SECTION 7

FREIGHT VEHICLE
BRAKES AND BRAKE EQUIPMENT

ROA MANUAL

SCHEDULE OF AMENDMENTS

SECTION 7

AMENDMENT NUMBER	PAGES AMENDED	AMENDMENT SUMMARY	DATE ISSUED

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7.1 SCOPE

This Section specifies the minimum requirements for compressed air brake equipment to be fitted to all new and rebuilt freight vehicles.

Additional equipment requirements for passenger vehicles are specified in Section 12.13.

Equipment requirements for Locomotives are specified in Section 13.9

7.1.1 DEFINITIONS

The terms "approved" or "approval" shall refer to approval by the Railway System involved.

7.2 GENERAL REQUIREMENTS

7.2.1 OPERATION OF EQUIPMENT

The equipment shall depend for its operation on the maintenance of an air pressure normally set at 500 kPa in a single brake pipe which runs the length of the vehicle, and is continuous throughout the train. The equipment shall, by a reduction in pressure in the brake pipe, cause air to flow from a reservoir charged initially from the brake pipe, and act on or to be relayed to a piston within a cylinder to apply the brakes. Increasing pressure in the brake pipe shall cause the brake cylinder or dummy volume to exhaust and simultaneously recharge the reservoir from the brake pipe ready for the next application.

7.2.2 EQUIPMENT

7.2.2.1 The standard air brake equipment on all vehicles shall include the following principal items:

(a) Control Valve Unit Assembly to control the air brake application and release. It includes a control valve, relay valve, automatic release valve and air filter (7.3.2.).
(b) A set of reservoirs (separate or combined), the volumes of which ensure correct operation of the system (7.3.9).
(c) Empty/Load Changeover Valve (Manual or Automatic) or a load proportioning valve (7.3.4 or 7.3.5).
(d) End Cocks (angle type) female threaded connection to suit 32 NB pipe. Two (2) required with single brake pipes; four (4) required with bifurcated brake pipes (2 LH, 2 RH). See 7.3.12.
(e) Hose Couplings, 32 mm nominal bore X 610 mm long: one (1) per End Cock (7.3.13)
(f) Dummy Couplings, one (1) per End Cock (7.3.13).
(g) Control valve isolating cock; may be fitted to control valve unit assembly (7.3.7).
(h) Grade Control Valve (7.3.8). Optional on broad gauge vehicles.

7.2.2.2 Vehicles with underframe mounted brake cylinders shall have, in addition to that specified in 7.2.2.1, :

(a) Brake Cylinder(s), horizontal type of either 254 mm or 305mm nominal diameter and 300mm nominal piston stroke (7.3.10).
(b) Slack Adjuster, automatic, double acting (7.3.11), installed in the fulcrum position.

7.2.2.3 Vehicles with bogie-mounted brake cylinders shall be fitted in addition to the equipment specified in 7.2.2.1, with all equipment required for brake operation appropriate to the bogie design.

7.2.3 INTERCHANGEABILITY

Complete interchangeability of the following major air brake components is mandatory irrespective of manufacturer.

Control Valve Sectn 7.3.2

Brake Cylinder Sectn 7.3.10

Double Acting Slack Adjuster Sectn 7.3.11

Refer to section numbers quoted for details of criteria.

7.2.4 COMPATIBILITY

Airbrake equipment conforming to this Specification shall operate with existing equipment in service on Australian rail systems.

7.3 SPECIFICATION OF EQUIPMENT

7.3.1 GENERAL REQUIREMENTS

7.3.1.1 The design of all air brake components shall be such as to permit their ready removal for cleaning and repair without the need for special tools.

7.3.1.2 The portions of the vehicle brake system which control the application and release, and also the brake cylinder(s), shall be adequately protected against the entrance of foreign matter.

Brake pipe air flow into the brake equipment shall pass through an easily replaceable filter element with a minimum filtration surface area of 30,000 mm² and a porosity rating 15-25 microns.

Brake pipe air flow into the auxiliary reservoir shall pass through a replaceable filter with a minimum surface area of at least 2500 mm² and a porosity rating of between 50 and 100 microns.

All air ports which are open to atmosphere shall be of a design which resists blockage.

7.3.1.3 The equipment shall be designed to operate effectively under all environmental conditions encountered throughout Australia.

7.3.1.4 The equipment shall be designed to withstand all normal operating air pressures without leakage, and also, when mounted on a vehicle, external forces due to accelerations of 5 g longitudinally and 2 g vertically and laterally without failure.

7.3.2 CONTROL EQUIPMENT (CONTROL VALVE UNIT ASSEMBLY)

7.3.2.1 The control equipment shall be of the diaphragm type, and suitable to operate on trains of up to 150 bogie vehicles or 3000 m in length. The control equipment shall be compatible in operation with existing equipment.

7.3.2.2 The brake system shall have the following features:

(a) Initial Inshot Feature
to ensure a fast initial rate of application of the brakes, to provide a rapid take up of the brake rigging on the vehicle.

(b) Regulated Recharge Feature
to slow the recharging of the vehicle brake system towards the front of the train after a brake application to give more uniform recharging and resultant brake release along the train.

(c) Brake Cylinder Pressure Maintaining Feature
to help ensure retention of brake cylinder pressure despite minor air leaks at the brake cylinder and associated pipework.

(d) Auxiliary Reservoir Pressure Maintaining Feature
to permit some stability in the service lap position.

(e) Charging Interlock Feature
to ensure that on trains of 80 or more bogie vehicles, the control valve cannot, due to slow flow rates, oscillate between the application and release positions during initial charging of the braking system.

(f) Reduction Ensuring Feature
to provide an additional feature to assist with the propagation of the brake application down the train.

(g) Quick Service Feature
to produce a substantially uniform time of quick service transmission regardless of the variations in frictional resistance in the brake rigging.

(h) Accelerated Application Feature
to provide a controlled localised reduction of brake pipe pressure at each vehicle so that a positive application is made on every vehicle.

(i) Accelerated Release Feature
to provide for a rapid rise in brake pipe pressure on each vehicle to assist with a positive release of the brakes.

7.3.2.3 Stability of the equipment shall be achieved by air pressure loadings, and sensitivity controlled by means of a suitable choke.

7.3.2.4 The control valve mounting face shall be strictly in accordance with Diagram 7-1, including the fixing holes and port location and functions.

7.3.3 FILTER UNIT

The branch pipe air shall be filtered (ref. 7.3.1) such that no foreign matter can enter the control valves. This filter shall be incorporated in the control valve unit assembly, and be positioned on the brake pipe supply side. The filter should be of such construction as to ensure ease of cleaning and/or replacement.

7.3.4 LOAD COMPENSATION EQUIPMENT

7.3.4.1 The equipment shall be designed to provide dual capacity braking to suit the empty and loaded conditions of the vehicle.

Mechanical empty-load braking systems which depend for their operation on the alteration of the main lever ratios shall not be used.

7.3.4.2 The mechanism for changing the air brake system to either the empty condition or the loaded condition shall be manually operated for vehicles in general traffic. Vehicles which normally travel either fully loaded or empty (eg tank cars, hopper cars) and are not bogie exchanged may be fitted with an automatic change-over device (see 7.3.5).

The manual changeover control shall be by means of either of two co-acting levers mounted one on each side of the vehicle. Both levers shall clearly indicate, by the display of a white "E" or "L" on each side of the vehicle, whether the brakes are set for the empty or loaded condition.

7.3.4.3 Load sensitive proportional braking systems may be used and shall provide brake ratios which comply with clause 7.6.1 across the load spectrum.

7.3.5 AUTOMATIC CHANGE-OVER VALVE

7.3.5.1 The automatic change-over valve shall be a continuous load sensing device used to control the change-over between the empty and loaded condition of the vehicle air brake system.

7.3.5.2 The valve shall be suitable for mounting on the bogie and shall operate by the movement of a plunger sensing changes in spring deflection due to load.

7.3.5.3 The change-over from the empty to the loaded position shall be initiated by any movement of the plunger of 3mm or more from the set empty (tare) position.

The change over from the loaded to the empty position shall not be initiated until the plunger has been fully extended to the set empty position.

Initiation of both conditions is subject to the time delays specified below.

7.3.5.4 The valve shall provide a delay, between the moment the plunger reaches the positions quoted above and actuation of the change-over to either the empty or loaded position, of between thirty (30) seconds and two (2) minutes.

7.3.5.5 The valve shall be designed to operate without lubrication or maintenance for not less than eight (8) years

7.3.5.6 The materials used in construction of the valve shall ensure correct operation under all environmental conditions experienced on railways throughout Australia.

7.3.6 AUTOMATIC RELEASE VALVE

A manually operated release valve shall be provided to vent the air from the vehicle brake system (brake cylinder, reservoirs etc) and thus release the brakes. It shall be so designed that, when the air brake system is isolated from the brake pipe or the brake pipe is uncharged, a single momentary actuation of the valve shall be sufficient to result in the valve remaining open until the air brake system has been evacuated. When the brake pipe is charged with air and the brake system not isolated, the valve design shall require the valve to be manually held open until evacuation is complete. The valve operating mechanism shall be capable of actuation from either side of the vehicle.

7.3.7 ISOLATING COCK

A single, vented isolating cock shall be fitted in the pipe or connection between the brake pipe and control valve to isolate the brake equipment on the vehicle. Supply of air from the brake pipe shall be completely isolated when the cock is closed.

This feature, combined with application of the automatic release valve to vent all the reservoirs and brake cylinders will enable the vehicle to continue in traffic unbraked should a fault develop in the brake equipment.

The air brake isolating cock shall be clearly visible and easily accessible from outside the vehicle.

7.3.8 GRADE CONTROL VALVE

7.3.8.1 The function of the Grade Control Valve is to retard or prevent the total exhaust of air from the brake cylinder as required during release.

7.3.8.2 The valve shall be operable from both sides of a vehicle, and each mounting plate shall incorporate provision for indicating the position in which the valve is set.

7.3.8.3 The valve shall be capable of being set to three (3) positions providing the following features:

(a) Open Exhaust Position
In this position the exhausting air shall pass to atmosphere via the Exhaust Choke and provide a full brake release.

(b) Intermediate Position
In this position the exhausting air shall pass to atmosphere via an Intermediate Choke and the Exhaust Choke. The reduction brake cylinder pressure from 350 kPa to 70 kPa shall occur in approximately 55 seconds. Full release is achieved.

(c) High Pressure Position
In this position the exhausting air shall pass to atmosphere via an additional choke, limiting valve, Intermediate Choke and the Exhaust Choke. The reduction of brake cylinder pressure from 350 kPa to 70 kPa shall occur in 105 seconds. The limiting valve shall ensure that brake cylinder pressure is maintained at not less than 70 kPa.

The choke sizes shall be appropriate to the brake cylinder and control valve fitted to the vehicle.

7.3.9 RESERVOIRS

The minimum design, fabrication and testing of air reservoirs shall not be less than that required by AS 1210. The design working pressure of reservoirs shall be 1,000 kPa and design and testing shall be in accordance with the requirements stated in AS 1210.

Each reservoir shall be protected against internal corrosion and shall be provided with a drain plug positioned at the lowest point.

Reservoirs shall be constructed with integral couplings having internal parallel pipe threads to AS 1722 to which all pipe connections can be made. Where practical, multi-compartment reservoirs shall be used.

The reservoir supplying air for brake applications with

(a) unrelayed 254 mm brake systems shall have a nominal capacity of 39.4 litres (auxiliary reservoirs)

(b) relayed brake systems shall have a nominal capacity of 4.6 litres (dummy volume)

All other reservoirs shall have their capacity matched to the design requirements of the equipment to give the specified braking performance of the vehicle.

All reservoirs shall be supplied and stored plugged to prevent entry of contaminants, and shall be `blown out' immediately before connection to the vehicle brake system.

7.3.10 BRAKE CYLINDER

The brake cylinder shall be designed to give a minimum of 15 years service, with provision for applying periodic lubrication with the minimum of inconvenience. Removable type aspiration filters shall be provided of adequate size to give a minimum of 5 years service between cleaning, and the cylinder construction shall provide for these filters to be so aligned as to prevent the ingress of moisture irrespective of the mounting position or orientation of the brake cylinder.

The brake cylinder shall be robust and designed for a maximum pressure of 700 kPa.

7.3.11 SLACK ADJUSTER

In line slack adjusters shall be of the automatic double acting type and shall comply with the latest revision of the AAR Manual of Standards, Section E.

7.3.12 COUPLING COCKS

Air brake coupling cocks shall be 32 mm nominal bore (N.B.) and shall be of such a design as to ensure that the cock will remain in the desired position whilst the vehicle is in motion. This shall be achieved by incorporation in the cock design:

(a) a detent to ensure the cock remains in the open position and,
(b) a ramp to ensure the cock remains closed.

Movement of the handle shall be by the application of force in the direction of rotation only. All coupling cocks shall be vented on the flexible coupling hose side when closed. The cock shall generally conform with the drawing shown on Diagram 7.16.

7.3.13 FLEXIBLE COUPLING HOSES

Flexible Coupling Hoses shall be 32 mm NB. and be in accordance with Australian Standard, AS 2435. The nipples, coupling heads, and dummy coupling head shall be in accordance with Diagrams 7.6, 7.7, 7.8, 7.9.

7.3.14 HANDBRAKE

For vehicles with underframe mounted brake cylinders, the handbrake shall exert a force on the crosshead pin or alternatively on the end of the cylinder live lever extension.

For vehicles with bogie -mounted brake cylinders the handbrake shall be connected to the appropriate point of the bogie brake rigging.

Handbrakes shall comply with the latest revision of the AAR Manual of Standards, Section E.

The mounting of handbrakes shall comply with Section 2.
Handbrake lever guides and sill slots, where required, should be so located and of sufficient length to prevent the lever fouling when the front or live cylinder lever is in its release position, or when the movement of the live cylinder lever is equivalent to not less than 300 mm piston travel.

7.3.15 BRAKE BLOCKS

Brake blocks shall be of the high friction composition type, 38 mm or 50 mm thick and shall comply with the latest revision of the AAR Manual of Standards, Section E.The brake blocks shall be secured to the brake head using the key shown on Diagram 7.11.

7.3.16 PIPEWORK

All steel pipe for the brake system shall conform with AS.1074 Heavy Duty. Pipe threads are to conform with AS.1722. External threads are to be tapered and internal threads parallel (except where otherwise specified).

Pipe fittings shall conform with BS.1740.

Steel piping in general shall conform with AS.CB 18 part 1.

Nylon tubing shall be black, ultra-violet stabilised and have a burst pressure of at least 8 MPa for sizes up to 12 mm O.D. and 4 MPa for sizes above 12 mm O.D. Fittings applicable to nylon tubing which provide durable air tight joints shall be used.

7.4 PERFORMANCE OF EQUIPMENT

7.4.1 GENERAL DATA

The standard control valve unit assembly for a vehicle shall be suitable for operating with a nominal train length of 3000 metres as a basis for timing, with control valve unit assemblies up to 50 m apart. The following data apply for a single vehicle:

(a) Brake pipe: 32 mm N.B. throughout the vehicle inclusive of end coupling cocks, hoses, coupling connections and bifurcations.
(b) Brake pipe pressure: 500 kPa nominal.
(c) Brake cylinder diameter: 254 mm, 305 mm or according to bogie design.
(d) Brake cylinder pressure: nominal 350 kPa (loaded condition), design 380 kPa maximum.
(e) Braking ratio: As specified in Clause 7.6.
(f) Brake cylinder piston travel requirements are as follows for underframe mounted brake cylinders:
Nominal operating: 100 mm
Design for reservoir volumes: 200 mm.
(g) Brake cylinder filling time from 0-275 kPa: 10 - 13 seconds.
(h) Time for release of brakes on a freight vehicle.
Exhaust rate from 350 kPa to 70 kPa shall be for Grade Control Valve Setting.
EX - 15 - 20 seconds.
IP - 55 seconds.
HP - 105 seconds, retaining 50 to 70 kPa for a minimum of five (5) minutes.
(i) Charging time of auxiliary reservoir:
Initial fill: 0-400 kPa in 60 seconds.
Recharge: 250-450 kPa in 20-25 seconds.
(j) Accelerated release reservoir charging time:-
0-420 kPa in 180 seconds nominal.
(k) Supplementary reservoir charging time:
Initial fill: 100-110 seconds
(l) Propagation rate in a train:
Brake application: 250 m/s - minimum.
Brake release: 80 m/s - minimum.
(m) Inshot capability:
70 to 84 kPa brake cylinder pressure shall be obtained in 1.5 to 2 seconds after control valve operation.

7.4.2 PERFORMANCE REQUIREMENTS

Control valve performance shall comply with the requirements specified in the latest revision of the A.A.R. Manual of Standards, Section E, wherever applicable, except as specified otherwise in 7.4.1.

7.4.3 ADDITIONAL REQUIREMENTS

7.4.3.1 Provision shall be made on the control valves for a clear identification specifying its individual capacity, timings and manufacture/re-conditioning dates using an approved tag.

7.4.3.2 Features of the control valve which govern its capacity shall be readily accessible to enable timings and capacity to be altered quickly and without difficulty.

The control valves shall be capable of being tested utilising existing air brake equipment test racks.

7.4.3.3 Wherever the dimensions or performance of equipment are specific to one application and there is a possibility of confusion with similar equipment for other applications, approved positive means for preventing mis-application of either equipment shall be devised by the manufacturer and incorporated in the design of the equipment.

7.4.4 TESTING ON NEW VEHICLES

(a) Brake Block Force Test.
The brake block force test shall be conducted in accordance with AAR Standard S-401, section 4.0 for both power and hand brakes.
(b) Brake equipment shall be tested in accordance with the Single Car Test Standard Section 7.7.

7.5 INSTALLATION REQUIREMENTS

7.5.1 PIPING GENERAL

All brake equipment shall be mounted to facilitate ease of operation, servicing, replacement, and pipe connections. Screwed pipe fittings shall be used at the brake cylinder, reservoir, brake pipe bracket and brake pipe tee connections. The piping installation shall provide a minimum distance between the brake operating components, particularly the piping between the brake cylinder and relay valve or control valve. Welded joints in the brake pipe may be used in conjunction with appropriate fittings and adequate local support for the pipe.
Instructions of manufacturers for installation of any compression type pipe fittings shall be followed. No intermediate joints shall be permitted in any pipeline, but, where necessary, steel barrel unions of approved manufacture shall be fitted. All pipe joints shall be sealed with an approved jointing material. Hemp compounds, lead compounds, or plastic tape shall not be used.

If an anaerobic thread locking compound is used, it shall have characteristics such that components are not damaged upon disassembly.

7.5.1.2 Wherever practicable, air pipes shall be fitted in long lengths, bent to contour. Elbow fittings are prohibited.

The following schedule gives the recommended MINIMUM radii for pipe bends that are consistent with good practice.

Size of Pipe/Tube		Pipe Type	Minimum Recommended Bend Radius
32 NB and 25 NB		Steel	300 mm
20 NB and 15 NB		Steel	150 mm
10 NB		Steel	75 mm
22 mm	Nylon	130 mm	
12 mm	Nylon	84 mm	

7.5.1.3 Under no circumstances shall the cross sectional area of the pipe be restricted. When the pipe is prepared for assembly, it shall be cut to length and shall be freed of burrs, oil and cuttings before being inserted into the fitting.

Should the pipe be less than 600 mm long it shall not be sprung more than 6 mm to bring the holes into proper alignment. If the pipe is more than 600 mm long, it shall not be sprung more than 12 mm to bring the holes into alignment. If the alignment is not satisfactory, the pipe shall be heated at a point not less than 250 mm from either fitting and bent to suit. Reservoir and valve pipe connections shall be applied with provision to absorb any stresses in service without placing undue forces on pipe fittings (sweeping relief bends may be used for this purpose).

Piping and fittings shall have all dirt and scale removed prior to installation. If piping is to be stored after cleaning then the ends shall be sealed.

Piping connecting the control valve unit assembly, grade control valve, and empty load valve shall preferably be in nylon and attached to the vehicle so that damage is avoided.

7.5.1.4 To avoid entrance of foreign matter, the protecting means installed by the manufacturer must not be removed from the control valve unit assembly pipe bracket or valve openings until the control valve unit assembly is mounted on the wagon, and the pipes are ready to be fitted.

7.5.2 BRANCH PIPE

Nylon tubing of 22 mm outside diameter is preferred. Where a steel branch pipe is used the branch piping shall be 15 NB minimum. The length of the branch pipe shall be no less that 550 mm in order to provide for movement between the brake pipe and control pipe bracket resulting from longitudinal shocks in a train.

7.5.3 BRANCH PIPE TEE

Where a branch pipe tee is used it shall be located in the brake pipe so as to avoid sharp bends in the branch pipe.
Connection of the branch pipe to the brake pipe shall be such that entry of moisture to the branch is minimised.

7.5.4 BRAKE PIPE

7.5.4.1 The brake pipe shall be 32 NB heavy duty black steel pipe supported on the vehicle and so installed that there are no water traps. The brake pipe at each end of the vehicle shall be provided with a union ended 686 mm length of pipe, and the hole in the headstock should be of sufficient size to clear the union on the inner end of the pipe. The end of the brake pipe shall be located within the limits specified in diagrams 7-12 and 7-13. The actual position shall suit the physical characteristics of the vehicle, and the swing of the automatic coupler. The clearance between the brake pipe coupling cock and automatic coupler head shall be a minimum of 50 mm after allowing for the full swing of the automatic coupler. The end cock shall screw onto the brake pipe.

7.5.4.2 The brake pipe shall be supported throughout its length with suitable clamps to prevent movement due to vibrations. Pipe fittings shall be accessible for maintenance. Brake pipe clamps of the 'U' bolt type, may be used for the securement of steel pipe and the coupling cocks. Brake pipe clamps or other means of approved securement shall not be more than 2500 mm apart. Non-ferrous tubing shall be secured by an adequate number of suitable clamps. The brake pipe shall be anchored at the coupling cock and at or adjacent to the branch pipe tee, to resist longitudinal movement. All anchors and all pipe clamps shall be left loose until pipe is assembled in position, then tightened.

7.5.4.3 The brake pipe shall be bifurcated when either the end swing of the vehicle, on a curve of 100 metre radius, is 220 mm or greater, or the vehicle is fitted with an automatic coupler with a shank length of more than 736mm. Where bifurcated brake pipes are fitted, the "Y" connection to the main brake pipe, shall be of such design that no flow restrictions result.

7.5.4.4 As an alternative to bifurcation and where the coupler and draft-gear combination together with the vehicle design permits, the brake pipe terminations at each end of the vehicle may be designed so that a single flexible coupling at each end lies on and parallel to the longitudinal centre line of the vehicle beneath the coupler (`underslung'). The coupling cocks shall be located and oriented to enable the longer flexible connection to adopt the correct alignment without crimpimg of the hoses. A standard coupling hose, head and dummy coupling shall be used.

7.5.4.5 Where a main reservoir supply pipe is required on a wagon, the respective coupling cocks shall be clearly labelled with "BP" and "MR" for Brake Pipe and Main Reservoir Pipe respectively.

7.5.5 RESERVOIRS

7.5.5.1 The reservoir(s) shall be installed on suitable mounting brackets so that the reservoir shall not slide longitudinally, nor drop in the case of breakage or loss of one of the supports. Supporting steel bolts or straps shall be secured with nuts with an approved nut locking feature. The size of nuts shall be M16.

Mounting brackets shall have adequate strength to prevent vibration and to withstand, without permanent deformation the forces specified in clause 7.3.1.4.

7.5.5.2 The reservoir(s) and control valve unit assembly pipe bracket shall be connected so that there is minimum movement with respect to each other, due to twisting of the wagon structure. The pipes connecting all items shall be so bent to provide flexibility and be free of intermediate joints. These pipes shall be adequately clamped at distances to eliminate failure from fatigue due to vibration.

7.5.6 BRAKE CYLINDER - UNDERFRAME MOUNTED

7.5.6.1 The brake cylinder shall be installed on suitable steel mounting brackets to minimise vibration and to withstand, without permanent deformation, the forces specified in Clause 7.3.1.4. The supports shall also have adequate strength to withstand a brake application with a cylinder pressure as specified in clause 7.4.1. The steel support shall be so designed that it will not contact the cylinder head flange. The brake cylinder shall be located and

brackets so designed that there is no interference with the removal of the piston from the cylinder.

7.5.6.2 The guide for the cylinder end of the live lever should be so located as to provide ample room for full piston travel and for the removal and replacement of the brake cylinder piston.

7.5.6.3 The cylinder shall be secured with M16 bolts with an approved nut locking feature. The relative location of the control valve unit assembly pipe bracket and the brake cylinder should be such as to permit both to be connected with a pipe having easy bends not more than 1500 mm long and without intermediate joints. Where the brake cylinder pipe is more than 1500 mm long, it shall be supported with suitable clamps at not more than 1500 mm centres.

7.5.7 AIR RELEASE MECHANISM

A 3 mm diameter wire rope shall be attached to the air release valve in such a manner as to ensure there is no tendency to twist the valve. It shall extend to both sides of the vehicle and terminate in a fitting which enables convenient operation from either side.

7.5.8 CONTROL VALVE UNIT ASSEMBLY MOUNTING

7.5.8.1 The control valve unit assembly shall be mounted on a support bracket attached to the vehicle underframe or body structure. The support bracket shall be designed to safely withstand in-service vibration and the forces specified in 7.3.1.4.

7.5.8.2 The control valve unit assembly shall be attached to the support bracket using M16 bolts and nuts with an approved locking feature, or pin-rivets of the same diameter.

7.5.9 AIR BRAKE EQUIPMENT MOUNTING

Wherever possible, components shall be pre-assembled into units which incorporate provision for attachment to the vehicle, and to which pipework may be secured.

7.5.10 PAINTING OF OPERATING HANDLES

All operating handles and embossed letters of the power brake equipment shall be painted white. An inverted 'U' or the word `Release' shall be painted on the vehicle underframe on each side above the attachment of the release cable. Refer to Section 22 of this manual.

7.6 FUNDAMENTALS OF DESIGN

The air brake system shall be designed to conform to the following parameters and minimum requirements.

Note: That sections 7.6.1.1, 7.6.2, 7.6.3, 7.6.7, and 7.6.11 are applicable only to vehicles with underframe mounted brake cylinders and conventional rigging as illustrated on Diagram 7-4; Section 7.6.1.2 applies to vehicles with bogie mounted brake cylinders. All other requirements apply to brake systems based on vehicle mounted or bogie mounted brake cylinders.

7.6.1 THEORETICAL BRAKE RATIO

7.6.1.1 ***Underframe-mounted Cylinders with Conventional Rigging***

The calculated design lever ratio shall ensure that the total theoretical brake block force shall:

(a) not exceed 50% of the tare mass of the vehicle with a brake cylinder pressure equal to the nominal `Empty' setting of the load compensating equipment,
and
(b) shall not be less than 16.7% of the maximum gross mass on rail with a brake cylinder pressure of 350 kPa.

No allowance shall be made in calculating the above ratios for losses due to friction, deflection or other causes.

7.6.1.2 ***Bogie-mounted Brake Cylinders***

The brake ratio of vehicles with bogie-mounted brake cylinders shall comply with the requirements of AAR Standard S-401, Section 3.

7.6.1.3 The theoretical ratios shall be used only for initial design and proto-type construction. Each prototype vehicle, or vehicles which have been modified or constructed individually, shall be subjected to an actual brake block force test in accordance with the requirements of Section 4.0 of AAR Standard S-401.

The `net shoe force' shall be the total force exerted on all the brake blocks of a vehicle and shall comply with the requirements for the Power Brake System specified in Table 1 of Section 3.0, AAR Standard S-401.

7.6.1.4 Where the results of the above test are not within the specified values, the test shall be repeated. If the results do not then comply with the requirements, the lever ratios and/or the `empty' pressure setting shall be modified to ensure compliance.

7.6.2 BRAKE LEVERAGE RATIO

The brake leverage ratio shall be such that the brake cylinder working travel, plus the slack adjuster take-up, is sufficient to wear out a full set of brake blocks from new without pin adjustment while maintaining the full brake performance for the vehicle. Total leverage ratio shall not exceed 12.5:1.

7.6.3 BRAKE RIGGING (Where used)

Brake rigging for vehicles with underframe mounted brake cylinders shall be of the equalised type shown on Diagram 7.4 and shall be designed to accommodate one left hand bogie and one right hand bogie as defined in Section 6.8.3. The rigging shall be located to enable all brake pins to be installed and removed easily by hand.

All sliding surfaces of each brake lever and lever support shall be provided with renewable wear strips of approved material.
The rigging layout shall be such that under normal operating conditions the brake system shall not be rendered ineffective due to binding or excessive angularity of the levers or other components.

7.6.4 APPLIED FORCES

Forces applied to all levers, particularly offset and bent levers, shall be such that when brakes are applied the lever remains in stable equilibrium and any movement is not impeded by levers and other components being forced against the carriers or guides.

7.6.5 BRAKE PINS, BUSHES AND COTTERS

All pin holes in levers, clevises, support brackets, connecting rods, etc. shall be fitted with case-hardened steel bushes.

Brake pins shall be secured in position with either round split cotter pins together with flat washers or flat split cotter pins. They shall be readily accessible for inspection and replacement purposes.

7.6.6 NUT LOCKING DEVICES

Spring washers or other approved nut locking devices shall be included on all fixing bolts, studs or setscrews. Castellated nuts or similar are not acceptable.

7.6.7 FRICTION IN BRAKE FORCE CALCULATIONS

No allowance shall be made for friction in either the power brake or handbrake mechanism when calculating the theoretical brake forces.

7.6.8 MAXIMUM TRAVEL

No part of the vehicle or its equipment shall interfere with the maximum travel of either the power brake or handbrake mechanisms.

The maximum travel shall be taken as the travel necessary to allow the conditions of Clause 7.6.2 to be met.

7.6.9 ECCENTRICALLY APPLIED LOADS

Eccentrically applied loads are undesirable but where they cannot be avoided allowance shall be made for combined bending and direct stresses which may result from the eccentric loading.

7.6.10 BRAKE RIGGING COMPONENTS

Brake rigging components shall be designed to withstand the forces resulting from 415 kPa brake cylinder pressure, or 560 N on the handbrake operating wheel or lever, whichever is the greater, without exceeding the following static stress limits for steel.

Levers	150 MPa
Pull rods (24 min dia.)	100 MPa
Pull rod jaws	70 MPa
Brake beams	150 MPa
Pins (in shear)	70 MPa
Pins (in bearing on projected area)	96 MPa

The force on chain shall not exceed the maximum safe working load.
Modulus of section for brake beams and levers shall be calculated with allowance made for bushed holes. A brake lever fitting into a slack adjuster clevis shall have a maximum width of 210 mm and a thickness of 25 mm. A brake lever fitting into a brake cylinder clevis shall have a maximum width of 76 mm and a thickness of 25 mm. Compression members shall be avoided if possible; if used, however, care shall be taken to treat brake hangers, push rods, or other compression members as columns or struts and check for buckling if the length exceeds five times the least transverse dimension.

In such cases the maximum stress shall be:

$$f = 96 - \frac{0.483L}{R}$$

where; f is maximum allowable stress, (MPa);
L is effective length of compression member (millimetres);
R is least radius of gyration of the mid section perpendicular to the axis (millimetres).

7.6.11 BRAKE PULL RODS

The vehicle pullrod shall not be less than 22 mm diameter and at the bogie end shall have a clevis which will connect by means of a 28.5 mm diameter pin to a 32 mm thick bogie live lever.

7.6.12 HANDBRAKE FORCE

7.6.12.1 ***Vehicles with Underframe-mounted Brake Cylinders***

The handbrake shall be designed to develop a total calculated braking force at the brake block (ignoring friction and other losses) of not less than 20% of the maximum gross mass on rail. The handbrake force shall be calculated assuming a 560 N tangential force applied to the rim of the handbrake wheel.

7.6.12.2 ***Vehicles with Bogie-mounted Brake Cylinders***

The handbrake system shall be designed to comply with the requirements of AAR Standard S-401, Section 3.

7.6.12.3 The handbrake system shall be subjected to the brake block force test specified in AAR Standard S-401, Section 4.0, with acceptable minimum values as given in Section 3.0, Table 1.

7.6.13 LOCATION OF BRAKE HEAD

The brake head shall be positioned relative to the wheel centre according to the dimensions shown on Diagram 7-5. Where primary sprung bogies are used the bogie shall have the brake blocks located at or about the centre line of the axle when loaded to 50% capacity. It is essential that the slack adjuster selected for this application be compatible with the movement of the brake block relative to the wheel to allow for axlebox spring deflection.

7.7 SINGLE CAR TEST STANDARD

7.7.1 SCOPE

7.7.1.1 This specification covers the testing of air brake equipment on all passenger and freight vehicles by means of the Single Car Test Device with Additional Volume as depicted in schematic form on Diagram 7-19.

7.7.2 TEST PROCEDURE

7.7.2.1 Preparation

(a) Verify that the single car test unit has been calibrated within a month. If not, recalibrate in accordance with 7.7.3.

(b) Fit pressure gauges (0-1000 kPa) to the brake cylinder and the auxiliary, supplementary and accelerated release reservoirs and to the dummy volume.

(c) Close all cocks on the test equipment.

(d) Connect the supply hose to an air supply of not less than 560 kPa.

(e) Connect the delivery hose to the vehicle to be tested and connect all other hoses on the vehicle to dummy couplings. Open all end cocks. This is essential to test all the end cocks and air hoses on the vehicle.

(f) All vehicles with relayed equipment shall be tested both with the Empty/Load device set in the 'L' (loaded) and in the 'E' (empty) position.

(g) Open the charging cock to charge the brake system to 500 kPa.

7.7.2.2 Brake Application Test

(a) When the brake system is fully charged close the charging cock. Release air from the brake pipe by opening the application cock.

(b) If the brakes have not applied by the time a 50 kPa reduction is achieved then the control valve is defective and shall be changed.

7.7.2.3 Brake System Leakage Test

(a) When a 100 kPa reduction has been made, close the application cock and then note the rate of fall in pressure.

(b) The maximum permissible rate of fall in pressure is 20 kPa in 15 minutes for new vehicles or vehicles issued following major air brake attention. For all other cases it shall be 20 kPa per minute, measured over a period of at least two (2) minutes.

(c) If this rate is exceeded the vehicle shall be checked for leaks, any leaks stopped and the tests recommenced from 7.7.2.2 (Brake application test).

(d) If the brakes release during this test the auxiliary reservoir and associated pipework shall be checked for leaks and rectified accordingly.

(e) If it is determined that there is internal leakage in the control valve it shall be changed.

(f) In the case of passenger cars fitted with water raising systems taking air off the brake pipe, the 100 kPa reduction shall be held for 60 seconds.

(g) On no account shall the additional volume cock be opened before or during the leakage test.

(h) On completion of the leakage test, open the charging cock and the additional volume cock to recharge the brake system.

7.7.2.4 Brake Release Tests

(a) With the brake system and the additional volume fully charged, close the charging cock and make a 70 kPa reduction by opening the application cock. Allow the pressure in the system to stabilise for 30 seconds and then open the sensitive release cock.

(b) Opening the sensitive release cock, combined with the additional volume, allows the air pressure in the brake pipe to increase at a very slow rate. The brakes must release within 30 seconds.

(c) Should the control valve fail to release in 30 seconds, brake pipe leakage shall be rectified and the release test repeated. If the control valve again fails to release in 30 seconds the valve shall be changed.

(d) Passenger cars fitted with a pneumatic water raising system shall first have this test made with the water raising system cut out. If the test is satisfactory the water raising system shall be cut in after releasing some air from the water raising system and the test repeated. Should the control valve fail to release within 30 seconds on this test, a defective air regulator or check valve on the water raising system is indicated and this defect shall be rectified and the test satisfactorily completed before the car is returned to service.

(e) On completion of the brake release test, recharge the system.

7.7.2.5 Testing of Charging Check Valves and Emergency Shut Off

After charging, close the charging cock and open the application cock. A continuous exhaust of air through the orifice nut on the application cock after the brake pipe has been drained indicates internal leakage in the control valve, leakage past the supplementary charging check valve or leakage past the water service check valve where fitted.

7.7.2.6 Testing of Empty/Load Device and Grade Control Valves

(a) After recharging the brake system of the vehicle, place the handle of the grade control valve (if fitted) to the H.P. position and the change over mechanism of the load compensating equipment, if fitted, to the 'L' (Loaded) position. On vehicles fitted with continuous load sensing equipment, the load sensing device shall be wedged up into the loaded position.

(b) Close the charging cock and make a reduction of 250 kPa by opening the application cock. After full pressure has developed in the brake cylinder move the changeover to the 'E' (Empty) position. Check that on vehicles fitted with volume device equipment, the safety valve on the variable volume device operates. If the safety valve does not operate, it shall be changed. Check that there is an exhaust of air from the relay valve, if fitted, and the brake cylinder pressure falls to the empty condition.

(c) Release the brakes by opening the charging cock and wait for a period of about two minutes before checking that there is no blow of air from the exhaust nipple of the grade control valve. If a continuous blow does exist it indicates a defective grade control valve.

(d) If air does not leak from the exhaust nipple, the grade control valve handle shall be moved to the 'normal' or 'EX' position. In this position a blow of air from the exhaust nipple of the grade control valve should be obtained until the brake cylinder is empty.

Failure to obtain this blow of air will indicate that the grade control valve, relative pipe connections, load compensating equipment pipe connections or the brake piston seals are leaking and the defect shall be rectified.

7.7.2.7 Checking Pressure Gauges

(a) On each vehicle fitted with a brake pipe pressure gauge the accuracy of the gauge shall be checked against the pressure gauge on the test equipment. Should any discrepancy greater than 15 kPa between the gauges be noted then the brake pipe pressure gauge shall be changed.

7.7.2.8 Concluding the Test

(a) Upon the conclusion of these tests, the test equipment shall be disconnected from the vehicles and all cocks shall be placed in the open position, and all flexible hoses connected to dummy couplings.

(b) Check the vehicle to see that the grade control valve is in the exhaust position and that the load changeover mechanism is in the appropriate position for the loading.

7.7.3 CALIBRATION OF SINGLE CAR TEST DEVICE

7.7.3.1 Each single car test device shall be tested at intervals of not more than one year. The pressure gauges shall be checked against the master shop gauges and any discrepancy greater than ±5 kPa shall be recorded and corrected. Gauges shall be replaced if there is a variation with the master gauges of more than 15 kPa.

7.7.3.2 The test device shall be connected to a shop air supply with a supply pressure not less than 560 kPa. All pipe joints, valves, fittings, hoses and connections shall be checked for leakage, the operation of all valves, including non-return (check) valves, shall be checked, and the condition and timings of the chokes checked and recorded. Each test device shall be clearly marked with the due date of the next test.

DIAGRAM 7-1

CONTROL VALVE MOUNTING FACE

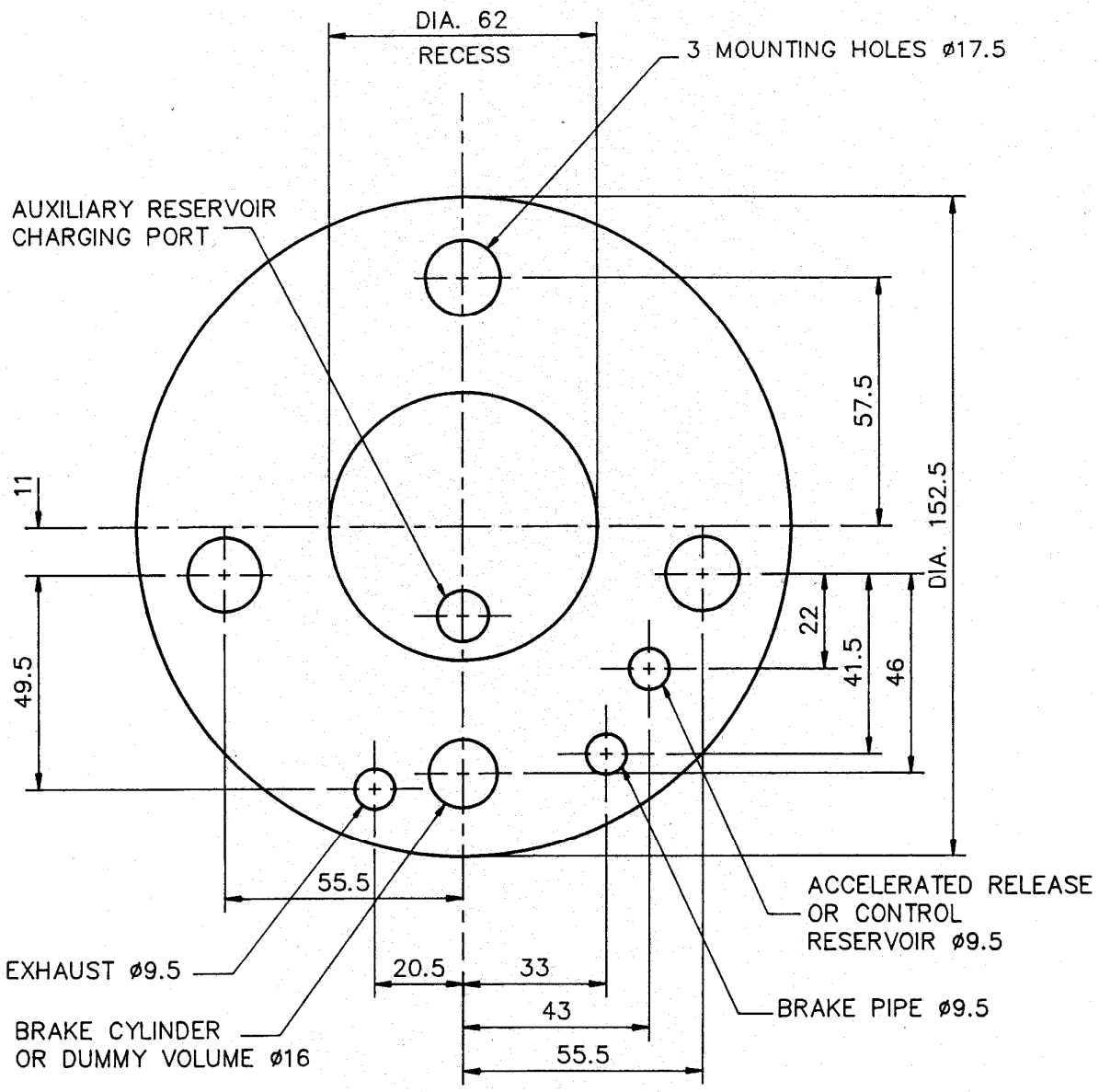


DIAGRAM 7-2

BRAKE CYLINDER
254 BORE X 300 STROKE

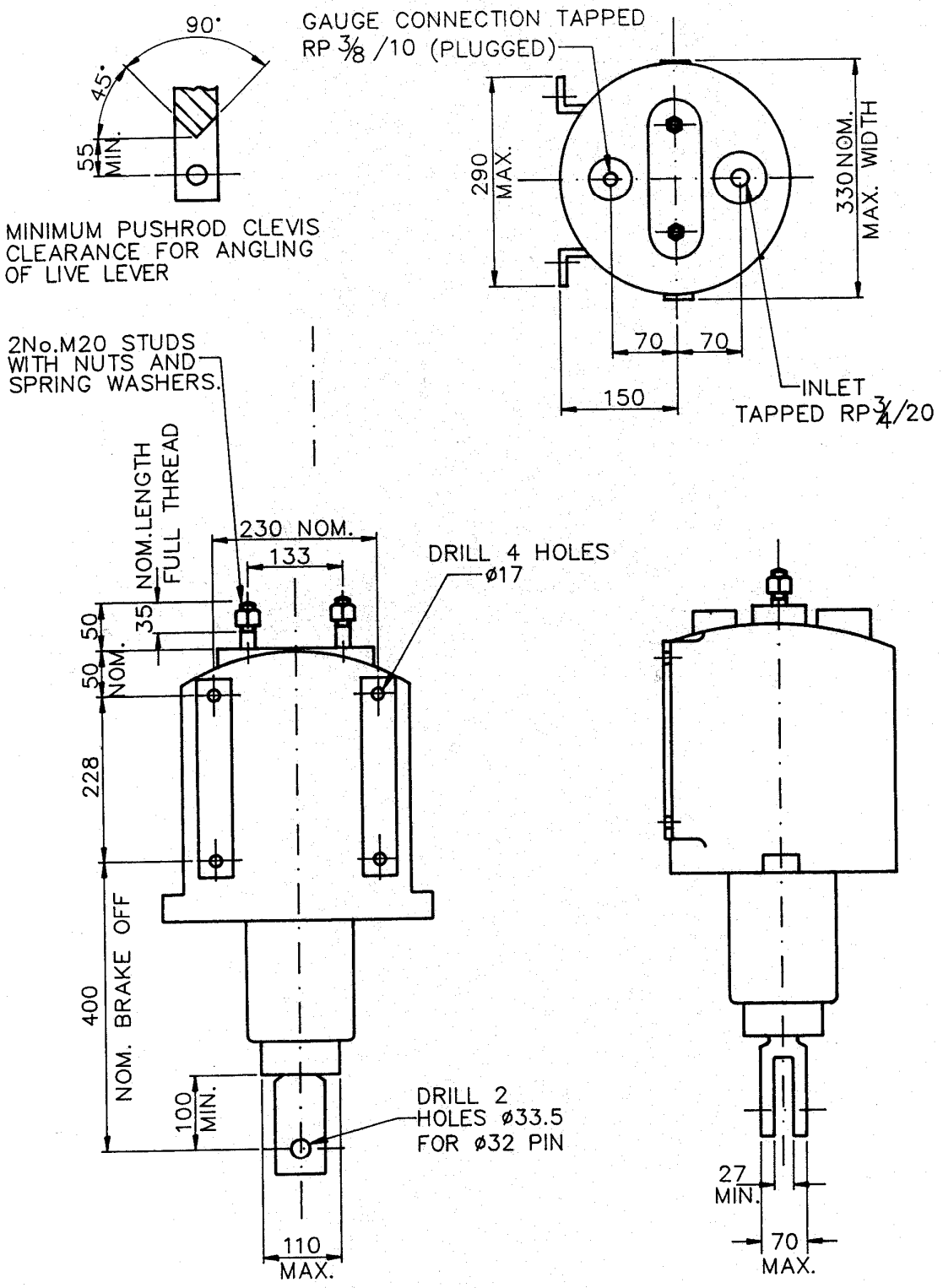


DIAGRAM 7-3

BRAKE CYLINDER
305 BORE X 300 STROKE

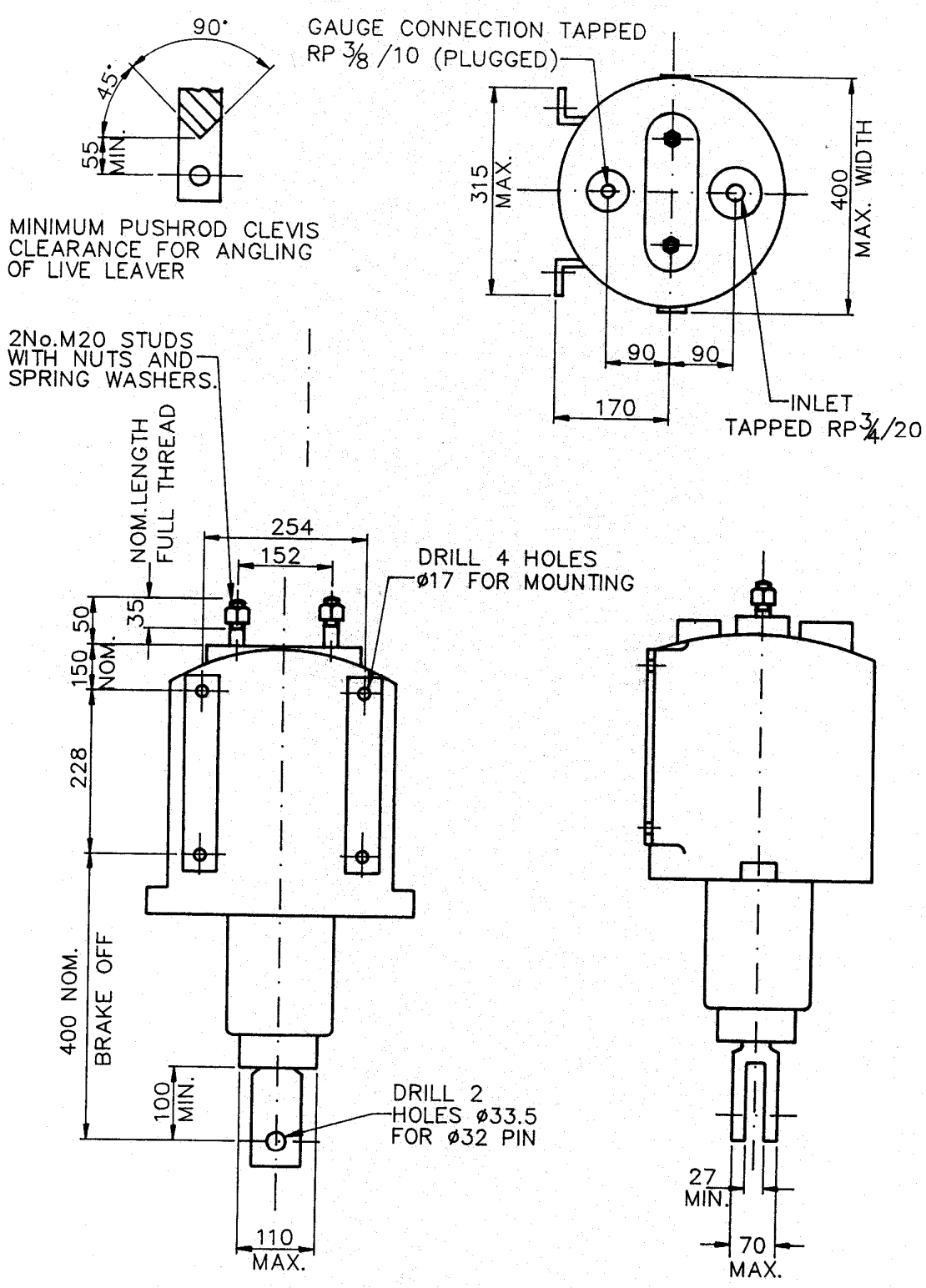
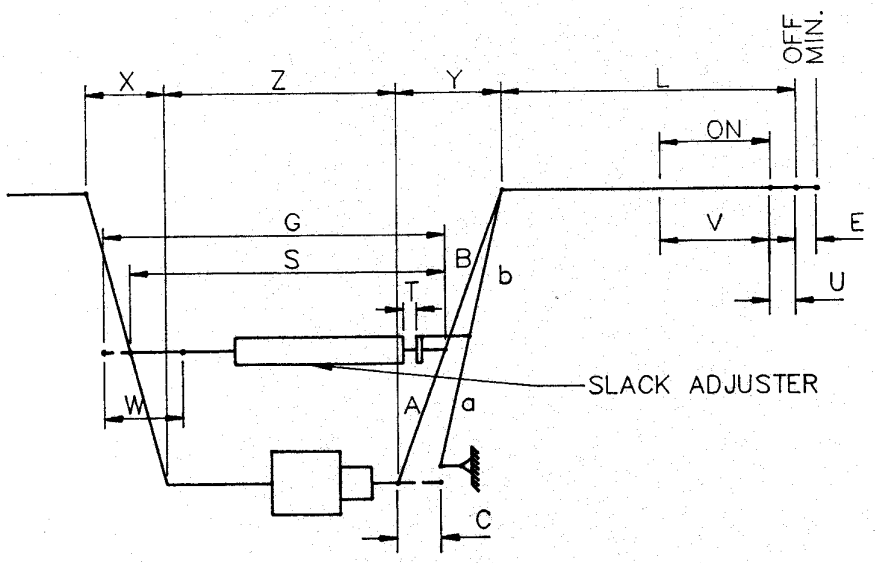


DIAGRAM 7-4

TYPICAL RIGGING LAYOUT
GENERAL PURPOSE VEHICLE

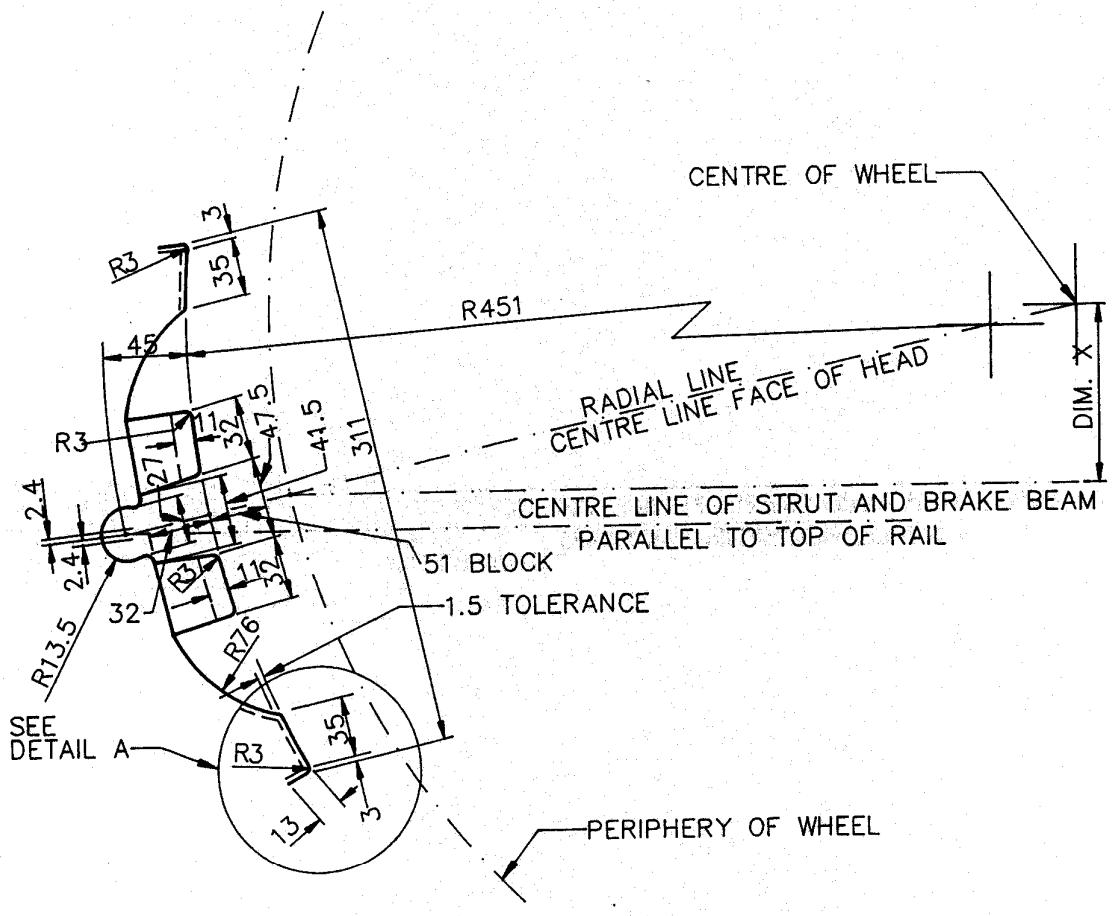


GROSS MASS ON RAIL			76t	92t	100t
BOGIE BRAKE RATIO	R		4	4	4
OVERALL VEHICLE RATIO			7.02	8.50	9.24
PULLROD FORCE per BOGIE		KN	15.56	18.84	20.48
LIVE LEVER RATIO; A/B=a/b			0.88	1.06	1.15
ASSUMED LIVE LEVER LENGTH=A+B		mm	890	890	890
BRAKE BLOCK WEAR	D	mm	38	38	38
BRAKE BLOCK CLEARANCE		mm	12	12	12
OFF TO ON DISTANCE per BOGIE	U	mm	48	48	48
ON RANGE OF PULLROD	V=DR	mm	152	152	152
MIN. TO OFF POSITION	E	mm	25	25	25
PISTON TRAVEL	C	mm	84	102	111
DEAD LEVER LAY	X=(V/2)+U	mm	124	124	124
LIVE LEVER LAY	Y=C+X	mm	170	188	197
EXTENDED LENGTH OF SLACK ADJ.	G	mm	2030	2030	2030
SLACK ADJUSTER INSTALLED LENGTH	S=G−(2EA/(A+B))	mm	2007	2004	2003
MINIMUM SLACK ADJUSTER TRAVEL	W=2(V+E)A/(A+B)	mm	166	183	190
CONTROL ROD CLEARANCE	T=CB/(A+B)	mm	45	49	51
PIN TO PIN DISTANCE	Z=G−(A/(A+B))(X+Y+2E)	mm	1887	1863	1852

***THE ABOVE VALUES ARE BASED ON A ø254 BRAKE CYLINDER AT A PRESSURE OF 350kPa, HIGH FRICTION BLOCKS AND A MINIMUM DESIGN LOADED BRAKE RATIO OF 16.7%.**

DIAGRAM 7-5

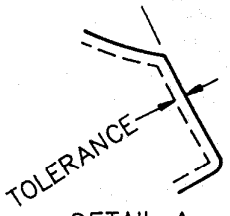
BRAKE HEAD LOCATION



DIMENSION X=89 FOR FREIGHT BOGIES, WITHOUT AXELBOX SPRINGING AT TARE

= 50 FOR FREIGHT BOGIES, WITH WITH AXELBOX SPRINGING AT TARE

= 25 FOR PASSENGER BOGIES AT TARE



DETAIL A

FOR CAST IRON BRAKE BLOCKS
MAXIMUM TOLERANCE: −1.5

DIAGRAM 7-6

AIR BRAKE HOSE NIPPLE

MATERIAL SPECIFICATION:
SPHEROIDAL GRAPHITE CAST IRON A.S.1831 GRADE 370–230–17
OR MALLEABLE CAST IRON A.S.1832 GRADE 340–12

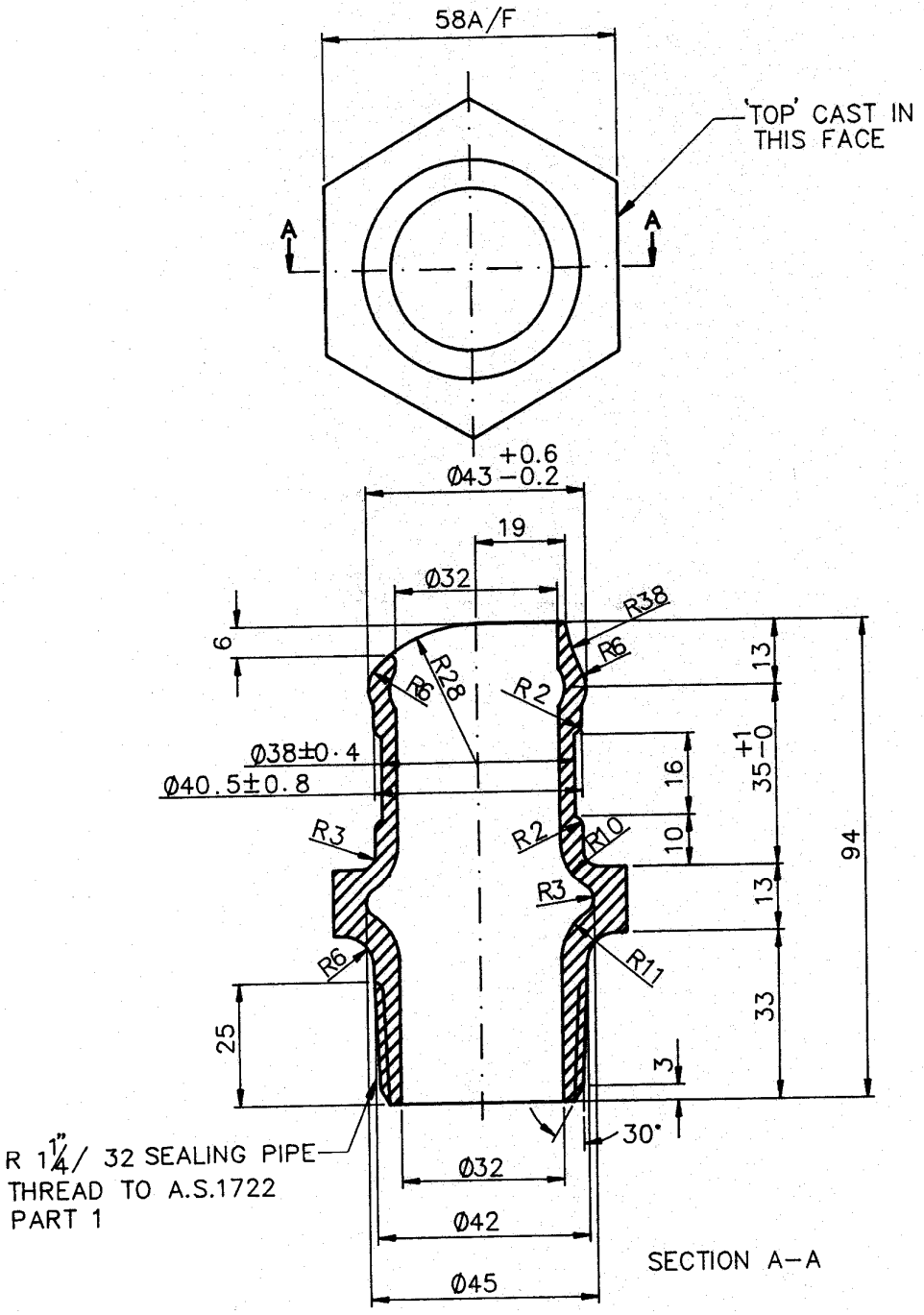


DIAGRAM 7-7

SEAL - AIR BRAKE HOSE COUPLING

MATERIAL SPECIFICATION: NITRILE RUBBER SHORE A DURO HARDNESS 75–80

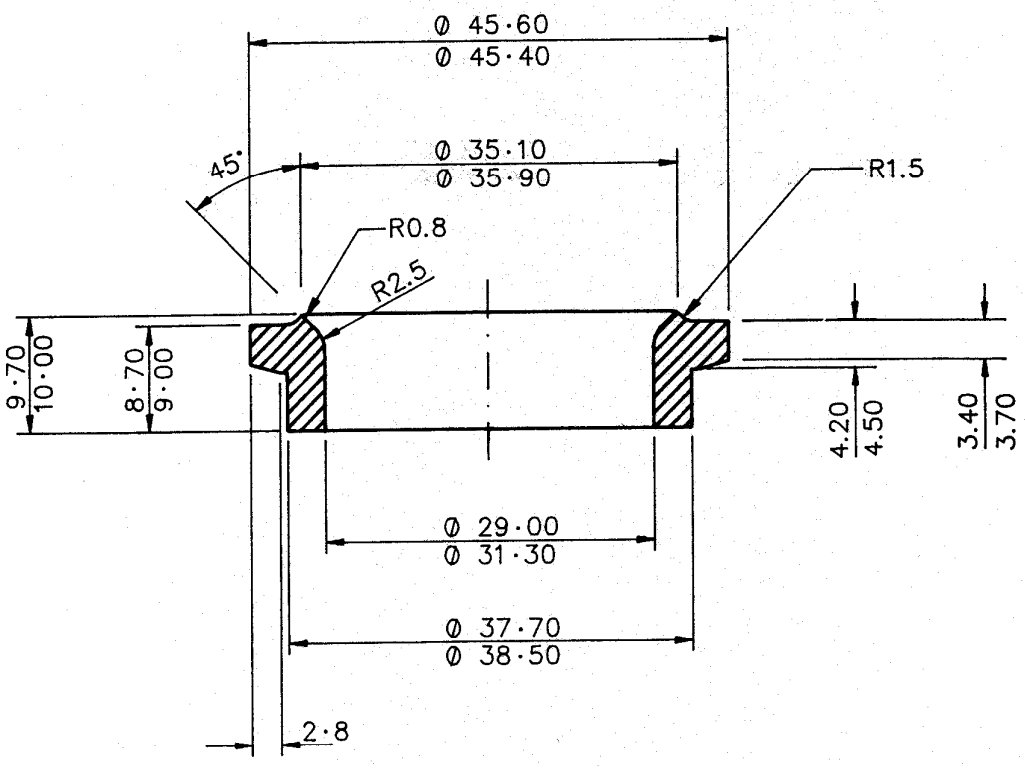


DIAGRAM 7-8

AIR BRAKE COUPLING -
32 mm NB

(PINLESS TYPE WITH EYE)

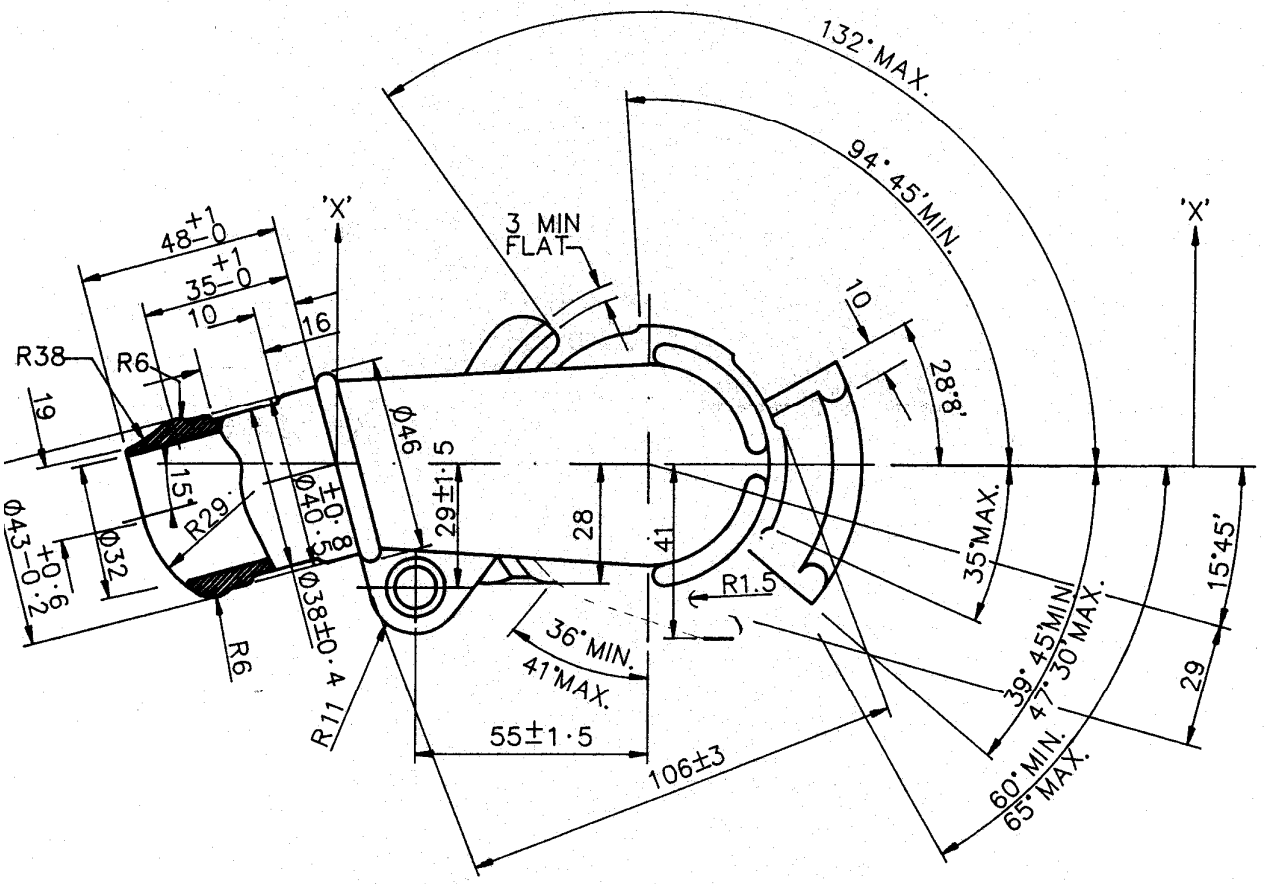


DIAGRAM 7-9

FLEXIBLE COUPLING HEAD
32 mm NB

NOTE: 1.Coupling heads to be manufactured to meet R.O.A. brake coupling gauges for new couplings shown in section '17' of this manual.

2.MATERIAL SPECIFICATION–Spheroidal graphite cast iron AS.1831 g.r.370–230–17 OR Malleable cast iron AS.1832 G.R.340–12.

3.SURFACE TREATMENT–To be specified by ordering system.

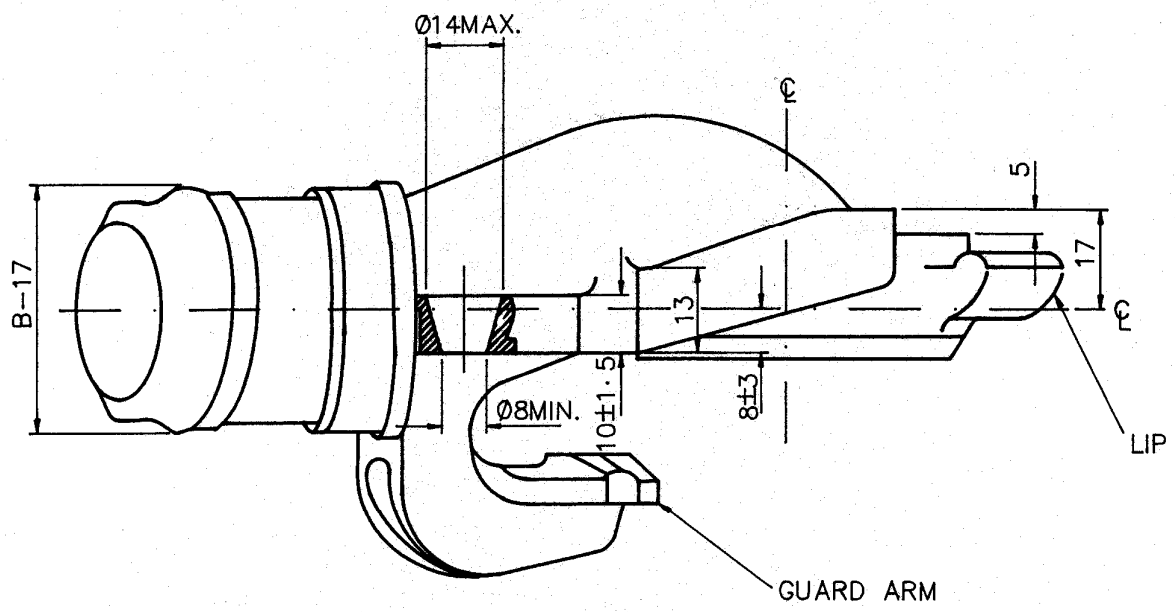


DIAGRAM 7-10

FLEXIBLE COUPLING HEAD DETAILS

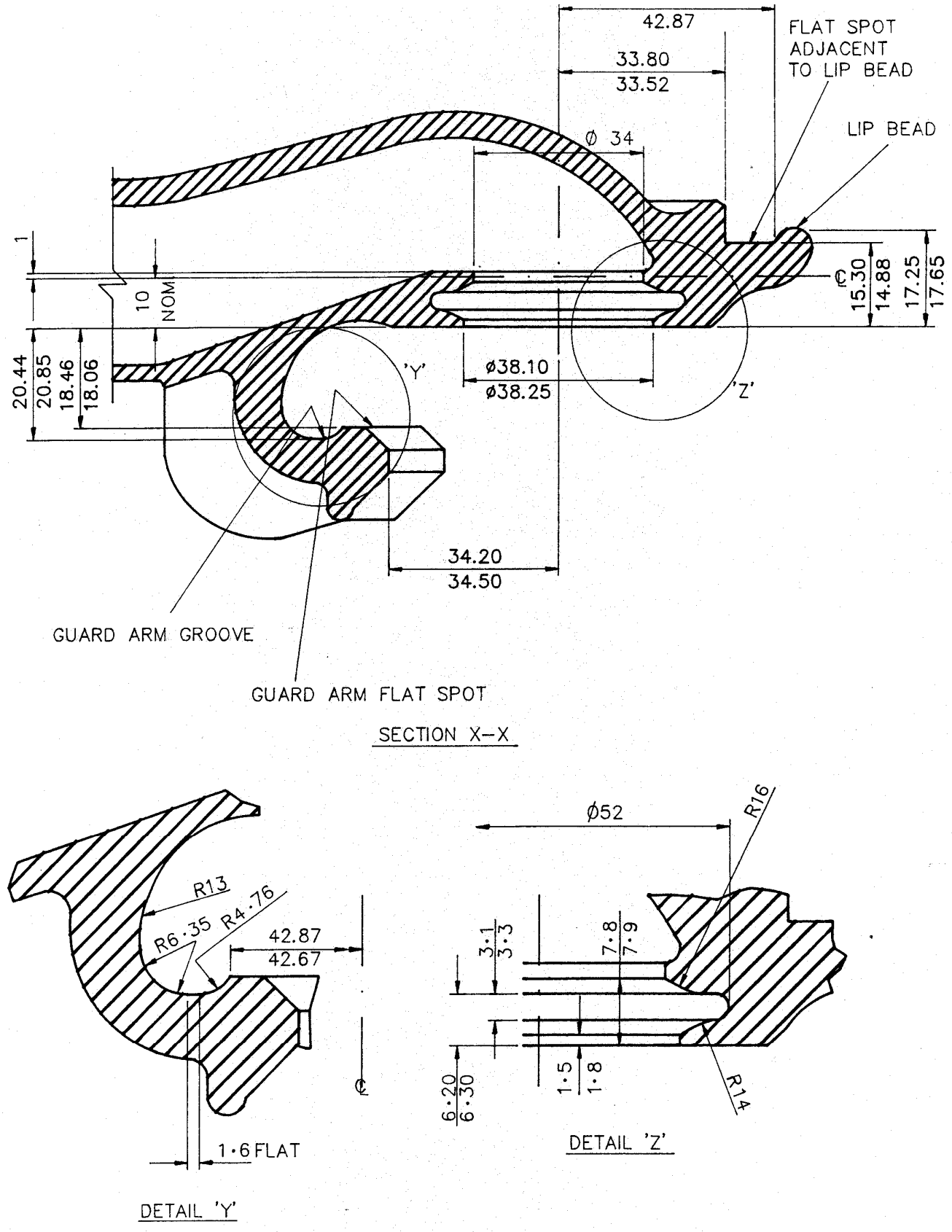
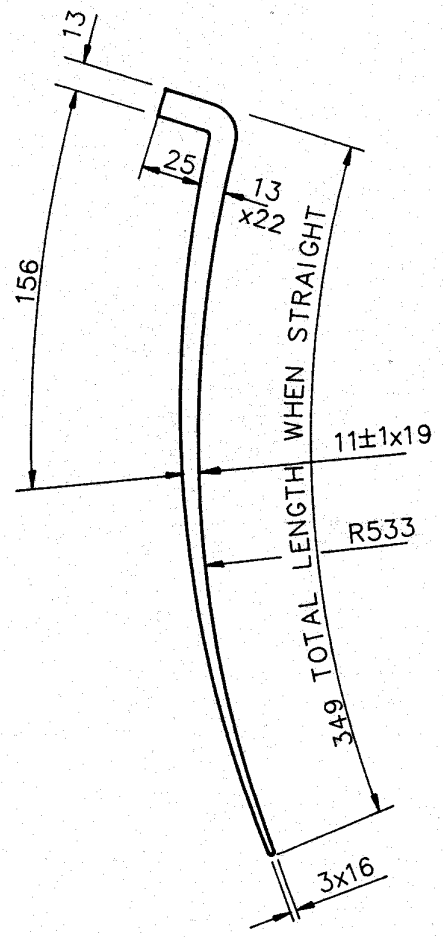


DIAGRAM 7-11

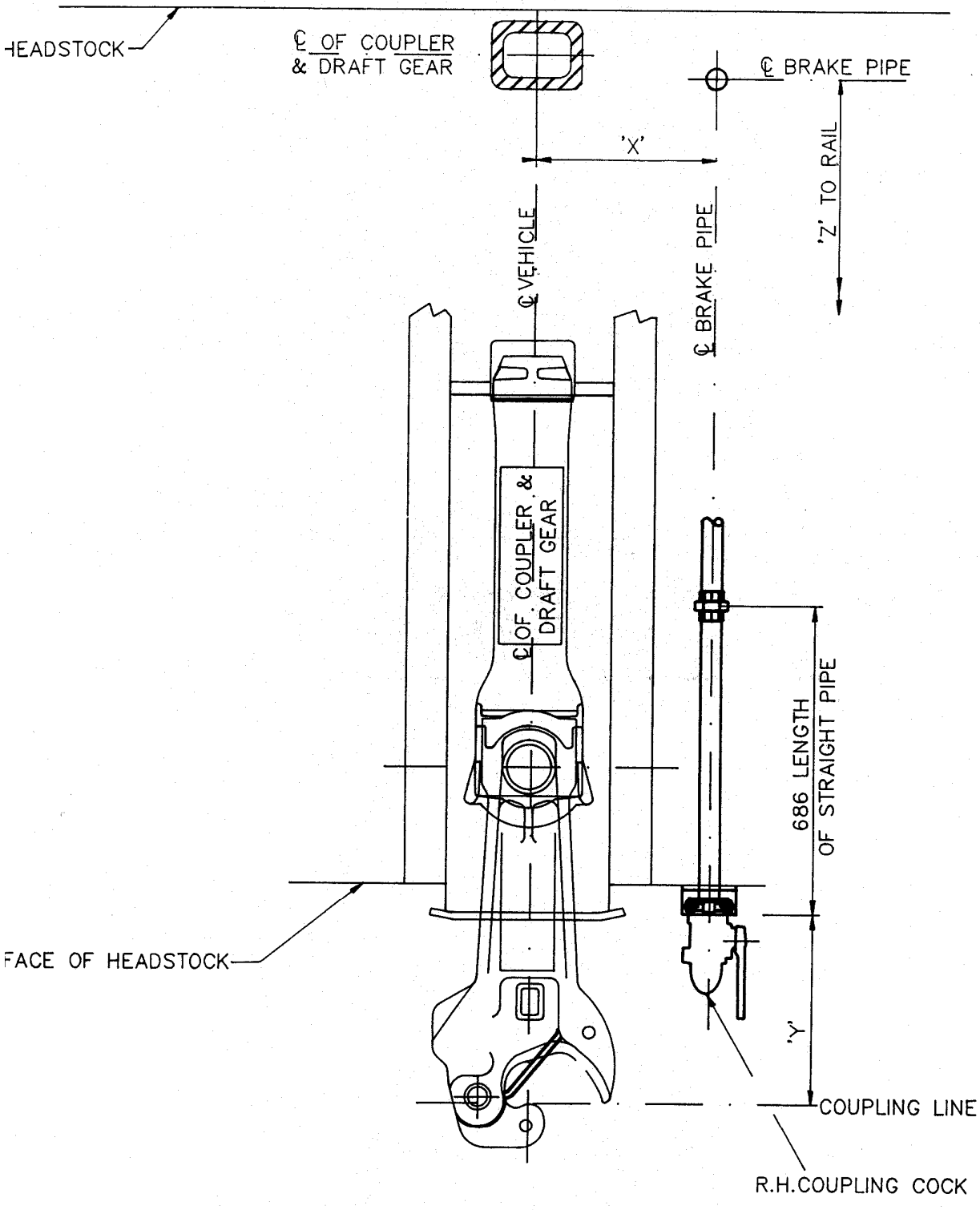
BRAKE BLOCK KEY



MATERIAL: SPRING STEEL AS 1449.

DIAGRAM 7-12

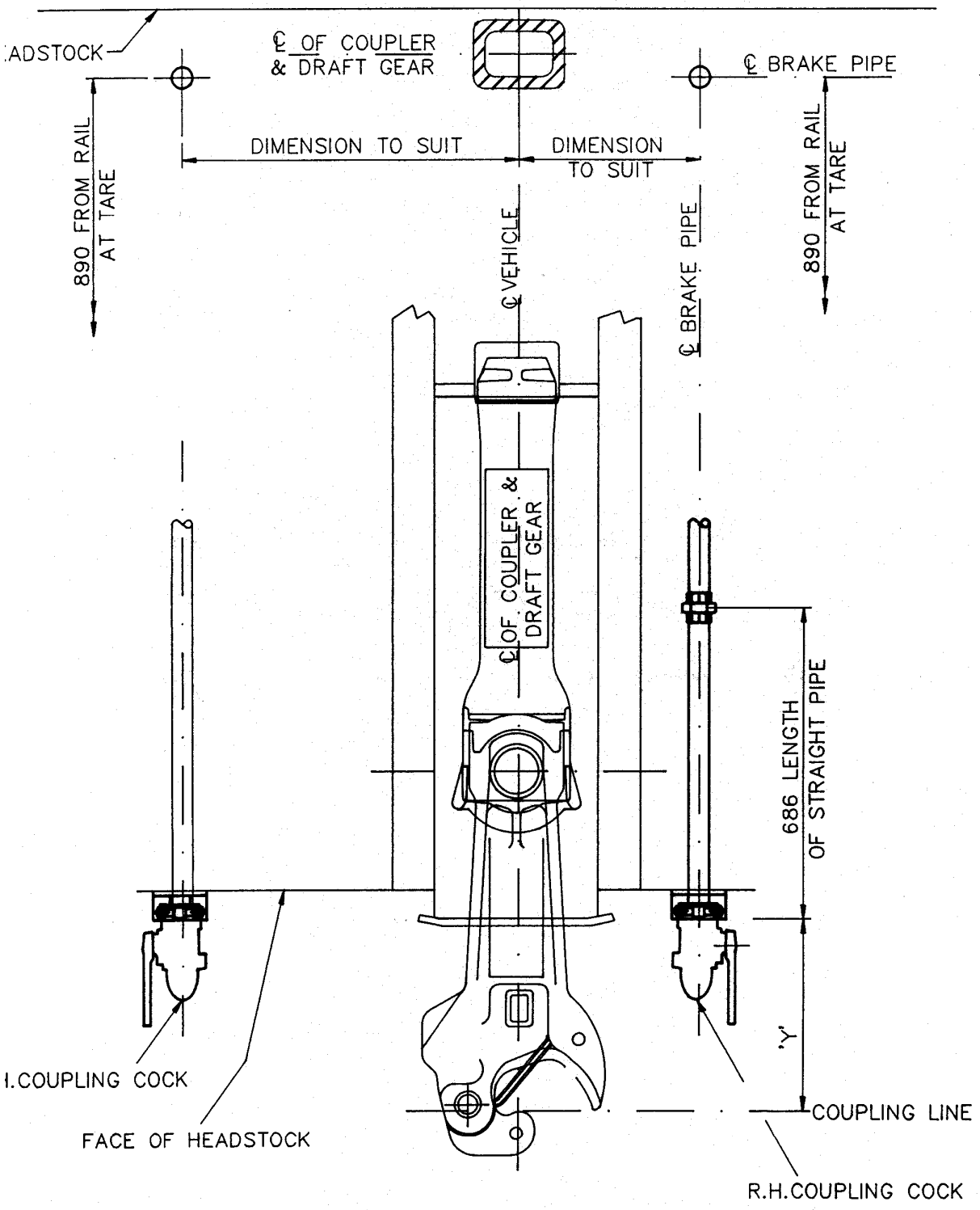
LOCATION OF BRAKE PIPE - SINGLE



DIMENSION 'X' MIN.330 MAX.410
" 'Y' MIN.330 MAX.410
" 'Z' MIN.840 MAX.860
} 'X'+'Y' MUST EQUAL 740

DIAGRAM 7-13

LOCATION OF BRAKE PIPE (BIFURCATED)



DIMENSION 'Y' MIN.330 MAX.410

DIAGRAM 7-14

TYPICAL PIPE LAYOUT - SEPARATE RESERVOIRS

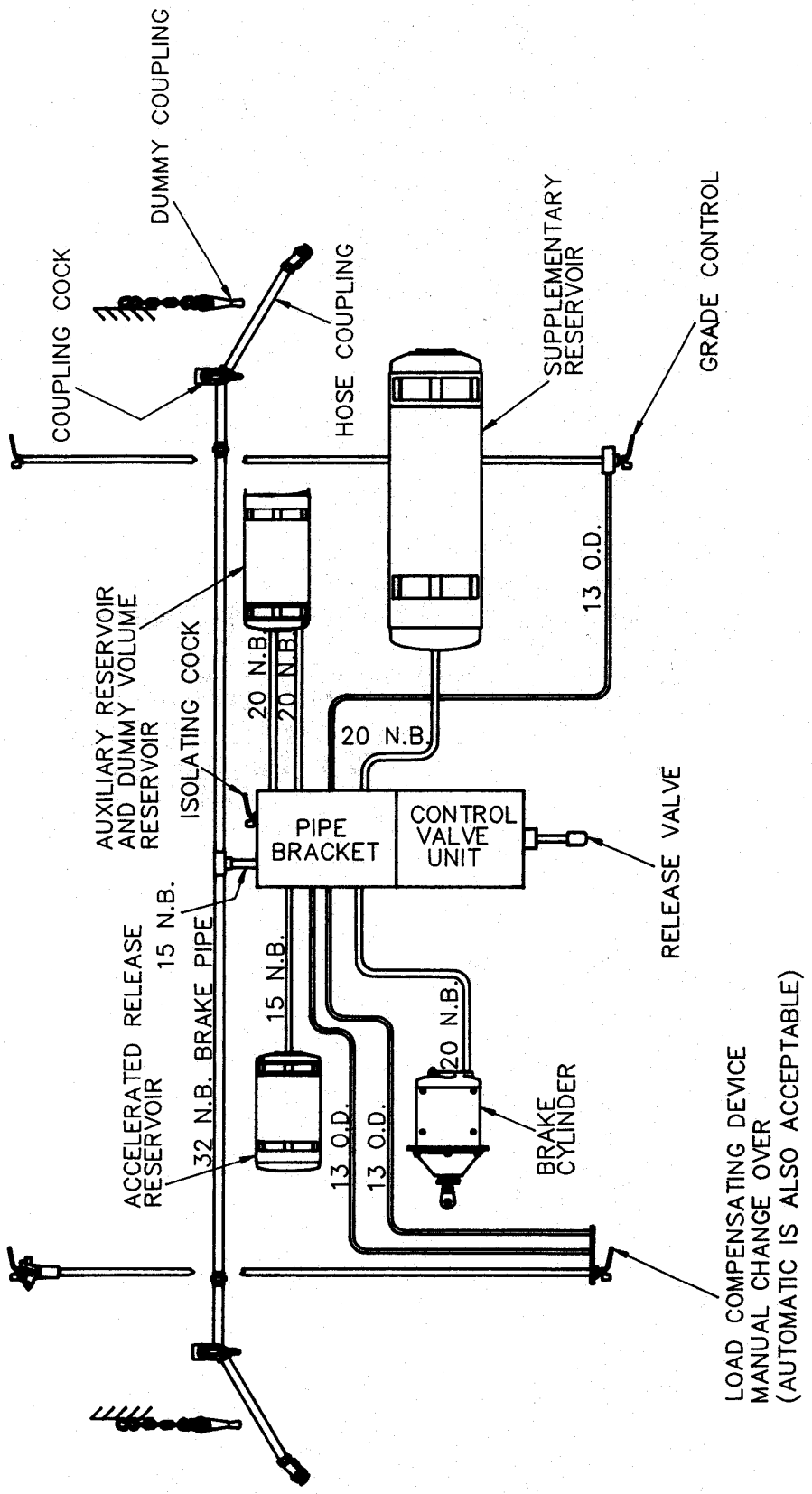


DIAGRAM 7-15

TYPICAL PIPE LAYOUT - COMBINED RESERVOIRS

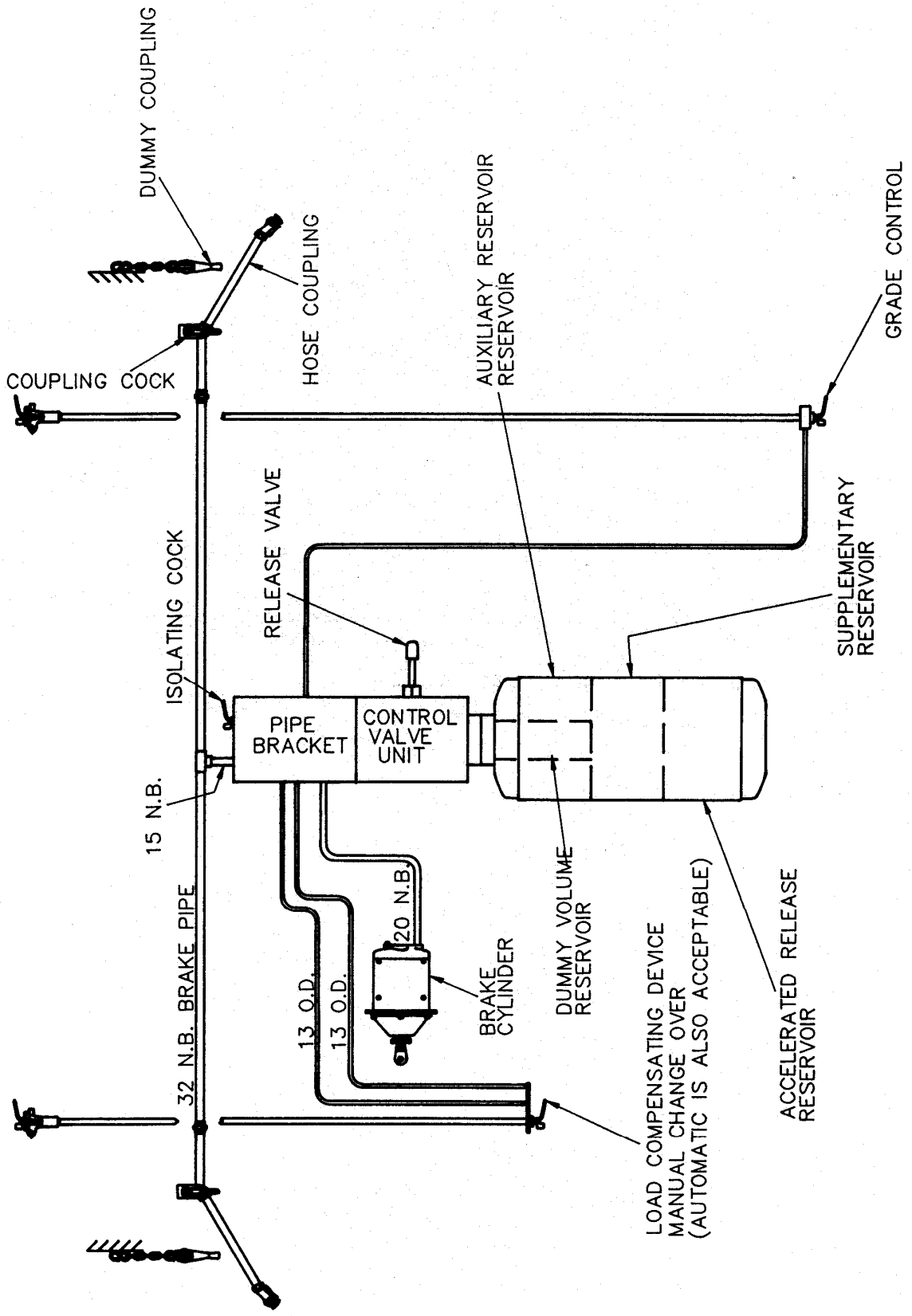
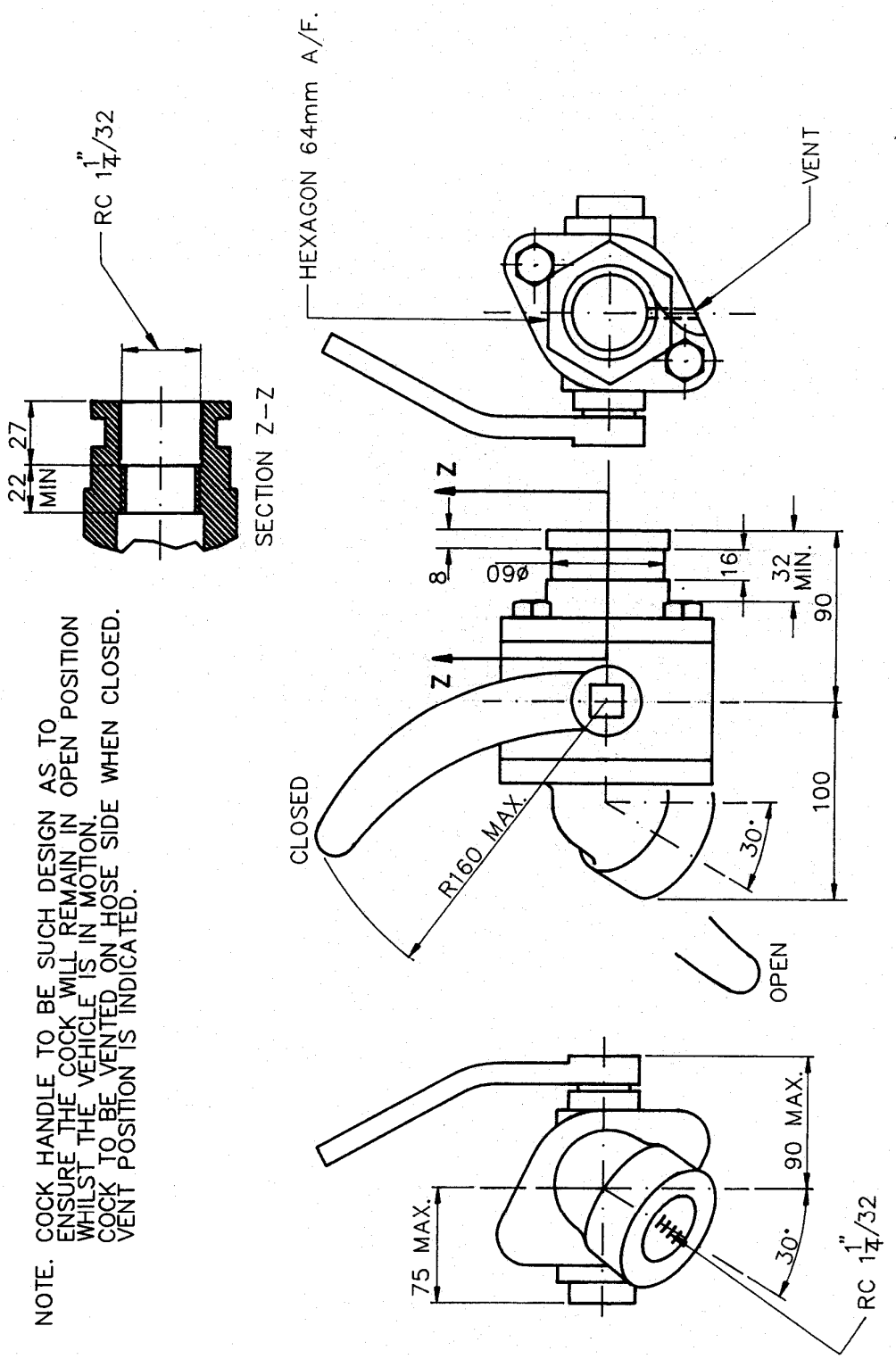


DIAGRAM 7-16

AIR BRAKE COUPLING COCK



NOTE. COCK HANDLE TO BE SUCH DESIGN AS TO ENSURE THE COCK WILL REMAIN IN OPEN POSITION WHILST THE VEHICLE IS IN MOTION. COCK TO BE VENTED ON HOSE SIDE WHEN CLOSED. VENT POSITION IS INDICATED.

DIAGRAM 7-17

HANDBRAKE HANDWHEEL

NOTE: CENTRE HOLE

1. TAPERED TO SUIT AAR HANDBRAKE
   OR
2. 28mm SQUARE FOR TRANSVERSE GEARED HANDBRAKES.

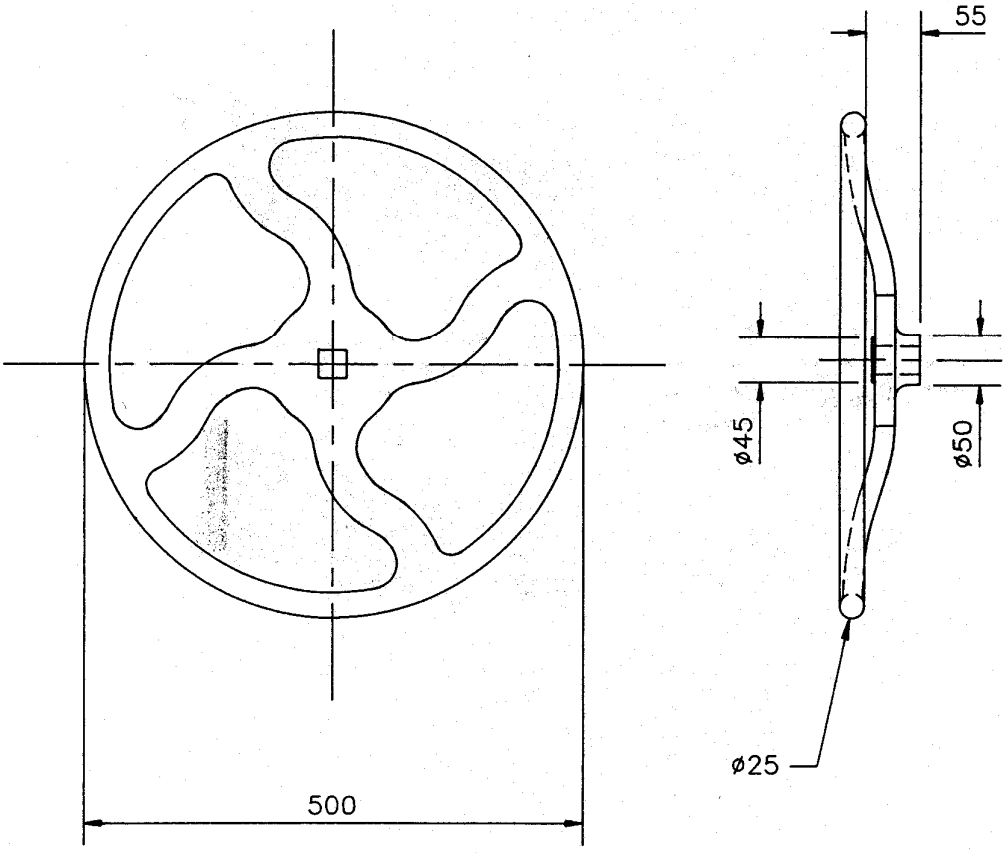
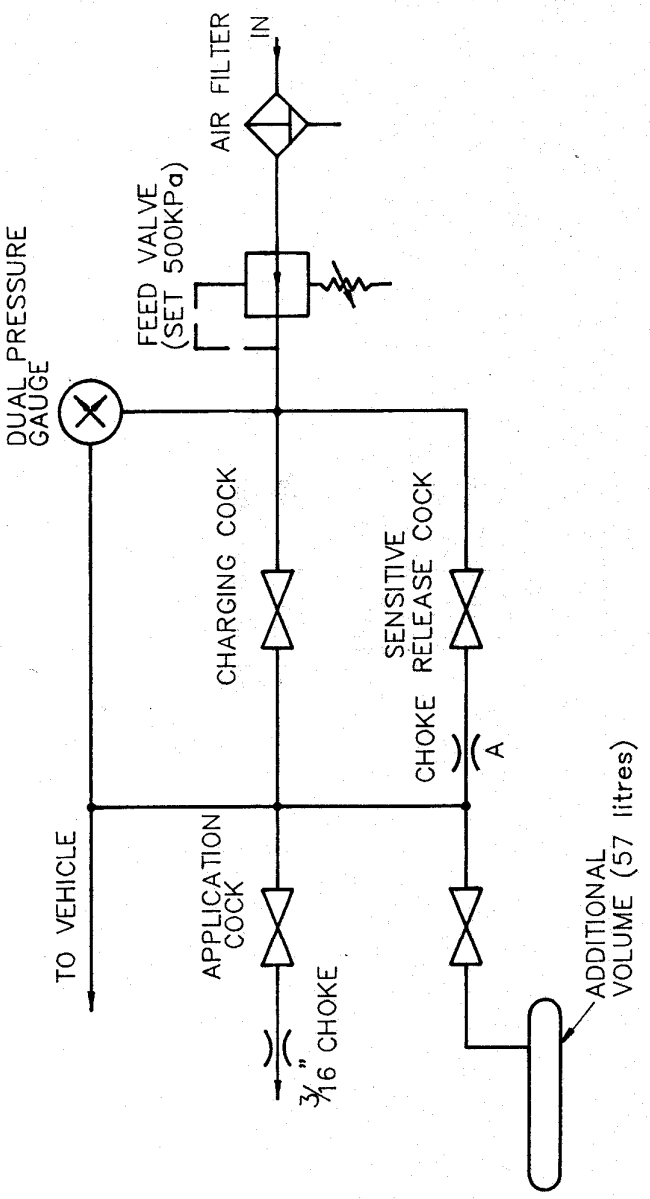


DIAGRAM 7-18

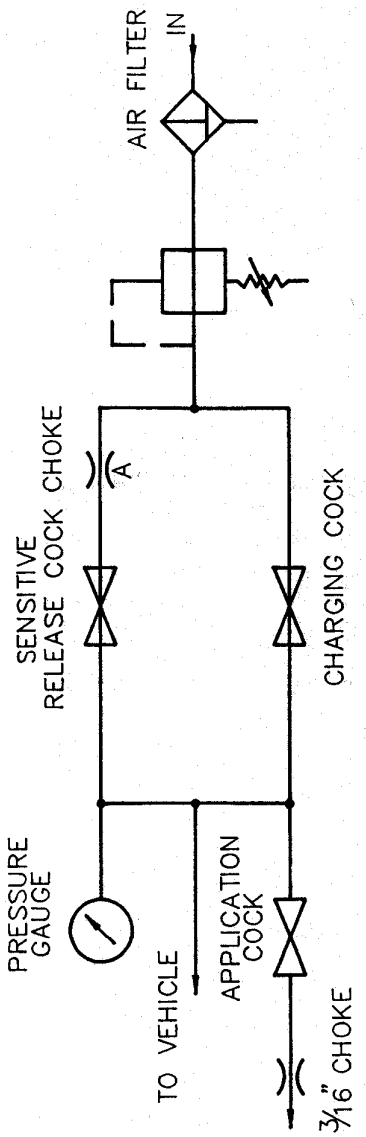
AIR BRAKE TEST STAND
SCHEMATIC DIAGRAM



CHOKE SIZE A	BRAKE EQUIPMENT
No.56(·0465")	12",14" or 16" Triple Valve
No.61(·1875")	Relayed or 10" Triple Valve

DIAGRAM 7-19

SINGLE CAR TEST DEVICE
SCHEMATIC DIAGRAM



CHOKE SIZE A	BRAKE EQUIPMENT
No.56(·0465")	12",14" or 16" Triple Valve
No.61(·1875")	Relayed or 10" Triple Valve