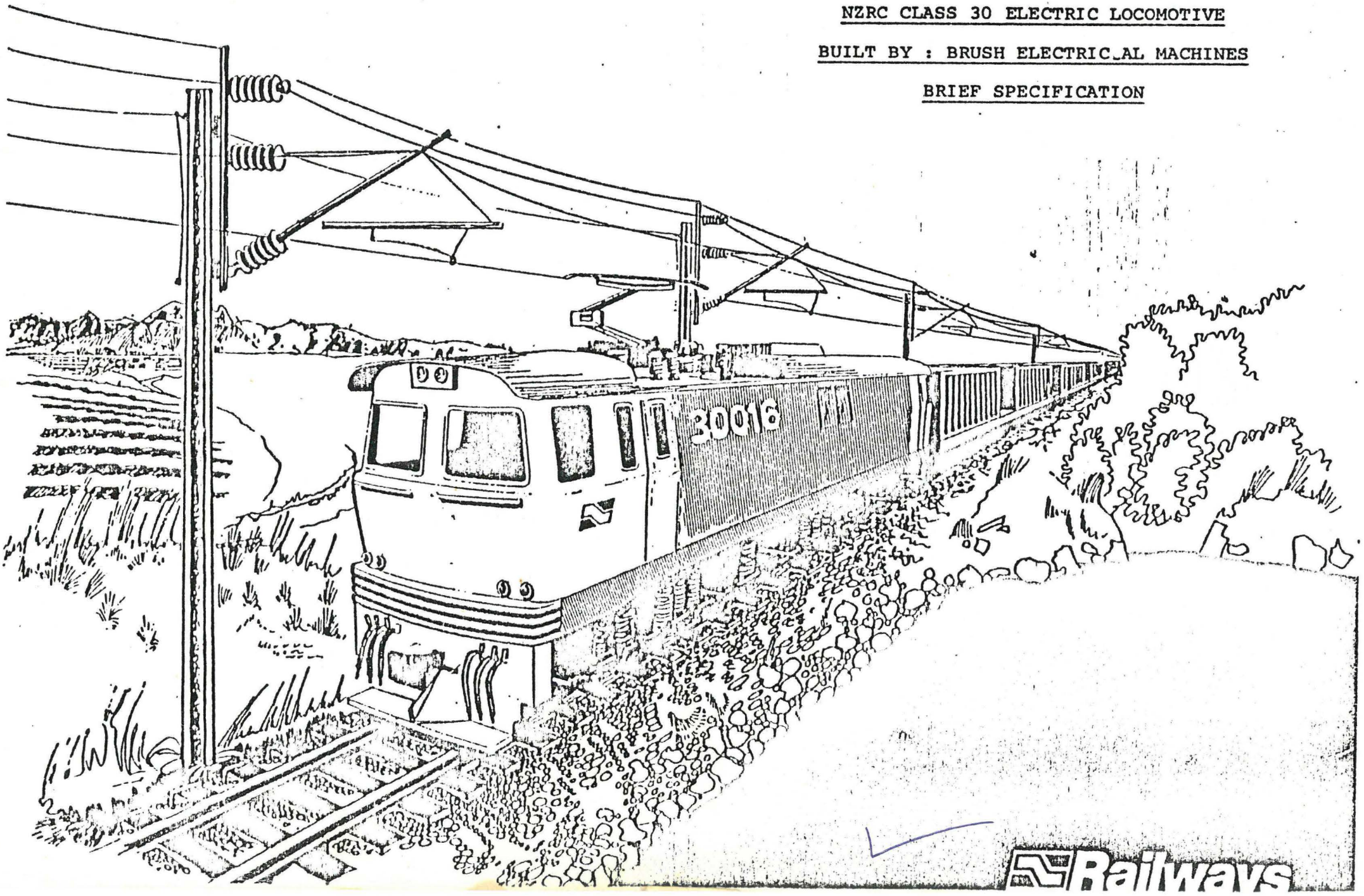
T.E. Moffat

NZRC CLASS 30 ELECTRIC LOCOMOTIVE

BUILT BY : BRUSH ELECTRICAL MACHINES

BRIEF SPECIFICATION



NIMT ELECTRIFICATION AND THE CLASS 30 ELECTRIC LOCOMOTIVE

INTRODUCTION - Brief Specification of Class 30 Loco.

Section 1 : Power Supply

Section 2 : Distribution within loco

Section 3 : Preparing loco for service

Section 4 : Regeneration

Section 5 : Neutral section

Section 6 : Fault finding

Section 7 : Drivers cab

Section 8 : Details of layout

NZRC CLASS 30 ELECTRIC LOCOMOTIVE

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BRIEF SPECIFICATION

1. Loading Gauge:

Overall height	3950 mm max (Pantograph housed)
Overall length	20000 mm max
Overall width	2720 mm
Max bounce	50 mm

2. Track Gauge 1067 mm : Axle load 18 tons max

3. Axles : 6 motored, 2 in 3 separate bogies BO-BO-BO.

4. Designed to work on nominal 25 kV, 50 Hz, single phase AC.

   Voltage variation range 28.5 kV to 19 kV

   Short time minimum 17.5 kV

   Converter will actual work at 12.5 kV but auxiliary supply cannot be controlled within voltage limits below 17.5 kV.

5. Body built to withstand static compressive load of 2,000 kN or 200 tons, at central drawgear.

   Front end built to withstand 400 kN (40) tons at front window level and 300 kN (30) tons at cant rail simultaneously.

6. Fabricated steel bogie frames - 2 wheel sets - wheel diameter 1100 mm, bogie centres : 5860 mm new spaced 2500 mm centres.

   Primary suspension - steel helical + rubber rolling spring
   Secondary suspension - steel helical (Flexicoil) + laminated rubber in series assisted by vertical and inclined hydraulic dampers.

   The secondary suspension consists of flexicoil springs which support a light bolster. The body is supported on this bolster by laminated rubber springs.

   On the outer bogies, the bolster is located in the body by means of a body mounted pin located in a bushed hole in the centre of the bolster.

   The centre bogie bolster has no central restraint but is restrained laterally by spring deflection damped by shock absorbers.

The outer bogie is relatively stiff laterally to control body yaw and keep the vehicle in gauge.

The inner bogie is relatively soft laterally and allows large lateral displacement for curve negotiation.

(a) Traction and braking forces are transmitted between bogie and body by simple low level traction rods connecting body headstock or similar level intermediate anchorages and the traction motor frames.

The inclined links intersect just above rail level at mid point of bogie and result in minimum weight transfer.

(b) The bogie and wheel set arrangement is designed to keep lateral rail loading, track shifting forces, wheel climb derailment and flange wear to a minimum.

7. Brake system comprises:-

(a) Electric regenerative brake system - a speed holding brake.

(b) Pneumatic mechanical brake applied by individual units on each wheel.

Control system for engine and train brake is supplied by Davis & Metcalfe - who also supplied wheel slip/slide equipment.

Davis & Metcalfe brake has all the features of the WHB 26L system. One air compressor - 3500 litres/min FAD at 1475 rpm. Unloaded to stop/start, runs on demand, provides main reservoir air. A battery powered air compressor provides air for emergency starting.

8. The main transformer is energised from the 25 kV line via one pantograph, vacuum circuit breaker, roof bushing and high tension cable terminating in a plug-in connector on the transformer. A lighting arrestor protects the transformer primary.

The primary circuit is completed via earth return brushes to the wheels and running rails.

If this circuit is interrupted - the loco will not move.

The main transformer has four secondary windings which supply via disconnection switches, four thyristor bridges.

The propulsion power supply comprises two sets of bridge circuits and three traction motors. Each individual bridge circuit consists of two bridges are connected in series feed three (3) parallel connected traction motor armature circuits. The traction motor field circuits are supplied from a separate winding on the motor alternator rotor and individual - reversible - Bi Phase thyristor bridges - The latter eliminate the conventional reversing switch.

The 6 motors are compensated for weight transfer both mechanically (traction rods) and electrically (excitation of 3 motors in module).

An auxiliary winding on the main transformer supplies power for the motor alternator set which is the power source for the 3-phase 400 volt motor driving the air compressor, three cooling fans (2 speed motors) and two oil pumps. The single phase heating and lighting supply and battery chargers for the 110 volt control circuit are supplied from a separate winding on the same alternator armature.

9. The interior noise is controlled to 75 dBa and external noise emission to 90 dBa.

The ride index is specified to 3.0 vertical and laterally at all speeds. The performance is to start and accelerate a 1200 ton train on a 1 in 60 grade up to 42 km/h at about 0.1 km/h/sec and to haul 1000 tons at 90 km/h on level tangent track. The Electric brake must hold 1200 tons at 40 km/h on a 1 in 50 down grade.

SPECIAL FEATURES included in the design are:-

(1) Two speed transformer and converter radiator cooling air fans - to keep noise to a minimum in stations.

(2) Flashing warning lights activated by air whistle to improve visability at level crossings.

(3) Interior insulation to keep interior heat level from sun - to a minimum.

(4) Pressurised compartments to keep dust problem to a minimum.

(5) Start up panel inside equipment compartment to No.1 end to control all start up features.

(6) One side door for cab, one side door for equipment cabs at each end to reduce draughts to a minimum.

(7) (a) Drop windows in side walls - 6 mm glass.

(b) Laminated 13 mm - triple glass - heated windows for front windscreen, High impact - "TRIPLEX" Autisun - green.

(8) Controls for single man driving all on one desk - Power/brake controls left, brakes right hand.

Second man - desk fitted with sink and cooking unit and correspondence box.

Features included on both desks include:-

Radio communication to train control UHF. Controlled heating and ventilation in cab. Lunch box cooler in No.1 cab only. Emergency shutdown to drop pan, open VCB, apply brake in emergency, heating and lighting control switches and fundamental driving indications.

Both positions fitted with seats with hydraulic bases.

(9) Regenerative electric brake.

(v0) Individual SABNIFF integral air brake units, with slack adjuster on outer bogies; 2 units per wheel or 8 per bogie. Centre bogie has a new unit with integral slack adjuster and parking brake. Release from cab or brake panel when main air reservoir pressure obtained - otherwise manual release when there is no air pressure.

(11) Automatic control for ramping off thyristor phase control circuits in power/brake at neutral sections. Induction magnets on trackside ramp off and restore power either side of neutral section without driver involvement.

(12) Provision for Automatic train protection if installed by signal group.

(13) Electronic vigilance associated with overspeed protection to limit top speed of loco to 85/105 km/h.

(14) Event recorder to continuously record speed, air brake operation, vigilance acknowledgement, power/brake movement.

(15) Annunciator panel to record 42 possible fault conditions in transformer, convertor, traction motors, protection devices. Flagged relays to stay indicating until fault corrected.

(16) Diagnostic equipment to put all control equipment for power factor correction, power/brake circuits, auxiliary firing circuits for MA set, through operating cycle and to isolate faulty conditions.

(17) Unique bogie design with minimum bogie components to give minimum flange forces and flange wear
Weight transfer - while exerting TRACTIVE EFFORT of 300 KN - If axles 3 and 4 have axle load 176 kN Axles 1 and 2 - have 166 kN and 5 and 6 have 186R
i.e. ± 1 ton at 2204 lbs force.

The electrical control system preserves overall constant power by electrical compensation of current to individual motors in the bogie, thus providing good mechanical adhesion.

At starting - on average rail conditions > 30%
At continuous rating > 25%

NZR can set load schedules on an all weather adhesion value of 25%.

(18) Locomotives can be operated in MU - using PWM system to pass operating commands.

(19) (a) Power factor correction in power is automatically applied to maintain PF above .90.

(b) The equivalent disturbing current (JP) from the AC power equipment when weighted according to CCITT is designed not to exceed 12 amps.

Maximum harmonic currents relative to the fundamental will not exceed allowable values.

(c) The in rush current (to be limited to about 100 amps) after circuit breakers closed) shall deminish to 35% of its peak after 0.5 secs and to 17% after 1 sec.

(d) The overall loco running efficiency shall be > 80%.

(e) Primary current should be 150 amps maximum at 42 kph.

(f) The equipment can be operated on one converter module of 3 motors and halfbridge if required under emergency conditions.

(20) Line current with 25 kV At the pantograph

At starting : 40 amps maximum 36 amps minimum
At 42 km/h : 150 amps maximum 144 amp minimum
At 100 km/h : 100 amp maximum 90 amp minimum

SS

SUMMARY

Ratings

Primary Voltage	25,000V 50 Hz
Locomotive continuous rating at rails	3,000 kW
Maximum continuous tractive effort	256 kN
Locomotive speed at continuous rating	42 km/h
Gear ratio, wheel diameter (new)	17.74 1100mm
Maximum tractive effort at starting	300 kN
Maximum locomotive speed	105 km/h

Weights

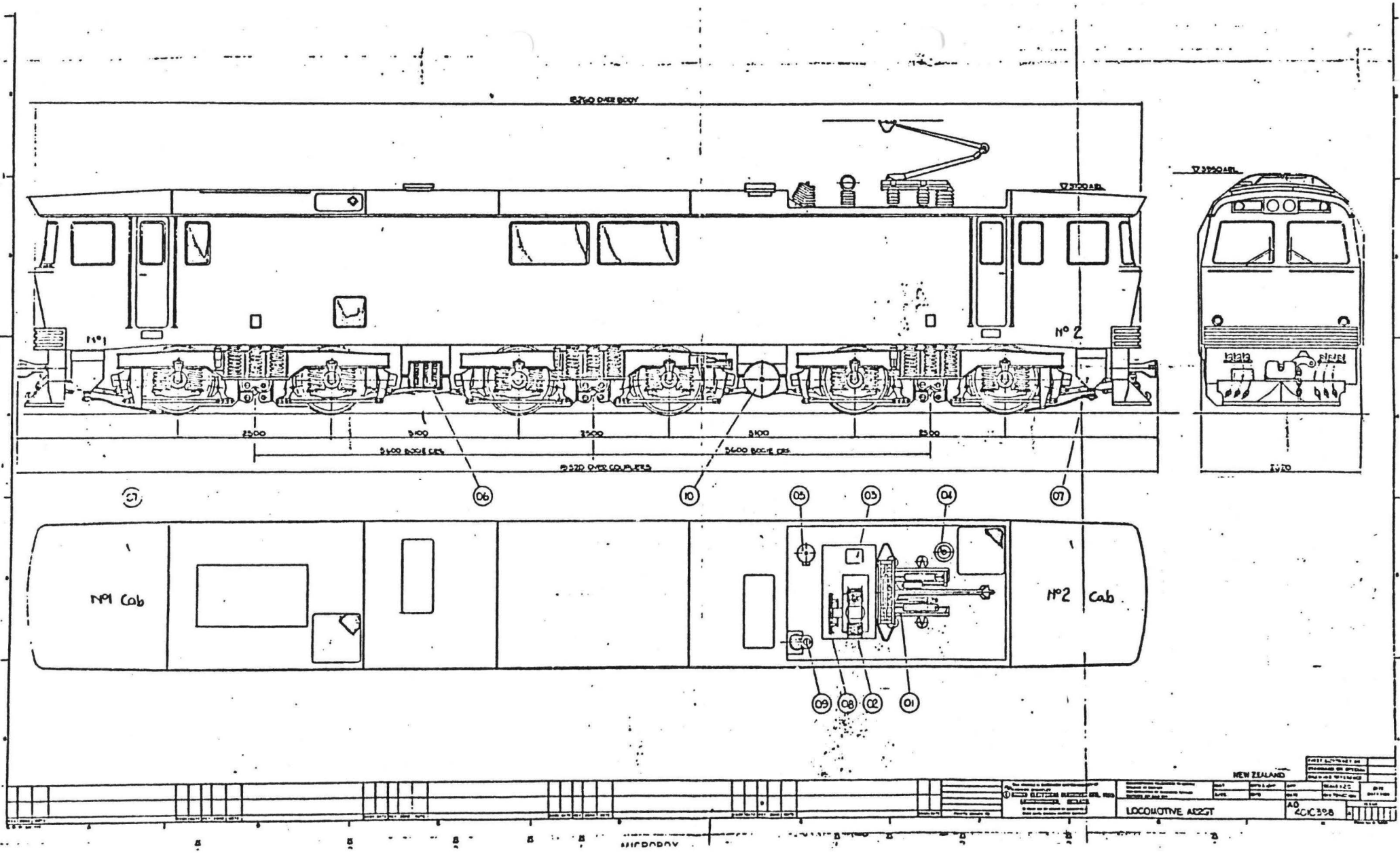
Total locomotive (fully loaded)	108,000 kg
Per driving axle (fully loaded)	18,000 kg
Wheel arrangement	BO-BO-BO

Dimensions

Length - over couplers	19,610 mm
Height over housed pantograph	3,950 mm
Maximum width over body	2,700 mm
Minimum radius of curvature	90m

Major Equipment

Traction Motors	Six Type TM 2191-A
Control - Dual station, microprocessor logic system	
Transformer	Oil filled, air cooled
Rectifiers	Oil filled, air cooled
Traction motor blowers (2) - two speed -	A.C. motor driven
Transformer and rectifier blower (1) (two speed)	A.C. motor driven
Compressor (1) 3 cylinder piston type	A.C. motor driven
Motor alternator : DC motor drive, two winding stator	A.C. output
Battery : Tungstone Ni Cad system 110 volt	
Pantograph : Single air raised, spring lowered	
Air brake equipment : Davis & Metcalfe analogue direct release	Type P85.


No 1
No 2
No1 Cab
No2 Cab
NEW ZEALAND
LOCOMOTIVE ASSY
AD 40C398

SECTION 1 : POWER SUPPLY

The NIMT Electrificaton scheme has been designed to operate from industrial frequency and A.C. power supplies i.e. 25KV at 50 HZ - single phase.

Single Phase - means that supply volts are taken from the national grid between one of the three phases and the neutral point of the supply transformer

There are three distinct systems available for use with industrial frequency AC electrification.

1. Direct Supply - the simplest system - comprising a transformer connected between the overhead contact wire and the rails.

   Its main weakness is that the rails are a poor conductor of alternating current, since they sit on the road bed and are not connected by cable to a driven earth.

   The return current flows back to the supply by the general mass of earth - after leaking from the rails to earth - and this ground current can cause interference with telecommunications or other cables buried in the ground and parallel to the rail.

2. Booster Transformer System

   This system uses a return wire to carry the return current and is fitted with booster transformers to compensate for the resistance of the return wire.

   Transformers are spaced at 3KM and the system provides good interference protection with other buried cables.

   The transformers increase the voltage drop in the supply wire so more power supply points are required than with the AT system.

   There is a gap in the contact wire at every transformer which can cause sparking as the pantograph passes.

3. Auto Transformer System

   There are four major advantages of this system over both the others described:-

   (a) It permits 50KV transmission with 25KV insulation.

   (b) Power supply points can be spaced up to 185 km and transformer spacing can be up to 15 kms.

   (c) The contact wire is continuous between neutral sections, therefore there is less sparking at pantographs.

   (d) It permits the use of regeneration.

The AT system is used where very high powered locomotive are required and/or where power supply points are widely spaced.

The 3MW loco is a moderately high powered loco - and the power supply points used on NIMT are very widely spaced by world standards and because the AT system provides the same protection to parallel communication cables as the BT system it has been selected for the NIMT.

Line voltage drop conditions under load are a major factor in selecting a suitable system.

Those of you who have driven at Otira will remember the great voltage drop between Otira Sub-station at the West Tunnel portal and the east portal - in 5 miles of tunnel.

If the BT system is used - a loco drawing 180 amps at 10km from a sub-station would produce 180 x 10 x 0.8 = 1440 volts drop in the catenary supply system.

i.e. volts at the loco = 25.000 - 1440 = 23,560V

If the AT system is used - the volt drop under the same condition is = 25,000 - 360 = 24,640V

or we are 1080 volts better off.

The system that NZR has adopted and that you can see at Bunnythorpe will now be described.

1. In the NZE Sub-station there is a 220KV to 55KV transformer taking volts from one phase of the national grid.

2. The NZR substation has pole top mounted equipment and ground level equipment supplying the auto transformers at 55 kV.

3. The auto transformer output terminals are connected to two of the four pole top mounted wires:

   (a) Auto transformer feeder wire.

   (b) Catenary wire and contact wire and the maximum voltage between the wires is 55 kV.

   third output terminal on the auto transformer is connected to the centre of an impedance bond which is solidly strapped between the two running rails. Impedance bonds are spaced at 7.5 kms or midway between the auto transformers.

   The maximum voltage between the contact wire and the running rail is then 55:2 = 27.5 kV.

4. The catenary wire is solidly connected to the contact wire by droppers.

When a locomotive connects the contact wire and rail by its pantograph and wheels a circuit is formed through the locomotive transformer.

As power is taken to overcome the resistance of a stationary train - the voltage at the substation falls from 27.5 to 25 kV - and the greater the distance is from the substation, when it begins to take load - the greater the volts drop. If the loco is 10 km distant from the substation the volts at the pantograph are reduced to 24.5 kV which effects performance i.e. it slows down the rate of acceleration.

5. The electrical path at the auto-transformer is thus :-

(a) from the catenary to the contact wire,
(b) from pantograph to transformer to wheels and rails,
(c) from rails to impedance bond to protection wire,
(d) from protection wire to the centre point of the auto-transformer.

6. You will have noticed that all concrete poles are tapered to the top and have an auxiliary steel mast bolted through insulators to the pole. The mounting bolts are joined together by wire which is in turn - connected to a traction earth wire. This wire, connects all the earth wires of signals, station buildings etc.

The auxiliary mast carries 4 separate wires, also separated from the mast by insulators - these are from top to bottom:-

(a) Protection wire - PW.

(b) Auto-transformer feeder or supply wire - AF.

(c) Catenary wire suspended from a swivel mast (which has additional insulators) - CAT.

(d) Contact wire - supported by another mast-pin jointed from the catenary support - CW.

Therefore, because the auxiliary mast is insulated from the concrete pole and all wires are insulated from the auxiliary mast - the assembly is said to be double insulated.

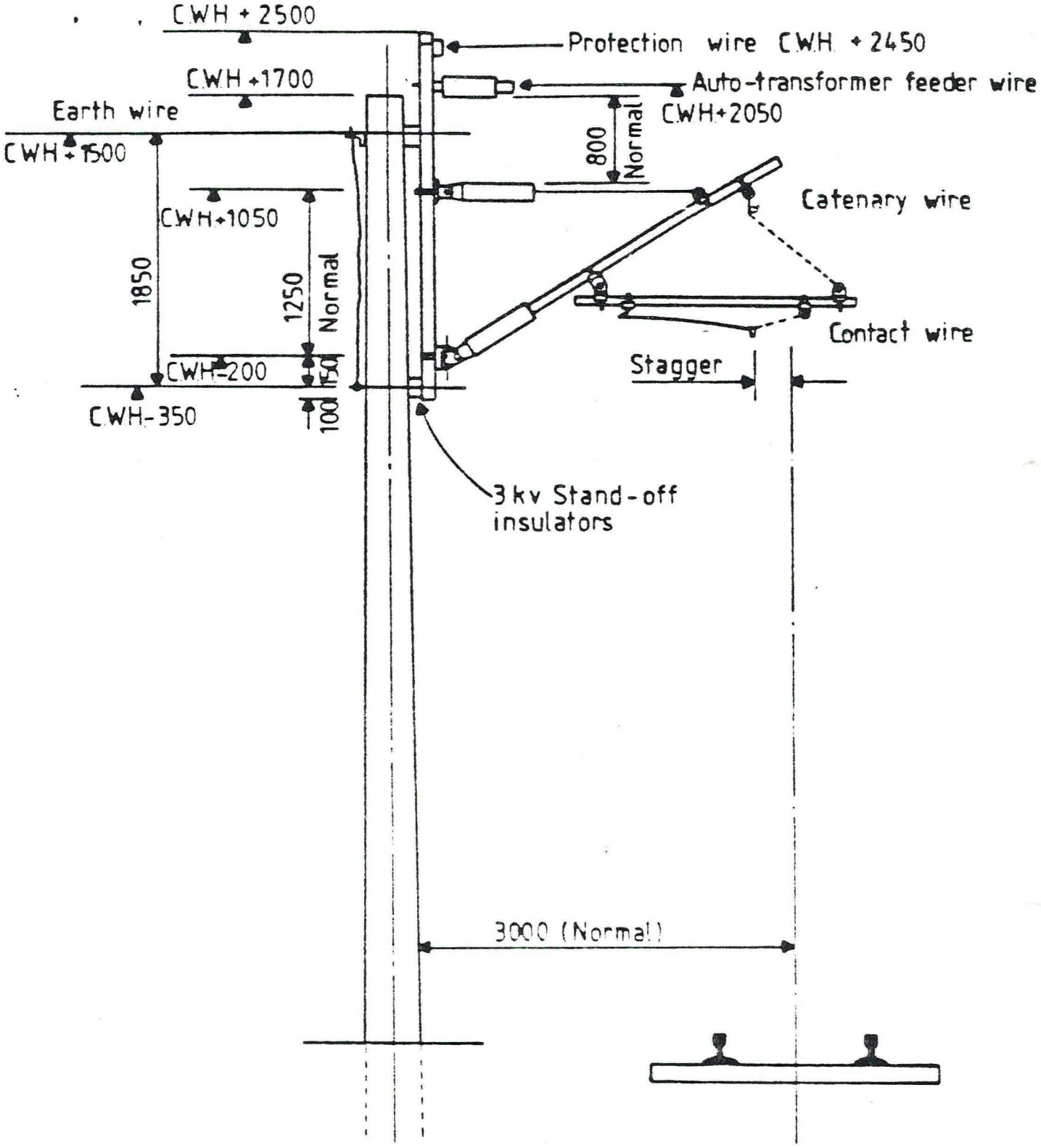
7. Coupled between traction earth wire TEW and the protection wire PW are pots that you have noticed on poles and are spaced 1 km between pin jointed insulators in the Traction Earth Wire.

The pots or spark gaps provide a path for fault currents from the earth wire to the protection wire back to the auto transformer centre tap connection. These protect the system in event of a flashover between the contact wire and a signal mast or any other earthed equipment - It provides reverse flashover protection. and the flash over value is 2500 - 3000 volts.

8. A major fault in the locomotive transformer, that could cause a direct short between the contact wire and earth bar of the locomotive raises the voltage at the impedance bond which is directly connected to the protection wire - and provides the direct connection to the substation protection equipment.

   The protection wire is designed to carry the large currents that may flow in event of a major short circuit in the feeder supply.

9. It must be emphasised - that while a major short circuit may raise the voltage in the rails to a remote earth, there is no danger to a driver standing on the ground and holding both loco entrance door hand rails - He becomes part of the earth path and under wet or dry ground conditions the probability of a fatality is calculated as 5 million to one.



Maximum stagger - Tangent track - 200 mm
Maximum stagger - Curved track - 250 mm
All staggers to be set to minimise mid-span offset

Contact Wire Height (CWH)

Minimum = 4210 mm
Normal = 5250 mm
Maximum = 6100 mm

FIG 3

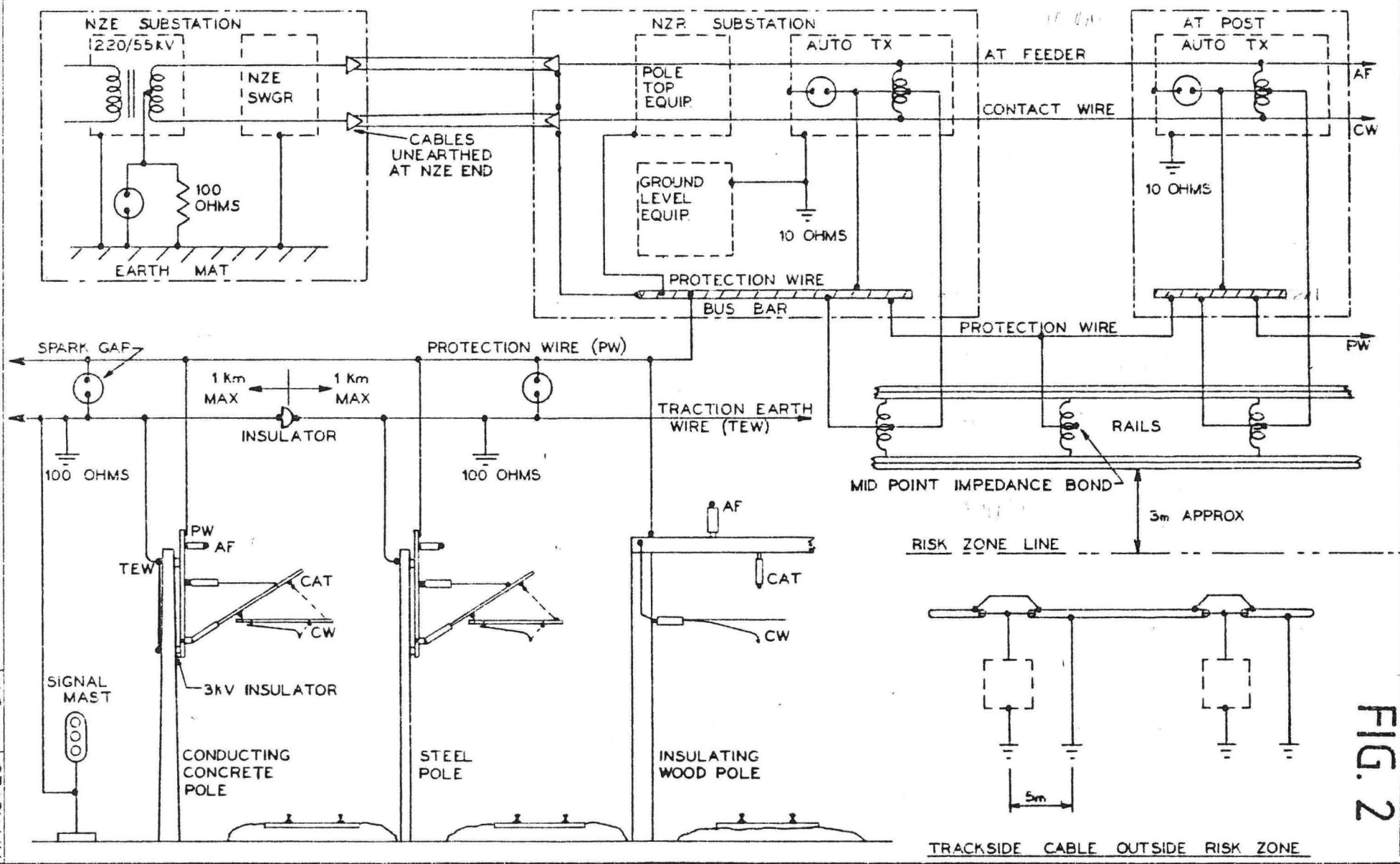


FIG. 2

ISSUE No.		
1	19-10-84	TRACING REDRAWN
2	22.11.84	APPROVED

SCALE		ALL QUERIES TO BE REFERRED TO DRAWING OFFICE
TOLERANCES		ALL ITEMS SHALL COMPLY WITH THE REQUIREMENTS OF BS 68B UNLESS OTHERWISE STATED
FINISH		REMOVE ALL BURRS & SHARP EDGES
MATERIAL		SUBMISSION OF PROTOTYPE FOR APPROVAL & INSPECTION OF EACH PRODUCTION UNIT IS REQUIRED FOR EACH ORDER
SPECIFICATION		

NIMT ELECTRIFICATION

TYPICAL BASIC BONDING SYSTEM

NZR WAYS & WORKS BRANCH, SIGNALS & COMMUNICATIONS

DRAWN	RKG	DATE	20-11-84	APPROVED
DESIGNED	GB	FILE	25772/29	
CHECKED	~~CHE~~	SUPERSEDES		
PASSED				
SIZE A.3	S. 25170			

NZR 3

SECTION 2 : POWER DISTRIBUTION WITHIN THE LOCOMOTIVE

We can now examine the circuit of the locomotive.

With the locomotive standing under contract wire energised at 25KV and the pantograph raised and in contact with the wire:-

1. The primary path is from the pantograph
   to the vacuum circuit breaker - by bus bar
   to the high tension bushing - by cable
   to the main transformer - by cable
   to the locomotive earth bar - by cable
   to the wheels, rails - by impedance bond
   to the protection wire - by cable to the auto transformers centre point connection.

2. The secondary path is from the output terminals of the main transformer secondary windings. There are 4 secondary windings and 4 fully controlled converters providing variable voltage to two-traction motor circuits - each of which has 3 armatures in parallel across the converter output terminals.

   The transformer circuit is via a disconnection switch (to isolate one transformer leg from the converter under fault conditions) to a converter bridge circuit of four thyristors which changes the AC to DC. There are two bridge circuits connected in series which combine to provide variable DC voltage for the traction motors i.e. from 0 to 950 volts - this provides the locomotive speed control.

   The output of the converter is supplied through a high speed breaker (to protect the motor armatures in electric brake) to the positive bus bar of the traction motor armatures.

   Each armature is supplied via a smoothing coil and a motor contactor.

   A power/brake switch connects a roof mounted braking resistor in parallel with the motor armature.

   The negative bus bar of each motor is connected to the return connection of the converter bridge circuit.

   An earth fault relay connects the negative bus bar to the locomotive earth bar.

   A power factor correction circuit, which is switched by a thyrister device and surge suppression equipment to protect the transformer secondary and the converter, is connected across the secondary transformer output terminals.

3. The tertiary (third) circuit is supplied from an auxiliary winding on the main transformer.

The output terminals of the auxiliary transformer are connected to a semi-controlled converter bridge which converts constant voltage AC to variable voltage DC to drive the motor of the motor alternator set.

A second connection on the same transformer is connected to a transformer unit supplying the battery charger and battery.

The alternator of the MA set is controlled from a rotating exciter on the same shaft as the alternator and the rotor supplies two separate circuits - a 3/1 circuit and a 6 circuit.

1 (a) The three phase 400 volt circuit provides power for

i transformer and converter oil pump motors
ii transformer blower
iii air compressor
iv traction motor blowers

the single phase 230 volt circuit provides power for the

i cab heaters and foot warmers
ii hot plate, kettle and refrigerator
iii headlights and warning lights
iv battery charger for radio battery and radio unit

2. (b) The six phase output, provides power for the bi-phase power converters which supply each of the six, motor armature field circuits through a field contactor.

It must be noted that the bi-phase power converter is controlled through the electronics to give forward or reverse direction of locomotive running

so that there is no conventional reversing switch provided in the motor field circuit.

An earth fault relay connected to the locomotive earth car is protection - together with converter field fuses - for this secondary circuit.

3. The battery output terminals provides a steady 110 D.C. volt supply for:-

(a) auxiliary air compressor
(b) electronic control and microprocessor control circuits
(c) cab lights, instrument lights
(d) compartment lights
(e) tail lights, coupler lights and step lights
(f) event recorder and vigilance unit
(g) annunciator panel

AD 2042162

REF	DESCRIPTION
AOR	AUXILIARY OVERLOAD RELAY
APRT	ARMATURE PHASE-REF VOLTAGE TRANSFORMER
APRF	ARMATURE PHASE-REFERENCE FUSE
BD	BLOCKING DIODE
BRE	BRAKING RESISTOR
DL	DI/DT REACTOR
DRE	DISCHARGE RESISTOR
DS	DISCONNECTION SWITCH

EAS	E
EPB	E
ELO	E
EBQ	E
FC	F
FCP	F
FEPR	F
FR	F
FOR	F
FPBF	F

25 kV 50Hz

VT

TO CONTROL CIRCUITS

EAS

VCB

LA

HT BUSBAR

TO CONTROL CIRCUITS

A2

a8

DS1

HSF APRT1 SSP SSF

HSCP

APRT1

SSC SSC

PFS

PFL

PFCP

HSF

POR

ELR

a7

SDR1

TO CONTROL CIRCUITS

TO CONTROL CIRCUITS

a4

HSF SSF SSF

HSCP

SSC SSC

PFS

PFL

HCP

HCF

a3

TO CONTROL CIRCUITS

HCP HCP TH HRE HRE TH

HRE HRE TH HCP HCP

DRE

GROUP 1

EFR1

AOR

a10

HSF ESP SSF

HSCP

SSC SSC

HSCP

HSF

TO MOTOR ALTERNATOR SET SEE DRG No AD2042163

a9

TO CONTROL CIRCUITS

FIELD CONVERTER FED FROM 6 PHASE WINDING ON ALTERNATOR SEE DRG No AD2042162

FPBT1 FPBT2

a6

DS2

HSF APRT2 SSF SSF

HSCP

APRT2

SSC SSC

PFS

PFL

PFCP

HSF

a5

SDR2

TO CONTROL CIRCUITS

TO CONTROL CIRCUITS

a2

HSF SSF SSF

HSCP

SSC SSC

PFS

PFL

PFCP

HSF

a1

TO CONTROL CIRCUITS

HCP HCP TH HRE HRE TH

HRE HRE TH HCP HCP

DRE

GROUP 2

EFR2

EPB

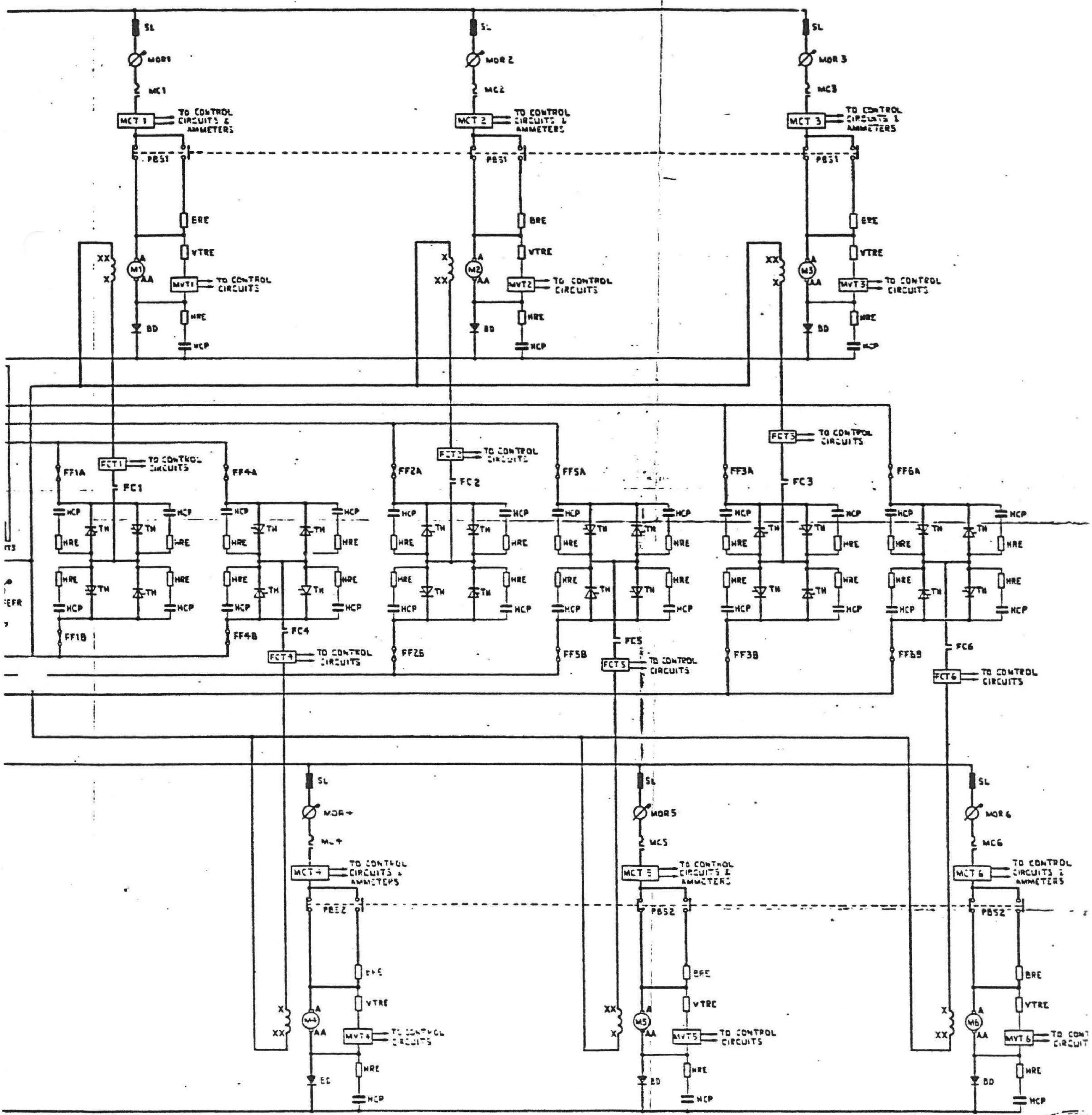
1 2 3 4 5 6

NOTES:
1 PFCP's ARE FITTED WITH INTERNAL DISCHARGE RESISTORS

ASSOCIATED DRAWING AD

QTY	REF	PART No	DESCRIPTION	MAT'L	SPEC	CODE No	MAT'L SIZE

THING SWITCH	FPRT	FIELD PHASE-REF VOLTAGE TRANSFORMER	MCT	MOTOR CURRENT TRANSDUCER	SOR	SECONDARY OVERLOAD RELAY
TH FAULT RELAY			MOR	MOTOR OVERLOAD RELAY	SL	SMOOTHING REACTOR
TH LEAKAGE CURRENT RELAY	HCP	HOLE STORAGE CAPACITOR	MVT	MOTOR VOLTAGE TRANSDUCER	SSCP	SURGE SUPPRESSION CAPACITOR
TH RETURN BRUSH	HRE	HOLE STORAGE RESISTOR			SSF	SURGE SUPPRESSION FUSE
	HSCB	HIGH SPEED CIRCUIT BREAKER	P	PANTOGRAPH	SSRE	SURGE-SUPPRESSION RESISTOR
.D CONTACTOR	HSCP	HIGH FREQ SURGE SUPPRESSION CAPACITOR	PBS	POWER-BRAKE SWITCH		
.D CURRENT TRANSDUCER	HSF	HIGH FREQ SURGE SUPPRESSION FUSE	PFCP	POWER FACTOR CORRECTION CAPACITOR	TH	THYRISTOR
.D EARTH FAULT RELAY			PFL	POWER FACTOR CORRECTION REACTOR	V	VOLTMETER
.D FUSE	LA	LIGHTNING ARRESTOR	PFS	POWER FACTOR CORRECTION SWITCH	VCB	VACUUM CIRCUIT BREAKER
.D OVERLOAD RELAY	M	TRACTION MOTOR	POR	PRIMARY OVERLOAD RELAY	VT	VOLTAGE TRANSFORMER
.D PHASE-REFERENCE FUSE	MC	MOTOR CONTACTOR	SSC	SURGE SUPPRESSION UNIT	VTRE	VOLTAGE TRANSDUCER RESISTOR



42163 AUXILIARIES CIRCUIT DIAGRAM
42164 CONTROL CIRCUIT DIAGRAM
42162

RECEIVED
21 ... 85

NAME	DATE	REV	ZONE		NAME	DATE	CIRCULATION
		C		DRG. GENERALLY REVISED	AD		
		B					

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NZRC LOCOMOTIVE
POWER CIRCUIT DIAGRAM

AD 2042162

CCT DIAG

SECTION 3 : PREPARING LOCO FOR SERVICE

NOTE: These notes are tentative and will be confirmed by the special handbook. We now consider the procedure to start-up a loco stabled in a storage road, wired for 25KV, where the locomotive pantograph is down and the handbrake is applied.

1. Inspect at ground level that:-

   (a) Earth connection cables between body and bogie are coupled.

   (b) Drawgear complete, transition coupling and hook in place.

   (c) All individual brake blocks in place and all three bogie air supply cocks cut-in.

   (d) All four sand boxes full

   (e) External power supply changed over from shed to loco.

   (f) Traction rods coupling bolts in place at motors and headstock anchor plates.

   (g) That pantograph (No.2) end is facing south

   (h) M.U. cable connected if two locos are to be M.U. operated.

2. Unlock and enter No.1 end cab door.

3. Enter cab, open door to equipment compartment, and face start-up panel

   (a) Turn on all circuit breakers on the top two rows.

   (b) Close battery rotary switch - check that battery voltmeter reads 110 volts.

   (c) With all compartment lights on walk through equipment compartment and check that main cubicle, motor alternator cubicle, field contactor cubicle and power factor connection cubicle doors are locked.

   (d) Check that earth switch is open and that the padlock is in place.

   (e) Check that the supplementary reservoir air supply to pantograph isolating valve is open and check the pressure gauge reading of the air reservoir. If pressure is less than 650 kPa, check that auxiliary air compressor is running. It cuts in automatically (when battery switch is closed) if pressure is less than 650 kPa.

   (f) Check oil level in the main air compressor and open/close the main reservoir moisture drain valve.

(g) Enter the No.2 end cab and fit the reverser key and independant and auto brake valve levers to their respective controller - (if driving from that cab - if not - return them to No.1).

(h) If there are two locos to be MU operated - unlock the No.2 cab door and enter the second loco by No.1 cab and repeat the start-up procedure.

Check that the "equipment defect annunciator" panel in the second loco is clear of defects - then return to the first locomotive.

4. Return to the No.1 driving cab of the "command" loco

(a) Check that the equipment defect annunciator panel is clear of defects.

(b) Check that the battery isolating switch is closed to supply 110 volts to control circuits.

(c) Check that the parking brake indicator panel light is "on".

(d) Check annunciator panel that the event recorder and vigilance lights are "on".

(e) Check master controller power and brake handles are OFF and that the reverser is in neutral.

(f) Cneck that both air brake handles are in release.

(g) Check that dry powder fire extinguishers are present.

(h) Check defect book for "open" defects.

5. At the start-up panel

(a) Press "pantograph up" button and check that pantograph rises smartly and stays in contact with the overhead contact wire.

(b) Press "Vacuum circuit breaker" close button and check that level of volts is in the green sector i.e. 19-28.5KV.

Note: The electronic circuits are operative when the battery switch is closed and will automatically begin to check out that the system can be safely set up for driving and will close an automatic power control relay whose 7 auxiliary contacts connect the converter circuit to the traction motor circuit.

The "disconnect switch" on the start-up panel must be closed to connect all four transformer secondary circuits to the converters.

(c) If the vacuum circuit breaker (VC B) does not close-one auxiliary contacts will be open in the transformer protection circuit and it should appear as an alarm on the annunciator panel.

(d) If the VC B has closed, the battery will be on float charge and the control circuit voltage 110 volts.

The electronics will give a signal to the "POWER PERMIT" relay and the MOTOR ALTERNATOR CONTACTOR will close.

The motor of the MA Set should run up to speed.

(e) At full speed, 1500 rpm, the electroncis then send a signal to a LOAD PERMIT relay which should close.

(f) The alternator load contact then closes automatically and connects the 3 phase and single phase loads to the alternator - the "Power Accept" lamp on desk flicks on.

(g) The converter oil pumps and the transformer oil pump starts immediately.

The circuit to the transformer blower motor and main air compressor is then energised in the following sequence of events:-

The main blower motor runs up to half speed.

2 secs later - the No.1 traction motor blower contactor is closed and the motor runs to half speed.

5 seconds later - the No.2 traction motor blower contactor is closed and the motor runs up to half speed.

12 seconds later - the main air compressor motor contactor is closed. An auxiliary contactor closes and energises the automatic drain magnet valve and the compressor unit delay relay.

This action allows the air compressor to run up to full speed and the compressor pumps to atmosphere briefly before the delay relay de-energise and the compressor pumps to the main reservoir.

When full MR pressure (975kPa) is reached (3 mins) from empty to full - the unload magnet valve operates and the motor is shut down.

Note: The timing delays allows the main alternator load to be gradually applied and the A.V.R. to compensate by field and phase angle control to maintain constant VOLTAGE output.

6. Push emergency stop button on desk - check that

   (a) Pantograph falls and that VCB opens - the blue lamp on the desk will light up.

   (b) Move the control key from OFF to Forward/Reverse -

   Push the reset button on the desk - this sends a signal to the electronics reset.

   Push the pan-up button on the start-up panel and watch the pantograph rise - The VCB will close after a 1 second delay and the blue warning light goes out.

7. Place the switch on the autobrake controller to Test.

   Make a graduated application and release and note that equalising pressure and brake pipe pressure.

   Make a full service application of the independent brake: check that the white light on the desk illuminates to indicate full brake cylinder pressure in each of the 24 individual brake cylinders.

8. Press the hand brake - "release button" on the desk - watch the indicator to ensure that the brakes on the centre bogie are fully released.

9. Check the operation of the vigilance by operating the foot pedal -

   Note that the amber light on the desk illuminates.

10. Place the control key in forward/reverse direction.

    Apply independant brake.

    Push power lever inwards to engage the safety slot and rotate clockwise to the first detent - minimum power.

    Note that all 6 ammeters move upwards from zero - listen for the blowers to move into high speed.

    Move power controller to off, the reverser to off and all blowers should fall to half speed.

11. Switch radio on at the console, and check channel selector and operation to train control.

12. Locomotive is now ready to be moved.

SECTION 4 : REGENERATION

A major benefit of the AUTO Transformer System of power supply is that power that is regenerated by a locomotive can be used by a second locomotive working in the same single phase section : i.e. between neutral sections.

The regenerated power can be used by a locomotive to supplement power being drawn from a substation, or it can be returned to the NZE - thus there is a resultant power saving.

Regeneration of power by the locomotive is developed in the same way that a diesel-electric locomotive develops power when operating in dynamic brake.

When the locomotive and train are preparing to run down a long descending grade i.e. from National Park to Raurimu.

1. The power controller is shut off and the train speed is brought down to a desired level - say 40km/h by the train automatic air brake. (Note that the electric brake lever cannot be moved until the power lever is off and released from the safety slot).

2. The electric brake lever is then pulled forward to minimum effort and the ammeters will rise. The air brakes are released from the loco after the brake proving relay has functioned and the speed of the train is then regulated by applying more electric brake.

3. If the speed cannot be held constant by electric brake alone, a graduated application of air brake is made to assist the electric brake.

   The electric brake is a speed control brake - and it is effective from 100 to 20km/h.

   Below 20km/ph the air brake takes over and is used to stop the train in the normal way.

4. The theory of operation is that when the train pushes the loco down hill, the motors act as generators of voltage

   The electronics reverse the excition current through the motor fields and the movement of the brake controller alters the firing order of the converter transforming it into an inverter. The D.C. voltage generated by the traction motors is passed through the inverter and becomes AC. The AC passes back through the transformer to the pantograph and into the contact wire where it is available for use by a following train working up the grade from Waiouru to National Park.

The brake contactor connects a section of the roof mounted resistor bank in parallel with each motor armature as a small load and power (300KW) is dissipated in the resistor during all brake applications.

The brake is thus a combination of regenerative and rheostatic brake.

The inverter/converter unit is very vulnerable to loss of voltage. It the pantograph dewires or there is a line voltage failure, the converter/inverter will not switch and to prevent the motor armatures being short circuited on themselves, the brake resistor acts as a small load to get rid of the generated power until the air brake is automatically reapplied on the loco, when the electric brake is automatically cut out of circuit.

The loco is never left without brakes

The brake resistor is cooled by the ram effect of the air over the resistor bank.

SECTION 5 : NEUTRAL SECTIONS

1. Power is supplied to the NIMT electrification system at :-

Bunnythorpe - 135km)		)	
Tangiwai)	) 157km	)	295kms
Taumarunui) 97km	)	)	
Hamilton (Claudlands)	) 141km		

2. At Mangaonoho)
   National Park) phase change takes place
   Hangatiki)

   N.B. Phase change is necessary to balance the load on the NZE - 3 supply.

3. The phase change is permitted by a neutral section, which is an 8 metre length of insulated rod in the contact wire each side of a 20 metre overlap.

   About 150 metres ahead of the overlap a warning notice advises (Entering neutral section).

   About 20 metres ahead of the overlap there are permanent magnets bolted to the sleepers - each side of the rail.

   An Automatic Power Control receiver mounted on the bogie frame is activated by the magnetic field and the electronics - without any action by the driver:-

   (a) Turns off the converter - to remove traction power/brake.

   (b) Opens the VCB - blue warning light comes on.

   The train will glide through the neutral section.

   About 20 metres past the second overlap, there is a second pair of track mounted permanent magnets.

   The field of the magnets acts on the bogie mounted receiver and causes the electronics to close the VCB and restore traction power or brake to the same level prior to entering the neutral section.

   (d) If there are two locos working in MU - the electronics act on both locomotives -

   there is a 1 second delay between the VCB on the 1st and 2nd loco opening - or closing at the opposite end.

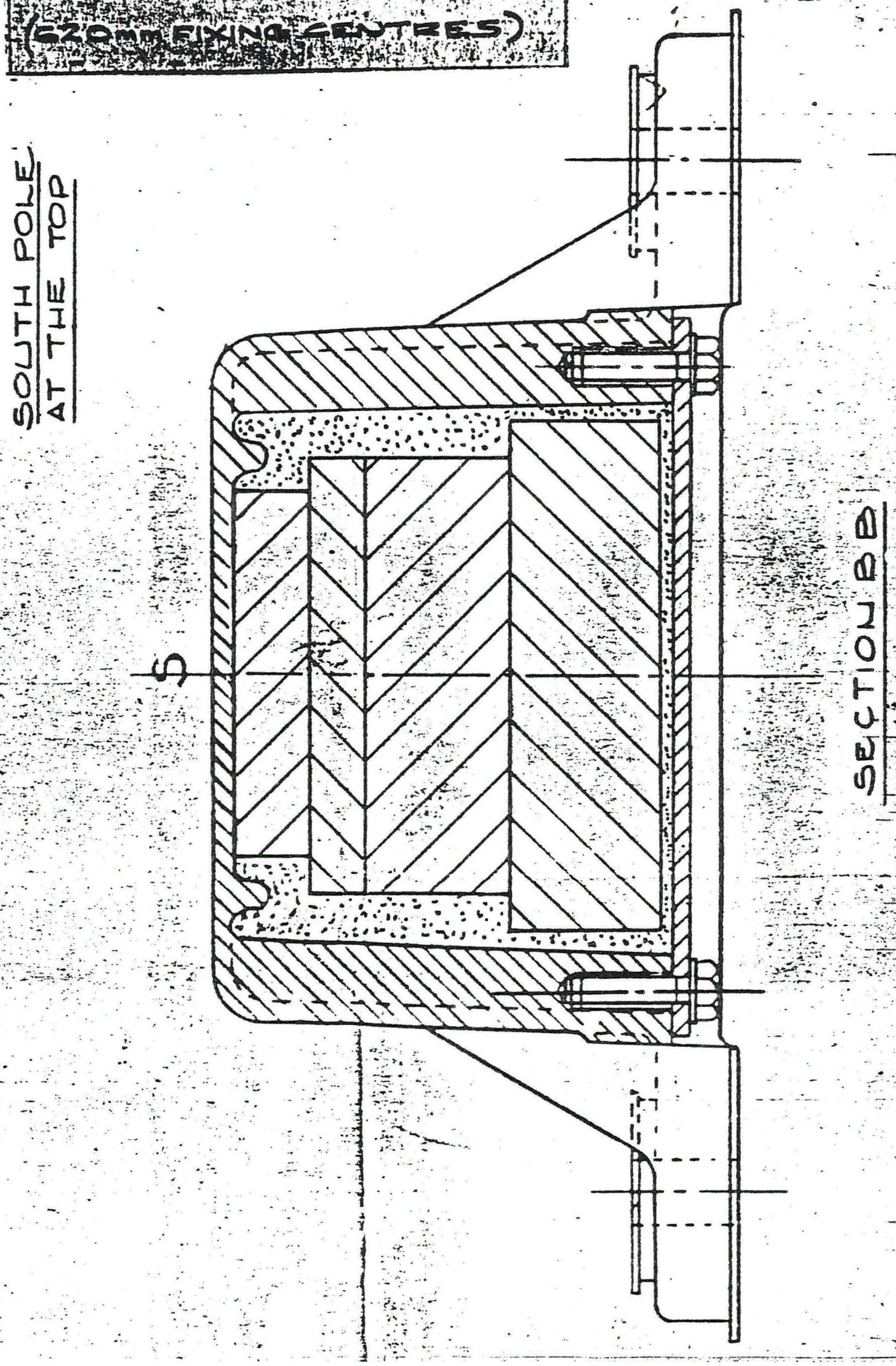
   (e) The motor alternator set has a very big fly wheel effect and takes 20 seconds to run down in speed to the stage where volts have fallen below the control of the automatic voltage regulator (and blower output has reduced).

There is a small fall in speed of fans pumps etc but the operation of the loco is not affected.

(f) The automatic operation can be overriden by a Manual control if needed.

If the loco stops inside the neutral section - it must be towed out

BR AUTOMATIC WARNING SYSTEM
TRACK INDUCTOR (PERMANENT)
EXTRA STRENGTH, TYPE CX FS.
(620mm FIXING CENTRES)



SECTION 6

Protective Devices

All protective devices fitted in the proposed locomotive shall be in accordance with the attached table.

Indicator Lights

Provision shall be made for indication lights associated with the protection devices to be fitted in each cab, at each driver's desk or remotely but in his direct line of vision. Lights shall be suitably protected against bright sunlight. Lights shall normally be off and a push button or switch shall be provided to test all lights and audible alarms.

Four warning lights shall be provided on the drivers desk:-

Wheelslip	-	White
Common Warning	-	Red
Vigilance	-	Amber
VCB Tripped	-	Blue

In addition an annunciator panel shall be mounted on the back wall of each cab carrying the following warning lights:-

Primary overload	-	1 light
Primary Earth leakage	-	1 light
Secondary overload	-	2 lights (Motor Mod 1&2)
Auxiliary overload	-	1 light
Motor overlaod	-	2 lights (Motor Mod 1&2)
Earth fault (armature circuits)	-	2 lights (Motor Mod 1&2)
Earth fault (field circuits)	-	1 light
Earth fault (auxiliary circuits)	-	1 light
Trans. Pressure relief valve operated	-	1 light
Trans. Overtemperature	-	1 light
Trans. conservator low oil level	-	1 light
Transformer oil flow failure switch	-	1 light
Converter Oil flow failure switch	-	2 lights (No.1 & No.2)
Main Cooling Air flow failure	-	1 light
Buchholz Relay tripped	-	1 light
Converter conservator low oil level	-	2 lights (No.1 & No.2)
Armature Converter Surge Suppression fuse blown	-	2 lights (Motor Mod 1&2)
Field Converter fuse blown	-	2 lights (Motor Mod 1&2)
Auxiliary Winding Surge Suppression fuse blown	-	1 light
Traction Motor cooling air	-	2 lights (Motor Mod 1&2)
Motor Alternator set failed	-	1 light
Power Factor Correction Circuit fault	-	2 lights (Motor Mod 1&2)
Electronics fault	-	2 lights (Motor Mod 1&2)
Low Main Res. Pressure	-	1 light
Event recorder	-	1 light
Line Voltage Detector	-	1 light

Audible Warnings

Audible warnings shall be fitted in each cab for:-

Vigilance	-	Whistle
Excess speed	-	Unique Audible Warning

TABLE OF PROTECTIVE DEVICES (See Below for Key Symbols)

DEVICE	FUNCTION	INDICATION	ACTION	LOCATION
Primary Over-Load Relay	Trips/Latches if Primary Current Excessive. Trips VCB	F.B. R A	Driver Reset	CC
Earth Leakage Relay	Trips/Latches if Primary Earth Fault Occurs. Trips VCB	F.B. R A	Driver to seek Assistance	CC
Secondary Overload Relays (4off)	Trips/Latches if Secondary current to Converter Excessive. Trips VCB	F.B. R 2A MM1 MM2	Driver Reset Isolate Faulty Group if Trip Recurs	CC
Aux. Overload Relay	Trips/Latches if Secondary Current to Battery Charger and Aux. Supply Unit Excessive. Trips VCB	F.B. R A	Driver Reset	CC
Motor Overload Relay (6 off)	Trips/Latches if Motor Armature Current Excessive. Converters Phased Back. Motor Contactors Opened. Trips VCB	F.B. R 2A MM1 MM2	Driver Resets & Isolates Faulty Group if Trip Recurs	Contactor Cubicle

KEY TO SYMBOLS : A - LIGHT ON ANNUNCIATOR PANEL
B - BLUE LIGHT (VCB TRIPPED) ON DESK
F - FLAG ON RELAY
R - REPEATED BY COMMON WARNING ON DESK
CC - CONTROL CUBICLE

DEVICE	FUNCTION	INDICATION	ACTION	LOCATION
Earth Fault Relay (Arm. Circuits)	Trips/Latches if Earth Fault Occurs in Armature Circuits (positive side) or Armature Converter Input. Trips VCB	F.B. R 2A MM1 MM2	Driver Reset Isolate Faulty Group if Trip Recurs	Contactor Cubicle
Earth Fault Relay (Field Circuits)	Trips/Latches if Earth Fault Occurs in Field Circuits or Field Converter Input. Trips VCB	F.B. R A	Driver Reset Isolate Faulty Group if Trip Recurs	CC
Earth Fault Relay (Aux. Circuits)	Trips/Latches if Earth Fault Occurs in Supply to Battery Charger or Motor Alternator Set. Trips VCB	F.B. R A	Driver Reset	CC
Transformer Relief Valve Operation	Operates if internal Pressure in Main Trans. Tank becomes Excessive. Relieves Pressure. Trips VCB. Latched Switch	B R A	Driver to call for Assistance	Transformer
Transformer Over Temperature	(i) Alarm Level, operates when Transformer oil Temperature rises above Normal (ii) Shutdown level operates when Transformer oil Temperature becomes unacceptably high Trips VCB	A R B	Auto Reset when Temp falls Drivers reset after temperature reduced	Transformer
Converter Oil flow failure Switch (2 off)	Flow Switch in Oil Circuit of each Converter operates if flow falls below Safe Level. Traction Power Removed Conductors Phased Back	2A MM1 MM2 R	Isolate Faulty Group Proceed on the other	Oil Cooler Circuit

DEVICE	FUNCTION	INDICATION		ACTION	LOCATION
Main Cooling Air Flow Failure	Detects blower failure. Removes power	A	R	Drivers to call for assistance	CC
Converter low oil level Switch	(i) Alarm level operates when oil falls below normal minimum	2A R	MM1 MM2	(i) Note and report	Converter
	(ii) Shutdown level operates when oil level falls unacceptably low. Converters phased Back, Traction Power Removed	B		(ii) Isolate affected Converter and proceed on the other	
Transformer Low oil level Switch	Operates when oil Level falls below Normal minimum	A	R	Auto Reset when Level Topped Up	Transformer Conservator Tank
Line Voltage Detector	Trips if line voltage goes outside limits	A R	B	No Driver Action	CC
Surge Suppression Fuses-Arm. Convertors (4 off)	Fuses blows if Suppression circuit Fault occurs. Fuse Microswitch trips VCB	R B 2A	 MM1 MM2	Isolate Faulty Group and proceed on the other	Isolation and Suppression Cubicle
Field Fuses Failure	Fuse blows for a short in field circuit Trips VCB	2A R	B MM1 MM1	Isolate Faulty group proceed on the other	CC
Event Recorder	Trips if Recorder Faulty	A	R	As per Operating Instructions	

DEVICE	FUNCTION	INDICATION		ACTION	LOCATION
Surge Suppression Fuses - Aux. Winding	Suppression Circuit Fault occurs. Alarm only - Suppression Circuits on other Windings give Temporarily Acceptable Protection	A		No Driver Action Replace Fuse at earliest opportunity	Isolation and Suppression Cubicle
Traction Motor Cooling Airflow Detector	Detects blower failure. Converters Phased Back. Traction Power Removed	R 2A	 MM1 MM2	Isolate affected Group & Proceed	CC
Motor Alternator Set Failure	Trips if M/A set Output lost.	A B	 R	Driver to call for Assistance	CC
Power Factor Correction Circuit Fault	Trips if Power Factor outside limit. Trips VCB	B R 2A	 MM1 MM2	Isolate affected Group & Proceed	Electronics
Electronics Fault	Trips if Electonic Fault Occurs. Trips VCB	B R 2A	 MM1 MM2	Isolate faulty group & proceed on the other group	Electronics
BUCHHOLZ Relay Operated	Trip VCB	A R B		Driver to call for Assistance	
Low Main Res. Pressure	Alarm Only	A R		No Driver Action	
Transformer oil flow Failure Switch	Trips VCB	A R B		Driver to call for Assistance	
Undervoltage Relay	Detects Low battery volts Removes power opens contactors	A R		No Driver Action	

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SECTION 7

TRAIN CREW REQUIREMENTS

1. General

The train crew, during their working day are an important part of a very complex man-machine-system and the bringing together of information and operating elements within the confines of a restrictive space must follow the recommendations of the international federation of the medical services of railways and other bodies who have studied driver fatigue and related problems.

2. Conception

The targets for the integrated drivers cab must be to arrange operating elements in an ergonomic manner, to provide an escape route to the main body of the locomotive and to provide the second man in the cab with the same view as the driver.

Specific requirements for the driver are as follows:-

(a) Driving seat to be on the right hand side of the cab.

(b) Control area to be around the driver so that important operating and information elements are arranged in an optimum range of sight and handling.

(c) An appropriate place for the feet to avoid fatigue when seated continuously for 2 or 3 hours.

(d) Standing control possible for relaxation on long journies. It is important that dimensions such as desk height, seat height, and vertical window opening are related to the average NZ male (1.65M to 1.9M).

(e) Only the operating and information elements which are required for driving the locomotive are fitted on the control desk.

(f) Air conditioning (non-refrigerated) must be considered in addition to a good heating and ventilation system.

(g) The cab must be insulated sufficiently against noise and heat.

(h) The seat must be fixed to the floor, oscillate up and down, the spring rate being adjustable by the driver. It shall rotate and have longitudinal movement for the driver to stand.

The seat and back unit base material shall be anatomically contoured and covered with expanded vinyl with a wool moquette centre panel.

3. Arrangement of Control Desk

The left hand, shall control driving and the right hand braking. Minimum size levers consistant with the control exerted are required for both power and brake application. The Power controller to give control of Powerande braking shall be a vertical lever and shall push away from the driver to increase power.

A second lever shall control direction of travel if not integral with the power control.

The independant brake valve shall be adjacent cab wall and the train brake valve nearest the driver. Both shall be vertical levers and pushed forward to apply brakes.

The instruments shall be placed in a console that is perpendicular to the drivers line of vision and a hood must avoid reflections in the windscreen.

The speedometer shall be a 110 mm diameter instrument placed centrally to the seated driver position.

Instruments for power shall be to the left and gauges for air brake shall be to the right of the speedometer. Dials and pointers shall be bright and the background dark so that visibility is good in both daylight and night time.

Warning or indicator lights dealing with function or operation that are desk mounted shall be a minimum.

The driver must have a clear unimpared view of the road ahead and must not be affected by sleeper dazzle.

4. Cab Equipment

(a) Windows:
Side windows shall be 6 mm toughened glass fitted with draught excluders.

Front windscreens shall be 13 mm thick high impact resistant, multi layer glass fitted with a demisting layer and outer glass to give best light transmittance but minimum solar heat transmission.

Sun Blinds:
Scissor controlled sun blinds shall be fitted to both front windows.

(b) Headlights:
Two 200 watt sealed beam units shall be housed above the front windscreens and provided with a shield to eliminate reflection on the glass.

A 200 watt sealed beam unit actuated by the air whistle shall be housed below the front windscreens to act as a warning to motorists at level crossings.

(c) Cab Linings

The side wall and ceilings shall be of melamine plastic coated hardboard and the interface to the outer wall be insulated with high density material against solar heat and vibration.

The cab must be absolutely draught proof and there shall be no external fittings that will be a hazzard to the train crew.

(d) Floor Covering

A non skid durable surface that is impervious to oil and water and is easily cleaned shall be provided.

(e) Heating

Air heating, a fresh air supply and recirculation of cab air to maintain a comfortable working environment consistant with the volume of the work space shall be provided.

(f) Radio Control Equipment

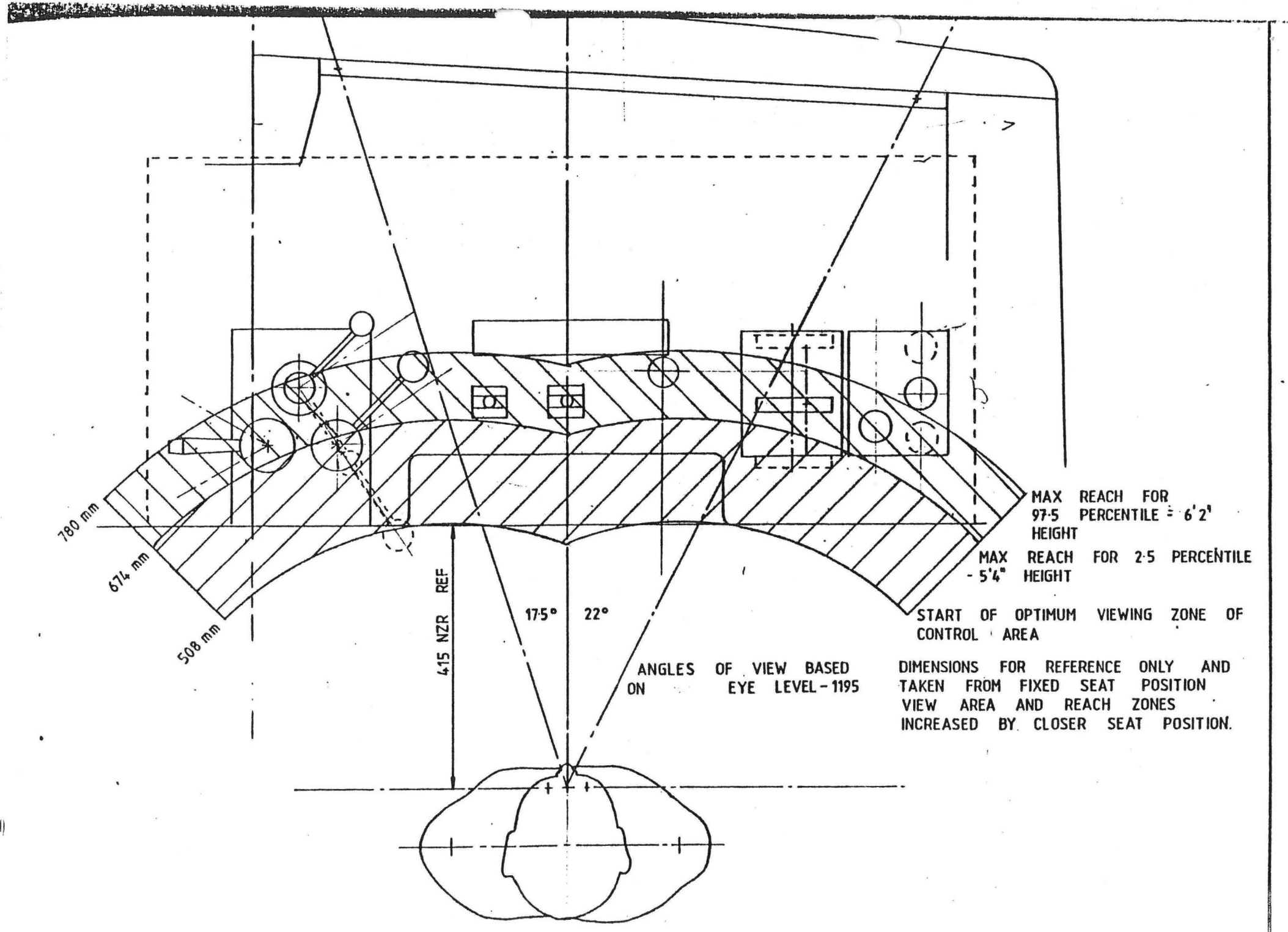
Standard NZR radio equipment currently supplied to all motive power units shall be installed in the train crew space.

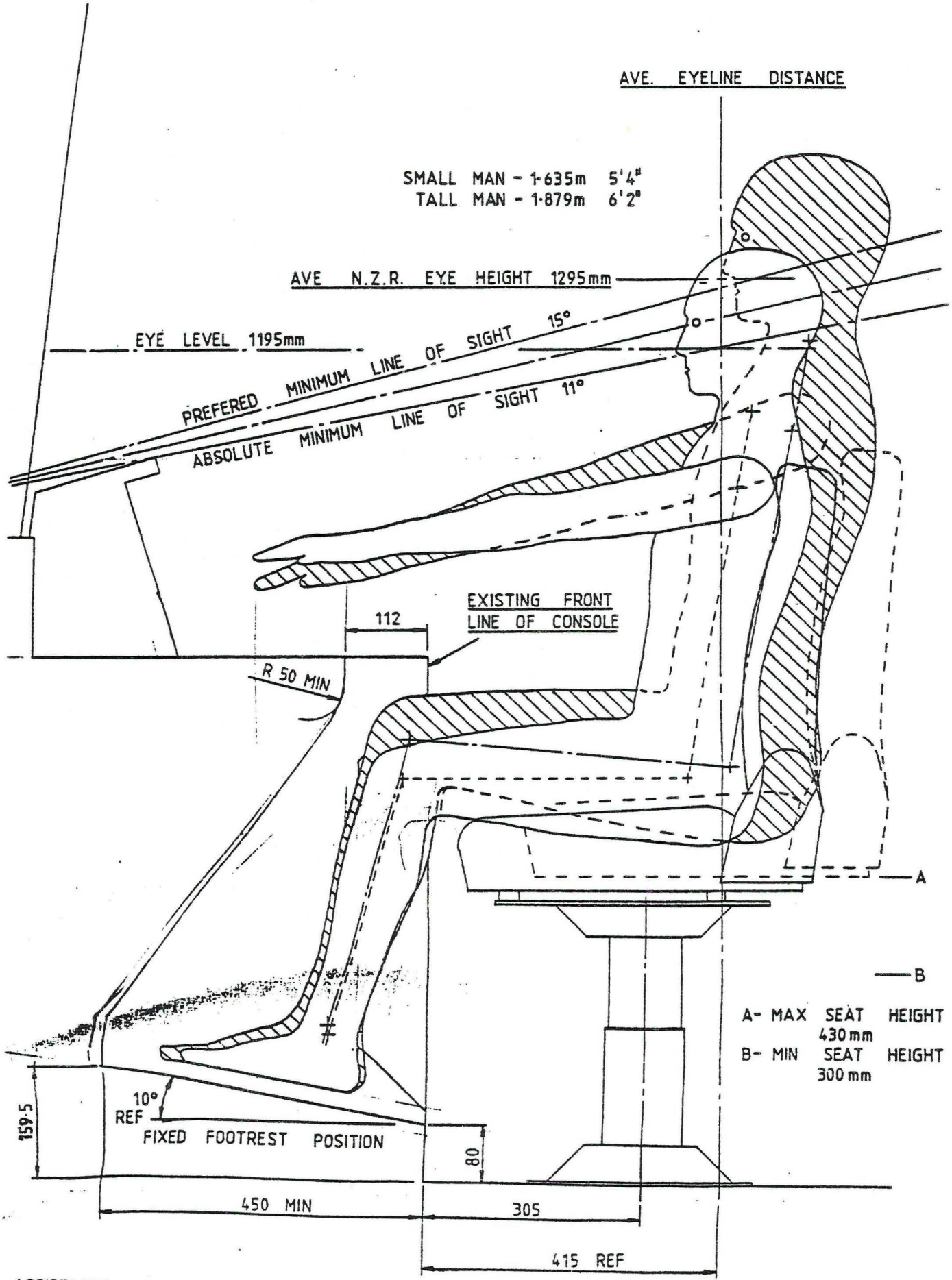
(g) Incidental Fittings

Coat hooks, ash trays, trouble book holder, correspondance clips and other details shall be included in the work space.

5. Information to be supplied

Sufficient information about the proposed train crew space, drawings of equipment layout and photographs of typical installations provided for other railway administrations shall be provided with the enquiry.


780 mm
674 mm
508 mm
415 NZR REF
17·5°
22°
MAX REACH FOR 97·5 PERCENTILE = 6'2" HEIGHT
MAX REACH FOR 2·5 PERCENTILE - 5'4" HEIGHT
START OF OPTIMUM VIEWING ZONE OF CONTROL AREA
ANGLES OF VIEW BASED ON EYE LEVEL - 1195
DIMENSIONS FOR REFERENCE ONLY AND TAKEN FROM FIXED SEAT POSITION VIEW AREA AND REACH ZONES INCREASED BY CLOSER SEAT POSITION.

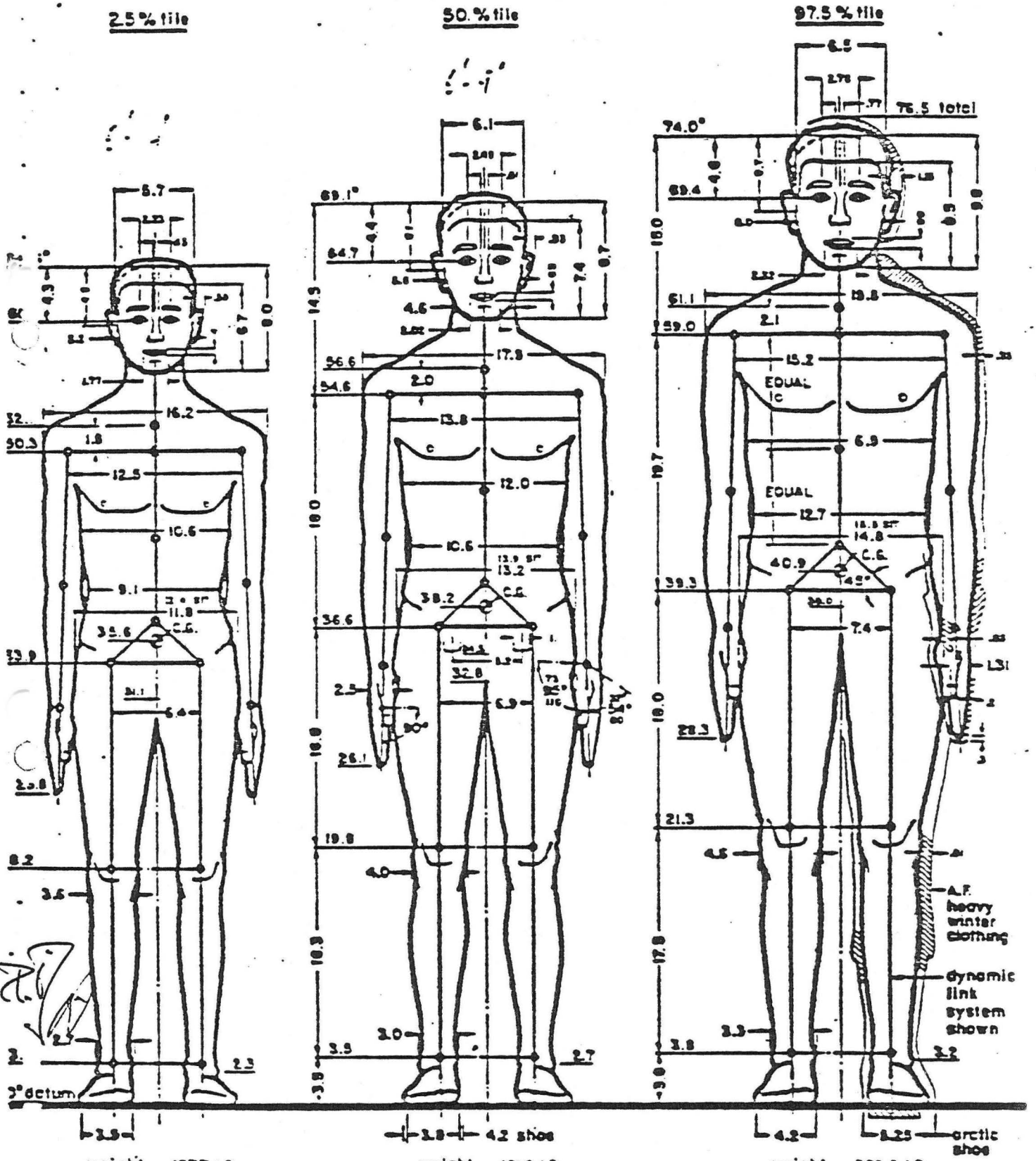


ASSISTANTS SEAT PLACEMENT AND KNEESPACE [HEIGHT, WIDTH, DEPTH, FOOTREST HEIGHT etc] TO BE THE SAME AS THE DRIVERS

IROPOMETRIC DATA — STANDING ADULT MALE

MMODATING 95% OF U.S. ADULT MALE POPULATION

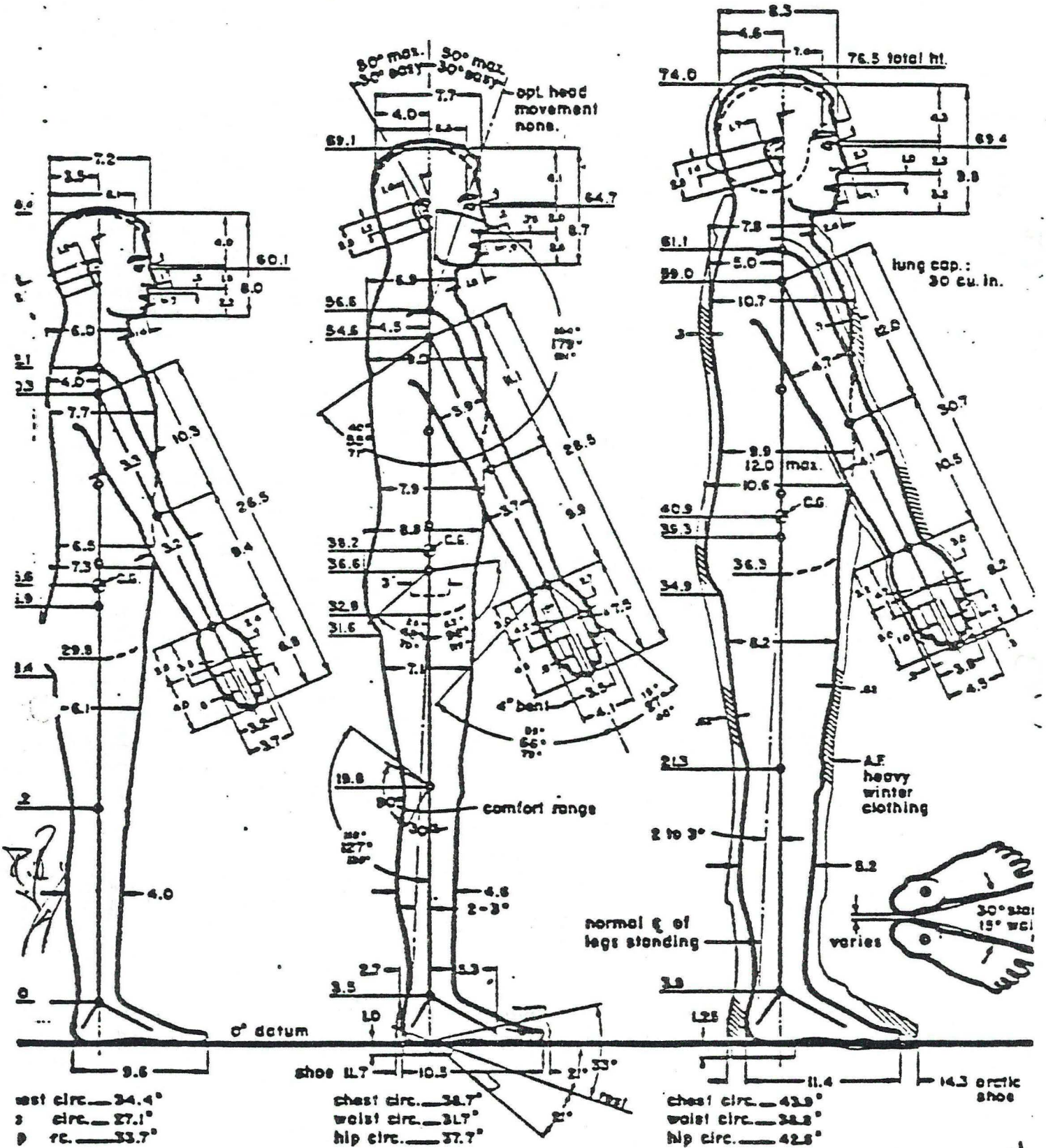
6'-2"



ROPOMETRIC DATA – STANDING ADULT MALE

MMODATING 95% OF U.S ADULT MALE POPULATION

2.5 % tile | 50 % tile | 97.5 % tile

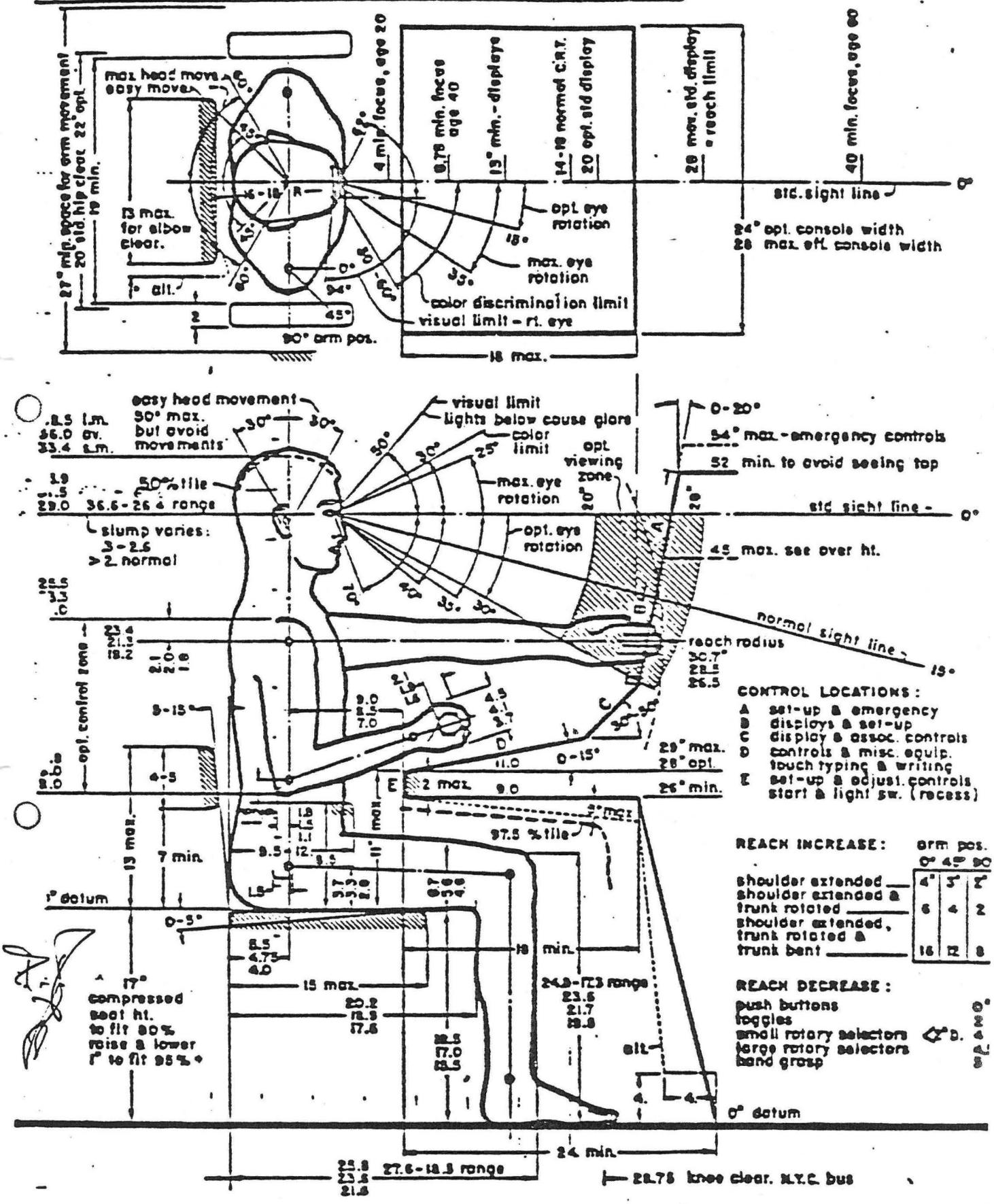


est circ.—34.4°
s circ.—27.1°
p rc.—33.7°

chest circ.—38.7°
waist circ.—31.7°
hip circ.—37.7°

chest circ.—43.9°
waist circ.—38.8°
hip circ.—42.6°

ANTHROPOMETRIC DATA — ADULT MALE SEATED AT CONSOLE



6-8.5% left handed, 3.3-6.5% color blind, 4.3% hard of hearing, 23.3% wear glasses

SECTION 8 : CAB LAYOUT OF EQUIPMENT

Item 1 : Exterior Mirrors

These will be a standard truck model, folded back against the cab side wall to stay within loading gauge when not in use.

Item 2 : Side Windows

Controlled vertical drop and fixed.
Glass : 6mm Pilkington sun glass - green - toughened

The drop windows are sealed with dense brush draught excluders.

Cab door and equipment doors : anti sun green 6mm Pilkington sun glass - toughened.

Front Screens : Glass 13mm - 3 layer - centre layer is a thick impact resistant PVB coated with a HI-VIZ demisting layer - electrical rating is 7 watts per dm^2 so as to give a defrosting capability and to limit the temperature of glass to $30^{o}C$. A temperature switch (sensor) will be fitted adjacent .

The power socket and a thermostat will be glued into the glass to protect it against overheating.

The outer layers are clear glass which gives a light transmittance of 87% and a solar transmittance of 84% - this means that it transmits maximum light but stops 84% of solar heat.

Item 3 : Cab door locks

Standard material similar to those used on BR locos.

Internal items made from Malleable iron.

Keys will be applied to one exterior door i.e. No.1 Cab door.

The No.1.2 end equipment compartment and No.2 cab door have interior locks.

All equipment cubicles are locked by a separate key which will be in the Depot Foremans Office.

Item 4 : Radio Antenna

NZR standard - bolted direct to the roof section using stainless steel bolts.

The antenna is on the cab centre line at the front of the cab immediately above the headlights.

Item 5 : Headlights

Each headlight comprises two GEC 200 watt sealed beam units.

The power supply is a transformer so headlights only burn while the Motor Alternator set is operating.

Full beam is 200 watts at 30 volts.

Low beam is 110 watts at 20 volts.

To give the sealed beam units a longer life - full beam voltage will be 28.5 volts and low beam 18.7 volts.

Item 6 : Cab Lining

The internal lining is British Steel Corporation - colourcoat Plastisol - sheet steel.

This is a plastic coated sheet with a crinkled finish.

The roof is covered with colour BS00E55 which is a very light white grey.

The cab side and rear walls are covered colour BS00A05 which is a light suede grey, from floor level to cantrail level - above this is the roof section.

The space between this 1mm wall and the outside cab wall is fitted with a special insulation matt consisting of a rubber mat and fibre glass resiliently mounted from the wall. The thickness-average-is 100mm.

The rockwool and fibre glass mixture is very dense i.e. 48 cubic feet/cubic metre - and will prevent the interior wall from drumming.

Loose fill slabs 900 x 600 x 100mm will be used where the sound absorbant material cannot be applied.

Detachable panels will have self adhesive nails to hold the panels in place.

Cab bulk heads and floor cavities will be filled with the rockwool slabs.

Item 7

The cab floor is resiliently mounted from the cab structure and comprises the following parts - see sketch

(a) Sealing angle

(b) Walkerrite non skid composition - dark grey

(c) 23mm marine bonded ply wood

(d) Steel top hat section supporting floor boards.

(e) Steel plate section rivetting the resilient section to the steel floor plate.

(f) Special rubber mounting pads.

(g) Steel floor of cab.

(h) 4mm rubber mat - impregnated with lead to deaden track borne noise.

Note: The seat pedestals and cab desk unit are directly bolted to this suspended floor which will eliminate any vibration from the cab to the driving crew.

The door well is clad in anti-slip material and is correctly drained so that rain water cannot penetrate the cab floor.

Item 8 : Doors and door seals

The external cab doors are heavy composite structures hinged into a clear opening of 470mm from floor to cant rail level.

Two door locks are fitted and interlinked so that the door can be opened from ground level from work platform level.

Stainless steel handrails 300mm diameter with an anti-slip pattern are recessed into pockets each side of the doorway opening.

Cab entrance steps fitted with anti-slip material are provided.

The doors are fitted with side and top weather seals of skinned foam. This non intercellular material does not absorb moisture but is resilient in action.

The seal material is glued to a seal plate welded to the door opening.

Three heavy duty cadmium plated steel hinges with stainless steel hinge pins support the door and the opening is sealed for its full length by a rubber strip - similar to the DC Loco cab door hinge.

The door is glazed with 6mm clear toughened glass and the interior pocket is insulated with rockwool material.

Item 9 : Footwarmer and cab heater

A 500 watt footwarmer to provide base heating is fitted adjacent both seat pedestals. It provides a curtain of warm air between the seated person and the cab side wall. Control is on the desk in front of the seated person.

A 3KW heater and forced air ventilation system is fitted on the rear wall of both cabs.

The heater has a three heat control to give 1, 2 and 3KW of electric heating.

The forced air ventilation has a two speed fan control.

Fresh air is drawn through a filter pack in the outside wall behind the cab by the fan unit. At low speed, the fan moves 200c.f of air per min., at high speed 330 c.f.m.

Parallel vertical and horizontal baffles on the outlet duct direct air into the cab. The best opening will be set on test.

Air can be recirculated within the cab. There is no roof ventilator and normally the controlled vertical drop side windows will allow oxygen depleted air to escape from the cab.

With the recircularing system in operation, at low fan speed 22 c.f.m. of air is mixed with incoming fresh air. At high speed - 33 c.f.m. air is mixed.

In the heating mode and with recirculation in use 198 c.f.m. at low speed and 297 c.f.m. at high speed is mixed.

This maintains a fairly constant air temperature within the cab.

Item 10 : Seats

Two seats are fitted into each driving cab.

Each seat has a gas spring operated pedestal mechanism incorporating vertical, horizontal and swivel adjustments.

The seat unit is shaped and contoured to give the best possible comfort, and is supplied with rake adjustable arm rests.

The Nova luxury seating will be covered with heavy duty transport quality moquette with an all wool pile.

The seat and back unit base material is anatomically contoured H.R. foam filling with a secondary spring support system.

Apart from the centre moquette covered section the remainder is I.C.I. ambla expanded vinyl - colour black.

The seats have a rise and fall adjustment of 100mm and a fore and aft movement of 200mm.

The foot step in front of each seated position is raised 80mm above floor level and is inclined 10° from the horizontal. This is clinically regarded as the best seated position since there is no strain on any leg muscles. The vigilance foot pedal is incorporated into this foot step.

The dimensions of the foot step opening are such that the driver can leave the desk merely by turning the seat. No longitudinal movement is required.

Item 11 : Desk unit and cab concept

The desk unit is constructed of steel members and covered in glass reinforced plastic with smooth curves.

It provides a space for the driver on the right hand side and an assistant on the left hand side.

There is a large front window in front of each seated position divided by a heavy steel structural member which is part of the crash worthy cab.

A door at the centre rear of the cab provides an escape route into the equipment compartment.

The controls have been located on the desk so that shunting duties can be controlled from the right hand side window.

Standing control is possible for shunting duties or for relaxation on long journies and the desk height, seat height, height and width of windows are given in relation to a body height of 1.65m to 1.9m which covers 90% of New Zealand males.

Only the operating and information elements which are required for driving the locomotive are fitted on the drivers desk. These are concentrated in functional elements about the centre line of the desk.

The round speedometer is the focal point and multiple gauges for control or air brake are grouped each side of the centre line. Controls for direction, power and brake and instruments related to these are on the left hand and controls for train, locomotive and parking brake and instruments are positioned for the right hand.

The location, distance and arc of operation from the seated position is within the clinically accepted range for minimum fatigue.

All instruments and switch controls are perpendicular to the drivers lines of vision and reflections in the windscreen and on the instruments is avoided by a hood on the console.

Dials and pointers are bright and visibility is good in both daylight and night time - neon plasma illumination.

Tubular lamps at the back of the console illuminate the instruments and switch positions through slots in the console.

Air brake handles and the reverser handle must be removed to the alternate driver position when changing cabs and interlocks prevent illegal operation.

The power and electric brake handles are interlocked against incorrect operation and the power handle must be pushed into an operating slot before it can be rotated.

Detents are provided for minimum power and brake operating positions and all air brake operating positions are positively detented.

The train and loco brake handles are tee bar and knob shaped to avoid confusion and there is an emergency push button in front of each seated position which drops the pantograph, opens the main circuit breaker and applies air brake in emergency.

Indicator lights in front of the driver warn that

(a) Main circuit breaker is open (blue)

(b) Wheelslip is occurring (white)

(c) There is a common warning of equipment failure (red)

(d) That vigilance must be acknowledged (amber)

(e) That power accept to reset all electronic controls is correct.

(f) That all 24 brake cylinders are functioning correctly.

The main annunciator panel of 42 lights is behind the driver and illuminates when a fault occurs in any circuit protected by the panel. The light remains illuminated until the fault is corrected. In event of MU operation, the common warning light indicates a fault in either unit.

Item 12 : Horn Control

The horn lever has two functions - when moved forward or to the rear, it admits air to the roof mounted air whistles. It also activates a pressure switch which energises the electrical circuit to two white flashing lights on the cab front at head stock level.

When the lever is moved side ways it operates the electric horn, which is purely a shunters warning device.

A pressure switch in the horn circuit also cancels the vigilance unit.

Item 13 : Windscreen Wipers

Each front windscreen is wiped by a Trico pneumatic pantograph operated double arm wiper unit.

A water wash unit is fitted to the wiper arm and this squirts water before the blade moves to ensure that only a wet window is wiped.

The wash bottle of 9 litre capacity is under the assistants desk.

Item 14 : Radio Control Unit

The radio equipment fitted in both cabs has been supplied by TAIT AWS and is similar to that fitted in Wellington EMU cars.

A 12 volt, 24AH battery, charged by its own battery charger is fitted in the No.1 cab desk.

This is the power supply for a radio unit fitted in a mounting cradle also in the No.1 desk.

The radio supplies through a cab interface, a control head, gimballed mounted on the front of each desk at its mid position in each cab.

A hand set is coupled to the control head and so that the output of the earphone is amplified to all people in the cab, a speaker unit is mounted on the instrumental console.

Item 15 : Boiling Ring

Supplied by Genristo Limited to their drawing 8474 - the 240 volt 1000 watt element is controlled by a simmerstat to give variable heat output.

The 12" x 9 1/4" x 6 1/4" diameter unit has a guard over the coil element and is inserted into the assistants side of the desk.

Item 16 : Kettle Socket

This 1 phase 230 volt outlet is fitted with switch socket with square pin outlet and will only accommodate the immersion heater supplied with the locomotive.

Item 17 : Sink Unit

This stainless steel bowl 234mm in diameter is supplied by Aarke and Partridge. It has a water trap discharge through the floor and the bowl is normally covered by a hinged cover.

Cold fresh water is carried in the standard NZR stainless steel container which is fitted to brackets attached to the side wall immediately adjacent to the equipment compartment door.

Item 18 : Food Cooler

This electrolux model 230 volt sealed unit refrigerated is fitted into the No.1 cab rear wall. The unit is in the equipment compartment but the door is opened from within the cab.

Item 19 : Cab Lights

Two 24 inch 20 watt fluorescent light fittings with pearl diffuser and supplied from the 100 volt battery circuit are fitted over each seated position. The lights are double switched from the door way or desk.

Two 110 volt 40 watt spot lights are fitted over each seated position. They are individually switched from each desk.

Item 20 : Sunblinds

Sunblinds, scissor controlled, supplied by Nicol Fraysse, and widely used in BR and road transport industry are fitted at each front window.

Item 21 : Coat Hooks

Two substantial metal coat hooks, retractable into the rear cab wall and suitable only for supporting clothing are provided.

Item 22 : Ashtrays

One, up and over, metal hinged ashtray is fitted to the front centre of the desk.

Item 23 : Clipboard

One spring metal clip to hold train advices etc is fitted to the front of the desk to the right side of the driver.

Item 24 : Trouble Book Holder

One standard NZR book holder is fitted to the rear wall of the cab.

Item 25 : Lunch Trays

A lunch tray holder is provided under each desk front adjacent to the seated position.

Item 26 : Fire Extinguishers

One portable dry powder fire extinguisher of about 5.4kg capacity and mounting brackets will be provided on each cab wall.

Two 5.4kg capacity dry powder fire extinguishers will be fitted in mounting brackets at each end of the equipment compartment.

Item 27 : Extra Seat

One tip up seat is fitted to the rear wall of each cab

Item 28 : Cab Auxiliaries

Air horns : One Sydney Smith Dennis KS1 and KS2 air whistle is fitted to the front of each cab.

The sound of these whistles will be heard in the cab.

Sand : One desk mounted push button is fitted in front of each driving position for manual sand application. Sand is not used automatically with the Davis and Metcalfe electronic wheelslip detection and correction system.

Four sand boxes each 100 litre capacity are bolted behind each headstock and supply through needle valve control ejectors, sand to the inside of each of the leading wheel flanges.

Sand is only applied to two leading wheels in the direction of travel.

Item 29 : Vigilance

One electronic vigilance to NZR drawing 12011816 is fitted to the brake rack.

It is a single man operation, cancelled by operation of the foot pedal, power or brake controller, reverser, or whistle.

An electronic warbler and amber light warn of impeding operation.

Penalty brake or overspeed operation can only be reset at the vigilance box on the brake rack at the No.2 end of the locomotive.

Item 30 : Event Recorder

One electronic event recorder to NZR drawing is fitted to the brake rack. It is identical in operation to the equipment now in universal use on NZR.