirement 218.23 Blue Signal display. Blue signals are to be displayed to signify that workers are on, under, or between rolling equipment.
The Blue Flag Operator raises and lowers a Blue Flag in conjunction with the placement of a Derail. It may also be used without a Derail if only a Blue Flag is required. Concurrent with the raising of a Blue Flag it initiates the operation of a Blue Strobe Light. It consists of a 12-volt DC electrically operated linear actuator, a micro-controller, and position sensors. It can also be provided with the necessary electrical components to interface with a voice position confirmation system used with the 03V Radio Control option.

13-Derail

The Derail option provides a Nolan double sided Derail and connecting rod that is to be used in conjunction with the Hydra-Switch Model 3000. This options provides a powered Derail Positioner that can be operated through the pressing of a pushbutton or remotely through a Remote Control panel or the 03 or 03V Remote Radio Control option. This option is frequently used with option 11 Blue Flag Operator and Strobe.

14-Voltmeter

The voltmeter option provides an LED display that corresponds with the voltage level in the battery. This allows a quick inspection of the state of charge of the battery without the need to use a voltmeter. The LEDs are color coded; green for good, yellow for caution, and red for low operating voltage. The Voltmeter is part of the switch machine and requires no action on the part of the observer to generate a reading since the unit continuously provides the LED indication.

15-Button Box Toggle

This option provides an "on-off" switch in the pushbutton enclosure. Moving this switch to the "off" position terminates operation of the switch machine either locally through the pushbuttons or remotely through remote radio or remote control panels. It provides the same "power down" function as the "Main Power Switch" located on the electrical enclosure inside the Switch Machine Case. It eliminates the need to open the case to power down the Switch Machine. ***It is recommended that option 22 be used with this option to assure a complete point movement once initiated.***

16-Button Door Kill Switch

This switch is used to disable or "power down" the switch machine when the pushbutton enclosure door is closed. This allows operation of the Switch Machine only when the pushbutton enclosure door is open. ***It is strongly recommended that option 22 be used in conjunction with this option.***

17-Cylinder port gauge

This option provides a way to easily monitor the amount of force generated to move the switch points. It also provides momentary force indication of the peak force generated at full point closure. It consist of pressure gauges installed at the cylinder ports giving a direct reading of hydraulic pressure. This can easily be converted into pounds of force by multiplying the area of the cap end (4.9 in^2) of the cylinder times the displayed pressure on the cap end times a factor of .842 to determine the cylinder force applied to the points. A value of 1400 pounds must be added to the cylinder force to include the additional point closure force exerted by the locking spring for the total point closure force. The rod end point closure force is determined by multiplying the rod end area (3.67 in^2) times the displayed pressure on the rod end times a factor of .842 to determine the cylinder force applied to the points. A value of 1400 pounds must be added to the cylinder force to include the additional point closure force exerted by the locking spring for the total point closure force.

18-Case Seal

This option is provide where blowing snow exist. This options tightly seals the case to prevent the entrance of blowing snow. It is also used to inhibit the entrance of insects or rodents.

19-Control Panel

Remote Control Panels can be provided by RTI to meet the customers needs for remote control of Switch Machines or Derail Blue Flag Machines. These panels can either be hard wired or operated through remote radio control. The Remote Control Panels are quoted on a case by case basis due to the variations in every installation. The design of the panel will be to the customers' specifications in conjunction with the requirements of the RTI Hydra-Switch.

22-Throw Enabler

The Throw Enabler option uses solid state electronic circuitry to enable or disable a switch throw by making or breaking the 12-volt DC current supply to the pressure switch on the Power Unit Assembly. The circuit is designed to ignore a disable input until the pressure switch reaches its' setpoint and the Power Unit electric motor operation is terminated. This insures that the switch machine does not abort a throw before throw movement is complete. The switch machine continues to be disabled as long as the disable input is held high as the result of an input device indicating the need to disable the switch machine. The switch machine will continue normal operation as soon as the input device ceases generating the disable signal allowing the disable input to go low.
This option should always be used whenever options 02, 04, 15 and 16 are used.

Railway Technology, Inc.

MODEL 3000 SWITCH STAND

☐ *First Time Install* Rev. 2 1-Jun-99

Date: _____ *Ship To:* _____

Sold To: _____ _____

_____ _____

_____ _____

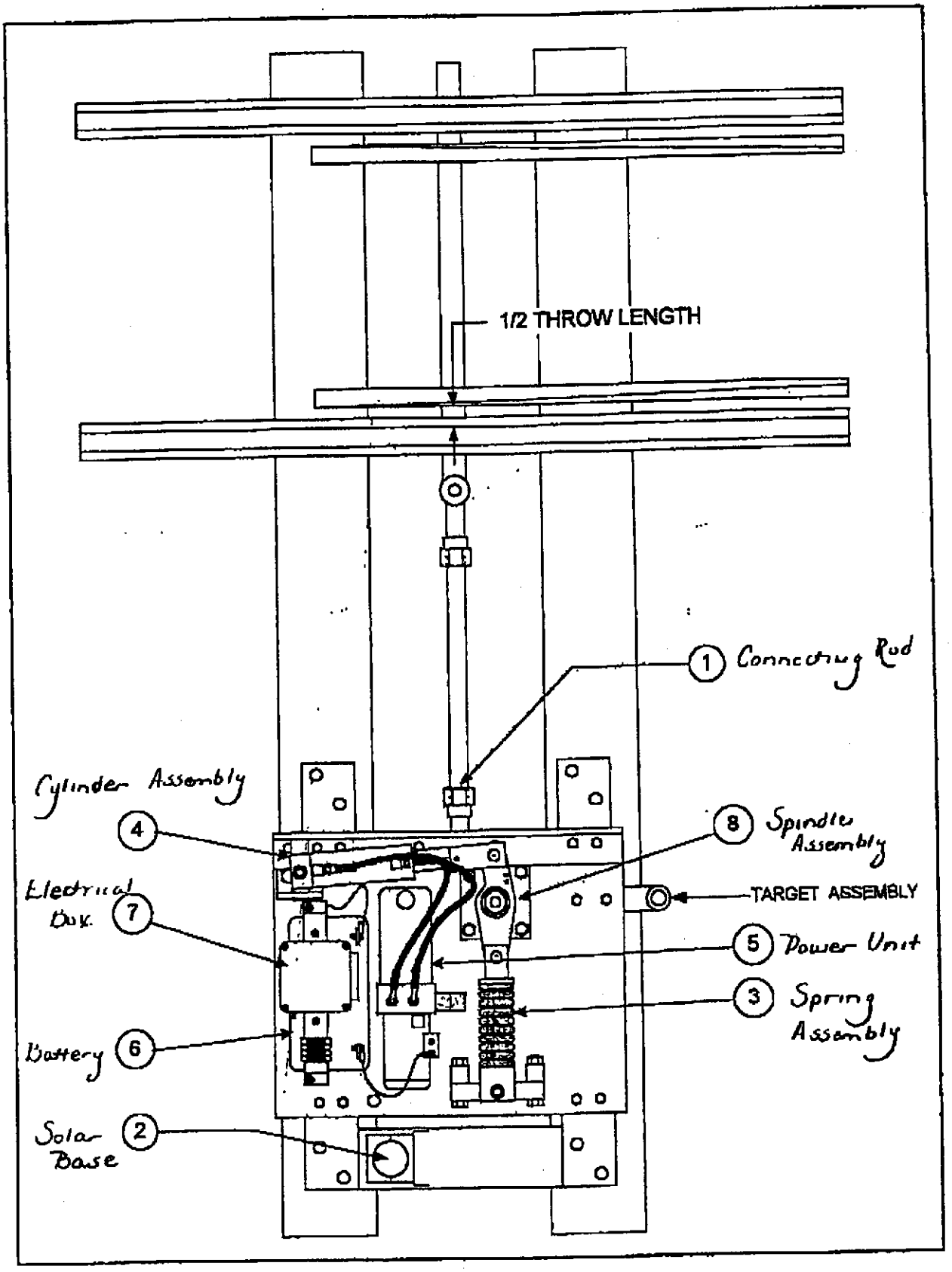
P. O. # _____ *Attn.* _____

Number of Throws per day ☐

Qty.	Model & Power Source		Price Ea.	Ext. Price $
____	3S	Model 3000 Solar Switch Stand	$ 3,830.00	$ -
____	S35X	35-watt Solar Panel & Pushbutton operator	$ 550.00	$ -
____	S75X	75-watt Solar Panel & Pushbutton operator	$ 830.00	$ -
____	S100X	100-watt Solar Panel & Pushbutton Operator	$ 1,184.00	$ -
____	3 I	Model 3000 120 VAC Switch Stand	$ 4,380.00	$ -
	Options:			
____	01	Hand Throw	$ 650.00	$ -
____	02-8'	Protection Circuit, 8'-0 detection zone	$ 595.00	$ -
____	02-46'	Protection Circuit, 46'-0 detection zone	$ 725.00	$ -
____	02-86'	Protection Circuit, 86'-0 detection zone	$ 925.00	$ -
____	22	Throw Enabler	$ 96.00	$ -
____	03	Radio Frequency Operation	$ 2,300.00	$ -
____	03V	Radio Frequency Operation W/ Voice Confirmation	$ 2,800.00	$ -
____	04	Cross-Over, (1) required on <u>each</u> switch machine	$ 150.00	$ -
____	05	Self-Restore	$ 1,800.00	$ -
____	06	Cycle Counter	$ 110.00	$ -
____	07	Remote Button Operation	$ 170.00	$ -
____	08	Strobe Light (Specify Blue, Red or Amber)	$ 490.00	$ -
____	09	Indicating Lights (Red, Green & Amber)	$ -	$ -
____	PRX-2	Double Prox. Kit, required with indicating lights.	$ 354.00	$ -
____	10	Auto-Line	$ 635.00	$ -
____	11	Blue Flag Operator & Strobe	$ 1,800.00	$ -
____	12			$ -
____	13	Derail	$ 850.00	$ -
____	14	Volt Meter	$ 85.00	$ -
____	15	Button Box Toggle	$ 65.00	$ -
____	16	Button Door Kill Switch	$ 215.00	$ -
____	17	Cylinder Port Gauge	$ 150.00	$ -
____	18	Case Seal	$ 100.00	$ -
____	19	Control Panel Kit for the Switch Machine	$ 450.00	$ -
____	22	Throw Enabler, recommended on 02, 05, 10, 15, 16,	$ 96.00	$ -
	# 1 Connecting Rod and Clevis Specification:		*Order Total*	$ -
____	C1-S	Clevis for 1" Bolt and 40" Connecting Rod (50" center to center, 14'-0 Headblocks)		Specify
____	C2-S	Clevis for 1-1/8" Bolt and 40" Connecting Rod (50" center to center, 14'-0 Headblocks)		Specify
____	C1-L	Clevis for 1" Bolt and 52" Connecting Rod (62" center to center, >=15'-0 Headblocks)		Specify
____	C2-L	Clevis for 1-1/8" Bolt and 52" Connecting Rod (62" center to center, >=15'-0 Headblocks)		Specify

☐ Technical Support For Installation $ 500.00 per day

_____ Shipping & special instructions _____


1/2 THROW LENGTH
1 Connecting Rod
Cylinder Assembly
4
8 Spindle Assembly
Electrical Box
7
TARGET ASSEMBLY
5 Power Unit
3 Spring Assembly
Battery
6
Solar Base
2

Railway Technology Inc.
Remote Radio Frequency Operation

Option 03: Remote radio frequency operation allows operation of the switch by wireless remote control. A handheld or base radio with a DTMF is all that is required to operate the switch.

The acceptable distance for operation by remote radio control is limited only by the power of the transmitting radio. Operation can occur from any distance up to several miles away with the appropriate transmitter. The radio frequency used is normally the frequency already licensed by the customer. This advantage allows the use of existing locomotive or hand held radios.

Each switch may be programmed with its own operating code. This eliminates the possibility of operating the wrong switch and provides independent control of each switch. The individual switch codes are always preceded by the # key and are then followed by up to 10 digits. The # must be the first entry after which the customer must decide the digits that follow.

Example: Switch 1—

- "Normal" # 011
- "Reverse" # 013.
- "01" defines the switch that is to be operated. "1" moves the switch to the normal position. "3" moves the switch to the reverse position.

  or

  - #001 moves the switch to the opposing position.
  - #003 interrogates the switch for its' present position.
  - This method is referred to as the toggle method of operation. The switch machine can be set up to operate in either of the above two modes. The RTI standard arrangement is the toggle method as it allows interrogating the position of the switch points without throwing the points.

The radios operate from the 12-volt system used on the switch machine. The power output from the radio varies from 10 to 25 watts. The radios are factory set at approximately 20 watts. The radio used is a Motorola SM50. Other radios may be substituted as long as they are DTMF compatible.

Railway Technology Inc.
Remote Radio Frequency Operation

The radios are installed in Nema 4 enclosures. The operating temperature range of the radio and message repeaters is -30° C to +80° C. The antenna provided with the radios are matched with the output of the radio.

Option03V: This option is the same as the 03 option with the addition of electronic voice confirmation of switch operation and point position. The electronic voice confirmation can be any message with duration of up to 20 seconds. A typical message could be "Switch number 01 Normal."

The operating codes and voice message may be easily changed in the field. The voice confirmation message will be given even if the points are moved manually provided that a good closure is made.

The operating frequency of the radio must be the same frequency licensed by the customer. This frequency must be made known to Railway Technology Inc. so the radios can be set at the factory to operate at that frequency.

Railway Technology Inc.

Description of Model 3000 Hydra-Switch operation

Application of the Model 3000 Hydra-Switch:

The Model 3000 Hydra-Switch is a solar powered hydraulically operated automatic switch stand. The Model 3000 Hydra-Switch can be installed anywhere that manual or conventional electrically operated switches are used. The Hydra-Switch is designed to provide the user with an extremely reliable and low maintenance switch operator. Productivity is greatly increased due to the machines' speed and ease of operation.

An operator injury, as the result of switch stand operation, is essentially eliminated with the Hydra-Switch machine. Operation of the switch requires nothing more than the push of a button. All moving parts are completely enclosed under a crosslink polyethylene cover.

The entire electrical system operates on 12-volts D.C. Electrical power for operation of the Hydra-Switch is provided through the use of a solar panel. The switch can be installed literally anywhere without the necessity of providing an external power source. An electrocution hazard does not exist with this type of power source and 12-volt D.C. operation.

The Model 3000 Hydra-Switch can also be used to operate de-rails with the same ease of operation, reliability and increased productivity. Productivity can be further increased with the addition of a remote Radio Control.

Overview of the Model 3000 Hydra-Switch major components:

Solar Panel:
Siemens manufactures the solar panel. The panel is completely encapsulated in high strength glass. This material is extremely strong and resistant to damage by hail, rocks, or temperature extremes. Siemens provides a ten-year warranty against defects in materials and workmanship. The length of this warranty exemplifies the quality of the solar panels.

The solar panels are normally provided in two sizes, 35-watt and 75-watt. Alternate solar panel sizes are available for applications where these two sizes are either excessive or inadequate in energy collection. The 35-watt panel is used where cycle frequency is less than 100 cycles per day and the unit is not operating any ancillary equipment. (Lights, radio control, voice confirmation, detection loops) The location of the switch relative to its distance from the equator will also have a bearing on the solar panel size. The 75-watt panel is used where the cycle frequency exceeds 100 per day or ancillary equipment is being powered by the solar panel.

The 35-watt panel will provide a charge rate of 2.5 amps on a clear day and .5 amps on a completely overcast day. The 75-watt panel will provide 5.0 amps of charge on a clear day and 1 amp on a completely overcast day. The solar panels can be banked together to supply additional power for extremely demanding applications. The 35-watt solar panel has proven to be more than adequate for normal usage switch applications even when overcast conditions are prevalent.

Railway Technology Inc.

Description of Model 3000 Hydra-Switch operation

Battery:
The battery design is a sealed lead acid, deep cycle 12-volt battery. The battery is rated at 90 amp hours. A fully charged battery will provide over 1000 throws of the basic Model 3000 switch with no charging occurring. This is a substantial energy reserve and will provide several days of operation in the event of damage to the solar charging system or the inverter power supply.

Battery maintenance is essentially eliminated with this type of battery design. The slow rate of charge, developed by the solar panel or the inverter power supply, keeps the battery fully saturated. This is the ideal operating condition for this battery design.

Hydraulic Power Unit and Actuating Cylinder:
The hydraulic power unit is a completely self contained design that includes the reservoir, pump, 12-volt D.C. electric motor, starter solenoid, relief valve, pressure switch and integrated directional valve. The normal operating pressure is 1,100 psig. This is the pressure that the pressure switch terminates operation of the electric motor. The relief valve is set at 2,000 psig and under certain conditions this pressure may be attained. Utilization of this power unit provides an average throw time of 1.5 seconds.

The hydraulic cylinder has a 2-1/2" bore and 1-1/4" diameter rod. When used in conjunction with the power unit, this cylinder develops thrust forces of 5,390 # and retraction forces of 4,037 # at the normal operating pressure. Point closure force is a combination of the hydraulic force generated and spring force generated. The spring is preloaded to a force of 1,400 #. This is the minimum force generated by the spring. Actual installations will not allow the spring to fully extend; therefore the spring forces are higher than the minimum 1,400 #. Therefore the minimum total combined force to move the points to the closed position at normal system pressures are 6790 # (3.4 tons) in one direction and 5437 # (2.7 tons) in the opposite direction.

The net force available to hold the points in the closed position is equivalent to the spring force. As previously noted, the minimum preload force is 1400 # (.7 ton) and in actuality this force is higher due to the spring always being compressed more than the preload.

The hydraulic reservoir contains 90 cubic inches of fluid. The power unit is shipped with the reservoir filled with fluid. The fluid provided is Univis J-13. This is a hydrocarbon-based fluid with a viscosity index of 378 and a pour point of –75 degrees Fahrenheit. The use of this fluid eliminates the need for heating the fluid even in extreme cold environments. This means no maintenance and assured operation even under the most adverse conditions.

Spring Assembly:
The spring is constructed of 9/16" chrome silicon steel. The spring is rated for infinite life. The spring pitch is .88" and contains 10.85 active coils. The spring is assembled with a 1,400 # preload. The maximum spring force attained when in the center of throw is 2,625 #.

The spring assembly's function is to hold the switch points against the stock rail. The hydraulic circuit is designed so that the fluid is free to pass into and out of the cylinder. Movement of the stock rail is compensated for due to the spring load forcing the points to follow the stock rail. The spring design in conjunction with the open hydraulic circuit eliminates damage to the Hydra-Switch 3000 in the event of an inadvertent run-through.

Roller Bearings:
The bearings used to support the spindle are a double row spherical roller design. The bearings carry a static load rating of 26,500 #. The spherical bearing provides both radial and thrust load capability. High shock loading and subsequent deflection is compensated for through the use of the spherical rollers. A stamped steel roller cage is used for maximum life under adverse conditions. Custom designed housings are incorporated to assure proper alignment between the bearings, spindle and baseplate.

Electrical Controls:
The electrical controls are designed for the adverse conditions associated with railroad equipment. Solid state circuitry is used to eliminate failures from the vibration generated by passing trains and transmitted through the headblocks. The electrical controls are totally encapsulated in epoxy to eliminate any possibility of failure from atmospheric conditions. Encapsulating the controls also prevents tampering with or damaging the control circuits.

Sequence of operation:

Operation and human interface with the Model 3000 Hydra-Switch is accomplished through pushbuttons located on the solar mast or remote pushbuttons located in a control panel or by radio frequency remote control. There is only (1) pushbutton required for the operation of the switch. This button will move the points to the opposing position with each push of the pushbutton.

Operation of the power unit, rotation of the flag and terminating operation of the power unit are automatic and require no human intervention. Verification of a good point closure can be done visually by the operator or electrically through the use of proximity sensors. Protection circuits are available to eliminate either the accidental or intentional throwing of the switch points while a train is passing over the switch.

Operation using local pushbutton station:

1. Unlock and lift the cover of the pushbutton enclosure.
2. Press the button to throw the switch points. Once the machine starts the cycle the pushbutton may and should be released. Visually verify a good point closure after the machine shuts off.
3. Close the pushbutton enclosure cover and replace the lock.

The time required for the switch to throw is 1-1/2 seconds.

Pressing a pushbutton or activating the switch machine via remote radio control simultaneously starts the D.C. motor of the hydraulic power unit and shifts the solenoid operated directional valve to direct the hydraulic fluid into the appropriate end of the hydraulic cylinder.

The cylinder then begins to extend or retract depending upon the instructions given through the pushbuttons or radio control. As the cylinder moves, the spindle rotates which in turn begins compression of the spring assembly and rotates the throw lever attached to the # 1 rod. Concurrent with this movement, the target mast is also being rotated in proportion to the distance the points have moved.

Mid stroke of the hydraulic cylinder is also mid position of the switch points. At this position the spring assembly is at full compression and is directly aligned with the spindle. The spring in this position exerts neither resistance nor assistance to the movement of the points. After passing through the mid stroke position, the cylinder continues to move the points toward the stock rail. The spring assembly is now decompressing and providing additional force to complete the closure of the points.

Hydraulic pressure rises as the points contact the stock rail. The pressure switch terminates operation of the hydraulic power unit and de-energizes the solenoid valve when the hydraulic pressure rises to 1100 psig. The spring assembly is now at a position, relative to the spindle, where the greatest mechanical advantage is attained. Therefore, the spring assembly holds the points firmly in contact with the stock rail.

Railway Technology Inc. does not promote nor recommend that run-throughs be considered the normal method of operation with the Model 3000 Hydra-Switch. However, should this occur the Hydra-Switch will not be damaged provided the speed of the run-through is less than 7 mph. The hydraulic system is designed so that an open circuit exists when the machine is not in operation. There is therefore no hydraulic resistance to point movement in a run-through condition. As previously stated the points are held closed due to the force exerted by the spring assembly. The wheels of the train moving through the switch in a run-through condition force the points away from the stock rail, rotating the spindle and compressing the spring assembly. The wheel gauge drives the points to the opposite stock rail. At this point, the spring assembly has passed over center and will now hold the points against the opposite stock rail.

Railway Technology Inc. recommends that the optional detection circuit be utilized where run-throughs are likely to occur. The detection circuit will automatically shift the points eliminating forcing the points over as the wheels pass through the switch. This option also assures the complete shift of the points eliminating the possibility of fouled points as the result of a run-through.

Safety, reliability, and absolute minimum maintenance requirements are the features and benefits derived from the use of the Model 3000 Hydra-Switch.

Motorola Report

This report is an addendum to Task 2, [illegible]. However, it was distributed along with the letter for Task 2, Deliverable 2.

MOTOROLA

Commercial, Government & Industrial Solutions Sector

RADIO COVERAGE SIMULATION FOR KERETAPI TANAH MELAYU BERHAD (KTMB) MALAYSIA

COMPILED BY : JOHNSON TAN

DATE : 4TH AUGUST 1999

EXECUTIVE SUMMARY

Motorola is pleased to present **ICF Kaiser** herein with our radio coverage simulation of Keretapi Tanah Melayu Berhad (**KTMB**) Radio Communications System. Prior to the coverage simulation, Motorola had conducted a site survey with KTMB on 8 of the existing 16 base station sites along the Klang Valley, although ICF Kaiser had called for 7 sites in the statement of work. Electrical parameters of the communication equipment, antenna system and site coordinates data were obtained during the site survey for coverage simulation purpose.

In order to provide a superior means of analyzing the radio coverage for KTMB, Motorola uses a unique program called **Mozaik**[SM], which is a proprietary coverage simulation tool developed by Motorola for many years. Mozaik is constantly under new development by Motorola's Resource Development Engineering team to create the most accurate and up to date coverage prediction tool. It is used extensively in the design and testing phases of Motorola's Radio Networks in Commercial, Government & Industrial Solutions Sector (CGISS). It can be used to accurately simulate coverage of Motorola's most complex radio systems or the simplest. Mozaik takes the guesswork out of predicting radio coverage – it provides a reliable, easy to read map of the coverage you can expect to receive with your new or expanding system.

The coverage simulation results for KTMB were then presented in colors graphical portraits of terrain, cartographic and coverage reliability plots. These coverage plots could be easily interpreted and analyzed based on desired criteria and the map scale could be user-defined in order to get the true understanding of the coverage results.

Motorola, the communication industry's leader in the design, implementation, and customer accepted state-of-the-art trunked systems, believes that the Mozaik simulation tool is able to accurately simulate the coverage for KTMB's nation-wide system in the near future.

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RADIO COVERAGE SIMULATION FOR KTMB

1. Mozaik Overview

Mozaik is an innovative software tool developed by Motorola to accurately predict the coverage provided by Motorola's diverse portfolio of Radio Networks. The tool accounts for the specific Environmental and System Factors unique to your system, and displays the resulting coverage on colorful, easy to read maps.

2. Mozaik Development

Mozaik was developed to provide an accurate prediction of radio coverage for a particular system by applying proven models to detailed system and environmental data across large geographical areas.

To accurately create a picture of the predicted radio coverage, many elements must be considered. Some of these elements, called system factors, are related to the system design parameters. The system factors affecting coverage performance include frequency, distance, transmitter power, receiver sensitivity, antenna height, and antenna gain. Other factors, called environmental factors, vary according to the path taken by the radio signal and the environment surrounding the signal. Environmental factors include terrain variations, atmospheric conditions, obstructions, vegetation, buildings, ambient noise, and interference.

All propagation prediction methods try to account for both types of factors and incorporate them into a computational model. In general, the currently accepted models, such as Okumura and Bullington provide excellent indications of coverage performance.

In the past this level of analysis was adequate for the type of basic systems that were available. However, today's complex technologies, such as digital radios or simulcast, require a much more in-depth analysis of the expected coverage performance to create a cost-effective design. This makes it necessary to select the appropriate coverage model, provide accurate representation of the environmental factors throughout the service area, and apply the coverage analysis method to every location within the service area.

Recognizing these facts, Motorola has developed Mozaik^{SM}, a coverage analysis program. Employing the knowledge gained from Motorola's many years of practical experience and coverage testing, Mozaik provides a superior means for analyzing system coverage. This program, which is unique to Motorola, is named for its technique of computing coverage on every tile in a service area rather than along a finite number of radials, as in past simulation tools. Mozaik computes "layers" of these tiles, with each layer containing the values of databases, propagation model losses, or simulation results. Layers can be displayed separately or in any combination as maps of the service area. Thus, the layers of tiles make up a propagation "mosaic".

3. Detailed Description

3.1 Tile Method

Mozaik uniformly divides the entire geographical area to be analyzed into small, distinct areas called tiles. The resolution (size) of the tiles can be as fine as three arc-seconds (approximately 300 feet at U.S. latitudes). At each tile, Mozaik models propagation from each site in the system.

The tile method is of particular importance in the calculation of simulcast performance, co-channel interference, and adjacent channel interference. The old radial method determines performance only at the locations where radials from all sites cross, leaving many areas where coverage performance is not calculated. With the tile method, the information from every site and all databases is available in every tile; this provides the most accurate results for multi-server analyses (simulcast, voting, interference, etc.).

3.2 Propagation Models

The prediction for each tile within Mozaik is generated based on one of the following industry accepted propagation models. Selection of the model used is dependent upon the frequency band.

3.2.1 Okumura Model

The Mozaik Okumura model is based (with modifications) on techniques described in "Field Strength and It's Variability in VHF and UHF Land-Mobile Radio Service", Yoshihisa Okumura, Review of the Electrical Communication Laboratory, Volume 16, Number 9-10, September and October 1968. The Okumura model is based on data taken from 150 to 1500 MHz with less data taken at 150 MHz.

3.2.2 Bullington Model

The Mozaik Bullington model is based on techniques described in "Radio Propagation for Vehicular Communications", Kenneth Bullington, IEEE Transactions on Vehicular Technology, Volume VT-26, Number 4, November 1977. The Bullington model is based on data taken from 54 to 216 MHz.

3.2.3 Propagation Model Selection

The Bullington model is generally considered to be preferable at frequencies below 132 MHz. Between 132 and 216 MHz, the Bullington and Okumura models are equally valid. The Okumura model is used at frequencies above 216 MHz.

3.3 Databases

Mozaik uses both topographical and environmental databases. With the proper databases, Mozaik produces highly accurate results. Because propagation prediction accuracy is directly dependent on the quality of the digitized databases, Motorola uses the best quality databases available for its analyses. These databases generally originate from official government agencies such as the U.S. Geological Survey in the United States and equivalent governmental organizations worldwide. When databases are not available from these sources, Motorola works with other approved vendors to produce high quality Mozaik databases.

Some of the databases which Mozaik can use include:

- Terrain - to determine shadow loss and elevation
- Land Use Land Cover (LULC) - for environmental clutter loss
- Cartographic - roads, railways, water features, political boundaries, feature names, etc.

Unfortunately, even the best databases can contain a certain amount of errors, caused by a number of factors that are difficult to totally overcome due to the massive amount of data involved. Some examples are:

- Source Information: Terrain and environmental databases are primarily derived from existing map information, so any errors in the existing maps will be carried over to the databases.
- Database Development Process: Limitations in the digitizing algorithms and computer hardware problems are potential error sources. Also, judgment calls by the database developer can lead to errors if they are not correct.
- Age: The physical world is constantly changing. Natural phenomena such as earthquakes, volcanoes, fires, storms, etc., change the topography and environmental factors. Over time landfills are created; hills are leveled; roads are built; communities are developed; and large buildings are constructed. Not all of these changes may be current in the database.

Mozaik provides coverage predictions which can only be as accurate as the available databases permit.

3.4 Coverage Reliability

Mozaik coverage maps indicate the probability (usually referred to as reliability) of the radio system providing a minimum acceptable criterion, such as a Delivered Audio Quality (DAQ) or a Bit Error Rate (BER). Since system coverage can never be 100% percent reliable, there will always be particular times and locations where the signal strength or BER is below that needed to reach the performance criterion. These

locations of unsatisfactory performance are often predicted in a coverage study. However, there are also areas of unsatisfactory coverage that cannot be predicted due to unknown circumstances such as shadowing of buildings, greater than average tree density, ambient noise, atmospheric conditions, terrain variations not accounted for in the coverage prediction, and interference from co-channel or adjacent channel units operating outside their normal service area.

Because these conditions exist and signals fade due to these environmental and terrain factors, coverage must be described statistically in the terms of a percentage of locations which exhibit some specified minimum level of reliable communications.

3.4.1 Area Reliability versus Contour Reliability

Mozaik is designed to predict area reliability based on a defined minimum acceptable criterion and a defined probability of achieving that criterion; this is referred to as contour reliability in TIA/EIA TSB88. It is important to distinguish between area reliability and contour reliability. Confusion on this topic, along with general coverage specification description, leads vendors to offer different types of communication coverage, thus limiting the user's ability to make an "apples to apples" comparison.

Area reliability is defined as the average of the reliabilities at each location within the total coverage area. As an example, radio system specifications that require 90% area reliable communications within a coverage area may have 30% or more communication failures in the test locations at the fringe of the coverage area. This high concentration of failures within the service boundary is usually unacceptable to the user.

To design radio systems which provide acceptably few communications failures in the fringe coverage areas, Mozaik maps show the aggregate of the individual locations (tiles) predicted to be at or above a specified reliability of meeting or exceeding a specified minimum acceptable performance criterion. The minimum acceptable performance criterion is typically a DAQ or a BER. Thus, Mozaik maps conform to the TIA/EIA TSB88 definition of contour reliability.

Note that the term "contour reliability" refers to the communications reliability in the fringes of the coverage area. Motorola has found that communication systems designed for 90% **contour** reliability typically produce greater than 95% **area** reliability. This method of defining contour coverage reliability will typically result in fewer than 10% test location failures in the fringe areas, as contrasted with up to 30% failures in the fringe areas when using a 90% **area** reliability coverage design criterion. It is also important to note that locations outside of a Mozaik map coverage area may still provide useable communications, even though such locations do not provide the specified reliability of achieving the minimum acceptable performance.

3.5 Mozaik Outputs

Mozaik can produce graphical "portraits" of these and other outputs:

- Coverage Reliability Maps
- Terrain Portraits
- Cartographic Portraits
- LULC Portraits
- Shadow Loss Portraits
- Interference Studies
- Antenna Patterns
- Parameter Sheets

4. Mozaik Coverage Interpretation

Since Mozaik is so unique, a brief explanation of how to presents the coverage information will help in the interpretation of the results. Mozaik starts with a colored display of the terrain map for the selected area (see Figure 1a). The colors, shades and elevation steps are chosen by the engineer. A scale on the bottom of the Mozaik plot shows the minimum and maximum elevations in the selected area. It also shows how the range between the elevations is displayed. There is a box on the left end of the scale which contains a "<". This means that any elevation below the minimum number is not displayed as a color on the results. In other words the blue background is displayed at these locations. In this example, the yellow and brown areas represent a portion of Malaysia's landmass, and the blue area represents the ocean.

Next, the cartographic on railway track is plotted. The track is displayed as black color (see Figure 1b) as an example. The colors and track width are chosen by the engineer. For cartographic plot, there is no scale shown on the bottom of the Mozaik plot, as it is not required. When the cartographic information is placed over the terrain, the cartographic color (black) covers the terrain as shown in Figure 1c.

Next, the coverage reliability is simulated. This is displayed as red shaded color (see Figure 1d) as an example. Like the terrain information, the colors, shades and reliability steps are chosen by the engineer. A scale on the bottom of the Mozaik plot shows the reliability range examined. Likewise, there is a box on the left end of the scale which contains a "<". This means that any reliability below the minimum number is not displayed as a color on the results. When the reliability information is placed over the terrain and cartographic plot, the reliability colors (red) cover the terrain and track colors as shown in Figure 2. The uncovered terrain information and railway track indicate that the reliability in these locations could not meet the minimum value (90% contour coverage reliability in this example) chosen by the engineer.

There are a few other items that should be considered when reviewing the results. The map scale for each output is presented in the lower left box of the page. In order to present the full coverage plot, it was sometimes necessary to change the map scale. Therefore, the map scale should be examined to get a true understanding of the coverage results. The lower center box briefly explains what path (base station to mobile radio or mobile radio to base station) was used to calculate the coverage area.

5. KTMB Site Survey Report

Prior to the coverage simulation, Motorola had conducted a site survey for KTMB Radio Communications System on 14th & 15th July 1999 to gather detail technical information for Mozaik simulation tool.

Currently, KTMB has altogether 16 base station sites as shown in Appendix A. However, although ICF Kaiser had called for coverage simulation of KTMB's existing 7 sites along the Klang Valley in the statement of work, Motorola surveyed 8 base station sites instead, namely:

1. Kuala Lumpur
2. Sentul
3. Rawang
4. Klang
5. Sungai Way
6. Kajang
7. Batang Benar
8. Seremban

During the site survey, electrical parameters of the base station, antenna system (Appendix B1 to B6) and site coordinates data (using GPS, Global Positioning System) were collected and tabulated in Table 1. Out of these 8 base stations, only Kuala Lumpur, Sentul and Sungai Way are using the 9dB Omni-Directional antenna. The rest of the base stations are using the Bi-Directional antenna (i.e. two directional antennas) with a 3dB splitter.

As shown in Table 1 that for the Bi-Directional antenna system, Rawang, Batang Benar and Seremban base stations use the same antenna gain of 13dB while Klang and Kajang base stations use a combination of 13dB and 18dB antenna gains. Each of these directional antennas was mounted in such a way that the antenna pattern was pointing to the direction of the railway track. For example at Klang base station site, with the North direction reference to 0°, the 13dB directional antenna azimuth was set at 68° (East direction) while the 18dB directional antenna azimuth was set at 254° (South-West direction).

Other than the base stations, the electrical parameters of the mobile radio and antenna system were also collected (Appendix C1 and C2) and tabulated in Table 2. In general, KTMB deployed most of the mobile radios in KTM trains, and a few in trolleys (for field maintenance and servicing purpose) and locomotives (i.e. in the vehicle). In additional, KTM also has hand carry type of portable radio that was using the same mobile radio for field maintenance and servicing purpose.

Site Name	Kuala Lumpur	Sentul	Rawang	Klang	Sungai Way	Kajang	Batang Benar	Seremban
General Site Parameters								
Latitude	03°07'00"	03°11'03"	03°19'11"	03°02'32"	03°04'59"	02°59'00"	02°49'50"	02°43'00"
Longitude	101°40'00"	101°41'23"	101°34'30"	101°26'54"	101°36'39"	101°47'27"	101°49'37"	101°56'27"
Type of Environment	City	Suburban	Suburban	Suburban	Suburban	Suburban	Suburban	Suburban
Site Elevation from Mozaik Database (m)	57	62	53	76	4	30	61	61
Base Station Transmit Parameters								
Transmit Power (W)	40	40	40	40	40	40	40	40
Transmitter Combiner Loss (dB)	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Base Station Receive Parameters								
Receiver Sensitivity (uV) @20dB SINAD	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Base Station Antenna System Parameters								
Type of Antenna	Omni	Omni	Bi-Directional	Bi-Directional	Omni	Bi-Directional	Bi-Directional	Bi-Directional
Antenna Gain (dB)	9	9	13 / 13	13 / 18	9	13 / 18	13 / 13	13 / 13
Antenna Azimuth (degree)	-	-	17° / 199°	68° / 254°	-	187° / 297°	333° / 236°	284° / 130°
Antenna Splitter Loss (dB)	-	-	3.0	3.0	-	3.0	3.0	3.0
Antenna Height (m)	35	25	40	25	30	45	45	30
Main Feeder Length (m)	40	45	60	45	50	70	70	45
Main Feeder Cable Type	½" LDF	½" LDF	½" LDF	½" LDF	½" LDF	½" LDF	½" LDF	½" LDF

Table 1 Base Station Parameters obtained from Site Survey and used in Mozaik Coverage Simulation

Model Number	Transmit Power (W)	Receiver Sensitivity (uV) @20dB SINAD	Type of Antenna	Antenna Gain (dBqw)	Antenna Height (m)	Cable Type	Typical Cable Length (ft)
DCM 4800 DR	12	0.5	Omni	O	3	RG214	10

Table 2 Mobile Radio Parameters obtained from Site Survey and used in Mozaik Coverage Simulation

6. Coverage Analysis

To accomplish the task of radio coverage simulation for **KTMB**, Motorola uses the Okumura propagation model that is more suitable for system like 800MHz. The Okumura prediction method is not a theoretical method, but rather a purely empirical method that makes use of a set of data collected by Okumura from the RF propagation tests which he conducted.

The following qualifications have been made for the coverage prediction:

- The coverage simulation was based on 8 out of 16 base station sites, although ICF Kaiser had called for coverage simulation of KTMB's existing 7 sites along the Klang Valley in the statement of work.

- The coverage was simulated using the 90% contour coverage reliability (or equivalently 95% area coverage reliability) and the digital terrain database in resolution of 30 arc second (i.e. the size of each tile used in Mozaik model is approximately 1 km by 1 km) as agreed in the statement of work.

- City environmental loss was considered for area like Kuala Lumpur base station site while suburban environmental loss was considered for the rest of the 7 base station sites.

- 40W (46dBm) base station transmit power and 12W (40.8dBm) mobile radio transmit power were used in the coverage simulation.

- The coverage analysis was based on worse case scenario, i.e. based on the talk-out performance of the base station to mobile radio. This is judging by the fact that the signal transmitting from the base station to mobile radio will undergo higher attenuation (due to 5.7dB transmitter combiner loss), as compared to signal level difference of 5.2dB (40.8dBm - 46dBm) when the signal transmits from mobile radio to base station. The rest of the equipment attenuation (e.g. splitter loss) and equipment gain (e.g. antenna gain) were not considered here because they are neutralized in the transmit and receive signal path calculation.

- Since most of the mobile radios are deployed in the KTM train, therefore 3m-antenna height was considered in the coverage simulation.

- Any other qualifications that not highlighted here are assumed to be in the Mozaik parameter sheet as shown in Table 1 and 2.

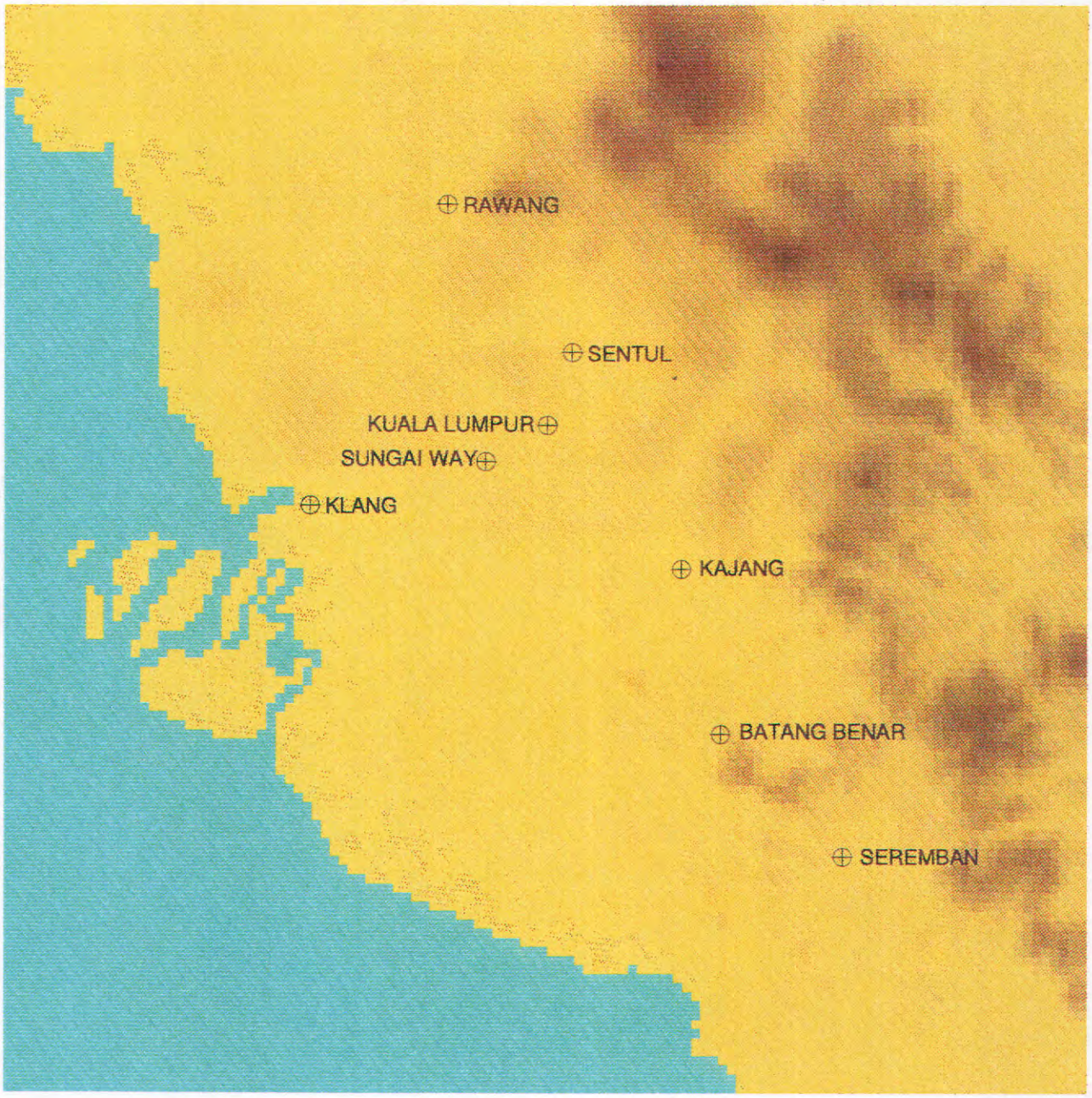
Figure 2 shows the overall radio coverage plot (shaded in red) for mobile radio based on 95% area coverage reliability. The plot shows that the radio coverage from all the 8 base stations covers most part of KTM railways except for area between Rawang and Sentul, and area between Batang Benar and Seremban sites. However, these areas shall be covered by the other base station sites, which are not included in the site survey and therefore not considered in the coverage simulation as mentioned earlier.

Figure 3, 4 and 5 illustrate in detail the radio coverage plot of each base station site based on 95% area coverage reliability. The combination of these 3 plots would yield the overall radio coverage plot as shown in Figure 2.

FIGURES

RADIO COVERAGE SIMULATION RESULTS

Figure 1a : KTMB Terrain Map Plot



Terrain m

297 593 888 1184 1480

MOTOROLA, INC.

0.0 5.0 10.0 15.0 20.0 25.0 30

SCALE : 6.25 KM PER CENTIMETER

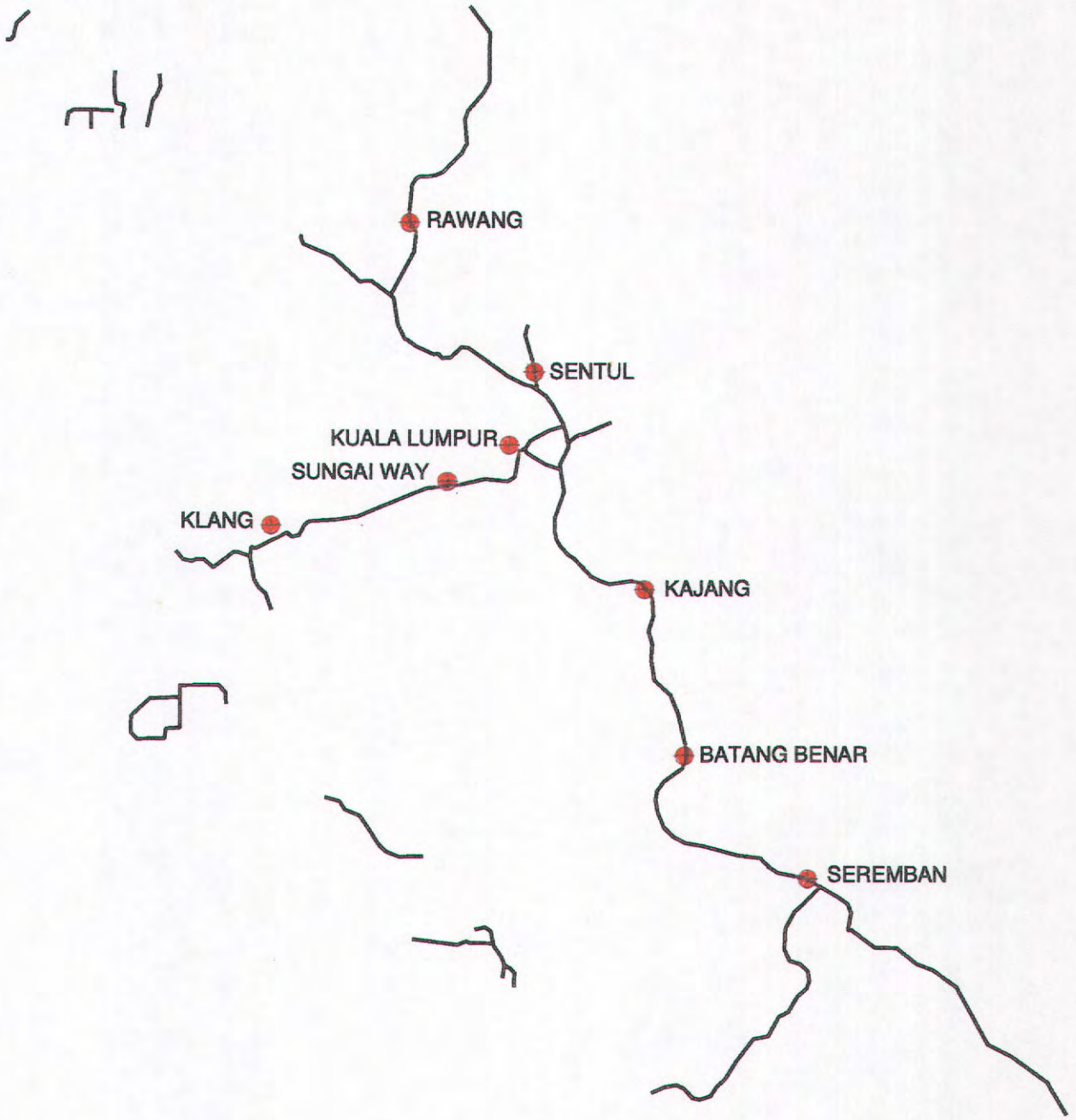
Job #	:	940319503
Engineer	:	CKT021
Date	:	07/29/1999
Time	:	15:47:52

REPEATER W/1 OMNI ANT. to ANALOG MOBILE
Field Unit On Street

Field Unit ERS	:	0.39μv(-115.2dBm)
Field Unit Ant Ht	:	3.0 Meters
Field Unit Ant Type	:	

Calculated values are derived using average loss values for surroundings. Some low lying heavily wooded or urban areas may result in lower values than those indicated.

Figure 1b : KTMB Railway Cartographic Plot



MOTOROLA, INC.

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SCALE : 6.25 KM PER CENTIMETER

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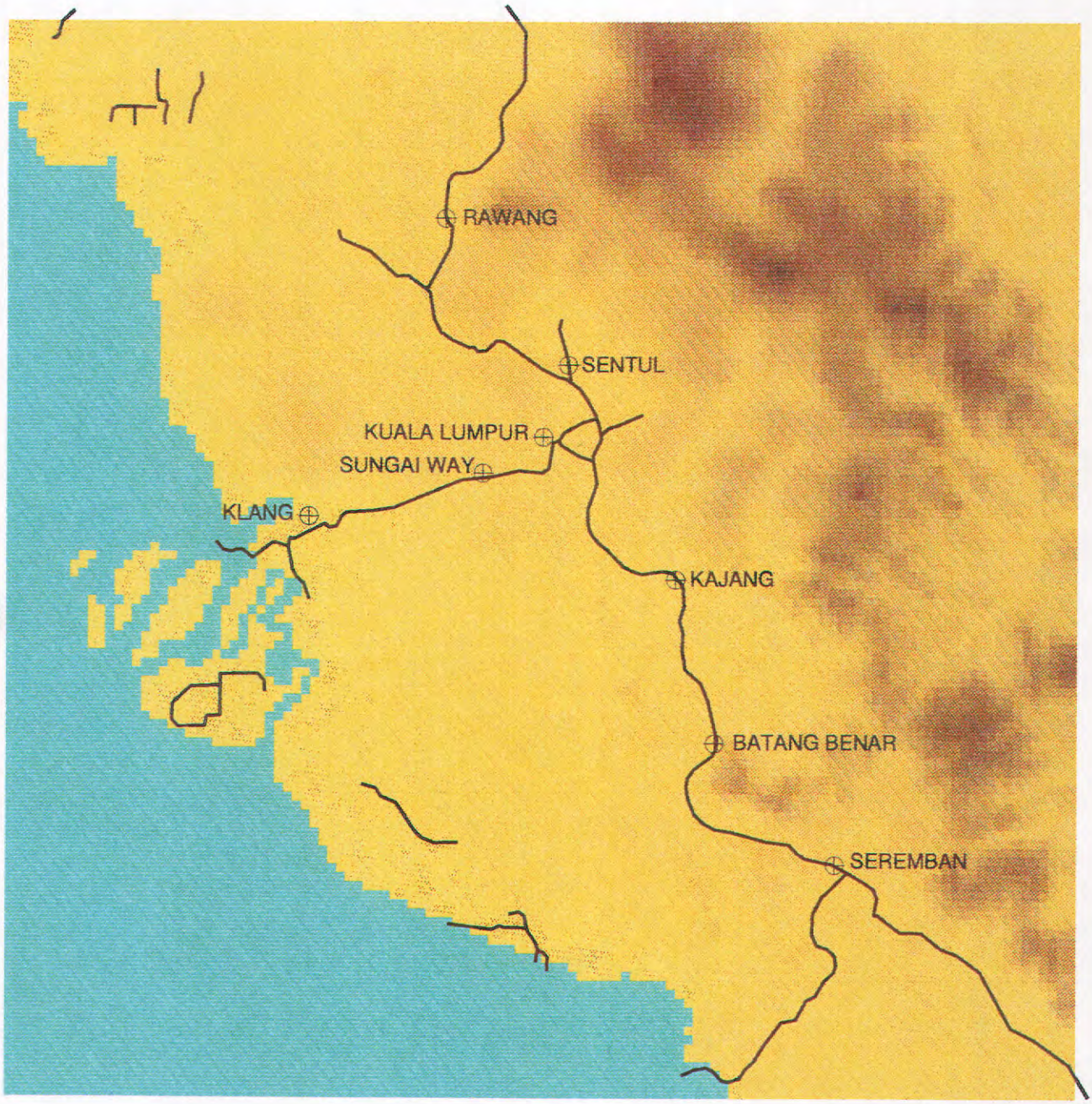
Field Unit Ant Type	:	

Calculated values are derived using average loss values for surroundings. Some low lying heavily wooded or urban areas may result in lower values than those indicated.

Figure 1c : Terrain Map with Railway Cartographic Plot



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Engineer : CKT021
Date : 07/29/1999
Time : 15:47:52

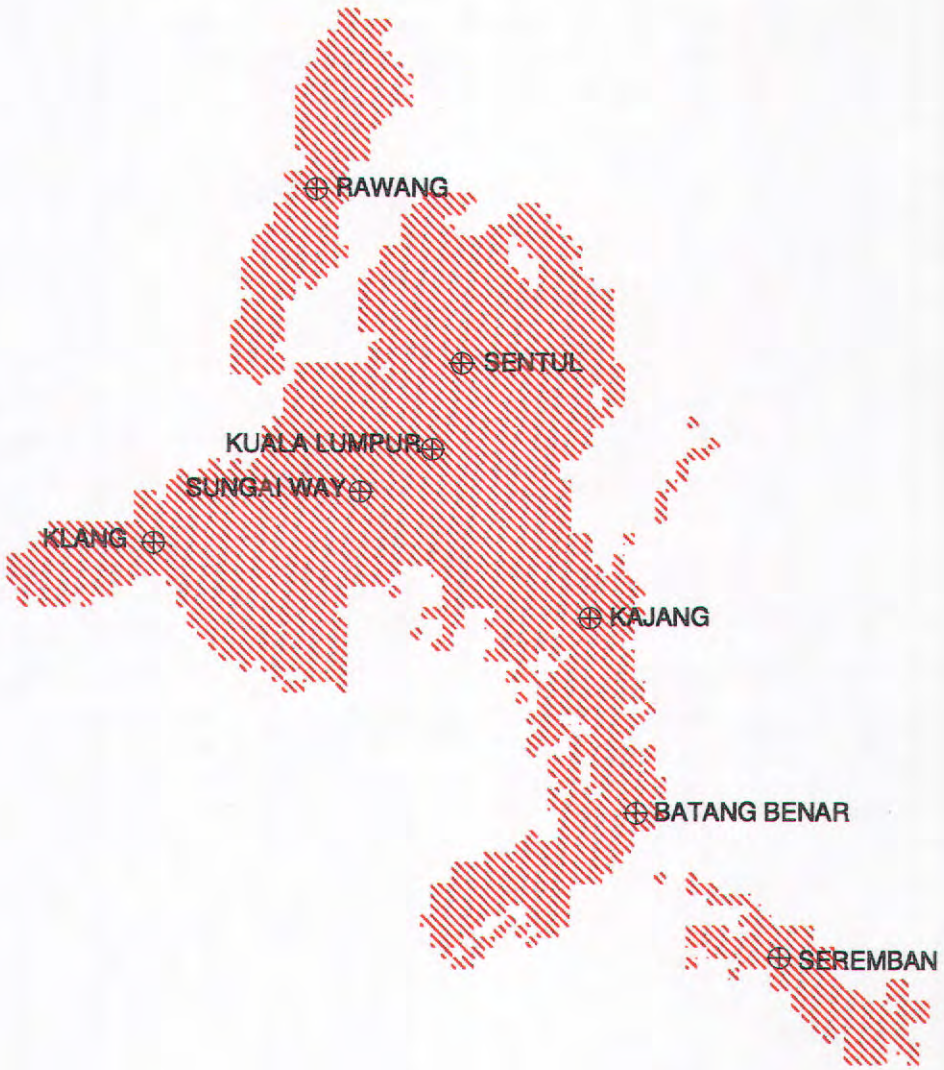
REPEATER W/1 OMNI ANT. to ANALOG MOBILE
Field Unit On Street

Field Unit ERS : 0.39μv(-115.2dBm)
Field Unit Ant Ht : 3.0 Meters
Field Unit Ant Type :

Calculated values are derived using average loss values for surroundings. Some low lying heavily wooded or urban areas may result in lower values than those indicated.

KTMB

Figure 1d : KTMB 95% Area Coverage Reliability Plot



Composite (Greatest % Rule) %

0 100

MOTOROLA, INC.

0.0 5.0 10.0 15.0 20.0 25.0 30

SCALE : 6.25 KM PER CENTIMETER

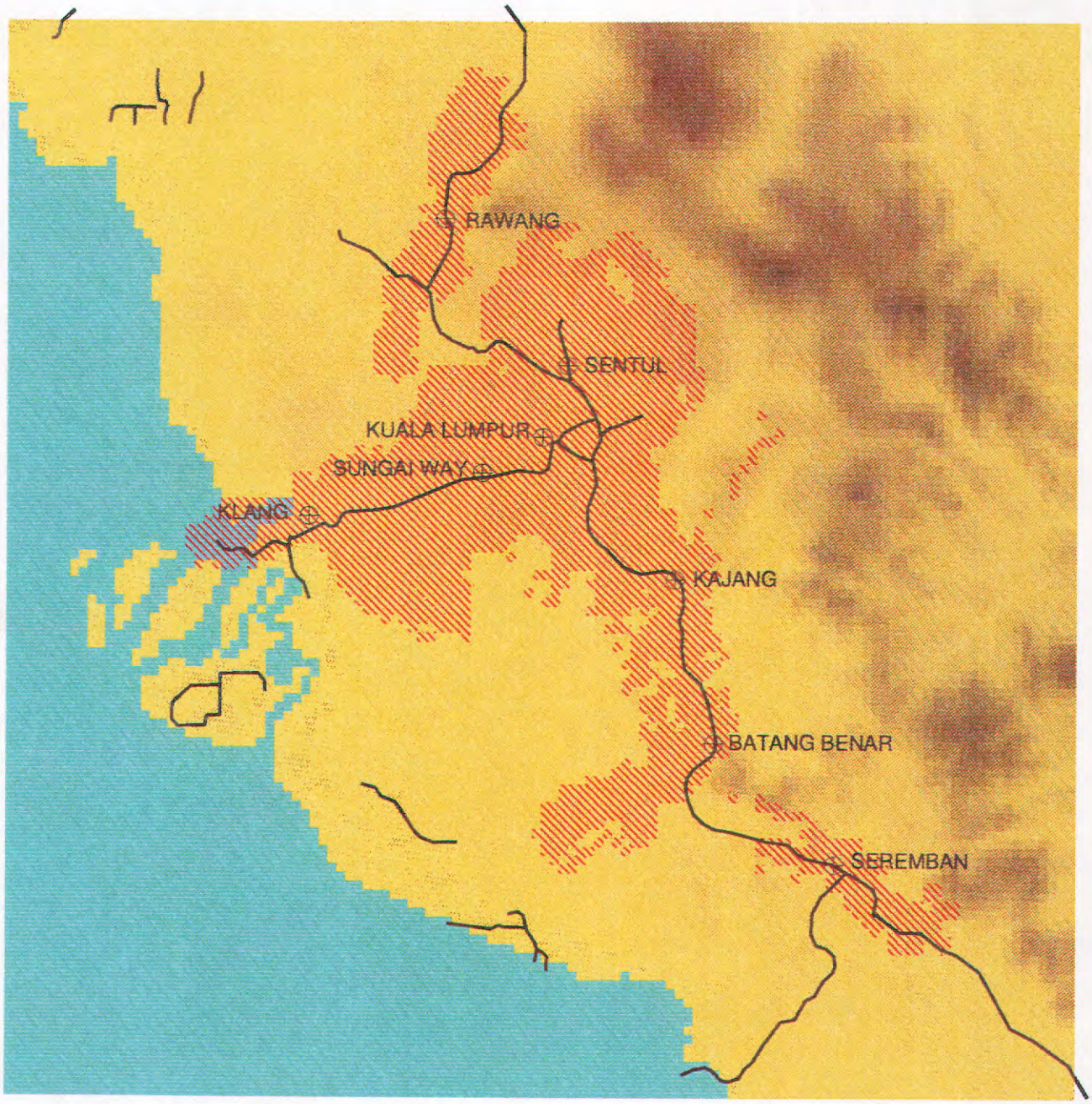
Job #	:	940319503
Engineer	:	CKT021
Date	:	07/29/1999
Time	:	15:47:52

REPEATER W/1 OMNI ANT. to ANALOG MOBILE
Field Unit On Street

Field Unit ERS	:	0.39µv(-115.2dBm)
Field Unit Ant Ht	:	3.0 Meters
Field Unit Ant Type	:	

Calculated values are derived using average loss values for surroundings. Some low lying heavily wooded or urban areas may result in lower values than those indicated.

Figure 2 : Overall Base Station to Mobile Radio Coverage Plot based on 95% Area Coverage Reliability



Terrain m

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Composite (Greatest & Rule) &

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SCALE : 6.25 KM PER CENTIMETER

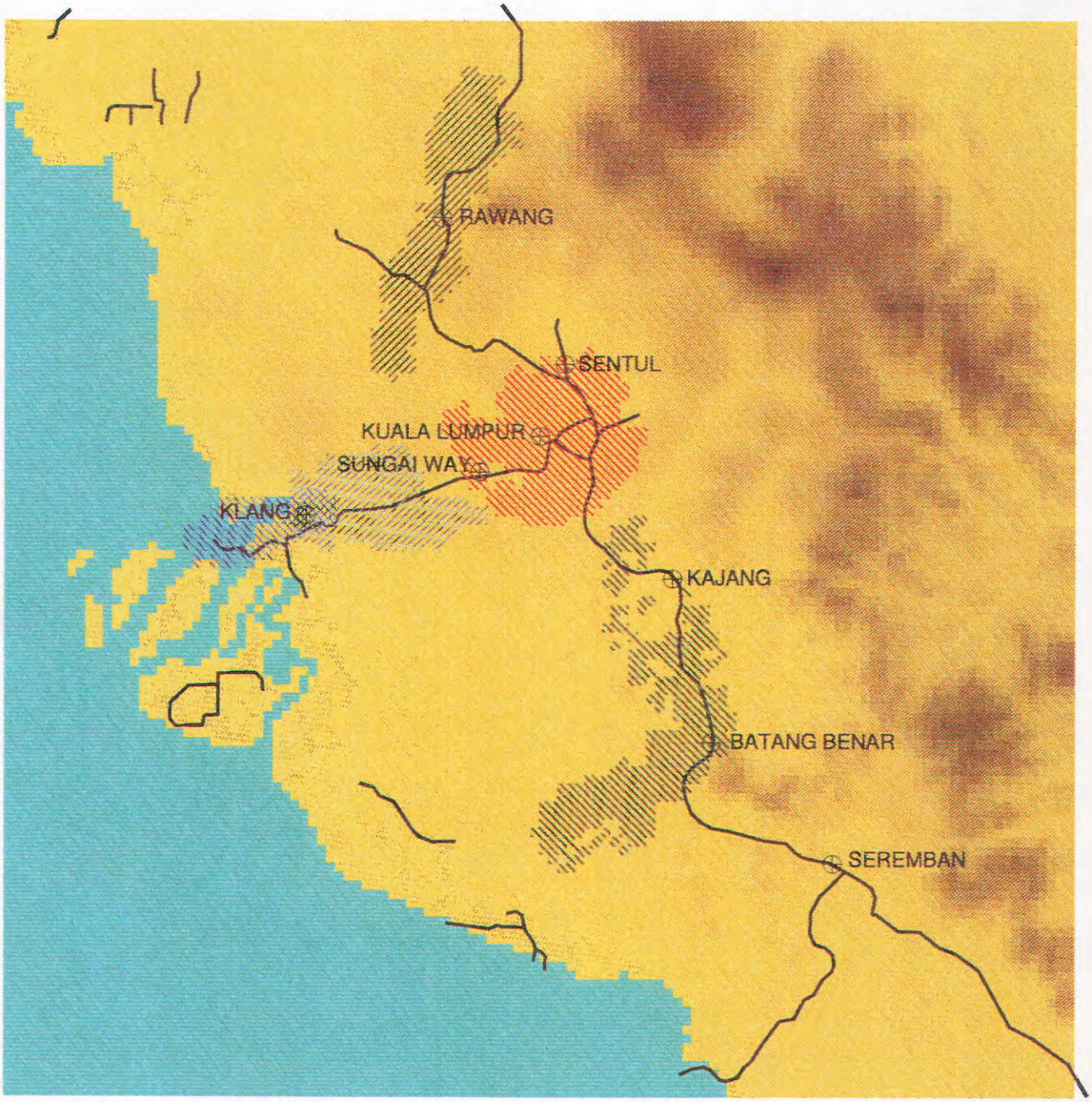
Job #	:	940319503
Engineer	:	CKT021
Date	:	07/29/1999
Time	:	15:47:52

REPEATER W/1 OMNI ANT. to ANALOG MOBILE
Field Unit On Street

Field Unit ERS	:	0.39µv(-115.2dBm)
Field Unit Ant Ht	:	3.0 Meters
Field Unit Ant Type	:	

Calculated values are derived using average loss values for surroundings. Some low lying heavily wooded or urban areas may result in lower values than those indicated.

Figure 3: 95% Area Coverage Reliability Plot for Kuala Lumpur, Rawang, Klang & Batang Benar base station site



Terrain m | Reliability % | Reliability % | Reliability % | Reliability % | Reliability % | Reliability % | Reliability %

90 100 90 100 90 100 90 100 90 100 90 100 90 100

MOTOROLA, INC.

0.0 5.0 10.0 15.0 20.0 25.0 30

SCALE : 6.25 KM PER CENTIMETER

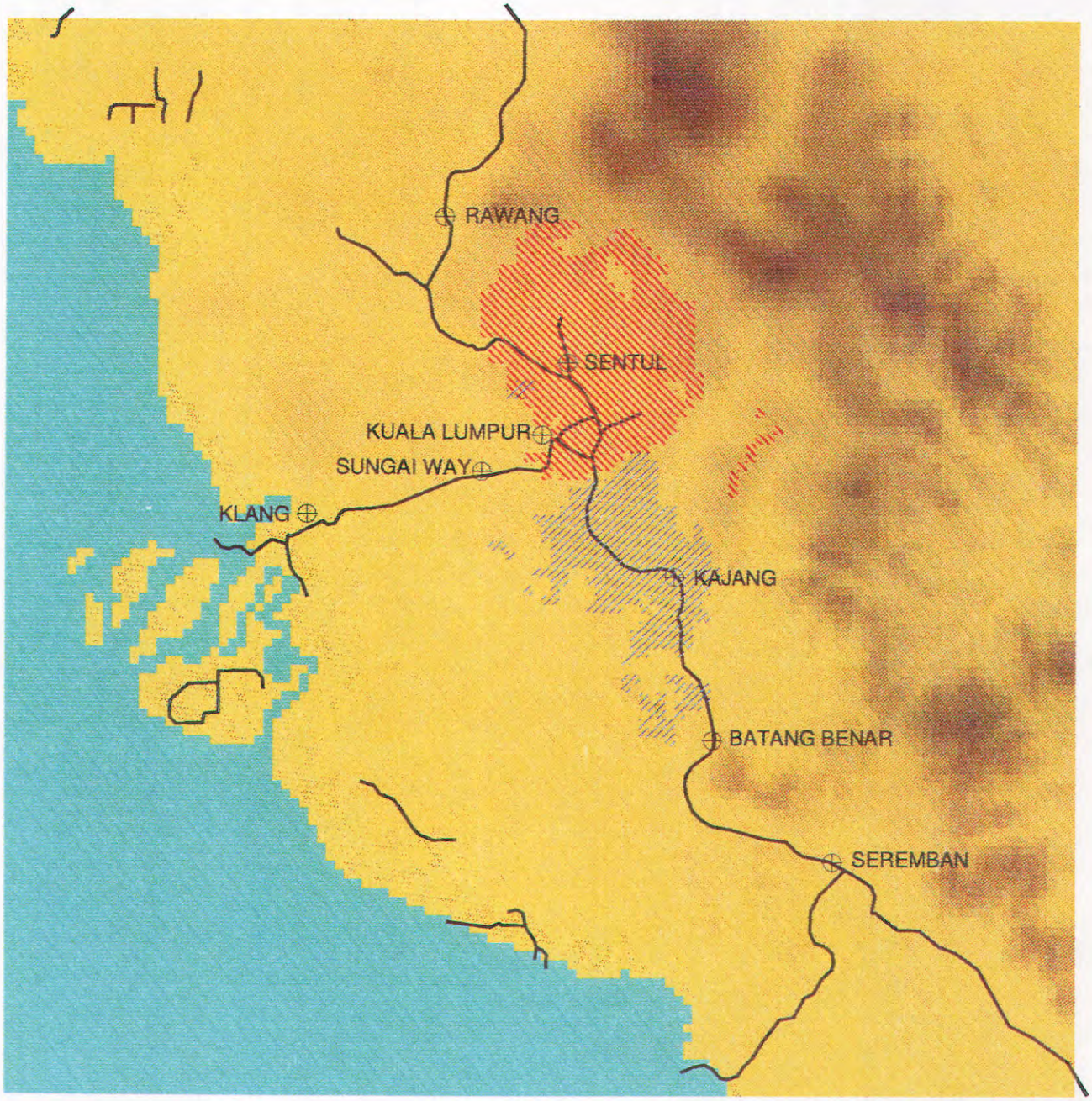
Job # : 940319503
Engineer : CKT021
Date : 07/29/1999
Time : 15:47:52

REPEATER W/1 OMNI ANT. to ANALOG MOBILE
Field Unit On Street

Field Unit ERS : 0.39µv(-115.2dBm)
Field Unit Ant Ht : 3.0 Meters
Field Unit Ant Type :

Calculated values are derived using average loss values for surroundings. Some low lying heavily wooded or urban areas may result in lower values than those indicated.

Figure 4 : 95% Area Coverage Reliability Plot for Sentul and Kajang base station sites



Terrain m

1 29759388811880

Reliability %

90 100

Reliability %

90 100

Reliability %

90 100

MOTOROLA, INC.

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SCALE : 6.25 KM PER CENTIMETER

Job #	:	940319503
Engineer	:	CKT021
Date	:	07/29/1999
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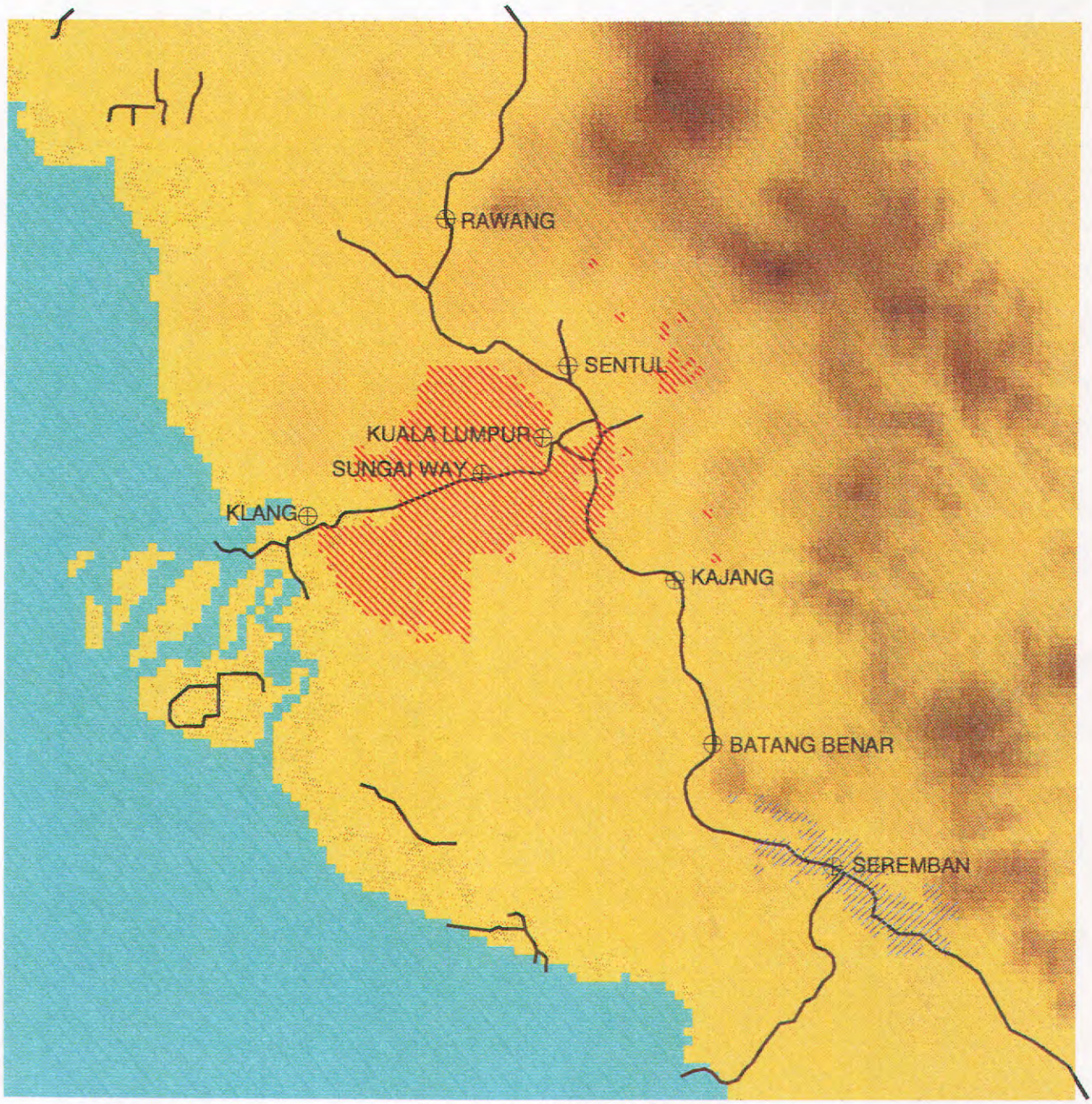
REPEATER W/1 OMNI ANT. to ANALOG MOBILE
Field Unit On Street

Field Unit ERS	:	0.39uv(-115.2dBm)
Field Unit Ant Ht	:	3.0 Meters
Field Unit Ant Type	:	

Calculated values are derived using average loss values for surroundings. Some low lying heavily wooded or urban areas may result in lower values than those indicated.

Figure 5 : 95% Area Coverage Reliability Plot for Sungai Way and Seremban base station sites



Terrain m

Reliability %

Reliability %

Reliability %

MOTOROLA, INC.

SCALE : 6.25 KM PER CENTIMETER

Job #	:	940319503
Engineer	:	CKT021
Date	:	07/29/1999

REPEATER W/1 OMNI ANT. to ANALOG MOBILE
Field Unit On Street

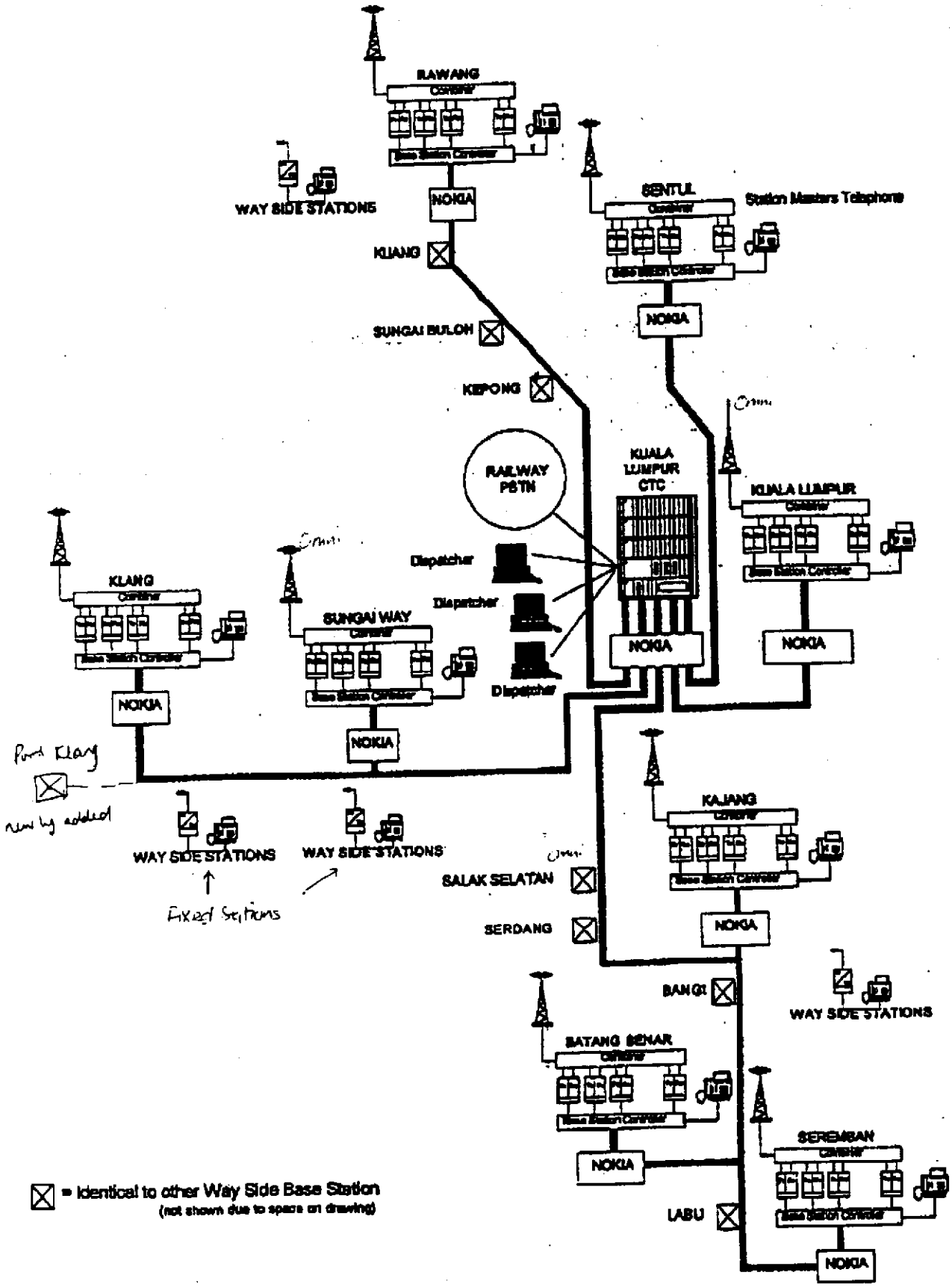
Field Unit ERS	:	0.39µv(-115.2dBm)
Field Unit Ant Ht	:	3.0 Meters

Calculated values are derived using average loss values for surroundings. Some low lying heavily wooded or urban areas may result in lower values than those indicated.

APPENDIXES

SYSTEM DIAGRAM AND TECHNICAL SPECIFICATIONS

DANPHONE



Appendix A : KTMB Radio Communications System Diagram

Frequency Stability:	± 2 ppm (-20º C to +60º C)
Antenna impedance:	50 ohm
Frequency Response:	+6 dB/Oct (+1/-3 dB @ 300 - 3000 Hz)

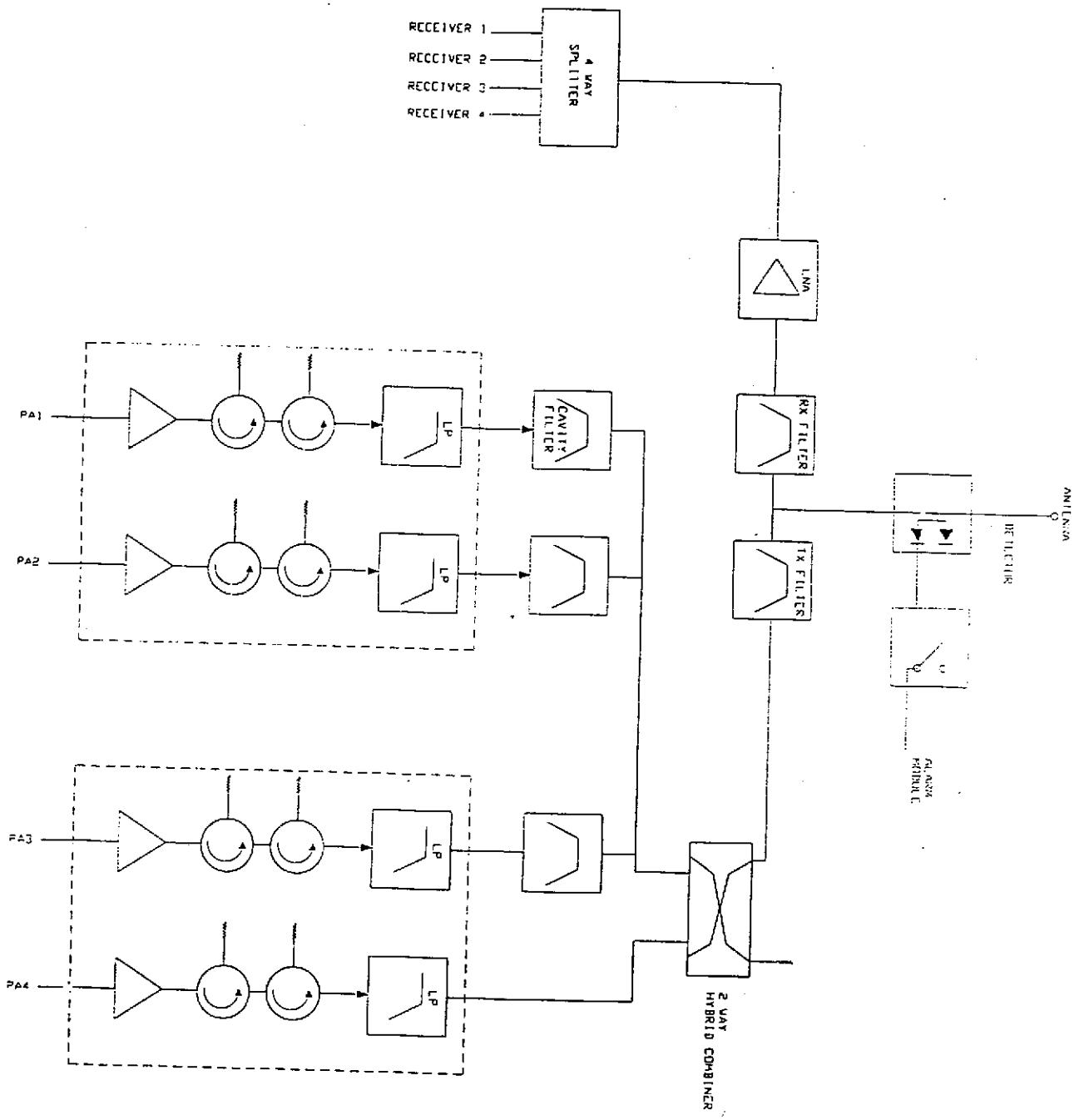
6.2 Transmitter:

Frequency range::	860 - 864 MHz
RF bandwidth:	5 MHz typical
RF power output:	12 Watts
RF power range:	1 to 12 W
Optional RF booster output:	10 - 50 W
Power adjustment:	Manual internal adjustment
RF power stability:	
- Normal conditions:	Within +1.5 dB and -1.5 dB
- Extreme conditions:	Within +2.0 dB and -3.0 dB
Transmitter timing:	
Attack time:	5 ms to 90% RF power
Decay time:	5 ms
FM hum and noise:	< -40 dB
AM hum and noise:	< -50 dB
Maximum freq. deviation:	±5.0 kHz
Frequency stability:	±2.5 kHz
Adjacent channel power:	< -70 dB
Radiated Spurious Emission:	
0.1 to 1.0 GHz:	< 0.25 µW
1.0 to 4.0 GHz:	< 1.0 µW
Intermodulation attenuation:	> 15 dB

6.3 Receiver:

Frequency range:	816 - 820 MHz
Sensitivity:	
20 dB SINAD (CCITT):	0.5 µV P.D.
Adjacent Channel Selectivity:	> 70 dB
Spurious Response Rejection:	> 70 dB
Blocking:	> 90 dB
Spurious Emission (radiated):	
0.1 to 1.0 GHz:	< 2 nW
1.0 to 4.0 GHz:	< 20 nW
Spurious Emission (conducted):	

0.1 to 1.0 GHz:	< 2 nW
1.0 to 4.0 GHz:	< 20 nW



Appendix B2 : Base Station Antenna System Diagram

3.3 Specifications

Frequencies

TX Path:	860-864MHz
RX Path:	815-819MHz

Electrical

Impedance:	50 ohms
TX Power Rating:	60 watts per channel
TX Insertion Loss:	5.7dB max
TX/TX Spacing:	>300kHz
TX/TX Isolation:	>65dB
TX/RX Isolation:	>95dB
TX VSWR:	better than 1.2:1
RX Gain:	1-3dB (factory preset)
RX/TX Isolation:	>85dB
TX/RX Isolation:	>20dB
RX VSWR:	better than 1.3:1
Antenna Monitoring System:	Alarm condition Antenna 2:1
Nominal Supply Voltage:	24VDC (negative ground)
Output Power Test:	better than 12.3 watts

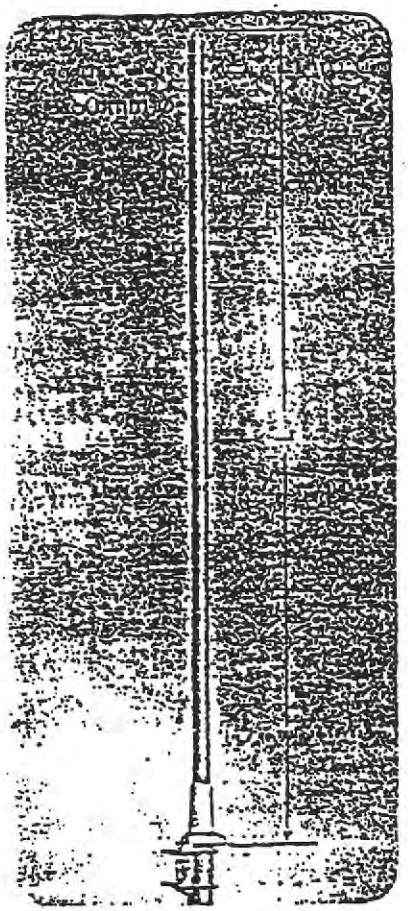
Omnidirectional High Gain Antenna

740 080

HS 330 A

dB gain omnidirectional
nier-fed collinear antenna

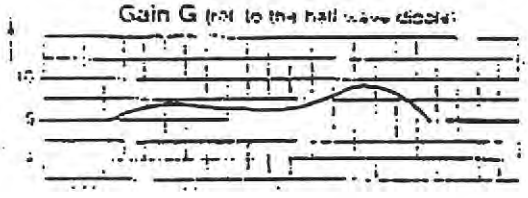
e radiator assembly is
closed in a rugged fibre-
ass radome for maximum
otection from severe
ather, saltwater and cor-
ive atmosphere. Special
nstruction provides com-
te weather-protection
the connector inside the
supporting pipe. For the al-
ternate mounting with coax
running outside the pipe the
housing also provides ade-
quate protection.
Careful design and material
selection results in an ex-
pectancy of long service
life, confirmed by the ex-
perience of our many cu-
stomers.



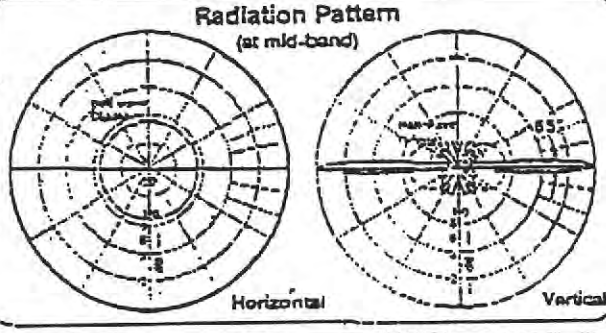
pe No.	740 080
ut	Type N female connector in the antenna base
equency range	805 - 866 MHz
WR	< 1.5
in	9 dB (ref. to the half-wave dipole)
ax. power input	500 Watts (at 50°C = 140°F ambient)
larization	Vertical
ghtning otection	The antenna is DC grounded by a cross-sec-tion of 31 mm² (0.048 sq.") copper
ope of supply	Antenna including mounting V-bolts and nuts
aterial	Radiating elements: copper and brass in a 50 mm (1 31/32") fibreglass radome (colour: ho-ney similar RAL 1007), rugged cast aluminum bottom, stainless steel mounting V-bolts. All screws and nuts: stainless steel
ounting	To pipes of 20-105 mm (3/4"-4 1/8") OD by means of supplied stainless steel V-bolts
ngth L	2150 mm (10.3 ft)
t weight	7.3 kg (16 lbs)
x. exposed ea	0.157 m² (1.69 ft²)
teral thrust	23 kp (51 lbs) at 160 km/h = 100 mph
nding moment	36 mkp (263 ft. lbs) at 160 km/h = 100 mph (at attachment point)
nd velocity w/o ice ½" radial ice	rated (1.65 safety factor)*/survival 160 km/h = 100 mph/220 km/h = 135 mph 115 km/h = 72 mph/150 km/h = 95 mph
cking	330 x 16 x 16 cm (130" x 6.3" x 6.3")

based on the yield point
a lightning strike at the antenna-top is directly connected to the bottom.

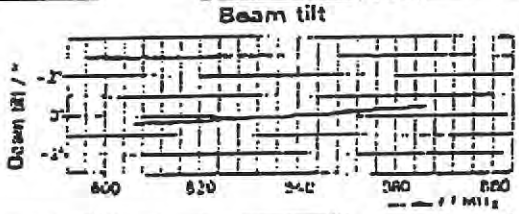
Gain G (ref. to the half wave dipole)



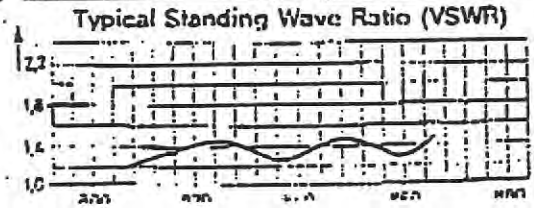
Radiation Pattern
(at mid-band)



Beam tilt



Typical Standing Wave Ratio (VSWR)



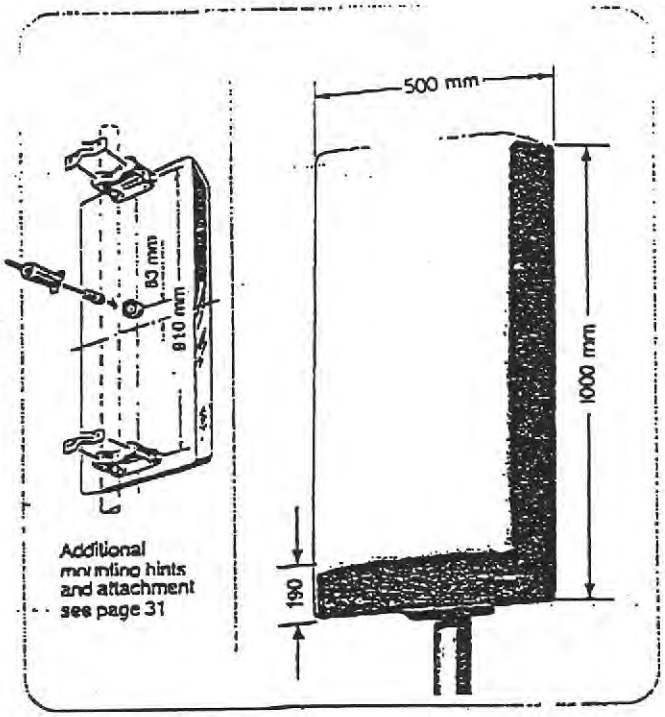
Appendix B4 : Base Station 9dB Omni-Directional Antenna Specifications

KATHREIN

Directional Antenna K 73 30 6 ..

790 - 960 MHz

Ice protected broadband 13 dB aluminum panel

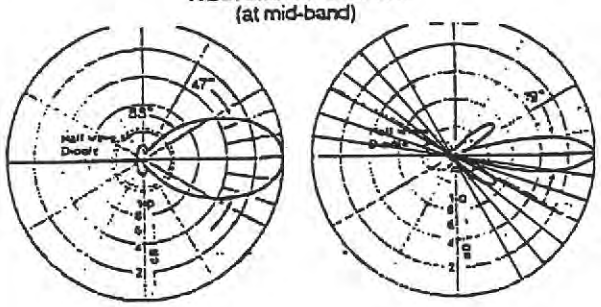


Type No.	K 73 30 6 1	K 73 30 6 7
Input	N female	7/16 female
Maximum Power	500 Watts (at 50° C ambient)	1000 Watts (at 50° C ambient)
Impedance	50 Ω	
Frequency range	790 - 960 MHz	
VSWR	< 1.2	
Gain	13 dB (ref. to half wave dipole)	
Front to back ratio	> 20 dB	
Polarization	Vertical	
Arrays	This antenna is especially suitable as a component in arrays to achieve various radiation patterns	
Scope of supply	Antenna with two types of weather protective housings for the connector (see page 31)	
Material	Dipoles and reflector screen: Weather-proof aluminum. Radome: Fiberglass. Fittings: Hot dip galvanized steel. All screws and nuts: Stainless steel	
Radome colour	Standard: White (RAL 9002): on request also available in red (RAL 2002) or grey (RAL 7001)	
Attachment (order separately)	To pipes of 40 - 521 mm Ø by means of clamps K 61 14 0 .. (see page 31)	
Ice protection	Since the radiators are fully protected by the radome and due to its very sturdy construction, the antenna will remain operational even during heavy icing	
Lightning protection	The metal parts of the antenna inclusive of the delivered mounting kit are DC grounded. The inner conductor is coupled capacitively	

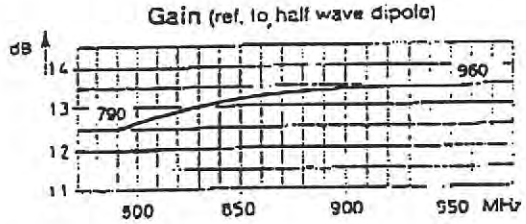
Mechanical data

Weight	10 kg
Wind area	0.5 m² max.
Wind load	frontal: 715 N, lateral: 220 N (at 150 km h)
Max. wind veloc.	230 km h, Safety factor: 2

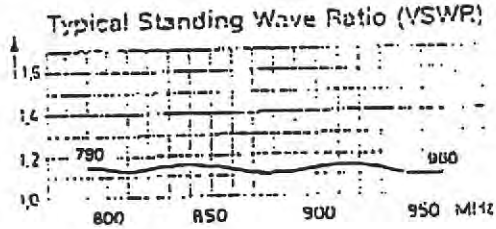
Radiation Patterns
(at mid-band)



Gain (ref. to half wave dipole)



Typical Standing Wave Ratio (VSWR)



Eurocell Panel
732 433
65° Half-power Beam Width

KATHREIN
Antennen · Elec

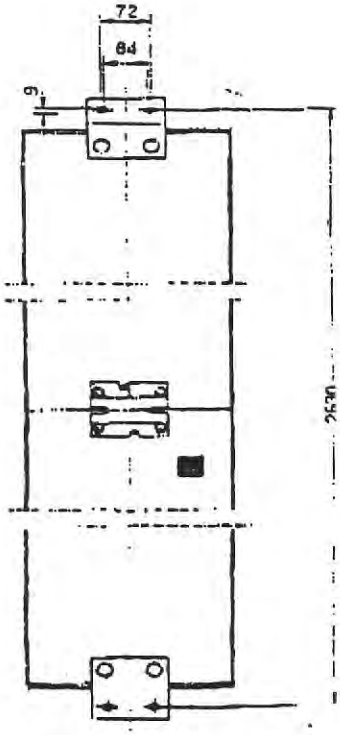
Panel 900 65° 18.5dBi

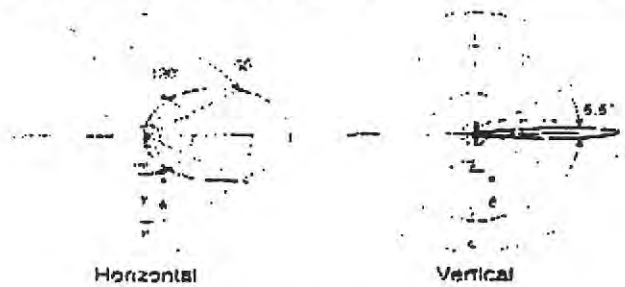
Type No.	732 433
Connector position	Nearside
Frequency range	806 – 960 MHz
Gain	18.5 dBi (870 – 960 MHz) 18 dBi (806 – 870 MHz)
VSWR	< 1.5
Impedance	50 Ω
Polarization	Vertical
Front-to-back ratio	> 25 dB
Half-power beam width	H plane: 65°/ E plane: 6.5°
Max. power	500 Watts (at 50 °C ambient temperature)
Input	7/16 female
Weight	12 kg
Wind load	Frontal: 740 N (at 150 km/h) Lateral: 330 N (at 150 km/h) Rearside: 1070 N (at 150 km/h)
Max. wind velocity	200 km/h
Height/width/depth	2570 mm/255 mm/105 mm

Material	– Reflector screen: Weather-proof aluminium. Radome: Fiberglass, colour grey. All screws and nuts: Stainless steel.
Ice protection	– Since the radiating systems fully protected by the radome and due to its very sturdy construction the antenna remains fully operational even under icy conditions.
Grounding	– The metal parts of the antenna including the mounting kit are DC grounded. The inner conductor is also DC grounded.

Accessories (order separately)

Type No.	Description	Remarks	Order quantity
731 654	3 clamps	28 – 64 mm	1 x
731 655	3 clamps	50 – 105 mm	1 x
733 677	1 clamp	60 – 115 mm	3 x
733 678	1 clamp	115 – 210 mm	3 x
733 679	1 clamp	210 – 380 mm	3 x
733 680	1 clamp	380 – 521 mm	3 x
732 819	1 Downtilt kit	Downtilt angle: 1.5° – 7.5° Use the downtilt kit together with 3 clamps suitable for the mast diameter.	1 x





Horizontal Vertical

KATHREIN-Werke KG · Anton-Kathrein-Straße 1 – 3 P.O. Box 10 04 44 D-83004 Rosenheim Germany Telephone (+49) 8031 / 184 0 Fax (+49) 8031

4. Technical data

4.1 Mobile transceiver — DCM 4800 DR

Frequency range:	RX: 816.000 MHz - 818.000 Mhz and 861 Mhz - 863 MHz TX: 816.000 MHz - 818.000 MHz	
Operating mode:	Duplex/Semiduplex/Simplex	
Duplex spacing:	45 MHz	
Number of channels:	64	
Channel spacing:	25 kHz	
Frequency stability:	2.5 ppm	
Temperature range:	-10 to +55 °C	
TX Antenna connection:	50 ohms	
RX Antenna Connection:	50 ohms	
Supply voltage:	10.8 to 15.6 volt	
Nom. voltage:	13.2 volt	
Current consumption:	Transmission	6,5 A at 12 W 4,5 A at 7 W
	Stand-by	0.3 A
Duplexer:	Build in	

4.2 Transmitter

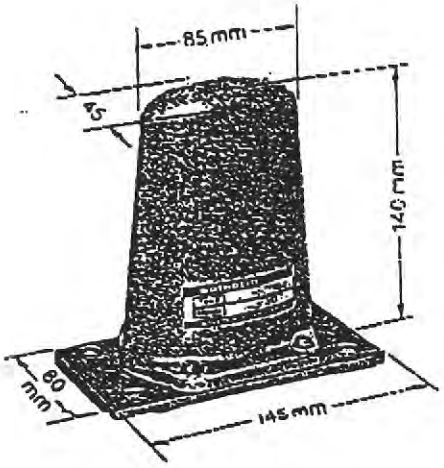
RF Output power:	7 W or 12 W
Spurious emission:	Better than 0.25 µW
Adjacent channel power:	Better than 70 dB
Modulation:	+6 dB/oct.
Deviation:	Nom. 3.0 kHz Max. 5.0 kHz
Modulation distortion:	Better than 3%
Hum and noise:	Better than 40 dB

4.3 Receiver

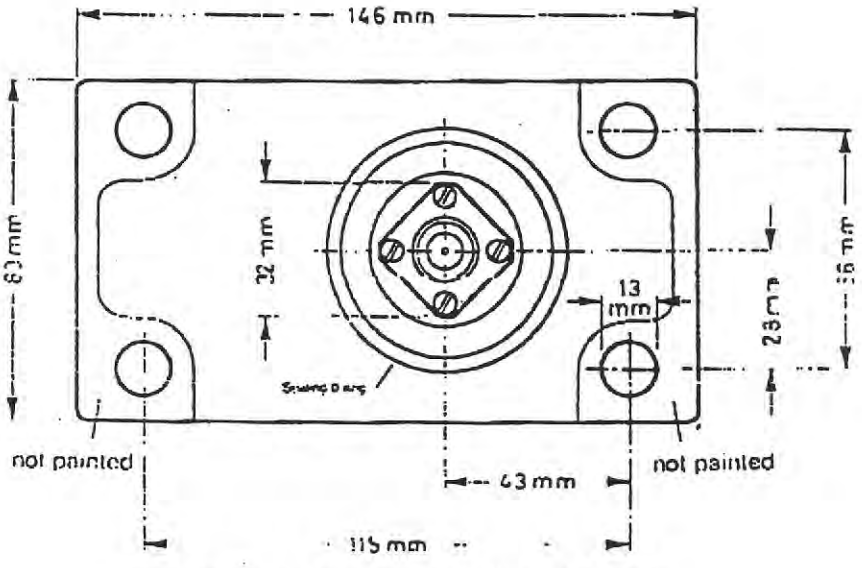
RX sensitivity:	Better than 0.5 μV_{pd} /20 dB SINAD CCITT filtered.
Spurious response:	Better than 70 dB
Intermodulation rejection:	Better than 70 dB
Adjacent channel selectivity:	Better than 70 dB
Blocking:	Better than 90 dBμV_{emf}
Co-channel rejection:	Better than 8 dB
Hum and noise:	Better than 40 dB
Distortion:	Better than 3%
Audio response:	-6 dB/oct.

TRAIN ROOF ANTENNA
TYPE K 70 20 61
7058.110

Type No.	K702061
Frequency range	806 - 960 MHz
VSWR.	< 1.5
Gain:	0 dB
(ref. to a quarter wave antenna)	
Input:	N female
Polarisation.	Vertical
Power Max.	500 Watt



Mounting flange:



Mounting hole for the connector. 33(max.35)mm ø

Note Keep mounting surface clear of paint for electrical contact.

ICF KAISER
ICF KAISER ENGINEERS AND CONSTRUCTORS

ICF Kaiser Engineers, Inc.
2101 Webster Street, Suite 1000
Oakland, CA 94612-3060
510/419-6000 Fax 510/419-5355
http://www.icfkaiser.com

October 14, 1998

Encik Abdul Radzak b. Abd. Malek
General Manager (Freight)
Keretapi Tanah Melayu Berhad (KTMB)
2nd Floor KTMB Headquarters
Jalan Sultan Hishamuddin
50621 Kuala Lumpur
Malaysia

Subject: KTMB Railway Modernization Project
Contract between KTMB and ICF Kaiser
Invoice No. 10-0034 and First Interim Report for the Intermodal Project (Task 3)

Dear Sir:

Please find enclosed for your review and approval Invoice No. 10-0034 and the First Interim Report which represents the respective milestone for the subject invoice. Please approve the invoice as soon as possible by signing in the space provided for the "Client Authorization", and forward the signed invoice by fax to Ms. Noreen St. Louis, Finance Manager, US Trade and Development Agency at (703)875-4009 in Arlington, Virginia, USA.

The attached interim Report is the result of preliminary data collection and provides the basis for the remainder of the work. It is not intended to deliver specific recommendations at this stage. Under the terms of our agreement with USTDA, the dispatch of this interim deliverable allows the release of TDA funds to continue the work in assisting KTMB to develop new intermodal strategies to increase volume on the railroad. Upon your approval of the attached invoice and payment by TDA, we can proceed to schedule with your staff the next phase of work, with particular focus on another site visit.

Again, your attention to the attached invoice and report is appreciated. We look forward to continuing our efforts on this important project.

Very Truly Yours,

John H. Bergerson
Sr. Vice President & Project Manager

Enclosures: Invoice No. 10-0034 and First Interim Report

Manalytics
International

M. E. Uremovich
Principal

October 19, 1998

Mr. Steve Bonde
Contracts Department
ICF Kaiser Engineers
2101 Webster
Oakland, California 94612

Dear Steve,

Attached are two copies of the First Interim Report for KTMB in Malaysia. You'll see a cover letter to Radzak also attached.

I am assuming that, since the invoice to the client comes from ICF Kaiser, that you will want to append the certification required under the terms of the TDA Contract in order for TDA to pay you and then you us. I didn't think you wanted the certification to be on our letterhead, so I've not prepared one. I will have my office in San Franciso cut an invoice to you this week.

We have, as agreed, sent a "backchannel" copy to Radzak today. He will get that before the official copy comes from you. We have periodic conversations with him and I think he understands that we cannot continue any work until he signs and returns the approval to TDA (when he gets it from you). I think it's very important that you be very specific with him about what he has to do so we don't hold up payment. He knows that we cannot send anyone back to Malaysia until this is done. I just don't want to advance the money to my subcontractor until we're current.

There is some urgency, both because this First Interim Report has been delayed, and because I will in Europe the first two weeks of November. I'd like to have Larry Wehrer in Malaysia in early November, and then I may pass through on my way back from London.

If there are any questions, I will be in the Santa Fe office all week. Thanks for the help.

Regards,

Michael E. Uremovich

1007 Sierra del Norte, Santa Fe, New Mexico 87501
Tel: 505-820-7089, FAX 505-820-0256 E-Mail: manalytics@earthlink.net

Manalytics
International

M. E. Uremovich
Principal

October 10, 1998

Encik Abdul Radzak b. Abd. Malek
General Manager (Freight)
Keretapi Tana Melayu Berhad
Kuala Lumpur
Malaysia

Dear Sir,

We have completed and attach the First Interim Report of the Intermodal Study Team for your consideration. This First Interim Report is the result of preliminary data collection and provides the basis for the remainder of the work. It is not intended to deliver specific recommendations at this stage, and much of what is presented is known by your staff.

Under the terms of our agreement with USTDA, the dispatch of this interim deliverable allows the release of funds to continue the work in assisting KTM to develop new intermodal strategies to increase volume on the railroad. Upon your acknowledgment of receipt, the team can proceed to schedule with your staff the next phase of work, with particular focus on another site visit.

We would like to dispatch Mr. Wehrer back to Malaysia as soon as possible to continue the work in discussing specific intermodal opportunities with current and potential KTMB customers. In order to do so, under the terms of our contract with TDA, it will be necessary to sign and return the attached to TDA to certify completion of this first key step in the project.

Thank you in advance for your assistance.

Very truly yours,

Michael E. Uremovich

1007 Sierra del Norte, Santa Fe, New Mexico 87501
Tel: 505-820-7089, FAX 505-820-0256 E-Mail: manalytics@earthlink.net

KTMB Intermodal Project

First Interim Report

October 1998

KTMB Intermodal Project
First Interim Report
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Chapter I
Introduction

First Interim Report
KTMB Intermodal Project
Chapter I - Introduction

I. Objectives of First Interim Report

Under the Scope of Work agreed between KTMB, ICF Kaiser, Manalytics and USTDA, upon completion of Intermodal team's initial visit, preliminary data collection, and analysis to reflect progress to date in Phase I of the Intermodal Project, the team was to submit its first interim report. This initial report was to reflect partial completion of Phase I tasks outlined in the workplan and was to contain:

(1) An overview of the Rail Intermodal Market in Malaysia with emphasis on estimating the current size and structure of the market relevant to KTMB

(2) A description of the key participants and segments of the relevant rail intermodal market as the basis for subsequent detailed evaluation

(3) Preliminary identification of major trends and characteristics of the relevant intermodal market as a basis for later development of strategic options for KTMB

(4) Preliminary identification of potential KTMB Intermodal Opportunities for later review with KTMB executives and for testing in the market. This would be based upon current KTMB intermodal business, combined with potential early identified opportunities.

(5) Development of an initial "competitive profile" of KTMB in the rail intermodal business for further examination among key current potential customers of the railroad's intermodal service.

This document is provided in fulfillment of the first milestone.

II. Relationship of Interim Report to Remainder of the Effort

The first interim report was intended to summarize the preliminary data collection efforts and to form the foundation upon which the remainder of the work would be based. It was expected to be completed roughly 6-8 weeks after the commencement of the work. The Intermodal Team visited Malaysia in mid to late July 1998, and thus this report is being submitted within the timeframe initially scheduled.

The overall workplan agreed upon consists of ten interrelated elements as follows:

Element I - Estimate Current Market Size

Element II - Evaluate Competitive Options

Element III - Interview Current Users of Feeders/Trucks

Element IV - Assess KTMB's Current Competitive Position (using input from Elements II and III)

Element V - Evaluate Likely Market Changes (using input from Elements I and IV)

Element VI - Identify Key KTMB Strengths and Weaknesses (with input from Element III)

Element VII - Develop KTMB Competitive Requirements

Element VIII - Estimate Capital and Organizational Requirements

Element IX - Estimate KTMB Intermodal Potential

Element X - Develop and Recommend Intermodal Strategy

As is obvious, the initial data collection and hypotheses presented in this first interim report provides part of the basis for development of the final intermodal strategy. It will be used specifically in the next phase of the work, mostly Elements III, IV, V and VI, to provide the basis for development of the specifics of the recommended intermodal strategy. Critically, the information collected in this early stage furnishes an understanding of the dynamics of the various participants in the Malaysian intermodal marketplace and their

relationships. It forms the framework within which the intermodal market can be understood and analyzed as various strategic options are reviewed.

The first interim report was not to reach any definitive strategic conclusions, or even to identify strategic options. It is to provide the foundation of information and understanding that will permit subsequent phases of the work to focus on key issues and participants with the data necessary for the analysis.

In approximately 6-8 weeks, a second interim report will be submitted that will further refine some of the initial estimates, and, most importantly, provide direct input from current potential customers of KTMB. This second interim report will be an objective assessment of KTMB's current competitive position (Element IV), identify likely market changes (Element V) and highlight the market's view of KTMB's strengths and weaknesses (Element VI).

Completion of the second interim report will require another site visit and the assistance of KTMB's commercial department in the identification and scheduling of customer interviews. We will work with them over the next several weeks to complete that scheduling. *The actual timing of the submission of the second interim report is heavily dependent upon this scheduling and our ability to collect this vital customer information.* Delays in interview schedule will result in commensurate delays in the submission of the second interim report, and could, potentially delay the final strategy recommendation. At this juncture, there is no reason to believe that the final strategy submission is in any jeopardy, however, we must emphasize the dependence upon the KTMB commercial department's ability to assist in interviews schedules.

Workplan flexibility given changes in the commercial climate in Malaysia -

Since the original work effort was defined in early 1998, there have been large changes in the commercial climate within Malaysia and elsewhere that have had and will continue to have significant impact on the intermodal

market for KTMB. This requires the workplan be sufficiently flexible to adjust to the realities of the external environment and yet remain consistent with the agreed upon effort. We will continue to work with the KTMB management to remain sensitive to the need to balance the adjustment of the workplan to deliver an intermodal strategy recommendation that reflects the realities of the current market. We do not believe, at this stage, that any formal alteration of the workplan or deliverables is required, however we do expect that greater emphasis will be placed on opportunity identification and growing the business will be required, as opposed to focusing on physical or other capacity constraints on the railroad.

Since the preliminary "desk study" was completed, volume in non-intermodal traffic has dropped significantly. What was thought initially to be a volume constrained situation, and a "competition" for capacity, no longer is the case. This suggests that the marginal profitability of intermodal traffic, relative to the marginal contribution of other traffic, will be less an issue than initially thought. By contrast, the ability to identify opportunities for greater volume will likely assume much greater importance and require more effort. While not altering current or projected work efforts, the difference in emphasis is worth mentioning.

Chapter II
The Rail Intermodal Market in Malaysia

Chapter II - The Rail Intermodal Market in Malaysia

Overview

This Chapter focuses on an overall description of the intermodal market in Malaysia, its key participants and estimated size. It describes the relative importance of the various participants and describes the relationships between them. It is descriptive in nature, and provides the overview against which later discussions of competitive dynamics and KTMB's current business can be undertaken.

I. Not all of the Intermodal Market in Malaysia is relevant to KTM

It is important to establish not just the overall size of the intermodal in Malaysia, but also to estimate the portion of the market that is realistically susceptible to diversion to the railroad. This requires defining the total market, but then removing those segments that are of marginal concern to the railroad because of physical freight flow characteristics or economics.

1. The total rail intermodal market is usually defined as that containerized traffic that is, or can be moved by KTMB -

In the broadest sense, any domestic or international movement of goods that is or can be physically placed in a container that will fit on a rail car can be considered intermodal. This broad definition needs to be more tightly focused in order to develop meaningful, and actionable, intermodal strategies. For the purposes of this report, the "intermodal market" is defined as:

> " The freight market for the movement of internationally recognized standard containers that can be physically operated by a common set of rail assets"

This definition focuses on the movement of the container more than on the freight within the unit. Similar to many other intermodal situations, the movement of the container, while ultimately driven by the requirement to move the freight contained therein, is not always (or even often) controlled by the beneficial owner of the cargo. Frequently, the routing of the container is the purview of an "intermediary", usually a freight forwarder, NVOCC or other form of intermodal marketing company. These firms are often seen as the direct customers of the railroad.

For the purposes of this work, the team has focused on the movement of the *container*, whether controlled by the beneficial owner or not. The team did not examine flows of traffic that are currently not placed in containers, and have not estimated the potential for flows that might potentially be placed in containers. It does not, for definition purposes, whether the beneficial owner makes the routing decision or not, only that the routing decision focuses upon the movement of the empty or the loaded container.

2. Ultimately, the total demand for intermodal movements is driven by Malaysia's international trade

In aggregate, the intermodal market in Malaysia is essentially driven by the international container flow. As will be shown below, it is the international market that accounts for 95% of the total flows. In addition, movement of empty containers for export loads and the inter-port movement of containers for use by the international shipping companies are important components of the business in their own right.

3. The Potential Intermodal market has yet to be fully identified but will be more closely examined in the upcoming work -

It is possible that the Malaysian intermodal market could be significantly larger were there a way to enter the domestic flow of business and encourage freight to move off the highway onto the railroad.

The development of these estimates will be based upon identifying major freight flows that might be converted to intermodal service based upon

service and price considerations. The team will develop estimates by extrapolating anecdotal information gained during the customer interview process, and not by detailed analytical examination of actual freight volumes.

It is not current possible to ascertain, from government or industry sources, the amount of intermodal potential traffic moving between points in the country. Reliable statistics on such flows are not available, and so the team will examine the flows of known key customers and targets, and based upon interview results make estimates of overall flows.

4. Traffic characteristics make some of the market irrelevant to KTM

While detailed analysis is not complete, it is clear that not all of the intermodal market will be relevant to KTM. There are large segments of the business that simply do not have the physical characteristics that would make them desirable or susceptible to intermodal service. The team expects to eliminate from the final estimate of the relevant market cargo that is:

- Extremely short haul - traffic moving distances of less than 100-125 kms are not likely to be susceptible to intermodal movement. Hauls of this length have economic characteristics that make it almost impossible for a railroad to compete economically.
- Extremely service sensitive - traffic that is moving to specifically, tightly constrained schedules on the eve of ship departure will not likely divert to intermodal. This and similar traffic is not considered relevant to KTM's intermodal strategy.

While there will be some exceptions, the team currently believes that some subsection of the overall market, perhaps as little as 50%, will actually be relevant to KTM's intermodal strategy. After elimination of international traffic within 150 kilometers of the exporting port, and elimination of certain highly service sensitive traffic, significant reductions in target volumes are expected.

I. Estimates of Intermodal Market Size and Growth

A portion of the early work was to focus upon defining the size of the current, potential and relevant intermodal markets against which KTM could potentially place effort to grow profitable volumes. While final estimates have yet to be made, initial estimates follow.

1. The overall market for the movement of both loaded and empty containers within Malaysia is approximately million 3.0 million TEU's annually

There is no single, reliable source of data regarding the overall market size for intermodal flows in Malaysia. It is generally agreed that the overwhelming amount of current intermodal flows is represented by the flows generated by the international flow of containers. There is essentially no current domestic, dedicated intermodal traffic in the sense known in other parts of the world.

The team has been able to make only very preliminary estimates of the flows of truck trailers on the railroad. KTM currently has a fleet of domestic containers that are primarily used for the movement of sugar and bricks. This fleet is not heavily utilized and with the reduction in the number of warehouse facilities on KTM property, is not seen as a major current market.

There are also infrastructure issues relative to the current market that make it apparent, very little domestic traffic is moving in intermodal service. The intermodal team plans to verify the estimate of domestic movements with customer interviews with key shippers and consignees.

Based upon best available statistics, judgmentally adjusted for the domestic market, the team's estimate of overall the intermodal markets is 3.0 million TEU's (twenty foot equivalent units) annually in 1998.

2. The movement of containers for the carriage of intra-Malaysian domestic traffic is estimated at 5-10% of the international driven market, or 100-250,000 TEU's annually

As indicated earlier, there is virtually no current domestic intermodal market within Malaysia. Traffic, once loaded into a truck, tends to remain in the truck until delivery to the consignee.

The team plans to explore this issue in greater depth during the interview phase of the work, but at this time estimates these volumes will not exceed 5-10% of the overall market, and may in fact be largely non-existent.

3. Market "size" can vary significantly from year to year as mainline shipping companies alter deployments

An important component (yet to be precisely estimated) of the intermodal market is the inter-port positioning of containers by mainline vessels or feeders. Thus, if a carrier calls at Port Klang, but not Penang, it will frequently move empties to the north which creates an intermodal "market" for the movement of the boxes. Alternatively, if the vessel deployment is altered so that the ship calls port ports, then this market is "eliminated" since the empties will be moved on the mainline vessel.

Thus the "market" size can be significantly altered because a large vessel operator has elected to alter their deployment and wide swings in volume may have little or nothing to do with actual flows of freight.

4. Of the approximately 3.0 million TEU market in 1998, only about 1.0-1.5 million is relevant to KTMB

While the overall market is estimated at 3.0 million TEUS, for reasons examined in earlier sections of this report, a significant portion of that market is effectively "out of reach" for KTMB.

While specific port detail is shown in the following section, overall it is estimated that 75-80% of the exports through the major ports originate within 150 kilometers of the port. The ports (as shown below) estimate that 90% of

the business originates within 200 kilometers of the port of export. The business under 150 kilometers is largely of marginal interest to KTMB since it is unlikely that the railroad can compete effectively for this freight. Traffic at 200 kilometers is judged to be "relevant" for preliminary market relevancy. This working hypothesis is subject to further verification and testing, but when preliminarily applied to current volumes, it effectively eliminate nearly 1.5 million TEUS from the "relevant" market. Share concerns should be focused on the "relevant" market to KTMB, not the overall container/intermodal market within Malaysia.

II. Role of the Ports

The Malaysian Ports, both directly and indirectly, play a major role in the intermodal business in Malaysia. More than in many countries, policies and competitive strategies of local ports play an important role in the routing of intermodal traffic and strongly influence whether the railroad will be positioned to participate.

1. Approximately 2.8 million TEU's were handled by the major six Malaysian ports in 1997; perhaps half of which is relevant to KTM -

Based on a variety of available sources (including ports, shipping companies, freight statistics, etc.). the team has estimated the container flows of the major six Malaysian ports as indicated in the table on the following page:

Table 1
Malaysian Port Throughput Estimates
1997 Volumes in TEU's

Port	Est. TEU Thruput	Imports	Exports	Transship	97 vs 96 growth
Penang	506,900	210,300	245,200	51,400	10.3%
KCT	993,000	426,000	404,000	163,000	4.9%
KPCT	578,600	200,200	275,100	103,000	30.4%
Jahore	429,450	Not Avail.	Not Avail	Not Avail	12.0%
Kuantan	54,885	Not Avail	Not Avail	Not Avail	26.6%
Westport	115,800	47,500	56,200	12,100	N.M.
Total	**2,678,635**	**N. M.**	**N.M.**	**N.M.**	

2. The ports in the Klang Region are particularly important in this market -

There are three major ports in the Klang area (KCT,KPCT and Westport) with combined estimated capacities of approximately 3.6 million TEU's annually. Interviews with key officers of the respective ports suggest that current actual volumes are approximately 1.6 million teu's annually, suggesting theoretical utilization levels of approximately 45%.

Both KCT and KPCT estimate that 90% of exports through their respective ports originate within 200 kilometers of the port, overwhelmingly in the Klang Valley area. Westport, because of it location, tends to reach further inland and they estimate that 30% of their export traffic originates with 200 kilometers. While verifiable data are not available, it is possible that Wesport's ultimate origin of traffic will more closely resemble the movements at KCT and KPCT. This is because Westport is currently in a "development" mode, and early traffic flows may not represent what will ultimately prevail. There is no obvious reason to believe that Westport will have significantly different origins of export traffic than the other two ports.

This is important since this traffic does not have a number of the characteristics that make it highly susceptible to rail movement. As will be later shown, it is and will be difficult for the railroad to compete for container flows that have such short lengths of haul and intensive lorry competition. The team currently estimates that only half of the traffic currently moving through these major six ports is relevant to KTM given length of haul considerations. These estimates will be further refined in the later work.

III. Role of the Shipping Companies

Vessel operators are also key in the Malaysian intermodal market. In many ways, the movement of shipping company containers *is* the intermodal market in Malaysia since virtually all freight movement relevant to this market is driven by international flow and the movement of empties for repositioning represents nearly half of the total market. There are three general classes of vessel operators of interest:

1. "Mainline operators" - these carriers are the largest and arguably the most important. They represent the major carriers (SeaLand, Maersk, APL, OOCL, NYK, etc.) that carry Malaysia's imports and exports and call at major Malaysian ports. Their role in the intermodal market is basically to supply container equipment to Malaysian exporters. They plan only a minor role in the physical routing the loaded export containers (see "Forwarders" below), but can be very influential in the movement of empties.

Just as importantly, these carriers can "create" markets by altering their vessel deployments, particularly relative to the Klang/Penang and Klang/Singapore corridors. Should a vessel operator elect to drop one or some combination of Malaysian, they will likely wish to continue to handle the freight that previously moved over that port. In doing so, they must now "equalize" the port, and position the empty from another location. In such cases, movements that did not previously exist come into being, even though no additional freight traffic actually is stimulated.

Currently, Port Klang has the greatest share of the "mainline operators" including virtually all of the major shipping companies. The largest (according to MDS Transmodal data of 1997) include

- The Global Alliance (NOL/APL/Hyundai) - (this alliance has been restructured since 1997) service the US, other ports in Asia
- Hanjin/Tricon - the "Pendulum" service, which includes US (PNW), Europe and other Asian destinations
- Evergreen - 'round the world eastbound service
- Various Japanese flag carriers, including NYK, K Line, MOL

The team has identified the major current deployments of these carriers and has begun the analysis to determine what, if any, alterations in their respective deployments might create further opportunities within the Malaysian market. We have held initial discussions with several of the major operators and have begun structuring the analytical framework to complete the assessment of the opportunity in the next phase of the work.

2. "Regional operators" -

In addition to the large "mainline" operators, there is significant flow of containers within the Southeast Asian and China Sea regions that might potentially create further opportunity. This might be particularly true for those carriers currently operating on the West Cost of Malaysia for points east of the Straits of Malacca. In such cases, redeployment over Pasir Gudang might provide an opportunity for KTM. This has not yet been explored and the team needs to collect further information relative to the deployments of vessel operators within the region to assess this potential.

3. "Feeder operators" -

There are several feeder operators between Port Klang, Westport and northern locations in Penang (particularly Butterworth). Initial interviews indicate these feederships are positioning a large number of containers that might be considered a relevant market for KTM. Some of the containers are moved for mainline vessel operators who do not wish to send their vessels to

more than one port. These carriers are important components of the relevant intermodal market in Malaysia

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In summary, the first phase of the Intermodal Project suggests that the overall intermodal market in Malaysia is approximately 3.0 million teu's annually. However, only about 50% of this market, given the length of haul and other characteristics, may really be relevant to KTM's intermodal marketing effort. This relevant market is a combination of roughly equal empty flows and loads and is highly integrated with the operations of vessel companies and ports. Opportunities needs to be examined in the context of these participants and the dynamics among them.

The second phase of the project will further analyze the specific opportunities within each of these segments and develop the kinds of economics that would be required for KTM participation.

Chapter III
Competitive Dynamics in the Relevant Intermodal Market

Chapter III -Competitive Dynamics in the Relevant Intermodal Market

Overview

This chapter focuses on the key players and geographic markets of particular relevance to KTM's future marketing strategy. While this first interim report was not to fully conclude the impact of competitive dynamics, nor to develop a final list of opportunities, an early review of essential participants and important flows will form the basis for concentrating later work effort on those areas of most potential opportunity for KTM. Much of this information is not new to KTM's Freight Management Team, but it is important to be specific about the participants that will ultimately be critical to the intermodal strategy.

I. Forwarders play a major role in routing the business

As in many intermodal markets, forwarders (or transport intermediaries) are major participants in the intermodal marketplace and are important potential customers for the railroad. In many cases, the actual "customer" of the railroad is a forwarder who has been granted significant routing authority by the beneficial owner of the goods. It is the forwarder who can decide, or profoundly influence, the choice of carrier and of mode.

In addition, the shipping companies view the forwarders as critical participants in the trade flows, and as "partners" in the solicitation and movement of containers. In many cases, these forwarders can be viewed as the "customers" of KTM in soliciting intermodal carriage on the railroad, and a market segment that calls for specific, directed attention.

In addition, as further indication of the forwarders' significant role in this market, several of the larger forwarders are affiliated with trucking operators and are thus in a position to exert even more influence on the routing of traffic. Further, they are in a position to alter the prices for an

individual component of the movement (say the local pick up charge) and yet still be profitable on the overall package. This can make it very difficult for a participant (like KTM) who participates in only one portion of the traffic (like the line haul) to be competitive within that single component.

II. Competition with trucks (lorries) is intense in virtually all markets

Unlike some rail operations, KTM faces intense competition from over the road services in virtually all lanes. In developing a implementable intermodal strategy, understanding the strengths and weaknesses of this competition is critical in selecting high priority opportunities to pursue.

1. Trucks have inherent flexibility and strong economics in dealing with ultimate customers and short haul (less than 150 kms) markets -

Many of the customers in Malaysia are not "rail served", and many have relatively unsophisticated warehouse and loading facilities. Many factories are of modest size and distribution infrastructure may be limited. The inherent flexibility of truck movements, give these carriers significant when compared to rail operations. Rail economics depends heavily on significant volumes in specific corridors, and does not present the kind of assembly and distribution capabilities inherent in truck. The multiplicity of origins and destinations, combined with the geographic difficulty of accumulating large volumes for long hauls, places rail at an inherent disadvantage relative to truck transportation for many customers in Malaysia.

In many situations, efficient rail operations have a roughly 25-33% line haul cost advantage measured on a per kilometer basis, when comparing precisely the same origins and destination, and assuming that there is sufficient volume to generate a 20 car+ movement . This relationship has to be further confirmed during the next several phases of work, however, this is roughly consistent with our experience in other markets and appears to be generally accepted by KTM staff. The difficulty is that traffic does not originate

and is not generally destined to points on the railroad, and certainly not usually in volumes required for efficient operation.

Thus, any movement by rail must be drayed to the rail terminal, loaded on the train and at the destination must be unloaded from the train and drayed to the consignee. These costs must be offset by the difference in direct line haul costs, and thus the movement must be of sufficient length to generate enough savings for the movements to be economically similar. The best current estimate is that such distance must exceed 150 kilometers in KTM's situation for rail intermodal to be economically viable.

2. Malaysian "licensing" enforcement has led to a bifurcated market

Two basic truck markets have developed within Malaysia, the formal market, served by licensed haulers with significant organizations, investments and operations. There are five licensed haulers:

Konsortium Perkapalan Bhd
MISC Haulage Services Sdn Bhd
Kontena Nasional Bhd
Multimodal Freight Sdn Bhd (a KTM affiliate)
Diperdana Corporation Bhd

These companies can be viewed as the "high end" of the truck market. They are all reputable companies with significant standing in community, large (some very modern) fleets. They are also affiliated with shipping companies forwarders or other transport organization and sometimes work in conjunction with these affiliates to joint structure offerings to customers.

Another key component of the trucking business is the informal market operated by unlicensed, often individually owned, truckers who do not have the organizational structures or formal business methods of the licensed haulers. This group, comprising a large component of the "spot" market, are often willing to price well below the licensed haulers, tend to utilize older equipment and lower paid drivers.

As the team develops the specific economic comparisons, it is important to keep this distinction in mind. Initial indications are that marketing to large organizations, like the shipping companies, will require some affiliation with a license hauler in order to structure a reasonable intermodal alternative. We believe, subject to later confirmation, that KTM will have to develop a close working relationship with at least one, perhaps more than one, of the licensed haulers in order to build an overall intermodal product. There does not appear to be any real opportunity to build a non-licensed operation that will be acceptable to major customers (this has to be confirmed) and the absence of the truck component will cripple the intermodal product, given the distribution patterns within the country.

At this early stage, it is premature to suggest specific solutions to this requirement, only to be aware that one will have to be developed and that it is very likely to require a closer working relationship with a trucker than appears to be present today.

3. There appears to be only limited marketing coordination between KTM and its affiliate in the trucking business, MMF

While most of the KTM management team believes some better cooperation with MMF has developed over recent times, the Intermodal Team tentatively concludes that there is little direct, coordinated marketing effort between KTM and MMF. Even though they are affiliated at the Corporate level, the companies are clearly run separately and there is little encouragement to share marketing knowledge, understanding or to develop joint marketing efforts. This is one area the Team expects to explore more fully during the next site visit to Malaysia since there might be some opportunity to develop a more effective wholesale/retail combined strategy that would be good for both companies and result in more volume on the railroad.

III. The Klang/Penang market is particularly important in the relevant market for KTM -

As will be developed elsewhere in this report, and we believe in subsequent work, the Klang/Penang market is likely to be a major opportunity for additional intermodal flows. The characteristics of this market in terms of length of haul, empty repositioning and overall size all point to its relevance for KTM. Addressing opportunities in this lane requires detailed understanding of the dynamics in the particular market. While the size of this segment has yet to be determined, this is believed to be one of the largest intermodal lanes in Malaysia.

Based upon initial market inquiries, to be confirmed in later aspects of the work, KTM's rate structure in the Klang/Penang lane are superficially competitive with the licensed lorry haulers. This includes the addition of dray charges for KTM at either end. Preliminary research suggests rates in the ranges of :

Table
Klang/Penang Competitive Rates

Carrier Type	Estimated Rates ($R)	Estimated Transit Times
KTM	230-240 R + 30/50R dray at either or both ends	24 hours
Licensed Lorry	450 R	8-10 hours
Unlicensed Lorry	300 R	12-14 hours

Sources: Interviews; KTM data

As can be seen by the data above, when competing with unlicensed lorries (said to be important particularly in the movement of empties), KTM's rates are marginally competitive. However, the service differential is a clear disadvantage, particularly given the flexibility of lorry service is positioning the empty to the customers' facilities.

The team has been unable to document the relative use of licensed vs. unlicensed lorries in this lane (or elsewhere for that matter). This will be the focus of some of the later work.

Further complicating competition in this lane is the presence of feederships and the use of mainline vessels to reposition empties. In some sense there are three basic markets within this lane"

(1) The market for "return" loads to the ports through which the containers were initially imported. That is, traffic originating between, say, Ipoh and the Klang Valley, when the empty has moved south from Penang and the load will move back north for export. The likely move is an empty from Penang to an inland container depot, the empty to the customer and the load back to Penang.

(2) The market for "return" loads when the empty was imported through a different port. This would involve a move of an empty, imported through Penang, to a customer (via an inland depot), and then exported through, say, KCT. It is not clear that such moves are common given what we understand may be some Malaysian Customs restrictions. This will be further examined as we collect more data

(3) The market for repositioning empties from one port to another. This competes mostly (we believe) with feeders and main line vessel repositioning.

The competitive dynamics surrounding each of these segments may be different and require specifically designed strategies. The movement of empties in the first two cases, for example, may require competing with unlicensed haulers in certain instances, while the competition for the loads may focus more on licensed operators. Similarly, the market for shipping companies may focus more on competition with feeders or with mainline positioning (like the recent OOCL movements).

IV. Competition for traffic to Singapore

The situation relative to traffic flows through the Port of Singapore, whether moved by the railroad or transshipped through Malaysian Ports is a sensitive issue. The Malaysian Government has recently attempted to encourage the movement of Malaysian exports directly through Malaysian ports, thus reducing the potential for the railroad to move containers south for direct loading in Singapore. There are currently several pending/actual actions that could make the intermodal market to Singapore via KTM very difficult to develop. The specific recent actions that may significantly reduce this potential include:

(1) Raising the toll over the Causeway to Singapore to RM 200 per TEU

(2) Considering legislation to compel Malaysian exports to move over Malaysian ports

This market was an early identified opportunity and is currently in a major state of flux. The team will further explore the dynamics in this important lane during its next site visit and assess the potential based upon the then-existing political climate and direct customer input.

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Thus, the competitive dynamics in the Malaysian intermodal create an environment within which the new intermodal strategy should be structured. The new strategy must recognize the routing control of the forwarder and the competitive/cooperative relationship with truck. It must focus on the Penang/Klang market corridor, recognizing both the vessel competition and the requirement to work closely with vessel operators.

Chapter IV -
KTMB's Current Intermodal Business

Chapter IV -KTMB's Current Intermodal Business

Overview

Some historical analysis of KTM's intermodal business is helpful in defining the foundation from which the new intermodal strategy can be built. This section provides a brief look at the recent past relative to intermodal growth and discusses the key characteristics of KTM's current business.

I. Intermodal traffic will account for approximately 22 million ringit in 1998, up from 20.7 million in 1997, though revenue per unit continues to be below 1991-1993 levels

In 1998 intermodal revenue is expected to be approximate 22 million ringit, based upon expected volume levels of 138,000 TEUS and maintaining 1997's average revenue per unit. Since 1991, revenue

Table
Revenue and Unit Revenue History
1991-1998

Year	Total Intermodal Revenue (mils)	Change from Prior year (%)	Rev/TEU (ringit)
1991	19.7		186.91
1992	17.0	(13.6%)	179.41
1993	15.5	(9.1%)	161.91
1994	19.2	24.5%	158.45
1995	22.4	16.7%	163.33
1996	19.6	(12.7%)	157.76
1997	20.8	6.1%	159.93
1998	22.0	9.6%	159.42

While final analysis is not complete, it is estimated that in 1998, intermodal will account for an increasingly important portion of the

railroad's overall freight revenue. However, this increase will not come as a result of intermodal's growth, but rather because of a significant decline in the carriage of other traffic, most notably cement and petroleum. Until better figures are available for the first nine months of 1998, intermodal's percentage of the total will not be known.

In June of 1998 container revenue amounted to approximately 27% of total rail revenue, the second most important freight segment (behind cement).

III. KTM's overall intermodal unit volume continues to grow, however growth rates vary widely from year to year

Intermodal traffic on the railroad has shown a strong growth pattern since 1990. Volumes on a TEU basis, have grown from approximately 94,400 annually in 1990 to over 138,000 expected in 1998. This is a compound growth of approximately 4.5% annually, which is generally good for rail traffic, though well behind the overall growth in container traffic in the country over that period of time.

Table
Year to Year Intermodal Growth
1990-1998

Year	TEU volumes handled	% growth over prior year
1990	94,400	
1991	105,300	11.5%
1992	93,200	(11.5%)
1993	95,600	2.6%
1994	121,540	27.1%
1995	137,100	12.8%
1996	124,000	(9.6%)
1997	129,800	4.7%
1998	138,800 (EST)	6.9%

IV. KTM's overall share of the container traffic is declining -

Since 1995, KTM's share of the traffic moving over the key six Malaysian ports has been declining as shown in the table below:

Table 2
KTM Share of Port Traffic
1995-1998 est.

Year	Total TEU's, major ports	TEU's handled by KTM	KTM Share
1995	2,112,900	137,137	6.5%
1996	2,28,5341	123,999	5.4%
1997	2,678,617	129,837	4.8%
1998 est.	2,860,000	138,830	4.9%

Source: Port and KTM data; MI estimates

During the discussion on KTM's current market position, the team will outline some possible causes of this share decline and indicate the intent to further ascertain the reasons behind the fall in relative traffic. Gaining back the lost share, assuming that the Port's "mix" of business (particularly as to length of haul) remained relatively constant, might provide some clues as to where new opportunities have arisen. Had KTM been able to maintain its share of the growing container market, volume would have been roughly 50,000 units higher than the currently estimated 1998 volumes. Focus on this market appears a high potential opportunity to the Intermodal Study Team and one that will be more thoroughly explored in the next phases of the work.

It is less clear whether KTM's share of the relevant market has declined. Given that nearly half of the total intermodal market is not "relevant" to KTM because of short length of haul or other reasons, it's not possible, at this time, to be certain that KTM's share has really declined as much as preliminary data suggest. However, the team has yet to isolate

specific factors that would determine this for certain. The preliminary conclusion, absent specific data to the contrary, is that share has declined in the relevant market at about the same rate as in the overall market. It is possible that this conclusion will be altered as the work progresses and that we will find that a disproportionate amount of the growth in the intermodal markets came in market locations or the kind of traffic that would not be relevant to KTM or not susceptible to rail conversion.

V. The Pedang Besar rubber movement is the largest single intermodal move on the railroad -

A terminal at Padang Besar, near the Thai border, operated by MMF accounts for the largest single laden movement of containers on the railroad. the business is 98% rubber from Thailand, trucked to the facility and transloaded into containers. The traffic then proceeds to Penang for export. This traffic moves at about 2700-3000 TEU monthly (about 25% of the total intermodal movements on the railroad).

The rail line is estimated to have the capacity of roughly five round-trip trains per day of 40 TEUS. Thus, volume could roughly double with existing train capacity, operating six days per week, on the assumption that turntimes could be maintained.

This movement competes directly with the Port of Bangkok and is susceptible to the competitive dynamics of that market. Were the Thai government to take the same position on its exports recently espoused by Malaysia, this movement could be at risk. This movement is marketed heavily by the Port of Penang, who is considered very instrumental in the routing.

There is a developing inland container depot at Sadao, approximately 15 kilometers from Padang Basar. This facility is new, with cross dock operations and plugs for refrigerated units. It was apparently constructed with certain high value traffic in mind, including the rubber currently being

handled by the MMF facility. It is not clear what impact this might have on the KTM volumes from Padang Besar.

It might be possible to develop a working partnership with the new management of the Sadao facility resulting in increased business to KTM. The specifics of this opportunity have yet to be fully explored, but will be during the next phase of work. This must be done in the context of competition with the Thai port of Songkhla.

VI. Inland Depot Operations are important components of KTM's intermodal business -

Today KTMB operates two "inland ports" at ICT (Ipoh Container Terminal) and NIP (Nilia Inland Port). A third location at Segamat is scheduled to open shortly.

At ICT (approximately 250 kilometers from the port), KTM maintains a schedule of one laden train six days a week from ICT to Port Klang. These trains contain freight for all three ports in the Klang complex. Movements from Port Klang to ICT, on a similar basis, are mostly empties to replenish the stock of empties at ICT for dispatch to ultimate customers. Total monthly volume is currently estimated at about 1500 TEU's monthly.

Volume in and out of Nilia are much smaller and sporadic. During mid 1998, have increased to 40+ per day, with a daily train dispatch. Volumes could reach an annualized level of approximately 1500/month at current expectations.

Segamat, due to open in September, is located about 200 miles from the Port Klang complex and slightly less than 200 kms from the Singapore KTM terminal. The ability to develop volume from this terminal will be more fully explored in the next phase of work, however, recent positions by the Government of Malaysia may restrict the ability to grow this terminal if overland flows to Singapore from Malaysian locations are discouraged.

Current examination is being undertaken as to the potential for two other locations on the Eastern Line of the railroad at Mentakab and in the

Tanah Merah region. Their potential remains unknown at this time, but will be examined in more detail during the next phase of work.

All current inland terminals are operated by non-KTM operators. While having a one third ownership of ICT, KTM apparently plays no role in the management, marketing or development of these businesses at the current time.

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KTM's Intermodal business has an inconsistent growth record in recent years, though the 1997-1998 forecasted growth in the face of the economic climate appears a strong performance. In spite of this growth, share position has been deteriorating, and the business continues to be highly concentrated among a few large movements. Yields per box have also been declining, and the new business seems to focus on traffic to and from established inland container depots.

Chapter V
Preliminary Views on KTMB's Competitive Position

Chapter V - Preliminary Views on KTMB's Competitive Position

Overview

Interviews of customers, to establish the current competitive position of KTMB are to be conducted in the next phase of the work. However, some preliminary test interviews were conducted during the recent on site visit, and the team was able to draw on some prior interviews completed by the Freight Department at KTM. These were helpful in establishing initial working hypotheses that can be tested during the full interview effort.

I. Preliminary interviews suggest overall customer perceptions of the railroad have improved since KTMB began operations

While subject to confirmation, limited interviews suggest growing confidence in the railroad's ability to deliver the basic intermodal service promised to customers. While not without service problems, there is felt to be significant improvement over the service offered in the recent past, and a greater willingness to try rail service as an alternative to truck or water.

These are very early and limited interview results and may be subject to modification as more interviews are completed

II. Unfortunately, prior performance has created some poor service perceptions that have not completely disappeared

Even in the presence of the improvement noted in I above, the railroad still does not have a service profile competitive with most truckers, or with the reliability of feeder vessels. The team has not yet developed the specific customer data that would definitively support this preliminary view, but plans to confirm this preliminary view in the next site visit and interviews of key customers. The team examined the results of a series of inquiries made by the Freight Management Department which made it clear that, while progress has been made, there is still some residual reluctance on

the part of some customers to commit volumes given the rail's service performance in prior years.

Such attitudes are common among rail shippers in many parts of the world and point out the necessity of closely coordinating the activities of the operating department with what has been committed to the customer. Too frequently, the physical operation fails to reflect what the customer has said was needed or the service levels that were committed by the rail organization when the commercial arrangement was completed. As the team develops segment service requirements, it is important that the operating activities be part of structuring the service packages to be delivered to customers. This will permit any of the residual reluctance to use the railroad to gradually erode as actual performance matches the commercial commitment to the customer.

III. Key shipping companies are reluctant to alter deployments based upon their perceptions of rail reliability

The team had a series of preliminary meetings with key deployment officials of major shipping companies. Many of these interviews were held at senior operating locations rather than in Malaysia. The results were relatively consistent across operators.

1. Vessel deployments are driven largely by international flows, and flows within a given country rarely impact deployments - Most carriers deploy their ships based upon market demand and the desire to maximize vessel utilization. Rarely is it possible to affect a mainline deployment by altering the sequence or number of ports called in a given country. The choices on the US West Coast were an exception to this rule, where the desire to serve both Los Angeles and Seattle for their inland rail connections, does heavily influence the deployment analysis of the major transpacific operators. In this exceptional case, however, most operators utilize separate vessel strings and do not typically call the same vessels in the California ports as they do in the Pacific Northwest.

Interviews with deployment executives at several of the major lines, and examination of their deployment decision processes, indicates that rarely is the ability of a railroad to position between ports in a given country a significant determinant of vessel deployment. This is particularly true in Asian locations, where multiple calls in a given country (as opposed to rail movement between ports) are the norm. Specific examples include Japan (typically Tokyo and Kobe), Korea (usually Pusan and Seoul), and Taiwan (Keelung and Kaoshiung).

2. Carriers are reluctant to place their entire service reliability in the hands of the railroad - Even in those hypothetical situations where shipping companies might see some advantage in permitting the rail movement between two ports currently subject to direct call, there was significant reluctance to permit their service profile to be dependent upon rail service. Many of these operators have experienced major service disruptions caused by the failure of railroads to perform. Most recent experience in the US with the service disruption on the Union Pacific was referred to several times in these discussions. Were a shipping company to cease direct vessel calls, and instead permit a railroad to substitute for the call, the railroad then becomes as extension of the shipping companies insofar as customer service is concerned. Even in situations of highly developed intermodal service (as in North America), this has not proven desirable. It is clear that KTM would have to establish a very strong service reputation and demonstrate the ability to recover from service failures so as not to disrupt the shipping companies' service to its customers, before mainline carriers would consider re-deployment as an option.

4. There is a perception that the failure to call a specific port will hurt the shipping companies' business - Because of the influence of forwarders (mentioned earlier), port authorities, governments and the historical flow of goods, there is a strong perception that failure to direct call a specific port would reduce the shipping company's business. Many customer surveys in

other countries support this view. Shipping companies believe that calling a wide range of ports is critical to their broad coverage of the market (even if the port could be operationally served overland) and are very reluctant to reduce the port coverage they serve. There has to be a compelling economic reason for such reduction in service and usually it involves:

- A port's volume drops so low that variable call costs are not met
- Port operating costs increase so much that the economics of the call are no longer feasible
- A major redeployment requires the reduction of port coverage
- Withdrawal from the market entirely
- The restructuring of a vessel alliance results in the port being dropped

Only in some combination of these cases does a vessel operator seriously consider dropping the port call.

5. In spite of these difficulties, individual situations may arise where this is possible - What might be true for the overall trade, may not be the case for an individual operator and there may still be isolated cases of opportunity for KTM in this situation. Were an operator going through a redeployment for other reasons, or were a shipping company forced to reduce vessels in a service, there may be an opportunity for KTM. Many of the large mainline operators are under significant and increasing financial pressure that might cause them to be required to reduce service. Were this the case for a mainline operator service both major ports in Malaysia, they may have limited options except to call one port and permit KTM to be their extension to the other. The team has not located such a situation, however, we do plan to have further discussions with key operators to judge whether such a condition might exist.

* * * * * * * * * * * *

Overall, it appears that KTM's overall competitive position has improved somewhat in recent years. While this is subject to further confirmation, KTM apparently has a recognized and respected position in key segments. However, share continues to erode, suggesting that competition is offerring a stronger service/price package. In addition, from the mainline vessel operator's perspective, they appear unwilling (except perhaps in isolated cases) to substitute KTM services for direct port calls.

Chapter VI
Preliminary Opportunity Identification

Chapter VI - Preliminary Opportunity Identification

Overview

At this early stage in the work, the Team is not to have identified specific opportunities. However, in the course of the work, and in conjunction with the Freight Management Department at KTM, we have been able to isolate a number of potential opportunities on which the team will focus in the next phase of the work.

We may subsequently find some opportunities that are not identified on the list below, and a number of those listed below are expected to drop in the priority list. However, it is important, even at this early stage, to highlight some of the areas where we believe opportunities may be present.

I. Klang/Penang; regaining port share - This is obviously a major lane with significant opportunity for the railroad. Completion of the track to Westport will strengthen KTM's position with the port segment and may help form the basis for an improved position. There might also be other ways to supplant current feeder operations, reduce mainline vessel empty repositioning and to strike at the truck market. All will be examined. Our initial investigation suggests that this may be the largest single available intermodal opportunity for KTM.

Further, the construction of the line extension into North Butterworth, the new Penang container terminal, will strengthen KTM's position to competed in this critical market.

II. Opportunities on the Eastern mainline - Some steps have already been taken (particularly at Mentakab) to establish some intermodal presence on the Eastern section of the railroad. It remains to be seen how "real" or how large this opportunity becomes, or what the physical plant can handle. The team expects to explore this more fully.

III. Traffic to Singapore over the railroad - From a purely economic point of view, this flow of traffic would be of great benefit to the railroad. It is long haul, high volume and consists of the kind of traffic most susceptible to rail intermodal transport. Unfortunately, it also clashes with some national interests regarding the use of Malaysian Ports and the desire to drive more traffic to "direct" calls in Malaysian Ports with no Singapore transshipment. It is not clear how this opportunity might balance out, but it is clear that it would be inappropriate for KTM to adopt a strategy counter to the overall transport strategy of the nation. It is possible that this major opportunity will have to be ignored in the overall interests of national policy.

IV. Domestic opportunities - Focus on the potential domestic opportunities is to occur later in the effort. However, our preliminary investigations did not identify any obvious or large opportunities in this are. We will continue to look in later phases of the work, but are prepared to suggest that this not be a major component of the ultimate intermodal market strategy.

V. "Inland" port opportunities (Segamat, Mentakab, Sadao(Thailand)) - KTM identified and has begun work on these opportunities. The team plans to more carefully examine both the volume and the operating economics of each potential inland depot and to provide recommendations to KTM as to which are the highest potential.

VI. Displacement of feeder vessels - Combined with #I (Klang/Penang), this might be a major source of new business for the railroad. It should be considered in a broader context than just Penang/Klang, and needs to include Pasar Gudang volumes from various points in Malaysia (particularly for regional services that call at both Port Klang and Pasar Gudang). There will be economic challenges to taking advantage of this opportunity, given the costs of feedership operation and the ability to examine traffic "on the margin". In spite of this, there may be situations where the railroad will be in a position to offer substituted service.

VII. Coordinated market development with Multimodal Freight - It is not clear how this would work, or whether a combined "wholesale/retail" marketing effort will prove effective. The team is aware, however, that in many countries, the foundation of successful intermodal strategies relies heavily on the ability to sell in cooperation with selected forwarders and truckers. This may involve some joint marketing effort, and may even involve MMF becoming a "marketing agent" for the railroad. Alternatively, it may involved selling space to major MMF competitors, and making no distinction for affiliated companies.

It is not obvious which is the better approach, or whether some combination is appropriate. The team does believe that the current working relationship with MMF should probably be strengthened, or at the very least, should not interfere with KTM's ability to deal with MMF competitors. This is a sensitive area internally and needs to be more carefully examined before any policy decision is implemented.

VIII. Increased volumes through Jahor Bahru (Pasar Gudang) -

While the detailed data have yet to be collected, it is estimated that approximately 400,000 TEUS annually (KTM estimates) move through Jahor Bahru, mostly by regional shipping companies. There may be some opportunity to encourage main line vessel calls at this facility and for KTM to participate in volumes from various inland points to this port of export.

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These opportunities are not meant to be exhaustive, nor are any specific recommendations about their priorities being made. These were the preliminary opportunities identified in the early stages of the work and are the "working list" from which the team plans to expand its examination, and to which we expect to apply rigorous economic analysis in later elements of the project.

Chapter VII
Next Steps

Chapter VII - Next Steps

Next steps in the project are detailed in the workplan provided under the TDA Grant. We expect to move forward as outlined below:

Elements III & IV - Interview Current and Potential Users and Assess KTMB's Competitive Position

We will require significant input and assistance from the Freight Marketing Department at KTM to identify and schedule key customer interviews during the next site visit (in late Oct/early Nov.) The work in this element focuses on an objective assessment of KTM's current market position, and customer perception of KTM's ability to provide intermodal service in key lanes. It is based upon customer perceptions of strengths that the intermodal strategy will be largely based.

These interviews have to be completed before the delivery of the second interim report, scheduled for early November. Delay in interview scheduling will result in a delay of the second interim report. If the interviews are not completed by mid-November, the final report could be delayed beyond the end of 1998.

Element V - Evaluate Likely Market Changes -

In addition to customer input, the team will combine input from other sources (shipping companies, truckers, forwarders and government) to highlight and project major changes in the fundamental market. The current economic challenges facing Malaysia, and the planned response to them, will create important environmental considerations for the ultimate intermodal strategy.

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April 26, 1999

Encik Abdul Radzak b. Abd. Malek
General Manager (Freight)
KTM Berhad
Jalan Sultan Hishamuddin
50621 Kuala Lumpur
Malaysia

Subject: **Transmittal of Deliverable #2 – Intermodal Task**
Interim Report #2
KTMB Railway Modernization Project

Dear Sir:

Attached please find three copies of the subject deliverable for KTM's review. The designated KTM responsible person to whom we report for this task is yourself. I have included a transmittal letter to you from Mike Uremovich which provides additional information concerning the deliverable.

Interim Report #2 is the deliverable associated with Invoice #4 under the Contract Payment Schedule. Our Invoice #4 is attached to this letter. As with previous invoices, if the Interim Report is acceptable to you, please approve the invoice and forward it to USTDA for processing and payment. If appropriate, Larry Wehrer will be pleased to assist you in expediting the transmission of the approved invoice to USTDA.

Very truly yours,

John H. Bergerson
Project Manager and Senior Vice President
Attachments

cc: Mike Uremovich
Larry Wehrer

c:\my documents\ktmb013.doc

Manalytics International

M. E. Uremovich
Principal

May 1, 1998

Encik Abdul Radzak b. Abd. Malek
General Manager (Freight)
Keretapi Tana Melayu Berhad
Kuala Lumpur
Malaysia

Dear Sir,

We have completed and attach the Second Interim Report of the Intermodal Study Team, in accordance with the terms of the our agreement with USTDA.

While not required, we felt it would be beneficial to deliver this Briefing in person, and as a result, Mr. Wehrer will formally present key aspects of this Second Interim Report during his site visit in early May 1999. He will be in a position to respond to any questions from you or your staff regarding the work to date. Upon the delivery of that Briefing and your formal acceptance, we will move on to the finalization of the effort.

The delay in the work, relative to initial schedule, has been occasioned by some difficulties in scheduling of interviews and the current somewhat disrupted state of the market. We have kept the prime contractor (ICF-Kaiser) informed of these delays and understand that comparable difficulties are present in the signaling and communications work as well.

We want to assure you that the scope of the work is in no way affected and we will move aggressively to complete the effort. We would hope that you prompt acceptance of this Second Interim Report and your acceptance of a Third Briefing at the conclusion of Mr. Wehrer's May visit, will permit us to prepare the final Intermodal Strategy Recommendations for you and your staff. Delays in acceptance of interim briefings further delay the completion of the work since we cannot commit the resources to finish until the earlier work is accepted.

As outlined in our Scope of Work, this Second Interim Report contains:

- Review and Confirmation of First Interim Report results
- The Ocean Carrier Industry Relative to KTMB's Market
- Assessment of KTMB's Current Competitive Position
  - Carrier Interviews
  - Customer Interviews
- Preliminary Intermodal Strategy Recommendations
- Next steps

1007 Sierra del Norte, Santa Fe, New Mexico 87501
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Manalytics
International

Under the terms of our agreement with USTDA, the dispatch of this interim deliverable allows the release of funds to continue the work in assisting KTM to develop new intermodal strategies to increase volume on the railroad. We would appreciate your acknowledgment of receipt of this briefing by the same formal process to USTDA as used previously so that the work can proceed. The proper format is attached and I would appreciate receiving a copy when it is dispatched.

It is anticipated that Mr. Wehrer will complete and deliver to KTMB the Third Interim Report at the conclusion of his current visit to Malaysia. This briefing will summarize :

- The evaluation for the prioritization of intermodal options
- The initially selected strategic options with the basis for their selection
- An assessment of key success factors in strategy implementation
- The recommended overall intermodal strategy

Upon your acceptance of that briefing, Mr. Wehrer and the remainder of the team will complete the final report for delivery of the Final Recommended Strategy. We would expect to complete the Final Report within 4-6 weeks of your acceptance of the Third Interim Report.

We appreciate the opportunity to continue working with KTMB and appreciate the unusual challenges that you face. Our work has identified some exciting and potentially profitable opportunities for your company and we are confident that you will find the intermodal market one of great potential.

Yours very truly,

Michael E. Uremovich

cc: J. Bergerson
Senior Vice President
ICF- Kaiser Engineers Inc.

KTMB Intermodal Project

Second Interim Report

May 1999

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Introduction

Status and Work to Date

First interim report contained....

- » Preliminary estimates of Malaysian Intermodal Markets
- » Description of Competition in the Relevant Intermodal Market
- » Analysis of KTMB Intermodal Business
- » Preliminary views of KTMB's Competitive Position
- » Preliminary Opportunity Identification

Purpose of today's session

- To review and supplement First Interim report
- To place the intermodal strategy in the context of industry trends
- To present results of customer and carrier interviews and summarize KTM's current competitive position
- To present preliminary intermodal recommendations
- To agree upon priority opportunities to be examined this week while the team is in Malaysia

Chapter I - Review of First Interim Report

This section summarizes the results presented in the October 1998 First Interim Report

Not all of the estimated 3.0 million TEU Intermodal Market in Malaysia is Relevant to KTM

- The overall market for both loaded and empty movements of containers was estimated at approximately 3.0 million TEU's annually (98)
- Not all of this market is "relevant" to KTMB
  - » Some is of extremely short length of haul
  - » Some has highly sensitive service making is inappropriate for rail movements
- Even the larger market is highly volatile, heavily depending upon international trading conditions and vessel rotations

The size of the relevant market for KTM is approximately 1.0-1.5 million teu's annually (based upon 98 estimates)

- While precise data are unavailable, the team, combined with estimates from customers, shipping companies and the KTMB staff, estimated that approximately 50% of total container flows were at least tangentially relevant to KTMB
- This results is approximately 1.0-1.5 million TEU's being a reasonable market definition for KTMB
  - » This adjustment focuses on major lanes where rail is judged to be potentially competitive
  - » It includes only characteristics where KTMB would have at least some reasonable chance of meeting variable costs
- This assumes an essentially "steady state" in vessel deployments
  - » No major withdrawal of feeder services
  - » No major line re-deployment that would alter port flows significantly

Virtually the entire Malaysian intermodal market is directly tied to international flows

- Discussions with customers, shipping companies, KTMB staff and others make it clear that the overwhelming amount of intermodal opportunity is concentrated in international flows
- Less than 10% (100-250,000 teus) of movement are estimated to occur for intra-Malaysia movements in intermodal boxes
- Similarly, virtually all of the market relevant to KTMB is directly tied to international flows

Forwarders were identified as key in the routing of much of the intermodal business

- As is well known by the KTMB staff, forwarders and other intermediaries are highly influential in the routing of both loads and empties
- Close working relationships with the ports are also key to routing control
  - » Ports play an active role in structuring movements with forwarders and customers
  - » Ports can and do provide economic advantages to incent movements through their facilities
- Subsequent direct customer interviews reinforce this conclusion, with forwarders being found influential in virtually every decision that might include a rail routing

Lorries are the major competition

- Trucks have inherent flexibility and strong economics in the less than 150 kms markets
- Interport feeder movements and movements on mainline vessels, as will be shown, are not high priority markets
- Even in the longer hauls, destination drays, lift charges and other costs mitigate against rail in certain situations
- The "unlicensed" hauler is a major issue in market stability
- KTMB has no current effective marketing arrangement with any of the licensed truckers

Klang/Penang is the major intermodal market/corridor of relevance to KTMB

- This is estimated to be the largest single intermodal lane in Malaysia
- KTMB was preliminarily assessed to be competitive in this key lane
- The service position of KTMB in this lane was untested at the time the preliminary report was written
- Feedership volume in the lane is large and highly competitive

Penang/Klang to/from Singapore is a potentially large market, however current public policy will make that market difficult to develop

- Movement of intermodal boxes to Singapore from Malaysian origins/destinations would clearly benefit KTMB, and the potential for the market is potentially large
- However, such movements run counter to larger public policy decisions to encourage traffic to move through Malaysian ports
- Continued expansion of current and the development of new Malaysian ports will continue to exacerbate this issue from KTMB's perspective

KTMB's current position represents approximately 5% of the overall market and has been declining

- KTMB's overall market share has been volatile and declining since 1995
- Based upon the TEU throughput of key Malaysian ports since 1995, KTMB's market share has declined from 6.5% in 1995 to less than 5.0% in 1998 (est.)
- It is less clear if the decline in share has greater or less in the truly "relevant" market
  - The team believes the share in the relevant market has been slightly slower than in the overall market
  - Port routings have moved some of the previously "relevant" business to outside the purview of the railroad

The Pedang Besar rubber movement is the most critical intermodal movement on the railroad

- It represents about 25% of the total moves
- This movement is seen as vulnerable to world rubber markets, Thai port policy and changes in economics driven by the Port of Penang
- The new Sadao facility may also threaten the move but could also become a source of business
- Protection of this movement, and continuing to provide high quality, efficient, service will be critical to the developing intermodal strategy on KTMB

Inland container depots were identified as critical to improved market position

- Ipoh (ICT) and Nilia Inland Port (NIL) were early seen as key to the future intermodal business on the railroad
- Segamat was also identified as important and is scheduled to open in September of 99
- The situation relative to the two potential sites on the Eastern mainline are unknown at this time
- As will be discussed, further expansion of locations and services offered at inland terminals may present significant opportunities for KTMB

Some potential specific opportunities were identified in the First Interim Report

- Regaining share in the Klang/Port Penang markets
- The Eastern Mainline opportunities
- Traffic to Singapore
- Expansion of Inland Port Opportunities
- Potential displacement of feeder vessels
- Coordinated marketing with Multimodal Freight
- Increased volumes through Jahor Bahru (Pasar Gudang)

Chapter II - The Ocean Carrier Industry in Perspective

There is significant strategic confusion among major carriers and no clear direction has been set among industry leaders

- Manalytics recently completed interviews with senior officials of major shipping companies
  - » These discussions including major Japanese, US, Canadian, and European owners
  - » Interviews were completed with senior officers (CEO's of Asian liner services, COO's of North American and Asian Divisions, etc)
- These interviews make it clear that:
  - » This is an industry that sees itself "under siege" without a clear direction
  - » There is no consensus as to likely industry structure over the next 3-5 years
  - » Some carriers are retrenching to "port to port", some are reinventing themselves as "logistics companies"
- From KTMB's perspective, this implies the need to maintain great strategic flexibility in this market and not constrain future action by restrictive choices at this time

Alliances, though unstable, will continue to dominate deployments

- Most major carrier executives expect that asset sharing, particularly of vessels and terminals, will continue, despite major challenges
- Asset sharing is seen as a mixed blessing
  - » Some cost reductions are possible
  - » Individual company flexibility is constrained
  - » Individual executives believe it can reduce their competitive edge
  - » Joint decisions are difficult to make
- Some key executives believe such alliances are inherently unstable and are unwilling to make binding commitments
  - » Recent changes in the structures of key alliances have emphasized this view
  - » There is a basic lack of trust among a number of major alliance partners

Carriers are expected to continue consolidating which could reduce the relevant market for KTMB

- One underlying theme in the discussions is the feeling that consolidations among major shipping companies will continue
- "Scale economics" is seen as key to survival by many major carriers
- "Niche players" are expected to virtually disappear from many trades
- From KTMB's perspective, the implications are:
  - » Fewer carriers to deal with
  - » More volatility in volumes as carrier negotiating leverage increases
  - » Likely greater "coverage" in key Malaysian ports, with less opportunity to compete for interport movements

Cost focus remains the single largest management concern of shipping company management

- While strategic consensus as to the direction of the industry is lacking, there is clear focus among all major carriers on cost reduction
- Most executives believe the business will become more, not less, competitive and that costs pressures will increase
- From KTMB's perspective this means:
  - » Carriers, in choosing the railroad, will be driven more by cost attributes than improvements in service
  - » Service will have to be "acceptable", but premium prices are not to be expected
  - » It will be difficult to be compensated for "Value added" services
  - » There will be intense pressure to provide, at little or no cost, ancillary services like lift services, etc..

Deregulation in US trades may significantly alter carrier competitive positions

- US deregulation has begun
  - » May 1st is a key date
  - » Carriers are rapidly altering marketing strategies and moving quickly to construct confidential service contracts
- While it is not clear the ultimate outcome of these actions, some early indications are:
  - » Business, especially from major customers, will continue to consolidate with larger carriers that have multiple trade coverage
  - » Regional movements (including intra-Asia flows) may well become part of global/super-regional contracts
  - » Carriers may well "trade-off" positions in some trades for stronger positions in others
- From KTMB's perspective, this could mean
  - » Requirement to enhance communications and working relationships with large carriers outside of Malaysia
  - » Increased premium on competitive knowledge of international trade flows not directly tied to rail volumes in Malaysia
  - » Strengthening of staff capabilities with broad based international experience

Malaysia's recent political situation was commented upon

- While not yet a major issue, several senior shipping company executives expressed concern about the recent political situation is Malaysia
- These concern focus more the potential economic impact than making any judgments regarding the political situation
  - » Will foreign investment be constrained?
  - » Will the ability of international companies to continue to independently manage their businesses be affected?
  - » Will any political decisions impact the ability of Malaysian exporters to compete?
- Specifically mentioned were:
  - » Malaysia's port inducement policies
  - » Potential friction with Singapore

Outbound Asian trade is expected to be strong

- While recent economic shifts in Asia have driven some major alterations in trade patterns, there is recent evidence of continued confidence in the recovery of key economies
  - » Key macroeconomic indicators show growing strength in major Asian countries
  - » Malaysia confidence continues to build
- Shipping companies have reflected this confidence in recent statements and actions
  - » Significant outbound rate increased ($800+/feu to US and $500+/FEU to Europe) have been posted
  - » An informal survey of key executives and forwarding agents suggests these rate increases will go into effect
- Somewhat offsetting this confidence is a continuing problem of inbound equipment to key Asian destinations and the drop in intra-Asia trade

Ocean carrier deployments are emphasizing outbound Asian flows

- Major alliances have redeployed specific vessels, including feeder rotations, to maximize outbound Asian capacity
- Additional all-water capacity to the US East Coast (including some through Suez) has been part of this shift
- The relative contribution of the trades has made it in the clear interest of the vessel owners to aggressively increase price and capacity to take advantage of the strong outbound flows
- Most carrier executives expect this to continue for the short to intermediate term (1-3 years)

Chapter III - Results of Carrier Interviews

The alliance structures mitigate against KTM participation in the empty repositioning of boxes by vessels

- As indicated earlier, ocean carriers seen the alliance structure as continuing in importance
- Unfortunately, this mitigates KTMB's ability to significantly impact the empty repositioning of units by rail
  - » Carries are making deployment decisions outside of Malaysia, often with little or no understanding of what might be done by the railroad
  - » The alliance has to balance multiple interests and thus are not likely to use interport positioning in Malaysia as a major component of their deployment decisions
  - » KTMB currently has no real way to insert itself in this decision process and there is no strong evidence it could impact the decision even if it were involved
- The probability of making a major arrangement with an alliance for interport positioning is seen to be small

Carrier cost methodologies make it appear as if inter-port positioning is essentially "free" to the carrier within Malaysia

- Another aspect mitigating against interport positioning is the evaluative process used by major ocean carriers to estimate the "costs" of such movements, particularly on alliance vessels
- Once the vessel is committed to the trade, and makes multiple Malaysian calls, the space between the ports is often seen as "free"
  - » The ship is going anyway
  - » The boxes have to be matched to vessel capacity for balance and flow reasons
  - » Some carriers do consider lift costs and hostling charges as legitimate costs, but others ignore even these charges
- This is even more so as/when alliances begin sharing boxes or shifting boxes among "master leases" to increase utilization
  - » Boxes become interchangeable
  - » Fewer empties are moved

Feeder vessels would react aggressively to any attempt by KTM to participate in this business

- There remain independent "feeder services" moving empties outside the alliance structures
  - » Some of the carriers are affiliated with regional shipping companies
  - » Some are affiliated with port operations (Westport) and independents
- Interviews with these carriers make it clear that they will react aggressively to any attempt by KTMB to capture share in the movement of empties currently on their vessels
  - » They believe they can reduce rates well below what the railroad can afford for the reasons described above
  - » They believe they have significant cost advantages given their current port operations (lack of dray, no rail lift, etc.)
- This will be a difficult market to effectively and profitably attack and has been downgraded as a major intermodal opportunity

Carriers identified an opportunity for depot-to-port or port-to-depot positioning

- During discussions with key shipping executives in Malaysia, opportunities for further inland depots were identified; specific locations were suggested and will be reviewed with KTMB staff during the current in-country visit
- Movement to/from the port, mostly of empties was seen as a major potential role for the railroad
  - » Using rail facilities for container interchange, inland container storage, repair and dispatch were most often mentioned
  - » Full trains to the port for vessel loading, closely scheduled and with high levels of service were seen as additional potential to avoid port congestion
  - » This will require a smooth and efficient integration at the port as well as at the inland depot; some customers are skeptical about the railroad's ability perform reliably

Carriers do turn to unlicensed haulers for some of these moves

- Ocean carriers have taken advantage of the limited enforcement of the licensing requirements in Malaysia
  - » Most use unlicensed haulers for empty repositioning and sometimes for loads
  - » These carriers provide the "surge capacity" necessary to meet vessel sailings
- Most ocean carriers would prefer to deal only with licensed truckers
- Some believe that the "spread" between the two classes of carriers is disappearing and that eventually only licensed haulers will play a major role
  - » Trucks are more expensive
  - » Operating costs may not be all that different between the two kinds of carriers

Carriers would also like to see support services offered at KTM's intermodal terminals

- Carriers would see the KTMB intermodal terminals as the nexus of their inland operations and would find it desirable to have ancillary services present
- A combination of leasing, drop offs, M&R, inspection, storage and other such services were most often mentioned
- This "one stop" shop for container operations and dispatch might provide KTMB with a competitive advantage over licensed haulers
- Key issues:
  - » Is there space?
  - » Can we make an arrangement with a leasing company or similar organization?
  - » Does KTMB have to provide the service directly?

Carriers would like to see KTMB have closer working relationships with key licensed haulers

- Ocean carriers would like the flexibility to move their units (both loads and empties) as the economics and services dictate
- Several indicated a combination of rail and truck is most desirable, and the creation of a "seamless" system would benefit everyone and might be highly used
  - » KTMB is seen lacking the operating integration with lorries that is desired
  - » Ocean carriers indicate there needs to be more cooperation between the modes in order to work for everyone's advantage
- This also was surfaced in customer/forwarder interviews. The lack of close working relationships with MMF was mentioned by carriers as well

Carriers would like scheduled, less than train load container rates

- A major issue in both carrier and customer interviews involved the current implicit policy that requires "full train" movements
- Carriers expressed a clear preference for time-definite, less than train service between key locations
  - » Same time of day departure and arrival
  - » Reasonable cut offs prior to train departure
  - » Ability to move as few as 5-10 containers for loading
  - » Lorry competitive, including on and off charges
  - » Absolutely consistent service
- Key issues:
  - » Can the railroad handle multiple departure, small intermodal trains as the service develops?
  - » Can the service be structured?
  - » Can it make any money?
  - » Is KTMB willing to make the investment to run the service as it develops?
- The team expects to address this in more detail, in specific locations, this week

Cutoffs and availability on pre-determined schedules would be critical for this market

- It was repeatedly reinforced that predetermined cut-offs and availability times are critical to the success of any scheduled service
- Focus on train running time is less important in the minds of customers than cut off and availability
- Implicit in this concern is the ability to process through the gate at either end and get the containers in the hands of customers

Carriers indicate a desire for the strengthening of KTM's information systems support of intermodal flows

- The lack of supporting information relative to container location and status was often mentioned in the interviews
- Direct information links to carrier equipment control systems and rapid response as to status information was particularly important
- Such systems could also support the creation of the terminals and depots as:
  - » Bill of lading points
  - » Formal interchange locations

Carriers will not likely make vessel deployment changes based upon any action by KTMB

- In discussions with key shipping company executives, none believed that KTMB could offer sufficient economic incentives to alter vessel deployments
- Analysis suggests there is insufficient economics from the perspective of the ocean carrier, even were KTMB to virtually "give away" interport repositioning
- There is little opportunity for KTMB to pursue this as a source of new intermodal business

Summary of Carrier Interviews

- Alliances will play a major role in determining interport flows in Malaysia
- The interport feeder market will be difficult to attack given the ocean carriers view of costs and alternatives
- KTMB probably could not provide sufficient inducement to alter vessel deployments
- The single most often expressed desire was for reliable, fixed schedule, less-than-trainload service for empties
- Broadened terminal services, combined with attractive cut-offs and scheduled availabilities will be important for success
- Information systems need strengthening

Chapter IV - Results of Customer Interviews

Interviews were conducted with customers representing major segments

- Approximately 20 interviews were held inside and outside of Malaysia representing major industry segments
- Shipping companies - major regional and international carriers
- Major Malaysian ports
- Licensed haulers
- Forwarders
- Shippers and receivers

Uniformly, Malaysian customers express a desire for "one stop" transportation purchases

- Beneficial cargo owners particularly desire the "one stop" transportation options
  - » The major reason for the use of the forwarder
  - » The reason for the success of the licensed haulers inroads into "controlling" the freight
- Ocean carriers express a similar desire for one or a limited number of major inland partners with whom to coordinate operations
- The continued and relentless cost pressures make it clear that simplification of the inland process could deliver economic advantages - carriers want to move in that direction
- Forwarders see this as their logical role and continue to market such an approach

Customers don't understand why there is not closer cooperation between KTM and MMF

- Repeatedly beneficial owners and carrier customers raised the issue of lack of apparent marketing cooperation between KTMB and MMF
- The corporate affiliation was seen as a natural foundation for a closer working relationships and the offerings of joint, coordinated services
- Some believed that KTMB's apparent attempt to maintain "neutrality" with the other four licensed haulers was bound to fail
  - » MMF does not seem to sponsor KTMB in the market and thus gives them no advantage
  - » Other haulers likely are suspicious of the relationship in spite of the apparent lack of joint effort

Such cooperation would have some residual customer issues to overcome

- Were KTMB and MMF to closely coordinate services and market efforts, there would be some residual customer issues to resolve
- KTM's service reputation has to be continually reinforced, particularly given the improvement in recent times
- There would likely be some concern on the part of the other licensed haulers
- Customers must be convinced that KTM/MMF is not just "re-arranging" profit with little or no customer benefit
- Some costs would have to be shared and some margins would be at risk; an economic evaluation of key aspects would be required

While improvement was noted, past service problems remain a concern for many customers

- After price, service reliability remains the single most important buying attribute
- In the minds of customers, in spite of recent improvement, KTMB's service reputation is marginal and remains of some concern
- The key issue is the willingness, in difficult economic times, to maintain the initial levels of improvement

High dray costs from rail ramp to vessel remain an obstacle in the minds of many potential customers

- Rail has an inherent operating disadvantage relative to lorry operations in the requirement for an extra dray and lift on/off activity
- Most customers see this as an "extra" cost of doing business with rail and seek to offset the cost by lower rail rates; these charges typically range from $10-$25 USD
- There may be some potential for reducing this cost were KTMB to operate and manage the dray service to make the customer indifferent
  - » Were train schedules coordinated, KTMB might well be able to perform the service at a lower operating costs than others
  - » KTMB could structure a low cost driver situation to make the operation efficient
  - » The service could be "bundled" with other depot and train services

Security concerns remain in the minds of many customers

- In several cases, customers raised the issue of perceived lack of security for the movements of loaded equipment
- While no specific losses were documented, the issue was sufficiently prominent to require addressing were KTMB to aggressively pursue major loaded movements
- There are several relatively inexpensive solutions
  - » International seals/locks
  - » Placing of containers with doors facing inward
  - » All require operating discipline and process management that is not currently in place

Interviewees expressed the desire for improved customer service interfaces

- There is confusion, and no clear process in many customers' minds, as to where and from whom reliable information is available
- While complimenting the KTM staff in trying to be helpful, there is no clear accountability as to what information is available and from whom
- Customers are highly focused on "user friendly" systems

KTM's schedules are not seen as integrating well with customer requirements

- Customers, particularly shipping companies and forwarders, believe rail schedules are set for the operating convenience of the railroad and are not coordinated with ship cutoffs or sailings
- The flexibility of lorry service to adjust to individual customer requirements was seen as a major competitive disadvantage for the railroad
- It was indicated that:
  - » KTMB needed to run regularly scheduled service to meet vessel sailings and arrivals
  - » That schedules need to coordinate with beneficial cargo owners' loading and manufacturing schedules
  - » That maximum usage should be made of weekend and night dispatch to permit customers to maximize their working hours

Customers express a desire for fixed schedule, single container service in key lanes

- Uniformly, customers object to the requirement for high multiple container volumes to receive acceptable service from the railroad
- It was clear that carriers, lorry operators, forwarders and beneficial owners, will not look favorably upon rail service unless and until some method is found to dispatch smaller numbers of units
  - » Dispatches of 5 or less containers would be ideal
  - » Train schedules must be credible and consistent
  - » Customers do not care about "trains"; they generally are concerned with "containers"

Issues surrounding KTM's customs bond capability are a point of confusion

- Throughout the discussions with customers, KTMB and carriers, there remains some confusion about the customs situation surrounding KTM facilities and services
- Key questions to be resolved:
  - » Can KTMB move a loaded box under their customs bond?
  - » Can empties be dispatched without complex customs bonding?
  - » Are the inland intermodal terminals fully "bonded" and available for use?
  - » Can cargo be transloaded at the inland depot within the customs bond?

The requirement to deal with multiple entities when using the railroad is a problem for many customers

- As emphasis for the "one stop" approach, customers continually object to the requirement to deal with multiple entities in order to use rail service
- While not the "fault" of the railroad, customers do believe this situation make railroad difficult to do business with and they are unwilling to absorb the extra costs and administrative difficulty of doing so

Customers believe the nation's port policy will make KTM less desirable as an alternative

- Continued dispersal of port facilities throughout the country mitigate somewhat KTMB's market potential
  - » As ports expand, distance to the closest export location shorten, cutting into KTMB's relevant intermodal market
  - » As new facilities are opened, KTMB may be forced to consider investment to become competitive at multiple locations
- Few customers expect this national policy to change in any meaningful way, at least in the short term
  - » This will raise the premium on KTMB's assessment of which ports are clearly critical to future rail operations
  - » It is clear that Port Klang and Penang will remain key, with Westport also having a major role

Customers are critical of some of KTM's intermodal processes

- Information on status and movement of boxes is considered inadequate
- Customer service, particularly in the creation of a single point of contact is desired
- While sales and marketing is seen as attentive, there is no formal process to quickly respond to customer needs

Some customers indicated customs clearance at KTM intermodal terminals is desirable

- The "customs" situation is not clear at either the inland container depots (ICD's) or KTM intermodal terminals. Customers believe operating savings are possible if KTM facilities can be used to interchange containers
- The team has been unable to find a definitive single source of information that permits a reasonable strategy to be defined at t his time
- Customers had differing views of what was permissible, what was informally being done and what changes might be upcoming
- The team will spend time during this visit further exploring what options are available

Extension of container terminal services is also seen as valuable by customers

- As mentioned previously, carrier, forwarder and beneficial owners, all see the inland container depot as the logical place for additional services to be provided
- They don't understand why this is not done
  - » It is demonstrably more efficient to do it at a container storage location
  - » It potentially avoids an extra truck move
  - » It leaves the container inventory where it will be used

Longer term, many customers believe some physical constraints will require resolution

- The inability to handle high cube boxes north of Ipoh on the railroad is often the subject of comment
- It is not clear that the economics of any infrastructure change is justified, however, many customers believe the high cube box will so dominate the Malaysian trade that KTM will require some resolution to this matter
- Line capacity, given the reduction of non-intermodal traffic, is not seen by customers as a major issue

Customers suggest some reorganization and focus of the intermodal marketing effort

- While KTMB's marketing efforts have clearly improved in the eyes of the customers, there is room for further significant improvement
- Issues most mentioned were:
  - » Difficulty in quickly responding to rate quotes, service commitments and the like
  - » Inability or unwillingness to construct flexible operating services to meet customer needs
  - » Focus on passenger
  - » Inability of the Commercial organization to make rate and service commitments for the railroad

Summary Customer Reactions

- Generally neutral, with improvements in recent 18-24 months
- General understanding that KTMB is sometimes constrained in its ability to act
- Appreciation for the challenges in restructuring the railroad
- Willing to work with KTMB, but....
  - » Economics are always the prime driver
  - » Prior disappointments still in the minds of some key customers
  - » Concern about KTMB's future strategies and willingness to commit

Chapter V - Preliminary Intermodal Strategy Recommendations

Major changes in focus and investment in the container business, will be required to stem the share erosion

- Based upon the current situation, the Intermodal team does not believe major changes can be made in KTMB's intermodal position without a significant and aggressive commitment to the business
- Continued pursuit of the current strategy is not likely to improve the situation and could make it worse
  - » There will be continued cost pressure from the lines
  - » The licensed haulers and forwarders will continue to be aggressive
  - » The customer community has some skepticism that KTMB will remain committed to a new intermodal program
- Starting a new effort, and then retrenching will severely damage the railroad's credibility in the customer community

To be successful with a new intermodal strategy, KTMB should reflect the customer requirements in the new services

- Fixed schedules
- Reduced container tenders
- Upgrade customer service and information systems
- Coordinated and integrated schedules with vessel operations and customer loadings
- Efficient "gate" and terminal usage
- Additional inland depots and expanded services at depots

See discussions that follow.....

Terminal and inland container depots will be key to the new intermodal strategy

- In order for a new strategy to aggressively grow volume, KTM will likely have to play a much larger role in providing teminal and related services to key customers
- The integration of intermodal terminal operations, inland depot services, container interchange, issuance of ladings, etc, will all be required
- Leverage of developing situations at locations like Butterworth and Westport are prime examples

Among the most important changes would be a coordinated "one stop" marketing approach

- Broadening of services will be required
- There are a range of options to be considered:
  - » A joint intermodal "company" with MMF
  - » Placing MMF marketing responsibility at KTM
  - » Combining both operations and marketing of KTM Intermodal and MMF
  - » Closer joint marketing efforts
- It is not clear which is best for KTM or MMF
- The team will spend time during this visit defining the options and developing a recommendation

Adopting such a marketing approach might require some organizational changes

- The current commercial structure is likely to require some modification for a new intermodal strategy to be effective
- Should MMF and KTMB consolidate certain intermodal marketing functions?
- Should intermodal be structured as a business unit, with direct margin accountability?
- Can the intermodal effort be sufficiently separated to be effective?
- Would the economics support such moves?

Preliminary recommendations will be developed during the current visit

Closer working relationships with one of the major licensed inland haulers need to be established

- Tentatively, the Intermodal Team recommends that some working relationship with MMF be structured
- In addition, some coordinated effort should be made to structure closer working relationships with one or more of the other licensed haulers, parallel with the closer MMF relationship
- Failure to develop such relationships, and the integrated packages required by the market, will significantly reduce the probability of success of any new intermodal strategy

Intermodal, less-than-trainload, schedules with well designed cut-offs and availabilities, will be required

- This will be a necessary condition for aggressive implementation of a new intermodal strategy
- They must be:
  - » Same time of day cut offs/departures
  - » Consistent arrivals and availability (90+% as advertised measured by "box" count
  - » Able to tender fewer than five boxes in a shipment

Continued redesign of schedules for the Klang/Port Penang should be a high priority

- This is the major lane with the most opportunity
- This will be seen as a major test by the customer community
- KTMB's credibility will be severely questioned if this basic service cannot be reliably demonstrated
- It will likely take 6+ months of operation to demonstrate the required commitment

Jahor Bahru remains an opportunity for regional shipping services and should be examined in more detail

- Several customers have also identified this lane a having high potential
- It might be possible to run longer distance trains from as far as Penang
  - » Much of the traffic flow is said to move to Japan and other locations served over this port
  - » Such flows would still be consistent with national policy of using Malaysian ports

A "sealed container" system should be examined to address the security concern of customers

- While this has to be consistent with the proper solution to the various "customs" issues, some enhance security system will have to be developed
- It does not have to be elaborate and may be as simple as:
  - » Seal and locks
  - » Modified operating procedures
- It will enhance the broadening of services that will be important to the intermodal strategy

Terminal gate procedures need to be revamped

- If the railroad is to broaden its intermodal services, terminal receiving and dispatch procedures will require strengthening
- Information systems will be particularly important
- Interchange and bill issuance procedures will also be critical
- Specific processes will be dependent upon resolution of the customs and bonding requirements

Further examination of opportunities to expand both ICD's and intermodal terminals will be undertaken this week

- While some initial locations have been identified, it is not yet clear that any are economically justified
- Some "integrated system" of depots and terminals will be critical to the longer term strategy

Action needs to be taken immediately to isolate the specifics of the customs situation and to work to mitigate this disadvantage

- This issue should be resolved and quickly by establishing a task force to immediately gather the relevant information and determine what specific steps need to be taken
- How do we arrange for KTM's intermodal terminals to become points of interchange?
- How do we establish new ICD's that can issue bills?
- What regulations do we have to comply with?

Summary of Preliminary Recommendations

- Make a commitment to the business that builds customer confidence
- Structure a working relationship with MMF that permits "one stop shopping"
- Expand the depot network and the services offered at each depot
- Restructure the commercial effort in intermodal to reflect the commitment and new services
- Establish known and consistent information measures for customer service
- Develop and implement fixed departure, less than train load service in key corridors; start with Klang/Port Klang and Ipoh/Singapore

Chapter VI - Next Steps and Prioritization of Intermodal Opportunities

Key next steps.....

- Resolve the MMF and organizational issues
- Define the terminal strategy; services, locations, etc.
- Restructure the customer service and information systems components
- Prioritize the inland depot opportunities..
  - » Where?
  - » What services?
  - » Who operates?
- Finalize priority new intermodal schedules
- Resolve the customs and securities issues

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November 23, 1999

Encik Abdul Radzak b. Abd. Malek
General Manager (Freight)
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Subject: **Transmittal of Milestone #4 Remaining Deliverables**
Signaling & Communications Task – Deliverable #2 and Radio Propagation Study
Intermodal Task - Interim Report #3
KTMB Railway Modernization Project

Dear Sir:

Attached please find three copies of the subject deliverables for KTM's review. The designated KTM responsible person for the Signaling and Communications Task is Mr. Lee Heng Cheong, and for the Intermodal Task, yourself. I would greatly appreciate it if you could forward the two submittals entitled "Phase II Signaling & Communications Improvement Study" and "Radio Coverage Simulation for KTMB Malaysia" to Mr. Lee for his review. The Radio Coverage Study was part of the scope for the initial task, but we had difficulty in arranging with Motorola to provide the simulation, so we are submitting their report with this submittal. The other deliverable that is included in this Milestone, the Concept Design Report for the Depot Task – was transmitted to you in April 1999 for Mike Shaman's review.

These three deliverables for Tasks 1,2 and 3 comprise Milestone 4 under the contract, and are associated with Invoice #5 under the Contract Payment Schedule. Our Invoice #5 is attached to this letter. As with previous invoices, if these deliverables are acceptable to KTM, please approve the invoice and forward it to USTDA for processing and payment at your earliest convenience.

The remaining submittal under our contract's scope of work is a final report that covers all three of the study tasks. We intend to complete that report in the next month and submit it to you, along with the final invoice.

Very truly yours,

John H. Bergerson
Project Manager and Senior Vice President
Attachments

cc: Mike Uremovich, Ron Rypinski

KTMB Intermodal Project

Third Interim Report
November 1999

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I. Status of Intermodal Project

The first two interim reports have been delivered

- The first interim report was delivered in October of 1998 and covered:
  - » Estimates of current market size
  - » Preliminary estimates of current competitive options
  - » Preliminary interview results
  - » Initial assessment of KTMB's competitive position
- The second interim report was delivered in May of 1999 and included:
  - » Evaluation of likely market changes, with particular focus on the ocean carriers
  - » Final results of carrier and customer interviews
  - » Preliminary Intermodal Strategy Recommendations

These reports provided the background and analysis for final recommendations

- Direct market input was incorporated in both earlier reports
- Analysis/data provided by KTMB was utilized in both earlier reports
- This reports provides the final intermodal strategy recommendations, based on these earlier reports

This third interim report was delayed by a combination of occurrences within Malaysia as well as at KTMB and the consultants

- It was initially anticipated that the work would be completed in early 1999
- The delay in the final submission was caused by a series of events over which the team at KTMB and the consultant had no control
  - » The rapidly changing economic conditions in SE Asia in general, and Malaysia in particular, made it clear that recommendations in the midst of this instability would have limited longer term value
  - » Conditions dramatically improved as 1999 progressed and the environment is now conducive to longer term strategy commitments
  - » Major customers were reluctant to be specific about needs until the environment improved

The final deliverable will be a combination of the three interim reports and is expected to be completed within 30 days

- This third interim report provides the final substantive recommendations in the Intermodal Strategy Area
- A final report, which will combined all three interim reports and summarize the work, is intended to be delivered within 30 days of the acceptance of this report
- The final report will also identify opportunities for joint KTMB/US firm cooperation
- This will complete the project

II. Summary of Earlier Reports

This section presents the major conclusions of the First and Second Interim Reports

The overall intermodal market was estimated at 3.0 million TEUs in 1998, less than half "relevant" to KTMB

- The overall market, both loaded and empty movements, was estimated at approximately 3.0 million TEU's in 1998.
- Overall market size can vary widely on a year to year basis as shipping companies alter deployments
- Approximately 1.0-1.5 million annual TEU's was estimated as the "relevant" market for KTMB
  - » Much of the traffic through the ports is too short haul for rail participation
  - » Some of the longer haul traffic has service requirements to meet vessels that make rail inland transport not likely

International flows are key to this market

- The overwhelming majority of intermodal traffic flows in Malaysia (in excess of 80%)is tied to international flows
- Intra-Malaysian domestic flows are estimated at 150-250,000 TEU's annually
  - » This estimate is seen as the upper bounds of such flows
  - » While there are no direct statistics on these flows, estimates were derived from interviews with both inland carriers (lorries), KTMB officers and customers
- Service requirements for all intermodal business will be driven by the demands of international traffic

Forwarders are critical to the business

- Many forwarders are given significant routing authority by customers
- Ocean carriers consider the forwarder the major local "customer"
- Carries and forwarders work closely in soliciting specific traffic
- Forwarders are closely allied or affiliated with specific truckers

KTMB share of the intermodal market continues to decline

- It is estimated that KTMB's 1998 intermodal market share will drop below 5% of the total market
- This is down from approximately 6.5-7.0% in 1995
- The decline may not be as great in the "relevant" market share as in the overall market, but share remains at best stagnant

Customers desire a "one stop" transportation service

- Reinforcing the role of the forwarder, many customers indicated a strong Desiree for "one stop" transportation service
- A requirement to deal with multiple participants (like lorry companies, international forwarders, rail, etc..) makes the transaction difficult and time consuming for the customer
- Ocean carrier encourage this "one stop" approach

Truck competition is strong and flexible

- Trucks have inherent flexibility in the shorter haul markets; they do not require high levels of fixed commitments as do rail operations
- Lorries can provide high levels of service that permit customers to reduce inventory in transit
- Lack of effective regulatory oversight permits some truckers to provide very low rates
- This is in spite of rail's potential line haul cost advantage in the 24-33% range based on specific operating and volume assumptions. Total cost advantage for rail is much lower after local dray and train discharge is considered

Fixed schedule, single container service was highlighted as important

- The consistency and reliability of rail service was identified as the most important attributes for rail service
- Customers are unwilling to commit large volumes in advance and will require single container service in most instances
- Rail schedules would have to integrate with vessel sailings and customer production schedules

The lack of coordination between KTMB and MMF is well known in the marketplace

- This issue was repeatedly raised during customer interviews
- KTMB's apparent attempt to maintain neutrality with the other four licensed haulers is seen as failing
  - » MMF does not seem to sponsor KTMB in the market and thus gives them no advantage
  - » Other haulers are believed to be suspicious of the relationship in spite of this
- This situation is the worst of both worlds....there's no real advantage to KTMB and some disadvantage to their market position

Klang/Penang is the major corridor

- This is the largest single intermodal lane in Malaysia; it may represent as much as 15-20% of the relevant market for KTMB
- KTMB is marginally competitive on this lane
  - » Rates permit delivery at or near the rate of regulated lorries
  - » Unregulated lorry service remains 10-15% below KTMB
  - » Service on the rail is at least 10-15 hours slower than lorry under the best conditions

KTMB received "mixed" reviews relative to current intermodal services

- Customers noted recent improvements (interviews conducted during late 98 and early 99)
- KTMB was seen as requiring improvement in the following areas:
  - » Integration of schedules
  - » Customer service processes
  - » Delivery reliability and consistency
  - » Container security
- At the same time, customers acknowledged significant improvements, especially in dealing with the commercial functions, during 1997 and 1998

Customer service and information availability were both cited as needing improvement

- One of the most important aspects of dealing with KTMB, in the minds of major customers, is the direct customer service interface and information availability
- Many of these customers are accustomed to the sophisticated systems employed by major world-wide carriers and by rail systems in other countries
- While some improvement was noted, particularly in dealing with KTMB's Traffic department, customers overwhelmingly cited the need for:
  - » Better shipment status information
  - » Faster response time on operational questions
  - » Improved train performance data

Forces in the ocean carrier industry could reduce the intermodal market relevant to KTMB

- Mergers and consolidations may reduce interport flows of empties and increasing use single ports for export
- Alliances may rationalize calls and flows that have the same impact as mergers and consolidations
- The cost focus of major carriers is causing them to re-examine specific flows and do everything possible to reduce costs of equipment positioning

III. Rail Intermodal Strategy Recommendations

KTMB's recommended new intermodal strategy contains three major elements

- The first is to focus on "basic" intermodal rail service to large shipping and trucking customers, both loads and empties - the "wholesale" component
- The second on provides single container service direct to beneficial owners - the "retail" component
- The final component positions KTMB to enter the higher value logistics segment

Strategy recommendations are driven by expected market behavior

- The strategy recommendations in this section are largely driven by the expressed desires of customers interviewed, when it appears that they can be economically justified
- Intermodal strategy also has to be integrated with other commercial and operating strategies
  - » The intermodal team is not aware of the other key operating strategies and cannot assess any potential conflict
  - » Discussions with KTMB officers did not highlight any specific conflicts however, more thorough internal investigation will be required by KTMB officers

Customers value service consistency at competitive prices above all other attributes

- The intermodal strategy must recognizes the single most important service attribute....service consistency at competitive price levels
- Service consistency must mean 80-85% performance to train schedule; 75% reliability to vessel
- Rail prices must permit door-to-door service at prices about 10-15% below lorry to offset inevitable service differences

The First Element

Strategy toward the wholesale market....

Focus on shipping company customers in the "wholesale market"

- In addition to direct sales to beneficial owners, a "wholesale" channel to shipping companies should be further developed
- This is where most of today's business comes from, though most of the current traffic is positioning empties
- Such efforts will probably require specific sales personnel and differential pricing to become attractive

Lorry competition in the key Penang/Klang lane will require delivery costs of approximately 400 ringit/TEU

- Based upon market input, targeting of the largest single intermodal lane is critical; if KTMB cannot create a competitive service in this lane, they will be unable to do so in other, lesser, lanes
- Based on price ranges in late 1998, rail rates in the range of 200-250 (R) will be required
  - » These rates are within the current range offered (as of late 1998)
  - » These rates assume dray costs to and from the train at about 50R/unit
  - » These rates assume no ancillary charges for loading or discharging of the train and no chassis charge
- Lorry rates were estimated (in late 98) at 350-450 R door-to-door. The above structure would permit rail door-to-door at about 300 R, which should create incentive to shift the traffic given the service differentials

Reliability in the range of 80-85% within 2 hours of scheduled arrival will be required

- Much of the loaded business in the Klang/Penang corridor is destined for specific vessels; if KTMB hopes to participate in that business, stringent service performance will be required.
- Train schedules in the 80-85% reliability range permit door-to-door service in the 75% range, given the potential for terminal and dray failures
- Lower levels of service run the risk of missing vessels
- Service designed for loaded containers will provide a level of service above that required for empties, but creates an operating discipline that builds credibility

Klang/Jahore Bahru is also key to developing a strong intermodal network for the wholesale market

- Traffic from Klang Valley or north, that might move to Singapore or Jahore Bahru would be very desirable from the railroad's perspective
- Length of haul and other characteristics suggest this would be traffic where KTM might be particularly competitive and where the traffic might be profitable
- Unfortunately, this flow may be counter to overall national policy. From the government's perspective, this could reduce the flow of traffic through specific Malaysian ports
- Nonetheless, the development of these flows might have market support (according to key shipping companies) and would provide more efficient and effective routings for specific Malaysian exporters
- KTM should meet with government officials to determine what development might be consistent with national policy and to ensure no competitive "backlash" from existing ports important to intermodal development in other markets

Maximize focus on Butterworth and Westport flows in the short term

- Both of these pending (in late 98/early 99) projects are important to the future growth of KTM's intermodal business and should be implemented as quickly as possible
- Butterworth (in the Penang port area) might form the major northern Malaysia intermodal operation for the railroad
- Westport also has significant potential, though in the Port Kelang area, exclusive reliance on or favoritism toward an individual terminal operator is not seen as desirable
  - » Competitive terminal operators may react
  - » Shipping companies periodically shift operations and it's to KTM's advantage to remain flexible.

"Cut-offs" and schedules will be critical to success and must reflect customer demand

- Schedules have to be established at customer convenience not the railroad's
- Late day cut-offs at origin terminals (say 6PM) are desired by customers to take advantage of daytime production in their factories
- Schedules that are integrated with vessel departure and permit boxes to be discharged and drayed to ocean terminals for export are also desired.
  - » Schedules should "work backwards" from ocean gate cut-off to train departure
  - » Schedules, where possible, should be adjusted t provide late day origin cut-offs

In these key lanes, single container service will be required

- Few customers are in a position to commit to volumes that permit running a full train
- During the interview process, it became clear that single container, or at a minimum less than five unit, service is desired
- This implies KTMB will have to schedule train departure without significant volume commitments in order to establish market presence and credibility

Support services should be offered at the key inland intermodal terminals

- Major wholesale customers (shipping lines)made it clear that supporting services at the inland container depots is important in their decision making process
- The following services are seen as desirable
  - » Container inspection
  - » Container repair
  - » Chassis inventory and repair
  - » Container dispatch services
  - » Container/chassis inventory and information services

Maintain service integrity/train schedules for six months in key lanes and the re-evaluate

- Customers remain skeptical about KTMB's commitment to maintaining high levels of service
- Prior attempts to upgrade service were withdrawn after what customers consider too short a trial period
- Periods of time between 6 and 9 months (to ensure service stability and ability to handle volumes during the "season") were most often mentioned as reasonable trial periods
- Selected intermodal schedules for the major two-four lanes should be maintained for at least six months to properly evaluate the service

The Second Major Element

Retail Intermodal Strategy...

Offer door-to-door service in a "retail" market directly to beneficial owners of cargo

- KTMB is not restricted to offering ramp to ramp service and should offer full door-to-door or door-to-vessel service for beneficial owners of cargo
- This will require a close operational working relationship with MMF (preferably) or another trucker who can handle the dray service at both ends
- It will require equipment positioning as well as inland truck service
- It should be priced to be competitive with current lorry traffic, recognizing where service differentials exist. If rail is disadvantaged in the range of 18-24 hours, door to door, 10-15% rate differentials will probably be required.

The new retail intermodal service should parallel and build upon the wholesale network

- The same lanes will be critical
  - » Penang to Klang Valley/Port Klang
  - » Westport and Butterworth
  - » Penang/Klang to/from Jahor Bahru
- Service requirements will be more stringent for the retail market since empty flows will be minimal
  - » There will be less room for error when moving loaded retail boxes
  - » Strong wholesale service levels can be the foundation for the retail service levels
- Single container service will be required

Maintenance of the Penang/ Pedang Besar rubber movement is critical to presence in the retail market

- It is the largest intermodal movement on the railroad, accounting for nearly 25% of total volume in 1998
- It is critical to KTMB's credibility in the market as it demonstrates the ability to compete with lorries
- The new container depot at Sadao may put the move at some risk
- Close attention to this movement is important
  - » Establish closer relationship with port of Penang
  - » Ensure senior executive attention to the customer
  - » Pay close attention to service levels provided the move

KTM should maximize use of customer equipment, but be prepared to evaluate equipment investment

- Particularly in the "wholesale" market KTMB should maximize the use of customer (primarily shipping company) equipment
- For direct sales to beneficial cargo owners, some equipment availability may be required
  - » KTM could structure a "master lease" with a major international leasing company and make equipment available through that arrangement
  - » KTM could also have equipment interchange agreements such that shipping company equipment could be present at key inland depots, dispatched to customers and then moved to the appropriate vessel

Closer port coordination may prove beneficial, though current public policy mitigates rail use

- Ports, especially Penang and operators around Port Kelang, are important participants in the intermodal system and flows; they can help position KTMB in the retail market
- As demonstrated by the Penang influence on the Pedang Besar rubber movements, ports can significantly impact intermodal flows
- Current government policy, to some extent, mitigates against rail use
  - » The Malaysian government has made it clear that the use of multiple Malaysian ports by exporters is desired
  - » The railroad, by contrast, would be better served by concentrating volume in fewer ports, or even in handling traffic to Singapore
  - » Closer understanding of government intentions, and more consistent communications with government officials may make it possible for KTM to cooperate in ways that will have more direct government support

Inland terminals at Ipoh, Segamat and Nila are critical for both the retail and wholesale strategies

- While portions of these terminals and some limited intermodal schedules are present, Ipoh, Segamat and Nila need to be strengthened
- Support services as indicated above need to be added to supplement the retail strategy
- Train schedules from/to these locations need to be adjusted to meet vessels and competitive cut-off times

The biggest challenge is balancing retail pricing to beneficial owners with the prices through the wholesale network

- Wholesalers will want some protection against KTMB's retail channel undercutting channel prices
- "Channel management" in this instance is analogous to what shipping companies do when selling to both beneficial owners and NVOCC's.
- In the retail channel, KTMB will be indirectly competing with some of its wholesale customers and must create a level playing field for all
  - » Cannot economically advantage the KTMB retail channel
  - » Let competition move away from pure price considerations

Improved customer service systems will be particularly important for the retail market

- In addition to competitive rates and consistent transit, customers were clear about the requirements for improved customer service and information
- Improvements in these areas were noted by certain wholesale customers, however, customers indicated KTM still need to focus on these areas
- Of specific importance were:
  - » Status information relative to container location and ETA's
  - » Train performance and status
  - » Pricing responsiveness
  - » Equipment availability information

Information systems need to be improved for the growing intermodal business

- Information technology is increasingly a "way of life" for international container operators and KTM is seen as lacking in this regard
- Railroads in other countries (including the US) have raised the standards by which the shipping companies assess their partners
- Customers are also attuned to major improvements in information systems; this is particularly true in the retail segment
- KTMB need to improve in this areas and should focus on:
  - » Insofar as possible, buy "off the shelf" IT technology that others have developed
  - » Buy the "basics" that provide ability to tell customers about status, and to track performance. Our final report will suggest some specific systems
  - » Examine the use of the internet as the enabling technology to minimize IT direct investment

There appears limited opportunity for intermodal service on the "Eastern line"

- With the possible exception of limited volumes to a new paper facility, there were no major opportunities identified on the "Eastern Line"
- Discussions with shipping companies and ports did not identify major new opportunities or plans to develop the intermodal capacity in this area
- Any opportunities that do arise will face significant economic challenges
  - » Lorry competition to the Kelang area or to southern Thai ports will be intense
  - » The rail infrastructure on the Eastern Line will likely require improvement

The Third Major Element

Logistics Services Recommendations

This section presents the opportunity for KTMB to establish a Logistics Services organization to serve retail customers

The major customers expressed significant interest in broader-based logistics services

- As part of the interview process, customers(beneficial owners) responded favorably to a new, broader-based logistics service that includes:
  - » Door to door full container transportation
  - » Forwarder functions like vessel booking, single bill and similar functions
  - » Stronger IT capabilities
- This activity is appropriate only for the "retail" customers, not for intermediaries like forwarders or for carriers
- To some extent, offering such services competes with potential wholesale customers however this channel conflict has been managed well by others in similar positions

Throughout the world, newly privatized rail operations are adding logistics services organizations

- In Europe, railroads are moving aggressively to strengthen their logistics capabilities
  - » The German Rail's various ventures are clear examples
  - » The Dutch and German post office moves into logistics activities are also indications of such interest
- In Mexico, TFM has taken steps to broaden its customer service initiatives in the logistics area
- In Japan, logistics partnerships are increasingly common between various modes
- Finally, in the US, virtually all railroads have established direct retail and logistics-focused links to key customers

KTMB should Create a Logistics Services Organization

- KTMB should take the first steps to expand its services to this key customer community
- It would strengthen its role with the underlying customer community
- It would integrate well into activities of the major shipping companies (including NOL/APL, Maersk/Sealand, NYK and others)
- It provides opportunity to participate in other aspects of the logistics transaction beyond basic rail transportation

Key success factors of this business

- Strong operational excellence across modes
- Good IT systems, providing shipment tracking and tracing at a minimum
- Ability to integrate with other carriers, particularly shipping companies
- Strong, knowledgeable logistics engineering talent

Entry to the logistics business can be gradual

- In the view of the intermodal team, KTMB is not currently in a strong position to stake out a major position in the logistics market
- It would require significant financial commitment
- It would require additional talent in the logistics area
- It would require delicate channel management techniques with this KTMB has little experience
- Gradually broadening the service offerings appears more appropriate

Entry to the logistics business with a partner would mitigate risk and place KTMB in a stronger position

- Joining with a major forwarder or NVOCC with strong IT capabilities and broad geographic coverage would be an advantage
- This would provide KTMB...
  - » Immediate global presence
  - » Strong IT capabilities
  - » Immediate access to key cargo flows
- This is seen as a "step beyond" any integration with MMF and might include such companies as:
  - » DSL
  - » Panalpina
  - » Mark VII/Ocean Group

Initially, KTMB could offer the following services jointly with a partner...

- Door-to-door full load service; alternatively door-to-ship for exporters
- Coordination of shipping services
- Information on status of containers while in transit (including on board vessel)
- Transport services within the Europe and North America

This effort would target the following customer groups....

- Major electronics exporters from Malaysia
- US retail chains
- Toy manufacturers
- Customers requiring multi-country consolidations, particularly in garments
- Major telecommunications companies

Both retail intermodal and logistics services will require trucking capability

- In both the retail and logistics segments, single container trucking service will be required to provide through service
  - » Positioning empties for loads
  - » Drays to and from rail
  - » Dray to piers
- This could be accomplished in several ways...
  - » Jointly with MMF (see organizational recommendations below)
  - » Through partnership(s) with other licensed carriers
  - » By starting an internal trucking operation

Improve IT by purchasing "off the shelf" logistics systems or sharing with partners

- Development of large logistics information systems has not been highly successful
- Large capital commitments and significant programming resources are required
- KTMB should focus initial investment in improving the basic physical service and minimize development costs for IT

III. Organizational Implications for KTMB

Improved intermodal service will require organizational realignment

- The current organization is not structured to bring the necessary focus and discipline to intermodal operations that will be necessary to meet customer requirements
- In both the operating and commercial functions, there is no single executive accountable for intermodal performance
- KTMB should centralize and concentrate the management of this service to ensure proper priority is given its development

KTMB should create an Intermodal Operations Department to focus on the new strategies

- In most successful intermodal operations at other railroads, a separate operating organization is necessary to focus on this high service activity
- KTMB should follow this lead and create a department that includes:
  - » Line haul operations and scheduling
  - » Terminal operations
  - » Equipment management

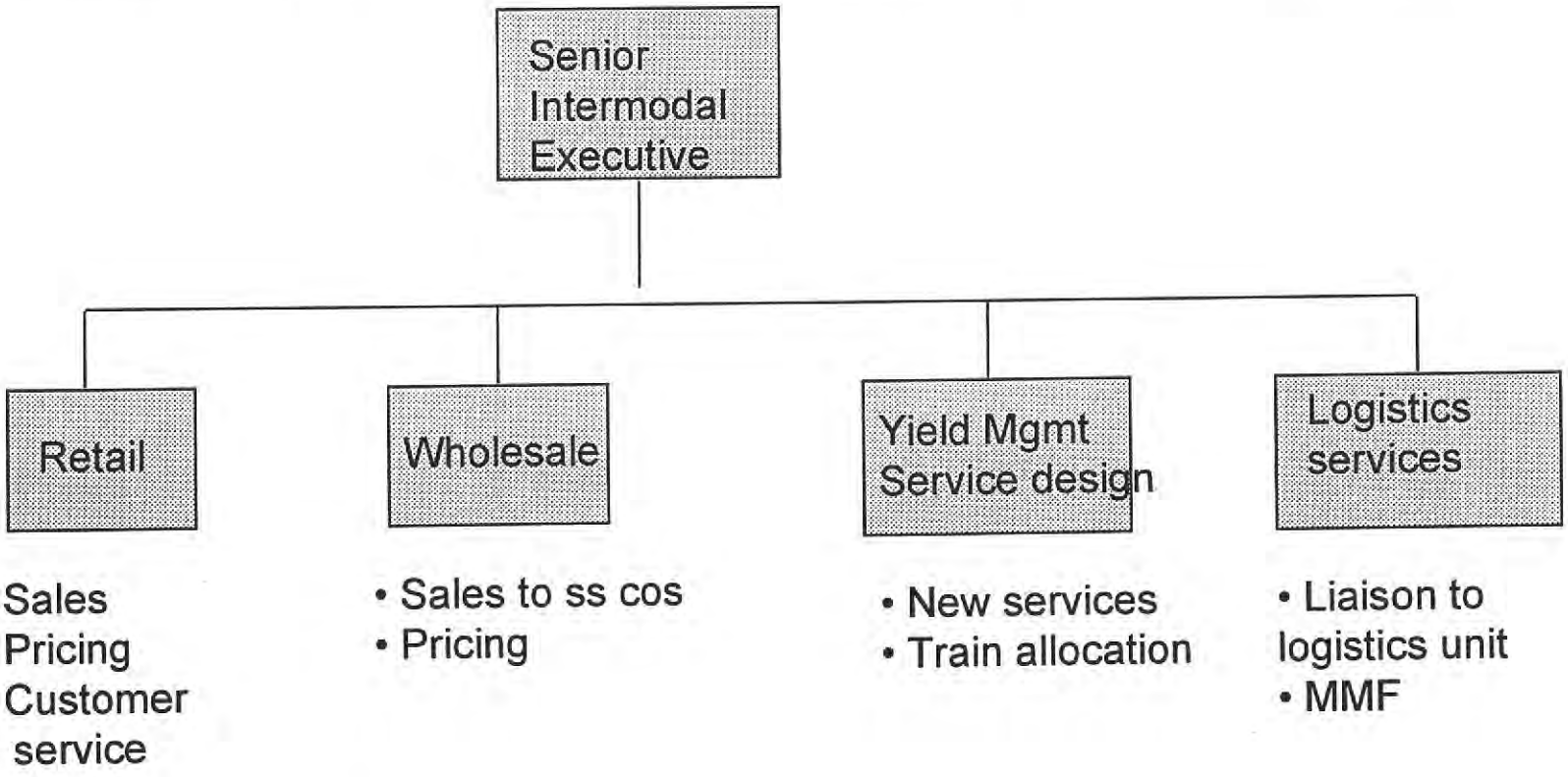
Similarly, the commercial organization should be restructured to create a single intermodal structure

- As in operations, a single executive should have accountability for overall intermodal performance
- His accountabilities should include:
  - » Pricing
  - » Sales/sales management
  - » Service design
  - » Yield management
- Because of the close inter-relationships between all the wholesale and retail segments, this executive should manage both channels

Separate channel management to ensure pricing coordination

- Immediately below the senior intermodal executive, channels (retail and wholesale) should be separated to ensure minimum conflict
- Sales and sales management should also be separated
- See proposed conceptual organization chart on next page

A conceptual commercial intermodal organization



MMF should be moved to KTMB Commercial Operations

- Combining MMF with KTMB's commercial organization would create a powerful multi-modal organization capable of offer a wide range of services
- It could provide the single container truck service so vital to the first two segments of KTMB's
- It could form the foundation for expansion into the logistics business
- It would reduce the perceived conflict in the market between the two organizations

If the focus on logistics services in implemented, a separate function outside of the railroad should be considered

- Logistics companies have found that direct, close affiliation with asset driven companies can create customer difficulties
- Logistics firms are focused on customer solutions, not on use of rail assets
- In similar situations, establishment of a logistics company was most likely to be successful if it was independent

V. Summary

An intermodal strategy focused on both the wholesale and retail segments could stem the erosion of KTMB market share

- As earlier reports indicated, KTMB has lost share of the relevant intermodal market over the last several years
- KTMB has focused primarily (except for the rubber move) on the movement of empties for the wholesale market
- Expansion of focus to the movement of loaded boxes for both beneficial owners (retail) or shipping companies will create significant new opportunity
- Combining with MMF and offering single container through service also creates significant opportunity

Specific lanes and inland terminals should be emphasized

- Klang/Penang is essential
- Klang/Jahor Bahu
- Focus on Butterworth and Westport
- Specific terminals at Ipoh, Segamat and Nila

Key operating commitments will be required

- 80-85% service reliability
- Within 12-24 hours of truck depending upon specific lane
- Expansion of services at terminals

Some organizational realignment will be beneficial

- Centralize intermodal operations
- Create a senior intermodal executive within the Commercial organization
- Bring MMF into the railroad

IT and customer service activities require significant strengthening

- Customers insist on some improvements in this area
- Both can be done by purchasing systems or "outsourcing" activity as opposed to internal development
- This can be done independently of other steps and can be expanded beyond intermodal services

While logistics services may add value to the corporation, it should be separate from the rail organization

- This appears an independent business opportunity for KTMB
- This should be done outside the railroad organization but can still report to the CEO of the railroad