

GT26

DIESEL ELECTRIC

LOCOMOTIVE

REMANUFACTURE

SPECIFICATION

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SECTION 1

OVERVIEW

OVERVIEW
OF
GT26 LOCOMOTIVE

The manufactured locomotives will provide the latest in microprocessor controlled wheel creep systems to maximise adhesion over varying rail conditions at all track speeds. They will also utilise the EMD 16-645E3C diesel engine as prime mover. Scheduled maintenance and locomotive "down time" will be kept to an absolute minimum by the use of tried and proven lubricating oil, fuel oil and air filtration systems capable of operating efficiently for the 92 days duration between scheduled inspections. Easy access for servicing and exchange of all components will be provided.

The electric power transmission system will consist of a remanufactured EMD AR10 - D14 traction alternator driving six D 77 traction motors. Alternator excitation is controlled using the Qtron QES - 3 microprocessor control system which provides controlled wheel creep to maximise adhesion levels.

The locomotive will be fitted with high tension and low tension wiring using Exane fire retardant cable throughout.

A 26 L air brake system will be fitted. This system will be contained within a standard AAR driver's controller in line with a clean cab layout. Air brake piping will include an air dryer and final filter will be installed to exclude moisture and particles from the locomotive air system as well as that of trailing rolling stock.

Primary air filtration for the diesel engine, traction motor cooling and traction alternator cooling will be achieved using inertial air filters. Each individual element will be able to be removed from the bank for cleaning at three year intervals. A 4 kW extractor fan is used to continually remove airborne particles during normal operation. Secondary engine air filtration will utilise fibreglass "BAGGY" filter elements.

Lubricating oil filtration as well as fuel filtration will be achieved using high efficiency pleated paper filter elements. A 6" lube oil cooler with a new mechanically bonded core will be provided.

Engine cooling will utilise two banks of radiators each consisting of three eight inch "double" elements connected in series. Cooling air will be provided utilising three 48" electric cooling fans.

Dynamic braking will include the "extended range" feature. Battery charging and D.C. supply for control functions will utilise an EMD 18 kw AC auxiliary generator.

An efficient exhaust muffler system will be fitted to ensure that noise emissions are reduced to an acceptable level without creating excessive exhaust back pressure.

New wheels and axles will be fitted. The bogies will be completely re-manufactured using new coil springs, dampers, pins and bushes.

The locomotives will be fitted with a new cab and narrow carbody

The driver's cab will be fitted with new 19 mm laminated windscreens, new windscreen wiper, washers, sliding side windows, heaters, seats, microwave, kettle and hotplate.

An air conditioning unit of 7 kw capacity will be fitted within the driver's cab

The air compressor will be a remanufactured Gardner Denver WBO compressor in order to provide optimum air supply.

New automatic couplers and draw gear will be fitted.

All air reservoirs will be pressure tested.

New battery boxes will be supplied and new 450 amp-hour batteries will be fitted. The locomotive will be painted internally and externally to internat. specs.

SECTION 2

LOCOMOTIVE DATA SHEETS

GT26 Locomotive Specification Sheet

DESCRIPTION	DATA
LOCOMOTIVE HORSEPOWER	2200/3300 HP gross
CONFIGURATION	Co-Co One Cab Narrow car body
DIESEL ENGINE: Manufacturer Model Type Number of Cylinders	EMD 16-645E / E3C Turbocharged / Roots Blown 16
TRACTION ALTERNATOR: Manufacturer Model	EMD AR 10 / D14
TRACTION CONTROL SYSTEM	QES - 3
TRACTION MOTOR: Manufacturer Model	EMD D 77 / 78
COUPLERS AND DRAFT GEAR: Manufacturer Type	Bradken Alliance Full Size Top Operated AAR 10A contour
BOGIE: Manufacturer Type	EMD High Adhesion
WHEELS: Manufacturer Gauge Wheel Diameter Gear Ratio	Comsteel 1435 mm (1000/ 1676 mm also possible) 1016 mm 60:17
AXLE BOXES AND GUIDES: Manufacturer Type	Timken Roller Bearing
AIR BRAKE SYSTEM: Manufacturer Compressor Number of Brake Shoes per Wheel Air Dryer	Westinghouse Gardner Denver WBO - 3 Cylinder 2 Salem Twin Tower 975

DESCRIPTION	DATA
STORAGE BATTERIES: Capacity Type	450 A.H. Lead/Acid
THROTTLE CONTROLLER	AAR Type
INSTRUMENT AND GAUGES	Westinghouse / Floyd
SPEED RECORDER: Manufacturer Type	QES - 3
PRIMARY AIR FILTRATION	Inertial
DRIVERS SEAT: Manufacturer Type	Bremshey FA 416E-1
SANDING EQUIPMENT: Manufacturer Type	Salem Pneumatically operated
HORNS	Westinghouse
COOLING SYSTEM: Radiators Cooling Fans Number of Fans	Touchstone - Mech. Bonded EMD - 48 inch A.C. 3
TRACTION MOTOR BLOWERS: Manufacturer Type Number of Blowers Model	EMD Driven by Aux Gen Shaft
CAPACITIES: Fuel Cooling Water Lube Oil Sand	12,000 litres 1115 litres 870 litres 340 litres
MAJOR DIMENSIONS: Overall Height Width over Handrails Length over Couplers Distance between Bogie Centres	4163 mm 2920 mm 19,900 mm 12,300 mm
WEIGHT (FULLY LOADED)	132t
MAXIMUM SPEED	130 km/h

SECTION 3
MANUFACTURING PROGRAM

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FOR

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- 3.6 Proposed Production Schedule

Section 3.1

QUALITY ASSURANCE

3.1 QUALITY ASSURANCE

A quality assurance program is a broad – based plan to ensure that every locomotive built to the same standards. Quality is the result of the people, who perform the work, skilled people who care about their and their high standards of a finished product.

It begins with clear, detailed work instructions that define assembly and testing requirements.

Training is an essential element, so that production personnel are able to do the work confidently, accurately and safely. Finally, the program includes a set of procedures for inspection and testing to verify those standards.

Program Overview. The Quality Assurance program based on ISO9002, Quality Systems for Production and Installation, contains provisions to identify and comply with contract drawings and specifications and referenced codes and standards. Its policies, procedures, and instructions:

- Provide control of activities affecting the quality and reliability of identified units, systems, and components.
- Assure that such activities are accomplished under controlled conditions.
- Address special controls, processes, test equipment, tools, and skills to attain the required quality and reliability.
- Verify quality by inspection and test.
- Provide for training of personnel.
- Provide regular review of the program for status and adequacy.

Key concepts and operating principles are:

- The existing, proven system will be tailored to incorporate procedures specific to the customer's requirements.
- The QA approach will ensure the continuity of quality from design and manufacture through, acceptance and maintenance.

The features of the organisation and procedures assure a responsive and responsible program to deliver the completed locomotives fully tested in operable condition with ease of maintenance to be performed.

Communication with Quality Representatives. Prior to the start of work, the QA manager will meet with personnel to establish a mutual understanding of the system and to identify communication interfaces and documentation requirements. Client hold points or witness points of in-process inspection and tests will also be identified. Contract-specific criteria will be included as an addendum to the Quality Assurance Manual. The proposed system will be revised as required, and during the term of the contract additional changes will be made, as necessary, to maintain a workable inspection system. Proposed changes will be submitted for review and approval in accordance with contract requirements prior to implementation.

Organisation for Management of Quality. The quality assurance staff provides objectivity and independence within the manufacturing and maintenance operation while being responsive to the program's requirements and schedules.

The Quality Assurance Manager will provide technical direction and support on an as-needed basis. He will also perform oversight and management reviews on an unscheduled basis to verify implementation of the quality assurance system and to evaluate its effectiveness.

Inspection and Tests. All work performed is inspected and tested to include in-process examination, measurements, final inspection and identification of non-conformances. The work is re-inspected after corrective action to resolve any non-conformance. Work procedures and tests are developed by engineering and reviewed by QA. Testing is at hold-points and is conducted by qualified inspectors and technicians.

Quality verification is accomplished by performing tests, examinations, measurements, and inspections using approved procedures and certified personnel. Personnel are independent of those individuals performing the work being inspected. These inspections and tests will be identified on the travellers and process control checklists with the applicable accept/reject criteria specified on the work document.

Corrective Actions. The system for corrective action is prescribed by the operating procedure and is implemented by forms and checklists which structure follow-up actions if necessary, the QA manager has direct referral to the program manager to allow corrective action.

Records. Records include all completed travellers, inspection and test records, certification, and correspondence. The status of inspection/test of

any item will be maintained from two primary sources: travellers or process sheets and a schedule of inspections and tests. In addition, photo documentation will be used to record deficiencies in order to retrain workmen and inspectors.

Material Issuance/Control. We will purchase only from approved suppliers, using requisitions based on contract drawings and specifications. These procedures, coupled with receipt inspection, form the basic quality control system for materials. Purchased items will be subjected to receipt inspection, as necessary, to verify conformance to the procurement documents and contract requirements. Non – conforming material will be separated.

Process Control. Material testing, welding, and other processes critical to quality that is performed by us and our sub – contractors will be performed by certified personnel using approved procedures. Qualification records of personnel and equipment will be maintained in a current status.

Procedures for welding, heat treating, and other processes are prepared and maintained to meet the requirements of the contract specifications, applicable codes, and quality standards. These include procedures for operator qualification.

Calibration/Certification Control. The QA manager is involved in defining the methods for control and calibration of tools, gauges, instruments, and other measuring and test devices used in work procedures affecting quality. He is responsible for having calibration of measuring and test equipment performed by an approved calibration lab. Calibration is in accordance with written procedures using certified measurement standards.

Section 3.2

MANUALS AND CATALOGUES

3.2 MANUALS AND CATALOGUES

The manuals and catalogues will be developed similar to OE specifications. Support from OEMs will be utilised as necessary; Our technical publications staff will manage all aspects of technical manual development and production. Electronic production hardware and software will facilitate production of the complete sets of documents required.

Manuals. A set of preliminary draft manuals will be prepared prior to delivery of the first locomotive. The draft manuals will be based on preliminary information. These manuals will be developed according to the specified format.

A set of final draft manuals will be provided. As part of the final issuance, after all comments are incorporated, one reproducible master copy of maintenance instructions and replacement parts catalogues (MIRPC) and two copies of each manual will be issued. Also, one master copy and fifty copies of the driver's operation handbook will be furnished.

The inputs to the MIRPC will include:

- System description
- Propulsion equipment
- Running equipment
- Special test equipment
- Maintenance instructions

Draft copies of the parts catalogue will be submitted for review concurrently with the maintenance portion. Data pages for the final catalogue will be provided.

Running maintenance Information. This information will contain all the instructions required to perform scheduled maintenance, including daily through 320 week inspection, lubrication, adjustment and parts removal. It will also include all schematics and system operation information required to accomplish on-line troubleshooting, fault isolation, and on locomotive repair.

Section 3.3

TESTING

3.3 TESTING

The test plan will support the applicable test requirements of the contract and will be governed by our Quality Assurance (QA) program. The plan will verify compliance with:

- Component and systems performance criteria
- Engineering and technical requirements
- Material and component certification
- Other testing requirements of the contract

Typical Procedures. Typical procedures include methodologies for testing of contractor-supplied components before assembly and subassemblies and systems during the manufacturing and maintenance process.

Contractor Certifications of Compliance and Inspection: When supplier certifications of compliance or inspection are required by the specification, QA completes QA Addendum to the purchase requisition.

During the remanufacture process incoming shipments are inspected in the receiving department by the receiving inspector. If the required certifications are not part of the shipment, the receiving inspector makes a non - conformance report (NCR), the shipment will not be released. A similar version would be put in place for the on-going maintenance. The material control department is responsible for securing supplier compliance. If the required certification is part of the shipment it will be filed in the relevant purchase order file. Files are maintained for five years, so that certifications are available for inspection by the client as necessary.

Test controls and reports: The QA document control maintains a complete audit trail of test requirement, test results, and engineering approvals for each sub system .Files will be indexed by system, sub – system, component serial number, contractor part number, and test hardware serial number

When items have been inspected by QA and our engineering and are ready for testing, the Project Engineer will notify the client of the impending test using the Notice of Test form.

Standard QA forms for process control will be used to document the test. Test reports and failure/discrepancy analysis will be completed by the project engineer, with copies forwarded to QA document control. Reports are developed jointly by the Engineering and Quality Assurance Departments. Data is compiled and delivered in the form of a Locomotive History Book.

Section 3.4

RELIABILITY PROGRAM

3.4 RELIABILITY PROGRAM

Our plan for the development of locomotive reliability will make extensive use of data and criteria resulting from previous manufacture programs, addressing performance as a complete system as well as the reliability requirements of the individual subsystems and components. The objectives of the reliability program will be to establish, by analysis, the approved goals for availability.

The overall reliability plan requires input at each step of design, production, testing and evaluation.

Section 3.5

**GENERAL ARRANGEMENT
AND PERFORMANCE CURVE**

SECTION 4
SPECIFICATION

Remanufacture Specifications for 3300 HP Locomotive

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GENERAL DATA

Model Designation	3300
Traction.....	2270KW
Engine	16-645E3C
Main Generator	AR10-D14
Auxiliary Generator.....	18 KW A.C.
Traction Motor.....	EMD D77
Air Brake	26 L
Sand Capacity	340L
Fuel Capacity	12,000L
Water Cooling	1115L
Lube Oil	870L
Gear Ratio	60:17
Operational speed.....	130 km/hour
Maximum Weight Loaded.....	132t
Gauge	1000/1435/1676 mm

Options:-

- Full width car body
- Dual cabs
- 16 – 645 E3B
- Lowered axle weight to <20T

MAIN FRAME

1. Manufacture new GT 26 underframe
2. Install new steps and handrails at the body side doors. Step spacing shall be not less than 300 mm or more than 500 mm. Recessed step pockets shall be no smaller than 120 mm high x 150 mm deep x 350 mm wide. Steps will have an approved non slip surface.
3. Manufacture new narrow car body
4. Suitable hooded lighting shall be provided above the coupler at both ends of the locomotive to illuminate couplers and coupling hoses. Lights shall be provided or repaired if equipped to illuminate coupler and shunter's steps.
5. Install new uncoupling levers as required. Uncoupling gear shall be arranged for both sides of the locomotive.
6. Fit new rubber draft packages.
7. Qualify and clean main air reservoirs, use internal "rust" inhibitor MIL spec.
8. Pipe engine air box drains below frame to the new retention tank.
9. Install new anti-climbers at the front and rear of the locomotives.
10. Install new pilot plates to the front and rear locomotive adjustable to suit wheel wear.
11. Install new vertical collision posts at the front of the locomotive.
12. An external engine coolant filler pipe shall be fixed below the underframe on both sides of the locomotive to enable pressure filling from formation level. The normal operating pressure for cooling filling is 200 kPa.
13. Install sand removal (from sanders to the rail) equipment at ends of locomotive. A system of direct blown air with timing valves will be incorporated.

FUEL TANK

1. Install new baffled fuel tank
2. Install one new 30,000 L/Hr (air) vent filter.
3. Install "Aeroquip" automatic shut offs.
4. Install new direct reading calibrated Nathan "Glo Rod" gauges.
5. Install a new 300 litre retention tank that will have manual drains to the side of the locomotive.
6. Battery boxes to be installed
7. Fuel Tank to be pressure tested to 20 kPa.

DRAFT GEAR AND COUPLER

1. Install new bottom operated self alignment type couplers.
2. Install new draft gear package.
3. Re-work coupler carrier using new manganese wear plates.
4. Adjust coupler height 890 from rail to centre line.

CAB

1. Install new pre-fabricated cab/electrical cabinet module. Cab module to have "Mock Up" union approval prior to manufacture.
2. Install new recessed ceiling lights and install new door well illumination lights.
3. Install new non-skid cab flooring, covering marine plywood (18mm). Cab wall insulation will consist of lead impregnated material
4. Install qualified laminated glazing, to FRA specification. A wedge locking mechanism shall be fitted. Install all new rubber seals. Install new windscreen washer equipment. Controls for washers to be fitted on each side for driver and his assistant, within easy reach.

Install electric control windscreen wipers. Install new front and side window blinds.

5. A standard padlock to be installed on the inside of the observer's door while the drivers door to be fitted with a lockwood 303 deadlock.
6. Install Bremshey Model FA416A/W cab seats (one driver, one assistance).
7. Electric refrigerated food storage and water cooling shall be provided in the cab. The total volume of the food, storage and water cooler compartments shall be nominally 70 litres.
8. Install cab heaters. Connect so that operation is only possible when the engine is running. A three stage heat switch and air flow control will be provided for each heater.
9. A 1,000 W hot plate with three position (off, low, high) control switch is to be provided in the cab and shall be fixed into a stainless steel drip tray.
10. A Country Horn shall be fitted externally to the cab operated by the stalk type operating switches located on both the driver's and his assistant's desk.

The device shall provide a minimum sound level of 96 dBA at 30 metres forward of the locomotive in its direction of travel. The measurement of sound level shall be taken from the centre line of straight level track and at height of 1.2 metres from rail level. "Low Noise: Horns" shall be mounted on the front and rear of the loco. A stalk valve shall be supplied for both the driver and his assistant to operate the two Low Noise Horns simultaneously.

11. An electronic speed and distance recorder shall be fitted and two speed indicators shall be positioned so that it is visible to both the driver and his assistant. The recorder shall record the brake pipe and cylinder pressure time on a 24 hour basis, vigilance cancellation, distance and locomotive power notch and speed.

The speed indicator shall be illuminated for night vision. Provision shall be made for the driver to record his name, train number, locomotive number and the date in the recording medium. A six digit kilometre (distance travelled) indicator shall be provided, together with a resettable indicator calibrated in a 100 metre graduations.

The overspeed trip feature shall be set initially at 125 km/hour via the P2-A valve.

12. A standard driver's control stand shall be fitted and shall incorporate the following:
 - a. Engine controller and reverser
 - b. Dynamic brake controller
 - c. 26 L driver's brake equipment or equivalent
 - d. Robust load meter
 - e. Lighting switches
 - f. Control switches
 - g. Manual power control (lead only [switch] all units)
 - h. Fault lights
 - I. Matt black vinyl gauge visor
13. An instrument panel shall be positioned in front of the driver and shall include:
 - a. Air brake pressure gauges and flow meter
 - b. Wheel slip indicator light
 - c. Fault light
 - d. Brake cylinder pressure warning light
 - e. Ground fault light
14. A battery charging ammeter shall be fitted.
15. Install connections and mounting for radio.
16. Install vigilance control indicator and cancelling buttons.
17. Install full window height exterior rear view mirrors on both sides of cab.
18. Install sanding pedal on cab floor at the driver's station.
19. Install flag holder.
20. Install logbook holder.
21. Install first aid box.
22. Install 20 litre water container and holder.

23. Install window level mounting padding for protection when utilising side windows for rear ward observations.
24. Install driver's reverser key holder.
25. Install cabinet to hold two man crew equipment, including portable radio battery charger.
26. Install new "clean cab" features:
 - a. Pull handle and rubber hinge guard for cab doors.
 - b. Head bump pads (where necessary).
 - c. Two (2) flush coat hooks on back wall.
27. Install a new roof mounted air conditioner with control panel within easy reach of the cab crew.
28. Install 75V headlight assemblies and resistors. The headlights shall be controlled from toggle switches located on the desk top control stand.
29. Two wide beam fog lights shall be fitted at the No. 1 end of the cab. An on/off switch for the lights shall be located on the drivers' desk top control shed.
30. Install new marker lights on the front of the cab, both sides at mid-height.
31. Step lights will be installed.
32. One 15 amp, double pole GPO to be installed in cab.
33. All gauges in the cab shall be illuminated by the indirect method and have dimmer control. The design of illumination shall ensure no glare to the driver nor reflection from the windscreen or side windows. Several sources of light for gauge illumination are preferable to one large source.
34. A roof mounted reading light shall be fitted above the driver's and assistant's desk for the purpose of preparing train journals and reports enroute. A spotlight shall be fitted above the inspector's seat.
35. An illuminated train notice clip holder shall be provided at the Driver's location in the cab.

36. **Advance Train Control Equipment**

Typical equipment that can be fitted includes:

VDU (driver's desk)
power supply
data radio
transponder interrogator
radio modem
end of train radio
computer
axle odometer
transponder/reader
roof mounted antennae (multiple)

37. **Number and Nameplate**

Numberplates, nameplates, etc. shall be installed. Road Number of the locomotive on an illuminated panel not exceeding 305 mm in height shall be mounted on each side of the headlight. The contractor shall also provide two suitable plates showing the date of manufacture, progressive number of contract and contractor's name not exceeding 200 x 350 mm, one to be affixed on the driver's side of the locomotive.

38. 2 new 27 pin MU receptacles will be installed at either end of the locomotive.
39. Micro – Wave oven to be installed
40. CD player to be installed

CARBODY

1. Install new prefabricated narrow width carbody.
2. Carbody panels to have fixed windows to allow sufficient light for maintenance and operation.
3. Install new radiator hatch assembly.
4. Carbody cooling panels to be provided adjacent to engine for cooling.
5. Install four new carbody side mounted sand boxes with fills accessible from platform level. Airlines will be equipped with condensate traps. Box lids to be of type as fitted to jumper cable receptacles.
6. Install new or remanufacture cooling fans (reference Cooling Fan section).
7. Install new mechanical bonded radiator cores for engine cooling.
8. Install new conduit.
9. Install new power wiring and cabling.
10. Install new marker lights.
11. Install new Salem magnet valves for sanding. Install new sand traps.
12. Install new rear headlight and resistors.
13. Carbody access door to be provided either side of the locomotive.
14. Extended range dynamic brakes:
 - a. Cable with Exane wire.or similar
 - b. Install new 700 amp grids.
 - c. Install new or remanufactured grid blower motors.
15. Install new dynamic brake hatch.
16. New engine air baggy filter housing to be installed.
17. An inertial air filtration system will be installed including new screens, inertial air blower and motor.

18. A new vertical wheel geared type handbrake will be installed.
19. At least 12 lighting outlets will be provided within the carbody.
20. **Train Equipment**
Install new M.U. jumper cable.
21. **Tools**
Owner to provide
23. **Miscellaneous Equipment**
Owner to provide
24. **Provide Equipment Storage Box**
Shadow board and equipment storage box.
25. **Fire Extinguishers**
Six (6) x 9 kg dry chemical type fire extinguishers shall be fitted in the engine compartment. Two (2) x 1.25 kg dry chemical type fire extinguishers shall be fitted in the Driver's cab.
26. A new fully enclosed toilet room will be constructed. The toilet room will be equipped with a new microphor type toilet and a sink.

RADIATORS AND WATER COOLING SYSTEM

1. Assemble new mechanically bonded 6" cores with new headers, screens and new gasket.
2. Water test assembled radiator section at 50-60 psi.
3. The engine cooling water flexible connections shall be of the metallic type (flexmaster).
4. The reserve cooling water tank shall be fitted with a suitable filler opening to permit the addition of a water inhibitor.
5. The radiator fans shall be microprocessor controlled.

BOGIES

1. Dismantle - clean, blast and prime frame.
2. Clean, blast and prime brake hangers.
3. Visually inspect frames for cracks and worn areas. Critical areas will be dye penetrant tested.
4. Trammel frame.
5. Weld and grind pedestal jaws as required.
6. Weld and redrill traction motor support lug.
7. Renew all pins and bushings.
8. Install new manganese wear plates. Provide new bolster wear plates or replacement parts as necessary.
9. Install requalified springs, replace as necessary.
10. Install new manganese or spring steel pedestal liners.
11. Rework brake hangers, modify to single shoe braking with new high friction non metallic brake shoes.
12. Provide for inboard and outboard sanding, nozzles and nozzle holders.

13. Fit new gear cases. Renew all seals.
14. Inspect bolster centre casting for wear - renew wear rings.
15. Install new pinions.
16. Fit new support bearings.
17. Install new or remanufactured EMD D77 traction motors.
18. Requalify slack adjusters.
19. Bogies will be painted gloss black.

AXLES - WHEELS - GEAR RATIO 60:17

1. Install new axles. Ensure that axles are splined on both ends.
2. Install new 60 tooth gear wheels.
3. Renew water guards as required.
4. Install new 40" multi-wear wheels, 51/2" wide.

JOURNAL BOXES ROLLER BEARINGS

1. New journal boxes to be installed to take new package roller bearings.
2. Install new seals and gaskets.
3. Wear plates to be fitted to correct tolerances.

EQUIPMENT RACK

1. Install new improved lube oil filter with 92 day filters.
2. Install new radiator fan contactor for microprocessor control.
3. Install water tank with pressurised system.

4. Remanufacture lube oil cooler with new mechanically bond cooler core. Fit new gaskets and seals.
5. Install new fuel pump with remanufactured motor.
6. Repair conduit as necessary and renew all wiring.
7. Renew small copper tubing and large piping as necessary.
8. Install remanufactured fuel strainer.
9. Install new engine start box, emergency stop button and transducer box.
10. New 92 day primary fuel filter will be installed.

LUBE OIL COOLER

1. Dismantle assembly.
2. Degrease heads and all other parts.
3. Coolers reassembled with new mechanical bonded core and all new gaskets.
4. Water test complete assembly at 80 psi.

ENGINE - MODEL 16-645E3C

1. Install remanufactured 16-645E3C engine.

EXHAUST SYSTEM

1. Install new exhaust silencer hatch assembly.

BRAKE EQUIPMENT

1. The diesel electric locomotives shall be fitted with Westinghouse 26 L unitised incorporating the latest developments from a train performance and maintenance point of view. All hose pipes, coupling and other details shall be compatible with those already fitted to locomotives. P-2-A and A-1 Cut off Valves are to be included.

These valves are to be utilised for engine power knock down, dynamic brake isolation, service brake application, automatic sanding and driver's brake valve isolation when the following occurs:

Train breaks in two)	and shall be expandable to
Overspeed trip)	incorporate automatic split
Vigilance control)	reduction for a train control
Non-cancellation)	application etc.
Other faults where)	
thought necessary.)	

2. The bogies shall be fitted with standard clasp brakes, adequate provision must be made for wheel wear from new to worn condemning limits.

Case hardened steel pins and bushes in accordance with Australian National drawings D/S400 and D/S401 shall be fitted to all brake gear.

3. Easy access to isolating cocks of coupling hoses and clearly defined identification marking shall be provided at both ends of the locomotive. Unless otherwise approved all isolating cocks shall be open with the handle in line with the pipe (ref Drawing A2/2-DE-202). All isolating cocks, except train pipe, shall be located behind the headstock such that they are protected from collision damage.
4. The independent locomotive brakes when fully applied shall be capable of holding at rest on a 1 in 100 grade in trailing load based on 1.5 hp per tonne.
5. All steel pipe work will be inspected, flushed out and treated with anti-corrosion solution. Any defective piping found will be replaced with new and treated with anti-corrosion solution.

The brake pipe shall be 32 mm nominal bore.

6. Install a new remanufactured shaft driven WBO air compressor.
7. Air reservoirs will be tested and reinstalled. The interior of the reservoirs shall be cleaned and coated with a rust preventative.
8. Approved air brake gauges and vigilance control device shall be installed in the cab.
9. A visual indicator will be mounted in the cab so that it is visible by both the Driver and his Assistant to indicate amount of time remaining between acknowledgments.

An acknowledgment button of cycle cancelling shall be located within easy reach of the Driver and another within easy reach of his Assistant.

The vigilance control equipment operation cycle shall be:

- a. After a ninety (90) second interval from commencement of cycle a flashing light will operate.
- b. Fifteen (15) seconds after operation of flashing light an audible warning signal shall operate with a gradual increase in the sound level should acknowledgment not be made.
- c. Ten (10) seconds after audible warning signal operates penalty brake application will be made.

The vigilance control equipment shall be so designed that once a penalty application commences it cannot be cancelled until the train is stopped.

An electronic vigilance control system will be installed, either incorporated within the locomotive control system or speed recorder, working in conjunction with the P2A valve in the air brake system.

10. An air drier of sufficient capacity shall be installed externally in the feed line to the No. 2 main air reservoir to air brake equipment and new auxiliary air devices.

11. Driver's brake valve and flow meter shall be exhausted outside the cab. The handles of both automatic and independent brake valves shall be plastic coated to provide thermal insulation.
12. New end train line hoses will be installed.

HIGH VOLTAGE CABINET & MICROPROCESSOR CONTROL SYSTEM

1. Manufacture new high voltage cabinet.
2. Install air filter box assembly for pressurisation of cabinet.
3. Paint interior of high voltage cabinet white.
4. Apply all new equipment in cabinet.
5. All new wiring and cabling will be installed.
6. All terminal boards will have fast-on terminals except terminal boards for 8 AWG wire size or larger which will have stud type.
7. Use high temperature fast-on lugs on high temperature wire to resistors.
8. High voltage cabinet will include grid protection, self-load feature, and traction motor cut out.
9. Install automatic ground relay reset.
10. Microprocessor to include the following:
 - a. Radiator cooling fan speed control.
 - b. Extended range dynamic braking control.
 - c. Wheel slip control.
 - d. Fault diagnostics.
 - e. On board monitoring systems.
 - f. Data recording.

NOTE: Axle generators may need protection from trackside debris.

A.C. AND AIR COMPRESSOR CONTROL CABINET

1. Rebuild AC cabinet.
2. Install and cable the following equipment:
 - a. AC fan contactors
 - b. Install CCR relay
 - c. Diodes
 - d. Terminal boards
 - e. Ancillary equipment

ELECTRICAL EQUIPMENT

1. The electrical power and control equipment shall be mounted on panels enclosed in pressure ventilated cubicles located in the engine room, but with access external to the engine room. All control contacts and interlocks must be fitted with dustproof covers and all wire terminations and connections shall be readily accessible to allow visual and physical checks to be made.
2. A diagnostic system shall be incorporated into the control system to enable accurate and quick diagnosis of component failure. The microprocessor fault display panel will indicate faults, eg traction motor over temp., traction motor flashovers, hot engine, excess pressure drip over engine air filter, ground relay, open motor circuit, excitation limit, locked power wheel, wheel slip control failure, dynamic brake ground relay, dynamic brake grid over current, dynamic brake grid open circuit, dynamic brake grid blower motor, traction motor excitation plus any other indications the manufacturer may consider necessary.
3. Electrical compartment doors shall be designed and sealed to prevent fumes or noise entering the cab if doors are in cab.
4. The locks for such doors shall be of the flush mounted type with provision made to prevent draught occurring around the lock.
5. Negative wires from similar circuits shall be connected separately to a common link that is separately connected to the main negative in order to simplify the detection of earth faults.

6. Full technical details shall be supplied of the starting battery offered which shall have sufficient capacity for the duty to be performed.
7. Electric motors for radiator cooling fans, ventilating fans and traction motor blowers shall be of the totally enclosed surface cooled types and shall comply with Australian Standard C2-1963 or the latest equivalent approved specification. Cooling and ventilating fans shall be protected with a wire mesh grille.
8. The motors for the radiator fans should be of microprocessor controlled randomly sequenced design.
9. Junction boxes for control cables must be designed in such a manner as to provide for orderly termination of wires, ready accessibility for fault rectification or testing and efficient sealing against entry of dust, water and oil. All wiring and wiring looms must be neatly arranged and particular care shall be exercised in the positioning and bracing of wiring looms to prevent cables from chafing on metal edges and from being placed under tension when connected to opening doors, etc.
10. Cable ducts shall be fitted with removable covers to facilitate inspection and repair. The covers shall effectively seal the ducts against ingress of oil, water and or other contaminants.
11. All cables used in the locomotives shall be multi-stranded and suitably insulated and sheathed and protected against, oil, water and high temperatures. The cables shall comply with the latest relevant Standards. A permanent type of cable marking and identification method shall be utilised on each and every termination.

Power cables shall be suitably rated to carry the short time rated loadings of the locomotive without exceeding the permissible temperature rise.

12. When ever possible, electrical sub-circuits shall be protected by double pole circuit breakers in preference to fuses. The circuit breakers shall be mounted on a hinged panel to allow ready access to all connections.
13. A double pole 15 amp circuit breaker from the locomotive batteries shall be provided for the operation of UHF and VHF radios. Sufficient room in the cab shall be provided for the installation of the radios.

14. Control equipment shall include a means to easily and manually isolate pairs of traction motors. The locomotive shall be designed to be able to continue working with pairs of traction motors isolated.

MAIN ALTERNATOR

1. Install remanufactured AR10/D14 main alternator.

AUXILIARY GENERATOR - 18 KW AC

1. Install new or remanufactured 18 KW AC auxiliary generator.

TRACTION MOTORS – EMD D77

1. Install remanufactured D 77 / 78 to the following specs
 - a. Motors are stripped complete.
 - b. Frame is remanufactured to new O.E.M. specifications/or replaced.
 - c. All coils to be tested and qualified to new O.E.M. standards/or replaced.
 - d. Armature tested and qualified to new O.E.M. standards/or replaced.
 - e. Armature shaft to be qualified to new O.E.M. standards/or replaced.
 - f. Commutator to be tested and qualified to new O.E.M. standards/or replaced.
 - g. All new Traction motor brushes to be installed.
 - h. New exane cable leads.
 - i. New umbrella sleeves to the carbody side of all tm leads.
 - j. Pinions will be new.
 - k. Traction motors will be tested and run (with wheels sets if required) for one hour prior to installation.
 - l. Traction motor (complete) will come with a one year or 200,000 KM warranty

FUEL PUMP AND MOTOR

1. Install new 6 G.P.M. fuel pump and motor assembly.

BATTERIES

1. Paint interior of battery boxes with acid resistant paint.
2. Install new batteries - 420 amp hour - 25 plate cells.
3. Install battery box drain.

TRACTION MOTOR BLOWERS

1. Install new mechanically driven traction motor blower assembly for air supply to all traction motors

COOLING FANS AND MOTORS

1. Install new or remanufactured 48" radiator cooling fans.

PAINT

1. Diesel engines, generators, motors, control gear and auxiliaries shall have their exterior thoroughly cleaned before painting and shall be finished to RTSG standards.

The locomotive exterior, underframe, bogies and exterior auxiliary equipment shall be painted with Dulux aquatmane or simliar

The paint system application directions available from the paint manufacturer supplying the material shall be adhered to precisely.

The following procedure shall also be adopted:

- a. Remove oil and grease with mineral turpentine or white spirits. Acid or alkali contamination shall be removed by thoroughly rinsing with clean water.
 - b. Rust, mill scale and other foreign matter must be removed by abrasive blast cleaning (or wire brush for small "touch ups") to Australian Standard 1627, Part 4 Class 2½ minimum.
 - c. The blast cleaned substrate shall be primer coated not later than the same day on which the cleaning is undertaken and the primer coat shall be applied as soon as possible after cleaning before visible deterioration of the surface has occurred.
 - d. The zinc phosphate primer conforming to GPC-C-27/2A (dulux luxaprime) shall be applied at a dry film thickness of 60 micrometres strictly in accordance with the manufacturer's direction.
 - e. The intermediate coat is to be dulux steelfab HB zinc phosphate applied to a D.F.T. of 60 microns.
 - f. The dulux aquathane top coat shall be applied at a dry film thickness of fifty (50) micrometres strictly in accordance with the manufacturer's direction.
2. Details of the final exterior colour scheme and particulars of lettering will be supplied at a latter date.

FINAL TEST - LOAD BOX

1. Check for leaks - water, fuel, lube oil and air systems.
2. Sequence test all circuits.
3. Check all lights.
4. Load test at full horsepower - check operation of temperature transducers.
5. Record all pressure, vacuum and temperature readings.
6. Make final movement and running checks.

7. Verify performance control function during load tests.
8. Conduct sound level check in cab and for horn loudness on the first unit.

TEST RUN

1. The finished locomotive will be ride and track tested before final quality control inspection.
2. Following test run, unit will be given Final Inspection and:
 - a. Take oil sample for laboratory analysis;
 - b. Correct all exceptions noted by our Quality Control.

LOCOMOTIVE WEIGHT

1. Weigh unit when completed - furnished (weight) ticket for front and rear bogies - adjusted for supplies.

TECHNICAL INFORMATION/TRAINING

The following documents/training sections are to be produced.

- a. 10 copies of Drivers Operating Handbook relevant to the units supplied.
- b. 6 sets of Maintenance Manuals and Replacement Parts Catalogues covering all equipment.
- c. A training program for operating and maintenance staff.
- d. Complete locomotive data sheets.
- e. Engine rebuild sheets.

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