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REPORT

OF THE

SUB-PANEL ON ROAD ROLLERS



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GOVERNMENT OF INDIA
DEPARTMENT OF INDUSTRY & SUPPLY
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REPORT OF THE SUB-PANEL ON ROAD ROLLERS OF THE INDUSTRIAL PLANT AND MACHINERY (HEAVY) PANEL

Introduction.—This Panel was constituted during the latter part of 1945 as a Sub-Panel to the main Panel dealing with Industrial Plant and Machinery (Heavy) to consider the manufacture of road rollers in India. It was not found possible to examine the road roller question in detail until some progress had been made in investigating the possibility of manufacture in India of Industrial Plant and Machinery in general.

Demand for Road Rollers.—There has so far been no manufacture of road rollers in India and the whole of India's requirements has had to be imported. No import figures are available in the published statistics ; and the figures given below have been estimated on the available data obtained from several sources.

The Transport Department, as the result of a questionnaire addressed to all important Administrations in India, estimate the number of road rollers registered in the country (including the States) at 1,800 to 2,000. Most of these are, however, more than 20 years old, and many have not only served their useful life but are beyond repair. It is estimated that of the total number available only 900 to 1,000 power driven road rollers will be fit for use during the next few years.

At a Conference of the Chief Engineers of Provinces and States held at Nagpur in December 1943, it was recommended that the immediate (ten year) post-war mileage of roads should be placed at 147,000 miles of hard crust roads (National and Provincial Highways and Major District Roads) against an existing mileage of 79,000 miles and of earth roads (other District and Village roads and National Trails) at 253,000 miles against the present mileage of 163,000. At the same Conference it was estimated, on the assumption of the completion of the programme in ten years and at the rate of 6 miles of new construction or 25 miles of maintenance for one road roller per year, that the minimum demand for road rollers would be 3,000. It was also decided at the meeting, as a matter of immediate importance, that pending manufacture in India, which would take time, orders should be placed forthwith for one-third of the final requirements of road rollers to take up the road construction work which would be required immediately on the cessation of hostilities. Accordingly indents for new road rollers have already been placed as follows :—

United Kingdom	250
Australia	250
United States of America	209
Total	709
India	*1,500
	2,209

* To be manufactured on a co-ordination basis between the Ordnance factories and few private workshops.

With the estimated 900 to 1,000 serviceable road rollers now available in the country, the immediate estimated demand for road rollers has been met.

On the basis of the figure of 3,000 road rollers to be kept in continuous service in the country, it was estimated by the Transport Department that the sustained annual demand for road rollers in the form of replacements would be about 300 after the year 1952. It was also provisionally decided by the same authority that of the 3,000 road rollers, a third should be diesel units and the rest steam units. Assuming the life of a diesel unit at half that of a steam road roller, the sustained annual demand after the year 1951 would be

150 road rollers (diesel) a year.

150 road rollers (steam) a year.

At the present day average cost of about Rs. 25,000 per road roller, the annual replacement cost of these road rollers may be taken at Rs. 75 lakhs. At the pre-war rate (1935-36 cost basis) this is equivalent to Rs. 41 lakhs. The annual demand for "spares" may be taken at the same amount, Rs. 75/41 lakhs.

DEVELOPMENT OF MANUFACTURE OF ROAD ROLLERS IN INDIA

During World War II, there was certainly some manufacture of small diesel engines and the manufacturing capacity might hereafter be expanded to form the nucleus of diesel road roller manufacture in India. Unfortunately, such manufacture has not yet reached a stage of development which would justify it being said that diesel power units for road roller construction can be made in India in any great quantity, although one firm has taken an "educational order" to manufacture 6 diesel road rollers in the country.

For the manufacture of steam powered road rollers, there is no manufacture of either steam engines or steam boilers, though extensive repair and maintenance work of this type has been undertaken in several of the railway workshops. It is understood that one engineering workshop has already worked out a scheme for the manufacture of locomotives for the railways, and this might very soon lead to the manufacture of steam powered units for the manufacture of steam road rollers in India.

As already stated, however, 1,500 road rollers, of which 500 are to be diesels and 1,000 steam, are already being manufactured in India on a co-ordination basis between the Ordnance Factories and private workshops.

Roughly speaking, the following components go to make road roller units :—

- (a) Power unit, either a diesel engine power unit of about 30 BPH or a steam boiler and steam engine power unit of about 30 BPH.
- (b) A Frame, to carry the power unit and transmission.
- (c) A Steering Head.
- (d) A Steering Fork.
- (e) A Fore-Carriage.
- (f) A Steering Gear.
- (g) A Speed Reduction Gearing and Power Transmission unit

- (h) Clutches.
- (i) Spring Mountings.
- (j) Brakes.
- (l) Fuel or Feed Water-Tanks, and
- (m) Miscellaneous Fittings and Instruments, etc.

With such varied types of component parts and the limited annual demand of 300 a year, it should be evident that it will not be economical to manufacture and assemble all the component parts in one workshop. The most practical course would be to set up a road roller manufacturing and assembling workshops where only a few of the major component parts such as the underframe, etc., would first be made. The other component parts should be manufactured in other engineering workshops suited to turn out specific types of products such as castings, steam boilers and engines, diesel engines, rolls, reduction and transmission gear units, etc. This is the method of manufacture suggested for the manufacture of Industrial Plant and Machinery (Heavy) in general.

REQUIREMENTS OF CAPITAL GOODS

Materials of Construction.—The materials of construction are mostly iron and steel. Alloy steels and non-ferrous alloys such as brasses and bronzes will also be required in limited quantities. The alloying elements like nickel, chromium, copper, zinc, tin and antimony, etc. will require to be imported to begin with.

Substitute alloys that require less of these alloying elements might be developed with the development of the machinery industries in general.

For the highly stressed parts such as the power units, steering gears speed reduction gearing and power transmission units, certain special alloy steels will be required. For sleeve bearings and for miscellaneous fittings, non-ferrous alloys will be necessary.

Rolled Sections.—Fortunately at the present stage of development of the metallurgical industries in India, the greater part of rolled sections of steel in general demand for this manufacture are being rolled in great quantities. Such rolled sections in demand for this manufacture are channels, plates and angles, etc.

Foundries.—The majority of component parts that go into the construction of a road roller are usually castings. The cylindrical block of the power unit, be it a diesel engine or a steam engine, is invariably a casting. The steering head and the steering fork are also castings. The rolls or wheels may be castings for the major part of their construction or they may be made up of mild steel plates. There are many other parts as well that are castings.

Though there are several iron foundries distributed all over India, the greater part of which are attached to some of the engineering industries already existing, yet few foundries have been developed on modern lines to turn out the heavy castings required for this industry. Most of the foundries in India are poorly equipped for the production of these heavy castings. There is usually too much of sand contamination, and except a few foundries, there is generally no sand cleaning and control. Except in a few foundries, there is no mechanical equipment for the proper cleaning of castings, nor are there any annealing furnaces provided to permit of proper annealing of castings

Further, modern technique of metallurgical controls and metal pouring is not much practised in most of the foundries which are therefore not quite suitable for the manufacture of road rollers.

The steering head and the steering fork, etc. must be steel castings if not forgings. Except in the Ordnance Factories and a few private workshops there is no manufacture of steel castings in India. With the establishment of steel foundries proposed for the development of manufacture of Industrial Plant and Machinery (Heavy) there should be no difficulty in obtaining proper steel castings for the manufacture of road rollers.

Forgings.—The forgings required for the construction of road rollers are not massive. They are required in the construction of power units, for the small parts of the gearing, transmission and steering systems and for the spring mountings, etc. Except in the Ordnance Factories, and a few private industries, where certain forgings are made mostly for wagon construction, there is very little organised forging in this country.

For the development of manufacture of Industrial Plant and Machinery (Heavy), it was proposed to organise a few forge shops. The manufacture of road rollers like other heavy industries cannot be undertaken satisfactorily without forge shops.

Welded, Riveted and Structural Work.—The underframe and the fore carriage of road rollers are usually riveted structures. The boiler and the fuel oil or water tanks are also of riveted construction. There is very little of welded construction in the manufacture of these component parts. The art of riveted construction is well developed in India, and there are several private concerns that can adequately meet the industry's demand. The welding industry had made great progress during the war period. Modern technique of welding has developed to a high standard, and it can be expected that several of the riveting operations that are now in vogue will soon be replaced by "welding". Unfortunately, the Indian Boiler Regulations are so rigid in the respect that no welding is permitted in the construction of parts subject to steam pressure in spite of the fact that in U. K. and U. S. A. such welding had been approved and become common practice of late. It is time that the Indian Boiler Regulations are redrafted and brought in line with the up-to-date practice abroad, and welding permitted in the construction of small boilers like those required for road rollers. Along with such welding practice should be developed the technique of X-ray photographic method of inspection as well. Such construction will simplify the manufacture of steam road roller boilers that are invariably small in size and of low pressure construction.

Gears, Steering, Gearing and Transmission Gearing, etc.—These high grade products are required for the construction of road rollers. These products are not being manufactured satisfactorily anywhere in India. High duty, precision gear units are necessary for the manufacture of road rollers. For the manufacture of Industrial Plant and Machinery (Heavy) in general the setting up of a few of such gear manufacturing units was proposed. In the meanwhile the greater part of these products can be made in the Ordnance Workshops.

Tubes.—Steel tubes are required for the manufacture of the steam power unit, viz., the boiler. There is no manufacture of tubes in India. It is understood that the plans for the manufacture of tubes have taken shape and applications for the import of plant have been registered. In the meanwhile, all tubes that are required for the manufacture of road roller boilers must be imported.

Miscellaneous parts such as Cranks, Flywheels, Clutches, brakes, Springs, Bearings and Fittings, etc.—There is in India no organised manufacture of these products of the desired grade or quality. Roller bearings required, mostly for the gearing and transmission systems require to be imported as it would be some years before these can be satisfactorily manufactured in India. In connection with the manufacture of Industrial Plant and Machinery (Heavy), the manufacture of certain ancillary products such as these was proposed. It is only after such units of manufacture are established, that it will be possible for this country to get supplies from indigenous sources. In the meanwhile some of these manufactures can be taken up by the Ordnance Factories which are equipped for that work. The rest must be imported.

OWNERSHIP OF THE INDUSTRY

Market.—The purchasers of power driven road rollers will consist almost entirely of Government Departments, local bodies, the railways, State Governments, and public bodies generally. For this reason the Government should exercise control over the manufacture.

Private Capital.—As the yearly demand will be small (300) and there is not much likelihood of an export market being developed in the near future, the manufacture of road rollers can never form a separate industry. Industries engaged in other forms of machinery and plant manufacture, however, will be glad to undertake the supply of road roller parts and there is no danger of lack of capital for this. The total capital to be invested to supply 300 rollers a year will be in the order of $1.6 \times 75 = 120$ lakhs on the 1944-45 cost basis—(See main report Industrial Plant and Machinery Panel). Since however this manufacture will be distributed among several factories, the capital required by each will be comparatively small.

Government Control.—Government control can be exercised by laying down specifications, by inspection, and by issuing instructions that public bodies are not to purchase road rollers that do not comply with the specifications.

TECHNICAL PERSONNEL AND TECHNICAL ADVICE FROM ABROAD AND CO-OPERATION WITH FOREIGN FIRMS

Technical Personnel.—The greater part of the specialist's advice necessary for the development of this industry must at present be obtained from abroad. There is good engineering skill available in India provided that such skill as is available in the Ordnance Workshops and in a few industrial organisations can be utilised. There is sufficient skilled and semi-skilled labour available in India, but as the mechanical industries in general develop, there will surely be a serious shortage in this respect unless immediate steps are taken to educate and train the necessary personnel.

Technical Advice.—There are at present no developed designs for the manufacture of road rollers in India but such designs are now being developed during the course of the manufacture of the 1,500 road rollers already in hand. It will be necessary to obtain at first further assistance from abroad for designs, specifications, patent rights, etc. on some relevant basis. This is already being done in co-operation with foreign firms.

LOCATION OF THE INDUSTRY AND STAGES OF DEVELOPMENT

Location.—As already stated, the demand (300 rollers a year) is not great enough to warrant the setting up of a single plant to manufacture completely in one place all the road rollers required. It is estimated that an output of not less than the equivalent of 1,500 units a year would justify the setting up of such a plant. Rollers, however, could all be assembled in one place and the best location for the assembly plant would be in the East of India near other plant handling heavy machinery.

Stages of Development.—About 50 per cent. of the parts and fittings required can be manufactured in India at the present time. Standardization of designs and specifications would much accelerate development and is practicable as the consumers are almost entirely Government departments and public bodies.

Designs and Standardisation.—As there has been no manufacture of road rollers in India, there are no developed indigenous designs. Designs drawings and specifications require to be obtained from abroad. As most of the road rollers are usually stationed far away from the industrial centres and workshops, serious difficulties relating to servicing and maintenance are to be taken into account. Unless large quantities of spares are stocked and distributed to various centres in the country, the serviceability of the road rollers will be seriously affected. The more varied the designs of road rollers in service, the larger would be the stock of the spares required. If the road rollers on the other hand are standardised in design and size, there will be a great reduction in the stock of spare to be consumed. Such standardisation will not only reduce the cost of servicing but also lighten the problem of technical staff required for servicing which is an important factor to be considered.

At the Conference of the Chief Engineers of Provinces and States already referred to, great stress was laid on this benefit of standardisation. It was stressed that multiplicity of types was quite unnecessary and was to be avoided as far as possible. It was agreed at that time that the following types would practically satisfy all anticipated construction, and maintenance needs ; all road rollers to be three wheelers, half the number of new purchases 8 tonners and the other half 12 tonners. At the same Conference modern trends of roller construction were discussed. The advantages of the diesel type were weighed against those of steam, and it was decided finally that only one-third the total quantity newly acquired should be diesel. It was recommended that all road rollers should be manufactured to approved standard designs, that the moving parts of 8 and 12 ton types should be interchangeable wherever possible and that in the case of diesels the provision of interchangeability of engines, gear boxes, fuel injectors, and other units was to be insisted upon. These conditions might ultimately make it possible to standardise *two* sizes of diesel power units, and *two* sizes of steam power units. The rollers and framework might also be standardised to *two* sizes only and adoptable to either type of power units.

Approved Standards.—The question was further studied by the Transport Department which approved two standard designs, one for diesel road rollers and one for steam road rollers. These standards are attached as Appendix I. All rollers constructed to these standards will be of one weight 8 tons, but by means of a mechanism which will adjust the relative weights

between the front and rear roller, the effect on the road surface ordinarily obtained by employing rollers of different weights is achieved. It is proposed to enforce these standards for all rollers manufactured in India.

Steam Power versus Diesel Power Road Roller.—At the Conference of Chief Engineers of the Provinces and States, it was recommended that a third of the total quantity of the newly acquired road rollers should be of the diesel type. For Indian conditions at present the widespread use of diesel road rollers cannot be recommended. The advantages and disadvantages of the two types of road rollers are as below :—

The Diesel Road Rollers

1. It uses a fuel which at present has to be imported and often has to be carried long distances by rail.
2. It is subject to heavier wear and tear than the steam road roller because the engine travels faster (1,000 r. p. m. against 150 r. p. m.) and at a higher temperature; gear reduction to the slow speed of the roller is correspondingly greater resulting in more gear wear and owing to its design, the number of engine parts is much more (several hundred against a few score) and less substantial in make which again makes for shorter life and heavier maintenance charges.
3. The engine is susceptible to damage from the dust laden air often encountered in road work.
4. The torque characteristics are not as satisfactory as those of a steam roller.
5. The diesel road roller can be started up and shut down in a few minutes and does not consume fuel when standing temporarily idle on a job. It is therefore particularly suitable for black-top road work.
6. It is not dependent on good water as steam roller and is not dangerous to work.
7. It is more expensive but less troublesome to overhaul and can generally be repaired much quicker than a steam road roller.

The Steam Road Rollers

1. It uses coal or wood fuel which are indigenous products. Special road side trees are often grown to supply fuel for these road rollers.
2. The engine is composed of a few heavy parts which move comparatively slowly; the gearing is simpler and more substantial; there is no clutch; no change of gear is required in ordinary running as speed is adjusted by steam pressure and reversing is simple.
3. Not appreciably affected by dust in the air.
4. Covered under item (2).
5. The steam road roller takes an hour to start up and cannot be temporarily shut down.
6. Is dependent on a good water supply and is subject to steam hazards.
7. It requires boiler inspection every year which may entail extensive stripping. Overhaul takes time.

A ratio of one diesel to two steam road rollers was recommended by the Chief Engineer's Conference. This recommendation is based on much experience.

SUMMARY

Arrangements have already been made to meet the existing "pent up" demand for more than 2,200 power driven road rollers and the sub-panel is only concerned with providing for a long term demand of 300 rollers a year.

This demand can be satisfied without setting up any special industry to manufacture rollers since component parts can be made by manufacturers

of other plant. Materials for construction already exist in India or will largely be provided as other (larger) industries develop. Government ownership is not recommended but Government Control through specifications and inspection is desirable. Technical personnel can be trained (and is being trained). Advantage has already been taken of the facilities available in Ordnance Factories in India and of technical advice from abroad so that it will now soon be possible to produce an indigenous design. Similar arrangements are in hand to work out detailed specifications, acquire patent rights, and manufacture component parts not hitherto manufactured in India.

Generally, the Transport and I. & S. Departments have already solved most of the problems on which the advice of this sub-panel was required.

G. M. Mc. Kelvie	Chairman.
Jang Bir Singh	Member.
A. J. Lund	Member.
F. G. S. Martin	Member.
W. B. Neilson	Member.
S. Antharamkrishnan	Member.
J. Ferguson*	Member.
C. S. N. Raju	Secretary.

*As Mr. J. Ferguson has left India permanently, the report has not actually been signed by him.

GOVERNMENT OF INDIA
WAR TRANSPORT DEPARTMENT—ROADS ORGANISATION

Specification for Steam Road Roller

Specification No. MPS-1, dated 30th April, 1946

(Note.—Any subsequent revisions of this specification will bear the same number but will be distinguished by the date of issue).

1. The roller shall be of the maker's latest standard three roll design except that this design shall be modified where necessary to comply with the current Indian Boiler Regulations.

2. In tendering, the contractor is deemed to have knowledge of the Indian Boiler Act and Regulations together with the amendments thereto and must sign the declaration to this effect on the Technical Schedule Annexure IV attached to this specification, at the time of tendering. Copies of the Boiler Act and Regulations may be obtained on payment from the office of the Labour Department, Government of India, New Delhi.

3. For the purpose of the Indian Boiler Act, under this specification the competent "Inspecting Authority" during manufacture will be notified in the invitation to tender.

4. The tenderer may at his discretion put forward a design departing in certain particulars from this specification, but he shall state clearly in his tender any such proposed departures from this specification; no such departure however, will be accepted which contravenes the Indian Boiler Regulations.

5. The roller shall be constructed throughout of the best material and workmanship complete with all accessories. All material used in the construction of the roller shall, except where modified by this specification, comply in all respects with the standards laid down by the British Standards Institution for similar material.

6. *Weight.*—The weight of the roller in working order shall be between 8 and 10 tons or as required to meet the requirements of para. 28 of this specification. A variation of plus or minus 5 per cent. shall be allowed on the maker's declared weight.

7. *Boiler.*—The boiler shall be of the loco-multitubular type and shall comply in all respects with the Indian Boiler Regulations. The thickness of plate, irrespective of boiler size or pressure, shall be not less than three-eighths of an inch.

8. *Mountings.*—The mountings as listed in the Technical Schedule Annexure II attached shall be provided. They shall be of substantial construction, first class workmanship and material, and shall comply in all respects both as to construction and as to the method of fitting with the Indian Boiler Regulations.

9. *Grate Area and Heating Surface.*—The grate area and heating surface shall be of ample size, suitable for burning wood fuel or inferior coal.

10. *Manholes and Washouts.*—Man hand-holes and washout plugs to permit of the efficient washing out of the boiler shall be provided. The provision of these shall be on a liberal scale, and ease of access is essential.

11. *Chimney.*—The chimney shall project well above the awning level and be fitted with spark arrestor.

12. *Feed Water Tank.*—The feed water tank shall have a capacity of not less than 75 gallons.

13. *Boiler Feed Pump.*—A feed water pump of ample capacity driven from the engine shall be provided, together with a suitable valve through which surplus water pumped can be returned to the feed water tank. The feed pump shall be securely bolted to a rigid member of the roller chassis.

14. *Boiler Feed Injector.*—An injector of the "Penberthy" or other approved make of ample capacity to feed the boiler under normal working conditions shall be provided. The injector shall be fitted as low as practicable to ensure the minimum lift, and shall be protected from heat. It shall be suitable for dealing with feed water at temperature up to 120° F.

15. *Lagging.*—The lagging shall be of substantially detachable type, made up of non-conducting material, and neatly finished on the exterior with suitable sheet steel and removable hoop bands.

16. *Engine.*—The engine shall be of the reversible, horizontal, single cylinder type, bolted to a base saddling the loco type boiler. All bearings shall be of solid bronze and all important bearings shall be adjustable for wear. Reversing gear of a good type shall be provided and all wearing surfaces shall be accurately fitted and finished to a fine smooth surface. Valve spindles and piston rods shall be of mild steel ground and fitted with brass neck rings and adjustable glands and locking nuts. The gland packing shall be metallic or a good quality fibre. If fitted with piston valve with inside admission, a simple form of seal on the valve spindle is admissible. The valve may be of the flat or the piston type and if of the flat type shall preferably be of gun metal. Cylinder drain cocks which can be operated from the foot plate shall be fitted and with piston valved engines a good form of automatic release valve shall be fitted to the cylinder heads; alternatively, approved automatic release valves without drain cocks will be accepted.

17. *Cylinder.*—The cylinder shall be steam jacketed and effectively lagged and shall be of close grained cast iron without blemish or flaw and suitably designed to withstand full boiler pressure. The underside joint face shall be machined true and located with dowels or fitted bolts. Safety valves in direct connection with the steam space shall be provided in accordance with the Indian Boiler Regulations.

18. *Governor and Counter.*—Provision shall be made for fitting a governor of the "Pickering" or other approved type and the application of a lock-up mileage recorder or counter of the "Harding" or other approved make, if required.

19. *Piston Valve.*—If the valve is of the piston type, it shall be of selected cast iron and fitted with cast iron spring rings, the whole working in a valve chest liner having the parts accurately machined.

20. *Piston and Piston Rod.*—The piston shall be of selected cast iron and fitted with cast iron spring rings. All wearing surfaces shall be smoothly and accurately finished and where made of mild steel shall be ground.

21. *Connecting Rod.*—The connecting rod shall be a solid steel forging accurately machined where required and fitted with bronze or gun metal bearings.

22. *Crankshaft.*—The crankshaft shall be accurately machined from a high quality steel forging.

23. *Lubrication.*—Cylinder lubrication shall be provided either by a positive mechanical lubricator driven from the engine or by approved displacement lubricator. Shafts shall be provided with ring or other approved lubrication. The remainder of the lubrication throughout the roller shall be of an effective type suitable for operation in tropical and desert conditions and by semi-skilled labour. The lubrication fittings shall include weather and dust—excluding reservoirs of large capacity.

24. *Transmission Gearing.*—The transmission gears shall provide for two roads speeds of approximately 1 mile per hour and $2\frac{1}{2}$ miles per hour, the gear wheels shall be of specially selected cast or forged steel, all teeth being machine-cut except those of the slow running final drive. They shall comply with British Standard specification No. 436 as far as applicable. The gearing shafts shall be best quality mild steel accurately machined. The gears shall be efficiently guarded and lubricated. The design shall be such as to make it impossible for more than one gear to be in mesh at one time.

25. *Reversing Gear.*—A reversing lever with notch plate quadrant having three positions forward and reverse shall be provided.

26. *Front and Rear Rolls.*—The rolls shall be constructed of mild steel or of cast iron of a high quality equal to that of the best imported makes. All wheels, including the front roller, shall have detachable centres. The holes for securing these centres to the outer portion of the wheel shall be jig drilled in order to ensure absolute interchangeability. The front wheel or roller shall be in two parts each revolving independently on the axle and its path shall overlap the paths of the rear wheels by not less than $1\frac{1}{2}$ " on each side. Good quality bronze bushes shall be provided in the wheel bearings. The front wheel or roller shall not be less than 3'—3" in diameter and 3'—7" wide (in halves) and the rear rolls not less than 4'—9" in diameter and 1'—2" wide. The thickness of the front rolls shall be not less than 1" if of cast iron or $\frac{3}{4}$ " if of mild steel; the thickness of the rear rolls shall be not less than $1\frac{1}{4}$ " if of cast iron and $1\frac{3}{8}$ " if of mild steel. The hubs shall have renewable gun-metal bushes and shall be lubricated by "Stauffer" type lubricators or by pressure type lubrication.

27. *Scrapers.*—Adjustable spring scrapers shall be provided at the front and rear of the rear wheels and adjustable scrapers at the front and back of the front roller.

28. *Variation in Rolling Pressure.*—Tenderers shall put forward their proposals for providing ballasting or other device to give road pressure on the rear rolls ranging from 350 lbs. to 470 lbs. per inch width of rim. Water Ballasting will not be accepted for this purpose.

29. *Differential Gear.*—A differential gear shall be incorporated in the drive to the rear rolls. The pinions and bevel wheels shall be so constructed and fitted that when assembled the load is evenly distributed between all the bevel pinions. A locking device shall be provided so as to cut the differential gear out of action when required.

30. *Forecarriage and Fork.*—The fork shall be of cast steel or mild steel. The forecarriage and forecarriage bracket shall be of ample strength for rough usage.

31. *Steering Gear.*—The steering gear shall be controlled by a hand wheel acting through a worn gear and spirally grooved chain barrel and

chains on the front roll fork, or through other approved type of mechanism. Provision shall be made for taking up backlash.

32. *Shafts*.—All shafts, including axles, shall be of good quality mild steel suitably finished and working in well lubricated bronze bushed bearings.

33. *Brake*.—A hand wheel operated hand brake acting on large diameter brake drums fitted to the rear wheels shall be provided. The brake bands shall be lined with approved friction material giving adequate holding power under all climatic conditions; the brake shall hold the roller stationary on an incline of 1 in 5 in either direction.

34. *Controls*.—All controls and levers shall be arranged so that they can be conveniently operated by the driver when on the foot-plate.

35. *Accessibility*.—All machinery shall be so designed as to afford easy access for cleaning, lubrication, repairs and adjustment.

36. *Centre of Gravity*.—The centre of gravity of the roller shall be as low as possible, consistent with the provision of suitable road clearance.

37. *Fuel Bunker*.—An adequate fuel bunker shall be provided.

38. *Awning*.—An awning extending the full length of the roller shall be provided. This shall be of sheet metal lined with timber or of other approved design.

39. *Curtains*.—Side and end "roll-up" curtains of heavy waterproof material shall be supplied together with straps and buckles for securing these when not in use.

40. *Draw Bar*.—A strong cast steel or mild steel draw bar attachment shall be fitted at the rear of the roller. A draw bar pin shall be provided, attached to the roller by a chain.

41. *Equipment*.—The tenderer's standard set of accessories shall be provided as shown in the Technical Schedule—Annexure III attached.

Note.—Water sprayers, water lifters, winding drums and lamps are not required.

42. *Extras*.—The tenderer may quote as an extra for any item which he recommends which is not included as standard equipment or not mentioned in this specification.

43. *Instructional literature*.—An instruction book or books dealing with the running and maintenance of the boiler and all moving parts of the roller, together with a lubrication chart, shall be supplied with each roller. Spare copies of these books and charts shall be supplied totalling twice the number of rollers ordered.

44. *Tools*.—The tenderer shall supply with each roller such tools as are required for the efficient maintenance and operation of the roller at site. Particulars of tools proposed shall be included in the Technical Schedule, Annexure III. The tools shall include with each roller one ten tonlifting and traversing jack of approved make. A fitting shall be cast on or securely attached to the front fork or other convenient place to hold the jack on the roller when it is travelling.

45. *Tool Box*.—A spacious and well fitted lock-up sheet steel tool box to accommodate all tools shall be supplied which shall be "built-in" or welded on the roller.

46. *Spare.*—The tenderer shall show in the Technical Schedule, Annexure III, a full list of spare parts he recommends to cover a period of two years' working. Two copies of a comprehensive illustrated spare parts list shall be supplied with each roller.

47. *Finish.*—The roller shall be painted with high quality weather resisting paint to the maker's standard finish.

INSPECTION AND TEST

48. *Boiler material.*—The contractor shall give notice in writing to the Inspector when the boiler and firebox plates, tubes, etc., are ready for inspection and test at the works of the manufacturer and shall forward a schedule in duplicate of the material ordered. Each plate shall be clearly marked in two places with the serial number, brand and maker's name ; after satisfactory test and surface inspection, the plates will be stamped for identification by the Inspecting Officer. The stamp marks must be visible on the outside of the completed boiler shall and on the inside of the firebox. To facilitate identification in a completed boiler, the marks shall be ringed with white paint.

49. *Boiler Inspections.*—The Contractor shall give in writing to the Inspector when the plates have been received by him from the steel makers and are ready for identification by the Inspecting Officer, who will if necessary re-mark any plate where an opening will remove the original marks. Any defect revealed in the plates during working up shall be brought to the notice of the Inspecting Officer before further work is put in on the plate. Subsequent inspections and tests including hydraulic test shall be carried out in accordance with the Indian Boiler Act and Indian Boiler Regulations.

50. *Boiler Identification Marking.*—After satisfactory hydraulic test and approval the boiler shall have stamped upon its front plate in a conspicuous position the following particulars :—

- Maker's Name.....
- I. S. D. No.....
- Tested to..... Lbs. per sq. in. Date.....
- W. P.Lbs. per sq. in.
- Govt. Mark (as given in the contract schedule.)
- Inspector's stamp.....
- Indent No..... Date.....

51. The first roller of a type shall be inspected under steam on a pit and tested under brake, and indicator cards shall be taken. The engine under such test must develop economically at its normal speed and working pressure of the Indicated Horse Power at which it is rated as given by the maker in the attached Technical Schedule Annexure 1. After satisfactory test all bearings and wearing surfaces shall be opened up for inspection. The finished roller after completion and painting shall be weighed in the presence of the Inspecting Officer on a suitable weigh-bridge. The roller shall then be loaded to full capacity and tested on the road under all normal conditions of service. It will be required to climb an incline of not less than 1 in 5.

The brake shall be tested on this-incline and shall hold the roller securely in either direction. The roller shall steer and manoeuvre, with the engine working at all speeds and notches forward and reverse, to the entire satisfaction of the Inspecting Officer. After satisfactory road test the bearings and wearing surfaces shall be opened up for inspection.

Subsequent rollers shall be tested under steam at the discretion of the Inspector.

52. *Cost of testing*.—The contractor shall provide all labour, facilities, tools and apparatus necessary for all tests. The cost shall be included in the tender price.

53. *Acceptance*.—Approval in writing from the Inspector shall be the only acceptance.

54. *Marking*.—The Government marking given in the contract schedule shall be cast on the maker's name plate.

55. *Packing*.—After approval, the roller shall be securely and suitably prepared for rail or sea transit. All easily detachable fittings shall be removed and separately packed; jointing material where necessary must be included for refitting. Bright parts shall be efficiently protected from corrosion where necessary and shall not be packed in straw. All packages shall have stencilled upon them in good oil paint the consignee's address as given in the schedule. Cases shall have stencilled upon them in addition net and gross weights and description of contents. Stencil plates shall be provided by the Contractor. A packing note, detailing the stores, indent number and item numbers is to be enclosed in each package. A duplicate copy of this packing note shall be sent separately to the consignee by registered post, and a triplicate copy shall be provided for the Inspector.

56. *Drawings*.—The Contractor shall supply without charge one general arrangement print of each roller to a scale of not less than 3/4" per foot. He shall also supply in duplicate with each boiler all drawings as required under the Indian Boiler Regulations. All drawings shall show the I. S. D. No. the Contract No. and date, the Indent No. and date, the item No. and the name of the Contractor. The drawings shall be handed to the Inspecting Officer at the time of final inspection and will be initialled by him as correctly representing the roller and boiler as made and finished.

57. *Boiler Certificate*.—To comply with the Indian Boiler Regulations the Contractor's certificate of manufacture and test, and the Steel Maker's certificate of manufacture and results of tests, shall be completed in duplicate by the Contractor and handed to the Inspecting Officer at the time of final inspection. They will be forwarded by him to the Inspector.

58. As soon as possible after acceptance of the tender the Contractor shall forward calculations with reference of the Indian Boiler Act and equations showing compliance therewith. The applicable Regulations and equations shall be clearly shown against each calculation.

TECHNICAL SCHEDULE ANNEXURE I.

Blank Boiler Certificates (See Clause 57).

For I. S. D. Boiler No. see schedule of contract and Clause 50.

Technical data to be given at the time of tendering :—

Net weight in working order..... tonsCwts.

Net weight of empty roller.....	tons	Cwts.
Ground pressure per inch of width. Front roller maximum		
Front roller minimum.....		
Hind Wheels maximum.....		
Hind Wheels minimum.....		
Method by which rolling pressure is varied.....		
Number of gears and speed in each gear on level.....		
Maximum grade roller will climb.....		
Cylinder(3) Dia and stroke.....		
R. P. M. of engine, normal.....		
I. H. P. at normal R. P. M.....		
Minimum turning circle (outside radius).....		
Steering rollers..... dia	width.....	thickness.....
Driving wheels..... dia	width	thickness.....
Lubrication, method of.....		
Boiler external firebox.....	long	wide
Boiler, internal firebox	long	wide
..... diameter	long..	
Thickness barrel plate.....		inch.
Thickness Firebox wrapper plate.....		inch.
Thickness Firebox front plate.....		inch.
Thickness Tube plate		inch.
Tubes.....No.....	Overall dia.....	thickness... length.....
Type of Furnace crown.....		
Rectangular crown girders.....	in deep.....	in thickness... .. in pitch..
Crown screw stays or bolts.....	dia.....	pitch.
Water space stays.....	dia	pitch.
Longitudinal stays.....	dia	pitch.
Heating surface, firebox.....		sq. ft.
Heating surface, tubes.....		sq. ft.
Heating surface— total.....		sq. ft.
Grate Area.....		
Working pressure of boiler.....		lbs. per sq. inch.
Maximum calculated working pressure of boiler with factor of safety of not less than four.....		lbs. per sq. in.
Capacity, water tank.....		gallons.
Capacity, coal bunker.....		cwts.

TECHNICAL SCHEDULE—ANNEXURE II—MOUNTINGS

The following shall be fitted to each boiler :—

	<i>Size</i>	<i>Maker</i>	<i>Cat.</i>	<i>Ref.</i>
A.	Double Spring Safety Valve, fitted on cylinder steam jacket, in direct communication with boiler steam space.			
B.	Two Gunmetal Water Gauges with protectors or reflex gauges ; cocks to be asbestos packed and to be self-closing.			
C.	Two Feed Check Valves of gunmetal, with intermediate shut-off valves, for injector and feed pump.			
D.	Blow-down asbestos packed cock of gunmetal, complete with spanner and spanner guard.			
E.	Pressure Gauge of Bourdon type with gunmetal syphon; working pressure to be marked with a heavy red line.			
F.	Fusible plug of National Insurance pattern, with removable cone.			
G.	Signal Whistle gunmetal, with cord.			
H.	Blower Steam Jet and valve, with rod.			
I.	Starting or Throttle Valve, with rod and lever.			
J.	Asphan, of steel plate, with front and rear regulating doors operated from foot-plate.			
K.	Firing hole door, with air grid and baffle.			
L.	Water level indicator.			
M.	Bearers, Firebars, etc.			

TECHNICAL SCHEDULE—ANNEXURE III.

STANDARD ACCESSORIES SPARES AND TOOLS.

These shall consist generally of the following :—

- Tool box, steel, with galvanised padlock and two keys.
- Hammer, fitter's $\frac{1}{2}$ lbs.
- 12-inch second cut file and handle.
- Cold chisel.
- Caulking tool.
- Two shifting spanners, 0 in. / $\frac{3}{4}$ in, $\frac{3}{4}$ in./1 in.
- Full set double-end spanners.
- Spare set manhole and mudhole joint rings.
- Spare set packing for all glands.
- Half gallon can filled with lubricating oil.
- Half gallon can filled with cylinder oil.
- Grease in tin for stauffer cups, 7 lbs.
- One pint oil feeder.
- Water funnel.
- Two gallon galvanised bucket.
- Two tube brushes and one rod.
- Set firing tools—slice, rake, pricker bar and shovel.
- Assortment split pins, etc. in tin box.
- 2 lbs. cotton waste.
- Six sponge cloths.

Frost coqs, or suitable non-slip fittings in lieu, shall be provided if called for in the contract schedule.

SPARE PARTS for 2 years' working, to include the following :—

- Set piston rings-
- Set crankshaft main bearings.
- Set connecting rod bearings.
- Set first motion shaft bearings.
- Set second motion shaft bushes. Set rear axle bracket bushes.
- Set pumps suction and delivery valves.
- Two stauffer grease cups.
- Six grease nipples (if fitted).
- Six boiler tubes.
- Pressure gauge.
- Set firebars-
- One dozen gauge glasses and packings (or two reflex glasses and joints)
- One fusible plug, National Insurance pattern.
- Six removable plugs for National Insurance pattern.

TECHNICAL SCHEDULE—ANNEXURE IV.

Declaration (to be signed at time of tendering) :—

We hereby undertake that the boiler offered will comply in all respects with the Statutory requirements under the India Boiler Act, 1932, the Indian

Boiler Regulations 1924, as amended up to 1st March, 1938, and any amendment or correction to the present date, and also with B. S. No. 931/1940 and any amendments thereto, and that the boiler will under existing statutory regulations be allowed full-rated working pressure in India.

We tender in full knowledge of the provisions and requirements of the said Act and the British Standard Specification cited, and the India Boiler Regulations.

Signed.....

Date.....

GOVERNMENT OF INDIA

WAR TRANSPORT DEPARTMENT—ROADS ORGANISATION

Specification for Diesel Road Rollers No. MPS.2, dated 30th April, 1946

(NOTE—Any subsequent revisions of this specification will bear the same number but will be distinguished by the date of issue).

1. The rollers shall be of the maker's latest standard three roll type designed for efficient operation in the Tropics.

2. The road rollers shall be of robust construction, simple in design, control and maintenance for use by Indian labour. The engine shall be well balanced and the roller shall be free from excessive vibration at all operating speeds. The power unit shall be of ample capacity for the rolling capacity of the roller, to work economically for long periods under the most exacting conditions.

3. The tenderer may at his discretion put forward a design departing in certain particulars from this specification, but he shall state clearly in his tender any such proposed departures from this specification ;

4. The roller shall be constructed throughout of the best material and workmanship complete with all accessories. All material used in the construction of the roller shall, except where modified by this specification, comply in all respects with the standards laid down by the British Standard Institution for similar material.

5. *Weight*—The weight of the roller in working order shall be between 8 and 10 tons, as required to meet the requirements of para. 19 of this specification. A variation of plus or minus 5 per cent shall be allowed on the maker's declared weight.

6. *Diesel Engine*—The diesel oil engine may have single or multi cylinders. It shall be of the compression ignition type and be designed for positive and certain starting from cold. It shall be capable of developing ample power to operate the roller efficiently when working fully loaded, and ballasted under the following conditions :—

Temperature	. . . . .	125°F.
Humidity	. . . . .	90 per cent.
Altitude	. . . . .	2000 feet.
Gradient	. . . . .	1 in 5.

The engine shall conform generally to B. S. Specification No. 649 as far as applicable. It shall be of the totally enclosed type and in addition shall in so far as is practicable be protected against weather and unauthorised interference.

7. *Cooling System*—The engine cooling system shall be of an efficient radiator type. It shall be of ample cooling capacity and suitable for the climatic conditions specified in para. 6 of this specification.

8. *Governor*—The engine shall be provided with a sensitive governor for controlling the speed.

9. *Filters*—Ample air and lubricating oil filters shall be provided. These shall be suitable for "desert" conditions.

10. *Fuel Tank*—The fuel tank shall have a capacity sufficient for at least 30 hours running under normal working conditions.

11. *Clutches*—The clutches shall be suitably protected and be of the fabric lined or other approved type. The clutches shall have renewable linings easily accessible for inspection and service.

12. *Gear Box and Gearing*—The gears shall be totally enclosed in a robust gear box having an oil bath or in which is incorporated a suitable oil pump providing ample lubrication to all wearing surfaces; input and output shafts shall be efficiently oil sealed. The gear ratios as provided shall be such that the roller is capable of operating in either direction within a range of 7/8 mile per hour to 4 mile per hour. All gear box shafts, except the output shaft, shall be of suitable alloy steel and all heavily loaded fast running shafts shall be mounted in adequate ball or roller bearings.

13. *Differential*—The differential gear shall be efficiently guarded and lubricated. If inside the main gear box, it shall comply with B. S. specification No. 436 as far as applicable; and if incorporated outside the gear box, the pinions and bevel wheels shall be so constructed and fitted that when assembled the load is evenly distributed between all the bevel pinion. A locking device shall be provided so as to cut the differential gear out of action when required.

14. All gear cases shall have covers of ample size and readily removable for examination.

15. *Final Drive*—The final drive shall be through spur gears direct to the rear rolls and be effectively guarded and lubricated.

16. *Lubrication*—Lubrication of the diesel engine shall be by an efficient forced feed system operated by an oil pump of ample size and with an efficient strainer. The remainder of the lubrication throughout the roller shall be of an effective type suitable for operation in tropical and desert conditions and by semi-skilled labour. The lubrication fittings shall include weather- and dust- excluding reservoirs of large capacity. Details of the method of lubrication shall be shown in the Technical Schedule—Annexure I.

17. *Front and Rear Rolls*—The rolls shall be constructed of cast iron of high quality equal to that of the best imported makes or alternatively of mild steel. All wheels including the front roller shall have detachable centres. The holes for securing these centres to the outer portion of the wheels shall be big drilled in order to ensure absolute interchangeability. The front wheel or roller shall be in two parts each revolving independently of the axle and its path shall overlap the paths of the rear wheels by not less than 2"

on each side. Good quality bronze bushes shall be provided in the wheel bearings. The front rolls shall be not less than 3' 3" dia. × 2' 10" wide (in halves) and the rear rolls not less than 4' 6" dia. × 1' 4" wide. The thickness of the front rolls shall be not less than 1" if of cast iron or 3/4" if of mild steel. The thickness of the rear rolls shall be not less than 1-3/4" if of cast-iron and 1-3/8" if of mild steel. The hubs shall have renewable gun-metal bushes and shall be lubricated by "Stauffer" type lubricators or by pressure type lubrication.

18. *Scrapers*—Adjustable spring scrapers shall be provided at the front and rear of the rear wheels and adjustable scrapers at the front and back of the front roller.

19. *Variation in rolling pressures*—Tenderers shall put forward their proposals for providing ballasting or other device to give road pressures on the rear rolls ranging from 350 lbs. to 470 lbs. per inch width of rim. Water ballasting will not be accepted for this purpose.

20. *Brakes*—Two independent brakes shall be provided, one operated by foot—the other by hand. These brakes shall act on large diameter brake drums. One brake may act on the transmission but at least one brake must act direct on the rear wheels. The brake bands shall be lined with approved friction material giving adequate holding power under all climatic conditions. Either brake shall be capable of holding the roller stationary on an incline of 1 in 5 in either direction.

21. *Forecarriage and Fork*—The fork shall be of cast steel or mild steel. The forecarriage and forecarriage bracket shall be of ample strength for rough usage.

22. *Steering Gear*—The steering gear shall be controlled by a hand wheel acting through a worm gear and spirally grooved chain barrel and chains on the front roll fork, or through other approved type of mechanism.

22. *Shafts*—All shafts including axles shall be of good quality mild steel suitably finished and working in well lubricated bronze bushed bearings, or in adequate ball or roller bearings.

24. *Exhaust Pipe*—The exhaust pipe or pipes shall be lagged where necessary and shall be carried clear to one side of the roller or to above the awning.

25. *Centre of Gravity*—The centre of gravity of the roller shall be as low as possible consistent with the provision of suitable road clearance.

26. *Awning*—An awning extending the full length of the roller shall be provided. This shall be of metal lined with timber or of other approved design.

27. *Curtains*—Side and end "roll-up" curtains of heavy waterproof material shall be supplied together with straps, and buckles for securing these when not in use.

28. *Draw Bar*—A strong cast steel or mild steel draw bar attachment shall be fitted at the rear of the roller. A forged steel draw bar pin shall be provided, attached to the roller by a chain.

29. *Controls*—All operating levers, controls; brake pedals levers, and steering wheel shall be so situated that the driver will have an unobstructed view of all operations. A suitable and comfortable seat shall be provided for the driver.

30. *Accessibility*.—All machinery shall be so designed and arranged as to afford easy access for cleaning, lubrication—repairs and adjustment.

31. *Operating Characteristics*.—The tenderer shall submit with the tender full details of the operating characteristics and capacity of the roller in the form shown in the accompanying Technical Schedule—Annexure I.

32. *Equipment*.—The tenderer's standard set of accessories shall be provided. A full detailed list of these shall be included in the Technical Schedule—Annexure II.

NOTE.—Water sprayers, water filters, winding drums and lamps are not required but lamp brackets must be provided so that the purchaser may fit his own lamps for night driving if desired.

33. *Extras*.—The tenderer may quote as an extra for any or all of the following:—

- (a) Provision of a hydraulic coupling "Fluidrive" incorporated in the main drive from the engine.
- (b) Provision of power steering.
- (c) Any item which he recommends not included as standard equipment or not mentioned in this specification.

34. *Instructional Literature*.—An Instruction Book or books dealing with maintenance of the power unit transmission steering gear and all moving parts of the roller together with a lubrication chart shall be supplied with each roller. Spare copies of these books and charts totalling twice the number of rollers ordered shall be supplied in addition.

35. *Tools*.—The tenderer shall supply with each road roller such tools as are required for the efficient maintenance and operation of the roller at site. Particulars of tools proposed shall be included in the Technical Schedule (Annexure II). The tools shall include one 10 ton lifting and traversing jack of approved make. A fitting shall be cast on or securely attached to the front fork or other convenient place to hold the jack on the roller while it is travelling.

36. *Tool Box*.—A spacious and well fitted lock-up sheet steel tool box to accommodate all tools shall be supplied. The box shall be "built in" or welded on the roller.

37. *Spares*.—The tenderer shall show in the Technical Schedule (Annexure II) a full list of spare parts he recommends to cover a period of 2 years working and two copies of a comprehensive illustrated spare parts list shall be supplied with each roller.

38. *Finish*.—The roller shall be painted with a high quality weather resisting paint.

INSPECTION AND TEST

39. Every engine shall be tested under load on the test bench prior to fitting in the roller.

40. The first engine of a type (selected at random by the Inspecting Officer from the batch) shall be tested under brake at engine builders' works and under such test must give the output at its normal speed over a period of 6 hours of the h. p. at which it is rated as given by the maker

in the attached Technical Schedule Annexure I. After satisfactory test all bearings and wearing surfaces shall be opened up for inspection. The finished roller after completion and painting shall be weighed in the presence of the Inspecting Officer on a suitable weigh-bridge. The roller shall then be loaded to full working weight and tested on the road under all normal conditions of service. It will be required to climb an incline of not less than one in five. The brake shall be tested on this incline and shall hold the roller securely in either direction. The roller shall steer and manoeuvre with the engine working at all speeds forward and reverse, to the entire satisfaction of the Inspecting Officer. After satisfactory road test the bearing and wearing surfaces shall be opened up for inspection. Subsequent rollers of that batch shall be given a road test at the discretion of the Inspector.

41. *Cost of Testing.*—The contractor shall provide all labour, facilities tools and apparatus necessary for all tests. The cost shall be included in the tender price.

42. *Acceptance.*—Approval in writing from the Inspector shall be the only acceptance.

43. Each roller shall bear a maker's name plate bearing the following identification particulars :—

Maker's name.....	.....
Type and size of roller.....	.....
Serial Number.....	.....
Contract No.....	Date.....
Indent No.....	Date.....

Government Mark (as given on the schedule).

44. *Government Marking.*—The marking given in the schedule shall be cast on the maker's name plate.

45. *Packing.*—After approval, the roller shall be securely and suitably prepared for rail or sea transport. All easily detachable fittings shall be removed and separately packed ; jointing material where necessary must be included for refitting. Bright parts shall be efficiently protected from corrosion where necessary and shall not be packed in straw. All packages shall have stencilled upon them in good oil paint the consignee's address as given in the Schedule. Cases shall have stencilled upon them in addition net and gross weights and description of contents. Stencil plates shall be provided by the contractor. A packing note, detailing the stores, indent number and item numbers is to be enclosed in each package. A duplicate copy of this packing note shall be sent separately to the consignee by registered post and a triplicate copy shall be provided for the Inspector.

46. *Drawings.*—The contractor shall supply without charge one general arrangement print of each roller to a scale of not less than 3/4" per foot. He shall also supply in duplicate with each roller such arrangement drawings as are necessary to enable the purchaser adequately to maintain and repair the engine and other parts of the rollers. Such drawings may at the contractor's discretion be incorporated in the instruction book referred to in para. 36 hereof. All drawings shall show the I. S. D. No., the Contract No. and date, the Indent No. and date, the Item No. and the name of the contractor. The drawings shall be handed to the Inspecting Officer at the time of final inspection and will be initialled by him as correctly representing the roller as made and finished.

TECHNICAL SCHEDULE ANNEXURE I

Technical data to be given at the time of tendering :

- (1) (a) Weight in working order..... tons.....cwts.
- (b) Net weight of empty roller..... tons.....cwts.
- (2) Ground pressure per inch of width. Front roller maximum.....
- Front roller minimum.....
- Hind Wheels maximum.....
- Hind Wheels minimum.....
- (3) Method by which rolling pressure is varied.....
- (4) Number of gears and speed in each gear on level.....
- (5) Maximum grade roller will climb.....
- (6) Minimum turning circle (outside radius).....
- (7) (a) Steering rollers dia.....width.....thickness
- (b) Driving wheels dia.....width.....thickness
- (8) Design and material of frame.....
- (9) Design and material of forecarriage and fork.....
- (10) Lubrication, method of.....
- (a) Engine
- (b) Transmission.....
- (c) Chassis
- (11) Road clearance.....

DIESEL ENGINE

- (12) Makers
- (13) Type :—

Maker's type of size (code) description.
- (14) Cylinders, number.
- (15) Cylinders bore and stroke:—

.....in x stroke.
- (16) R. P. M. normal

..... revs. per minute
- (17) Rated output at 30" mercury 62° F. as defined

in B. S. S. No. 649.

B. H. P.....
- (18) B.H.P. required to drive the Road Roller on the level when fully loaded and ballasted.
- (19) Reserve oil Engine power available after allowing for working with the roller ballasted and fully loaded, at a temperature of 125° F humidity 90% altitude 2,000 ft., and on a Gradient of 1 in 5.

- (20) Guaranteed consumption of fuel oil in lbs. per hour under normal working conditions at site.
- (21) Consumption of lubricating oil lbs per hour in the engine under normal working conditions at site (no credit to be taken for recovered oil) :—

.....lbs. per hour

(22) Specification of lubricating oils recommended.

(23) Engine Cooling System :—

- (a) Type ;
- (b) Radiator ;
- (c) Water Circulation ;
- (d) Maximum temperature of cooling water leaving the cylinder jackets when the engine is working at the rated output given under Item 17.

TECHNICAL SCHEDULE—ANNEXURE II

(a) *Standard Accessories and Tools.*

To be specified in detail by Contractor, but shall in general consist of the following :—

Tool Box, steel, with galvanised padlock and two keys.

Hammer, fitters' 1½ lbs.

12-inch second cut file with handle.

Cold Chisel.

Two shifting spanners, 0 in/3/4", 3/4 in/1 inch.

Full set double ended spanners.

1/2 gallon can filled with lubricating oil.

Grease in tin 7 lbs.

One pint oil feeder.

Water funnel.

Petrol funnel.

Two gallon galvanised bucket.

Assorted split pins.

Pinch bar.

Clutch adjusting tools.

Two lbs. cotton waste.

Frost cogs, or suitable non-slip fittings in lieu shall be provided if called for in the contract schedule.

(b) *Spare.*

The Contractor shall give a list, with prices, of the spare parts recommended for 2 years' normal working.

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