EAST AFRICAN RAILWAYS AND HARBOURS

ENGINEERING MANUAL

VOL 1 — TECHNICAL INSTRUCTIONS

1962

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CONTENTS

SECTION 1

INTRODUCTION

The instructions contained in this Manual will come into force immediately and supersede all relevant instructions contained in the publications Engineering Department Circulars — Revised 1940, of the Kenya and Uganda Railways and Harbours and Engineering Manual, Vol. I — Technical Instructions — 1925, of the Tanganyika Railways.

Circulars on administration matters will be provided in Volume II.

The instructions contained in this book must be read in conjunction with, and not in lieu of, the regulations contained in the following publications, which they in no wise supersede.

General Rules.

General Appendix to the Working Time Table and General Rules.

Sectional Appendix to the Working Time Table and General Rule Book.

Accident Instructions.

Working Time Table.

Each employee placed in possession of a copy of this Manual must make himself thoroughly acquainted with and act upon the instructions contained in it. In the event of a contingency arising which is not provided for in the Manual, he will exercise all necessary discretion or follow implicitly orders received from his superior officers.

The instructions contained herein are subject to amendment from time to time. Any such amendments will be notified by the Chief Engineer and issued in the form of printed slips numbered consecutively. The slips must be pasted or neatly written in ink in the appropriate places and their receipt recorded in the page Register of Amendments.

The attention of the Chief Engineer shall be drawn to any instruction that appears to require amendment, owing to a change in circumstances or conditions.

Personal issues will only be made to Engineers, Permanent Way Inspectors, Sub-Permanent Way Inspectors, Signal Inspectors, Trainees and to such other supervisors as the Chief Engineer may decide. All such persons must, on receipt of the Manual, complete the Acknowledgment Form, which must be forwarded to the Chief Engineer.

All other copies of the Manual must remain with the posts or in respective offices, and a special note will be made in handing over papers that it is up to date and is handed over in good condition.

All recipients of the Manual will be held responsible for its safe keeping and for it being maintained properly. The book must be returned before an employee leaves the service of the Railway Administration, and it will be the duty of the responsible official to see that this is done.

material shall be well distributed throughout the embankment and shall be deposited in layers, the lumps being broken down to a maximum size of 6 inches.

2.09 **Banks to be built up in Layers.**— The earthworks shall be taken up in layers not exceeding 6 inches in thickness, and the side slopes shall be carried up and consolidated simultaneously with the core of the bank. In no circumstances shall the bank be constructed by means of a central core finished off by side dumping of spoil to make up the section.

The layers shall have a cross-fall of 1 in 30 on either side of the centre line of the embankment.

2.10 **Allowance for Shrinkage.**— All embankments shall be made up to an extra height in order that due allowance shall be made up for subsequent settlement. The extra amount of fill will depend on the character of the soil and the means employed in construction. In normal earth, and where compaction is not effected by earth moving plant or other means, the allowance for shrinkage may be one inch per foot of height of the bank.

Such extra material for shrinkage shall be deposited simultaneously with the construction of the bank to ensure an integral whole.

2.11 **Raising Banks.**— When, in the course of regrading operations, it becomes necessary to raise a bank, the slopes of the existing bank shall be benched before any material is deposited on them.

2.12 **Inferior Soil in Cuttings.**— Black cotton, clay or other inferior soil in cuttings shall be excavated to an extra depth and replaced by suitable soil to form a blanket.

2.13 **Rock Cuttings.**— No rock shall protrude above true formation level. Where the formation is left rough with holes these must be filled in and levelled with hard broken stone. Earth, shale and soft rock must not be used for this purpose.

2.14 **Disposal of Surplus Spoil.**— Surplus excavation from cuttings, over and above what is required for the adjacent embankments within the economic limit described in Clause 2.01, should be used to widen the embankment near the side of excavation. Such widening shall not be made over the site of a culvert where the section of the embankment must conform strictly to the standard.

Where it is unavoidable that spoil shall be deposited on the top of a cutting it shall not be placed nearer than 12 feet from the top edge of the cutting nor nearer than 3 feet from the edge of any drain, and the pile shall be adequately sloped on both sides.

Where a catchwater drain is provided in accordance with Clause 2.15 the spoil bank shall be sited between the top of the slope of the cutting and the drain.

2.15 **Catchwater Drains for Cuttings.**— The primary purpose of these is to prevent

SECTION 2

EARTHWORKS AND DRAINAGE

2.01 **General.**— As a general principle banks on new constructions should be made up, where possible, by leading spoil from cuttings in preference to borrow.

The maximum limit of over-haul or the maximum distance that material should be "lead" will depend upon the rate paid for material excavated in borrow, and such limit is to be so arranged that the cost of "lead" from cut does not exceed the cost of excavating from borrow.

Where the material in cuts exceeds the quantity economical to "lead", the surplus must be carried to spoil; wherever possible within the limit of "free lead".

In all new constructions and major works a Mass-Haul Diagram for calculating lead shall be prepared as shown in Drawing No. 3549 (Revised), from which it can be determined in advance the most economical method of disposing of the spoil from cuttings.

2.02 **Cross Sections of Formation.**— The normal cross sections in banks and cuttings and the side slopes in normal soil shall be those illustrated in ANNEXURE 1.

2.03 **Borrow Pits.**— All borrow pits shall be located within the Railway Reserve. They shall be regular in shape and width and shall be graded and drained to the nearest culvert and neatly finished off on completion of work.

The edge of any borrow pit shall be not less than 12 feet in a horizontal line from the toe of the Railway bank. See also Clause 2.16.

2.04 **Benching on Sloping Ground.**— Where embankments are to be constructed on ground having a side slope exceeding 15 degrees above the horizontal, the surface of the ground shall be stepped.

2.05 **Removal of Roots and Tree Stumps.**— Before commencing the construction of an embankment the roots and stumps of bushes and trees shall be removed and cleared away.

2.06 **Removal of Ant Hills.**— Ant hills occurring on the sites of either cuttings or embankments will be excavated completely and the soil removed right away from the completed earthworks. The Queen ant shall be destroyed and the excavation thoroughly burnt out before being refilled.

2.07 **Construction of Banks.**— Only suitable and approved materials obtained from cuttings or borrow pits shall be placed in embankments. Where the use of clay or other low quality material is unavoidable, the top 12 inches to the finished surface of the bank shall be made up of selected earth.

2.08 **Treatment of Clods and Rocks in Banks.**— Clods or hard lumps of earth shall be broken up as the construction of the bank proceeds.

When embankments are formed of large rocky material or hard lumps such as conglomerate or cemented gravel which cannot be broken readily, such

Normally, the top of the wall shall not be higher than the toe of the ballast section.

Where the soil tends to erode, the bed of the drain should be pitched with dry stone.

Very long side drains should be avoided and, where the terrain permits, the water shall be led out of the side of the cutting at intervals with a little dam of earth across the side drain at such exits.

The outfalls of side drains adjacent to the track should be suitably graded to avoid silting or erosion and the sides and bottom should be pitched with boulders.

2.18 **General Drainage.**— Care shall be taken to see that pools and lakes, which are likely to endanger the Railway, especially during protracted and heavy rainfall, are adequately drained to bridge openings or away from the Railway.

On no account should water be allowed to stand on the tops of cuttings or against the embankment in narrow deep valleys.

2.19 **Inspection of Catchwater Drains in Cuttings.**— Before and after the rainy season the Permanent Way Inspector shall walk over the drains. Shrubs and earth falls shall be cleared and pockets which may hold water must be filled up.

2.20 **Slope Protection.**— Grass and vegetation shall be encouraged to grow on the slopes of banks and cuttings to reduce slips and erosion, and, where earth slopes are bare, planting with grass shall be done.

Large shrubs and trees should, normally, not be allowed to grow in the slopes of cuttings.

2.21 **Note of Special Drainage and Protective Works.**— Where special works exist, such as contour drains on hill sides and above tunnels, revetment to banks etc., which from their location are not readily seen from the Railway, the outgoing District Engineer shall record particulars of these when handing over the district to his successor.

all outside water reaching the slopes of a cutting and the formation, and to direct water as quickly and as early as possible away from the Railway.

In horizontal ground catchwater drains are generally required to be provided on both sides of the Railway. In ground sloping transversely across the Railway catchwater drains are required on the upper side of all cuttings. The drain shall be of ample dimensions with a minimum depth of 2 feet and side slopes to suit the soil.

The minimum gradient should be 1 in 333 (0.3 per cent). If the grade be so great as to erode the soil, paving and/or little boulder dams will be necessary at intervals in the drain.

Where surplus soil from a cutting is not placed on top of it in accordance with Clause 2.14, the distance from the top of the slope of the drain to the top of the slope of the cutting should be a minimum of 15 feet, to prevent seepage from the drain to the cutting. Where the soil is of such nature that seepage takes place the drain should be paved.

Material excavated from the drain should be deposited on the side of it towards the cutting, and the slope of this spoil bank should be as long as possible. The spoil must be kept well clear of the edge of the cutting and adequately sloped.

2.16 **Catchwater Drains for Banks.**— These should be made on the upper side of all banks to divert water flowing towards the embankment. In practice, the drains are usually made from borrow pits which are graded to act as catchwater drains.

The horizontal distance between the toe of the Railway bank and the top of the slope of the drain should be not less than 12 feet to avoid any danger of causing slides in the embankment.

Where possible, the area between the embankment and the edge of the drain should be graded towards the drain to prevent water standing in pockets along the toe of the embankment.

2.17 **Side Drains in Cuttings.**— These are only intended to deal with water from the slopes of the cutting and from the formation and can be kept reasonably small and shallow having the minimum dimensions shown in ANNEXURE 1.

Side drains shall be provided in all cuttings and shall be maintained at a true grade not less than 1 in 333 (0.3 per cent).

In level cuttings the drain should be graded to have a minimum slope of 1 in 333 (0.3 per cent). Generally the side drains should follow the Railway grade.

Where the soil of the road-bed is unstable, and also in long cuttings on steep grades, the side drains should be reinforced with stone walls, either dry or laid in mortar, with provision made in the walls for draining the road-bed.

Normally, the top of the wall shall not be higher than the toe of the ballast section.

Where the soil tends to erode, the bed of the drain should be pitched with dry stone.

Very long side drains should be avoided and, where the terrain permits, the water shall be led out of the side of the cutting at intervals with a little dam of earth across the side drain at such exits.

The outfalls of side drains adjacent to the track should be suitably graded to avoid silting or erosion and the sides and bottom should be pitched with boulders.

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Large shrubs and trees should, normally, not be allowed to grow in the slopes of cuttings.

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SECTION 3

3.01 **Size of Bridge and Culvert Openings.**— The calculation of the proper sizes of bridge and culvert openings on new lines is a matter of considerable importance, if waste of money is to be avoided.

Bridges and culverts should be designed to provide reasonable security over a period of years. Designs calculated to deal with the maximum floods that have been known, would be unduly expensive, while designs which are too much on the small side are also costly owing to frequent replacements being necessary.

The size of opening required can be obtained from the diagrams and data in ANNEXURES 2 and 2A, compiled from the Dempster Formula suited to the intensity of rainfall in East Africa.

In easy and flat terrain the results tend towards being too liberal and, in such circumstances, they should be used with discretion.

Each catchment area must be roughly surveyed and plotted to a small scale where suitable topographical maps do not already exist. Great accuracy is not, of course, required.

The class of area drained — Diagram 1A.— requires the application of considerable judgment and is usually the cause of all variations in results obtained by the use of the other well known formulae of Myer, Talbot and Hearn.

The slope of the channel, which is used in Diagram No. 2, is a measure the velocity of the culvert. The greater the velocity through the culvert t smaller the opening need be. The velocity is determined by:—

(a) Natural conditions of site; i.e. a good slope and easy and clear outfall, with a possibility of water banking up over the inlet, are conducive to high velocities, while flat surroundings, such as swamps, low banks preventing banking up, restricted outlet, all prevent high velocities.

(b) Design of Culverts.— For high velocities, such as 12 ft. per second or over, rock foundations or their equivalent in protective works, are required. From 5 ft. to 12 ft. per second drop walls and floors are usually essential. Up to 4 ft. per second the culvert need not be floored. The head above the inlet or slope of stream bed that is required to give such velocities is not high. A head of 2.5 ft., for example, above the centre of the culvert may give a velocity of over 12 ft. while a slope of 1.5 ft. per 100 ft. may give an equal velocity.

3.02 **Temporary Bridges.**— The arrangements of sleeper cribs and rail cluster girders are shown in ANNEXURES 3 and 4 respectively, and the footnotes thereto shall be carefully read.

Rolled Steel Joists, with equivalent properties in shear and bending to the clusters of rails, may be used in lieu of rails, **but only on the authority of the District Engineer.**

Two sets each of shallow EMERGENCY GIRDERS of 31 ft. and 42 ft. maximum effective span respectively, principal details of which are given below, are stored at Nairobi for temporary use at washaways, accidents, or for bridges being repaired under traffic.

	31 ft. Span	*42 ft. Span*
Drawing Nos.	8125/1R & 2	8131/1R & 2
Overall length of Girder	33′ 4″	43′ 0″
Number of R.S. Joists	6	6
Section of each Joist	18″ x 6″ x 55 lb./ft.	24″ x 7½″ x 95 lb./ft.
Weight of heaviest Joist 'B'	1.007 tons	2.044 tons
Total weight per span excluding sleepers and rails	6.222 tons	12.468 tons
Designed loading	59 Class locomotives at 4 m.p.h.	

The spans are designed for ease of handling and this has been achieved by the use of Rolled Steel Joists bolted together in clusters of three with easily adaptable diaphragms. The spans are complete with service bolts, wood sleepers, hook bolts, dogspikes and the necessary spanners.

One set of the drawings shall be filed in the Drawing Office and a further set in the office safe of each District Engineer.

All engineering officers should familiarise themselves with the assembly of the spans and with the erection instructions which are clearly set out on the Drawings.

The following procedure will apply in ordering the spans and returning them after use:—

(i) Requests for the spans should be telephoned or telegraphed to the Works Engineer, Nairobi. In his absence the matter will be dealt with by the Assistant Design Engineer.

(ii) On completion of permanent repairs the spans shall be returned complete in every respect to the District Engineer, Nairobi, who on receipt of the spans will immediately replace any deficiencies.

(iii) The District Engineer in whose charge the spans are will be responsible for their care and maintenance while they are on his district.

(iv) When the spans are prepared for transit care shall be taken to complete them as far as possible recovering all bracings, sleepers, bolts and nuts etc., carefully bagging or boxing the small components.

The District Engineer, Nairobi, will comply with the following special instructions:—

(v) The spans will be stacked in pairs in the Building Superintendent's Yard within the area served by the 2½ ton gantry crane.

(vi) The track and adjacent area must be kept clear to expedite despatch.

(vii) The spans will remain assembled until required when they will be dismantled, the bolts, wood sleepers, dogspikes and spanners and any other equipment being carefully tallied and packed in readiness.

(viii) A responsible officer will superintend the loading and subsequent off-loading on return of the spans to ensure that they are made complete again in all respects.

(ix) The spans must be inspected regularly and the bolts removed and greased. The R.S. Joists should also be pulled apart to ascertain if painting is required.

(x) The spans should be re-assembled when returned to Nairobi.

Whatever type of girder is used, the general arrangement of sleeper cribs shall be as shown in ANNEXURE 3.

3.03 **Concrete Pipe Culverts.**— Concrete pipes used under railway tracks must be of **reinforced construction** in accordance with type drawings or to such other designs approved by the Chief Engineer.

When constructing new culverts or restoring damaged ones due care shall be taken to comply with the following instructions. To ensure this in a line open to traffic, the track shall be supported over the excavation to enable the work to be properly executed.

The pipes shall be laid in the centre of a trench on a properly graded and compacted bed with the invert shaped for true bedding over a reasonable part of the lower half of the circumference of the pipe. Where rock is encountered the trench shall be excavated to a depth of at least eight inches below the bottom of the pipe and made up with fill of suitable soil thoroughly compacted.

Care shall be taken to lay the pipes to uniform level but, where a concrete bed is not provided and there is a possibility of them settling in high banks, the pipes at the centre of the culvert shall be raised not less than three inches above the true grade of the invert from inlet to outlet, to allow for final settlement to grade.

Nothing but fine material, free from excess clay or stones over 1½" in any dimensions, shall be placed under and around the pipe. The deposited material

shall be placed in layers of about four inches and each layer thoroughly compacted.

On bad ground of poor stability it may be necessary to lay the pipes on concrete beds or on reinforced rafts with concrete haunching to the pipes.

The pipes shall be laid true to line and grade and shall be firmly set into the bedding material. All joints shall be tight and true and shall be grouted with 1 to 3 cement sand mortar.

The ends of pipe culverts shall be finished off with head walls constructed in accordance with type drawings.

In normal construction the minimum depth of cover from the top of the pipe to formation level shall be three feet. Where it is not possible to provide this, the cover may be reduced to an absolute minimum of eighteen inches with the pipes laid in concrete haunching on a concrete bed.

3.04 **Bridges across Public Roads.**— Unless otherwise specified the normal minimum vertical clearance between road level and the underside of a railway bridge or part of any permanent fixture thereto shall be 16 ft. 6 ins.

No bridge shall be constructed over a road of any classification without the agreement of the responsible road authority with regard to height, clear span, road visibility, and other features.

3.05 **Guard Rails for Bridges and Tunnels.**— The provision of guard rails (not check rails) is desirable on long bridges and in long tunnels, their purpose being to prevent the wheels of derailed vehicles moving too far from the running rails and either falling off the sleepers on deck spans or striking the sides of through spans and tunnels.

Designs exist for the guard rails being located either within the track or outside the running rails as best suits the situation.

The Chief Engineer shall decide where such guard rails shall be installed.

3.06 **Routine Inspection of Bridges.**— The Permanent Way Inspector and his staff shall at all times keep a close watch on all bridges and culverts and report at once to their superior any signs of failure, weakening or scour.

They should know the bridges which have existing cracks in or under bedstones, and in piers, abutments and wing walls, and should keep them under close observation. Signs of general movement (e.g. walls out of plumb, movement of girders on their bearings, new cracks or worsening of old cracks) should be immediately examined and precautions, such as a speed restriction or blocking of the track, arranged immediately if there is any doubt as to the safety of the structure.

Rubbish and ballast must not be allowed to accumulate at the ends and in bottom booms of girders.

Abutments, piers, wing walls and copings shall be kept clear and free from vegetation.

Waterways shall be cleared of vegetation and obstacles likely to prevent the free flow of water. Suitable paths should be cut from the formation to the waterway to facilitate inspections.

3.07 **Flood Damage.**— Engineers and Permanent Way Inspectors must acquaint themselves with the behaviour of rivers and streams, and the sites of previous incidents of scouring, washaways etc. Information concerning these can be obtained from history sheets, Gangers and the older employees in the Gang.

The highest flood level (HFL) shall be painted on one abutment at all bridges with a thick black line on a white background and the date recorded against it. Such flood history marks should be regularly re-painted.

3.08 **Painting of Steelwork.**— Girders shall be painted at regular intervals as laid down in Section 22 and each district shall prepare a programme covering all girder bridges, arranging it so that a proportion of the bridges is painted each year.

The date a bridge is painted shall be marked on the girder where it can be readily seen, and this date shall be recorded in Forms CE.8/1 and C.E.8/2 of the Annual Bridge Inspection Report register.

3.09 **Bridges having Steel Decking and Stone Ballast.**— The stone ballast on steel decked bridges shall be cleared of earth and small particles in order to ensure that free drainage is not impeded through the drain holes provided.

When using bars, picks or other sharp pointed tools on steel floored bridges care shall be taken to avoid damaging the waterproof coating.

The condition of the steel decking shall be regularly examined, and shall, when necessary, be thoroughly cleaned of all traces of rust and re-treated. A mixture of 50 per cent bitumen and 50 per cent cement shall be applied thickly to the steelwork, care being taken that the mixture is spread evenly. The stone ballast will be replaced when the mixture has set.

The date of painting shall be marked on the girder where it can be readily seen, and this date shall be recorded in Forms CE.8/1 and CE.8/2 of the Annual Bridge Inspection Report register.

In bridges provided with steel troughing laid transverse to the rails, the sleeper spacing shall be adjusted so that the sleepers occur over the troughs and not over the crests of the flooring.

Where steel sleepers are laid the depth of stone ballast shall be a minimum of 6 inches between the top of the crest of the troughing and the underside of the running rail. In bridges having the steel troughing arranged parallel to the running rails this dimension shall be a minimum of 8 inches.

If wood sleepers are laid the foregoing dimensions shall be increased by 3 inches.

3.10 **Bridge Sleepers and Fastenings.**— On steel girders not provided with riveted flange plates, the sleepers should be provided with flat steel straps or a suitable section of timber at their ends, to maintain correct sleeper spacing.

On steel girders having rivets these are sufficient to prevent the sleepers moving provided the sleepers have been carefully prepared. It is incorrect to cut a channel across the underside of the sleeper to accommodate the rivet heads. The correct procedure is to place the sleeper over the rivets, in the position it is required to occupy, beat it with a wooden mallet to obtain impressions of the rivet heads, and to gouge out with a chisel or remove with a large auger sufficient of the wood to accommodate the rivet heads.

Each timber shall be provided with two holding down or hook bolts; having steel washers under the nuts of a size not less than 3 inches square x $\frac{1}{4}$ inch thick in order not to crush the wood. The bolts may be placed either outside or inside the rails as best suits the girders.

The holes for the hook bolts shall be bored from the underside of the sleeper to ensure that the bolt fits close to the girder flange, thus preventing the sleeper from shifting laterally once it is fixed in place.

See Section 11 for further instructions regarding bridge sleepers.

3.11 **Bridge Records.**— The procedure described herein was brought into effect from the 1st January, 1962.

Form CE.6 (Revised) — Bridges and Culverts Register.

This is a list of all bridges and culverts, including pipe openings. Copies are required to be held by the Chief Engineer, District Engineer, Permanent Way Inspector and Inspector of Works (Bridges).

Form CE.7 — Bridge Inspection Register.

The term "Inspection" is a misnomer as the register is a record for Registered Assets giving the age and structural details of each major bridge. It will remain in use and copies are required to be held by the Chief Engineer and District Engineer.

Form CE.8/1 & 8/2 — Annual Bridge Inspection Report.

Form CE.8 was revised in 1948 and has now been replaced by Forms CE.8/1 and CE.8/2. A register containing a sheet in Form CE.8/1 for each bridge of 20 feet span and over is required to be maintained by the Chief Engineer, District Engineer and Inspector of Works (Bridges). The slip Form CE.8/2 will be prepared by the Inspector of Works (Bridges) for each of his annual inspections of a bridge and will be pasted in the registers.

Form CE.9 (Revised) — Permanent Way Inspector's Bridge and Culvert Certificate of Inspection.

This form has been revised in minor respects and is required to be completed by each Permanent Way Inspector for his half-yearly inspections. One copy

will be retained by the Permanent Way Inspector and one copy will be forwarded to the District Engineer.

Annual Bridge Inspection Report Register.

The Register in Form CE.8/1 and the annual report in Form CE.8/2 are described above.

As the Inspectors of Works (Bridges) will keep records of all bridges under their jurisdiction comprising several districts it will be more convenient to use two or more binders. In these cases one binder should be allocated to Main Line bridges and the other binder to Branch Line bridges.

The Annual Bridge Inspection Report on Form CE.8/2 will be simply pasted into the register. The reports for succeeding years will be pasted on top of those for the previous years but not so as to obscure the earlier reports.

3.12 Special Instructions applying to Inspectors of Works (Bridges)

Organisation.

For all administrative purposes the Inspector of Works (Bridges) will be regarded as a member of the District Engineer's staff at his headquarters station.

In all matters concerning bridges the Inspector of Works (Bridges) will communicate directly with the District Engineer in whose district the bridges are situated.

The Inspector of Works (Bridges) must keep the Chief Engineer and the District Engineer of his headquarter station informed of his movements.

Duties.

The Inspector of Works (Bridges) will inspect in detail all bridges of 20 feet span and over in his jurisdiction once per year. He will make such out-of-turn inspections as may be necessary.

The Inspector of Works (Bridges) will supervise repairs as required and in this connection he will obtain the necessary materials, labour, tools and plant from the District Engineer concerned.

The Chargehand will work directly under the Inspector of Works (Bridges).

The primary function of the Inspector of Works (Bridges) is inspection; supervision of repairs must not prevent the systematic annual inspection of all bridges. In the event of large scale repairs being undertaken which might absorb too much of the Inspector's time the Chief Engineer shall be informed and arrangements made to provide additional supervision.

Programme of Inspection.

Each quarter the Inspector of Works (Bridges) will prepare a programme of inspections for the ensuing three months.

The programme will show the dates between which it is proposed to inspect bridges on a particular section, the mileages of the section and the number of bridges on the section. At the same time a brief note indicating the progress made during the previous three months should be given.

Copies of these programmes shall be forwarded to the Chief Engineer, the District Engineer of the Inspector of Works' headquarter station, the District Engineer of the district in which the Inspector of Works (Bridges) proposes to work and the District Engineer of the district which he has just left.

The Chief Engineer will amend the programme if necessary taking into consideration any special requests for the services of the Inspector of Works (Bridges) which may be made by the other District Engineers.

Copies of the programme must be submitted to the Chief Engineer and the District Engineers concerned at the end of March, June, September and December.

3.13 Special Inspections by the Permanent Way Inspector.

Scope and Frequency.

The Permanent Way Inspector will inspect all bridges and culverts, including pipe culverts in his section every six months i.e. in the half years ending June and December.

His inspection will include a general examination of the steelwork and bearings and a close examination of abutments, piers, wing walls, head walls, drop walls, pitching, and signs of scour.

At bridges where water is running or standing, a check for scour around and under foundations shall be made with a sounding lead or by probing with a long pole or rod.

In special circumstances the advice and instructions of the District Engineer shall be obtained.

Certificate.

After each inspection the Permanent Way Inspector shall complete Form CE.9 (Revised) in duplicate. He shall retain one copy and forward the other copy to the District Engineer. It will be the responsibility of the Permanent Way Inspector to bring to the notice of the District Engineer cases where repairs and remedial works previously reported have not been attended to.

3.14 Inspection by the Inspectors of Works (Bridges).

Scope and Frequency.

The Inspector of Works (Bridges) will inspect all bridges under his jurisdiction of 20 ft. span and over once per year. This inspection will cover both the sub-structures and super-structure of bridges as outlined above for the Permanent Way Inspector's inspection. In addition he will make a particular examination of all steelwork.

Report and Records.

After each inspection the Inspector of Works (Bridges) shall complete the Annual Bridge Inspection Report (Form CE.8/2) in triplicate. He shall retain one in his Bridge Register (Form CE.8/1) and forward the other two copies to the District Engineer.

Programme of Inspections.

A programme of inspections for each quarter shall be made out by the Inspector of Works (Bridges) as described in Clause 3.12.

Any arrangements for the Inspector of Works (Bridges) to supervise special work on bridges which might interfere with his normal inspection programme must be agreed in advance with the Chief Engineer.

Action to be taken when repairs to bridges are found to be necessary.

Defects may be divided into 3 categories:—

(i) Defects which render the bridge unsafe for the passage of trains.

(ii) Defects which, though extensive and involving a considerable amount of work for their correction, do not jeopardise the safety of trains.

(iii) Minor defects.

The action to be taken by the Inspector of Works (Bridges) on observing a defect will depend on the category into which the defect falls. In case (i) he should impose a line block or speed restriction at once and, with the assistance of the Permanent Way Inspector undertake any cribbing etc., which may be necessary. The District Engineer must be informed by telegram of the situation immediately.

The Inspector of Works (Bridges) must not leave the site until the bridge has been rendered safe for the passage of trains at slow speed. Before leaving he must arrange with the Permanent Way Inspector for the posting of watchmen. He should then proceed to make arrangements with the District Engineer for the permanent repairs.

3.15 Action by District Engineer on Inspection Reports.

Permanent Way Inspector's Certificate.

The District Engineer will maintain a file for the Permanent Way Inspector's half yearly certificates (Form CE.9 revised). Before filing the reports he will note thereon details of action being taken to remedy any faults which have been reported. Copies of the Permanent Way Inspectors' certificates are not required to be sent to the Chief Engineer.

Inspector of Works (Bridges) Reports.

The District Engineer shall personally sign the duplicate copies of the Annual Bridge Inspection Reports which he has received from the Inspector of Works (Bridges) to indicate that he has seen them. At the same time he

carry out such examinations himself as he finds necessary in order to satisfy himself that the certificate he is signing is correct.

3.18 **Tunnels.**— The Permanent Way Inspector shall, in the course of his routine inspections, give careful attention to the unlined portions of the roof and walls.

Loose and unsafe rock must be removed under the protection of signals, and any extensive work requiring to be done in this connection must be reported to the District Engineer.

Drainage shall be maintained in good condition and the cause of any increase in water leakage into the tunnel shall immediately be investigated.

Open drains above the tunnel must be inspected at suitable intervals and attended to before rainy seasons.

See Clause 13.26 regarding the examination of the track in Tunnels.

Types of Bridge Sleepers Drawing 1907 (REVISED)

Types 13-19

TYPE	LENGHT	WIDTH	DEPTH	CANTED FOR
13	9'	9"	6"	½"
14	9'	9"	6 5/8 - 5 3/8"	1"
15	9'	9"	7 1/4 - 4 3/8"	1 ½"
16	9'	9"	7 7/8 - 4 1/8"	2"
17	9'	9"	8 ½ - 3 ½"	
18	9'	8"	8"	
19	9'	8"	6"	

SECTION 4

BOUNDARIES, FIREBREAKS, TELECOMMUNICATION LINES AND ELECTRIC SUPPLY LINES.

4.01 **Boundaries and Beacons.**— Boundary marks and other beacons, where provided, must be carefully preserved and maintained. This is especially important on Railway land in townships and industrial areas.

4.02 **Royalties.**— When materials such as stone, sand, gravel and murrum are required to be removed from locations outside the Railway Reserve, royalties may or may not have to be paid. Before entry on the land the matter shall be referred to Headquarters for a decision.

4.03 **Entry on Private Property and Crown Land.**— Prior to the execution of any works, other than those on the actual formation of the existing Railway, it is necessary to ascertain the ownership of the land and to establish that no land or interest other than that controlled by the Railway will be affected.

The diversion of flood water or drainage into new channels outside the Railway Reserve constitutes an encroachment.

The exact boundaries of the Railway Reserve must first be ascertained before any excavation is made, which must not be outside the Railway Reserve or be closer to the boundary than 1½ times the depth of the borrow pit or excavation below the surface of the ground. Such borrow pits and excavations shall be sloped off at 1½ to 1 inside the Railway boundary lines.

4.04 **Power to Enter Land to Prevent Accidents.**— Under Section 11 of the East African Railways and Harbours Administration Act — 1950 — any authorised employee may, for the purpose of preventing the occurrence of any accident, preserving the safe operation of any transport service provided the Administration, or repairing any damage caused by an accident, enter upon any land and —

(a) cut down or remove any tree or other obstruction, **not being a building,** which obscures the view of any fixed signal or which is likely to cause any obstruction or any danger to any such transport service;

(b) execute such other works as may be necessary to prevent the occurrence of any accident or to repair any damage caused as a result of any accident.

Whereas the Act provides the necessary authority, such entry should be limited to real emergencies such as accidents and washaways. When time permits the owner or occupier of the land should be given notice of the action proposed to be taken.

Any subsequent claim for compensation shall be referred to Headquarters.

4.05 **Encroachment in Railway Reserves.**— Engineering Staff shall make themselves acquainted with the boundaries of all Railway Reserves and the Permanent Way Inspector shall report to the District Engineer when he has reason to

believe that encroachments of any kind have been or are being made. Particular attention shall be paid to the erection of buildings, fences, reservoirs and the planting of large trees.

✳ On no account are non-Railway natives, including squatters, allowed to settle on or occupy Railway land for residential, grazing, or agricultural purposes.

4.06 **Activities outside the Railway Reserve.**— The Permanent Way Inspector shall take notice of any outside activities in the vicinity of the boundaries, such as the establishment of factories, alteration to existing roads and the construction of new roads, and shall inform the District Engineer who, where necessary, shall advise Headquarters.

4.07 **Water Conservation and Drainage Works.**— All construction of dams, weirs, reservoirs, drains and waterways, outside the Railway Reserve, shall be closely observed and early contact shall be made with the party where it appears that the safety of the Railway is likely to be endangered.

4.08 **Joint Firebreaks.**— With the adoption of oil fuel for locomotives, firebreaks along the boundary of the Railway Reserve are now only required to be provided where a property owner specifically applies for this safeguard.

Such cases are covered by a Joint Firebreak Agreement which requires:—

(a) a width of 20 feet (or such other width as may be agreed) to be cleared, half on the side of the Railway and half on the side of the owner's property for a stated length along the boundary;

(b) each party to bear the cost in its own land;

(c) supervision and labour to be provided by both parties when one or the other gives notice that the periodical clearance by burning off is to take place;

(d) the Railway to burn inflammable matter **between the firebreak and the Railway line.**

The District Engineer will record details of all such Joint Firebreak Agreements in a register and shall ensure that the Permanent Way Inspectors are fully informed of the extent of the obligations assumed by the Railway under each such Agreement and of the names and addresses of the parties concerned.

4.09 **Clearance of Firebreaks.**— Care shall be taken that the Firebreak is **at all times** maintained in a clean and cleared condition. Well established trees should not be removed.

When the Permanent Way Inspector decides that the grass or scrub **between the firebreak and the formation** is becoming dry enough to burn, he will notify the District Engineer that he proposes to burn off the grass on a certain day. This notification should be two weeks in advance of the proposed date of burning.

The District Engineer will immediately advise the occupier or landowner of the adjacent farm or property by **registered post** giving him seven days notice. A record of all such notifications will be made in the register and entries should be made in due course stating what action the occupier or landowner took in connection with the burning off operation.

The Permanent Way Inspector must appoint a competent man to supervise the burning of the grass or scrub and must satisfy himself that the labour is properly equipped with wet sacks or brushwood for controlling the fire and beating it out where necessary. Before the supervisor leaves the area he must satisfy himself that the fire has been extinguished.

Areas to be burnt shall be confined to the limits that can be satisfactorily dealt with on the one day.

Burning should not be undertaken when the wind is high or when it blows from the formation to the Railway boundary, and fires should be started against the wind and not with it.

Section gangs must be carefully instructed that whenever possible they must assist landholders in putting out fires near the Railway, even if they think that the fire was not caused by the Railway.

Where the other party to the Agreement gives notice that he shall be burning off grass on his side of the Railway boundary, the Permanent Way Inspector shall arrange to have a supervisor and labour present to deal with any fire which may extend within the Railway Reserve.

4.10 **Telecommunication Lines.**— Railway staff are required to render every facility possible to the engineering staff of the Posts and Telecommunications Administration in assisting their staff in repairing telecommunication wires along the track. Application for assistance will only be called for in exceptional circumstances.

Permanent Way Inspectors and Sub-Permanent Way Inspectors must provide labour, provided the loan of such labour will not affect equally urgent track work which may be in operation.

4.11 **Fallen or Broken Telecommunication Poles.**— In the event of broken or fallen telecommunication poles occurring along the line, action as follows shall be taken in order that communications may be interrupted as little as possible.

A small hole should be dug sufficient to keep the pole upright and, after ensuring that the wires are not twisted together, the pole should be inserted in the hole and supported with bush poles or any other means to prevent the wires touching anything.

When broken wires occur, the ends of these wires should be so arranged that they do not touch any of the others.

Permanent Way Inspectors should explain these instructions to their gangs

in order that they may know what to do in the event of a breakdown. It should be pointed out to them that no harm can come to them from electric current in handling these wires.

After action as above has been taken the nearest member of the Posts and Telecommunications Administration should be notified by first means.

Where electric power lines cross the Railway the gangs must be shown them and instructed that on no account must they handle any of the wires, cables and supporting poles. See Clause 4.19.

4.12 **Excavations near to Telecommunication Poles.**— No borrow pit or excavation should approach closer to a pole than 5 feet plus one and a half times the depth of the pit below the surface of the ground at the pole.

4.13 **Clearing Undergrowth beneath Telecommunication Lines.**— It is the responsibility of the Railway to prevent high vegetation and branches from touching the wires and to reduce the risk of damage to poles and wires by fire.

The area round the base of each pole and stay wire shall be cleared of all growth and in a strip 20 feet wide below the telecommunication wires the grass and vegetation shall be kept close cut. Where dangerous trees need felling or heavy trimming the work should be done in conjunction with the Posts and Telecommunications Administration to avoid damage and interruption to the circuits.

4.14 **Cultivation by Railway Employees.**— Subject to the approval of the District Engineer a Railway employee may be permitted to cultivate food crops in a small area within the Railway Reserve to meet only the needs of his family and not for sale. It is not a right and is subject to conditions such as soil erosion, interference with drainage, damage from fire to the telecommunications route, and visibility of trains on curves and at level crossings.

Such cultivation should not be permitted in townships because the "shambas" tend to become insanitary when adjacent to dwelling places.

4.15 **Cultivation by non-Railway Employees.**— Cultivation within the Railway Reserve by outside parties is not permitted.

In special circumstances a licence may be granted by Headquarters to an applicant to cultivate within the Railway Reserve. The properly executed Agreement provides that:—

(a) there shall be no cultivation on land having a steeper slope than 35 per cent or be within 30 feet of the centre line of the nearest railway track;

(b) no permanent or temporary buildings, walls and fences shall be constructed;

(c) there shall be no afforestation;

(d) the land shall be kept in clean condition.

4.16 **Visibility on the Insides of Curves.**— For the safety of trains, trolley users and staff working on the track, grass, bushes, trees and high crops on the inside of a curve in the Railway Reserve shall, wherever possible, be cleared to provide good visibility.

4.17 **Electric Supply Lines Crossing the Railway.**— Each crossing is covered by a Wayleave Agreement approved at Headquarters. The standards of construction conform to technical regulations, laid down by the Governments of the three territories, with which the electric supply Companies are required to comply.

Before a wayleave is approved the scheme shall be examined for clearances of the power line and its supports to the railway track in accordance with Standard Dimensions.

In OVERHEAD crossings the supports are required to be self supporting structures, suitably stayed where necessary, against falling on the Railway. Impregnated wood poles of sufficient strength are accepted as being suitable material for such supports.

In an UNDERGROUND crossing through a track the power supply cable should be passed through a protective sleeve pipe or conduit of adequate strength to avoid disturbance to it by rail traffic, minor accidents, and track maintenance works.

It should be located where water cannot obtain access to the cable and a surcharge of suitable fill material with a minimum depth of 2 ft. 6 in. between the top of the conduit and the bottom of the rail should be provided.

The position of the underground crossing shall be marked by a notice board or in some other prominent manner on each side of the railway track.

4.18 **Register of Wayleaves.**— A record of all wayleaves is maintained at Headquarters and the District Engineer is kept informed. He will advise full particulars to the Permanent Way Inspector who should observe construction and promptly report if the approved scheme is departed from.

The Permanent Way Inspector shall ensure that his staff know the exact locations of all underground crossings.

4.19 **Safety of Staff.**— The construction by the Power Supply Companies normally provides for the current to be automatically disconnected upon severance of a supply line.

Sub-Permanent Way Inspectors and section labour must be cautioned against:—

(a) climbing support poles;

(b) touching power supply lines, cables and earthing wires;

(c) digging into conduits of underground crossings with picks or bars;

(d) lighting fires either over or near such poles, conduits, or cables.

The "markers" at underground crossings must be shown to the Gange Grass and weeds should be carefully cleared from them.

4.20 **Action in the Event of breakage of Conductors, Cables and Connections.**— Where it is observed that an overhead conductor wire has sagged to an exte less than 20 ft. above rail level, or where the conductor has broken an obstructs the track so as to constitute a danger by contact to passing train the Railway line shall be protected with hand signals and detonators. Train shall be stopped short of the obstruction and, if clearance is sufficient, the shall be passed slowly past the site. These precautions must be carried o until the fault is repaired by staff of the power supply Company.

The Permanent Way Inspector shall instruct all his staff in these matte and warn them that on no account must they attempt to handle conductor cables and connections or to move them by any other means.

Information concerning the obstruction shall be sent immediately to th nearest station, giving the Station Master the track mileage of the crossing.

4.21 **Safety Regulations in connection with Low Voltage and High Voltage Unde ground Cables.**— The following procedure has been agreed with the Chie Mechanical Engineer regarding the cutting of trenches, preparation of founda tions etc., in close proximity to underground electricity cables, and shall b adopted immediately:—

(a) Before any proposed excavation work is carried out in an area wher cables are known to be, or where there is reason to believe, cables ma be buried, contact must be made to the appropriate District Officer o the Chief Mechanical Engineer's Department for confirmation as t whether cables are likely to be encountered and their approximat position.

(b) No excavation shall be carried out within 6 ft. of a known undergroun cable energised at 415 volts or less, unless the power supply has bee switched off, or unless a responsible electrical foreman is present wh can advise the Supervisor of any excavation gang as to how near th cable such digging can be allowed to proceed, prior to the circuit bein switched off.

(c) No excavation shall be carried out within 6 ft. of a known undergroun cable energised above 415 volts unless the electricity supply has bee switched off.

(d) If the exact position of an underground cable is doubtful then no exca vation shall be permitted within its vicinity until such time as th supply has been switched off.

(e) All staff who have to make excavations should acquaint themselve with the shape and form of cable markers and under no circumstance

should cable markers be removed when found in any given position without reference to a responsible electrical foreman.

The attention of all Supervisors and Staff should be drawn to the danger of using hand tools and power operated tools in the proximity of underground cables where such equipment is capable of penetrating or damaging a cable.

4.22 **Reporting of Electrical Accidents.**— See Vol. II of the Engineering Manual for detail instructions on the reporting to other parties concerned in the three territories, all accidents by electric shock or any accident which could have arisen from the generation, transformation, conversion, transmission, distribution, or supply of electric power.

4.23 **First Aid for Electrical Shock.**— All staff who have anything to do with electrically operated equipment, should be made aware of the fact that the rendering of immediate first aid in the event of electrical shock is vitally important. There have been cases where a person, apparently killed by an electric shock, has been revived by the method of artificial respiration immediately applied. It should never be assumed that a person subjected to shock is dead, and attempts at artificial respiration should be continued without remission until a Doctor has seen and examined the casualty.

4.24 **Electric Supply Lines owned by the Railway.**— The relevant instructions mentioned above shall equally apply to power supply lines installed and maintained by the Railway.

SECTION 5

STATION YARDS AND SIDINGS

5.01 **Tidiness.**— Responsibility for the general tidiness and cleanliness of station yards rests with the Engineering Department.

The planting of trees and shrubs, if done with taste, materially helps towards good apearance, but any tendency to overdo planting should be checked where necessary.

The section gang should regularly go through a wayside station yard, including Goods sheds and sidings, and systematically clean up and weed the tracks and platforms.

Heavy materials such as rails, sleepers and pipes should, where the quantities are not large, be moved to the Permanent Way Inspector's depot. Otherwise they must be neatly stacked and the areas around them kept clear of vegetation.

5.02 **Danger of Materials between Tracks.**— Special consideration must be given to the safety and convenience of passengers, and the yard operating and running staff.

Rails, sleepers, loose ballast etc., must not be left lying between tracks, and the track must not be left opened out overnight.

5.03 **Drainage and Surfacing.**— Effective drainage shall be provided. This can generally be attained by a net-work of well graded and shallow surface drains filled with stone ballast so as not to cause dangerous obstructions.

The formation should not be too low between tracks. The dimension should be between 6 and 8 inches below the top of the sleeper.

Where the formation consists of material liable to become muddy in wet weather or dusty in the dry season, the surface should be blinded by a thin layer of sand, fine gravel or murrum.

Particular attention must be paid to the surface and drainage at water columns, both from the point of view of the stability of the track and the safety of the locomotive crews.

5.04 **Fouling Points.**— The clearance point laid down in the book of Standard Dimensions is where adjacent straight and curved tracks are at 14 ft. 0 ins. centres.

A marker shall be provided at all converging tracks, including sidings, which should be made of an unserviceable steel sleeper or rail, laid flush with the formation so as not to form an obstruction.

The marker will be painted WHITE to make it conspicuous at night.

5.05 **Derailers, Derailing Switches and Catch Sidings.**— One or other of these safety devices is required to prevent any vehicle or vehicles fouling an adjacent line

in case of irregular movement; the choice of type depending on the gradient of the approach track and the importance of the line being protected. Which device is to be provided is decided by the Operating and Engineering Departments.

The use of **Scotch Blocks** and **Safety Chains** has been discontinued, and shall be replaced with Derailers where still required.

(A) **Derailer.**— The type now in general use is the built up Tanganyika pattern. Some early HAYES derailers of cast steel are still in existance.

Any make of derailer is unreliable where a runaway vehicle could attain a speed of more than 15 miles per hour, because it is possible for the vehicle to bump over the derailer and continue running on the track.

The derailer is designed to sit on the rail and to be locked in this position. In the open position no part of it must project more than 2 inches above rail level and to effect this the ends of the wood sleepers must be cut down.

It is the responsibility of the Permanent Way Inspector to ensure, by regular inspections and tests, that all Derailers are in good working order.

Any member of the Railway staff who observes that a Derailer is left in an open condition when it should have been restored to the derailing position, must report the matter. This is particularly important at sidings between stations.

A requisition for a Derailer should state:—

(i) Right Hand or Left Hand (i.e. to derail to the right or to the left);
(ii) the rail section it is required to fit;
(iii) the method of locking to be used viz: Soulsby lock, simple pin for a padlock, or an interlocked succession lock as provided by the Signal Engineer.

All Derailers must be painted WHITE.

(B) **Derailing Switches.**— These provide a certain means of derailing a runaway vehicle, and are sometimes referred to as Catch Points.

The arrangement may be a half set of switches or a full set. The latter is preferable because short lengths of rails can be laid in extension of the stock and tongue rails and arranged parallel and close to the running rails. Thereby a derailed vehicle could remain upright on the sleepers and not capsize.

Derailing Switches are used where either the cost of a complete turnout is not justified or there is no room to locate one.

The common method of locking are with a Soulsby lock, ~~or~~ a point locking pin with a padlock. In special situations a properly interlocked succession lock may be provided by the Signal Engineer, or the switches may even be operated from a signal box.

(C) **Catch Siding.**— This is sometimes referred to as a Trap Siding and comprises a complete turnout leading into a length of siding track.

The methods of locking are the same as for Derailing Switches.

Where the function of the siding is solely to act as a trap, a buffer stop should not be installed. Instead, a neat stack of loose sand or ballast, should be provided at the end, having dimensions from 30 feet to 100 feet length depending on the length and gradient of the approach track, with a top width of 10 feet and a depth of 1 foot above rail level. In addition the last rail length or two should be lifted to a reasonable extent.

In special cases a boxed in drag may be required over each rail, filled with pea size gravel or stone (not sand), to provide a braking effect on the wheels of vehicles.

5.06 **Choice of Safety Device.**— The general principles to be observed in the choice of the type are:—

Derailer.— in all simple situations where the gradients are easy, the sidings short, and where the speed of a runaway vehicle is not likely to exceed 15 miles per hour.

Derailing Switches or Catch Sidings.— in all cases where the gradient of a siding falls towards a running line and also where the gradient rises towards the running line but is easier than 0.3 per cent.

Each situation should be carefully considered by the Operating and Engineering Departments.

5.07 **Location of Derailers, Derailing Switches and Catch Sidings.**— In parallel lines and other situations, where the standing capacity of the line cannot be reduced, the derailing device should be located at or just inside the Fouling Point and so that a derailed vehicle will not foul the adjacent line it is designed to protect.

Where a siding takes off a running line the derailing device should be located at a minimum of 20 feet between track centres in order to provide sufficient clearance to running trains in the event of an accident in the siding.

5.08 **Numbering of Points.**— In the case of interlocked signals and points the numbering of the points and operating levers will be arranged between the Chief Operating Superintendent and the Signal Engineer.

At other stations, and in marshalling and locomotive yards, where the points are operated by switch levers, points facing UP trains and shunt movements in the UP direction will be allotted ODD numbers and points facing DOWN trains and shunting movements in the DOWN direction will be allotted EVEN numbers.

Succeeding points in a yard will follow the same principles.

In simple uninterlocked wayside stations the outermost points used by

incoming trains will be allotted 1 for the UP facing points and 2 for the DOWN facing points.

Where, in a larger yard, an additional turnout is subsequently laid, the re-numbering of all the existing points is not required to be done. It is merely necessary to allot it the next higher odd or even number according to the direction in which it faces. This is to avoid correcting local station working rules, registered assets books and drawings.

Where extensive remodelling of a yard has been carried out it may then be necessary to renumber all points in the manner described above with the approval of the Operating Department.

All corrections in point numbering should be advised to the Chief Engineer.

5.09 **Alterations.**— Except in cases of emergency, no alterations, additions, or connection, whether permanent or temporary, shall be made in any yard without the prior approval of the District Officers having been obtained on a plan showing the proposed work.

Any scheme for alterations which will affect the general layout shall be referred to Headquarters.

5.10 **Securing of Unused Points.**— Points which have been installed and not handed over to the Operating Department for use, and points which have been put out of use and are awaiting removal, must remain secured for the line in use.

Either a padlocked point locking clamp as described in Section 19.16 or a fishbolt securely riveted through the tongue and stock rails, close to the toe, may be used for the purpose.

The security of the points shall be the responsibility of the Permanent Way Inspector.

5.11 **Switch Levers.**— The lever boxes and the lever handles will be painted white.

In tumbler type switch levers the cast iron counterweight will be painted half red and half white with the dividing line parallel to the handle. The red half will be uppermost when the points are set for the turnout or less important track, and the white half uppermost when set for the straight or main track.

The allotted point numbers will be painted in black on the lever box.

The ballast shall be ramped up around the long sleepers carrying the lever box, for the safety of the pointsmen, yard staff, and train crews.

5.12 **Cleaning and Lubricating Switch Slide Chairs.**— This work shall be performed by the Keyman. At interlocked points the slide chairs will be cleaned of dirt and lubricated at least once every three days and at points worked by switch levers at least once a week.

A thin chisel ended pick shall be used to scrape off dirt and a fine coating of graphite mixed with paraffin oil applied to obtain a smooth polished surface.

The Keyman shall inform the Station Master or Signalman when he is proceeding to do the work and obtain their co-operation in opening locked switches.

When cleaning points which are worked from a distance the Keyman should be equipped with a wood block which he will insert between the stock and tongue rails to guard against a switch movement injuring his hands and feet.

5.13 **Lubricating Tongue Rails.**— At the same time as the Keyman cleans slide chairs, he should grease the **gauge** side of both tongue rails for a distance of 4 feet from the toe to reduce side wear. The grease to be used will be the mixture applied to curves as mentioned in Clause 13.21.

5.14 **Opening Sidings for Traffic.**— The following shall be the procedure:—

(a) The Permanent Way Inspector will make out the certificate and forward it to the District Engineer who will pass a copy to the Chief Engineer.

(b) The Permanent Way Inspector will issue a telegram to the Chief Operating Superintendent, copy to the District Engineer, Chief Engineer and the Station Masters on either side, which should read:—

"Siding at ..... certified fit for

traffic on the ..... instant".

5.15 **Closed Stations.**— When notification is received from the Transportation Department that a station is to be closed indefinitely, the Main Line points and crossings are to be removed from the track unless the Transportation Department requires to use the station as a siding.

The turnouts are to be laid out alongside the track in exactly the same way as though they were still laid in the line.

It is appreciated that the wooden sleepers in such disused crossings will undoubtedly rot away in time but they must be renewed from time to time with other sleepers recovered from renewals. On no account are they to be renewed with new sleepers.

The laying out of disused crossings alongside the track means that all three sections of the turnout will remain on their sleepers and be fishplated together.

The portions of the main line formerly occupied by the turnout are to be made good with lengths of track removed from another line in the station, preferably the dead end siding.

The points and crossings are to be treated as an integral part of the station layout and are not to be brought on to the Stores Books, neither are they nor any part of them to be removed from the site for any purpose whatsoever. In other words they are to be treated as though they were still in the line and are to be maintained in such condition that they can be replaced in the track at short notice.

No asset of any kind may be removed from any closed station without the consent of the Chief Engineer and the Chief Operating Superintendent.

The custody of buildings and station machinery at those stations which are temporarily closed for traffic purposes reverts to the Engineering Department and should be placed on a care and maintenance basis.

Permanent Way Inspectors must therefore, apart from casual inspections, carry out a thorough inspection of such stations each month and notify the District Engineer the results of such inspections through the medium of a definite monthly return.

SECTION 6

GRADIENTS. 6.01

6.01 General.— In the Kenya/Uganda system and in new works over the whole Railway system the practice is to express a gradient as its rate per cent. In Tanganyika the original location was set out in terms of 1 in ..... units.

The following is a useful table of common equivalents in the two notations computed from the formula:—

$$\frac{100}{\text{Grade \%}} = 1 \text{ in } .....$$

Grade per cent	*Equivalent Grade 1 in .....*
4.0	25
3.5	28.6
3.0	33.3
2.5	40
2.0	50
1.67	60
1.5	66.7
1.25	80
1.18	84.7
1.0	100
0.67	150
0.5	200
0.4	250
0.33	300
0.25	400
0.2	500
0.1	1000

6.02 Grade Compensation for Curvature.—

For Curve	*Per cent per degree of Curve*
Up to 800 feet length	0.03
Greater than 800 feet and up to 1600 feet length	0.035
Greater than 1600 feet length ...	0.04

Except where a gradient plus the compensation value for curve resistance exceeds the ruling gradient for the section of the line being considered, no compensation need be applied to curves up to 3 degrees sharpness.

In curves exceeding 3 degrees sharpness, compensation should normally be applied no matter what the gradient is.

6.03 Vertical Curves.—

(a) **Running Lines.** The lengths for Sags and Summits for the different ranges of change of grade per cent, and the formulae for fixing the reduced level

of the formation at each station, are shown in ANNEXURE 5.

(b) **Wayside Stations.** See Notes (a) and (b) to Item 21 of Standard Dimensions. The reduced levels of the formation for a vertical curve 300 feet long shall be computed from the formulae of ANNEXURE 5.

(c) **Marshalling and Loco Yards.** Normally no severe change of grade occurs in such yards. Where there is a slight change the grades are eased off by eye.

Out of consideration for locomotives the vertical versine should normally not exceed ½ inch on a chord of 30 feet, which may in difficult situations be increased to a maximum versine of 1 inch. These are equivalent to curve radii of 2700 feet and 1350 feet respectively.

6.04 **Maximum Gradient in Sidings and Station Yards.**— See Items 5 and 21 of Standard Dimensions and the exceptions made in the footnotes thereto.

6.05 **Momentum Grades.**— These were provided in the Main Line between Turbo and Mbulamuti and in the Branch Line sections Nairobi — Thika, Sagana — Nanyuki, Leseru — Kitale and Tororo — Mbale.

It is not intended to use Momentum Grades again.

The instructions contained in the original Chief Engineer's Circular No. 66 of 1940 are reproduced below, and the gradients as then planned are suitable for locomotives now operating.

1. **Rules and Notes for designing.**

Momentum Grades will in all cases be designed by the Chief Engineer but the following rules and notes are circulated for information.

These are the result of exhaustive tests and investigations carried out by the Railway.

(a) The maximum speed used in the design of a Momentum Grade will in no case exceed 25 miles per hour.

(b) Where level crossings over important roads exist, the maximum speed allowable for momentum grades over such level crossings will be 20 miles per hour. It is also essential that there should be good visibility at all level crossings.

(c) Where curves exist on a momentum grade it is essential that there should be sufficient visibility to ensure the safety of workmen and trolleys on the line.

(d) No momentum grades will be used on ruling 3% or steeper grades, nor where any curves exceed 10°.

(e) No momentum grades will be allowed within station limits or between stations and their distant signals.

(f) The method for limiting the length and severity of momentum grades will be controlled by the use of acceleration and retardation charts, based on the E.B.3 type of engine (24 Class) using wood fuel. These charts will be prepared in this office and supplied as occasions demand to engineers requiring them.

Note:—A description of the use and preparation of these curves can be seen in W. L. Webb's Railroad Construction in Chapter XVIII (The Power of a Locomotive).

2. **Marking of Momentum Grades by Notice Boards.**

(a) A circular board with the letter "M" in the centre and figures at the top and bottom wil be placed at the commencement of all momentum grades: the top figure represents the speed in miles per hour which has to be attained as a maxiumum, the lower figure represents the distance in which this speed has to be attained, expressed in the number of telegraph poles to be passed.

(b) At the point of Maximum speed, a special grade post will be placed notifying the Driver that he has reached the point at which maximum speed is required for the grade.

3. Should a speed restriction be at any time required on a momentum grade, the corresponding reduction in engine loading must be notified at once to the Station Masters in charge of the engine changing stations on each side of the restriction. Such restriction must be removed at the earliest possible moment. This instruction must be carefully observed by the Maintenance Staff.

4. In order that none of the essential points should be missed, momentum grades are always fully plotted, showing the approach grade, maximum speed and total length.

The type of "M" and special grade posts is shown in ANNEXURE 39A.

6.06 **Check of Momentum Grades.**— The District Engineers concerned are required to satisfy themselves that all existing momentum grades are provided with the Notice Boards mentioned in Clause 6.05 and that they are correctly marked and located. It should be noted that the original instructions referred to telegraph poles but the line is now marked in half furlongs.

Records of the calculations for the momentum grades are shown in the main line sheets which should be consulted.

SECTION 7

LEVEL CROSSINGS

7.01 General.

(a) A Level Crossing is an intersection of road and railway at the same level i.e. without an over or under bridge. It includes a Private Cattle Crossing but excludes a Livestock Crossing Point (See Clause 7.03) and a Trolley Crossing between Decauville and railway tracks. The latter, which may include a road crossing as part of the railway crossing, is covered by a special agreement, and is protected and worked in accordance with Instruction No. 152 of the General Appendix to the Working Timetable and General Rules.

(b) The legal provisions regarding level crossings are dealt with in sections 17, 18 and 19 of the East African Railways and Harbours Act. It can generally be taken that where a new railway crosses an existing road, public or private, or severs land in such a manner that in order to pass from one severed part of the land to the other a level crossing (or bridge) is required, then the cost of providing the crossing and maintaining it is borne wholly by the Railways.

(c) Conversely, if a level crossing is required across an existing railway the cost of construction is borne by the party or parties requiring the crossing. The cost of maintenance is apportioned as provided in the Agreement relating to the crossing.

7.02 Types of Level Crossings.

(a) *Public Road.*— The cost of construction is apportioned in accordance with the principles referred to in Clause 7.01 (b) and (c) above. No Agreement is required. The maintenance is dealt with in accordance with the general Agreement between the Railways and Road Authorities which provides as follows:—

"The Railway Administration will carry out all necessary maintenance work on roads at level crossings to a standard not less than that of the remainder of the road (in so far as this is possible, taking into account the gradients and cant on the Railway track and gradient and camber of the road) for the width of the road and for a distance of seven feet on each side of the railway track, or tracks where more than one track exists, measured from the centre line of the track or of each track".

(b) *Private Road (Including Accommodation Crossing).*— The cost is also dealt with in accordance with the principles previously referred to. There is an Agreement in all cases and the cost of maintenance is provided for in each Agreement.

(c) *Cattle Crossing.*— As for Private Road. Vehicular traffic of any description is forbidden from using this type of crossing.

7.03 **Classes of Level Crossings.**— For the purposes of fixing the character and standard of construction, level crossings will be classified as follows and as detailed in TABLE 7.03A.

Class		*Description.*
A	—	Situated within principal townships and with through running trains.
B	—	Situated within principal townships and with only shunting over the tracks.
C	—	Situated on important roads outside principal townships.
D	—	Situated on less important roads, both Public and Private.
E	—	Situated on footpaths.
Cattle Crossing.	—	Solely for the passage of livestock (not vehicles) across the railway.

Livestock Crossing Points are not level crossings. They may be provided where necessary, in unfenced grazing country in order to avoid damage to the track and formation. Such sites shall be selected for visibility which is at least as good as that shown in the diagram, ANNEXURE 7. The specification for such crossing points is included in Table 7.03A. Collaboration of the Civil authorities shall be sought to ensure that livestock is driven across the railway only at such sites.

7.04 **Register of Level Crossings.**— All level crossings and livestock crossing points shall be recorded in registers in the offices of the District Engineer and Chief Engineer.

In them will be recorded the mileage, type, class, and the party with whom the Agreement if any has been concluded.

Where required, a decision regarding the class of a level crossing should be sought from the Chief Engineer.

7.05 **Closure of Level Crossings.**— The District Engineers will keep all crossings under review. Any crossing which appears to be redundant or in disuse on account of road reconstructions, change of ownership etc. shall, after local investigation, be put up to the Chief Engineer for sanction to its removal as provided for in the relative Agreement.

7.06 **New Level Crossings (including Re-siting an Existing Crossing).**— No new crossing will be agreed to unless its site is or can be made safe for road and rail traffic, and the necessity for any new crossing shall be fully established before it is approved.

When an application for a new crossing is made it shall be considered by the district officers of the Engineering, Operating and Mechanical departments who shall prepare a joint report in the form shown at 7.06A. The joint

report, along with a joint covering letter stating the reasons for accepting or rejecting the application, shall be sent by each of the district officers to his head of department at which level the decision shall be given.

The crossing shall have the minimum visibility shown in the diagram, ANNEXURE 7, and also, because of the complications resulting from the cant of the track, shall not be located on sharp curves.

The road shall cross the railway at right angles even if this requires curves to be provided in the road approaches.

Only in exceptional cases will a skew crossing be considered and the angle of skew shall not be less than 30 degrees between the road and railway.

7.07 **General Specification.**— For the standards of construction in normal circumstances see Table 7.03A.

7.08 **Visibility (Road to Railway).**— The minimum desirable areas of clear visibility, which shall apply to all level crossings, are shown in ANNEXURE 7. The diagrams are only typical as the shape of the area will vary with the alignments of the railway and road. The essential dimension is the minimum of 300 feet in each of the four directions along the diagonals. Where speed on the railway is likely to be high or the road carries fast traffic, consideration shall be given to increasing the sighting distance over 300 feet, particularly from the road to the railway.

These areas shall be defined by markers of unserviceable rails, steel sleepers, or other permanent means, painted or lime washed white.

There shall be clear vision between the eyes of a motorist and **rail level.** Land adjoining the track should not be above rail level and the land adjoining the road not more than 3 feet above road level and with the intervening land not rising above a plane defined by these two levels. The aim shall be a distance standard of visibility that will enable a motorist, when he is at least 300 feet from the crossing, to see the leading component of a train when it also is at least 300 feet from the crossing.

Vegetation and cultivation of any description on these areas shall be allowed to grow to a height of no more than 9 inches. Such clearance and cutting, as is required, shall be part of the duties of the track maintenance gangs and the Permanent Way Inspector shall maintain a register showing the dates when the vegetation is cut.

The register shall be kept in his office and made available for inspection by visiting railway officers. See also Clause 7.12 concerning the cleaning and painting of Warning Signs.

Engineers will make it their duty to examine all level crossings and initial these registers during their routine inspections.

Where, because of local conditions, the required area of clear visibility

cannot be obtained within the Railway Reserve, the co-operation of the adjacent land owner, local road authority and District Administration shall be sought, and District Engineers are reminded of their powers in this respect as contained in section 11 of the East African Railways and Harbours Act. See Clause 4.04 of this manual.

7.09 **Road Surface at the Crossing.**— Table 7.03A shows the limits on either side of the track for which the Railway shall be responsible.

Earth only, shall not be used for the surfacing of level crossings. The minimum standard, even if the approach carriageways are of earth, shall be waterbound macadam; where the standard of the approach carriageways is higher than this, the standard of the carriageways shall be adopted.

The centre line of the carriageway shall, as far as possible, be horizontal for a distance of 7 feet on each side of the railway track, or tracks where more than one track exists, measured from the centre line of the track or of each track. Beyond the 7 feet point the grade shall be that of the approach road but not steeper than 1 in 20 for a distance of 20 feet from the centre line of the track. Responsibility for the 20 feet in Class 'D' level crossings, see TABLE 7.03A, has been assumed by the Railway in order to reduce the possibility of vehicles stalling on the railway track, and the road authorities and private parties shall be asked to co-operate in attaining this standard.

The surface at all level crossings shall be maintained up to the tops of the rails over the width of the railway track. The surface of the carriageway on each side shall be graded to conform with the level of the track both in regard to its gradient and cant.

7.10 **Warning Signs.**— A schedule of the signs required to be provided at level crossings is given in Table 7.10A and the types and their normal location at a level crossing are shown in ANNEXURE 6.

(A) SIGNS TO BE PROVIDED BY THE RAILWAY.

(1) *Whistle Boards* — These shall be erected 10 feet from the centre line of the track on the right hand or Driver's side.

The siting of the Whistle Board shall be the joint responsibility of the Engineering, Operating and Mechanical departments, whose representatives shall take into account speed, gradient, and curvature on the railway and road, and also any topographical features that may tend to prevent a road user hearing the whistle of a locomotive.

Where a level crossing occurs near or in a station the Whistle Board shall be located as follows:—

(a) Crossing between the last set of trailing points in the direction of travel and an Advanced Starting Signal where provided, or between the last set of trailing points and a Limit of Shunt board or Starting Signal in advance of those points, or where an advanced starting signal, a limit of shunt board or a starting signal is not provided, a crossing located not more than 220 yards in advance of those points.	'W' board at the trailing points in question, sited on the right hand side of the track in the direction of travel towards the crossing. 'W' board for trains travelling in the opposite direction, sited in the normal way.
(b) Crossing within the last set of points.	'W' board only for a train entering the station, located in the normal way.

(2) *Level Crossing Marking Board (St. Andrew's Cross).*— This is intended to mark, as nearly as possible, the actual place where the railway crosses the road. It is therefore located as near the railway track as local circumstances permit subject to the dimensions shown in ANNEXURE 6.

It shall be placed on the left hand side of the road facing an approaching road vehicle and, if necessary, at a skew to the road to enable it to be readily seen by a road user.

Where, as shown in Table 7.10A, an Advance Warning Sign is not provided on a Private Road, and it is considered advisable to site a Level Crossing Marking Board at a greater distance than 60 feet from the centre line of the track, the case shall be referred to the Chief Engineer for a decision.

Where the crossing is over two or more railway tracks the Level Crossing Board shall show the number of tracks to be crossed, on a banner secured below the cross arms.

(B) SIGNS TO BE PROVIDED AND MAINTAINED BY THE ROAD AUTHORITY.

Advance Warning Sign.

This is a black silhouette of a locomotive on a yellow rectangle 2 feet square, surmounted by a red triangle on the same post. This sign is intended to give road users warning that they are approaching a crossing over the railway, and, depending on local circumstances, is erected at least 300 feet from the actual crossing, on the left hand side of the road for approaching vehicles.

Where there is a junction of two or more roads in the immediate vicinity of a level crossing and local circumstances require Level Crossing Marking Boards and Advance Warning Signs on each road, these shall be provided.

7.11 **Warning Signs in Industrial, Port and similar Areas.**— At level crossings where the responsibility for providing all warning signs devolves on the Railway, these shall be the same as described in Clause 7.10. In the case of any doubt the Engineer shall consult the local officers of the railway departments concerned.

7.12 **Cleaning and Painting of Signs.**— Whistle Boards and Level Crossing Marking Boards, and their posts, shall be re-painted whenever necessary. Thereafter they shall be washed down at regular intervals, this being particularly necessary where the signs may have enamelled or special reflecting material surfaces.

The dates such re-painting or washing is done shall be entered in the register referred to in Clause 7.08.

7.13 **Accidents at Level Crossings.**— In the event of a collision occurring between a train and a road vehicle, the conditions obtaining at the site at the time of the accident shall be immediately recorded on a scale plan, supplemented, if possible, with photographs. This particularly refers to vegetation and other objects which, it may be alleged, obstructed the vehicle driver's view of the train. The Warning Signs shall also be shown in the plan.

7.14 **Tracked Vehicles using Level Crossings.**— Vehicles with caterpillar tracks can cause serious damage and leave the railway track in an unsafe condition for trains. They shall not be permitted to cross the railway without special approval of the District Engineer or Permanent Way Inspector, when wood planks or steel plates shall be laid across the rails or the tractor shall be fitted with road plates on its caterpillar tracks.

All cases of unauthorised use of such vehicles causing damage to the railway shall be immediately taken up with the owners and full particulars advised to the Chief Engineer.

7.15 **Maintenance of Level Crossings.**— The maintenance of the track, marking signs (St. Andrew's Cross), Whistle Boards, and the road surface at the crossing, shall be the responsibility of the Permanent Way Inspector. Engineers shall examine all level crossings as a regular feature of their routine inspections.

The Permanent Way Inspectors and Engineers shall also inspect the approach warning signs and if these have not been provided, or are not being properly maintained, the Engineer shall refer the matter to the road authority responsible.

The Inspector or Sub-Inspector shall be present on all occasions when the road surface is opened up to an extent making it unsafe for road vehicles.

When possible only one half of the width shall be opened at a time, and flag signals shall be displayed to road vehicles.

The surfacing shall be replaced before nightfall.

The road surface over the track shall be opened and the sleepers packed and fastenings attended to whenever rail movement under trains appears excessive.

Once annually all track components shall be overhauled, the rails examined for cracks, and all steel work tarred or heavily painted.

The flangeway between running and guard rails shall be kept clear down to the flanges of the rails and this cleaning shall be regularly attended to by the Keyman.

Rail joints in level crossings should be avoided where possible by using cut rails on either side.

The tops of the running and guard rails shall be maintained at the same level.

7.16 **Flashlight Signals, Warning Bells, Barriers, Track Circuits and other protective devices.**— Where these are provided the responsibility for their maintenance shall be vested in the Signal Engineer.

Permanent Way Inspectors shall keep all such equipment under observation and promptly report defects or failure to the stations on either side and to the party responsible for maintenance.

As opportunity offers the Permanent Way Inspector shall note, on the approach of trains, whether the warning devices are operating satisfactorily.

7.17 Where level crossings of class BCD are required in lines using 45 RBS Rail, use should be made of the 50 NS - 50 BS check block type NS 3

Ref Drawing No 4206 (P.W.I Instruction No 10)

TABLE 7.03A — GENERAL SPECIFICATION FOR LEVEL CROSSINGS

Class	Overall Length of Guard Rails	Width of Carriageway at the track.	Character of Surfacing at the Railway.	Distance to be maintained on either side of the centre line of the track.	Length of Pipe Drains across the road where required for side and catch water drains.	Fencing.
A and B	Width of approach carriageway plus 1′ 6″ at each end for splay.	Same width as approach carriageway	See Clause 7.09	7 ft.	As required.	Not normally necessary but as required.
C	30 ft.	25 ft.	— do —	7 ft.	27 ft. with headwalls.	None.
D	15 ft.	12 ft.	— do —	7 ft. where approaches are adequately graded. 20 ft. where steeply graded.	15 ft. with headwalls.	None.
Cattle Crossing	18 ft.	18 ft.	— do —	7 ft.	20 ft. with headwalls.	Short wire fencing to guide animals over the crossing. **Not Hedging.**
Livestock Crossing Point	No guard rails.	50 ft.	Stone pitching to top of sleeper level	10 ft.	None.	Stone set vertically or low hedging to mark the crossing.

NOTE: Where the road crosses the railway at a skew, the dimensions in the Table shall be increased correspondingly so as not to narrow the width of the approach carriageways across the railway.

APPLICATION FOR A LEVEL CROSSING 7.06A

This report and the supporting plan are to be jointly signed by the District officers of the Engineering, Operating and Mechanical departments and each will forward a copy to his head of department for a final decision.

1 Name of Applicant .....

2 Site of Crossing Mile ..... Between Stations .....

3 Permanent or Temporary (state period) .....

4 Reasons put forward and area to be served .....

.....

.....

5. Mileage and Class of existing crossing on each side .....

.....

6. Reasons put forward why these crossings are unsuitable .....

.....

7. If approved, is it possible to close any existing crossing? .....

8. Estimated road vehicles — by Day .....

by Night .....

9. Type of Crossing proposed; Public; Private; or Private Cattle .....

10. Class proposed — A; B; C or D .....

11. Additional Warning Signs required over normal standard .....

12. State objections if the crossing is not recommended .....

.....

13. Attached Plan No. .....

(The plan shall be foolscap depth, to a scale 1" = 100 ft., and shall show the railway for 1,000 ft. on each side; the road within the Railway Reserve; gradients; cuttings and banks on railway and road; actual boundary of clear visibility to the railway from points on the road 300 ft. from the crossing; major obstructions in the Railway Reserve requiring to be removed).

District Motive Power Superintendent	District Traffic Superintendent	District Engineer.
.....	.....	.....
e	Date	Date .....
No.	File No.	File No. .....

TABLE 7.10A — WARNING SIGNS FOR LEVEL CROSSINGS.

(The numbers shown are for each direction of traffic)

Type of Crossing	Class	SHOWING TO RAILWAY		SHOWING TO ROAD	
		Whistle Board	Additional Whistle Board	Level Crossing Marking Board (with Baner for multiple tracks as required)	Advance Warning Sign.
PUBLIC ROAD — In principal townships with through running trains.	A	1	NIL	1	1
PUBLIC ROAD — In principal townships with only shunting over tracks.	B	1	NIL	1	1
PUBLIC ROAD — Important road outside principal townships					
(a) Dangerous	C	1	1 if required	1	1
(b) Not dangerous	C	1	NIL	1	1
PUBLIC ROAD — Less important road					
(a) Dangerous	D	1	1 if required	1	1
(b) Not dangerous	D	1	NIL	1	1
PRIVATE ROAD — (a) Dangerous	D	1	1 if required	1	NIL
(b) Not dangerous	D	1	NIL	1	NIL
PRIVATE CATTLE CROSSING	—	1	NIL	NIL	NIL
LIVESTOCK CROSSING POINT & TROLLEY CROSSING } These are not scheduled as level crossings	—	1	NIL	NIL	NIL

SECTION 8

STANDARD DIMENSIONS

8.01 **General.**— Standard Dimensions are laid down to ensure:—

(a) that rolling stock shall not be designed in such a way that it cannot be used on existing tracks without alterations to the permanent way or adjacent structures;

(b) that no alterations to existing structures and tracks be made, new structures built, or tracks laid which would prevent the safe passage of rolling stock;

(c) the safety of railway servants and the public using the railway;

(d) that the relationship between rolling stock, tracks and structures shall be kept under constant review and that developments will take place along rational lines.

8.02 **Standard Dimensions (1959).**— All staff of the Engineering Department concerned with the design, setting out, construction, and maintenance of railway tracks, yard layouts, and structures affecting railway tracks, must be in possession of and comply with the publication entitled Standard Dimensions (1959) — Metre Gauge.

It has been issued under the joint authority of the Chief Engineer and Chief Mechanical Engineer, whose departments are chiefly concerned with it.

As particular features in this publication are of information to the Operating, Commercial and Harbour Departments, copies of the publication have also been supplied to them.

The principle features of Standard Dimensions are the Maximum Loading Gauge and Minimum Structure Gauge shown in DIAGRAM 8, and the Appendices "A" and "B". The latter respectively lay down the additional horizontal clearances required to be provided in curved track located Out of Stations and In Stations.

Attention is also drawn to the explanatory foreword on page 1 and to the descriptive notes on pages 11 to 15.

8.03 **Alterations and New Works.**— The horizontal clearances from a track to a structure shown in Standard Dimensions are minima. Where an increased clearance would serve its purpose equally well and is economically acceptable, such extra clearance should be provided.

Members of the executive staff should bear this in mind when carrying out alterations and new works and should not hesitate to suggest amendments to the approved plans to which they are working.

When planning new schemes due consideration shall be given to future works such as doubling the line, additional tracks, and yard extensions.

Headquarters staff must see that District Engineers are supplied with drawings showing the positions of all structures that are to be erected close to the track, and if an infringement of Standard Dimensions is involved because of unavoidable circumstances, then their particular attention must be drawn to this fact. The information must be sent to them well in advance to enable them to examine site conditions and, if possible, suggest a modification.

Once a work is completed, either by the District Engineer's staff or by staff under direct control from Headquarters, the supervisor concerned is responsible for seeing that a dimensioned record drawing of any infringement of Standard Dimensions is prepared and this must be sent to the District Engineer who, in turn, must send a copy to Headquarters.

8.04 **Sidings serving Godowns on Railway Land.**— In the case of railway owned Godown layouts the "Station Yard" Standard Dimensions and DIAGRAM 7 shall apply, unless the tenant of any plot has obtained a special exemption.

It is not permissible for the tenant of a plot on railway land to erect any structure thereon unless he is in possession of a plan of the structure approved by the Chief Engineer, and it is the duty of all Engineering staff to report immediately any building operations which are observed within the railway boundaries (or within 200 feet of these boundaries outside developed township areas), unless they have been advised that the erection of the particular structure has been approved by the Chief Engineer.

8.05 **Sidings on Private Land.**— Structures adjacent to Private Sidings on land belonging to the owner or lessee of the Sidings are also subject to the "Station Yard" Standard Dimensions and DIAGRAM 7, unless the owner or lessee holds the written approval of the Chief Engineer to any infringement.

The owner or lessee of a Private Siding does not require the permission of the Railway to erect structures on land **outside** the railway boundary, but service to the Siding is liable to be withdrawn if any structure which he may erect creates unsafe working conditions.

Permanent Way Inspectors should draw the attention of such owners or lessees to this fact whenever they find that construction is taking place, and advise them to consult the District Engineer before proceeding with the work unless it is certain that the structures will not infringe any Standard Dimensions.

8.06 **Infringements of Standard Dimensions.**— It is a serious offence for any member of the Engineering Departmnet to infringe or permit others to infringe any Standard Dimension without the consent of the Chief Engineer in writing.

Infringements may be divided into two categories viz.:—

(a) those which are definitely dangerous; and

(b) those which, although not actually dangerous do constitute a breach of regulations.

It is the duty of any member of the Engineering Department to take whatever steps are in his power to remedy a dangerous infringement immediately it comes to his notice, and to report to his superior on the same day, the nature of the infringement and the steps taken to deal with it.

Infringements in category (b) must be reported with full details, and no other action should be taken until definite instructions have been received.

All infringements are to be reported eventually to the Chief Engineer by the District Engineer concerned.

8.07 **Works executed by other Departments.**— The Chief Mechanical Engineer may execute certain types of work, such as electric supply and lighting schemes, which involve structures in close proximity to the track, and his staff are required to comply with the Standard Dimensions. This, however, does not relieve District Engineers and their staff of their responsibilities for seeing that the regulations for the safety of the track are carried out.

Where it becomes evident that Standard Dimensions will be infringed or that the character of construction may endanger the safety of the track, the District staff must refuse to permit the work to proceed until the matter has been reported and a decision obtained from the District Engineer or Chief Engineer.

The same instructions shall apply in the event of any other department causing structures, plant and other materials to be located adjacent to the railway track.

8.08 **Marking Infringements.**— The increase in the size of rolling stock and the acceptance of the Tropical Africa Structure Gauge have resulted in some infringements of Standard Dimensions (1959) in early constructions.

General Rule 103 requires that each infringement shall be marked with an "I" sign of the pattern and size shown in the type drawing.

In the case of water columns, oil columns, lighting poles, signal posts, columns, ladders, walls of over-line bridges, main girders and bracings of bridge spans and similar structures, the "I" sign shall be painted in a prominent place on each.

For buildings on platforms, lean-to roofs etc. the "I" sign should be painted adjacent to the infringement and where it can be readily seen.

Where telecommunication and electric supply lines infringe the vertical clearance over a track the "I" sign shall be painted on the post.

Infringements in track spacings obviously cannot be marked but these must be recorded in the Registers referred to in Clause 8.10.

8.09 **Candy Stripe Marking.**— Where posts and other structures infringe the horizontal clearance of Standard Dimensions (1959) or are so located as to endanger locomotive and yard operating staff, candy stripe marking consisting of wide

diagonal yellow stripes of reflecting material on a black background should be provided to serve as an advance warning to such staff.

If the structure is a permitted infringement it shall also be marked in accordance with Clause 8.08.

8.10 **Register of Infringements and their Correction.**— The District Engineer shall maintain a register of all infringements of Standard Dimensions (1959) in two separate parts, viz:—

PART I.—Infringements in Running Lines, Wayside Stations and Marshalling Yards.

PART II.—Infringements in all other areas not covered by Part I.

The register shall show the station name, description of the structure or item, its location, the Item of Standard Dimensions infringed, the extent of the infringement, the action necessary to remove it, and the approximate cost of such correction.

A copy of each Part shall be sent to Headquarters where it shall be kept under review, and a copy shall also be given to each of the Permanent Way Inspectors showing the infringements in their sections.

The District Engineer shall, to the extent of his financial powers and where the correction is a simple operation, remove existing infringements and shall report to the Chief Engineer in June and December of each year stating which infringements have been corrected.

8.11 **Minimum Horizontal Clearances to an Existing Structure.**— The minimum horizontal clearances to an existing infringing structure, until the clearances can be increased, shall be those of the Interim Structure Gauge of 1948 shown in DIAGRAM 8 of Standard Dimensions (1959), plus the additional clearance of APPENDIX "A" or "B" where the track is curved.

8.12 **Periodical Check of Infringements.**— It is the duty of the District Engineer and his staff to see that infringements are checked periodically to ensure that no change has taken place e.g. by alteration of track alignment and movement of or damage to the structure.

8.13 **Track Alignment and Levels at Special Structures.**— To ensure that the horizontal and vertical clearances at special structures are not upset in the course of track maintenance and repairs, the level of the running rail and the centre line of the track shall be fixed with reference to a rail piece set in concrete in the following manner:

(a) At each end of a tunnel, semi-through and through span girder bridge. a marker rail shall be fixed within the track, having its top at rail level and a chisel mark to indicate the centre line of the track.

(b) At a short overline bridge, one marker as described above, located in the middle of the bridge will suffice.

Where the track is curved, the top of the marker rail within the track shall be level with the low running rail and the curve must be properly beaconed.

In addition, the existing horizontal clearances left and right of the centre line of the track and the vertical clearance from rail level (over each rail) shall be painted on the structure where they can be readily seen.

8.14 **Lifting, Slueing and Altering Tracks.**— When string lining curves and when lifting and slueing the track at structures, platforms, and where double or multiple tracks exist, care shall be taken to ensure that the minimum clearances of Standard Dimensions are not infringed.

8.15 **Stacking of Stone and other materials near Running Lines.**— No materials which are liable to endanger the safety of train working shall be stacked nearer to the centre line of any running road than 10 feet plus the height of the stack, except where a frontage line has been demarcated with pegs by a responsible official.

A frontage line should always be demarcated for material supplied by a Contractor and for large departmental stacks, and the meaning of the pegs must be clearly explained to the Contractor's Agent or the Railway employee in charge of the work.

The frontage line is to be marked by large pegs not more than 30 feet apart placed at a horizontal distance of not less than 7 feet plus the height of the stack in the case of surface line or the same distance from the edge of a cutting when the track is lower than the surrounding ground.

The term frontage line means the toe of the slope of the stack on the side nearest the railway track.

8.16 **Track Ballasting.**— Track staff must fully appreciate that anything standing above rail level within a distance of 5 feet 1 inch from the centre of the track constitutes an infringement of Standard Dimensions.

It may on occasions be necessary to pass traffic over a portion of the line during ballasting operations whilst the ballast is slightly infringing above rail level. Whenever this occurs the train should first be stopped and then passed over at a dead slow speed on account of the infringement.

8.17 **Approximate Rules for Track and Signal Staff.**— Instances have occurred of footboards of vehicles, and locomotive steam cocks and cattle guards being damaged by material placed too high on or at the side of the track.

Track and Signal Staff should be taught to observe the following approximate rules:—

(a) **Material between the two rails of a track.**
To be not higher than the **bottom of the rail head** for one hand span (8 to 9 inches) from the gauge face of each of the two rails, and not higher than rail level over the remaining portion within the track.

(b) **Material outside each rail.**

To be not higher than rail level for a distance of **one** track gauge (3ft. 3⅜ in.) measured from the **outside edge of the rail head,** provided the material is not heaped more than 3 feet (four hand spans) above rail level and the track is straight. On curved track the distance must be increased by one hand span (8 to 9 inches). The distance to the face of the material for the portion exceeding 3 feet above rail level shall be clear for two track gauges (6 ft. 6¾ in.) from the **outside edge of the rail head,** which will suffice for both straight and curved tracks.

These rules apply particularly to work of a temporary nature such as opening out track and level crossings, and putting down materials for construction and replacements, and the matter is of special importance because locomotives are now constructed to the full limit of the Loading Gauge outline shown in DIAGRAM 8 of Standard Dimensions (1959).

The measurements are expressed in terms of the track gauge and hand span because a tape measure is not available to Gangers and Artisan staff.

3.18 **Track Signs.**— The Standard Dimensions (1959) shall apply to all track signs standing above rail level, whether they are of a temporary or permanent nature.

Permanent track signs, except half furlong, mile and gradient signs, should be placed at an increased clear distance of 10 feet from the centre line of the track, the formation being widened if necessary to effect this.

3.19 **Trees.**— Item 11 of Standard Dimensions (1959) shall apply to trees which might fall on the track. Exception may be made in the case of indigenous hard wood trees of slow growth, but their boughs must be clear of the formation. All other trees in Railway Reserve must be brought within Standard Dimensions either by removal or pollarding. (Cream off tops branches)

Trees which infringe Standard Dimensions and are outside the Railway Reserve shall be treated in accordance with Clause 4.04.

3.20 **Loading Trucks.**— Staff loading trucks must ensure that the material is within the Loading Gauge.

In the case of extra long material, such as girders and masts, which require the use of one or more dummy trucks to accommodate the overhang, care shall be taken to see that no weight of the projecting portions of the load bears on the dummy truck. As a general rule the portion of the load overhanging the dummy truck shall be clear of the latter by 9 inches as a safeguard for gradient changes in the track.

In accordance with Section VI of the General Appendix to the Working Timetable and General Rules any article which projects beyond the ends of the vehicle in which it is loaded must be dealt with as an out-of-gauge load

see Clause 8.21.

The projection must also be checked, by calculation or by drawing to scale, for displacement outwards on a curve and the sharpness of the curve to be used for the purpose shall be 16 degrees (350 feet radius).

8.21 **Out-of-Gauge Load.**— The carriage of such a load is regulated in accordance with the records of limiting structure clearances maintained by the District Engineer, Dar es Salaam, for the Central Line, and by the Chief Engineer for the Kenya, Uganda and Tanga Line systems.

Where it is found necessary to temporarily reduce the normal clearances of an existing structure by the erection of falsework, and also where a track is restored at the side of derailed vehicles which results in restricted clearances for trains using the line, immediate information shall be sent by telegram by the Enginering Department official concerned to the District Traffic Superintendent and to the Chief Engineer (or District Engineer, Dar es Salaam) instructing them to suspend the passage of out-of-gauge loads until further notice.

The regulations concerning the carriage of out-of-gauge loads is contained in Section VI of the General Appendix to the Working Timetable and General Rules.

8.22 **Overhead Wires.**— See Clauses 4.11, 4.19 and 4.20 which lay down the action to be taken.

Track Staff must keep a careful watch on all wires crossing the railway.

SECTION 9

CURVES, SPEED AND CANT. 9.01

9.01 **Circular Curves.**— It is usual to express the sharpness of a circular curve in terms of its degree 'D'. Occasionally it is expressed as radius in feet 'R', whilst in Tanganyika the original curves were set out as radius in metres 'Rm'.

The approximate conversion formulae are:—

$$D = \frac{5730}{R} = \frac{1747}{Rm}$$

$$R = \frac{5730}{D} = 3.281 \times Rm$$

$$Rm = \frac{1747}{D} = \frac{3.281}{R}$$

The scale on the left side of the graph in ANNEXURE 11 shows the equivalents in feet and metres of curves up to 16 degrees.

The following approximate formulae are accurate enough for all practical purposes and will be found useful.

Given V = versine (middle ordinate) in inches;
C = chord in feet; and R = radius in feet:—

$$V = \frac{3C^2}{2R}$$

$$R = \frac{3C^2}{2V}$$

A Right Hand curve and a Left Hand curve are ones that curve away to the right and left respectively, when faced in the direction in which the mileage progresses.

9.02 **To ascertain the Degree of a Curve.**— Using a chord length of 62 feet, the versine (middle ordinate) in inches is equivalent to the degree of the curve.

If a half length chord of 31 feet is used, then the versine in inches multiplied by 4 is equivalent to the degree of the curve.

9.03 **Limiting Curvature.**— The sharpest curves which may be used are laid down in Standard Dimensions and are:—

Main Lines (ordinary)	8° (716 ft. Rad.)
Main Lines (in special circumstances)	10° (573 ft. Rad.)
Branch Lines	16° (358 ft. Rad.)
In Sidings	16.4° (350 ft. Rad.)

In a Diversion at the site of an accident 16° is the sharpest curve which may be laid and, where possible, the curve should be made considerably easier.

9.04 **Transition Curves.**— In new location work transitions shall be provided for curves of all degrees of sharpness. The lengths of the transitions shall be in accordance with ANNEXURE 8 in which is also given the relevant formulae and information for setting out the transitions either by offsets from the tangent or by deflection angles.

The lengths are designed for possible higher speeds in the future and for gain of cant not exceeding 1½ inches per second of time at the highest speed.

9.05 **Transitions in Compound Curves.**— The two circular curves shall be connected with a transition which should have a length as specified in ANNEXURE 8 applicable to the difference in degrees between the two curves; e.g. 8° to 5°, use the transition length applicable to a 3° curve.

In location work the difference in curve sharpness shall not exceed 3°.

9.06 **Reverse Curves.**— In running lines a minimum length of 50 feet shall be provided between the beginnings of the two transition curves.

In sidings and in temporary diversions a sharp curve shall not reverse directly into another curve. In such situations a minimum length of 30 feet of straight should separate the two curves.

9.07 **Checking Curve Alignment.**— In existing track, reliance must not be placed on the eye alone for detecting irregularity in the alignment of a curve. Local deformation amounting to two or three degrees is not readily discernible by inspection. The versines on all curves shall be checked at regular intervals using a chord length of 62 feet or 31 feet as described in Clause 9.02.

9.08 **Correcting local irregularities.**— Local flat or sharp places in a circular curve and in a transition curve can be speedily corrected, and with a minimum amount of slueing, by the simple method of averaging three versines.

The method is described and illustrated in ANNEXURE 9.

Using any length of chord, preferably 62 feet, place five chalk marks on the outer rail at intervals of half the length of the chord e.g. 31 feet, keeping Station 3 at the point needing correction.

This method is based on the principle that if the versine is altered at any point on a curve it automatically alters the versines on each side of such point by **half** the amount of slue at the first point. How this is effected can be seen from the dotted chord lines in the illustrations of ANNEXURE 9.

Thus the main slue is at Station 3 and the track between Stations 2-3 and 3-4 is lined in by eye.

The versine line in a track recorder chart frequently shows up local sharp and flat spots in a curve which may easily be regulated by this method with-

out having to string line the entire curve.

This method is equally useful in correcting the centre line marks on Beacons which may have become displaced; see Clause 9.13.

9.09 **String Lining of Curves.**— Engineers and Permanent Way Inspectors are expected to make themselves conversant with the process of correcting a whole curve by string lining. Any approved chord and versine method of doing this may be used.

The track frequently becomes distorted both by the Ganger lining in by eye and by trains. A relatively immoveable alignment in the form of reference beacons placed outside the track is therefore necessary.

District Engineers should see that all curves in running lines are string lined and beaconed, and that there is a regular programme for checking not only the curves to the beacons but also the correctness of the beacons themselves.

Where the District Engineer is satisfied that a Permanent Way Inspector is competent to do the calculations, it should not be necessary for the latter to send his measurements to the District Engineer for arithmetical checking. This is desirable because it is essential to beacon a curve as soon as possible after measuring it up, since the track is liable to be displaced under traffic.

To avoid this disturbance it is a good plan to put in temporary wooden pegs with nails at an uniform distance of 12 inches from the gauge face of the outer rail, and to use the marks on these as a copy of the centre line of the existing curve alignment. It makes no appreciable difference to the result if the half chord station is over a sleeper and the temporary peg is required to be driven between two sleepers. The half chord stations will have to be painted on the rail at uniform intervals and the permanent beacons can be put in opposite these paint marks.

The Permanent Way Inspector shall maintain a record of his calculation sheets for string lined curves showing the original versines, "throws", and final versines, and send a copy to the District Engineer for scrutiny and comment by him if necessary.

In measuring up curves the outer rail shall be used as the base line, due allowance being made for excluding from the versine any side wear which may be present in the rail.

The chord length to be used shall be 62 feet giving versine stations 31 feet apart.

Boxwood rules 20 inches long and divided in tenths of an inch, designed specially for the measurement of versines on curves, are obtainable from the Chief Engineer's office.

9.10 **Transitions in String Lined Curves.**— Every curve in a running line has a transition, either a properly designed one put in at the time of location, or one

put in by eye to suit deformation of the curve under traffic. The latter type is only obtained at the expense of sharpening the curve at the beginning of the circular curve.

In the process of string lining a curve a proper transition shall be introduced, having a length nearly equal to that shown against the corresponding degree of circular curve in ANNEXURE 8. The selected length will have to be in multiples of the half chord length of 31 feet e.g. for a normal 5° curve use a transition length of 155 feet.

Where the desirable length cannot be fitted into the calculations without excessive "throws", it may be reduced by one half chord length, viz. 31 feet. It must be borne in mind that in a proper transition of gradually increasing sharpness, the versines increase at an uniform rate at each half chord station.

9.11 **Compound Curves.**— A transition shall be provided between the two curves on the same principle as laid down in Clause 9.05.

9.12 **Limit of Throw.**— As far as possible the slue or "throw", either outwards or inwards, at any one station, should not exceed 6 inches.

Care shall be taken to adjust the "throws" so as not to move the track on bridges or to reduce horizontal clearances to fixed structures thus infringing Standard Dimensions. For this purpose it may be necessary to sharpen or flatten the curve to a slight degree by small increases or decreases in the versines.

Any reduction in the **existing** clearances to fixed structures must be referred to the Chief Engineer for a decision, **before the track is slued,** as this matter affects the carriage of out-of-gauge loads.

9.13 **Beaconing of Curves.**— The gauges to be used for string lined curves are:—

Drawing 7808 — Inspector's Adjustable Gauge for string lining curves.

Drawing 7808/A — Ganger's Fixed Gauge for Beaconed Curves.

Beacons having permanent track centre marks, shall be fixed on the inside of the curve, 5 feet from the centre line of the corrected track alignment, the top of the beacon being 12 inches below the top of the inner (low) rail.

The beacons shall be of cedar wood where procurable or of durable hardwood, coated by dipping or painting with creosote oil, and shall be 2′ 6″ long x 4″ to 6″ diameter. Wood beacons readily lend themselves to subsequent adjustment of the marking points, which shall be 4″ long wire nails driven flush with the top of the peg.

The first beacon in any series is to be on the straight 200 feet from the beginning of the transition curve. Thereafter beacons will be put in at intervals of 31 feet throughout the transition and circular curves.

All beacons shall be protected by ballast arranged neatly around them and level with the tops.

In normal maintenance the Ganger must slue the track to the marking points on the beacons, using a spirit level and the special gauge provided for the purpose. Should he suspect that any of the beacon marks have been displaced or removed, he must report the fact to the Inspector.

See Clause 9.08 for the method of correcting such local irregularities.

As laid down in Clause 9.09 Permanent Way Inspectors are required to regularly check the correctness of beacons.

9.14 **Slueing of Curves.**— The work shall be protected with signals in accordance with the General Rules and supervised by an employee not below the rank of Sub-Permanent Way Inspector or certified Passed Ganger.

To avoid cutting rails the expansion gaps at the rail joints should be adjusted prior to the slueing being done, allowing extra wide gaps if more of the track is to be moved inwards and tight joints if more of the track is to be moved outwards.

Slueing is facilitated by easing the fishbolts, fishplates and sleeper fastenings.

On completion of the slueing the sleeper spacing must be corrected, all fastenings re-tightened and the joint expansion gaps adjusted.

9.15 **Double Tracks.**— In string lining curves in existing track, care shall be taken to see that the clearance to the adjacent track is not reduced without the authority of the District Engineer.

The minimum distance centre to centre of tracks outside station yards is laid down in Item 2 of Standard Dimensions (1959) and varies from 14 ft. 0 in. on straight track to 15 ft. 6 in. on the sharpest curve.

Where the length of straight between the beginnings of two adjacent curves does not exceed say 1,000 feet, the track centres on the straight may be made uniform with that required for the sharper of the two curves. Cases involving bridges and extensive earthworks shall be referred to the Chief Engineer for a decision.

In the event of the track centres having to be variable on the straights and curves, the following general principles will apply:—

New track on the inner side of an existing track.

The track centres over the **circular** portion of the curve shall be uniform at the increased spacing required for the curve in accordance with Standard Dimensions. From the PCC a transition shall be set out for the inside track, the length of transition being computed from the formulae for "shift" shown in ANNEXURE 8, using the amount of difference between the straight and curved track centres as the "shift".

Example:— 6 degree curve;
S = 15′ 3″ — 14′ 0″ = 1′ 3″
L = 169.26 feet instead of the normal length of 140 feet.

New track on the outer side of an existing track.

The centres over the entire circular and transition portions of the curves shall be uniform at the increased spacing required for the curve in accordance with Standard Dimensions. From the point of the transition curve (PTC) the difference between the track centres on the straight and curved tracks shall be run out in a reverse consisting of two simple curves not sharper than half a degree with 200 feet of straight between the two curves.

Example:— 6 degree curve; Difference between straight and curved track centres = 1′ 3″;
Half degree simple curves.
The overall length of the reverse, computed from any text book, is 211.60 feet.

9.16 **Speed Limit.**— The maximum permissible speed on **straight** track over any section of the Railway is decided by the Chief Engineer and published in the Working Timetables.

For trains operated with steam and electric locomotives the following are the normal maximum section speeds in miles per hour on straight track. These maxima are permitted by the Chief Engineer only where the condition of the track materials, amount of curved track, gradients etc., merit such speeds.

	Track over 60 lb. & GHSC.	*Track 60 lb. & GHSC.*	*Track under 60 lb. & GHSC.*
Passenger Trains and Special Goods Stock ...	45	35	30
Ordinary Goods Trains ...	40	35	30

The maximum permissible speeds on curves are shown in ANNEXURE 10, which are subject to any lesser maximum speed on straight track laid down for a particular section of the Railway.

The broken stepped line in the diagram represents probable future maximum speeds which may be approved by the Chief Engineer for suitably designed Rail Cars with a low centre of gravity.

9.17 **Checking the Speed of Trains.**— Engineering Department officials should immediately report cases of excessive speed, particularly over curves, giving the name of the Driver if known, number of the locomotive, train number, mileage over which recorded, and the estimated speed. The incident should be reported by the District Engineer to the District Motive Power Superintendent.

9.18 **Formula for Estimating Speed.**— The speed in miles per hour is the number of rail joints passed over in the number of seconds obtained from the formula 0.7L where "L" is the length of rail in feet. The figures for the more usual

rail lengths are:—

Rail Length	*Number of Joints in:—*
40 ft.	28 seconds.
36 ft.	25 ,,
30 ft.	21 ,,
10 metres	23 ,,
9 metres	20 ,,

As the speed of a train can fluctuate appreciably within the time given above, it is generally better to count the joints over half the time and double the result e.g. 40 ft. rail — the number of joints counted in 14 seconds is 24, therefore the speed is 48 miles per hour.

When the length of the rail is not known, the speed of a train may be found by timing it over one quarter of a mile (4 half furlong posts) in seconds. Divide this number into 900 and the result is the average speed in miles per hour.

Example:— Timing over $\frac{1}{4}$ mile is 19 seconds.
Speed = 900 divided by 19 = 47 m.p.h.

9.19 **Cant (Superelevation).**— The inner rail on a curve shall remain at the grade line of the railway and cant shall be provided by raising the outer rail.

It is more important that cant shall be maintained at a uniform amount on a curve than that the cant shall be exact for the speed.

Because of the difference in wheel loadings on the low and high rails on account of variations in speed, the cant, especially on earth ballasted track and soft formations, is very liable to become upset.

Inspectors must frequently check cant, especially where a Ganger is working on curved track. Abrupt change in cant, especially in combination with deformity in the curve alignment and loosely packed sleepers, is very liable to cause derailment of a vehicle.

9.20 **Equilibrium Cant.**— This is the exact cant computed for a particular speed and it would provide equal wheel loadings on the low and high rails of a curve. It is seldom that the speed of a train exactly suits the cant provided.

The graph in ANNEXURE 11 is only included for a better understanding of Table 9.22A and as an aid to deciding the actual cant to be provided in special circumstances.

9.21 **Cant Deficiency.**— This is the term used to indicate the amount of unbalanced cant i.e. the difference between equilibrium cant and any lesser cant actually provided on a curve.

Taking into consideration the size of the rolling stock in relation to the track gauge and other related factors, cant deficiency has been fixed at the maximum amount of $1\frac{3}{4}$ inches.

9.22 **Cant to be provided.**— Cant on curves has been too frequently fixed to suit the maximum section speed, resulting in excessive wear on rails and sleepers at low speeds and increasing the danger of a wheel climbing the rail.

Cant will be fixed in accordance with Table 9.22A and the footnotes thereto, **and will not exceed 3 inches in any circumstances.**

District Engineers will personally fix the cant for each curve and, in cases of doubt, will refer the matter to the Chief Engineer for a decision. Each district will open a Curve Register showing the mileage at the beginning and end of each curve, the degree of the curve, and the cant fixed for it. Each Permanent Way Inspector will also be given a Curve Register in which this information will be provided for his section.

In the event of the maximum section speed being altered at any time, the cant for each curve shall be re-fixed by the District Engineer and the Curve Registers corrected.

The metric system of applying cant, as used in Tanganyika, will be altered to cant in inches.

The equivalent curvature in degrees of radius in metres can be read from the scale on the left side of the graph in ANNEXURE 11.

9.23 **Cant Gradient.**— The cant gradient or rate of run-off must not be steeper than 1 inch in 40 feet (1 in 480).

(a) **Transitioned Curves.** The cant is to be run off in the length of the transition i.e. from NIL at the commencement of the transition to full amount at the commencement of the circular curve.

Where the length of the transition is insufficient to run off the cant at 1 inch in 40 feet, the remaining cant will be run off in the straight.

(b) **Ordinary Curves.** The cant is to be run off half on the curve and half on the straight at a rate of 1 inch in 40 feet. Curves without transitions are infrequent in main lines, and in most cases transitions can be provided in the course of adjustment by string lining. The cant will in such cases be run off as for (a) — Transitioned Curves.

(c) **Compound Curves.** The full cant for the sharper curve will be given at the beginning of the sharper circular curve, and the difference in the cants will be run off into the easier curve at 1 inch in 40 feet.

(d) **Curves with insufficient Straight between them.** In exceptional cases, where reverse curves or two curves in the same direction, are too near to each other to give effect to the arrangement of cant as in clauses (a) and (b) above, there shall be a minimum length of 50 feet between the curves over which there shall be no cant. In such cases the residual cant for each of the curves shall be run off into the circular curves at a rate of 1 inch in 40 feet.

9.24 **Marking of Curve and Cant.**— The nominal degree of the curve, taken from

the main line sheets, will be painted in 3 inch black figures on a white ground, on the middle of a sleeper at each end of the circular curve; also at the junction of compound curves.

The cant will be painted as white strokes on the middle of a sleeper at each end of the circular curve, one stroke representing ¼ of an inch; thus there will be 8 strokes for 2 inches of cant. Such marking will not be put on the rail as hitherto.

Intermediate markings will similarly be provided in multiples of ¼ inch on the nearest sleeper to enable Gangers to effect a uniform run-off, and the point where the rails are level will be marked with an O.

Gangers will be provided with cant boards in steps of ¼ inch.

9.25 **Temporary Speed Restrictions.**— Where it is necessary to impose a speed restriction for any reason, the cant of the curve must be temporarily reduced to that shown in the column MINIMUM in Table 9.22A.

9.26 **Turnouts on Curves.**— In situations where full interlocking is provided, higher speeds may be authorised by the Chief Engineer on the main line through a station on a curve. In such a case the cant to be provided on the turnouts and plain track curves will be decided by the Chief Engineer.

In other situations the following general instructions will apply, any special cases being referred to the Chief Engineer for a decision.

(a) **Turnouts with Curves of Similar Flexure.** Where the curvature, including that in the "turn-in" to the 2nd line, is all in the one direction, the turnouts and curves will be canted ½ inch, but where the curvature to the "turn-in" reverses, as may occur if the main track curve is very flat, no cant will be given over the whole layout, including the main line turnout.

(b) **Turnouts with Curves of Contrary Flexure.** No cant will be given.

(c) **Turnouts from the Main Line between stations.** Such cases must be referred to the Chief Engineer for a decision.

In all cases of turnouts on curves the level of the rails in the turnout will be run off to meet the cant provided in the main line track at a uniform rate not steeper than 1 inch in 40 feet; the cant gradient commencing at the heel of the crossing and stock rail joint, i.e. there will be no change in cant within a turnout.

9.27 **Cant on Sidings.**— Derailments on sidings are frequently caused by excessive cant on sharp curves since cant at slow speeds tends to take the weight off the wheel on the high leg of the curve thus enabling it to climb the rail.

The maximum cant permitted on any curve in station yards, loco yards and triangles is ½".

On long sidings outside station yards cant should be applied to suit the normal working speed of trains on the siding using the graph of

ANNEXURE 11, but no curve on such sidings may be canted more than 1½".

9.28 **Cant on Temporary Diversions.**— Speed is normally severely restricted over Diversions and the instructions of paragraph 3 of Clause 9.27 shall apply.

On newly packed track and soft formation the low rail will repeatedly sink and frequent checking of the cant will be necessary.

JAMES KAJANJA

1976 — 1977

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R.T.C.

TABLE 9.22A

CANT IN INCHES

TO BE READ IN CONJUNCTION WITH ANNEXURE 10 — SPEEDS ON CURVES.

Degree of Curve	MAXIMUM for section speeds of M. P. H.						NORMAL for section speeds of M. P. H.						MINIMUM for all section speeds
	45	40	35	30	25	20	45	40	35	30	25	20	
Up to 1	1	¾	½	½	½	¼	¾	½	½	½	½	¼	¼
1 to 2	2	1½	1¼	1	¾	½	1¼	1	1	¾	½	½	¼
2 „ 3	3	2¼	1¾	1¼	1	¾	2	1½	1¼	1	¾	½	½
3 „ 4		3	2¼	1¾	1¼	¾		2	1½	1¼	1	½	½
4 „ 5			3	2¼	1½	1			2	1½	1	¾	½
5 „ 6				3	1¾	1¼				2	1¼	1	¾
6 „ 7				3	2¼	1½				2	1½	1	¾
7 „ 8				3	2½	1½				2	1¾	1	1
8 „ 9					2¾	1¾					2	1¼	1
9 „ 10					3	2					2	1½	1¼
10 „ 11					3	2¼					2	1½	1¼
11 „ 12						2¼						1½	1½
12 „ 13						2½						1¾	1½
13 „ 14	For curves over 13 degrees the speed limit is 15 miles per hour, and the cant shown in the column MINIMUM will be used.												1½
14 „ 15													1¾
15 „ 16													1¾

SINGLE TRACK.

Maximum Cant. On curves approached by descending gradients in both directions, and in other situations like long level track, where maximum speeds must be expected in both directions, the cant shown in the column MAXIMUM will be used. It is generally the full or equilibrium cant for the speed of the section.

Normal Cant. Where, because of grades, there is considerable difference between the speeds of trains in the two directions, the cant shown in column NORMAL will be used. It is two-thirds of the maximum cant and represents equilibrium cant for five-sixths of the speed of the section.

Minimum Cant. At summits, and elsewhere such as curves between the facing points and signal of a station, where normal speed cannot be maintained, the cant shown in column MINIMUM will be used. It represents equilibrium cant for 15 m.p.h.

DOUBLE TRACKS

The cant to be used will be the equilibrium cant, to the nearest quarter inch, for the speed attained by normal trains, obtained from the graph in ANNEXURE 11. Such cant must not exceed that shown in the column MAXIMUM nor must it be less than that shown in the column MINIMUM.

SECTION 10

FORMATION AND BALLAST

10.01 **Formation.**— The minimum widths of the formation in banks and cuttings are referred to in Section 2 and illustrated in ANNEXURE 1.

10.02 **Stone Ballast.**— The broken stone shall be roughly cubical in shape and of a size that shall pass through, in any direction, a 2½ inch square mesh sieve or ring and shall be retained on a ¾ inch square mesh sieve or ring.

The broken stone shall be hard angular material which will weather well and not easily crumble with beater packing. It will be broken from sound rock which is free from weathered particles, and which does not contain a high proportion of mica, shale or similar laminated materials.

In the event of a District Engineer requiring advice on the quality of stone for track ballast he should send samples to the Chief Engineer who will arrange to have them tested.

10.03 **Earth Ballast.**— It should be recognised that earth is not a porous ballast like broken stone or gravel, and it is therefore required to be well drained; see Clause 10.07. Earth Ballast is only used in unimportant branch lines and in siding tracks.

Murrum is the best earth track ballast but is generally difficult to obtain. Good murrum has a very low earth content.

Volcanic Ash is too light and powdery and should not be used as ballast.

Earth for track ballast shall be carefully selected. It should not be of a texture which will break down into powder or become very soggy when wet.

Quarry fines, but not fine dust, make an excellent ballast and may be used where the cost of it can be economically justified.

10.04 **Supplies of Stone Ballast.**— The broken stone shall be supplied clean and free from all deleterious matter such as stone dust, contamination from earth and weathered overburden, and vegetable matter.

The Engineer shall closely watch supplies and take early action to set right defects which come to his notice. Sieves or square rings of the specified size must be available at all quarry sites and regular checks made on the size of the ballast being produced.

10.05 **Measurement of Stone Ballast.**— The measurement of the ballast shall be in stack, except where the approval of the Chief Engineer has been obtained to any other method being employed of arriving at the quantity being supplied.

The ballast shall be stacked in areas that have been levelled off, the stacks being rectangular in plan, level on the top, and with a height not less than 2 feet and not exceeding 5 feet.

The measurement of stone ballast shall be made only by an Engineer.

Measurements shall be taken in feet and inches and the unit of volume shall be a cubic foot.

For stacks up to 100 feet in length the volume may be computed from the formula for Average End Areas. Where the length of the stack exceeds 100 feet the Prismoidal Formula shall be used. The formulae are:—

Let A = area of one end cross section.
A′ = area of opposite end cross section.
M = area of middle cross section.
L = length of the stack.
V = Volume.

Method of Average End Areas.

$$V = \frac{L}{2} (A + A')$$

Prismoidal Formula.

$$V = \frac{L}{6} (A + A' + 4M)$$

10.06 **Stone Ballast Sections.**— Ballast for the track shall be provided in accordance with the cross sections shown in ANNEXURE 12. Attention is drawn to the Note thereto concerning the additional width to be provided where the rail joints have been welded.

The standard for running lines will normally be the Full Section shown.

The 8 inch depth section will only be used in the replacement of earth by stone ballast and in such other situations as the Chief Engineer may decide.

10.07 **Earth Ballast Section.**— Earth ballasted track will be provided with the quantities and dressed off to the profile and dimensions, shown in ANNEXURE 13. The profile is primarily designed to afford efficient track drainage and the Gangers must be instructed how to obtain the necessary slopes and clearances under the rails.

10.08 **Boxing to Templates.**— Stone ballast shall be neatly boxed and dressed in accordance with ANNEXURE 14 and each Ganger shall be provided with the steel template shown, suited to the class of running line he is maintaining. Attention is drawn to the Note in ANNEXURE 14 concerning the increased width of ballast section to be provided where the rail joints have been welded.

Ballast surplus to the standard cross section shall be trimmed off, placed on the cess and then moved forward to track which is not up to full section. The work should be done along with Programme Track Maintenance described in Clause 13.08.

Where the ballast is insufficient, it should be placed outside the ends of the sleepers to hold the alignment, leaving the centre bare until the shortage can be made up. Thus, too, the shortage can be readily seen.

A full section of ballast must be provided on the approaches to all bridges, over arch bridges and trough floored bridges, and in welded track.

Care shall be taken to see that all ballast is picked up from bank slopes and placed on the cess for use in the track.

10.09 **Screening Stone Ballast.**— See Clause 13.18.

10.10 **Cess Repairs.**— An Engineering Train may only be used to train out earth for cess repairs in very special circumstances such as good soil required for topping black cotton banks, or for repairs to high embankments. In all other situations the section gang will obtain earth from borrow pits along the line.

Before earth is put down on the cess the stone ballast from the track slopes shall be drawn into the centre of the track to prevent it being buried.

The clods of repair earth shall be broken down and the cess dressed to the template shown in ANNEXURE 14.

Ridges should not be allowed to form along the edge of a cess in such a way as to prevent water from getting to the drain or down the slopes.

Cracks, which sometimes appear in the cess and in the slopes of the formation, must immediately be filled in with earth and rammed to prevent water entering the cracks and possibly causing the formation to slip.

10.11 **Grass growing on the Cess.**— The growth of suitable types of short grasses on the cess is in many ways beneficial as it reduces erosion and decreases the labour required in making up deficiencies due to this cause. Such grasses however should be kept under control, and care taken to see that there is no interference with the surface drainage of the line.

Tall growing grasses and weeds are undesirable on the cess and should be eradicated where they occur.

The cess must not be cleared of grass with a shovel or hoe as this loosens up the earth. The grass must be cut short.

All that is permitted is to lightly clear with the hoe a width of about 6 inches along the toe of the ballast to prevent weeds creeping into the track.

10.12 **Weak Formation.**— This often occurs in patches or over the whole length of a cutting, generally where the soil has a large mica content aggravated by springs of water or rain. Top and cross levels become seriously upset and the track dangerous for unrestricted speed.

The track should be dismantled or jacked up, side walls built, and one or both together of the following remedies adopted as the seriousness of the situation requires:—

(a) a 2 feet deep blanket of rammed murrum laid;

(b) a layer of flattened steel sleepers or scrap plate laid.

The stone ballast is then restored over this material.

SECTION 11

SLEEPERS AND FASTENINGS

11.01 **Sleeper Spacing for Straight Track.**— The number of sleepers to be used per rail length on straight track for the various weights of rail, and the spacings of the sleepers are shown in ANNEXURE 15.

The table shows the sleeper density under the three categories of Main Line Standard, 2nd Loops and Important Sidings, and Minor Sidings. Care shall be taken to see that sleepers are not wasted in the two latter categories by using more than the scheduled numbers.

The sleeper densities to be used in new constructions and relayings shall be decided by the Chief Engineer.

The rail joints in straight track shall be laid square to each other.

11.02 **Sleeper Spacing for Curved Track.**— The practice of staggering the rail joints on curves has been abandoned in favour of square joints, which shall be adopted in all new works in future.

Curved track already laid with staggered joints will remain unaltered except where otherwise directed by the Chief Engineer.

The number of sleepers to be used per rail length on curved track laid with square joints shall be the same as that provided for straight track.

11.03 **Arrangement of Square Joints in Curves.**— The amount by which the inner rail in a curve advances on the outer rail is, for Metre Gauge track, calculated from the formula:—

Increase in Inches = 0.0072 x D x L.

Using the following values for a **one degree** curve the increase per rail length for any other degree of curvature is obtained by multiplying the given value for the appropriate rail length by the degree of curve.

Length of Rail	*Increase per rail per Degree of Curve*
40 feet	0.288 inches
36 „	0.259 „
30 „	0.216 „
10 metres	0.236 „
9 „	0.213 „

Example.—Given a 8 degree curve and 40 ft. rails, the increase per rail length will be:—

8 x 0.288 = 2.3 inches.

It is not practicable to cut and drill every rail by the calculated amount, consequently the normal method is to cut from a standard rail an amount equal to the dimension 'a' between fishbolt holes given in ANNEXURE 25,

thus retaining one of the original holes for jointing during track laying. An additional hole is required to be drilled in the rail at the bolt pitch dimension 'a'.

One such special rail is laid at intervals in the inner side of the curve, its location being so arranged that the rail joint here, in relation to the joint in the outer side rail, is not ahead of or behind the latter by much more than **half** the dimension 'a'.

The interval at which a special rail is required to be placed diminishes with increasing degrees of curvature. Thus, with a 40 ft. rail shortened by 4 inches in the example of an 8 degree curve given above, one such special rail would have to be laid alternately with a standard length rail and at times even two consecutive special rails; whereas on a 2 degree curve the interval would be about every seventh rail.

The laying of "square joints" on a curve necessitates an adjustment of the spacings of the sleepers at the joints, which should be as little as possible depending on the character of the sleepers fastenings and the type of fishplate being used.

To obtain an even closer adjustment, rails only about 2 inches shorter than the standard rail were used in Tanganyika.

In collecting second hand rails for relayings and new constructions, all rails of the sizes shown in the column of "special shorts" in ANNEXURE 25 should be set aside for use on curves.

Where the length and degree of a curve are known and not the intersection angle, the formula mentioned above can be used to find the number of special rails required.

Example.—4 degree curve; length 800 ft.
special rail 4 ins. short.

$$\frac{0.0072 \times 4^\circ \times 800 \text{ ft.}}{4''}$$

$$= 6 \text{ Nos.}$$

In the case of curves over a length of railway, such as in new construction, the total number of special rails required can be computed from the total degrees of the intersection angles using the formula in Clause 11.04.

Example.—Total of all intersection angles 317 degrees; special rail 4 ins. short.

$$\frac{11 \times 317 \text{ degrees}}{15 \times 4 \text{ ins.}}$$

$$= 58 \text{ Nos.}$$

11.04 **Arrangement of Staggered Joints in Curves.**— The stagger shall commence and finish as near as possible to the ends of the transition curves.

Only one standard length rail will be cut into two pieces, the **longer piece** being laid in the **outside** rail at the **beginning** of the curve and the **shorter piece** in the **inside** rail at the **end** of the curve, the difference in length between the two pieces being the "lead" which the inside rail would have attained over the outside rail had only standard length rails been used. The "lead" and lengths of the cut rails will be calculated from the undermentioned formulae:—

$$L \text{ in inches} = \frac{11}{15} \times \textit{delta}$$

$$S1 = \text{Half the standard rail} + \frac{L}{2}$$

$$S2 = \text{Half the standard rail} - \frac{L}{2}$$

where L is the "lead" of the inside rail over the outside rail; *delta* is the intersection angle of the curve in degrees as taken from the Main Line sheets (not to be confused with the degree of curve); S1 is the longer cut rail; and S2 is the shorter cut rail.

NOTE: For the limits placed on L and "delta" and for examples, see below.

By the arrangement of cut rails described above, the inside rail joint will at first **fall behind** the mid-point of the opposite rail on the outside by an amount equal to half L inches; then the inside rail joints will advance progressively until midway on the curve; the inside rail joint will be opposite the mid-point of the outside rail. Thereafter the inside rail joints will continue to advance until, at the end of the curve, the inside rail joint will be **ahead** of the mid-point of the opposite rail by an amount equal to half L inches. The insertion of the cut rail S2 here should bring the rail joints square to each other. Any small difference that may occur should be adjusted by opening and closing the joint expansion gaps on the outside and inside rails, the maximum gap being limited to 5/16 inch and the minimum gap to 1/8 inch.

The "lead" L will be limited to a maximum of 5 feet (60 inches) so that in the extreme position the inside rail joints will not be more than 2′ 6″ behind or ahead of the mid-point of the opposite outside rail. With this limitation *delta* **will be a maximum of 82 degrees,** which intersection angle will cover the majority of main line curves.

Where the intersection angle is greater than 82 degrees the curve must be divided into two or more equal parts, each part being treated as a separate curve, thus:—

for a curve over 82° and up to 164° — 2 equal parts.
" " " " 164° " " " 246° — 3 " "
" " " " 246° " " " 328° — 4 " "
and so on.

In all such cases one standard rail will be cut into two pieces for each part, in the manner described above, and at the beginning and end of each part a S1 rail and S2 rail will be laid in the outside and inside rails respectively. Here, one pair of rail joints will be square to each other before picking up the stagger again.

Example 1. Standard length of rail = 40 feet.

Delta = 30 degrees.

$$L = \frac{11}{15} \times 30 = 22 \text{ inches.}$$

$$S1 = 20' + \frac{L}{2} = 20'\ 11''$$

$$S2 = 20' - \frac{L}{2} = 19'\ 1''$$

Example 2. *Delta* = 135 degrees.

Divide the curve into two parts each $67\frac{1}{2}°$

$$L = \frac{11}{15} \times 67\frac{1}{2} = 49\frac{1}{2} \text{ inches}$$

$$S1 = 20' + \frac{L}{2} = 22'\ 0\frac{3}{4}''$$

$$S2 = 20' - \frac{L}{2} = 17'\ 11\frac{1}{4}''$$

The District Engineer or Resident Engineer should supply the Permanent Way Inspector, from information in the Main Line sheets, the *delta* angle for each curve and the S1 and S2 cut rails required to be laid in it.

If the intersection angle *delta* is not available from the Main Line sheet, proceed as follows:—

(a) Find the degree of curve on a chord of 62 feet taking the average of 3 or 4 versines. The versine in inches equals the degree of curve.

(b) Measure the length of the curve **in feet** between the middle of the transition curve at one end and the middle of the transition curve at the other end. There will be no appreciable difference if the measurement is made along the high rail or the low rail.

(c) $$Delta = \frac{\text{Length of Curve} \times \text{Degree of Curve}}{100}$$

Example.—Curve length 650 ft.; Degree 6

$$= \frac{650 \times 6}{100} = 39 \text{ degrees.}$$

11.05 **Widening Gauge on Curves.**— Excessive widening of the track gauge increases the rate of side cutting of the high rail and of wear in the flanges of locomotives and rolling stock.

The revised regulation is that no gauge widening shall be provided in curves up to 8 degrees. In sharper curves, widening shall be provided in accordance with the attached Table 11.05A the dimensions of which refer to new materials. In second hand materials mechanical wear will be present and the nearest arrangement to the ideal shall be worked to.

The revised gauge widening was adopted in all main line relaying and new construction with steel sleepers carried out subsequent to April, 1957.

The gauge in all curves laid with steel sleepers not of the German types shall, if not already done, be altered to conform to the revised instructions.

In wood sleeper track these instructions will be given effect to only where through renewal of the sleepers is done or new wood track laid.

Care is to be exercised to see that the change round of fastenings does not produce excessive wide gauge. Suitable designs of 1/16″ and 1/8″ thick steel liners are available for use both with steel keys and distance pieces in lug type sleepers for the purpose of correcting gauge and tightening the grip of the key.

In German track, in which gauge widening is effected by changing the sole plates and clips, the adoption of these revised regulations may not be practicable in existing track.

The widening of the track gauge shall be effected by moving the inner rail, not the outer or high rail. Full widening shall be provided at the beginning of the circular curve, the difference from normal track gauge being run out at the rate of 1/16 inch per sleeper into the transition or straight. To effect this gradual widening in steel sleepers it will be necessary to cut the fastenings and use thin metal shims.

Where side wear in the high rail is present, the track gauge shall be measured as shown in ANNEXURE 27 and the footnote thereto.

In no case shall the widening of the track gauge, including side wear in the rail, exceed one inch.

11.06 **Types of Steel Sleepers.**— The various types of steel sleepers and their component fittings are illustrated in ANNEXURE 17 to 22A, which also show the setting of the fittings to obtain variations in the track gauge.

11.07 **Lug Type Steel Sleeeprs.**— The lug types with a single key and later with a key and distance piece were the earliest designs, subsequently superseded by clip and bolt type sleepers.

The disadvantages of the lug type are:—

(a) the keys work loose under traffic and are easily removed by thieves;

(b) over-driving the key lifts and splits the lug;

(c) in the earliest single key type the rail has to be canted to effect spot renewals of the sleepers;

(d) finer adjustments in gauge widening are not available;

(e) when the rail seats wear down and the fastenings lose their grip, rail creep becomes troublesome.

The earliest single key sleeper (ANNEXURE 17) was quickly superseded by the key and distance piece sleeper (ANNEXURE 17 and 18) in order to overcome the disadvantage of (c) above and to give finer adjustment for gauge widening on curves. *The single key sleeper can only be recognised from the key and distance piece sleeper for the same rail section, by measuring across the lugs, the dimension for the latter type being the greater.*

Steel Keys.— The types are described below:—

One Way (not handed) — Are driven in **opposite** directions on the rails and therefore are **not** stamped 'R' and 'L'. See the upper drawing in ANNEXURE 17.

Occurs only in the early 50.OBS and 50.NS sleeper types.

One Way (handed) — Are both driven in the **same** direction and are therefore stamped 'R' and 'L'. See the lower drawing in ANNEXURE 17.

Occurs in the later 50.NS, and in the 45R.BS; 55.OBS; and 55R.BS sleeper types.

Two Way — The key is double faced for use in **any** direction to overcome the disadvantage of stocking 'R' and 'L' one way keys. It is shaped as shown in the lowest drawing in ANNEXURE 18 and is available for 50.NS; 50.OBS; and 80.OBS sleeper types.

It is important to note that for the corresponding rail section a Two Way Key will suit any sleeper designed for a One Way Key.

11.16 **Drilling Wood Sleepers.**— The holes in track and turnout sleepers shall be drilled vertically and right through the sleeper. In bridge sleepers the depth of drilling shall be suited to the length of spike used, and a little deeper than the length so as not to split the sleeper.

The sizes of augers to be used for dogspikes, screw spikes and coach screws shall be $\frac{5}{8}$ inch diameter for hardwood and $\frac{1}{2}$ inch diameter for softwood.

Where other types of spikes are used the auger size shall be that recommended by the maker of the spike.

In the pre-drilling of large numbers of wood track sleepers in depots, the work shall be carefully done to proper templates designed to provide for the height of the rail, thickness of the bearing plate and the normal inward tilt of 1 in 20 in both rails.

Where standard track sleepers are to be impregnated the drilling shall be done before they are treated. In cases where holes may have to be drilled in sleepers after they have been impregnated, each hole shall be stopped up at one end and filled with creosote.

11.17 **Plugging holes in Wood Sleepers.**— All holes from which spikes have been drawn shall be filled with hardwood plugs, cut square and of a length to completely fill the hole. It will generally be found that the plugged hole can be re-drilled to receive the spike.

In cases where new holes are required to be drilled, the old holes shall be plugged as described above, and the sleeper pulled lengthwise to obtain sound wood for the new holes.

For bridge sleepers which cannot conveniently be moved transversely a $1\frac{1}{2}$ inch diameter hole shall be drilled and a hardwood plug of that diameter driven into it. The plug may then be drilled to receive the spike.

All plugs shall be dipped in tar or bitumen before being driven into the sleepers.

11.18 **Bridge Sleepers.**— The minimum dimensions and spacing of sleepers on girder bridges, where the sleepers are fixed direct to the steelwork, are laid down in Standard Dimensions (1959). They are:—

Minimum length	8′ 0″
Minimum width	9″
Minimum depth excluding any notching on the underside for cover plates, rivets etc.	5″
Maximum spacing centre to centre	1′ 6″

The purpose of the minimum length and the maximum spacing is to provide support to derailed wheels.

The old standard of 6′ 6″ length and 7″ to 8″ width in the Tanganyika system is cancelled and the minima of 8′ 0″ length and 9″ width shall be adopted whenever bridge sleepers are renewed.

11.19 **Unballasted Girder Bridge on a Curve.**— The Sleepers will be tapered to suit the amount of cant fixed for the curve, the minimum depth under the low rail being 5″ as stated in Clause 11.18.

11.20 **Allowance for Adzing in Bridge Sleepers.**— When ordering new sleepers an extra ½″ in depth should be allowed to provide for dressing the timber to good shape when laying them.

11.21 **Preparation of Bridge Sleepers.**— In addition to the instructions in Clause 3.10 the following points shall be attended to.

Before the sleepers are bolted down the girders shall be thickly coated with paint under each sleeper to keep out water and prevent corrosion of the steel.

The sleepers shall be neatly cut to uniform length and any that show signs of splitting shall be suitably bound or clamped near the ends, preferably with a ⅜ inch diameter bolt and large washers.

The top and two exposed sides, but not the two ends, of the sleeper shall be painted with hot creosote oil.

In renewals, all the sleepers on a bridge or on a single long span should be replaced at the one time in order to obtain good line and levels, except where the majority are in good condition and only an isolated sleeper requires replacement.

The removed sleepers which are fit for further service shall be plugged and used for isolated renewals or for another complete span.

Thin packing pieces of timber shall not be used between the girders and sleepers or under rails and bearing plates. The correct procedure to be adopted where renewal of the entire sleepers is delayed, is to temporarily use one or more 1/16 inch or ⅛ inch thick plates cut and drilled to the size of the bearing plate.

11.22 **Maintenance of Track on Girder Bridges.**— It is essential that the track on girder bridges shall be maintained to a high standard in alignment, top, and cross levels. All movement must be prevented and all fastenings kept tightened.

11.23 **Spacing and Squaring Sleepers.**— A pick, beater or hammer must not be used to drive wood or steel sleepers into place. The damage to a wood sleeper can be very serious from the use of such tools, greatly shortening the life of the sleeper.

The proper tools to use are a heavy wooden mallet or a crow bar driven into the ground to lever the sleeper forward.

11.24 SEE P.W. Instruction No 6 FASTENINGS FOR TIMBER SLEEPERS

11.25 SEE P.WAY INSTRUCTION NO 7. PANDROL FASTENINGS (PANDROL STEEL SLEEPERS)

Distance Pieces.— The types are described below:—

Early Type (One Way)	—	As shown in the lower drawing of ANNEXURE 17 and in the right corner of the lowest drawing in ANNEXURE 18. They are stamped 'R' and 'L' and occur in the 80.OBS; 55R.BS; and 45R.BS sleeper types.
Later Type (Two Way)	—	As shown in the left corner of the lowest drawing in ANNEXURE 18, and are not stamped 'R' and 'L'. It occurs only in the 80.OBS sleeper type.

11.08 **Laying Lug Type Steel Sleepers.**— Except in the very earliest 50.OBS and 50.NS steel sleepers, all of the other lug type sleepers have raised arrows branded on the sleeper at about 6 inch intervals along one of the sides.

The purpose of the arrows is to indicate the direction in which the keys should be driven when laying track.

Where there is rail creep the keys will be driven in the direction of the rail movement, which should cause the keys to tighten.

Where there is no rail creep in existing track, and when laying track in new construction, the keys will be driven in the direction of down gradients, and with the mileage where the gradient is level.

The sleepers will be uniformly laid with the arrows pointing in the same direction as the keys.

11.09 **Weight of Keying Hammer.**— To avoid over-driving of the keys and thereby lifting the sleeper lugs, the weight of the hammer shall not exceed 4½ lbs.

11.10 **Variation of Track Gauge in Damaged Steel Sleepers.**— In the case of a derailment, all severely dented sleepers must immediately be replaced with sound ones taken from the Breakdown Train. The less dented sleepers left in the track with defective gauge shall be removed for repair with as little delay as possible.

After adjusting the gauge to the extent that the existing fittings will permit, the track gauge on the damaged sleepers awaiting replacement should not exceed the following limits.

Straight Track and Curves up to 3°	—	¼ inch Tight.
Curves over 3° to 8°	—	Normal Gauge.
Curves over 8°	—	¼ inch Slack.

It is dangerous to have excessive variations in the track gauge, especially on consecutive sleepers, and the variation should be eased off with a difference of not more than 1/16 inch on each sleeper.

These instructions shall also apply to sites of old derailments, and steps shall be taken to restore all such track to a normal state.

11.11 Wood Sleepers.— All types of wood sleepers are obtained in accordance with the specifications laid down by the Chief Engineer.

Sleepers accepted from suppliers by the Engineer making the inspection, shall be stamped with the acceptance mark bearing the initials of the Railway. It may also have a letter to indicate the species of wood.

Sleepers which have been rejected by the inspecting Engineer will bear the stamp "R".

Permanent Way Inspectors should note the stamp marks on new sleepers supplied to them, and bring to the notice of the District Engineer any case of a sleeper bearing the rejection mark "R".

11.12 Stacking Wood Sleepers.— Track, crossing, and bridge sleepers which have already seasoned shall be stacked as shown in ANNEXURE 23, on ground open to air and wind and well drained.

A space of 4 feet should be allowed between adjacent stacks and the grass shall be kept short or be cleared between the stacks and to a distance of 20 feet from the outermost stacks as a precaution against fire.

Care shall be taken to see that the earth used for covering the stacks is free from termites.

Where sleepers are held for air seasoning, the arrangement of them in stacks shall be in accordance with instructions and a type drawing to be obtained from the Chief Engineer.

11.13 Bearing Plates.— Bearing plates shall be used in all plain track, turnouts and bridges, and with both hardwood and softwood sleepers.

SEE P.W. INSTRUCTION NO 7 PANDROL FASTENINGS BEARING PLATES.

11.14 Laying Wood Sleepers.— Untreated hardwood sleepers shall be laid with the heart side down and the sap side up, as the heart side is liable to split.

Impregnated hardwood sleepers may be laid with either the heart or sap sides up.

All softwood sleepers shall be impregnated, and they shall be laid with the heart side up, as the heart wood offers the harder surface.

11.15 Arrangement of Spikes.— Spikes shall be placed so that the two outer spikes are on one side of the longitudinal centre line of the sleeper, and the two inner spikes in one line on the other side of the centre line. This is to prevent the sleeper skewing on the rails.

On straights, easy curves, and bridges two spikes only shall be laid to each rail in the manner described above.

On sharp curves, three spikes shall be laid on the high rail and two on the low rail. The arrangement of the former shall be two spikes on the inside to resist the rail tilting outwards.

TABLE — 11.05A

GAUGE WIDENING ON CURVES

No widening shall be provided for curves up to 8 degrees. For the equivalent Degree of curve to Radius in Feet or Metres see the left hand side of ANNEXURE 11.

Type of Sleeper	Rail Section.	Widening for Curve (Inches)	
		Over 8 to 12 degrees.	Over 12 degrees
WOOD	ALL	1/4	1/2
Clip & Bolt "K"	95N.BS 80R.BS 60R.BS 60N.BS	1/4 One "B" clip inside.	1/2 Both "B" clips inside.
80R.BS "K" with cast iron fillers.	75R.BS	- do -	- do -
Clip & Bolt "F" without Sole Plate.	80 OBS 50 OBS 50 ASCE	1/4 One "O" clip inside.	1/2 Both "O" clips inside.
- do -	50 NS	5/16 One "O" clip inside.	5/8 Both "O" clips inside.
Clip & Bolt "F" with Sole Plate.	80 OBS 75R.BS 50 OBS	1/4 One "O" clip inside.	1/2 Both "O" clips inside.
- do -	50 NS	5/16 One "O" clip inside.	5/8 Both "O" clips inside.
Clip & Bolt (Tanganyika)	55R.BS 45R.BS	1/4 One "O" clip inside.	1/2 Both "O" clips inside.
Lug with Key and Distance Piece.	80 OBS	3/8 One distance piece inside.	3/4 Both distance pieces inside.
- do -	55R.BS 55 OBS 45R.BS	1/4 One distance piece inside.	1/2 Both distance pieces inside.
Lug with Single Key (Magadi Branch)	80 OBS	9/16 One key inside.	9/16 One key inside.
Lug with Single Key	55 OBS	3/4 One key inside.	3/4 One key inside.
- do -	50 OBS 50 NS	5/8 One key inside.	5/8 One key inside.
GHSC (Central Line — Heavy Section)	56.12	5/16 Sole Plates Nos. 2 & 3	1/2 Sole Plates Nos. 2 & 2
GLSC (Central Line — Light Section)	43.14	3/8 Sole Plates Nos. 2 & 2 Clips Nos. 2 & 2	9/16 Sole Plates Nos. 2 & 3 Clips Nos. 2 & 1
GHST (Tanga Line — Heavy Section)	40.32	3/8 Sole Plates Nos. 3 & 3 Clips Nos. 1 & 1	9/16 Sole Plates Nos. 2 & 3 Clips Nos. 2 & 1

SECTION 12

RAILS AND FASTENINGS

12.01 **Rail Sections and Fishplates.**— The rail sections and fishplates in use and their principal dimensions and characteristics are shown in ANNEXURES 24 and 25A.

12.02 **Rail Lengths, Holing and Properties.**— See ANNEXURE 25.

12.03 **Fishbolts and Nuts.**— These are shown in ANNEXURES 26 and 26A. The following features should be noted:—

(a) certain bolts are common to several sections of rails;

(b) the alternative bolt that can be used for the 55.OBS rail section;

(c) the alternative British make bolts that can be used with the German rails.

12.04 **Weight of a Track Mile of Rails.**— The weight of a track mile of rails in long tons (2,240 lbs.) is equal to the weight of the rail in lbs. per yard multiplied by 11 and divided by 7.

12.05 **Square and Staggered Rail Joints.**— The instructions for laying square or staggered rail joints on curves, and the sleeper density and spacings to be used, are given in SECTION 11.

12.06 **Unloading and Spreading Rails.**— The rails shall be pushed off the wagons **singly** and so that both ends reach the ground at the same time.

Care shall be taken that each rail is dropped on to earth or ballast and **not** on top of another rail or on sleepers.

Serious kinks and even breakage occur in rails due to neglect of these precautions.

12.07 **Handling of Rails.**— Bars and rail tongs, and not the bare hands, should be employed wherever there are likely to be injuries caused to the men.

The use of hammers on the ends of rails is forbidden.

Care must also be taken when driving spikes not to dent the flanges of a rail. Such dents and nicks have been the cause of later failure of the rail through cracks originating from them.

12.08 **Cutting of Rails.**— Rails shall be cut with a rail saw and not marked with cold chisels and broken with a jimcrow. The latter method may only be employed in cases of emergency.

Except for curves as described in SECTION 11, standard length rails should not be cut. Cut rails should be obtained from other cut rails or from "shorts" supplied on contracts for new rails.

12.09 **Straightening and Bending Rails.**— The work should not be done in very cold weather as the rail is very liable to break.

Lateral kinks in the rails shall be carefully removed with a jimcrow before they are laid in the track. Subsequent straightening in the track is difficult and should be avoided, since the rail has either to be removed from the track for straightening and then replaced, or the rail must be completely freed by loosening the sleeper fastenings. Jimcrowing a rail without loosening these fastenings is forbidden.

Vertical kinks in rails cannot be removed with a jimcrow and such rails must not be laid in track. They may, where a suitable length is obtainable, be cut for closure rails.

12.10 **Pre-bending of Rails for Curves.**— A straight rail, except when it is of light section and of a length which can easily be flexed, shall not be laid in a sharp curve without first being bent to suit the curve. Standard length rails of 60 lb./yd. section and under do not require to be pre-bent for curvature up to 10 degrees.

Rails of over 60 lb./yd. section shall be pre-bent for curves of 4 degrees and over. The bending shall be carefully done with a jimcrow to uniform curvature and without leaving kinks, the rails being bent to a curve within 2 degrees ((approx.) of the required main line curvature, e.g. for a 4 degree curve use the versine for a 2 degree curve. This is to allow for the rails to be pulled to the true curve when laid.

Degree of Curve.	Versines in inches for rail lengths of			
	40 ft.	36 ft.	33 ft. & 10m.	30 ft. & 9m.
2	$0\frac{7}{8}$	$0\frac{5}{8}$	0.9/16	$0\frac{1}{2}$
3	$1\frac{1}{4}$	1	$0\frac{7}{8}$	$0\frac{3}{4}$
4	$1\frac{5}{8}$	$1\frac{3}{8}$	$1\frac{1}{8}$	1
5	$2\frac{1}{8}$	$1\frac{3}{4}$	$1\frac{3}{8}$	$1\frac{1}{8}$
6	$2\frac{1}{2}$	2	$1\frac{3}{4}$	$1\frac{3}{8}$
7	$2\frac{7}{8}$	$2\frac{3}{8}$	2	$1\frac{5}{8}$
8	$3\frac{3}{8}$	$2\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{7}{8}$
9	$3\frac{3}{4}$	3	$2\frac{5}{8}$	$2\frac{1}{8}$
10	$4\frac{1}{4}$	$3\frac{3}{8}$	$2\frac{7}{8}$	$2\frac{3}{8}$
11	$4\frac{5}{8}$	$3\frac{3}{4}$	$3\frac{1}{8}$	$2\frac{5}{8}$
12	5	4	$3\frac{3}{8}$	$2\frac{3}{4}$
13	$5\frac{1}{2}$	$4\frac{3}{8}$	$3\frac{3}{4}$	3
14	$5\frac{7}{8}$	$4\frac{3}{4}$	4	$3\frac{1}{4}$

The versines for any other length of rail or degree of curve may be calculated from the following formulae, in which the curves are expressed either

in degrees or in radius in feet as required.

L = length of rail in feet.
D = degree of curve.
R = radius in feet.
V = versines in inches.

$$V = \frac{3\ L^2}{2R} \text{ or } \frac{D\ L^2}{3820}$$

To bend a rail to uniform curvature versines to points on either side of the mid-point are necessary, and the method of "quartering" should be applied. In this the versine for each succeeding sub-chord is one-fourth of that for the preceding chord.

Example:— 6 degree curve; 40 ft. rail.

Versine on full chord of 40 ft. = $2\frac{1}{2}$ inches.
- do - half chord of 20 ft. = $\frac{5}{8}$ inch.
- do - quarter chord of 10 ft. = 5/32 inch.

12.11 **Minimum Closure Rail.**— The minimum length of a **permanent** closure rail which may be laid in running line or in siding track shall be 12 feet.

The joint sleepers shall be spaced as for normal rail and the number of sleepers shall be such as to provide spacings not exceeding those for the corresponding standards shown in ANNEXURE 15.

The bolt holes must immediately be drilled and the joints completely fished.

Temporary closures of less length than 12 feet may be used to pass trains or to close up work for the night provided a speed restriction is imposed. Such closure rails must be adequately packed and supported.

12.12 **Rail Joints at Level Crossings and Girder Bridges.**— Except where the width of the roadway is greater than the length of the standard rail, no rail joint shall occur within the crossing.

On girder bridges the rail joints shall be placed so that they are at least 6 feet on the bridge or at least 10 feet on the embankment (measured from the end of the girder).

In multiple span bridges rail joints should, where possible, not occur directly over the end of a girder. This applies only where the track is resting directly on the superstructure i.e. where the track is not ballasted through the bridge.

Suitable length closure rails may be used to comply with these requirements and it may be necessary to have such rails on either side of a bridge.

12.13 **Expansion Gaps in Rail Joints.**— Excessive expansion gaps cause the rail ends to become battered by the wheels and the rail joints to dip. Joints that are

closed up prevent fine lining up of the rails, and may lead to buckling of the track.

In laying new track very careful attention must be given to providing proper expansion gaps, and, since the rails are never at first to proper level and line, it is essential that the gap shims be left in the joints until the track is packed and lined, to avoid the joints closing up.

Plywood or metal shims, preferably the latter, shall be used. Plywood shims will have to be removed by sawing through them, and large stocks of each size will consequently have to be obtained for relaying works and new constructions. Metal shims should be of a pattern which permits of the passage of trains, is not pinched by the burred over ends of old rails, and can be easily drawn out with a tommy bar without damage to the shim.

The following expansion gaps, which are suitable under all conditions except extreme cold and extreme heat, shall be used for rail lengths of 40 feet and less:—

Between 7.00 and 10.00 hours	...	$\frac{1}{4}$ inch
Between 10.00 and 16.00 hours	...	$\frac{1}{8}$ inch
Between 16.00 and 18.00 hours	...	$\frac{1}{4}$ inch

12.14 **Side Wear of Rails on Curves.**— The rails in curves shall at all times be kept under close observation and the amount of side wear present shall be recorded in a register at intervals of not less than 6 months. Where it is observed that side wear is developing at an abnormally fast rate the case shall be reported to Headquarters.

The limit of side wear in the high rail of a curve in a through running line is shown for each rail section in ANNEXURE 27. Such wear shall be developed in one face only and, except as laid down below for rails 75 lb./yd and over, when the limit of wear is reached the rails shall be removed from the running line for use in wayside station yards and sidings.

Rails of 75 lb.yd. and over should be removed before the limit of side wear is reached. When worn to a minimum width of 2 inches, as measured with the side wear gauge shown in ANNEXURE 28, the rails shall be exchanged with the rails on the low side of the curve, placing the side worn face on the outside of the track.

In replacing side worn rails the entire curve shall be dealt with at the one time.

12.15 **Side Wear Gauge.**— Engineers and Permanent Way Inspectors shall equip themselves with the gauges shown in ANNEXURE 28, for each of the rail sections laid in the through running lines. Gauges are not required to be held for rails in station yards and sidings.

The gauges shall be accurately manufactured at the Permanent Way Depot.

12.16 **Table Wear in Rails.**— In a through running line the limit of wear on the table of the head of a rail in straight track and in the low rail of a curve, shall be that stated below, provided that side wear is not also present in the rail.

95N. BS 80R. BS 80 OBS	5/16" depth.
75R. BS 60R. BS 60N. BS 55R. BS 55 OBS 56.12 GHSC	1/4" depth.
All lesser rail weights	3/16" depth.

The limits stated represent a loss in the head, amounting to approximately 10 per cent of the nominal weight.

Table wear shall be measured with a calliper on the vertical centre line of the rail, the depth of wear being the difference between such measurement and the height of a new rail.

Except in sharp curves in heavily graded line, where the head may squeeze or wear down fairly rapidly, the limits given are not likely to be found in track due to attrition alone. The density and speeds of trains are not usually enough to cause so great wear before the rails become unfit for other reasons.

12.17 **Laying Side Worn Rails.**— When second hand rails, having side wear, are again laid in the track, the worn side shall be on the outside of the track and the unworn side shall be on the gauge line.

12.18 **Lubrication of Rails on Curves.**— See SECTION 13.

12.19 **Rail Defects.**— These fall into two categories.

Manufacturing defects.— They are faults in the structure of the steel which cannot be detected by visual inspection and only show after service in the track.

Such defects are segregations, rolled in "pipes", surface laps and seams, inclusions of non-metallic substances, and occasionally pieces of metal picked up in the rolling process.

Defects arising in Service.— These normally occur in the head of the rail and the more usual defects are given below.

Skidded Rails.—

Caused by train brakes being applied suddenly causing the wheels to lock

and slide along the rail. The wheels develop "flats" in consequence.

Wheel Burns.—

Caused by the slipping of the driving wheels of locomotives. They appear as depressed patches on the rail table from which cracks may develop due to the burning of the surrounding metal. Passing wheels hammer the rails causing the sleeper packing and fastenings to loosen.

Corrugations.—

The cause of which is still obscure. The rail develops alternate hollows and ridges of quite small depth. Rails so affected are called "roaring rails" because of the noise set up by passing wheels.

Battered rail ends.—

Caused by the wheels hammering the ends of the rails. The trouble is aggravated by excessive expansion gaps at the rail joints, low joints and worn fishplates. In an advanced state of age, a crack may commence at the end of the rail and develop along its length.

Fracture through a Bolt Hole.—

Resulting from wear in the rail end and in the fishplates, battering by wheels, and pulling up the fishplates towards the web of the rails by over-tightening the fishbolts.

Spreading of the Rail Table on Curves.—

Caused by wheels slipping across the rail table and flattening it. Occurs mostly in the low rail.

Shelling.—

This feature has attained prominence in recent years. The defect commences as black spots along the gauge edge, the surface of the table breaks down and pieces may fall away or a split may commence about ¼ inch below the table and extend transversely into the head. It is caused primarily by overloading the rail.

Local Flattening of the Head.—

Appearing as a settling down of the table indicating that a crack has probably developed along the top or bottom fillet, at the junction of the web with the head or flange.

Transverse Failure.—

Resulting in a crack starting, because of stress concentration, from corrosion pits or heavy hammer marks in the flange of a rail.

12.20 **Examination of Rails.—** A close watch shall be kept for signs of failure and any unusual occurrences shall be brought to the notice of the District Engineer and Chief Engineer.

Special care shall be taken to examine the rails when level crossings are opened for overhauling the track, and the rail ends when lubricating the fishplates.

See Clause 13.26 regarding the examination of the track in Tunnels.

12.21 **Breakage of Rail in the Track.**— The track must immediately be protected, and trains passed slowly, if safe enough, over the defective rail until repairs have been effected.

Until a replacement rail is obtained, the nearest sleeper should be put under the break so that both portions of the rail are held by the sleeper fastenings. If some little time must elapse before the broken rail can be replaced, holes should be drilled and a pair of fishplates bolted on.

In the event of a large piece of the head being detached, or more than one break occurring through the whole cross section of the rail, the line must be blocked against the passage of trains until repairs are effected.

12.22 **Reporting Broken Rails.**— All instances of broken rails will be reported, on the special form provided, by the Permanent Way Inspector to the District Engineer who will send a copy of the report to the Chief Engineer.

The Permanent Way Inspector will forward a further copy of the report to the Senior Foreman, Permanent Way Depot, Nairobi, if the occurrence is in Kenya, Uganda or in the Tanga District, and to the District Engineer, Dar es Salaam, if the occurrence is in the Central Line or the Southern Province Railway.

The fractured ends will be cut off short and despatched, with the reports, to the Permanent Way Depot or to the District Engineer, Dar es Salaam as the case may be.

The ends will be greased and wrapped in sacking.

On receipt of the fractured ends the Senior Foreman and District Engineer, Dar es Salaam, will enter the details from the report into a register to provide a complete record.

The Chief Engineer will decide whether he requires any of the broken rails for further examination.

The fractured ends will be retained, properly labelled, at the Permanent Way Depot and at Dar es Salaam for a period of 6 months and then disposed of as scrap.

12.23 **Hogged Rails.**— This is the term used for rails, the ends of which have a permanent vertical set downwards in a length of 2 to 3 feet. It is caused by neglected low joints and wear in the fishplates and rail ends. The test for hogged rails is to remove the fishplates and sleeper fastenings, turn the rail over on its side, and measure the amount of permanent distortion downwards by applying a straight edge along the table of the rail.

In many cases apparent hogging is due to wear in the fishing planes of the rails and fishplates, and the dip can be removed by fitting WONHAM tapered rail joint shims, instructions concerning which should be obtained from the Chief Engineer.

12.24 **Lubrication of Fishplates.**— See SECTION 13.

12.25 **Care of Fishplates in the Track.**— A heavy hammer must not be used to drive fishplates into the rail and thereby seriously dent the plates.

The fishbolts must not be screwed up so tight as to wedge the fishplates too severely into the rail and overstress it. This will also prevent the free expansion and contraction of the rails.

See SECTION 13 for the standard length of fishbolt spanner and the reason for it.

12.26 **Reporting failures in Fishplates.**— Where the incidence of breakages and cracks in old fishplates is unusually high, and in every case of failure of a fishplate of new or relatively new material, the cause shall be investigated and particulars promptly reported to Headquarters.

12.27 **Lubrication of Fishbolts.**— See SECTION 13.

12.28 **Care of Fishbolts.**— The tight fit in the screw threads of the bolt and nut must be preserved. Corrosion is a common cause of deterioration and bolts and nuts must be kept oiled during storage.

The threads of new bolts must not be run down with dies merely to ease the fit. This may only be done where the threads have become damaged, and for this purpose a Die Nut, as stocked by the Stores Superintendent, may be used with an ordinary spanner.

Bolts must not be removed by hammering their ends unless the thread of the bolt is protected by a nut with a minimum of 3 turns of the thread engaged.

SECTION 13

TRACK MAINTENANCE

13.01 **Inspections.**— The track shall be patrolled daily by the Keyman, and in his absence by a selected man from the section gang.

Permanent Way Inspectors and Sub-Permanent Way Inspectors shall inspect their sections as often as possible, spend time with the gangs instructing them, examine track components, and occasionally travel on the engine and in a vehicle at the back of the train to observe the riding condition of the track. Voids under the sleepers in track laid with heavy rails are often not detectable in inspections by trolley and foot, as the rails deflect under the train and then spring up again.

Because of the large loading gauge in relation to the small track gauge, the vehicles are unusually sensitive to track faults. It is essential therefore that special care must be given to cross levels, alignment and top.

13.02 **Works affecting the Safety of the Track.**— No work such as removing a rail, heavy slueing and heavy lifting of the track shall be carried out until the line has been protected with signals in accordance with the General Rules. Except in an emergency such works shall not be carried out unless a supervisor, not below the ranks of Sub-Permanent Way Inspector or certified Passed Ganger, is in attendance.

13.03 **Major Operations on Track.**— Major operations in connection with track maintenance, such as changing rails on curves, replacing earth ballast by stone ballast etc. may not be undertaken without prior approval of the District Engineer. In cases where a large amount of work is involved, the matter should also be referred to Headquarters.

13.04 **Track Alterations (Experiments).**— No experiment in connection with any part of the Permanent Way (i.e. any departure whatsoever from approved standards) is permitted without the approval of the Chief Engineer.

13.05 **Care of Tools and Equipment.**— It is essential to good work that tools and equipment supplied to the section gangs shall be kept clean and be in good and safe condition and ready for use. Hand Flags and Detonators shall always be carried on duty, the latter in a tin case. Banner Flags shall be furled each on two poles to each flag, and stored at the Landie. Hand Signal Lamps shall be clean and filled with oil. Chisels, Spanners, Hammers and the handles of tools tend to become unsafe and must be kept in good order. At the close of work all tools should be taken to the Landie and stored under lock and key. **Thefts of spanners, in particular, must be reported to the Police without delay and urgently investigated.**

13.06 **Track Gauge and Spirit Level.**— The normal gauge of the track is 3′ 3⅜ inches which is the approximate equivalent of one metre.

The steel track gauge, wooden straight edge and spirit level with Sub-Permanent Way Inspectors and Gangers shall be personally tested for correctness by the Permanent Way Inspector at frequent intervals.

The combined wooden track and cant gauge for issue to Engineers and Permanent Way Inspectors is a delicate instrument and must be treated with due care, particularly in regard to the bubble tube.

13.07 **Fishbolt Spanners.**— The standard overall lengths for the different rail sections are:—

75 lb. to 95 lb. —24 ins.
60 lb. and under —21 ins.

The use of a pipe sleeve to increase the length of a fishbolt spanner is forbidden as, with increased leverage, the bolt can be strained, the fishplates wedged too tightly in the rail preventing contraction and expansion, and the rails may even be stressed to a degree which may eventually lead to fracture through the bolt holes.

The jaws of spanners tend to spread and in this condition there is danger to the user from slipping and the corners of the nuts become damaged. Spanners should be regularly inspected and repaired.

13.08 **Programme Track Maintenance.**— Except where the track is welded up (see Section 15) and where Flying Gang Maintenance is in operation, track maintenance will be carried out systematically to a programme, the purpose of which is to ensure that:—

(a) essential works are regularly carried out each year;

(b) these works are done in suitable seasons and in an organised manner;

(c) section gangs are employed on specific jobs and do not waste their time between the intervals of inspections by the Permanent Way Inspector.

The typical maintenance programme for stone (and gravel) ballasted track is shown in ANNEXURE 29. On earth ballasted track the exceptions will be that "through packing" may be planned when the ballast has been moistened by light rains, and in place of "screening" a second through packing and formation repairs may be done.

The essentials of the programme are:—

(d) through packing on stone ballasted track to be done in fine and cool weather;

(e) lubrication of fishplates to be done before the hot season;

(f) screening of ballast to be done when the road bed is dry.

Each District Engineer will prepare a programme suited to seasonal conditions and ballast in his area. Such a programme may vary for different sections of his district.

The periods in the programme allow for two days per week being allotted, at the discretion of the Permanent Way Inspector, to "slacks" and miscellan-

eous works. **It should be made clear to the Gangers that track requiring urgent attention will take precedence over the programme work, and that the Keyman's normal duties of patrolling the length and lubricating curves will continue.**

13.09 **Chart to be maintained.**— The District Engineer will maintain a Chart, in the form shown in Drawing No. 8893, which will be posted regularly from progress reports obtained from the Permanent Way Inspectors. The latter will be issued with copies of the same chart which they shall post up as the works progress.

The charts show only the following essential works:—

(a) Through Packing and Dressing.

(b) Oiling Clip Bolts of Steel Sleepers.

(c) Lubricating Fishplates and Fishbolts.

(d) Screening Ballast and Making Up Cess.

Engineers and Inspectors will check, on their routine inspections of the line, that the works have actually been done and, in particular, will open up track to see whether the screening of ballast has been satisfactorily carried out.

The progress charts shall be handed over by the District Engineers and Permanent Way Inspectors to their successors when vacating charge of their posts.

13.10 **Model Track Lengths.**— Opposite each mile post five rail lengths of track and formation shall be finished in all respects to exact standards, both to serve the section gang as models and to readily provide visual evidence of the shortage or excess of stone ballast in the intervening lengths. Where the existing ballast section is sub-standard, stone for this model length may be obtained by trimming the track on either side of it.

13.11 **Tracks in Station Yards.**— The tracks at wayside stations must be overhauled at the same time as the programme work on the main line is carried out and in a similar manner.

In marshalling and locomotive yards the Permanent Way Inspector shall obtain occupation of each track as opportunity offers and overhaul it.

Particular attention should be given to drainage.

13.12 **Fastenings.**— Track cannot be maintained to a good standard where the sleeper fastenings and rail joints are loose.

When lug type steel sleepers are worn in the rail seats and in the lugs, and in consequence the taper keys slacken under traffic, steel liners of standard design shall be used. These are available in thicknesses of 1/16 and 1/8 inches. Keying hammers shall be of the standard design not exceeding 4½ lbs. in weight.

In clip and bolt type sleepers frequent tests shall be made to check the tightness of the bolts. They are particularly liable to become loose in newly relaid track and after the annual lubrication of the bolts. The nuts of all later design clip bolts are of a patent lock type and when properly tightened should not normally slacken.

Fishbolts have ordinary nuts but the screw threads are finished to provide a tight fit of the nut on the bolt. This tightness must not be destroyed by running down the screw threads with taps or dies.

Fishplates are designed with sufficient clearance to the web of the rail to provide for a wedging fit and to allow for wear during service in the rail and fishplate. When the wear in old track has reached a degree where the clearance does not exist, the rail joints shall be fitted with proper tapered shims. The fitting of flat steel shims made locally by the Permanent Way Inspector is forbidden.

Inspectors will find a small hammer with a long handle a great aid in detecting loose sleeper and rail fastenings.

13.13 **Beater Packing.**— Gangmen must be instructed that the correct way to pack a sleeper is for two men, standing back to back, to beat each end crosswise with simultaneous strokes. Care must be taken to avoid forcing under the sleepers any stones so large as to cause an uneven bearing, and to avoid striking the edges of the sleepers, particularly wood sleepers.

The portions to be firmly packed in a sleeper are 12 inches on each side of the centre of the rail. The sleeper ends and centre should only be loosely filled. Packing the ends causes sleepers to break under the rail and packing the centres causes a rocking motion to rolling stock; see the illustrations in ANNEXURE 30.

13.14 **Lifting.**— In the course of normal maintenance the track may only be lifted sufficiently to correct "slacks". If a general lift of the track is required the line must be protected with signals, and a speed restriction imposed.

In normal maintenance on a curve the low rail should first be lifted when labour is insufficient to lift both rails together.

When the track requires excessive lifting both rails should be lifted together in order to preserve the proper cross level and cant, and in order to pass trains safely during the operation the lift must be run out at a gradient not steeper than 1 inch in 40 feet. At the close of the day's work this gradient must not be steeper than 1 inch in 60 feet.

A lift must not exceed 3 inches at any one operation and sufficient time should be allowed to pack the sleepers securely before the next train is due.

Lifting should be done against a gradient if such is present in the line, as this enables the level to be run out quickly.

When lifting on the approaches to a bridge, work should proceed from the

bridge and not to the bridge, and in the case of girders care shall be taken to see that the bridge timbers and girders are not lifted.

Gangers should be cautioned against unnecessary lifting, which weakens the road bed and reduces the shoulder support of the ballast at the ends of the sleepers.

13.15 **Lining and Slueing.**— After repairing and packing a length it is always necessary to true up the alignment, that is, "fine lining" is required.

Where the track gauge is variable all lining should be done to one rail only so that the one rail is true and gauge defects may be seen on the other, and steps taken to correct them. The practice of "halving" the gauge error in each rail should not be permitted.

In steel sleeper track it is necessary to ease the ballast under the ends of the sleepers before lining, otherwise the sleeper moves up the mould and returns to faulty alignment with the passage of trains. It may also be necessary to ease the sleeper fittings so that the rails may adjust themselves, the fastenings being re-tightened after lining.

On curves, lining must be done on the high rail.

No greater amount of slueing than that required in the correction of minor faults should be carried out without the line being protected with signals and a speed restriction imposed.

Where curve beacons exist and are correct, the rail must be kept at the specified distance from the mark on each beacon, and the track between beacons maintained to a true line by eye.

13.16 **Boxing and Dressing.**— Except during the work of Through Packing, when done in fine weather, the track must be boxed before closing a day's work and the ballast dressed to the template shown in ANNEXURE 14.

Tracks should be kept well ballasted, especially on curves, with a good shoulder on each side.

13.17 **Through Packing and Opening Out.**— In the programme work referred to in Clause 13.08 the track should be completely opened out to the bottom of the sleeper and each sleeper will be firmly packed at the rail seats. The ballast under the middle and the ends of each sleeper, shown in ANNEXURE 30, will be eased to prevent the track becoming centre and end bound.

As the work is done in fair weather, each day's quota will be closed up and dressed the following day, after re-packing any slacks which may have occurred. Thus two days' work will always be open for inspection, showing the condition of the sleepers and the state of cleanliness of the ballast and road bed.

Inspectors will check the track for correctness of cross levels and cant. Variation in cross levels is one of the principal causes of rough riding track, setting up oscillation in the vehicles.

They will tap the sleepers to test by sound the solidity of the packing.

The condition of the sleepers and fastenings shall also be closely examined.

Level Crossings will be opened out and overhauled as laid down in Section 7.

13.18 **Screening Stone Ballast.**— Ballast must not be allowed to become water-logged. Clean stone ballast, free of powdered stone, clay from the formation, and weeds, is essential to good track. Plants growing in ballast are a sure indication of the presence of dirt.

In the work referred to in Clause 13.08 a minimum of one mile of each gang length shall be thoroughly screened each year **by the section gang** in accordance with the illustrations in ANNEXURE 30. Thus the entire track will be screened once every 4 or 5 years. Track recently ballasted with stone must be similarly screened as some stone dust and dirt will have got into the track with the new ballast.

It is a misconception that screening of track in normal condition will leave it bare. All that is removed is the dirt between the stones. Where the earth content preponderates, arrangements must be made to unload stone ballast to make up shortage before screening is done. The progress chart referred to in Clause 13.09 will show where such lengths remain to be screened.

The screening described does not require a speed restriction to be imposed, as the ballast packing under the sleeper is not removed during the operation. Slight deterioration in the running top may occur but this is very temporary. The track must be kept well packed as screening progresses and closed up at the end of the day's work.

Normal track tools are sufficient for the work. Each gangman should be allotted a day's task of a certain number of sleeper gaps or "cribs". A hoe (jembe), **not** a shovel, should be used to empty the crib to ensure that all dirt is removed with the ballast. The formation shall be graded to the line shown in ANNEXURE 30 and only clean stone returned to the completed crib using a ballast fork.

A suitable method is for each man to empty a single crib of all ballast and dirt on to the cess on each side of the track. The bed must then be graded. The ballast from the adjacent crib will be riddled with a ballast fork and thrown into the empty crib, and the process repeated. At the conclusion of the task the ballast removed from the first crib will be carried to the one last emptied.

The work must be closely supervised by the Ganger who should be supplied with a template of the correct dimensions to measure down to the bed from the bottoms of the rails and at the middle of the sleeper.

The dirt removed from the track may, if suitable, be used to build up or widen the cess.

13.19 **Lubricating Fishplates and Fishbolts.**— In the work referred to in Clause 13.08 and shown in ANNEXURE 29, half of each section gang's length is required to be lubricated each year, that is, each rail joint will be attended to once in two years. Alternatively the quota may be half of the Sub-Permanent Way Inspector's section in a single stretch each year.

Lubrication will be done only at **one site at any one time on each Sub-Permanent Way Inspector's section,** employing either of the following methods:—

(a) two adjacent gangs working together, or

(b) two competent men taken from each section gang to form one party.

The work must be supervised by the Sub-Permanent Way Inspector or by a Passed Ganger authorised by the District Engineer as competent to carry out the duties of a Sub-Permanent Way Inspector, and it may be limited to 4 or 5 days per week to enable the Sub-Permanent Way Inspector to inspect the remainder of the track in his charge.

The site of work must be protected in accordance with General Rule 423 and signals displayed in the manner illustrated in Diagram V of ANNEXURE 43.

Where the rail joints are closed up and when the joints are excessively open over a considerable length of track, and there is danger of buckling or run-away rails, the track shall have the expansion gaps adjusted before the work of lubrication is undertaken.

The lubricant to be used on both fishplates and fishbolt threads will be the same as is used for manual lubrication of rails on curves (Clause 13.21) viz. a ready mixed paste of graphite and grease. Plain oil must not be used.

The fishplates and rail ends must be cleaned with wire brushes and examined for cracks. Very careful examination of the rails and fishplates must be made in Tunnels.

The fishplates will be put back in the same manner as they are laid, only the fishing surfaces and the inner side being liberally greased. The plates will not be exchanged from inside to outside nor, where the design permits, will the plates be reversed top to bottom.

The fishbolts will be replaced with the nuts of the two inner bolts on the gauge side of the track and the nuts of the two outer bolts outside the track in **even** years. In **odd** years these bolts will be reversed. The purpose is to check that the lubrication work has actually been done and also to prevent the shearing of **all** four bolts in a derailment. Where two hole fishplates are laid the same principle shall be employed.

To pass trains during progress of work, at least two bolts through the two inner holes must be tightened. The completed work shall be worked through

again to ensure that the joints are tight, the fishplates being lightly tapped home in the process.

13.20 **Lubricating Clip Bolts.**— In the work referred to in Clause 13.08 and shown in ANNEXURE 29, half of each section gang's length is required to be lubricated each year. It is not necessary to remove the nut but only to unscrew it for half its depth so that the bolt threads below the nut and the threads inside the nut may be lightly oiled. Black oil of low grade or reclaimed lubricating oil is to be used for this purpose.

To avoid weakening the grip of the sleeper fastenings on the rails the work shall be arranged so that only one spanner is allotted to a rail length, and the clip bolts of only one sleeper at a time should be eased and refastened.

The completed work shall be worked through again immediately afterwards to ensure that the nuts are tight.

See Section 15 for the special instructions pertaining to welded track.

13.21 **Lubrication of Rails on Curves.**— All curves of 6 degrees and over, and any curves of less degree showing any sign of wear, must be greased twice weekly by the Keyman, this work being done on Mondays and Thursdays of each week.

The grease will be applied with a hard brush of the stencil type to the inside running face of the outer rail.

Every fifth rail of the curve shall be greased on one day and on each successive greasing day the next rail shall be greased and so on in rotation until all the rails in the curve have received an application. The operation shall then be repeated all over again.

The composition of the paste, which is stocked ready mixed, is 1 lb. Graphite with 5 lbs. of Grease, and 2½ lbs. of this mixture should suffice for one mile of rail.

In cold climates the mixture may have to be softened by warming or by thinning with the addition of paraffin or other suitable oil. It must not be thinned to an extent that the mixture runs off the side of the rail.

The Keymen should be cautioned against applying the grease to the table of the rail as this causes locomotive wheels to slip.

Where relaying has been done with new rail the section Permanent Way Inspector shall commence the greasing immediately following the relaying in order to arrest initial side wear.

Mechanical lubricators, where provided for sections having many closely spaced curves, shall be located in accordance with the manufacturer's instructions and the Chief Engineer's approval. These appliances require careful and skilled attention which should not be left to the ganger. The reservoirs shall be regularly replenished with the special graphite grease recommended by the

manufacturer and the lubricators shall be adjusted to avoid wastage and splash on to the tables of the rails.

13.22 **Rail Creep.**— One of the principal causes of rail creep is loose fastenings in the sleepers and rail joints. Where there are a large number of closed joints, particularly in light rail sections, there is danger of the track buckling; and when the joints are open to the limit, the fishbolts, fishplates and even the rails may break through tension. Facing points also may become distorted to an extent that the switches do not move freely.

All sleeper and rail fastenings must be maintained tight and Permanent Way Inspectors must take timely action to adjust the joint expansion gaps. Where lubrication of the fishplates has been neglected and the rails are not free to expand and contract, a buckle could occur even though the joints appear open. A sure indication of an impending buckle is distortion in the alignment in hot weather.

The cutting of rails to relieve the stress may only be resorted to as an emergent action in order to prevent a buckle. The proper action is Pulling Back in good time.

13.23 **Pulling Back.**— This is the term applied to the adjustment of rail expansion gaps.

The work must be supervised by an Inspector and protected in accordance with General Rule 423 and the signals illustrated in Diagram V of ANNEXURE 43.

Pulling Back should be done in cool weather and proper expansion shall be provided at the rail joints as laid down in Section 12. Excessive rail gaps should be avoided as they increase the batter at the rail ends, and cause dipped joints and broken fishplates.

Only where creep pulling is required to be done frequently shall cut rails be permanently inserted in the track. In these circumstances the cut rails should be located at selected places, such as at mile posts, and near facing points, to ensure that pulling back is done over sufficient length of track.

During the work slotted fishplates and small rail pieces of 4 to 6 inches in length (depending on the pitch of the bolt holes in the rails) will be required to pass trains. **These must be removed at the close of the day's work.** All fastenings must be tightened up as the work advances.

Where a creep adjusting machine is not available the rails will be drawn through the sleepers with tommy and crow bars. The practice of hammering the rail ends and fishplates with a piece of rail is forbidden.

If the joint gap condition is properly calculated and timely pulling back is done, it should not be necessary to seriously disturb sleeper spacings, particularly the sleepers at the rail joints.

13.24 **Buckled Track.**— Where rail joints are closed over a considerable length, the Ganger should be cautioned against lifting, opening the ballast, or slueing the track during hot weather until the rails have been adjusted. This is particularly important in light rail sections and where wood sleepers are laid.

In the event of a buckle occurring the track must first be protected with hand signals and detonators. Then loosen the fishplates on each side of the buckle and, in the case of straight track, slue it to reverse curves. In the case of curved track slue the track outwards.

To restore the track to its original alignment the rails should be pulled back when the temperature drops and the expansion gaps at the joints adjusted. Only in the last resort should rails be cut to shorten the length of the track.

All cases of distortion of track by buckling must be reported as an Accident.

13.25 **Rail Anchors.**— Rail anchors are necessary where rail creep is excessive, pulling back frequent, and as an insurance against rail joints moving away from the joint sleepers or pushing these sleepers out of square.

In single track laid with clip and bolt type sleepers there should be no rail creep if care is taken to keep all sleeper fastenings tight. Under normal circumstances 4 anchors per rail (8 per rail length of track) are sufficient to eliminate creep and they should be fitted towards the middle of the rail. For example, in a 40 ft. long rail laid on 17 sleepers the anchors should be fitted against the 5th; 8th; 10th; and 13th sleepers.

The sleepers against which the anchors are fitted must be well boxed in with ballast and in extreme circumstances it may be necessary to provide narrow and deep close fitting wood struts between the anchored sleepers and below the rails, in order to distribute the longitudinal thrust over more sleepers.

Rail anchors should be fitted over a length of at least half a mile in front of interlocked facing points, where rail creep occurs.

Rail anchors must not be laid in points and crossings or on unballasted girder bridges without the approval of the District Engineer.

Each rail anchor must be kept hard up against the sleeper and if it is observed that the rail has commenced to creep in the opposite direction, the anchors should be removed and put on the other sides of the sleepers. In the event of the two rails creeping in opposite directions to each other, rail anchors must be fitted to both sides of the sleeper to prevent it skewing.

13.26 **Examination of Track in Tunnels.**— Deterioration in rails, sleepers and fastenings is far more rapid in tunnels than in open track, due mainly to a combination of the fumes from locomotives with the damp atmosphere normally present in tunnels producing a high rate of corrosion and wear of the metals.

The Keyman must be instructed to particularly look for cracks and breakages in the rails, fishplates and fishbolts when patrolling the track.

The Permanent Way Inspector shall at frequent intervals make a thorough inspection of the track on foot.

The rails shall be checked with a suitable gauge for table wear at six monthly intervals and the measurements, with a general report on the other track materials, shall be forwarded to the Chief Engineer.

The stone ballast tends to become fouled up with dirt earlier in tunnels and shall be screened at intervals.

The painting of the rails, steel sleepers, and fastenings, where done, shall be maintained in good condition.

SECTION 14

POINTS AND CROSSINGS

14.01 **Names of Parts of a Turnout.**— Points and Crossings is the name given to the whole layout consisting of the switches and crossing with their connecting straight and curve rails, the term being synonymous with turnout. The switches are often referred to as points.

The names of the components of switches, crossing and the complete turnout are given in ANNEXURE 32 and 33 and only these names shall be used in correspondence and the preparation of requisitions.

It is incorrect to call a tongue rail a switch or switch rail. A set of switches comprises the two stock rails and the two tongue rails, and a half set would comprise one stock rail and its partner tongue rail; L.H. or R.H. as the case may be. Where the component fittings are also required this should be clearly stated.

The terms Left Hand and Right Hand are used in describing stock rails, tongue rails, wing rails and turnouts, when viewed in the direction of the points towards the crossing as shown in ANNEXURES 32 and 33.

14.02 **Facing and Trailing Directions.**— The facing direction is that where a train runs from the switches towards the crossing and the trailing direction is that where a train runs from the crossing towards the switches.

The term facing points is sometimes loosely used to describe the outermost turnout at each end of a simple station yard.

14.03 **Existing Designs of Turnouts.**— ANNEXURE 34 shows all existing designs and a particular type can be identified from the principal dimensions and features given.

The current standards to be used in new works are those marked with a black dot.

The continued use of the designs not marked with a black dot shall be confined to spot renewals of units in existing turnouts.

As a general rule, when such old design turnouts are released from relaying and remodelling works, they shall be broken down and reconditioned for spot renewals. In special cases their re-use as complete turnouts may be authorised by the Chief Engineer.

14.04 **Flexible Switches.**— See ANNEXURE 32 for illustrations of the earlier Loose Heel or Hinged Switches and the modern Flexible or Heel-less Switches. The disadvantages of the former are:—

(a) the two front bolts in the heel joints must be kept loose to allow for the "throw" of the short and stiff tongue rails;

(b) when the heel joint is excessively loose the tongue rail tends to tip up at the toe and gape under the passage of a train;

(c) the greater length of straight tongue rail and switch angle cause an abrupt change of direction to a train taking the turnout road.

In the Flexible Switch the tongue rail is fixed further back on the stock rail with two bolts at the "virtual heel" to enable the tongue rail to act as a spring, its rear end being joined to the lead rail with normal tight fishplates.

For the turnout road the tongue rail is semi-curved, the straight portion extending only from the toe to the end of the side planing of the rail head, the remainder of the tongue rail being curved. This enables a train to enter the turnout road smoothly.

ANNEXURE 34 shows the following designs of Flexible Switches:—

Section of Rail	*Crossing Number*	*Type of Switch*	*Total Length of Tongue Rail*	*Length of Stock Rail*
60R.BS	7½	A	24′ 0″	29′ 0″
	8½	A	,,	,,
	12	B	,,	,,
80R.BS	7½	C	24′ 0″	29′ 0″
	8½	D	,,	,,
	12	E	,,	,,
	16	F	,,	,,
95N.	8½	G	28′ 0″	35′ 4″
	12	H	,,	,,
	16	J	,,	,,

The different letter symbols only indicate, for each rail section, a difference in designed curvature of the turnout side tongue and stock rails. It is important to note that, except for the curvature, studs and distance blocks, the lengths of the stock rails and tongue rails and their machining are identical for all crossing numbers in each group of rail sections. **Thus the stock and tongue rails are interchangeable,** and consequently manufacture and the holding of spares are simplified.

The curving or straightening of them for replacements can readily be done, when necessary, on the works site by the Permanent Way Inspector.

14.05 **To find the Crossing Number.**— The crossing angle is set out by the Right Angle Method, i.e. the base is the number of the crossing and the perpendicular is 1.

It is usual for the number to be cast on the distance blocks. If this is not decipherable, put a mark at the place where the spread between the gauge faces of the wing rails is 6 inches and another mark on the "vee" of the crossing where the spread between the running faces of the point and splice rails is 6 inches. The distance between the two marks **in feet** represents the number of the crossing.

Example:—If the distance measured is 6 ft. 9 ins., the number of the crossing is 1 in $6\frac{3}{4}$.

14.06 **Leading Dimensions of Turnouts.**— In the manufacture and in the laying of turnouts only the theoretically correct dimensions shown in ANNEXURE 34 shall be used.

Except in turnouts for very temporary works, switch lengths, crossings, and rails different from those shown shall not be used in any one turnout.

14.07 **Setting the Curves of Turnouts by Offsets.**— The turnout curve must not be set by "eye" but in the manner illustrated in ANNEXURE 34 using the perpendicular offsets from the main track given for each design of turnout.

14.08 **Leading Dimensions for Turnouts from Curves.**— The dimensions for the lead "L" and the offsets for setting the curve will be the same as if the turnout is laid on straight main track. For the method of measuring the lead in a curved turnout see the diagrams in ANNEXURE 34.

The only alterations which may require to be made are in the:—

(a) lengths of the closure rails between the switches and the crossing;

(b) bending of the stock and tongue rails;

(c) bending of the wing rails in front of the nose of the crossing.

14.09 **Curve Formulae for Turnouts from Curves.**— The simplest method of computing the changes in curvature is to use the degree notation and the conversion formulae for degrees and radius given in Clause 9.01.

Using the same crossing number and the following notation,

Ds = degree of the turnout when laid from straight track;

Dm = degree of the main track curve from which the turnout is to be laid;

Dt = altered degree of the turnout track curve; the relationships become:—

From the Inside of a Curve	$Dt = Ds + Dm$
From the Outside of a Curve	$Dt = Ds - Dm$

Laid as a Symmetrical Split	The degree of each curve is half of Ds
Laid from the inside of a main track curve the degree of which is Ds	Dt = Twice Ds

Example:—Given Dm = 4 degrees and Ds for a 1 in 12 turnout = 6 degrees.

From the inside of the curve Dt = 10 degrees
From the outside of the curve Dt = 2 degrees
If the main track curve is 3 degrees the turnout would be a Symmetrical Split.
If the turnout is laid from the inside of a main track curve of 6 degrees, the degree of the turnout curve would be 12 degrees.

14.10 **Limits of Curvature in Turnouts.**— The specification used by the Chief Mechanical Engineer in the design of locomotives and special vehicles is that they shall negotiate a curve of 290 feet radius (19.8 degrees) having ½ inch gauge widening, which in effect is equivalent to a curve of about 350 feet radius (16.4 degrees) with no gauge widening. The limits for turnout curves shall be:—

Siding tracks and lines not used by running trains — 16 degrees

Lines used by running trains — 10 degrees

The corresponding sharpest turnouts from straight track are 1 in 7½ and 1 in 10 respectively.

14.11 **Crossing Loops.**— Where a curve in the main line is unavoidable the layout shall be properly calculated and designed so as to provide the best combination of curves, the normal track spacing being increased if necessary for this purpose.

As a general rule, the limits of curvature of the main line for tracks spaced at not less than 16 feet shall be:—

Parallel Loop on the Outside of the Curve.

With 1 in 12 and 1 in 16 turnouts — 8 degrees.

Parallel Loop on the Inside of the Curve.

With a 1 in 12 turnout — 3 degrees.

With a 1 in 16 turnout — 6 degrees.

14.12 **Reverse Curves.**— Except in crossover tracks, gathering lines, and turnouts from curves to parallel loops, a minimum length of 30 feet of straight track should separate the reverse curves. This is especially necessary in sharp curves to avoid excessive strain on the central buffers.

14.13 **Selection of Turnouts.**— The following general instructions will apply; see Clause 14.03.

1 in $6\frac{3}{4}$	— Because of its very sharp curvature, this angle turnout shall no more be used in new work. Existing turnouts should be replaced by 1 in $7\frac{1}{2}$ where space permits of the latter being accommodated. Where 1 in $6\frac{3}{4}$ turnouts are retained they must be specially gauge widened in accordance with Clause 14.42.
1 in 7 1 in 8 1 in $8\frac{1}{2}$ (S.P.Rly)	— These are to be found in Tanganyika and infringe the limit of curvature stated in Clause 14.09. No more turnouts of these designs will be manufactured.
1 in $7\frac{1}{2}$	— Is the normal standard for siding tracks.
1 in $8\frac{1}{2}$	— For use in turnouts from loops used by running trains and in important sidings.
1 in 10	— These are to be found only in Tanganyika and in situations corresponding to 1 in 12 turnouts in the Kenya/Uganda system. No more will be manufactured and existing turnouts should gradually be replaced by 1 in 12.
1 in 12	— Is the normal standard for turnouts used by running trains. It may also be necessary in certain circumstances for a turnout from the inside of a siding or other curve in order to obtain suitable turnout curvature; see Clause 14.09.
1 in 16	— Is a special design turnout for use only in the special circumstances of main lines on curves; see Clause 14.11.

14.14 **Common Track Connections.**— These are shown in ANNEXURE 31 and only the names given shall be used in the preparation of requisitions and in correspondence.

14.15 **Turnout to Parallel Straight Tracks.**— The dimensions for the minimum spacing of 14′ 0″ laid down in Standard Dimensions and the formulae for any greater spacing are given in ANNEXURE 36.

The portion of straight track in continuation of the leg of the crossing is an essential requirement and must always be provided when the main and loop lines are straight.

14.16 **Turnout to Parallel Curved Tracks.**— The dimensions must be calculated for

the particular degree of the main line curve, following the principles of Clauses 14.09 to 14.13.

In such cases there will normally be no straight track behind the crossing, the connecting curve commencing at the heel of the crossing.

14.17 **Crossover to Parallel Tracks with Same Number Crossings.**— The dimensions for the minimum spacing of 14′ 0″ laid down in Standard Dimensions and the formulae for any other spacing are given in ANNEXURE 37.

In laying a crossover it is essential that the two tracks be slued to good alignment and to uniform track spacing.

Where a crossover is laid between two parallel curved tracks, the dimension "X" will be the same as for parallel straight tracks but the portion connecting the two crossings will be a curve of the same degree as the main tracks. The selection of the correct crossing numbers must fulfil the conditions of Clauses 14.09 and 14.10.

14.18 **Crossover to Parallel Tracks with Different Number Crossings.**— This arrangement may only be adopted where track space is limited and the speeds of trains using the crossover road are low.

The dimensions for the various combinations of crossing numbers for the minimum spacing of 14′ 0″ laid down in Standard Dimensions and the formulae for any other spacing are given in ANNEXURE 38.

In laying the crossover it is essential that the two tracks be slued to good alignment and to uniform track spacing.

This arrangement of different number crossings should not normally be used in parallel curved tracks. Where this is unavoidable the arrangement conditions of Clause 14.09 will apply.

14.19 **Scissors Crossover.**— See ANNEXURE 31. The arrangement is the same as two simple crossovers with crossings of the same number as shown in ANNEXURE 37, and the addition of a diamond.

It is incorrect to call the whole assembly a Diamond Crossing. The diamond is only the centre portion made up of two acute and two obtuse crossings, the numbers of which are approximately **half** that of the crossing numbers used in the two parallel tracks.

In preparing requisitions it should be specified whether the complete diamond, or a single acute or obtuse crossing of it, or the entire Scissors Crossover is required stating the number of the main turnout and the track spacing.

As it is an expensive arrangement both in first cost and in subsequent maintenance, a Scissors Crossover should only be used where space prevents the location of two separate simple crossovers.

Where space on one of the main tracks is unavoidably restricted the diamond may be located closer to it to form an unsymmetrical arrangement.

A Scissors Crossover may only be used between parallel tracks which are straight.

14.20 **Tandem Turnout.**— See ANNEXURE 31. The arrangement is only to be adopted where space prevents the use of two simple turnouts butting on to each other. A tandem turnout is an improvement on a three-throw turnout in which the disadvantage is that all four tongue rails are grouped together. The latter should never be used.

14.21 **Single and Double Slips.**— These special layouts in which the switches and the curved track are located within a flat diamond, are not shown in ANNEXURE 31.

They have not been adopted on this Railway as it has been possible to avoid their use by the arrangement of simple turnouts.

14.22 **Setting Out from the Delta Point.**— All turnouts should be set out from the "delta point" which is denoted by the small triangular sign at the distance "F" from the theoretical nose of the crossing so shown in the diagrams of ANNEXURE 34.

The dimension "F", which is obtained from the table, is constant for all arrangements of a turnout, whether it takes off a straight or curved main track.

To locate the delta point first place a stake at half track gauge opposite the theoretical nose of the crossing in each of the two tracks, making the measurements square to the two legs of the crossing and using small nails in the stakes for precise location.

From these two nail marks the dimension "F" is measured with two steel tapes, the delta point being at the intersection of the two dimensions "F".

The prolongation of the lines joining the delta point and the stakes opposite the nose of the crossing will be parallel to the two legs of the crossing, and the angle formed by these two lines will be equivalent to the angle of the crossing.

From these lines, which are tangential to the crossing, any required straight or curved track may be set out behind the turnout, commencing these at the heel of the crossing or further back if desired.

Such setting out is normally done by the Surveyor using a transit, but the Permanent Way Inspector can obtain sufficiently accurate work with the careful use of steel tapes.

14.23 **Installation of Turnouts.**— No turnout may be installed except in an emergency, until its exact location has been approved by the Engineer in charge of the section.

14.24 **Level Crossings in Turnouts.**— Except in properly designed paved track, a level crossing should not be located within a turnout. Where it is unavoid-

able to do so it should be within the "lead" and clear of the switches and crossing.

14.25 **Arrangement of Crossing Sleepers.**— The numbers of each length of wood crossing sleeper in the different designs of turnouts are given in ANNEXURE 35, and attention is drawn to the notes given under the diagram.

It is not essential for a Permanent Way Inspector to have the type drawing of the turnout concerned but the number of sleepers in each of the panels shown must be provided. In Panel 2, which applies to the switches, and in Panel 4, which applies to the crossing, the spacings of the sleepers are fixed by the positions of the slide chairs and crossing chairs.

In Panels 1 and 5 the sleepers should be so arranged as to give close spacing at the rail joints.

In Panel 3, which covers the "lead" of the turnout, the sleepers should be uniformly spaced regardless of the positions of the rail joints.

The sleepers under the switches and in the "lead" must be laid square to the straight or main track. Those under the crossing should be square to the centre line of the crossing to ensure that the check rails of the main and turnout tracks are in the same position relative to the nose of the crossing.

14.26 **Steel Crossing Sleepers.**— These occur in the turnouts in Tanganyika and no more will be obtained. Where it is necessary to renew these the whole turnout shall be re-sleepered with wood and any serviceable steel sleepers recovered shall be used for spot renewals in other turnouts laid with steel.

The sizes of wood sleepers to be used are given in ANNEXURE 35, and the flat steel bearing plates described in Clauses 14.31 and 14.32 shall be provided over the whole turnout, including the check rails and the crossing.

14.27 **Interlaced Wood Track Sleepers.**— When crossing sleepers are in short supply the turnout may be laid with standard track sleepers up to the toe of the crossing. They should be placed side by side, touching each other and square to the main track. The gap between each pair of sleepers should be about 10 inches to enable beater packing to be done from one side only.

14.28 **Rail-Block Crossing Sleepers.**— These were primarily designed for use with the interlaced wood track sleepers described above. The advantages of the rail-block sleepers are that they are stiffer than long wood sleepers, they keep all of the rails at a uniform level, and the wood blocks can be individually replaced when they become unserviceable.

14.29 **Rail-Type Sleepers for Switch Levers.**— Two such sleepers, fabricated from unserviceable rails, are recommended for use at the toe of the switch to provide a rigid connection between the switches and the switch lever. When used, the Gauge Tie Plate described in Clause 14.44 will not be required.

14.30 **Care of Wood Crossing Sleepers.**— Because of their length they are very liable to warp and bend if left in stacks. They should therefore be laid without

delay in the track, where the ballast will protect them from the sun and the fastenings to the rails will hold them to good shape.

The instructions in Clauses 11.11 and 11.12 concerning passing and stacking of wood sleepers shall apply equally to wood crossing sleepers.

14.31 **Bearing Plates.**— These must be used in all turnouts in order to prevent the rails from cutting into the wood and the gauge from spreading.

As the rails in the switches and crossing are laid without the normal 1 in 20 tilt, it is preferable to use flat steel bearing plates in the "lead". The tilt is not a matter of great importance and canted main line pattern bearing plates may be used in lieu when available.

The flat bearing plates are manufactured from 6" x $\frac{5}{8}$" thick steel and some designs provide holes to suit two rail sections, such as 60R.BS and 50 OBS in order to reduce the number of types. See Type Drawing No. 7583 for the whole range of these.

14.32 **Back of Heel Bearing Plates.**— These are included in the modern turnout designs in 60R.BS; 80R.BS; and 95N rails, but were not provided in the earlier designs of turnouts.

To prevent movement under traffic of the curved and straight "lead" rails behind the heel joint and to increase the life of the sleepers, bearing plates made up locally from 6" x $\frac{5}{8}$" thick flat steel to accommodate two rails and holed for screw spikes, should be provided in all heavily used early design turnouts.

14.33 **Chair and Rail Fastenings.**— Square headed Coach Screws are used for fastening down the switch slide chairs and the steel key and clip bolt type of crossing chairs to the timbers.

Screw Spikes shall be used to fasten down the rails in the "lead" and in the 60R.BS and 80R.BS crossings and check rails which are provided with flat steel bearing plates.

14.34 **Drilling and Plugging Holes in Wood Sleepers.**— See Clauses 11.16 and 11.17; para two of the latter is of particular importance in crossing sleepers to extend their life.

14.35 **Standard Dimensions and Clearances.**— No infringements of Standard Dimensions are permissible.

The prescribed limits particular to points and crossings are given in Items 29 to 35 of the book of Standard Dimensions.

14.36 **Handling of Points and Crossings.**— When loading, off-loading or handling any points and crossings, never allow staff to throw them. They must be handled carefully as they are damaged much more easily than rails and sleepers.

Also see Clause 12.07.

14.37 **Cutting of Rails.**— See Clause 12.08.

14.38 **Straightening and Bending Rails.**— See Clause 12.09 and 12.10. As the curve in turnouts are relatively sharper than in plain track, and as much of the rails are in cut lengths, the rails should be pre-bent using the formulae in Clause 12.10.

14.39 **Minimum Closure Rail.**— See Clause 12.11.

14.40 **Gaps in Rail Joints.**— A gap of $\frac{1}{4}$ inch should be provided at each rail joint in all points and crossing layouts.

14.41 **Table and Side Wear in Rails.**— Only the best available rails, free from excessive table wear and side wear, shall be used in the laying of turnouts. The rails joined to the switches and the crossing should be carefully matched so as to avoid wheel batter on the joints.

14.42 **Gauge.**— See ANNEXURE 33. The track gauge in turnouts shall be as follows:—

Switches.
Main Track in "lead".
Crossing (both tracks). } Normal gauge of 3 ft. $3\frac{3}{8}$ in.

Turnout Track in "lead" — $\frac{1}{4}$ inch widening by moving out the inside rail, the difference from normal gauge being run out over three or four sleepers to the heel of the switch on the one side and to the toe of the crossing on the other side, as shown in the diagram.

In the case of a turnout taking off curved track the gauge of the main track should be kept at normal gauge for about 50 feet in front of the stock rail and behind the crossing.

The exception to the foregoing instructions is the 1 in $6\frac{3}{4}$ turnout in which because of its excessively sharp curve and the introduction of more rigid locomotives, the gauge over the switches, turnout curve, and crossing must be widened by $\frac{1}{2}$ inch and gauge tie plates provided in the manner shown in the special type drawing prepared for the purpose. Permanent Way Inspectors having 1 in $6\frac{3}{4}$ turnouts must provide themselves with this type drawing.

14.43 **Switch Levers.**—

General:— The Switch Lever must be mounted on two long wood or steel sleepers, each in one piece. The rail-type sleepers described in Clause 14.25 are a substitute for these and more satisfactory. The practice of using pieces of unserviceable steel sleepers screwed down to wood track sleepers should cease, as the steel sleeper pieces tend to cock up and the whole assembly lacks rigidity.

For the painting of switch levers see Clause 5.11 and Section 22.

be interposed in order to save the ends of these expensive turnout units from becoming battered.

In the manufacture of junction fishplates the spacing of the two inner bolt holes is usually reduced in order to close up the rail and thereby reduce wheel impact.

In certain designs, such as for the 50 NS rail, the portion of the fishplate and the bolt spacing for such rail have been reduced in order to shorten the plate and cheapen manufacture. One new hole is therefore required to be drilled in the rail at the works site.

14.65 **Ballasting Turnouts.**— All turnouts in running lines and in other heavily worked situations must be stone ballasted to improve track maintenance and drainage and thereby extend the life of the crossing sleepers.

The depth of stone ballast should be a minimum of 8 inches below the bottom of the rail.

See Clause 19.22 regarding the clearing of ballast at switches and working connections.

14.66 **Inspection and Testing.**— Each day the Keyman (or Ganger) when carrying out his patrol, should turn all non-interlocked points at stations over and back again to make sure that the tongue rails are housing properly, all loose bolts and chair fastenings are tight, and that nothing is out of order.

Where the points are padlocked it will be necessary for him to inspect them in conjunction with the Station Master, or a pointsman deputed by him, who will open the locks.

A careful watch must be kept for broken rails in crossings as a fracture may be obscured by fastenings.

The Keyman (or Ganger) shall inform the Station Master of any serious defect found and it will be the duty of the Station Master to inform the Inspector concerned.

For the instructions concerning the compulsory periodical examination of fixed signals, points etc. see Clause 19.10.

No adjustments, repairs or alterations in turnouts, which would affect the safety of the equipment or cause delay to traffic working, may be undertaken without the knowledge and consent of the Station Master or official in charge of the safe working of the station.

14.67 **Turnout Maintenance.**— Turnouts are weak points in the track structure and their upkeep in first class condition is of prime importance requiring considerable personal attention by the Permanent Way Inspector.

The switches and their conections and levers must be regularly attended to by the Permanent Way Inspector's artisan.

Williams Two-Way Trailable Lever.

These are of two makes, Llewelyn Wynn-Williams and Henry Williams, having similar appearance and working principles.

The term "two-way" denotes that the spring is so arranged that it will hold the switches closed in one direction or the other, until they are moved by the handle being pulled.

The lever handle is of the "still" type, i.e. it must be returned to the original position after the switches have been pulled, before the switches can be reversed. If properly installed and maintained this is accomplished by the weight of the handle of itself. Where the handle is of the bent type it must be fitted so that it lies in its lowest position when at rest.

The box frame should be so positioned that the spring exerts equal pressure on the tongue rails in both positions. To effect this the crank in the frame should be in the half-way position when the tongue rails are equidistant from the stock rails. Closer adjustment is then made by means of the turnbuckle screw provided in the pull rod, after the box frame has been fixed down to the sleepers.

The box frames have hitherto been of cast iron which require careful handling to prevent breakage. Steel box frames are now being adopted.

The Williams Lever will throw any design of Loose Heel or Flexible Switch and is trailable. It is the most suitable of the switch levers for busy yards and is normally provided for all new works in which Flexible Switches are used.

14.44 **Gauge Tie Plates.**— A through tie plate or a combined tie and slide chair must be provided on the sleeper at the toe of the switch, to resist the thrust of wheel flanges and to maintain correct track gauge.

The rail-type sleeper described in Clause 14.29 is a substitute for a through tie plate.

Small adjustments to the track gauge may be made by inserting steel packing pieces between the slide chair jaw and the stock rail.

Where softwood crossing sleepers are used, two or three tie plates will be necessary within the "lead" of 1 in $6\frac{3}{4}$ and 1 in $7\frac{1}{2}$ turnouts to hold the gauge from spreading in the curved track.

14.45 **Bend in the Curve Side Stock Rail.**— As the stock rails are not parallel, the one on the turnout side must be bent in order that the track gauge ahead of the toe of the switch may be exact. In turnouts of contrary flexure both stock rails will require to be bent to the extents suitable to the curvature in each of the two tracks.

The bend should be given 6 inches in front of the toe of switch as shown in the topmost diagram in ANNEXURE 34, so that the blade toe is covered and housed behind the bend given, without causing gape in the closed switch.

14.60 **Nose being struck by Wheel Flanges.**— This is caused by one or a combination of the following defects:—

(a) tight track gauge;

(b) excessive check rail clearances;

(c) loose bolts and chair fastenings, particularly in the throat of the crossing causing the wing rail to spread under wheel thrust.

It is a serious defect which must be corrected immediately it is detected.

14.61 **Scrapping Limits.**— The safe condition of the rails in a turnout must remain within the judgement of the Permanent Way Inspector and Engineer, who should take into account the character of the traffic and other conditions. The following will serve as a guide in deciding when to renew a unit:—

Stock Rail.

Excessive thinning down of the rail table due to wear or flattening, causing the head of the matching tongue rail to break down over its thinned portion.

Side wear on the gauge face causing excessive side wear to the matching tongue rail which may result in it splitting at the toe.

Tongue Rail.

Side wear or chipping at the thin end to an extent which may cause a wheel flange to force itself between the stock and tongue rails.

Vertical Wear on the Wing Rail.

The grooving of the wing rail and not the squeezing of the nose rail will normally determine when the crossing should be replaced. The rate of wear in a wing rail may be noticeably rapid within the first year of the crossing being laid, thereafter slowing down appreciably.

The entire crossing unit (wings and vee) should be replaced when the vertical depth in one or both of the wing rails, measured at the rubbing edge and **opposite the blunt nose of the crossing** reaches $\frac{1}{4}$ inch. See Clause 14.68.

Side Wear in the Check Rail and Wing Rail.

Wear on the rubbing face to an extent causing the flangeway clearance to exceed $1\frac{3}{4}$ inches.

14.62 **Reconditioning by Welding.**— As a general rule it is not economical or satisfactory to repair worn crossings in the track and they must be sent to the Permanent Way Depot for overhaul as stated in Clause 14.68.

Authority may be applied for to carry out "in situ" welding in large yards and port areas.

14.63 **Points and Crossing Bolts.**— The bolts and nuts shall be obtained from the Permanent Way Depot where they are made in multiples of $\frac{1}{2}$ inch in length.

of the tongue is hard against the stock rail.

With the 95N designs of switches, flat flexible stretcher bars of spring steel are used in place of round steel.

14.51 **Connecting Rod Brackets.**— These are the brackets riveted or bolted to the tongue rails and to which the connecting rods are fitted. The rivets or bolts must at all times be kept tight.. Any looseness in the rivets can generally be removed by hammering without heating.

14.52 **Connecting Pins and Bolts.**— A tolerance of 1/16 inch is generally provided between **new** pins and bolts and the corresponding holes in the connecting rods and pull rod. That is to say that the diameter of the hole is 1/16 inch greater than the diameter of the pin or bolt. This tolerance should not be allowed in service to exceed $\frac{1}{8}$ inch. The cumulative effect of wear in the several pins or bolts will prevent the proper closing of the tongue rail against the stock rail.

14.53 **Gape at the Toe of Switch.**— The tongue rails should fit closely against the stock rails throughout the planed length of the former, and they should sit uniformly on the slide chairs.

The limits for gape shall be:—

(a) Interlocked switches; see Clause 19.17 — 1/16 inch.

(b) Padlocked switches — 1/8 inch.

(c) Ordinary unlocked switches — 3/16 inch.

Gape in excess of 3/16 inch could alllow a wheel to force its way into the opening and cause a serious accident. Prompt steps must be taken to correct the defect, and in the cases of (a) and (b) above, should the gape amount to 3/16 inch the switches must be considered unsafe and spiked or clamped and trains hand signalled over the points at dead slow speed until the fault is corrected.

The test for gape is to force the tongue rail away from the stock rail by means of a pinch bar. The common causes of gape are:—

(i) excessive wear and incorrect adjustment of locking assemblies;

(ii) excessive wear in connecting pins;

(iii) incorrect length of the back connecting rod;

(iv) loose connecting rod brackets and slide chair pins;

(v) loose spikes fixing the lever box frame to the sleepers;

(vi) excessive tightening of the two forward bolts in Loose Heel type joints.

Inspectors and Engineers shall check switches for gape during their routine inspections paying particular attention to locked points in running lines.

14.54 **"MACK" Switch Point Protector.**— This is a fitting comprising a protector plate of manganese steel, a back plate and a washer plate, each 9 inches long, which are fixed to the stock rail with two bolts having lock washers.

The nearest edge of the protector plate should, unless interlocking connections require a little more space, be located 2 inches in front of the toe of the switch. Its function is to draw the wheels away from the running face of the rail and so retard the wear of the tongue rail at its thin end.

It is only required for the protection of the tongue rail for the curved road, i.e. it shall be placed on the right hand stock rail in a left hand turnout and on the left hand stock rail in a right hand turnout. **It must not be installed on both side stock rails.**

The only component that wears down is the protector plate. This is reversible, i.e. when the original wearing surface becomes so grooved as to begin to show side wear on the tip of the tongue rail, the plate must be reversed and the other surface (the bottom of the plate as first used) brought into use.

Only the protector plate should be requisitioned for replacements, stating the rail section. The back plate, washer plate, and bolts can be used repeatedly.

This appliance could be a danger if not properly installed and maintained. The important points are:—

(a) do not fit the protector to a stock rail which has excessive table or side wear;

(b) see that the bolts are fitted with lock washers and are at all times tight.

Failure to observe these points may cause a worn wheel flange to mount the protector plate.

When installing "MACK" Switch Point Protectors, the Permanent Way Inspector should be in possession of the maker's booklet which may be obtained from Headquarters.

14.55 **Lubricating Tongue Rails.**— See Clause 5.13; grease shall also be applied to the face of the protector plate of the "MACK" Switch Point Protector to retard wear on it.

14.56 **Cleaning and Lubricating Switch Slide Chairs.**— See Clause 5.12.

14.57 **Rail Creep.**— The instructions of Clause 19.17 shall apply to all switches and particularly to the facing points at wayside stations and other padlocked switches.

14.58 **Padlocked Points.**— Locking devices are provided as a security measure to prevent unauthorised manipulation of the switches, and as a safety measure to ensure that the tongue rail fits closely against the stock rail.

Where interlocking is not provided, the switches in all running lines and such other switches as the Operating Department require, shall be padlocked.

℗ The only safe way of securing the switch is to hold the tongue rail to the stock rail; **not** to provide the locking at some remote point such as at the switch lever. The intermediate pins in the linkage between the switch lever and the points are subject to excessive wear and possible unauthorised tampering.

The type of point locking pin to be used shall be that shown in Drawing No. 7531, the pins being provided by the Engineering Department and the padlocks by the Operating Department.

This type of pin is designed with a loose collar and a split pin instead of a solid bolt head, in order to prevent the crippling of the tongue rail in the event of the points being run through. In such an event the split pin will be sheared, the loose collar will fall off the pin, and the cotter holding the lock may become slightly distorted. The connecting rods and pull rod may become distorted where the switch lever is of the Tumbler type, but this should not occur with Soulsby and Williams levers.

The fitting of this type of point locking pin does not absolve the Station Master from reporting a "run through" as an accident.

Only the authorised size and design of split pin shall be used and, to ensure that any damage is properly repaired, spare collars and pins shall be held by the Permanent Way and Sub-Permanent Way Inspectors and not given to the Station Master.

The pin shall be correctly fitted as shown in the drawing, it being important that the padlock is on the outside of the stock rail.

The locking assembly shall be regularly examined by the Inspectors and kept in good order, and it must comply with the conditions for "gape" laid down in Clause 14.53.

14.59 **Flangeway Clearances in Check Rails and Wing Rails.**— The clearances required in check and wing rails opposite the nose of a crossing, to prevent wheel flanges striking it in a facing direction, are controlled by the wheel gauge and the maximum and minimum thickness of wheel flanges in relation to normal track gauge of 3 ft. $3\frac{3}{8}$ in.

These limiting clearances are $1\frac{5}{8}$ inches minimum and $1\frac{3}{4}$ inches maximum as laid down in Items 30 to 33 of the book of Standard Dimensions.

Excessive clearance may result from widening of the track gauge, loose bolts, dirt, or wear on the rubbing side of the rail head. In the last named there is no alternative but to renew the check or wing rail.

Reduced clearance is caused by wear in the distance blocks and in the webs of the rails, and in some cases it is due to flattening of the head of the running rail. Steel liners inserted between the distance blocks and the rail web may be used to increase the clearance subject to the limits mentioned above.

Flangeway gaps must be kept clear of ballast and dirt.

The bend shall be given with a jimcrow and shall be sufficient to prevent the rail springing back and causing the other side stock rail to distort outwards.

14.46 **Loose Heel Joints.**— The disadvantages in Loose Heel Switches is described in Clause 14.04.

The fishplate at the heel should be bent outwards at its middle, but only sufficient to ensure that it fits snugly against the tongue rail when it is open at the toe. ¼ inch of bend will generally be sufficient for all switches.

The two rear bolts connecting the "lead" rail to the heel block and stock rail must be spanner tight as for ordinary track. The two forward bolts connecting the tongue rail to the heel block and stock rail must be tightened only to the extent at which the nuts touch the fishplate when the tongue rail is open, and the heads of the bolts are in contact with the web of the stock rail.

Excessive tightening of the two forward bolts and insufficient bending of the fishplate may cause the closed tongue rail on the other side to gape.

The sleepers under the heel joint must be kept hard packed.

14.47 **Stock Rail Fastenings to Slide Chairs.**— The stock rail must be held quite tight to the chairs by the pins and cotters or bolts, whichever type is in use, and the ends of split cotters must be opened out.

14.48 **Studs or Stops.**— These are provided between the heel block and the point where the heads of the tongue rail and stock rail meet, and their purpose is to prevent the tongue rail bending under the lateral pressure of the wheel flanges.

The studs or stops must just contact the web of the tongue rail when it is closed. When they are either too long or too short the closed tongue rail may tend to gape.

14.49 **Slide Chair Pins.**— The ordinary pins or bolts holding the stock rail to the slide chairs, over the portion between the junction of the rail heads and the toe of the switch, must be clear of the web of the tongue rail when it is closed.

14.50 **Connecting Rods.**— See ANNEXURE 32. The length of the front connecting rod fixes the clearance at the toe of the open switch known as the "throw", and this rod must first be installed.

The minimum "throw" is 4" and is standard for all Loose Heel Switches. In Flexible Switches this dimension is increased in accordance with the "throw" shown in the drawings.

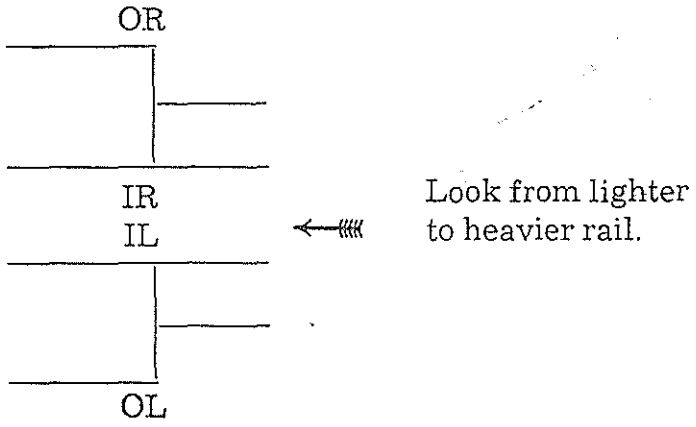
The length of the back connecting rod must then be so adjusted that the pins coupling it to the brackets on the tongue rails can be inserted without the use of excessive force. If the length is incorrect, the rod will put a strain on the tongue rails and deform them, causing the toe of the tongue to touch the stock rail before the switch is properly closed, or to gape after the back end

The nuts shall be the same as used with fishbolts and only two standard bolt diameters will be used, viz. $\frac{3}{4}$ inch for rail sections up to 60 lb./yard and 1 inch for rail sections exceeding 60 lb./yard.

The bolts and nuts stocked by the Stores Superintendent for general engineering work shall not be used, as these are not manufactured to close fit limits and the nut dimensions are generally very variable.

14.64 **Junction Fishplates.**— The practice of ordering junction fishplates "in pairs" is incorrect. They should be indented as a "single" fishplate, or a "half set", or a "set" stating the symbols described below, which shall be stamp marked on each plate.

The "hand" of the fishplate is defined by looking at the rail joint from the lighter to the heavier rail, or, in the case of two different but equal rail weights, by looking from the rail with the smaller to that with the larger section modulus (ANNEXURE 25).



OR denotes Outer Right; IR denotes Inner Right;
OL denotes Outer Left; IL denotes Inner Left.

Junction fishplates are not ordinarily made with steps to suit varying amounts of table wear in the rails. Only for the combinations of the newer rail sections with the older ones, e.g. 60 lb. to 50 lb., is an allowance made during manufacture for a suitable degree of table wear in the older rail.

The following points should be attended to when installing junction fishplates:—

(a) the rails shall be selected for good shape in order to level up the top surfaces of the two rails as best as possible;

(b) the running face of one rail must be a true continuation of the running face of the adjoining rail;

(c) the sleepers at the rail joint should be brought near together to provide maximum support;

(d) where avoidable a junction joint should not be made directly to a crossing or a switch, but rails of the same section as the turnout should

For the minimum clearances of a switch lever in relation to the track see Item 29 of the book Standard Dimensions. This is an essential condition to prevent the falling door of a livestock wagon, when unfastened, striking the switch lever, which may even cause the switches to be "thrown" under a train.

Cast Iron Tumbler Lever.

The box frame must be so positioned that the bell crank lever is at the centre of its travel when the tongue rails are equidistant from the stock rails.

In order to obtain the full effect of the cast iron counterweight to hold the tongue rail against the stock rail the following conditions must be fulfilled:—

(a) the joint between the pull rod and the crank must clear the lever box frame by about one inch;

(b) the cast iron tumbler inside the box must not touch against the narrow sides of the frame in either of the two positions of the tumbler.

This switch lever is not designed to be trailable, despite the fact that, under certain circumstances, the lever may lift when the points are run through and no damage to the lever and rodding may occur.

It must **not** be used with the Flexible Switches described in Clause 14.04, as there is no spring provided in the lever to overcome the stiffness of the tongue rails.

The use of the Locking Bar with a pin passed through one of the two holes in the pull-rod is an obsolete method of padlocking the switches; see Clause 14.58. It has no function in the proper working of the switch lever and will only cause excessive damage to the tongue rails, switch lever and rodding in the event of the points being run through.

Soulsby Lever.

This is a trailable lever having a spring which, because it is arranged vertically, does not close the switch with great force.

It requires very careful attention and the box should be opened periodically, the cam and spring examined and adjusted, and the box refilled with grease.

To install the lever the frame should be positioned so that the spring exerts equal pressure on the tongue rails in both positions, adjustment being made by means of the screw threads provided on the pull rod.

This lever may be used with any design of Loose Heel switches, but only with the light 60R.BS Flexible Switches. The spring force is **not** sufficient to work Flexible Switches of 80R.BS and 95N designs. The manufacture of the Soulsby lever is now restricted to special requirements, the Williams lever having superseded it.

Having regard to the speeds of trains and the relatively sharp uncanted reverse curves present in turnouts in running lines, special care must be taken to ensure that the alignment and levels of the track in front of, through, and behind the turnout are well maintained.

14.68 **Renewals.**— Once a year each Inspector shall prepare and the District Engineer shall, after scrutiny, forward to Headquarters a statement of switches, crossings, check rails, and crossing sleepers requiring to be renewed in the following year.

Small parts of turnout must be renewed as the need arises.

Worn wing, point and splice rails of a crossing should not normally be replaced by the Inspector. When the scrapping limit laid down in Clause 14.61 has been reached, the whole crossing should be renewed and the defective one returned to the Permanent Way Depot where the work of reconditioning will take into account relative table wear on all the rails. The bolts and blocks will also be overhauled. It will then be re-issued as the need arises.

All the crossing sleepers in a turnout should be renewed at the one time. This enables the metals to be overhauled and the track gauge and curve re-set at the same time. The serviceable crossing sleepers released shall be plugged and used again as spot renewals in other turnouts.

All switches and crossings removed from the track shall be returned to the Permanent Way Depot, where they will be broken down and the usable items reclaimed.

14.69 **Permanent Way Imprest.**— The imprest stock is primarily provided for the replacement of material damaged in accidents. Items may also be drawn to effect urgent renewals, and in such a case a requisition shall immediately be submitted to recoup the items used.

Ordinarily, material required to replace wear and tear should be planned and obtained in good time.

14.70 **Annual Overhaul of Turnouts.**— The calendar for Programme Track Maintenance shown in ANNEXURE 29 lays down a period for the specific overhaul of turnouts, at a time when other works are in abeyance due to wet weather. This work particularly applies to the turnouts in running lines and the Engineer must see to it that such overhauling is carried out.

SECTION 15

LONG WELDED RAILS

15.01 Fahrenheit and Centigrade Temperatures.— In the instructions that follow the temperatures referred to are in degrees Fahrenheit. Descriptions in the technical press are, however, frequently expressed in degrees Centigrade. The conversion formulae are:—

$$F^\circ = \frac{C^\circ \times 9}{5} + 32$$

$$C^\circ = \frac{(F^\circ - 32) \times 5}{9}$$

15.02 Rail Temperatures.— In order to find the **neutral temperature range** for fastening down continuously welded rail, so as to ensure nearly equal tensile and compressive stresses in the rails under temperature changes, it is necessary to know the extremes of temperatures for the region where rail welding is done.

TABLE 15.02A has been compiled from the records of **air temperatures** supplied by the Meteorological Department for various regions in East Africa.

The corresponding maximum and minimum **rail temperatures** have been computed from the following formulae used by the South African Railways.

$$Y = 1.64X - 34.8$$

where Y = rail temperature in degrees F; and
X = air temperature in degrees F.

In all rail welding work rail temperatures and **not** air temperatures must be used, the former being ascertained by means of the rail thermometers described in Clause 15.09.

15.03 Expansion and Contraction in Rails.— To understand the behaviour of long welded rail it is desirable to appreciate the extent of restraint imposed on rail movement under temperature changes.

For rail that is free to move without the restraint imposed by sleeper fastenings, the change in one foot of length for every degree Fahrenheit of temperature change is .0008 inches.

The following are typical values of such free movement:—

Rail Length	*Movement for 10°F*
40 feet	1/32 inch
100 „	3/32 „
300 „	1/4 „
Quarter mile	1 1/16 inches
Half mile	2 1/8 „

For any other number of degrees the movement will be proportionate to the values given or may be calculated from the coefficient of expansion and contraction given above.

15.04 **Essential Requirements for Long Welded Rails.**— The grip of the sleeper fastenings, the sleeper density, and the provision of stone ballast to full section, must provide sufficient restraint to equal the expanding or contracting force in the rail under the extremes of temperature change.

Given these conditions, longitudinal movements due to temperature are confined to the end 300 feet or so of a welded length i.e. the remainder of the welded length neither expands nor contracts with temperature changes.

The thermal forces set up in the welded rail due to changes in temperature are taken up as stress in the rail, and to keep this stress within safe limits, it is essential to fasten down the rail at about the mean temperature of the rail for summer and winter.

To guard against the track buckling the design of the sleeper and fastenings shall afford high lateral strength and rigidity as a frame, and the ballast width outside the sleeper ends must be adequate.

The welded rails being under stress, track maintenance operations such as removing ballast and sleepers, releasing fastenings, lifting and slueing the track must be very carefully controlled and may only be carried out within or near to the **neutral temperature range** for fastening down the rails, pertaining to the region of the country in which the work is carried out. See TABLE 15.02A.

As the force in a given type of rail varies only with the change in temperature measured from the unstressed condition, and is not affected by the length of the rail, there is theoretically no limit to the length of rail that can be welded.

15.05 **Types of Welded Track.**— The types of welding adopted on this railway are the Thermit full-fusion process and the Flash-Butt electric resistance weld, the former being made in the track and the latter in a depot.

Where Thermit welding alone is carried out the length of welded rail has been 200 feet (5 x 40 ft. rails).

With Flash-Butt welding it is intended to lay continuous welded rail in panel lengths of about half a mile, made up of such "strings" of 40 ft. rails as can conveniently be butt welded at a depot and transported to the work site where they will be joined up with Thermit welds to form the complete long welded panel.

15.06 **Rail Joint Support.**— The Thermit weld is relatively weak in bending and care must be taken during site welding not to disturb the joint sleepers, which must be kept well packed.

The Flash-Butt weld is nearly as strong as ordinary rail and it is not essential to reduce sleeper spacings at the joints as is necessary in conventional fishplated track.

15.07 **Allowance for Expansion at the ends of Welded Panels.**— With short welded lengths of 200 feet or so, the open joints will be made with ordinary fishplates and expansion gaps of $\frac{1}{4}$ inch shall be provided at each joint.

With long welded rails an expansion joint will be provided at each end of the welded panel.

Although, theoretically, there is no limit to the length of continuous rail which may be laid, the insertion of an expansion joint at intervals is a safeguard against excessive longitudinal movement of the rails due to error in the fastening down temperature and looseness of the sleeper fastenings, and enables de-stressing of the rails to be localised.

In both short welded and long welded track it is essential to fasten down the rails within the neutral temperature range given in the last column of TABLE 15.02A for the region of the country in which the work is carried out.

The location of all expansion joints will be decided by the Chief Engineer who will take into account curves, bridges, level crossings, and turnouts within the section of line being welded.

15.08 **Setting the Gap in the Expansion Joint.**— The right hand and left hand side joints in the track shall be laid simultaneously, and only after the welded panels on each side of the joints have been fastened down at the neutral temperature range, when the expansion gaps will be at the normal dimension. If, at the time of installing the joints, it is found that the rail temperature has either fallen or risen outside the **mean** of the neutral temperature range given in TABLE 15.02A, an allowance of $\frac{1}{8}$ inch shall be added or subtracted from the designed normal gap in the joint for every 10°F change in rail temperature i.e. an increase in the gap for a fall in temperature and a decrease for a rise.

The allowance of $\frac{1}{8}$ inch per 10°F is adequate for rail movements in both panels of the welded track.

15.09 **Rail Thermometers.**— Rail thermometers are of two types. One has a dial set by the maker into the face of a short piece of rail about 9″ long. This type, because of its weight and dimensions, is only suited for use at the site of rail welding, where it should be placed exposed to the sun on a steel sleeper in the track, for the whole period of the day's work.

The other type consists of a mercury thermometer tube set in a copper plate, and is easily carried about by the Inspector in the wooden box provided with it. To obtain the rail temperature, place the thermometer on the head of the rail covering it with the box. The thermometer should be in contact with the rail for at least 5 minutes before the temperature is read. Do not record rail temperatures where rail webs are covered by excessive ballast as at level crossings.

One thermometer of this type shall be carried on inspections by each

Permanent Way Inspector and Sub-Inspector in whose sections welded track is laid.

15.10 Recording the behaviour of Welded Track.— In order to obtain further experience of welded track with the types of sleepers and fastenings and under the temperature and maintenance conditions on this railway, Engineers and Inspectors must keep such track under close observation and shall bring to the notice of the Chief Engineer any matter which they consider affects the design of the track components, and the installation and maintenance instructions laid down herein.

The following information shall be recorded in registers for reference:—

During installation: —

(a) amount of work done each day;

(b) state of the weather;

(c) temperature at which the rails in each panel were laid;

(d) temperature at which the rails in each panel were fastened down;

(e) the amount of the gap provided in each pair of expansion joints and the temperature of the rail at the time of their installation.

During maintenance; by the Permanent Way Inspector: —

(f) gap measurements and rail temperatures at frequent intervals during routine line inspections in order to obtain representative rail movements over all changes in temperatures;

(g) date, mileage, rail temperatures, movement of the rails at the expansion joints in extent and direction at the time a panel may be destressed in accordance with Clause 15.16;

(h) all incidents such as deformation of the track alignment and breakage of components and rails, and the rail temperatures at the time;

(i) details of out-of-course replacement of sleepers and ballast, lifting and slueing.

15.11 Welded Rails on Curves.— The experience of railways varies. On the South African Railways long welded rail may only be laid on curves not exceeding 3 degrees sharpness, whereas welded rail has been laid without expansion joints in track having curves as sharp as $8\frac{3}{4}$ degrees in the Congo and $14\frac{1}{2}$ degrees in French West Africa.

The limit of curve sharpness depends on the type of sleeper used and will vary with the range of rail temperature in the region in which the work is carried out; see TABLE 15.02A.

Where expansion joints are used these will not be located within sharp curves, the welded rail being carried throughout the curve instead.

The decision in these matters will rest with the Chief Engineer who will plan all long welded rail programmes.

15.12 **Level Crossings.**— As a general rule welded rail will be laid through the level crossings to avoid open joints occurring within them.

15.13 **Bridges.**— Where the track is stone ballasted on bridges, welded rail will be laid in the normal manner across the bridge except that expansion joints will not be located on a bridge.

On girder bridges where the sleepers are fixed to the steelwork the question of expansion will be examined in relation to the length of span, number of spans, the location of the fixed and free ends of the girders, and the type of sleeper fastenings to the rail.

15.14 **Preparation of Track ahead of and behind Welding.**—

Curves.— Every curve shall be string lined, beaconed, slued to final alignment, and the sleepers solidly packed. This work must be completed well in advance of the welding.

Ballast.— The minimum ballast widths shall be those shown in ANNEXURE 12, with the addition stated therein for welded track. Existing ballast in excess of the minimum may be removed to make up deficiencies elsewhere or left in place if not required for this purpose. Where an excess exists on curved track it should be placed on the outer side for increased lateral strength.

This preparation work must be completed before the welding reaches the site.

Lining and Levelling.— Since the length of the rail is virtually unalterable after welding, and slueing and lifting must later be confined within very small limits because of stresses in the welded track, it is essential that all slacks in levels and faulty alignment must be removed before the welding is done. This shall be attended to again immediately in front of the welding work.

Packing and Boxing.— Hanging sleepers and insufficient filling of the spaces between and outside the ends of the sleepers with ballast must be corrected immediately in front of the welding work, and again attended to behind the welding, in order to provide the necessary restraint in the rails.

Repacking Welded Joints.— At Thermit welded joints the 3 sleepers on each side of the joint must be solidly packed immediately the weld has been made, and these joints shall be kept well packed at all times.

Cess Repairs.— The cess must be made up to the dimensions shown in ANNEXURE 12, and where the cess is already high it must be cut down.

15.15 **Installation Temperature for Welded Track.**— To ensure that the tension and compression stresses, which will be induced in the welded rails through summer and winter temperature changes, are kept within safe limits as explained in Clause 15.04, welded track must be finally fastened down only

when the rail temperature is within the **neutral range** shown in the last column of TABLE 15.02A for the region concerned.

Since the consequences of buckling of the track are more serious than those of contraction of the rails, the **neutral temperature range** is fixed a little higher than the **mean** of the rail temperatures for summer and winter.

In the work of Thermit welding of short lengths of 200 feet, fastening down at neutral temperature can generally be done the same day at a suitable time when the rails have attained the desired temperature. The work is facilitated also by the use of short closure rails.

In long welded track the rails may be laid at any temperature, **but the fastening down must be done within the neutral temperature range, and both side rails must be fastened simultaneously.**

The laying of welded rails must be supervised by a competent Engineering official.

15.16 **De-stressing Welded Rail.**— De-stressing is the term used for releasing the sleeper fastenings and freeing the rails. It may require to be done to:—

(a) fasten down at neutral temperature rails which had been laid outside this range either deliberately or through error;

(b) to cut in expansion joints in track which had been laid with temporary closure rails at such locations;

(c) adjust rail creep due to loose sleeper fastenings;

(d) correct distortion in track alignment and top levels;

(e) restore track upset by an accident or any other cause.

De-stressing must only be done within the **working temperature range** mentioned in Clause 15.17 viz within $\pm$ 10°F of the **average** of the neutral temperature range for the region concerned, and the work must be supervised by a responsible Engineering official.

The work may be carried out under a speed restriction when trains may be passed slowly over the track with the fastenings of every third sleeper screwed down to a reasonable extent but not so tightly as to prevent rail movement, which is to be encouraged during the operation.

Commence at the extreme free ends of the welded panel (after removing any temporary closure rails if such exist) slackening off the bolts and lifting the clips and rail to encourage the rail to move, and continue the work to the mid-point in the panel where rail stress is **nil.** Then work back again from here over this half of the panel to the extreme free end, easing the clips and rail again ahead and screwing down tightly behind the fastenings of every sleeper as the work proceeds. On reaching the extreme free end repeat the operation over the other half of the welded panel.

The rails on both sides of the track must be so dealt with simultaneously.

8 men using 4 box spanners can accomplish the unscrewing and screwing of the sleeper bolts over ½ mile of track in 2½ hours.

If, because of a fall or rise in temperature, it is not possible to complete de-stressing of the entire welded panel in the one day, one half panel must be completed. The remaining half panel can be done the following day. It should be possible, with sufficient labour, to complete an entire panel within the period at which the temperature is correct.

See Clause 15.08 concerning setting the gaps in the expansion joints.

15.17 **Special Work on Welded Track.**— No work outside normal day to day maintenance shall be carried out without the approval of the Engineer. Such exceptional works are de-stressing the rails, heavy lifting and slueing, skeletonising the track, replacements of rails and sleepers, and the lubrication of clip bolts.

15.18 **Maintenance Works on Welded Track.**— Section Gangers must be carefully instructed regarding the precautions to be taken in day to day maintenance of the track, and the necessity for any unusual conditions arising to be brought to the notice of the Inspectors promptly.

The **working temperature range** within which certain types of work may be done on welded track is 10°F below or above the **average** of the neutral temperatures stated in the last column of TABLE 15.02A. Thus in an area having a neutral range of 90 to 100° the working temperature range will be from 85° to 105°F on the rail.

Packing.— With beater or shovel packing not more than 6 adjoining cribs should be opened out at any one time for packing purposes, leaving the adjoining 6 on either side pending consolidation of the disturbed ballast; proceeding to the third set of 6 and so on. The ballast must be replaced immediately after the packing.

Where mechanical tamping is done this restriction will not apply as the ballast is not removed from the cribs. The disturbed ballast must however be boxed up to full section immediately behind the machine.

Lining.— The extent of the slue must be confined to simple fine lining up. Lateral movement over ¼" could appreciably reduce the resistance of the track to buckling.

Ballast Cleaning.— Only 3 consecutive cribs should be dealt with at any one time and a minimum distance of 40 feet should separate each such location.

The cribs should be cleaned in one operation and the ballast put back, and then the shoulders cleaned; both should not be disturbed at one time.

Where it is expected that the minimum ballast cross section will be reduced by the cleaning, additional make-up ballast must be put down in advance of the operation.

Replacement of Sleepers.— One sleeper only per 40 feet length should be changed at a time and the ballast well consolidated before disturbing any other sleeper in the length. Care shall be taken to repack all such sleepers after the passage of traffic.

Lubrication of Expansion Joints.— The expansion joints referred to in Clause 15.07 must be clean at all times, and kept under observation to see that there is no hindrance to rail movement.

At the beginning of each summer, and at any other time if necessary, the brackets shall be removed, and the two rail ends lifted slightly and moved apart about ½ inch, by removing the clips on a minimum number of sleepers on each side of the joint. After clearing away the dirt, only the contact surfaces of the base plate, rail ends and brackets will be lubricated with the graphite and grease mixture mentioned in Section 13.19.

This work must be supervised by the Sub-Permanent Way Inspector who will see that the components are replaced correctly and that the running faces of the rails are properly lined up.

Lubrication of Fishplates.— The fishplates at open joints at the ends of the 200 feet panels in Thermit welded track will be lubricated as laid down in Section 13.19 for conventional fishplated track.

Lubrication of Clip Bolts.— Clip bolts in welded track **will not be lubricated** in the manner laid down in Section 13.20 for conventional jointed track. Should the need for lubrication arise the District Engineer must issue special instructions to the Inspector on the manner in which the work should be done and the supervision required.

The anchoring of welded rails to the sleepers is of primary importance and the fastenings must not be allowed to slacken.

Grease flowing down from the lubrication of the high rail on curves must be regularly cleared from the rail foot and clips.

15.19 **Working Hours on Welded Track.**— In summer the maintenance gangs should commence work earlier than usual to take advantage of the lower temperatures in the early hours of the morning.

15.20 **Buckling.**— Provided the rails have been fastened down at the correct temperature as laid down in Clause 15.04, the sleeper fastenings are kept tight, the ballast cross section is to the full width and topped up, and the maintenance instructions in Clause 15.18 are strictly observed, there should be no fear of the track buckling.

Inspectors shall keep a sharp look-out for kinks in the alignment in hot weather, and Gangers must be instructed that should they observe this fault, trains should not be allowed to pass or passed at slow speed on hand signals, as the seriousness of the condition of the track warrants, and information should be sent immediately to the nearest Station Master with a request to

pass it on to the Inspector.

Should a buckle occur, the track shall be slued outwards with easy curvature to increase the welded length and so relieve the expansion stress in the rail; and a speed restriction over the defective length shall be imposed.

Arrangements must then be made to de-stress and adjust the rails as laid down in Clause 15.16.

15.21 **Broken or Defective Rails.**— In addition to the normal daily patrol by the Keyman, he will closely examine the welds over $\frac{1}{4}$ mile of track (33 welds on each side rail) each day in a continuous length, repeating the examination on the completion of the section length.

On observing a fracture at a weld, he will, if the condition of the rail permits, put on without delay the special fishplates supplied to each gang for this purpose, and inform the Ganger who must report the incident to the Inspector through the nearest Station Master.

Traffic will be passed at restricted speed and the joint should be kept under continuous observation until a closure is inserted.

A piece of rail on each side of the break must be cut out and a closure rail put in, drilled, and fastened with fishplates. The rails are to be saw cut midway between sleepers to give a closure a little less than 20 feet (cut from a 40 ft. standard rail). The closure rail should be laid in the track as near the neutral range temperature as is attainable, and its length should be such as to leave little or no gaps at the two joints.

As opportunity offers the joints will be Thermit welded.

15.22 **Action at the Site of a Derailment.**— The track will be restored with standard length rails and fishplated joints, leaving little or no gaps at the joints. As soon as possible after restoration of the track for traffic, the length will be de-stressed and fastened at neutral range temperature as laid down in Clause 15.16 closing up all joint gaps.

As opportunity offers the joints will be Thermit welded.

15.23 **Rail Anchors.**— It may become necessary to install rail anchors on each side of expansion joints and even over the entire welded panel in the event of the sleeper fastenings loosening with age.

Anchors may also have to be fitted to the rails on girder bridges if the sleeper fastenings are of a type which does not provide sufficient anchorage to the rail.

Where rail anchors are required they shall be fitted on both sides of the sleepers to prevent movement of the rail in both directions.

Rail anchors may only be used in welded track with the consent of the Chief Engineer.

TABLE 15.02A

AIR AND RAIL TEMPERATURES AT VARIOUS STATIONS

The temperatures given are in degree Fahrenheit (F°). For conversion to degrees Centigrade use the formula in Section 15.01.

KENYA AND UGANDA

Station	Altitude above Mean Sea Level (Feet)	AIR TEMPERATURE		EQUIVALENT RAIL TEMPERATURE		Mean Rail Temper-ature	NEUTRAL TEMPER-ATURE RANGE
		Absolute max:	Absolute min:	Max:	Min:		
MAIN LINE							
Mombasa	59	96	66	122	74	98	100-110
Voi	1834	99	53	128	53	91	95-105
Makindu	3278	97	48	124	45	85	90-100
Nairobi	5453	91	39	114	30	72	75-85
Limuru	7349	90	35	113	23	68	,, ,,
Naivasha	6233	91	35	114	23	69	,, ,,
Nakuru	6073	93	36	118	25	72	,, ,,
Eldoret	6878	87	37	108	27	68	,, ,,
Tororo	3868	97	52	124	51	88	90-100
Jinja	3869	95	55	121	56	89	,, ,,
Kampala	3789	92	52	116	51	84	,, ,,
Kasese	3153	100	58	129	61	95	95-105
NANYUKI BRANCH							
Nairobi	5453	91	39	114	30	72	75-85
Thika	4897	92	40	116	31	74	,, ,,
Fort Hall	3952	101	40	130	31	81	90-100
Nyeri	5747	81	37	98	27	63	70-80
Nanyuki	6389	87	33	108	20	64	,, ,,
KISUMU BRANCH							
Nakuru	6073	93	36	118	25	72	75-85
Molo	8065	85	33	105	20	63	70-80
Londiani	7533	93	38	118	28	73	75-85
Lumbwa	6339	91	39	114	30	72	,, ,,
Kisumu	3759	96	53	122	53	88	90-100

TABLE 15.02A — continued.

TANGANYIKA

Station	Altitude above Mean Sea Level (Feet)	AIR TEMPERATURE		EQUIVALENT RAIL TEMPERATURE		Mean Rail Temperature	NEUTRAL TEMPERATURE RANGE
		Absolute max:	Absolute min:	Max:	Min:		
TANGA LINE							
Tanga	69	94	64	119	70	95	95-105
Mombo	1355	96	62	122	67	95	,, ,,
Same	2815	97	55	124	56	90	90-100
Moshi	2661	100	48	129	45	87	,, ,,
Arusha	4534	88	47	110	43	77	80-90
MAIN CENTRAL LINE							
Dar-es-Salaam	43	94	59	119	62	91	90-100
Morogoro	1634	94	53	119	53	86	,, ,,
Kilosa	1611	97	53	124	53	89	,, ,,
Dodoma	3717	97	48	124	45	85	,, ,,
Tabora	3930	96	50	122	47	85	,, ,,
Kigoma	2539	97	53	124	53	89	,, ,,
MWANZA LINE							
Tabora	3930	96	50	122	47	85	90-100
Shinyanga	3668	94	54	119	54	87	,, ,,
Mwanza	3724	95	53	121	53	87	,, ,,

SECTION 16

TRACK SIGNS, PROTECTION OF TRACK AND TROLLEYS

16.01 Only track signs of the patterns and in the colours shown in ANNEXURES 39 and 39A shall be used.

16.02 **Mile, Half Furlong and Kilometre Posts.**— These may be made from stone, concrete, unserviceable steel sleepers or plates fixed to scrap steel posts.

The mile, kilometre and half kilometre posts shall have two faces to show in both the Up and Down directions of traffic.

Between the kilometre posts on the Central Line the telegraph poles shall be numbered, each pole showing the full kilometre in addition to its own number.

Half furlong posts shall show the full mile in addition to the half furlong number.

Marking shall be black numerals on a white background, the kilometre or mile being placed above the pole number or half furlong number.

Half furlong posts and the marking on poles shall be arranged so that alternate ones face in opposite directions, to enable them to be read from both Up and Down trains.

Mile and half furlong posts shall be placed on the **left** side of the track when facing the UP direction.

Kilometre posts shall be placed on the same side of the track as the telegraph poles.

16.03 **Gradient Posts.**— A gradient post should be erected at each point where the gradient in the line changes. In many parts of the railway system in Tanganyika these do not exist but will be provided as opportunity offers.

Where the gradient changes are many and in close proximity to each other, as particularly occurs in difficult terrain, a post may be provided only where one of the gradients is 1.00 per cent (1 in 100) or steeper.

Where the gradient is reduced for a curve because of compensation it is not necessary to provide gradient posts at the change points.

For the information of the drivers and for fixing load tables, gradient posts must be put in to mark the commencement of long climbs and the summit, and all stretches at the ruling gradient laid down for the section of the railway.

Gradient posts must be placed at right angles to the track so that the grade is readily visible to the approaching train crew. In the case of posts having the marking on a single face there will be a post **on each side** of the track to face the driver on the right hand side of the line. Posts having the marking

on both faces shall be placed on the **right** side of the track when facing the UP direction.

16.04 **Maintenance Sections.**— The boundaries between permanent way sections, sub-sections, and gang lengths shall be marked by simple boards showing designations and gang numbers.

16.05 **Standard Dimensions affecting Track Signs.**— See Clause 8.18.

16.06 **Track Signs to be clearly visible.**— Vegetation around and in front of all track signs shall be kept permanently cut so that the signs can be readily seen by engine drivers and inspecting officers.

The signs shall be maintained in good order and be clearly legible at all times.

16.07 **Location of Permanent Speed Restriction Boards for Sharp Curves.**— The combined permanent speed and "OFF" board shall be of the triangular type shown in ANNEXURE 39.

The speed restriction board shall be located at the following **minimum** distances from the tangent point of the curve.

1900 feet — in sections where station loops are 1900 feet long.

1600 feet — in all other sections of the railway.

The speed board shall be on the driver's side of the track and so located as to be clearly visible from the footplate of a locomotive for a reasonable distance before it is encountered.

The board should not be sited in a cutting on a sharp curve but should be placed a further distance out to obtain clear visibility.

Where two or more sharp curves are very near to each other, say not more than $\frac{1}{4}$ mile apart, the question of using a single set of boards to cover the entire curved section shall be considered. In this event the speed for the sharpest curve shall be exhibited.

Where the commencement of a sharp curve is less than the required distance from the outermost turnout of a station, the board relating to trains leaving the station should be placed at the turnout.

16.08 **Location of Permanent Speed Restriction Boards for Weak Bridges.**— The instructions of Clause 16.07 shall apply with regard to the distances of the boards from each end of the bridge.

Where the restriction is required to be observed by all classes of locomotives, the triangular board shown in ANNEXURE 39 shall be used.

If the restriction applies only to one or more particular classes of locomotives, a rectangular board painted yellow shall be provided showing the speed in large black numerals and the classes of locomotives in smaller

numerals and letters also in black.

16.09 **Location of Whistle Boards at Level Crossings.**— See Clause 7.10.

16.10 **Temporary Speed Restrictions.**— Where a speed restriction is required to be imposed it shall be a multiple of 5 miles per hour viz. 5, 10, 15 etc., as the nature of the work or state of the track requires.

Where a DEAD STOP is required to be imposed at a works site, the instructions of Clause 16.23 (E) shall be carried out.

A speed restriction must not be retained for longer than is absolutely necessary and the length of track over which it is operative must be kept at a minimum.

Heavy track operations must be adequately supervised and carried out on the minimum length of track at one time.

When a speed restriction is imposed by a Permanent Way Inspector the necessity for it shall be investigated by the District Engineer without delay.

16.11 **Publication of Speed Restrictions.**— Restrictions of a permanent nature, as for sharp curves and weak bridges, are included in the Working Time Table.

Temporary and semi-permanent speed restrictions must be published in the weekly Traffic Notice for the information of all concerned, and, when the restriction can be foreseen, ample notice shall be given by the District Engineer to the Operating Department to enable it to be published in good time.

The imposition of a speed restriction without previous publication in the weekly Traffic Notice is only permitted in the case of an emergency.

16.12 **Closing a Line to Traffic in an Emergency.**— Any member of the Railway staff may advise a Station Master to close a block section to traffic should he observe an occurrence which, in his opinion, will affect the safety of trains. The Station Master will then advise the Permanent Way Inspector, Sub-Permanent Way Inspector, or Ganger who must inspect the site without delay and deal with the situation.

16.13 **Operations performed by Inspectors of Works.**— No work affecting the safety of the track, its components, and its support, should be commenced without the approval and co-operation of the Permanent Way Inspector of the section.

In special circumstances the following officials are authorised to impose speed restrictions and issue warning notices (not to be confused with the Warning Orders used by Station Masters to give instructions or information to train crews).

Inspector of Works (Bridges) — for a defect in a bridge found during inspection vide Clause 3.14; strengthening girders; jacking up girders etc.

Inspector of Works —for structural repairs to bridges and tunnels; girder painting.

The Permanent Way Inspector must be consulted and his assistance obtained, and where the nature of the work requires the line to be protected, it shall be the Permanent Way Inspector's responsibility to display the necessary signals.

16.14 **Officials to be advised in Warning Notice.—**

(a) Station Master of the station on each side of the restriction;

(b) Head Train Controller;

(c) Permanent Way Inspector (when issued other than by himself);

(d) District Engineer;

(e) District Traffic Superintendent.

16.15 **Restrictions of Speed on Momentum Grades.—** When work which will necessitate slowing down the speed of trains has to be undertaken on a Momentum Grade, it is essential that the undermentioned officials of the Operating Department be advised, **with as much advance notice as possible,** in order to enable them to arrange for the service to be operated with reduced train loads:—

(a) Station Master on each side of the restriction;

(b) Depot Station Masters on each side of the restriction;

(c) District Traffic Superintendent;

(d) Head Train Controller;

(e) District Engineer.

The information required to be given is:—

(f) the extent of the mileage where the restriction is located;

(g) the actual grade of the Momentum concerned;

(h) the time and date from which the restriction will be imposed;

(i) the date on which the restriction will be lifted.

16.16 **Verbal instructions of a Restriction not to be given.—** The issue of instructions to a Station Master (or to a Driver in an emergency) shall only be given in writing, and the signature of the party shall be obtained in acknowledgment.

A memo shall be issued and the track protected by signals as soon as possible thereafter.

16.17 **Information to be given in a Warning Notice.—** The telegraphic notice imposing a speed restriction shall state the following **in the sequence here given:—**

(a) the speed in miles per hour required to be observed;

(b) the limits of the length over which the restriction will apply;

(c) the mileages where the outermost warning signals will be located;

(d) the nature of the engineering operation or obstruction.

On completion of the operation or repair, a telegram cancelling the original warning notice shall be issued.

For progressive works such as pulling back or relaying, the original mileages shall be corrected for each day's work.

Note.—The message may be issued using code from the Telegraph Message Code Book, provided the information given above is clearly indicated.

16.18 **Track and other Work in a Tunnel.**— Because it is difficult to ensure that the protecting signals are clearly visible to a driver, and because of the danger to the train crew from fouled air inside a tunnel, no work requiring to be done under the protection of signals shall be undertaken inside or in the immediate vicinity of a tunnel unless complete occupation of the line is obtained i.e. the section is blocked to traffic.

16.19 **Earth Moving Plant used in the vicinity of the Track.**— Earth moving plant shall not be operated in the vicinity of a track without prior information being given to the Permanent Way Inspector.

Where the safety of the track or trains is likely to be affected by the operation of such plant, the Permanent Way Inspector shall advise the Station Master on each side to issue warning orders to the drivers of trains and shall arrange to protect the site with the signals shown in ANNEXURE 43.

Such plant may only be operated in the vicinity of the track during the hours of daylight and when visibility is good.

Where the plant is required to pass from one side of the track to the other, wood decking or rammed earth (up to the bottom of the rail head) shall be laid over the sleeper length to avoid damage to the permanent way.

See Clause 7.14 for the precautions to be taken when a vehicle with caterpillar tracks uses a Level Crossing.

16.20 **Gang Boards.**— The General Rules require that a "G" board of the pattern shown in ANNEXURE 39A shall be displayed not less than 440 yards (four half furlong posts) on each side of the site where a section gang is working **on the track.**

The existence of the board only requires a driver to whistle in order to warn the men of the approach of the train but not to reduce the speed of the train.

Gangers must be clearly instructed that the display of "G" boards does not authorise them to do any work affecting the safety of trains, such as lifting, lowering, slueing etc. **in excess of correcting "slacks" in the track in the course of ordinary maintenance.**

In an emergency the Ganger shall protect the track in the manner laid down in Clause 16.23(A). See Clause 13.02 also.

16.21 **Temporary Warning Boards.**— Each Permanent Way Inspector and Sub-Permanent Way Inspector (not at the section headquarters) shall hold ready

for use one complete set (for two sides of Single Line) of the Caution and "C" and "E" boards shown in ANNEXURES 39A and 42.

The Caution Boards shall be provided with means for padlocking the lamp which shall be specially adapted and reserved for use with it. A set of 5, 10, 15 and 20 numeral plates should also be held.

Note. Where the Caution Boards are faced with yellow reflecting material approved by the Chief Engineer the white light need not be displayed on the board.

16.22 **Hand Signals, Detonators, and Gang Equipment.**— The following General Rules apply to permanent way staff:—

Hand Signals (for use by day and by night — GR.88(a); (b) and (e).

Detonators — GR.91 to 96.

Gang Equipment — GR.408 (xi)

The Permanent Way Inspector shall regularly inspect the flags, detonators, and lamps in the custody of Keymen, Gangers, and Sub-Permanent Way Inspectors. The lamps shall be clean and filled with oil, and all equipment stored ready for immediate use.

16.23 **Protection of Track Works affecting the Safety of Trains.**— The instructions that follow are given in order to simplify and clarify, with the aid of diagrams, the separate General Rules dealing with protection of the track.

See General Rule 412 and Clauses 13.02 and 16.13 of this Manual concerning the persons authorised to carry out work affecting the safety of trains.

A Passed Ganger may carry out the duties of a Sub-Permanent Way Inspector when he is expressly authorised to do so by the District Engineer, who shall satisfy himself that the Passed Ganger is conversant with the regulations concerning the protection of track works.

Except in an emergency, no work affecting the safety of trains shall be undertaken until:—

(a) due notice has been given in writing to the Station Masters in accordance with Clause 16.17 to enable them to issue warning orders to trains;

(b) a full complement of the signals required by General Rules is provided;

(c) suitable men are employed to display the signals, who shall be carefully instructed by the supervisor in their duties and responsibilities.

(A) ACTION IN AN EMERGENCY — GENERAL RULES 285; 288 AND 295.

In the event of a situation arising suddenly, such as a broken rail, buckled track, land slip etc., the Ganger (or other track employee) detecting the incident shall immediately protect the site in the manner shown in DIAGRAM I of ANNEXURE 40.

As soon after as possible, when two men and the equipment are available, full protection shall be provided in the manner shown in DIAGRAM II of ANNEXURE 40.

In both circumstances, attention shall first be given to the side from which a train is expected, or the side having a sharp approach curve or a grade falling to the obstruction.

Verbal or written information should be sent to one or other of the adjacent stations through a messenger or through the train crew, describing the nature of the obstruction, the mileage, and the designation of the person making the report.

Keymen, Gangers, and illiterate Sub-Permanent Way Inspectors shall be instructed by the Permanent Way Inspector in the proper manner of carrying out such protection in an emergency.

(B) LINE RENDERED UNSAFE AT AN ISOLATED ENGINEERING WORK — GENERAL RULES 415 AND 416.

These rules apply to **complete occupation** of the line, i.e. when the section between two stations is totally closed to traffic, occasioned by work of a nature that does not permit of the track being temporarily restored to pass a train e.g. renewal of a girder span, or changing bridge sleepers.

The signals to be provided by day or by night shall be those shown in DIAGRAM III of ANNEXURE 41.

It must be clearly understood that the prescribed signals must be displayed even though the section has been blocked by a message issued in writing. They are an additional safeguard against a train being sent into the section through failure on the part of the station staff.

(C) TEMPORARY SPEED RESTRICTION CONTINUING OVER A PERIOD OF DAYS — GENERAL RULE 417.

This rule covers circumstances where a temporary speed restriction is imposed which is expected to last through the night or for an extended period, such as at the sites of derailments, washaways, relayings, stone ballasting, and deteriorated track.

The site shall be protected with the Temporary Warning Boards shown in ANNEXURE 39A and in the manner shown in DIAGRAM IV of ANNEXURE 42, the numerals on the Caution Board being the speed required to be observed.

Note. When the Caution Board is faced with yellow reflecting material vide Clause 16.21, a white light need not be exhibited.

(D) LINE RENDERED TEMPORARILY UNSAFE DURING ENGINEERING WORK — GENERAL RULE 423.

This rule applies to work which is of a nature permitting a train to be passed during the course of the work **and which can be completed in daylight.**

Examples of such work are changing rails on a curve, lubricating fishplates, and slueing a curve after string lining.

It is essential for a man to be present at each of the signal positions. It is also essential that two detonators be exploded at the outermost signal by each train **approaching the site of work** to provide both visible hand and audible signals to the driver.

The signalman must be instructed to stand on the right hand or driver's side of the track and at a safe distance from the detonators. They shall keep a sharp lookout and signal back to the site of work when a train is observed to be approaching, to enable the track to be speedily restored.

When the outermost signalman is not visible from the site of work, an intermediate link man should be stationed (without detonators or flags) to pass on the warning to the site of the approach of a train. This may be done by moving both arms up and down in the manner illustrated in G.R.88 (b).

The train is authorised to approach up to the banner flag and to halt short of it if the track has not yet been restored. Should the supervisor at the site of work signal, before the train arrives at the banner flag, that the track is ready, a "proceed" signal shall be given by the signalman attending the banner.

The running down of a banner flag by a train must be reported as an accident.

(E) DEAD STOP RESTRICTION.

There is no specific General Rule at present defining the action to be taken and signals to be shown when it is required to halt every train and then pass it at dead slow speed over a work site, such as at a bridge under construction.

In such circumstances the following precautions shall be taken on each side of the site, the boards being placed on the right hand or driver's side of the track.

(a) Provide a Caution Board **without speed numerals**, at the minimum distance of 880 yards from the site of work as shown in DIAGRAM IV of ANNEXURE 42.

The Caution Board must be suitably located and aligned in relation to the approaching curves and gradients, with the approval of a representative of the Mechanical Department.

(b) At a distance of $\frac{1}{4}$ mile (4 half furlongs) from the site of work provide the board shown in ANNEXURE 39 bearing the legend "STOP BOARD 400 YARDS AHEAD".

(c) At a distance of about 40 yards (3 or 4 rail lengths) from the site of work provide the Stop Board shown in ANNEXURE 39 having a red light and bearing the legend "STOP AND AWAIT HAND SIGNAL".

(d) Station a signalman at the Stop Board with instructions to show a RED light or flag **until the train stops.** He will then present a book to the driver who must endorse in it the time, train number and his signature. Only after this has been done will the signalman show a GREEN proceed signal to the driver.

This restriction shall be suitably described in the Weekly Traffic Notice in which it should be made clear that the speed over the work site is **4 miles per hour.**

16.24 **Flags.**— See Clause 13.05.

16.25 **Detonators.**— See G.Rs. 91 to 96 and Instruction No. 11 in Section III of the General Appendix to the Working Time Table and General Rules, concerning the supply, care, testing, placing etc. of detonators.

16.26 **Equipment to be carried on a Push Trolley.**— Each push trolley, when on the line, shall have the following equipment:—

Two Red Hand Flags (one on a standard at least six feet in height on the trolley).

One Green Hand Flag.

Twelve Detonators.

One Hand Signal Lamp, tricolour.
One Trolley Lamp (showing red to back and front).
} The lamps need only be carried when a journey is likely to be made in darkness or in fog.

Chain and Padlock.

Spanner, Clyburn (to fit the largest nut in use).

Hand Hammer, 1 lb.

Chisel, cold, flat.

Pin Punch.

File, flat 12 inch.

Pliers, 8".

Rule, boxwood 2 feet 4 fold.

Tape, metallic 50 feet.

Fishing Line, 100 feet.

Chalk.

Rail Gauge.
Straight Edge.
Cant Board.
Spirit Level.
} Or the combined Track and Cant Gauge.

Current Working Time Table..

Standard Dimensions.

Engineering Manual.

Other books such as General Rules can be consulted at any station or at the trolley holder's headquarters.

16.27 **Equipment to be carried on a Motor Trolley.**— The essential equipment which must be carried on a motor trolley is stated in G.R.~~433~~.359

16.28 **Persons authorised to use a Push Trolley and a Motor Trolley.**— No railway servant shall place a trolley on the line unless he has been licenced to use the specific type of trolley mentioned in the licence i.e. push trolley or a motor trolley or both.

Other than the licenced driver of a motor trolley, only an Engineer may, in normal circumstances, drive a motor trolley.

16.29 **Drivers of Motor Trolleys.**— A driver appointed to work a motor trolley must be licenced and also hold a certificate of competency to drive.

The licence, which shall be renewed each year, will be issued by the Chief Engineer, on the recommendation from a District Engineer stating that he has satisfied himself that the driver is conversant with the General Rules pertaining to the running of motor trolleys.

All corrections to such rules and the publication of new rules relating to the running of motor trolleys shall immediately be brought to the notice of the driver by the District Engineer under whose instructions he serves.

16.30 **Illiterate Supervising Staff using a Push Trolley.**— A Sub-Permanent Way Inspector, and a Passed Ganger deputed to carry out the duties of the former, who may be illiterate in English, shall not be licenced to use a push trolley until he has been certified by an Engineer as being conversant with the General Rules and the instructions contained in this Manual concerning the safe working and care of a push trolley.

16.31 **Responsibility for Observing Rules.**— See G.R.~~432~~: 358

16.32 **Speed of Motor Trolleys.**— It should not be necessary to run a motor trolley at a speed exceeding 40 miles per hour at any time.

The driver shall reduce speed on approaching a level crossing and be prepared to stop to avoid collision with a road vehicle.

Sharp curves shall be negotiated at a safe speed, and particular care shall be taken when passing pedestrians, livestock and game animals, and in places where there is not a clear view.

16.33 **Maximum number of Persons to be carried on a Push Trolley.**— Not more than six persons shall be carried on a push trolley, including the trolleymen; and only railway servants may be so carried.

16.34 **Carriage of Persons not employed by the Administration.**— See G.R.~~316(b)~~ 256-(c) and G.R.~~430(c)~~. ~~254~~ GR-430(c)

16.35 **Delayed Halts on Line.**— When it is necessary for a trolley user to halt for any length of time on the line, the push trolley shall be removed from the track.

16.36 **Weight of a Push Trolley.**— A push trolley shall be manufactured in accordance with the type drawing and no alterations to the principal dimensions shown therein may be made which will have the effect of appreciably adding to the weight of the whole trolley.

The box used by the Inspectors for carrying equipment shall be as small and light as possible.

16.37 **Carriage of Heavy Material on a Push Trolley.**— When it is necessary to carry a heavy article, such as a rail into a section on a push trolley, it shall be run under the rules applicable to the working of a material trolley.

The practice of carrying a jimcrow on a push trolley as normal equipment is forbidden. It may be so carried only when required for a specific repair job.

16.38 **Care of Push Trolleys and Material Trolleys.**— The trolleys shall be kept clean and in good order. The wheels shall be regularly examined to see that they are a tight fit on the axles, and the axles shall be secured to the frame to prevent the wheels falling apart during removal of the trolley from the track.

All trolleys must be fitted with efficient hand brakes and immediate steps must be taken to repair a defect found in them. Particular care shall be taken to ensure that the brakes are effective during wet weather.

SECTION 17

ACCIDENTS AND WASHAWAYS

17.01 **General Instructions.**— Supervising staff of the Engineering Department shall make themselves fully conversant with the regulations contained in the following:—

General Appendix to the Working Time Table and General Rules	SECTIONS XIII AND XV.
Sectional Appendix to the Working Time Table and General Rule Book	SECTION XI.
Accident Instructions Parts III, IV and V.	For use in District and Headquarter Offices.

17.02 **Prompt Action to be taken when notified.**— When called upon, an Inspector must proceed without delay and by the quickest means to the place of an accident or obstruction.

He shall take with him such men and tools as he considers necessary, and shall arrange for additional labour to be sent to the site.

Where an accident has occurred on the section adjacent to his own and it is evident that the Permanent Way Inspector or Sub-Permanent Way Inspector of that section will be delayed in attending, the Inspector must proceed to the site to take initial action.

It is also the duty of an Inspector on special works, to attend and render all assistance with his labour when called upon to do so.

Engineers, Permanent Way Inspectors, and Sub-Permanent Way Inspectors shall make it a point of duty to inform the Station Master or other official in charge, at their headquarter station, of their absence from the station for any reason. The Inspectors should also advise the official of their movements on duty when leaving headquarters.

17.03 **Official in charge of an Accident.**— See G.R. 305; it is the senior official at the site who will take charge of the operations for dealing with an accident.

The staff of the Engineering Department shall work under the instructions of such official even though he may be a member of another department, and shall keep him informed in all matters such as the priority of repair operations, transfer of labour, resting of labour, and absence from the site.

17.04 **Diary of Events.**— The Engineer and Inspector should maintain a brief diary at the site of an accident noting the times of events and instructions received or given. Such a diary is of value in preparing the subsequent report and when giving evidence at an inquiry which may be held.

17.05 **Protection of the track at the site of an accident.**— It will generally devolve on the Engineering Department to provide adequate flag or lamp signals on each side of the site of an accident and to place suitable and properly instructed men to attend them.

This is especially necessary in the early stages when a Breakdown or other train may approach the site.

The official in charge of operations shall be kept advised of the precautions taken and any alterations made.

17.06 **Danger of Fire.**— Full instructions are contained in Instruction 494 of the General Appendix to the Working Time Table and General Rules, on the precautions to be taken when wagons containing petrol, kerosene, gas oil, or other highly inflammable fluids are derailed or damaged.

It is not generally appreciated that an empty petrol tank is more liable to explode than a full tank, and at an accident such tanks must also be approached with care.

The Permanent Way Inspector shall post guards to prevent anyone from smoking, using matches, exposing naked lights, using oil-burning hand lamps, and lighting fires in the vicinity of the derailed or damaged wagons. If police arrive they shall take over this duty.

The situation is particularly dangerous where petrol and aviation spirit vapour can be smelt, and where such fuels have been spread by running water.

The use of hammers, chisels, beaters, shovels, and anything made of steel shall be avoided until the site is free from the risk of fire.

Where wagons containing such dangerous commodities are concerned in an accident, the first duty of the Permanent Way Inspector shall be to collect the labour force and warn them of the precautions to be observed.

17.07 **Immediate Action at Site of Accident or Obstruction.**— The following is an indication of the order in which matters should normally be dealt with:—

(a) protect the track on either side as stated in Clause 17.05;

(b) take precautions against fire;

(c) ensure the safety of passengers;

(d) render first aid to any injured persons and, if required, arrange for immediate medical assistance;

(e) investigate and estimate the extent of damage to the permanent way and structures;

(f) in consultation with the senior official in charge and the representative of the Mechanical Department decide the quickest method of restoring communications;

(g) instruct staff at the section or district headquarters to despatch any additional material and labour which may be required;

(h) arrange, if necessary, to call forward a water tank wagon and covered wagons for the labour.

17.08 **Special Information for the Chief Engineer.**— The accident instructions contained in the General Appendix mentioned in Clause 17.01 require the senior official at the site to pass information to all concerned at Headquarters throughout the period of the blockage.

In serious accidents and washaways the Engineer will, as soon as possible after the occurrence, inform the Chief Engineer or other senior engineer at Headquarters by telephone, of the details as known at the time.

Where technical matters of a departmental nature arise, such as continuing movement in a bridge structure, behaviour of a river, and flood conditions, the Engineer will thereafter keep the Chief Engineer informed by telephone or other means, at frequent intervals.

17.09 **Breakdown Train.**— See SECTION 20 for the equipment to be carried in Breakdown Trains.

Where it is evident that the material carried on the train is insufficient or where a special item required is not held in the train, a request for such shall be made through the Control to the neighbouring District Engineer or the Chief Engineer.

17.10 **Power to enter upon Land not within the Railway Reserve.**— See Clause 4.04.

17.11 **Pilferage from Damaged Wagons.**— Until special arrangements are made to police the area, the Permanent Way Inspector should place a guard to prevent pilferage from the contents of damaged wagons, and warn his staff against such actions.

17.12 **Investigation into the Cause of the Accident.**— In cases of derailments where the cause is not obvious a careful examination of the surroundings should be made as early as possible and the position of any moveable piece of evidence noted.

The line should be searched for a distance of at least one mile in the direction from which the train was travelling for any piece of rolling stock mechanism which may have fallen off.

The locomotive and wagons should be examined in conjunction with the Mechanical Department for broken parts, difference in wheel gauge, sharp flanges, and excessive wear on the tyre showing a pronounced "false flange" on the outer side of the tyre rim.

In plain track the permanent way shall be accurately measured for track gauge, cross levels, alignment, loose packing causing depression of the sleepers under wheel load, and the condition of the rails, sleepers and fastenings.

In straight track it may be necessary to indicate bad alignment by offsets to a parallel straight base line set out with pegs and fishing line about 12 inches away from one of the existing rails.

Wheel marks and the disposition of derailed vehicles shall be recorded in a sketch, which, with the track particulars, shall be obtained without delay and before restoration of the track is commenced.

The purpose of the investigation must be to establish the true cause and so enable a repetition of the occurrence to be avoided where a fault in design or practice is involved.

17.13 **Temporary Diversion of the Line.**— Where the formation permits of it being done, a diversion is often the quickest means of restoring communications. When laying a diversion the following points should be observed:—

(a) The gradient should be as easy as possible and not exceeding 2.5 per cent (1 in 40).

(b) Curvature should not exceed 16 degrees or 350 feet radius vide Clause 9.03.

(c) A minimum of 30 feet of straight should be provided between reverse curves vide Clause 9.06.

(d) Full gauge widening must be provided in accordance with Table 11.05A.

(e) The cant should not exceed ½ inch and the cross levels should be kept under observation as the low rail will repeatedly sink in newly packed track on a soft formation.

(f) Where earth ballast is used during rain it should be provided with a cambered top as shown in ANNEXURE 13.

(g) Should the curvature and gradients be severe it will ease stress in the track and train resistance if the running faces of both the high and low rails are greased, care being taken not to apply the grease to the top surfaces of the rails.

(h) The horizontal clearances between the track and derailed vehicles and structures should be at the minimum of 6 ft. 9 ins. of the Interim Structure Gauge shown in DIAGRAM 8 of Standard Dimensions (1959) plus, where the track is curved, the additional clearance shown in Appendix 'B' therein.

17.14 **Variation of Track Gauge permitted in Damaged Sleepers.**— Clause 11.10 lays down the limits for retaining damaged sleepers in the existing main line until they can be removed for repair.

The limits for temporarily passing traffic at 10 miles per hour speed may be taken as:—

Straight Track and Curves up to 3°	— ½ inch Tight.
Curves over 3° to 8°	— ¼ inch Tight.
Curve over 8°	— Normal Gauge.

As much improvement in the gauge, as is possible by the adjustment of the sleeper fastenings, shall be obtained.

17.15 **Resting the Staff.**— Where the work of clearing the line is likely to be prolonged, the supervising staff and labour should be organised to work in shifts and additional staff should be called forward for this if necessary.

Staff who are resting should, where practicable, be accommodated in covered wagons, tents, or under tarpaulins.

17.16 **Food Supply.**— The General Appendix mentioned in Clause 17.01 shows the scale of rations that should be stored in breakdown vans.

The Permanent Way Inspector should organise the feeding of the staff, detailing a few men to prepare the meals. Drinking water should be served to the men, when necessary, at the place of their work.

17.17 **Accident Reports.**— The forms which will be used by the Engineering Department for reporting on accidents are:—

Form EAR.2056 — Accident Report Form (used by Permanent Way Inspectors.)

„ EAR.1201 — Accident Report Form (used by Operating and Signal staff.)

„ EAR.1203 — Level Crossing Accident Final Report.

The Permanent Way Inspector's form shall be used for all accidents which are not collisions at a level crossing between a train and a road vehicle, and are not incidents connected with signalling on interlocked sections of the line.

Full particulars shall be obtained and the accident report shall be submitted with as little delay as possible after the occurrence.

The Permanent Way Inspector's report has been designed to bring out all essential features and to cut down writing by the outdoor staff. Words and details not applicable should be crossed out, and answers and details, where relevant, written in the appropriate spaces.

In **all cases of derailment on a running line** the complete track particulars required in the form and a supporting plan showing derailed wheel marks on rails and sleepers, must be submitted.

Running lines are lines normally used for the passage of trains between stations and the reception and despatch of trains at stations, i.e. principal lines in yards will be included.

Where the cause of the accident is obviously not directly connected with the track these particulars need not be given

For derailments in non-running lines the Permanent Way Inspector should use his discretion. When agreement as to the cause is not reached with the

other departments at the site, he will record and report the versines, cant and gauge readings and append a sketch as for running lines.

The Level Crossing Accident Report is similarly designed to bring out complete information and attention is drawn to Clause 7.13 of this manual.

It has been the experience that sufficient care has not been taken in the preparation of accident reports resulting in unnecessary correspondence.

In forwarding the reports District Engineers are required to add any further relevant information, give their comments, and state the disciplinary action being taken where he considers this to be necessary.

17.18 **Likely Places of Slips, Floods etc.**— It is the duty of Engineers and Inspectors to make themselves thoroughly acquainted with places affected by rock falls and slips, and with the behaviour of rivers and swamps crossed by the railway.

Revetment and boulder protection works and special drainage must be carefully watched and put in good order before the onset of the rains. Instructions concerning these should be given to the Sub-Permanent Way Inspectors and Gangers. See SECTION 2 and Clause 3.07.

17.19 **Equipment and Materials to be kept in readiness for the Rains.**— The equipment with Gangers, Keymen and Watchmen, for the protection of the track in an emergency, should be put in good order and kept in readiness. Supplies of paraffin oil for lamps shall be adequate.

Where trouble is expected or likely the District Engineer shall keep in readiness reasonable stocks of empty sand bags, boulders, wood or German pattern steel sleepers for cribs, and rails and fastenings for rail cluster girders. See Clause 20.30 and TABLE 20.30A for the emergency stocks that should be held at various stations.

Arrangements should also be made for immediate access to explosives and tools for the purpose of breaking down large rocks which may fall in cuttings.

The availability of earth moving plant with adjacent estates and road-making gangs should be noted.

17.20 **Patrolling Track during Heavy Rain.**— Permanent Way Inspectors and Sub-Permanent Way Inspectors shall cover the line by push trolley as often as possible during rain, and it is their duty to see that the Gangers, Keymen and Gangmen show due vigilance and are properly equipped and prepared to keep the line clear of any obstruction to traffic. They must be trained to recognise danger and take suitable action when track protection is required — See Clauses 16.22 and 16.23(A).

During very wet weather and in cases of exceptional rainfall, whether by day or by night, the section shall be patrolled by the Ganger and his men. An issue of rain capes has been made to each section gang for this purpose.

The Ganger and one gangman should patrol half the section length in one

direction and the Keyman and one gangman in the other direction, each party carrying with them a handsignal lamp or flags, detonators and Jembes. If a washaway is encountered a gangman can be left to protect the site of accident whilst the Ganger or Keyman, as the case may be, can return to the Landie for further assistance and to pass a message, if necessary, to the nearest station.

Where Flying Gang Maintenance is in operation the Permanent Way Inspector and Sub-Permanent Way Inspectors shall patrol the line using the motor trolleys.

Where overtime is worked in patrolling the track it should either be paid for at the normal overtime rates or time off in lieu granted at the discretion of the Permanent Way Inspector.

Detailed instructions must be issued to cover the individual peculiarities of each section so that appropriate action may be taken as and when necessary in each case.

17.21 **Watchmen.**— At particularly dangerous places watchmen should be stationed for the necessary period, and they must be properly equipped and instructed to protect the line in case of danger to it.

17.22 **Temporary Bridges.**— See Clause 3.02.

17.23 **Washaway Register.**— The District Engineer shall record, in the register provided for the purpose, every instance of a breach in the line due to washouts, slips, and flooding, and the steps taken to repair it.

A copy of such entry shall be sent to the Chief Engineer who will record it in his register. At the same time the District Engineer will put forward proposals and an estimate for any work required to avoid a repetition of the trouble.

SECTION 18

WATER SUPPLY AND STATION MACHINERY

18.01 **Repairs to Structures etc.**— It is the function of the Engineering Department to keep in a good state of repair all structures and appliances as are dealt with under Abstract "A".

Engineers shall satisfy themselves that inspections are carried out at regular intervals. In most cases an annual general inspection will be sufficient, and this inspection should be carried out during the first four months of the year.

The officers detailed for these inspections shall report in writing to the District Engineer, stating the condition of each building etc., the nature of repairs required and the estimated cost of the same. The District Engineer will then decide which repairs can be undertaken during the current year and make provision for the balance in the following year's Revenue Estimates.

This general inspection does not relieve executive officers of the responsibility for carrying out any minor repairs which may become necessary between the annual inspections, such as broken windows, refixing guttering and downpipes, oiling woodwork, whitewashing etc.

Inspectors of Works, Overseers and Permanent Way Inspectors should always be on the lookout for such details as these, and deal with them immediately.

18.02 **Maintenance of Mechanical Plant.**— The following general instructions are laid down in a General Manager's circular.

Plant	*Maintained by*	*At cost of*
(a) Weighing Machines in the Commercial/Operating Departments.	Owning Department	Owning Department
(b) Other Weighing Machines	Station Equipment Inspector of the Operating Department upon requisition.	Department using the machine.
(c) Wagon Weighbridges	Engineering Department with the assistance, if required, of the Station Equipment Inspector.	Engineering Department.
(d) Mechanical Plant in Workshops, Engineering Yards and works not controlled by the Chief Mechanical Engineer.	Owning Department	Owning Department

Plant	*Maintained by*	*At cost of*
(e) Fixed Hand Cranes at Stations, turntables, traversers, level crossing signals and gates	Engineering Department	Engineering Department.
(f) Water pipe lines, valves, pumps, pumping engines, hydrants, columns, and any other plant connected with water supplies.	Engineering Department	Engineering Department.

18.03 Water Tests.— Before finally deciding on any new water supply, the water shall be submitted to the Government Chemist for a report as to its suitability for the purpose required.

When forwarding samples for analysis the following information shall be given to the Chemist:—

(a) Situation of water supply.

(b) Purpose for which the examination is required i.e. locomotive or domestic.

(c) Source of supply; river, stream, spring, well or borehole.

(d) If a river or stream state:—
  (i) depth below surface at which the sample was taken;
  (ii) whether at or near middle or side;
  (iii) whether the level of the water was above or below average.

(e) If a well, state:—
  (i) depth of well;
  (ii) depth of water;
  (iii) whether the well is open or closed;
  (iv) whether it is protected from surface water.

(f) Observations with reference to any possible source of pollution.

(g) Is the water, in quantity or quality, changed by weather conditions.

(h) Particulars of recent rainfall.

(i) Full details of treatment if any.

(j) Date and time of collection.

(k) Any other information.

Of each supply to be tested 6 large white glass bottles shall be sent in, having well fitted glass stoppers. Suitable "Winchester" bottles can be

obtained for the purpose from the Chief Engineer.

The bottles should be thoroughly cleaned with sand and water and rinsed at least five times with the same water which is to be tested, and then filled completely to the stopper.

If the water is taken from wells or boreholes by pumping, the pump shall be worked for at least a quarter of an hour before the bottles are filled.

In collecting from a pipe, the tap should be turned on at full for at least two minutes before the sample is taken, in order to prevent impurities in the pipe being collected in the specimen.

In collecting from a stream, lake, spring or well direct, the stopper should be inserted in the bottle and the whole bottle placed well under the surface, the stopper removed and the bottle filled. The sample of water should not come in contact with the hand.

The stopper should finally be secured by capping with a piece of clean linen, the bottles distinctly labelled, and despatched as soon as possible.

18.04 **High Service Tanks.**— These shall be emptied and the inside surfaces cleaned by rubbing down (not scraping) once in every 6 months, and the dates shall be recorded in the offices of the supervisors concerned. At wayside watering stations the Permanent Way Inspector shall be responsible for such cleaning; at other stations and locations the District Engineer shall lay down which official shall be responsible.

The inside surfaces of steel tanks shall, unless the surface is in a satisfactory state of preservation, be painted with a good quality black bitumastic composition every 12 months. **The inside of water tanks must not be treated with any paint of lead composition.**

18.05 **Water Supplies at Wayside Stations and Landhies.**— The attention of all staff at wayside stations and landhies is drawn to the fact that water supplied by the Railway is principally for use in locomotives for steam raising and, as such, is untreated.

Staff using untreated water for domestic purposes are advised, for health reasons, to ensure that it is boiled and filtered before use. Where supplies are given to private consumers and the public in accordance with Clauses 18.06 and 18.07 the Station Masters at stations and the Permanent Way Inspectors for take-off points in section should advise the consumers accordingly.

Where water is stored in ground tanks replenished periodically by a water train, dirt, insects and surface water must not be allowed to enter the tanks, and the hole covers must be in place when not in use.

18.06 **Water supplied by the Railway to Private Consumers.**— All applications for a private water supply must be referred to the Chief Engineer for approval, and the applicant must first obtain from the Water Board its permission to obtain the desired quantity of water from the Railway.

An agreement is required to be executed between the licensee and the Railway Administration in every case and provides for the following:—

(a) a price per thousand gallons of water delivered and a monthly rental for the meter supplied by the Railway;

(b) the applicant to pay for the supply and installation of all the materials involved from the point of take-off to an agreed point within the Railway reserve:

(c) construction and maintenance of the supply line beyond the agreed point to be at the expense of the licensee;

(d) maintenance of the supply line up to the agreed point of delivery, and of the meter, to be a charge to the Railway;

(e) no guarantee that the supply may not be interrupted or discontinued, and that the water as supplied is fit for human consumption.

18.07 **Supply of Water to the Public at Stations.**— The conditions under which water may be supplied other than as laid down in Clause 18.06, and the charges to be collected by a Station Master are laid down in Traffic Working Orders — Part II.

18.08 **Wagon Weighbridges.**— As stated in Clause 18.02 the maintenance of the structure is the responsibility of the Engineering Department. 1

The maintenance and adjustment of the machinery is carried out by the Station Equipment Inspector of the Commercial/Operating Departments and the cleaning of the pits and surroundings is the responsibility of the Station Master. See Traffic Working Orders — Part II.

The Permanent Way Inspector shall attend to the following:—

(a) drainage of the pit;

(b) the gaps between the approach track rails and the rails on the weigh-bridge platform should not exceed $\frac{3}{8}$ inch, and rail creep should be corrected immediately it is observed.

To maintain correct levels in the approach tracks it is desirable that the rails be carried on wood sleepers laid longitudinally and suitably tied for the track gauge.

18.09 **Turntables and Traversers.**— As stated in Clause 18.02 the maintenance of the structures is the responsibility of the Engineering Department.

The girders and riveted connections shall be inspected in detail once every 12 months by an Engineer or by the Inspector of Works (Bridges).

The propelling machinery, locking gear, wheels, wheel bearings, and balance adjustment (of turntable girders) is the responsibility of the Mechanical Department.

It has been decided, in consultation with the Chief Mechanical Engineer, that the Engineering Department will be responsible for the lubrication of turntables in future.

Grease is the best form of lubricant for the slow-moving parts of a turntable, and it is to be used wherever the design of the bearing or its housing will permit the application of grease. In some turntables, such as the 100-ft. turntable at Nairobi, the lubricating holes are internally threaded for nipples. In such cases grease-guns should be indented for, and if the holes are without nipples, these also should be indented for, stating the size of the hole in which they are to be used.

In some cases provision for grease-gun nipples is not made, but grease can be applied by removing the bearing covers. In others, however, the bearings are not accessible unless the turntable is jacked up, or unless the main girders are supported. In these cases oil may be used.

The grease to be used is Shell Retinax A. Where lubrication by grease is not possible, Shell CARNEA 72 oil is to be used.

The turntables at Nairobi, Moshi, Dar es Salaam, Morogoro, Dodoma and Tabora must be lubricated once a week; all others will be lubricated once every fourteen days.

18.10 **Fixed Hand Operated Cranes.**— The Engineering Department is responsible for:—

(a) Inspecting

(b) Testing and

(c) carrying out of necessary repairs to

all fixed cranes other than those under the control of the Mechanical, Marine and Port Departments i.e. all hand operated cranes at stations, Goods depots and Engineering yards.

The District Engineer or equivalent Officer shall arrange for quarterly inspections to be carried out by the Permanent Way Inspector in whose area the crane is located and he must ensure that following such inspections he receives a certificate in regard to the condition of the crane and stop posts.

Quarterly reports must be based on a thorough examination of all parts of the crane and the various information columns in the return must be fully completed.

The District Engineer or equivalent Officer shall arrange for cranes to be tested to full capacity at least once a year by a senior Inspector of Works or other senior Supervisor on the District concerned. All testing dates must be clearly indicated on the jib of the crane.

Each crane shall have an indicator fitted to it showing the safe loads at the various radii and the cranes must be tested with the jib in such a position

that the indicator shows the maximum load. The test load shall be 25% in excess of this indicated amount.

During the test the cranes shall be swung throughout their radius from side to side and the person carrying out the test must ascertain that the two stop posts which must be erected at each crane to prevent it swinging too far round, are in position. These posts shall consist of old rails set in concrete.

The person carrying out the test must ensure that all chains, ropes and lifting tackle conform to the provisions laid down in Section 31 of the Factories Ordinance for the Territory concerned.

The senior Inspector of Works or other senior Supervisor of the district concerned must ensure that a register is maintained containing details of all tests of hand operated station cranes carried out on his district.

The District Engineer or equivalent Officer shall ensure that the duties laid down in this circular are carried out by the senior Inspector of Works or other senior Supervisor on his district and by his Permanent Way Inspectors. The division of duties between the senior Inspector of Works or other Supervisor and the Permanent Way Inspectors is that the former will ensure that the yearly load and movement tests are carried out under his personal supervision and that the latter (Permanent Way Inspector) will be responsible for the maintenance, including oiling and greasing of cranes and the periodic inspections of the crane and equipment.

No member of the staff is permitted to operate a crane unless he holds a certificate signed by a competent examining Officer of the Engineering Department, who must ensure before issuing such a certificate that the applicant is fully conversant with the instructions contained in Weekly Traffic Notice No. 404 dated the 6th May, 1939, paragraph 5850.

EXTRACTS FROM WEEKLY TRAFFIC NOTICE
No. 404 Dated 6th May, 1939.

OPERATION.

Hand-operated cranes must be operated under the supervision of the Station Master, Goods Agent or other employee in charge.

Such supervisors must possess certificate of competency which will be issued by a Permanent Way Inspector after the supervisor has successfully passed an examination. Members of the public are not allowed to operate or supervise the operation of cranes unless the above-mentioned supervisor is satisfied that they are competent to do so.

SUPERVISION.

The employee whose duties include the supervision of cranes is responsible for the following:-

(a) *That the crane is not overloaded. The safe working loads at the respective radii are usually shown on a load table attached to the crane, or on the radius indicator, and in no circumstances are the specified loads for the specified radii to be exceeded.*
In cases where a load has to be lifted at one radius, slewed and lowered at another radius, the load must not exceed that specified for the greater of the two radii. The radius is the distance from the centre pin to the centre of the lifting hook.

(b) *That any special instructions regarding the operation of the crane are strictly carried out.*

(c) *That the crane is properly secured, whether in use or not.*

(d) *For any accident due to misuse of the crane.*

(e) *That when loads handled by hand-operated cranes are being lowered with the brake, the operating handles are, where possible, removed, or the hoisting and lowering mechanism put out of gear. Where this cannot be done, the lowering speed must be controlled by the brake so that the handles and gearing cannot revolve rapidly.*

MAINTENANCE AND INSPECTION.

All cranes are inspected every quarter by a competent examiner of the respective Departments.

After each quarterly examination, a certificate signed by the Examiner must be submitted to the Head of the Department responsible for the maintenance of the crane.

The condition of the respective parts of the crane must be briefly stated on the certificate.

The employee whose duties include supervision of operation of cranes must ensure that the working parts of cranes are oiled.

CRANE WIRE ROPES, WIRE ROPE SLINGS, CHAINS AND CHAIN SLINGS.

The care of ropes, chains, slings etc. is the responsibility of the Department which maintains the cranes, and those parts are to be dealt with as follows:-

(a) *Main hoist, auxiliary hoist and derrick ropes must be coated with crater compound once every three months, and a remark to this effect is to be entered on the Quarterly Inspection Certificate.*

(b) *No crane wire ropes or wire rope sling shall be used in hoisting or lowering if, in any length of eight diameters, the total number of visible broken wires exceeds 10 per cent of the total number of wires, or the rope or wire rope sling shows excessive wear, corrosion or other*

defect which, in the opinion of the person who inspects it, renders it unfit for use.

The safe working load of all wire rope slings must be stamped in plain figures or letters on the sling hook or rings.

(c) All main hoist, auxiliary hoist and derrick chains and chain slings must be annealed annually. The safe working load is to be shown on a suitable tablet or ring of durable material which must be attached securely to each chain sling.

18.11 **Siting of Oil Fuel and Water Columns.**— The positioning of oil fuel and water columns in station and locomotive yards shall be in accordance with the type drawing of the Chief Mechanical Engineer, and plans for new installations must receive the approval of the Operating and Mechanical Departments as the case may be.

18.12 **Oil Fuel Installations for Locomotives.**— The Engineering Department is responsible for the maintenance of pipelines, valves, storage tanks and all concrete works and buildings and allowance for the work must be made under Rev. A. IV(b).

The Mechanical Department is responsible for the maintenance and operation of the pumps, engines, and oil cranes.

Where oil fuel installations exist at isolated stations where it is very difficult for the District Motive Power Superintendent to maintain the diesel pumps, there is no objection to this work being carried out by the Pump Foreman of the Engineering Department on a Work Order issued by the Mechanical Department.

18.13 **Oil Fuel Decanting Points.**— See the instructions in Volume II of the Engineering Manual.

18.14 **Steam Boilers — Care and Working of in Engineering Department.**— No member of this Department will be allowed to work a boiler in connection with any machine or plant unless he holds a certificate of proficiency. This certificate will be issued by an approved member of the Chief Mechanical Engineer's Department.

In the event of a boiler having to be worked and no local qualified man in possession of a certificate is available, the Engineer concerned must obtain one from elsewhere.

No boiler attached to any machine or plant shall be left without a guard, unless the conditions are such that there is no possible chance of interference or tampering by outsiders.

As the Chief Mechanical Engineer is responsible for the periodical examination and testing of all boilers worked by this Department and the issuing of the necessary certificate that they are safe to work, it is essential that he

or his representative be informed of the movement of all boilers.

18.15 **Electricity Supply Arrangement.**— For detail instructions concerning the division of responsibility between the Engineering and Mechanical Departments see Volume II of the Engineering Manual.

It will be noted therein that electric motors up to 5 H.P. driving water pumps are the responsibility of the Engineering Department.

SECTION 19

SIGNALLING

19.01 **Division of Responsibility between the Signal Engineer and District Engineer.**— The Signal Engineer shall, through Signal Inspectors and staff working directly under his instructions, be responsible for the construction and maintenance of all Signalling involving interlocking between points, derailers, and signals, track circuits, electrically protected level crossings, and also such other installations of a specialised nature as he may be required to assume charge of.

He shall also be responsible for Tokenless and Double Line Lock and Block Systems, excluding aerial lines and the vibrator telegraph/telephone sets associated with these systems.

The construction and maintenance of all other installations of simple signalling and non-interlocked derailers, for which the Signal Engineer has not assumed responsibility, shall be carried out by the Permanent Way Inspectors under the direction of the District Engineers.

District Engineers will, when they consider it necessary, call on the Signal Engineer for technical advice and assistance.

District Engineers are expected to take an interest in the functioning of the equipment and the work of Signal Staff in their districts and to get in touch with the Signal Engineer on any matter which they consider requires his attention.

19.02 **Administration of Signal Staff, Accounts, and Stores.**— This shall be in accordance with the Administrative Instructions issued on the subject of Maintenance of Signalling and Block Systems, relating to installations which are the responsibility of the Signal Engineer and his staff.

These instructions include the administrative assistance to the Signal Engineer which is required of the District Engineers concerned.

19.03 **Signal Fitters.**— When placed under a Signal Inspector the fitter shall receive instructions solely from him.

19.04 **Certificate of New Installations.**— The Signal Engineer or a responsible member of his staff deputed by him, shall examine and test all new installations before they are handed over to an official of the Operating Department to be brought into use.

Where a District Engineer is responsible for simple installations, the testing and bringing of them into use may be conducted at Permanent Way Inspector level.

19.05 **Movements of Signal Staff.**— The Signal Inspector and Signal Fitter shall advise the Transportation Control Office of their movements, before leaving their headquarter stations, giving details of their destinations, mode of travel, and estimated time of arrival. Before leaving a station they will again inform Control of their movements.

Control must also be kept advised of their movements when they remain at their headquarters, including public holidays and the rest period over week-ends.

19.06 **Reporting of Faults.**— Station Masters are required to report faults by telegram to the Signal Inspector and Signal Fitter concerned, with a copy of the message to the Signal Engineer, in accordance with standing instructions.

19.07 **Clearance of Faults.**— It is the duty of the Signal Inspector to see that a fault is cleared in the earliest possible time by the Signal Fitter, the mobile gang, or himself, as he considers necessary.

Action shall be taken by Permanent Way Inspectors for installations in their charge.

19.08 **Use of Point Locking Clamp.**— Each station is equipped with one or more screw type clamps in the charge of the Station Master. Its use in an emergency is covered by the General Rules.

19.09 **Permission of Station Master to be obtained.**— No Railway servant shall interfere with any signals, points, derailers, and their fittings and connections for the purpose of testing or effecting repairs, without the previous consent of the Station Master or official in charge of the safe working of the station.

Inspecting staff shall make, or cause the Station Master or official to make, an appropriate entry in the Trains Register, before work is commenced on any part of the apparatus which may affect trains working. This is to ensure that the official is aware of the state or readiness of the equipment, and also to enable train movements to be continued without interruption, by using hand signals in accordance with the General Rules.

19.10 **Inspection of Fixed Signals, Points, etc.**— The signals, points, derailers and all ancillary equipment connected with their working, at each station and siding, shall be regularly inspected as follows, and at more frequent intervals as necessary.

Person to make inspection.	Details of the inspection to be made.	Maximum interval between each inspection.
Signal Fitter.	Whole installation, signals, points, succession locked derailers, and lamps.	Fortnight.
Signal Inspector.	- ditto -	One month.
- ditto -	Inspection and testing of inter-locking.	One year.
Permanent Way Inspector.	**Interlocked Stations.** Inspect and test all points, and derailers which are not succession locked.	One month.
Permanent Way Inspector, or a responsible person deputed by him.	**Non-interlocked Stations and mid-section Sidings.** Inspect and test all points, signals, lamps and derailers.	One month.

The person making the inspection or test is required to sign the form kept at each station as an indication that all the mechanism concerned is in proper working order, that appropriate action has been taken to remedy any defect which may have been found, or the apparatus has been put out of commission in accordance with General Rules.

It will be the responsibility of the person making the inspection to ensure that prompt action is taken to remedy any defect.

In addition to testing signals and points daily in accordance with General Rules, the Station Master must countersign the test made by any person, and his signature will be an indication that points and signals are in proper working order and that any defects previously reported have been put right.

19.11 **Division of Responsibility between Track Staff and Signal Staff.**— At stations and other locations where the signalling is maintained by Signal Inspectors division of responsibility for maintenance at the points shall be as follows:—

Track Staff shall be responsible for the switches and components, connecting rods and their brackets on the tongue rails (not lock stretcher bars), sleeper bolts and spikes, up to but **excluding** the joint of the connecting and drive rod.

Signal Staff shall be responsible for all signalling apparatus and rail attachments, the drive rod and its joint with the switch connecting rod.

19.12 **Work affecting both Track Staff and Signal Staff.**— Except to remedy a dangerous condition in the track, work of slueing, lifting, renewal of switches, timbers and components, squaring of switches, regauging, etc., shall not be

carried out by Track Staff without prior notice to and unless the Signal Fitter is in attendance.

Signal Staff shall not slacken or remove tongue rail connecting rods, switch components, and any track fittings except by arrangement with the Sub-Permanent Way Inspector or Permanent Way Inspector.

19.13 **Temporary Repairs by Track Staff.**— In the event of an accident, and where Signal Staff will be delayed in attending, Track Staff may disconnect the joints of the driving apparatus at the points and remove damaged components which infringe track clearances, in order to permit the passage of trains. The work shall only be done with the knowledge and co-operation of the Station Master and in accordance with Clauses 19.08 and 19.09.

Where, however, the efficient working of the switches has not otherwise been affected and a switch lever can be fitted, a member of the Track Staff not below the rank of Sub-Permanent Way Inspector may authorise the points to be worked by hand and trains to be received and despatched on hand signals. He will remain at the site until the Signal Staff arrive.

On no account shall Track Staff attempt to re-connect signalling apparatus or repair broken wires.

The re-connecting of the signal apparatus must be done by the Signal Staff.

19.14 **Examination and testing points and signals after an Accident.**— The Permanent Way Inspector and Signal Inspector must examine all points and signal apparatus after an accident, effect permanent repairs and sign the Trains Register to this effect.

The Station Master or official in charge must test and satisfy himself that the points and signals properly respond to the lever movements, and that all is in order for the safe passage of trains.

19.15 **Assistance from Track Staff.**— The Permanent Way Inspector shall instruct his staff to assist the Signal Staff when called upon to do so in an emergency.

Track labour shall also be provided, on request by the Signal Staff and at the discretion of the Permanent Way Inspector, for the purpose of straightening up signal and point indicator posts.

19.16 **Installation of Points and Signalling.**— As much work of laying out a turnout and fitting signalling apparatus to the switches and rails, as possible, shall be done outside the track. When the turnout is laid in the running line and the signalling apparatus is not fully connected up and tested by the Signal Inspector, the switches shall be clamped and padlocked for the principal track as required by the Operating Department.

The keys of the padlock shall be retained by either the Permanent Way Inspector or the Signal Inspector, or by a responsible member deputed by either of them, who shall be present throughout the operations of opening and

closing the switches for the passage of trains. Such work shall only be done in daylight and with the permission of the Station Master or official in charge of the safe working of the station, in accordance with Clause 19.09.

Where possible the screw type point locking clamp referred to in Clause 19.08 shall be used for the purpose. Alternatively, a suitable clamp shall be made for the purpose to clip over the flanges of the stock and tongue rails with provision for a padlock.

The use of bolts and spikes to secure the switches, in lieu of the padlocked clamp, is forbidden.

19.17 **Switch Maintenance and Squaring of Points.**— It is essential in interlocked points to eliminate, as far as possible, all creep of rails. The tongue rails in switches which have loose heel joints are particularly prone to movement. The Permanent Way Inspector shall attend to enlarged bolt holes and renew components which cannot be repaired.

See Clause 13.25 concerning rail anchors.

Tongue rails should fit closely against the stock rails throughout their length, and sit uniformly on the slide chairs.

Interlocking at the points will not operate efficiently when there is even the slightest amount of gape at the toe of a closed tongue rail. See Clause 14.53.

A single washer of a thickness not exceeding one-eighth of an inch on each side rail may, at the discretion of the Permanent Way Inspector, be used between brackets and the webs of rails to adjust track gauge and the fit of the tongue rail. Where it is necessary to do this at interlocked points, Clause 19.12 shall be complied with.

The nuts of all bolts which tend to slacken shall be fitted with spring washers and the bolts burred over and Keymen shall be provided with spanners to fit all nuts required to be maintained by him.

The switches shall not be permitted to get out of square and requests from the Signal Staff to attend to this matter must be promptly complied with.

19.18 **Cleaning and Lubricating Slide Chairs.**— The instructions of Clause 5.12 shall apply.

19.19 **Facing Points.**— In fixing facing point locks, lock bars, detectors, etc., the Signal Staff may drill holes in the web of the rails and tongue rails.

When the Signal Inspector and Permanent Way Inspector, in consultation, consider that the table of the running rail has worn down to an extent where the lock bar is being damaged by the wheels of rolling stock, the rail shall be renewed. Care shall be taken to select a replacement rail which has the same table shape and wear as the stock rail of the switches.

Where lock bars are fitted, the rail joint gaps at the bar shall be opened

to the limit and a cut slice of rail of exact thickness inserted in the joint. This is to eliminate rail movement and consequent disturbance in the working of the lock bar.

19.20 **Metal Covers over Signal Apparatus.**— As required by Standard Dimensions, metal covers ramped in both directions, must be provided over interlocking gear which projects above rail level between the rails of a track. They shall also be provided in other circumstances at the discretion of the Signal Engineer.

19.21 **Clearing Vegetation and Drainage.**— It is the duty of the Track Staff to clear vegetation, earth and other obstructions along all wire and rodding routes and to prevent water lying around points and signal apparatus.

19.22 **Ballast to be cleared.**— Ballast must be kept clear of all working connections, particularly lock bar clips and signalling rods. Between the toe and heel of the switch, ballast shall be 2 inches below the top of the sleeper to prevent fouling the slide chairs and entry of stones between the tongue and stock rails.

19.23 **Track circuits.**— Before any track operations are undertaken which will involve interference with or removal of track circuit connections and bond wires, the Permanent Way Inspector will communicate with the Signal Inspector, who must then arrange for a member of his staff to be present.

The renewal of insulated joint fittings and fishplates will be jointly undertaken by the Track Staff and Signal Staff.

See SECTION III (6) of the General Appendix to the Working Time Table and General Rules for instructions relating to the installation, maintenance and repair of track circuits.

To prolong the life of insulating material at rail joints and fishplates made of special insulation material, it is essential that the fishbolts be maintained in a tight condition.

Where track circuits exist care must be taken not to bridge across opposite rails or adjacent rails with metal objects such as a steel or metallic tape, bar, gauge, shovel, pick or other tool. Neither should ballast be piled against the wires nor the wires on any account be broken. Track gauges and light inspection and material trolleys shall be insulated.

19.24 **Visibility of Signals.**— Trees and branches obstructing the view of signals, both from approaching trains and the station or signal box, shall be removed. See Clause 4.04 on the right to clear such obstructions outside the Railway reserve.

Sight screens of approved pattern shall be fitted to signal posts where the arms are not clearly visible by day to the drivers of trains and the station staff.

19.25 **Signal Lamps.**— The focussing of lights on curved approaches shall be carefully adjusted. Signal Inspectors and Permanent Way Inspectors shall make night inspections to check visibility and consult the drivers of trains.

A back blinder, worked off the same spindle as the semaphore arm, is required to be fitted to every signal whcih does not face a station. Its purpose is to indicate to the Station Master at night whether the lamp is burning and also whether the signal arm, on being put back to the normal position, has returned to the correct 'ON' position.

The back blinder must, therefore, be adjusted so that the white back light becomes visible from the station only when the arm has returned to within 5 degrees of the normal 'ON' position.

19.26 **Signal Arms and Lights.**— Lower quadrant semaphore arms shall be adjusted to correctly indicate the 'ON' and 'OFF' positions, which, in relation to a horizontal line, are:—

'ON'	—	Horizontal to 5 degrees below.
WRONG	—	Between 5 and 45 degrees.
'OFF'	—	Between 45 and 60 degrees.

To ensure that the arm does not remain above the horizontal a stop should be fitted on the post.

The lamp case bracket shall be so adjusted as to show full indications by night in the 'ON' and 'OFF' positions respectively.

The weight of the spectacle frame at the end of the signal arm must be sufficient to return the arm to the 'ON' position in the event of the rod between the spectacle and the balance lever becoming disconnected or broken.

19.27 **Balance Lever on the Signal Post.**— The balance lever, having a cast iron weight, is provided for the purpose of returning the pull wire to its normal position when the signal lever is released at the station.

Failure of the signal arm to return to the 'ON' position has, on occasions, been the cause of the drooping signal being mistaken by the driver of a train for the 'OFF' indication. To ensure efficient working, the following points must be carefully attended to:—

(a) a retaining bolt shall be fitted at the end of the lever to prevent the balance weight falling off;

(b) the balance weight should normally be positioned at the end of the lever, against the retaining bolt (a);

(c) a bolt and nut (not a set screw) shall be passed **through** the weight and the lever, the latter being drilled for the purpose, to prevent the weight sliding forward along the lever;

(d) neat cut plates, of the same size as the weight and held by the bolt (c), may be added where necessary, on each side of the weight to increase the return effect.

19.28 **Wire Route.**— Careful attention shall be given to the following points:–

(a) as few angular changes as possible in the direction of the route;

(b) change of direction to be effected in a series of straight runs with a substantial stake and angle pulley or wheel at the change point;

(c) stakes to be provided at a spacing of 40 feet to reduce excessive sag in the wire, and maintained at an uniform level and to good alignment;

(d) wire pulleys to be riveted to prevent mischievous removal;

(e) pipes through which the wire may be passed to be as short in length as possible and clear of obstructions;

(f) lubrication of flat and vertical direction changing wheels, where provided. Wire pulleys should not be lubricated as oil and grease collects dirt.

19.29 **Lever at the Station.**— At stations in charge of the Permanent Way Inspector the working parts of the lever shall be regularly attended to for wear and lubrication.

The counterweight provided for taking up slack and temperature changes in the wire route shall be sufficient for that purpose and made up neatly with proper cast iron slabs.

The sump shall be kept clear of rubbish and the counterweight free of interference.

SECTION 20

STORES AND EQUIPMENT

20.01 **Responsibility for Stores.**— Permanent Way Inspectors, Inspectors of Works, Overseers, and other executive officers are responsible for the safe custody and accounting of all material, tools, plant and stores placed under their control.

Stores Clerks are required to scrutinise all returns to ensure that issues and receipts are correctly accounted for and that the necessary tallying and checks are carried out at regular intervals.

20.02 **Transfer of Charge.**— In the event of a change of supervisor definite instructions must be given for a check of materials, tools etc., against the accounts and there must be a written hand over/take over certificate, showing details of any discrepancies.

Should it occur that the supervisor is not able to hand over to his relief, due to sickness or other reason, then a check must be made at the earliest opportunity by a responsible officer, and a further check on arrival of the relief.

RELAYINGS AND OTHER LARGE PROJECTS

When a relaying organisation or a similar project is set up the District Engineer must issue written instructions to the supervisor directly in charge. These instructions must cover the acquisition of materials, tools and plant and accounting of them. They must also cover receipt, care and maintenance, periodical checks and disposal.

When a relaying gang is handed over from one District to another, hand over must be arranged between the District Engineers and financial adjustment made between the appropriate estimates on an assessed value of materials, tools etc. The accounts of the District handing over must be properly closed and clear entries made regarding disposal of materials, tools etc. The accounts will be retained by the District and new accounts opened by the District taking over.

20.03 **Accounting of Stores.**— Adequate records must be maintained of all materials, tools and plant, and consumable stores, whether held at value or not.

All receipts and issues must be properly shown in the returns, ledgers or other accounts required to be maintained.

20.04 **Stores Unallocated Suspense.**— These are stores not definitely allocated to specific works as in Clause 20.05 and control over which is exercised by the Stores Superintendent, even though the stores may remain in the custody of Districts.

Such stores stand at a value and the Suspense Stock may only be added to with the consent of the Stores Superintendent. They are primarily for the maintenance needs of the Railway and comprise:—

(a) General stores held by the Stores Superintendent at his main and subsidiary depots.

(b) Approved stocks in the custody of the various departments of the Railway, and which in the case of the Engineering Department comprise:—

(i) Permanent Way Materials in Imprests, Breakdown Trains and a few special holdings;

(ii) Signalling Materials;

(iii) Materials and manufactured items of a special nature held by the Chief Engineer's and District Engineers' Workshops;

(iv) Drawing Office and Survey instruments.

20.05 **Allocated Stores.**— As the term signifies these are stores obtained for a specific work and paid for against an estimate i.e. it is not a Suspense Account as that described in Clause 20.04.

The practice of passing large consignments of stores intended for use on definite works through the Suspense Account is prohibited.

The District Engineer must assure himself that his Stores Clerk is supplied with a copy of each sanctioned estimate. The Stores Clerk will check that quantities requisitioned in excess of those shown in the estimate and non-stock items are not passed without the approval of the Engineer. He will also assure himself that suitable materials are not already available in the District.

Each sanctioned estimate must have its own schedule of materials, and each job should be allotted a separate bay or bin to hold materials awaiting issue. A copy of the schedule should be kept in the bin, with suitable additional records showing the position regarding requisitions, receipts, issues to the job etc.

On completion of a work an account of the materials received, issued and surplus shall be prepared and steps taken to dispose of the surplus, as is required to be done before the Completion Report for the work is certified.

Materials allocated to definite works in excess of the actual requirements of those works are cleared as follows:—

(a) New or unused stock items of the Stores Department may be returned on a D.S.8 and a credit obtained;

(b) Other non-stock items for which there is a reasonable chance of use on another work may be transferred to Stores Unallocated Suspense but only with the prior approval of the Stores Superintendent.

20.06 **Permanent Way and other materials for ordinary Maintenance.**— Such materials as are obtained for ordinary maintenance of track, buildings, pipe lines etc. are purchased against the Revenue Abstract "A" and are carried without value in the ledger and other accounts until issued.

They must be stored separately from materials of other accounts and installed without undue delay and within the year of purchase.

20.07 **Released and Retrieved Materials.**— These are generally permanent way materials released from relayings and similar large projects.

A special return is maintained for each job as the second hand values vary with the age of the material.

Issues of any of this material may only be made against requisitions approved by or on instructions from the Chief Engineer, who is responsible for seeing that the necessary financial adjustments are made.

20.08 **Tools and Plant.**— Once purchased they are subject to a numerical account only i.e. the value has been charged off. Except when transferred from one sanctioned work to another or from one District to another, no financial adjustments are necessary.

Each supervisor shall maintain a register of tools and plant which should contain a list showing the distribution of the items among the artisan staff, gangers, workshops, store rooms etc.

The registers of the supervisors shall be tallied periodically with the register of tools and plant maintained by the District Engineer.

20.09 **Consumable Stores.**— These comprise items such as oils, paints, brushes, bolts, nails, cement etc. the values of which have been charged off to ordinary maintenance or to an allocated work as the case may be.

Maintenance Stores.

The type of record adopted may consist of stock cards EAR.1042, or a Consumable Stores Ledger, which would record receipts according to Stores Issue Notes or other Stores Voucher, issues and a stock balance.

Day to day issues of consumable materials should be made in a Petty Issues Book and a signature obtained where possible. The issues in the Petty Issues Book should be totalled at suitable intervals and the amounts entered in the issues column of the Consumable Stores Ledger.

Allocated Stores.

Each sanctioned estimate shall be dealt with as laid down in Clause 20.05.

20.10 **Scrap Materials.**— No scrap materials may be sold without the sanction of the Stores Superintendent.

Staff are inclined to retain scrap unnecessarily for a future use. All unwanted scrap material must be collected at regular intervals and consigned to the appropriate Stores Department depot. A considerable revenue is obtained from the sale of scrap, and the accumulation of scrap is an inducement to thefts by outsiders.

Where stocks with individual supervisors are too small arrangements

should be made at suitable intervals to pass a wagon on from supervisor to supervisor collecting scrap, the last one to consign the wagon to Stores.

Unserviceable permanent way materials and rolling stock components, such as brake blocks, which are in mid section should be collected by Engineering Train.

Cast iron scrap is of special value as it is not sold but sorted by the Stores Department for use in the Railways' foundries.

Non-ferrous scrap such as brass and copper is very liable to be pilfered and should be collected in locked stores and consigned to the Stores Department in wooden boxes.

Serviceable components, such as clips and clip bolts on unserviceable steel sleepers should be recovered for re-use.

For instructions concerning the disposal of unserviceable steel sleepers and rails see Clauses 20.25 and 20.26.

20.11 **Preparation of Requisitions.**— Care must be taken in the preparation of requisitions to correctly state the Stores Item Number and description of the item selected from the Stores Catalogue.

With regard to permanent way materials it is intended to provide the staff with a comprehensive list showing the correct names and appropriate part list numbers. Such a list already exists for Signalling materials.

The illustrations at the end of this Manual are provided to aid the staff in identifying permanent way materials, and only the names and descriptions given therein shall be used in the preparation of requisitions.

It is the duty of a Stores Clerk to scrutinise all requisitions to see that the material indented is properly described.

He should also satisfy himself from his returns and records whether the material indented or a suitable substitute is available within the district, particularly in regard to tools and plant and consumable stores.

For Allocated Stores see paragraph 3 of Clause 20.05.

20.12 **Drawing of Permanent Way Materials.**— Except where the Permanent Way Inspector's Imprest is insufficient to meet urgent maintenance or accident repairs, no permanent way materials may be drawn from other stocks without the authority of the Chief Engineer.

In all such issues a requisition shall be submitted.

20.13 **Returns.**— The following returns are required to be submitted by Districts.

(a) **Stores Unallocated Suspense — Form EAR.0032.**

Twice a year in the months laid down for each District by the Stores Superintendent, a full return of the balances.

Separate returns are required to be made for permanent way materials and general stores.

The return is submitted to the Stores Superintendent and copied to the Chief Engineer. See Clause 20.14.

(b) **Released and Retrieved Materials.— Form EAR.2194.**

A return is to be submitted each month to the Chief Engineer, for each estimate or work.

All materials recovered from any work, whether serviceable or unserviceable, must be included in the returns, as also full details of receipts and issues.

For issues, the authority and the estimate or other head against which charges are to be raised **must invariably be stated.**

As laid down in Clause 20.11 for requisitions, all material must be correctly described.

District Engineers should make it their duty to scrutinise all returns of stores to acquaint themselves with stocks held in the districts, and to enable them to reduce stores left over from works and to use them to the best advantage.

20.14 **Stock Verification and Checks.**— Engineers should make it their duty to examine the store yards and store rooms of their supervising staff particularly with a view to seeing that stores are being properly recorded and cared for, that unnecessarily large stocks are not held and that unwanted stores are disposed of to the best advantage.

Apart from the occasional physical check of stores made by a Stock Verifier of the Chief Accountant's Department, checks by the supervising staff and Stores Clerk are required to be made at regular intervals.

A complete check of tools and plant and consumable stores in the custody of a supervisor, including items allotted to subordinate supervisors, artisan staff and gangers should be made quarterly.

The General Manager has laid down that one sixth of the physical stocks of Unallocated Suspense Stores (Clause 20.04) in each district shall be checked each month and a return on Form 0032, with the certificate on the reverse completed, sent to the Stores Superintendent monthly.

A full return of balances of these stores is also required to be sent **twice a year** on Form 0032 to the Stores Superintendent with a copy to the Chief Engineer. In order to spread the checking of these balances throughout the year in his office the Stores Superintendent will fix the two months in each year in which each District must submit the return.

See Clause 20.13.

20.15 **Care of Stores.**— Staff must appreciate that any cases of waste or lack of proper care and custody of stores, traceable to individuals may result in such individuals being called to make good the value of such.

MAINTENANCE STORES.

All stores shall be kept in yards and buildings specifically set aside for the purpose to prevent deterioration or removal by unauthorised persons.

Unallocated Suspense stores shall be kept separate from Allocated Stores and other stores.

Only authorised persons may be allowed in such buildings and yards.

Small fittings shall be locked in store rooms and placed on racks, properly labelled where necessary, to enable easy identification and checking.

Larger items of stores such as permannet way items of Imprest, sleepers, pipes etc. shall be placed clear of the ground which must be well drained and free from weeds.

Rails and switches and crossings and their components of Imprest Stock shall be periodically rubbed over with black oil to prevent corrosion.

Fishplates and bolts and nuts will be similarly coated with black oil or grease and stored in locked rooms or in a covered shed.

Tools and other stores in the custody of the section gangs shall be kept in the store room or tool box provided at the Landie.

PERMANENT WAY MATERIAL ON NEW WORKS.

Special care must be exercised on major works such as new constructions, relayings, resleeperings, industrial area sidings and yard extensions as excessive losses of permanent way materials are likely to occur.

District Engineers should issue suitable instructions to the staff engaged on such works covering the following points, and they and their Assistant Engineers must see that the instructions are complied with.

(a) Sleepers and all small fittings shall be located in dumps under the care of watchmen by day and by night.

(b) Small fittings shall only be issued and taken to the work in such quantities as can be laid in the track on the same day.

(c) Loose small fittings such as clips, clip bolts, steel keys etc. shall be conveyed to and from the worksite in bags or other containers.

In no circumstances shall they be carried loose in wagons.

(d) On completion of the day's work or task all small fittings shall be collected in the same bags or containers and taken to a place of safe storage.

(e) Following up gangs on such works as relayings shall search the line-side and collect all fittings for removal each day.

(f) At the depots the materials shall be neatly laid out to facilitate checking, on ground that is well drained and clear of weeds.

No material shall rest directly on the ground and fishplates, fishbolts and other components liable to suffer from corrosion shall be oiled.

(g) All materials in depots shall be sorted by kinds and sign posted to enable easy identification and checking.

District Engineers and Resident Engineers shall see that full records are kept of all receipts, issues and stocks, and that regular and prompt returns are made of new and released materials.

20.16 **Excessive Stocks.**— The retention of excessive stocks, redundant and obsolete stores is an offence, and District Engineers when signing completion reports should satisfy themselves that all materials surplus to projects have been returned to Stores or otherwise disposed of in accordance with standing instructions.

The retention of stores saved from or not utilised on works is highly irregular and liable to considerable abuse.

Requisitions must be carefully scrutinised and indents should be prepared only for such quantities as are necessary to prevent a work being held up.

Engineers must make it a duty to inspect store yards and store rooms to ascertain what stocks are held.

20.17 **Survey Board Rules.**— See Volume II of the Engineering Manual.

20.18 **Thefts and Pilferage.**— It is essential that District Engineers and their staff should keep a very close watch on all Railway property of a nature which can be easily pilfered and sold as scrap. This applies particularly to permanent way materials, G.I. sheets, pipes and fittings, cast iron material, copper and brass.

It must not be assumed that heavy materials cannot be carried away, and particular attention must be given to inhabited areas and where road access is easy.

Materials must be collected and placed where they can be watched. Thefts and attempted thefts must be promptly reported to the Police.

20.19 **Protection of Material along the Line.**— All material used in connection with the maintenance of the permanent way must, as far as practicable and with as little delay as possible, be removed and stored away from the line so as to prevent such material being utilised by evilly disposed persons to create obstructions on the line.

Special care shall be taken with sleepers during relaying and resleepering

works. Too many shall not be spread ahead of the work and the released ones shall be picked up.

Where there is likelihood of thefts and mischief watchmen shall be appointed to patrol the lengths.

20.20 **Consignment of Stores.**— Small items shall be properly packed for despatch in bags, boxes or old drums and clearly marked, and not thrown loose in open wagons.

Fishplates, rodding etc. should be securely wired in bundles and labelled.

Full details of the consignment shall be sent to the consignee immediately the materials are despatched.

20.21 **Loading of Wagons.**— The carrying capacity of a wagon must not be exceeded and the weights of materials given in SECTION 27 will be found useful.

Material shall be distributed over the wagon floor so that more or less equal loading at the two ends and at both sides is obtained. Neglect of these precautions may upset the loading on the wagon wheels and cause it to derail in transit.

Attention must also be given to the proper securing of the materials against movement in transit and to the locking of doors.

Engineering staff should note the instructions contained in the following:—

(a) Clauses 8.20 and 8.21 of this Manual.

(b) Section VI — Out of Gauge Loads in the General Appendix to the Working Time Table and General Rules.

(c) Traffic Working Orders — Part II — Order No. 356 — Loading Diagrams.

20.22 **Stone Ballast.**— In ordinary circumstances there should be no allocated stock of ballast other than that currently provided against estimates and renewals.

Surplus stocks of unused ballast, if any, must be brought on to the Stores Unallocated Suspense Account with the approval of the Stores Superintendent, and shown in the return mentioned in Clause 20.13.

A separate account shall be maintained in the District for each quarry site or depot, and where more than one ballast account exists, the stacks must be clearly numbered. This can easily be done by using a signboard on which the quantity of ballast should be shown.

Permanent Way Inspectors and Inspectors of Works shall obtain permission of the District Engineers to remove ballast and shall report the amounts taken, which shall be verified by re-measurement of the stacks.

For instructions on the stacking and measuring ballast see Clause 10.05.

20.23 **Boulders.**— The instructions in Clause 20.22 above for stone ballast shall also apply to stocks of boulders.

20.24 **Wood Sleepers.**— All wood sleepers shall be neatly stacked by classes at suitable depots on well drained ground and not left lying about promiscuously.

See Clause 11.12.

Suitable precautions against fire shall be taken with all large accumulations of sleepers.

Unserviceable wood sleepers removed from **spot renewals** have no value.

Wood sleepers released from major works such as through resleepering, must be sorted into three classes viz. S.H. Fit for Running Lines, S.H. Fit for Sidings, and Unserviceable.

The spike holes in the two serviceable classes shall be plugged before re-use as laid down in Clause 11.17.

The two serviceable classes must be accounted for, and the instructions of the Chief Engineer obtained with regard to the financial adjustments to be made.

The instructions of the Chief Engineer shall be obtained for the disposal of large stocks of unserviceable sleepers.

20.25 **Steel Sleepers.**— All steel sleepers shall be neatly stacked by classes at suitable depots on well drained ground and not left lying about promiscuously.

Second hand steel sleepers shall be classified and paint marked in accordance with TABLE 20.25A, which also shows the uses to which the sleepers may be put.

On relaying and resleeping works the classification and paint marking will be done on line side after removal of the sleepers from the track. As the sleepers will be laid out singly each can be closely examined.

Steel sleepers damaged in derailments can generally be repaired by reblocking and removal of the denting, and such repaired sleepers **and not new ones** shall normally be used for the stocking of Breakdown Trains.

All used steel sleepers, whether serviceable or unserviceable, must be shown in the returns submitted to the Chief Engineer.

Where lug type sleepers are repressed to "F" type clip and bolt sleepers, sole plates to strengthen the rail seats will be provided if the sleepers are to be laid in Main and Branch through lines. For use in siding tracks the sole plates are not essential.

20.26 **Rails.**— To prevent bending, twisting and sagging all rails shall be stacked on an even bed in firm well drained ground, and clear of the ground on picked unserviceable wood or steel sleepers. The latter shall be spaced at close

intervals and levelled up to ensure that the rails are not distorted vertically.

At least 3 bearer rails shall be placed under each row of rails in stack and a little space of $\frac{1}{4}$" to $\frac{1}{2}$" shall be left between the flanges in the rows to prevent water collecting and setting up corrosion.

Except where stacking space is limited and the quantities are large as in relaying depots, or the rails are to be removed in a reasonably short time, rails **must not be arranged in clusters of alternate upright and reversed rails as this results in serious corrosion.**

A notice board showing the rail section and rail length shall be placed in front of each stack.

Separate stacks must be made of the Standard Short and Special Short rails shown in ANNEXURE 25, and of cut rails and each of the latter shall have its length painted on the web or flange.

All rails whether new, second hand serviceable or unserviceable, must be shown in the returns submitted to the Chief Engineer.

Second hand rails shall be classified and paint marked in accordance with TABLE 20.26A, which also shows the uses to which the rails may be put.

On relayings the classification and paint marking must be done in the track **ahead** of the relaying. This will enable defects in the head of the rail to be more readily detected whilst it is still polished.

Special metal gauges for checking the table wear and side wear shall be used on relaying works, the gauges for the particular rail sections concerned being obtained on requisition through the Chief Engineer.

20.27 **Scales of Tools for Permanent Way Staff.**— Permanent Way Inspectors are inclined to hold excessive stocks against future use. Recoupment requisitions should only be submitted for quantities which can be used within the year.

The scales shown in TABLE 20.27A will serve as a general guide for normal section maintenance and for the first equipment for newly constructed lines.

20.28 **Imprest of Permanent Way Materials with Inspectors.**— The purpose of the Imprest with Permanent Way Inspectors is to provide a stock of essential materials for the restoration of track after an accident and for the replacement of a unit which may have failed in the track suddenly. **It must be clearly understood that such materials must not be used for ordinary maintenance renewals.** Permanent Way materials for this purpose are provided each year as a charge against the Revenue Abstract 'A'; see Clauses 20.06 and 20.12.

The Imprest is a Suspense stock as described in Clause 20.04 and represents a large sum of money locked up. For this reason it is only possible to provide Inspectors with essential items. In exceptional cases a Permanent Way Inspector should be able to remove special components such as clip bolts, keys etc. from a little used siding and replace them by supplies obtained on

requisitions.

Issues from the Imprest must be recouped with the least possible delay, the requisitions being marked URGENT — Recoupment of Suspense.

The scale of Permanent Way Imprest to be held is shown in TABLE 20.28A and each District Engineer shall prepare for his district a chart for each Inspector's section showing the items and quantities to be held and their distribution. Corrections will be necessary when the type of track changes with relayings and yard remodellings.

Imprest materials which cannot be locked up shall be neatly laid out in the Inspector's store yard; see Clause 20.15 on the care of stores.

The materials kept at crossing stations shall be located at a convenient place such as along the back edge of the passenger platform where they can be regularly inspected. The fishplates and fishbolts shall be greased and screwed tightly on to the rails, the sleepers placed across the tops of the rails, and the latter raised off the ground.

The fishplates and fishbolts allotted to section gangs shall be oiled or greased and screwed together, and kept in the store room or tool box provided at the Landie.

To prevent the track and crossing wood sleepers deteriorating they must be exchanged each year with sleepers received for maintenance renewals.

20.29 **Breakdown Organisation — Engineering Department.**— The stations at which Breakdown Trains (also called Relief Trains) are kept in readiness for accidents are shown in the Working Time Table.

The Permanent Way Inspectors at these stations are responsible for keeping the permanent way materials, tools and rations in good condition and up to scale.

On no account are materials, stores etc. to be taken from Breakdown Trucks except for use in the case of derailments. On returning to Headquarters after a derailment the Permanent Way Inspector must see that the recoupment of all materials and stores takes place **immediately,** that all lamps, small tools etc. are overhauled and that the trucks are re-loaded in an orderly manner all ready for the next emergency.

Keys:—

Care must be taken that the key of the covered wagon accompanies the Relief Train. Permanent Way Inspectors must constantly keep one key of the padlocked covered wagon in their possession. The duplicate key must be hung in a prominent position in the Engineer's office (or Inspector's office where there is no Engineer stationed there), and all concerned acquainted of the fact.

Lists:—

Signed official lists of the contents of all wagons must be permanently

pasted up inside the Covered Wagon at each Depot. Copies should be displayed in the Engineer's and Permanent Way Inspector's office as well. Alongside pasted up on a detachable board should be the following inspection form, viz:—

.....District

Inspection Form for Breakdown Wagons at.....Depot.

Date Inspected	B.C.B. No.	B.O.B. No.	B.O.B. No.	B.O. No.	On Ground	Remarks and Signature of Inspecting Officer

Permanent Way Materials:—

The scale of Imprest to be held is shown in TABLE 20.28A.

The larger numbers of rails in the scale are fixed so as to permit of laying a diversion of reasonable length at an accident site. The Chief Engineer will decide, from time to time, the section of rail and type of sleeper to be held for this purpose on each Breakdown Train.

At certain stations which serve sections of the Railway having different weights of track, the Chief Engineer has agreed to hold some of the rails and sleepers "On the Ground" in order to economise in the use of wagons. Where this is done the materials must be stored and sign posted at a convenient point for loading on to wagons.

As relaying or resleepering is carried out the section of track will alter. District Engineers shall keep the matter under review and raise it with the Chief Engineer for a change in the holdings.

Turnouts and turnout materials have not been provided on the Breakdown Train. These are held at each Permanent Way Inspector's depot from where they can be called forward if required.

The fishplates, fishbolts and sleeper fastenings should be loaded in the wagons containing rails and steel sleepers. The wood sleepers shall be loaded in the covered wagon with the tools and rations.

Tools and Equipment:—

See TABLE 20.29A for the items to be stored in the covered wagon.

Rations:—

The commodities and scale per man per day for African, Asian and

European staff are laid down in paragraph 517 of the General Appendix to the Working Time Table and General Rules.

The quantities to be provided for the staff of the Engineering Department shall be sufficient for 4 days and for:—

100 Africans

6 Asians

4 Europeans.

The maize meal shall be exchanged monthly. Full sacks of meal should be returned to the Stores Department on form EAR.0008; used sacks should be destroyed.

All foodstuffs should be examined every two months by the Health Inspector of the District who will submit a written report to the District Engineer.

Condemned stocks will be written off and replaced immediately.

20.30 **Flood Damage Emergency Stocks.**— In order to facilitate expeditious repairs in cases of flood damage, Districts will hold stocks of the materials shown in TABLE 20.30A at the stations named therein.

The gabions should be made from 3″ or 4″ Weldmesh or other suitable material. The size of 4′ x 2′ x 2′ may be modified slightly to suit the size of available sheets of Weldmesh.

The sandbags must be carefully stored from damp and termites and shall be aired out at frequent intervals.

TABLE 20.25A

CLASSIFICATION OF SECOND HAND STEEL SLEEPERS

Sleeper	Class	Mark	Defects	Uses
All Lug Types	A	NONE	Crack alongside the lug not exceeding $\frac{3}{4}$".	For Main Lines and 2nd Lines in Station Yards.
	B	/	(a) Crack alongside the lug exceeding $\frac{3}{4}$". (b) Sleepers dented in accidents but otherwise sound.	For conversion to "F" type clip and bolt.
	C	//	Defects in addition to "B" Class such as light crack in rail seat or skirt; one lug broken; excessive wear on the rail seat.	For Sidings. Not to be converted to "F" type clip and bolt.
	US	X	Serious cracks through the rail seat or skirt; excessive corrosion.	**Not to be laid in track.** Will be disposed of as scrap by the Stores Superintendent. *(See Note 3 below).*
All Clip and Bolt Types	A	NONE	NONE	For Main Lines and 2nd Lines in Station Yards.
	B	/	(a) Slightly dented in derailments not seriously affecting the track gauge. (b) Slightly cracked lug in repressed sleeper. (c) Light cracks in rail seat. (d) Crack not exceeding one inch length in **one side only** of the skirt. (e) Wear not exceeding $\frac{1}{8}$" depth on the rail seat. (f) Light corrosion.	For Sidings. Sleepers dented in derailments to an extent seriously affecting the track gauge will be repaired by re-blocking.
	US	X	(a) Serious cracks in or complete failure of the rail seat. (b) Cracks in **both** sides of the skirt. (c) Wear exceeding $\frac{1}{8}$" depth on the rail seat. (d) Excessive corrosion.	**Not to be laid in track.** Will be disposed of as scrap by the Stores Superintendent. *(See Note 3 below).*

Note:— 1. The marking shall be done in one inch wide **white** stripes across the upper side at the middle of the sleeper.

2. There is no Class 'C' in clip and bolt type sleepers.

3. Only such 'US' class sleepers as are seriously thinned or holed by corrosion should be sent direct to the Stores Department as scrap. All other 'US' sleepers must be sent to the Sleeper Press, Nairobi, where they will be sorted for repair and the manufacture of sole plates.

TABLE 20.26A

CLASSIFICATION OF SECOND HAND RAILS

Class	Colour Mark	Condition	Uses
1	WHITE	(a) Both running edges unworn and no other defects. (b) Table wear not exceeding 1/16".	For Main Lines and manufacture of points and crossings.
2	YELLOW	(a) One running edge unworn. (b) Side wear on other edge up to 5/16". (c) Table wear not exceeding 3/32". (d) Wheel skid marks on the table. (e) Metal flowing or flaking along top edges of the table.	For 2nd Lines in Station Yards and important tracks in large Yards.
3	GREEN	(a) One running edge unworn. (b) Side wear on other edge exceeding 5/16" but not exceeding 11/16". (c) Table wear exceeding 3/32" but not exceeding ¼". (d) Lightly hogged or dished rail ends. (e) Moderate corrosion in web and flange.	For Sidings.
US	RED	(a) Both running edges side worn. (b) Side wear on one running edge exceeding 11/16". (c) Table wear exceeding ¼". (d) Excessive corrosion in web and flange. (e) Cracks or splits. (f) Flattened head. (g) Vertical twist. (h) Severe scabs on the table. (i) All cut rails under 12 ft. length.	**Not to be laid in track.** Instructions regarding disposal to be obtained from the Chief Engineer.

Note:— 1. The classification will apply to standard length rails (including cropped rails of special lengths) and to cut rails of 12 feet and over.

2. All released second hand rails must be classified and painted with a 6" wide band on one side of the rail and 2 ft. from the end, with the appropriate colour of the class.

TABLE 20.27A

SCALE OF TOOLS FOR PERMANENT WAY STAFF

Description of Article	Per P.W.I.	Per S.P.W.I.	Per Section Gang
Hand Flags, Red and Green	6 of each	2 of each	2 of each
Detonators (Fog Signals)	6 dozen	1 dozen	1 dozen
Banner Flags, Red	6	2	2
Hand Signal Lamps, Tricolour	4	1	2
Trolley Lamp, Red both sides	1	1	—
Chain and Padlock for Trolley	1	1	—
Rail Gauge (track)	4	1	1
Straight Edge (level board)	6	1	1
Spirit Level	4	1	1
Cant Board	4	1	1
Track and Cant Gauge	1	—	—
Gang 'G' Board	—	—	2
Caution Board (arrow)	2	2	—
'C' Board	2	2	—
'E' Board	2	2	—
Lamp white with padlock for Caution Board	2	2	—
Numeral Plates for Caution Board	2 sets	2 sets	—
Tool Box (if no separate store room)	—	—	1
Rule, boxwood 2 ft. four fold	3	1	—
Tape Metallic, 50 feet	1	1	—
Tape Steel, 100 feet	1	—	—
First Aid Box	1	1	—
Augers, Carpenter ½" (for softwoods)	6	1	1 if required
„ „ ⅝" (for hardwoods)	6	1	1 „ „
„ „ ¾"	4	1	1 Stn. Yards
„ „ 1"	2	—	—
„ „ 1½" (for plugging bridge sleepers)	2	—	—
Bar, claw	6	—	1
Bar, crow, slueing	6	—	6 maximum
Bar, Tommy, Platelayer's	4	1	1
Beater, steel	20	—	1 per man
Shovels, round nose	10	—	1 per man
Jembe (Hoe)	10	—	1 per man
Ballast Forks	10	—	1 per man
Hammer, Spiking 5 lb.	2	—	1
„ Keying 4½ lb.	2	—	1
„ Sledge 7 lb.	2	—	—
„ Hand 1 lb.	2	1	—

Continued

TABLE 20.27A

SCALE OF TOOLS FOR PERMANENT WAY STAFF (Continued)

Description of Article	Per P.W.I.	Per S.P.W.I.	Per Section Gang
Spanner, Fishbolt	6 of each kind	—	1
,, for crossing bolts	—	—	1
,, for bridge bolts	—	—	1
,, Box, T handle	6	—	2
,, Clyburn large	2	1	—
Chisel, cold flat	1	1	1
Cold Set, rodded handle	2	1	1
Bucket, G.I.	4	2	1
Bill Hook (Machete)	6	—	1
Pan, mortar (Karai)	10	—	4
Ballast Template	—	—	1
Log Line	500 ft.	—	100 ft.
Fishing Line (for curve versines)	200 ft.	100 ft.	—
Boxwood Rule 20″ (for curve versines)	1	1	—
Padlocks	As required	2	1
Files, flat 12″	3	1	—
Pliers 8″	1	1	—
Side Wear Gauge for Rails	1	—	—
Lamp, Hand, pressure	1	—	—
Lamp, Hurricane	1	1	—
Axes, felling	2	—	—
Forge, portable	1	—	—
Jim Crow	1	1	—
Rail Tongs	6	—	—
Rail Saw	1	—	—
Rail Saw Blades	12	—	—
Rail Drilling Machine	1	—	—
Rail Drills	6 of each size	1 of each size	—
Ratchet Brace, Engineer's	1	1	—
Clamp for Ratchet Brace	1	1	—
Track Jack	2	—	—
Track Square	1	1	—
Handles for all Tools	As required	—	—

TABLE 20.28A

SCALE OF IMPREST PERMANENT WAY MATERIALS

Item	Description	Break-down Train	P.W.I's Depot	Per Crossing Station Except Hd. Qrs.	Per Gang Excluding Station Yards
1	RAILS 40 ft. 95 N.BS	10	20	1	—
2	„ 40 ft. 80 & 60 lb.	40	20	1	—
3	„ under 60 lb.	50	20	1	—
4	FISHPLATES (each rail section)	2 per rail	40	2	2
5	FISHBOLTS (each rail section)	4 per rail	80	4	4
6	STEEL SLEEPERS complete with fittings (any rail section). For 50 OBS and 50 NS the sleepers will be 'F' type. *(See Note 1 below).*	320	100	6 (without fittings).	—
7	JUNCTION FISHPLATES (each combination required, 1 set = 4 plates).	2 sets	4 sets	—	—
8	HARDWOOD SLEEPERS				
	Type 1	50	30	—	—
	Type 2	—	20	—	—
	Types 3 to 6	—	10 of each size	—	—
9	BEARING PLATES FOR BRIDGES (each rail section)	—	30	—	—
10	SCREW SPIKES	100	200	—	—
11	COACH SCREWS	50	100	—	—
12	DOGSPIKES	200	200	—	—
13	TURNOUTS (for each rail section and crossing angle)				
(a)	Switches comprising R.H. and L.H. Stock Rails and Tongue Rails fitted wih slide chairs and distance blocks. *(See Notes 2 and 3 below)*	—	1 set	—	—
(b)	Gauge Tie Plate	—	1	—	—
(c)	Check Rails (two) without stock rails but with check blocks, and bolts fastened to them and component chairs or bearing plates. *(See Note 4 below).*	—	1 set	—	—
(d)	Crossing, with component chairs or bearing plates. *(See Notes 2 and 4 below).*	—	1 set	—	—

(Continued)

TABLE 20.28A

SCALE OF IMPREST PERMANENT WAY MATERIALS (Continued)

Item	Description	Break-down Train	P.W.I's Depot	Per Crossing Station Except Hd. Qrs.	Per Gang Excluding Station Yards
14	SPARE TONGUE RAILS (only for fully interlocked points — for each rail section and type) R.H.	—	—	1	—
	- do - L.H. (*See Note 3 below*).	—	—	1	—
15	SWITCH LEVER (of each type).	—	1	—	—
16	PULL ROD (of each type).	—	1	—	—
17	CONNECTING ROD FRONT AND BACK (of each rail section and type).	—	1 of each	—	—

Note:— 1. Item 6 — The sleepers on the Breakdown Train should be reconditioned ones, not new, in order to keep down the costs of accident repairs.

2. Separate R.H. and L.H. Switches and Crossings will not be held. Order R.H. and 'hand' them as required at site with a Jimcrow.

3. In the case of flexible switches of 60 R.BS, 80 R.BS and 95 N.BS; except for curvature, studs and distance blocks, the lengths of the stock rails and tongue rails and their machining are identical for all crossing numbers in each of these rail sections. The curving or straightening of them can be done on site. See Clause 14.04 of the Manual.

4. Items 13(c) and (d) — The fittings required are:—

   For Lug type chairs — Steel Keys.

   For Flat bearing plates 60R and 80R — Nil. Use Item 10.

   For Flat bearing plates 95N — Clips and special Clip Bolts.

TABLE 20.29A

TOOLS AND EQUIPMENT FOR BREAKDOWN TRAINS

Tools	
Axes, felling	2
Augers, Carpenter ¾" and ⅝"	6
Beaters with handles	12
Bars, claw	2
Bars, crow, slueing	6
Bars, Tommy, Platelayer's	1
Jim Crow (to suit rail)	1
Rail Gauge (track)	1
Hammers, Keying	2
Hammers, Sledge	4
Jumpers, steel	3
Track Jacks	4
Spirit Level	1
Pans, mortar	20
Jembes (Hoes) with handles	20
Picks with handles	10
Shovels	10
Slashers	10
Spanners, Fishbolt	4
Spanners, Box for clip bolts	4
Spanners, Box for coach screws	2
Spanner, Clyburn large	1
Cold Sets, rodded handle	6
Rail Sawing Machine	1
Rail Saw Blades	12
Rail Drilling Machine	1
Rail Drills (to suit rails)	3
Rope 3" circ.	100 ft.
Hooks pulling	4
Rail Tongs	12
Detonators (Fog Signals)	2 doz.

Miscellaneous	
First Aid Box	1
Tents, Bush	2
Tarpaulins with poles for resting labour	4
Cooking Pots with lids	15
Buckets, G.I.	2
Empty Dhebies	5
Primus Stove	1
Parchment Cups	500
Lamps, Tilley	6
Lamps, Pressure, hand	4
Lanterns, Hurricane	6
Lamp, Handsignal	2
Mantles for Tilley Lamp	12
Mantles for Hand Lamp	12
Washers for Pressure Lamps	6
Cleaning Equipment	1 set.
Methylated Spirit	2 quarts
Matches	24 boxes
Kerosene Oil	16 galls.
Funnels, filling	2
Fire Extinguishers	2

TABLE 20.30A

FLOOD DAMAGE EMERGENCY STOCKS

District	Station	Boulders Cft.	Sleepers Nos.	"Dogs" Nos.	Gabions Nos.	Sandbags Nos.
Mombasa	Mombasa	—	—	—	100	1,000
	Mazeras	10,000	500	1,000	—	—
	Voi	10,000	500	1,000	—	—
	Mtito Andei	—	500	1,000	—	—
	Kibwezi	10,000	—	—	—	—
Nairobi	Sultan Hamud	10,000	500	1,000	—	—
	Nairobi	—	1,000	2,000	100	1,000
	Kajiado	4,000	—	—	—	—
	Thika	4,000	500	1,000	—	—
	Karatina	4,000	500	1,000	—	—
Nakuru	Nakuru	10,000	1,000	2,000	100	1,000
	Kisumu	10,000	500	1,000	—	—
Eldoret	Eldoret	10,000	500	1,000	100	1,000
Kampala	Tororo	10,000	500	1,000	—	—
	Kampala	10,000	500	1,000	100	1,000
	Nkonge	4,000	—	—	—	—
Tanga	Tanga	10,000	500	—	100	1,000
	Mombo	10,000	—	—	—	—
	Moshi	10,000	—	—	—	—
Dar es Salaam	Dar es Salaam	4,000	500	—	50	500
	Morogoro	10,000	500	—	50	500
	Kilosa	4,000	500	—	50	500
Dodoma	Gulwe	—	500	—	—	500
	Msagali	10,000	—	—	—	—
	Dodoma	—	1,000	—	100	1,000
	Manyoni	4,000	—	—	—	—
	Itigi	—	500	—	—	500
Tabora	Tabora	10,000	500	—	100	1,000
	Bukene	10,000	300	—	50	500
	Shinyanga	4,000	300	—	50	500
	Kaliua	4,000	300	—	50	500

Note:— 1. The "Dogs" are bent pointed hooks of ½" dia. steel for fixing the wood sleepers in cribs.

2. The sleepers in Tanganyika Districts will be the German types.

SECTION 21

EXPLOSIVES AND BLASTING

21.01 **Explosives Regulations.**— Each territory has its own Explosives Ordinance which must be complied with.

The instructions which follow in this Manual generally conform to the Ordinances and where they may be found to conflict with the latter the requirements of the Ordinances shall be paramount.

All Engineers concerned with the storage and use of explosives must acquaint themselves with the Ordinance of the territory, and if in doubt obtain the advice and instructions of the local Inspector of Explosives.

21.02 **Appointment and Responsibilities of a Mine Manager.**— The Ordinances require that a "mine manager" be appointed who shall be responsible under the regulations for the control, management and direction of the storage of explosives and blasting operations.

He may be an Engineer or other responsible official licenced by name by the Mines Department.

Application for a licence should be made to the local Inspector of Explosives. It is required to be renewed annually and any change in the person named therein should be communicated to the issuing authority.

21.03 **Licence to hold Explosives.**— No explosives may be held without a licence issued by the Inspector of Explosives, to whom application shall be made by the District Engineer or Resident Engineer.

Each separate explosives magazine is required to be licenced, and the licences shall be renewed annually.

21.04 **Blasting Certificate.**— No person shall use, or cause to be used, any blasting material unless he is in possession of a valid permit issued to him, for such purpose, by the Inspector of Explosives, who will satisfy himself that the applicant may be safely entrusted with the use of blasting materials.

The District Engineer or Resident Engineer shall apply to the Inspector of Explosives for such permits, as the need arises, naming the persons, who must be responsible officials capable of carrying out blasting operations in accordance with the Explosives Ordinance.

The permits are required to be renewed annually.

21.05 **Explosives Magazines.**— No explosives may be stored except in an explosives magazine, which shall be adequate in space for the quantities of explosives to be stored, and shall be constructed in accordance with the requirements of the Explosives Ordinance.

Each magazine shall be approved by and licenced by the Inspector of Explosives. For the construction of a new magazine his prior approval shall

be obtained, suitable drawings being submitted of the structure and its location in relation to buildings, roads, the railway etc.

See Chief Engineer's Drawings Nos. 5501/1, 5501/2 and 5501/3 for permanent types of Explosives Magazines.

Where it is necessary to erect a temporary magazine at a worksite suitable designs shall be prepared and submitted with an application for a licence to the Inspector of Explosives.

21.06 **Explosives required to be stored in Magazines.**— All blasting materials are required to be stored in magazines. Those commonly used are:—

	Packed in
Gelignite 40% or 60% in cartridges (sticks)	50 lb. cases.
Detonators	Boxes of 100.
Fuse Igniter	24 ft. coils, or 2,400 ft. reels.
Safety Fuse	1,000 ft.
Blasting Powder	Lbs.

Fog Signals (also called Detonators), as used for the protection of track are not classed as explosives, **and are forbidden to be stored in a magazine.**

Requisitions for explosives shall be prepared only for multiples of the minimum packs shown above.

Explosives deteriorate with age and such quantities only shall be obtained as can be used within 12 months or a lesser time.

21.07 **Security of Explosives.**— Any person in charge of explosives shall keep the boxes, places or receptacles containing explosives locked by means of substantial locks and shall not allow the key to leave his possession.

This regulation applies equally to magazines and to boxes used by Blasters in the conveyance to and storage of explosives at a worksite.

21.08 **Care in storage of explosives in Magazines.**— Subject to any restrictions which may be imposed by an Inspector of Explosives the following general precautions shall be taken.

(a) All explosives shall be stored in wooden boxes.

(b) Blasting cartridges and Blasting Powder shall be kept in separate compartments of the same magazine or in separate magazines.

(c) Detonators, in whatever form, shall not be stored together with blasting cartridges or blasting powder. Where a separate magazine is not provided for detonators they shall be kept in a locked box which shall

not be placed within 6 feet of boxes containing other explosives.

(d) Fuse Igniters and Safety Fuse may be kept in any dry and cool place provided that they shall not be kept with any other explosives.

(e) No capped fuse i.e. fuse to which a detonator has been fixed, shall be stored in a magazine.

(f) No primed cartridge shall be stored in a magazine.

(g) No other materials, implements or tools shall be placed in the boxes which contain explosives.

21.09 **Care of explosives at a Worksite.**— At any place where explosives are used locked wooden boxes shall be provided in which blasting cartridges (or powder) and, separately, detonators (or capped fuses) shall be kept from the time of withdrawal from the place of storage until required for immediate charging of each hole or for the preparation of primers or until returned to the authorised places of storage.

Where primers are prepared in advance of immediate requirements they shall be kept in a similar locked box separate from other blasting cartridges, powder, detonators or capped fuses.

The boxes shall be kept not less than 6 feet apart from one another and shall not be within 6 feet of any hole which is being charged with explosives.

21.10 **Record of explosives in a Magazine.**— Issues should only be made for quantities that can be used on the same day, and unused explosives must be returned to the place of storage.

A register shall be kept at the magazine of all receipts, issues, stocks and dates.

21.11 **Returns.**— A return should be submitted monthly to the District Engineer or Resident Engineer giving the following particulars for each magazine:—

(a) Quantity and descriptions of explosives on hand at the beginning of the month.

(b) Quantity received during the month.

(c) Quantity used during the month and to whom issued.

(d) Balance on hand at the end of the month.

(e) Surplus.

(f) Dates on which each item of stock on hand at the end of each month was received.

21.12 **Disposal of Unsafe or Old Explosives.**— All items in storage should be examined at frequent intervals for signs of deterioration.

The date of manufacture of the explosive is marked on the outside of each

box and the normal stores principle of "first in — first out" should be followed for issues to avoid deterioration in stock.

Explosives should be destroyed only by a person having considerable experience of explosives.

In all cases application should be made to the local Inspector of Explosives to examine deteriorated stocks and to advise on the method of their destruction and precautions to be taken.

21.13 Transport of Explosives.—

By Rail.

The regulations are laid down in Section XIV of the General Appendix to the Working Time Table and General Rules, and also in Chapter XI of Traffic Working Orders — Part II.

Application for the despatch of explosives by rail should be made to the District Traffic Superintendent giving him at least seven days notice.

By Road.

Application for a permit should be made to the Inspector of Explosives and his instructions obtained with regard to packaging and other instructions to be taken.

A vehicle belonging to the Railway should be used and a responsible official should accompany the consignment.

21.14 Safety of the Public during Blasting Operations.— The use of explosives on or in the immediate vicinity of any public thoroughfare shall only be carried out under proper authority and with all due precautions for the public safety.

The hours between which blasting will be done shall also be agreed and fixed.

21.15 Blasting Operations affecting the safety of the Railway Line.— General Rule 420 lays down that no blasting operations may be performed on or near a railway line unless previous arrangements have been made with the District Traffic Officer.

The authority of the District Engineer shall also be obtained.

The line must be protected on both sides in the manner shown in Diagram II of ANNEXURE 40, and care shall be taken to see that the line is clear of dislodged stones or other obstruction before removing the danger signals.

21.16 Blasting Operations affecting the safety of Telecommunication Lines.— In the event of it being necessary to carry out blasting operations which may result in damage to or severance of Telecommunication lines and poles, due notice shall be given to the Posts and Telecommunications Administration and a request made for a representative to be present to effect repairs.

21.17 **Blasting Operations carried out by a Contractor.**— The regulations stated herein shall equally apply to any work executed for, or on behalf of, the East African Railways and Harbours Administration and under the direction of the Administration.

They do not absolve the Contractor in any way from complying with the Explosives Ordinance of the territory.

The District Engineer or Resident Engineer shall satisfy himself that the regulations are carefully observed, that the overseer placed in charge of the explosives magazine is qualified to supervise such duties, and that the person conducting the blasting operations is in possession of a valid permit issued by the Inspector of Explosives.

The Engineer shall make any further regulations he may think necessary for safe working or for the protection of persons or property.

21.18 **Accidents.**— In the event of an accident occurring during the performance of blasting operations, the Railway employee (or in the case of the work being carried out by contract, the Contractor) must immediately report same to the Engineer by telegram if possible. A detailed report in writing must, in every case, be submitted to the Engineer as soon as possible after the occurrence of the accident.

Accident reports should contain the following information:—

Mileage or station, or both, at which accident occurred.

Time and date of accident.

Nature of accident.

Number of people killed or injured.

Cause of accident.

SECTION 22

PAINTING

22.01 **Standard Colours.—**

STEELWORK

Buildings — External	Aluminium.
Internal	- do -
	Other colours may be used, if specified, to suit the colour scheme of the building.
Bridge Girders, Viaduct Trestles	Aluminium.
Bridge Troughing (under stone ballast)	Equal parts Bitumen and Cement.
Crane — hand operated — fixed	Aluminium.
Tank — storage — External	Aluminium.
Internal	Black Bitumastic.
Tank Staging	Aluminium.
Turntable, Traverser	- do -

STATION YARDS

Buffer Stop	White with buffer beam in Signal Red.
Derailer	White.
Fouling Point Marker	- do -
Fire Hydrants & Boxes	Yellow.
Loading Gauge	Aluminium.
Manholes and Covers	White.
Name Board — Station	White with Black lettering and Black on posts for 12 inches above ground level.
Platform — Lamp post and frame	White with Black on posts 12 inches above ground level.
Platform Wall and Examination Pits	White (limewash) on face and for a width of 6 inches from top edge.
Water Column	Aluminium.
Oil Column	Black.

POINTS AND CROSSINGS	
Connecting Rods and Pull Rods	White.
Counterweight of Tumbler Lever	Half White/Half Signal Red.
Switch Lever Boxes and Handles	White.
Point Number (on lever box, handle or tumbler)	Black.
SIGNALLING APPARATUS	
Lever Frame (non-interlocked stations)	White.
Signal Post	Aluminium.
Signal Ladder	Black.
LEVEL CROSSING AND TRACK SIGNS	
Boundary Stones	White (limewash)
Gradient, Mile, Half Furlong, and Kilometre Posts	White, with Black markings.
Level Crossing Marking Board	See ANNEXURE 6.
Whistle Board	- do -
Warning Boards	See ANNEXURES 39 and 39A.
MOTOR AND PUSH TROLLEYS	Signal Red.

STATION AND OTHER BUILDINGS ON PLATFORMS, AND STAFF QUARTERS IN THE VICINITY THERETO.

No variation in the existing colour schemes may be made without the prior approval of the Chief Engineer.

At stations where rainwater is collected from roofs, the surfaces of the roof, guttering, and downpipes in contact with water will not be painted with any lead composition.

Latrines will be limewashed white and kept whitewashed periodically. Lime is an excellent disinfectant.

22.02 Frequency of Painting Steelwork.

Internal.— With the exception of the inside surfaces of water tanks, which will be treated in accordance with Clause 18.04, all other internal steelwork will be painted as its condition and circumstances require, and in appropriate colours using approved paints.

External.— Girder bridges will be painted at the following intervals:—

Within 50 miles of the coast ... ... 3 years.

Between 50 and 100 miles from the coast ... 4 years.

Over 100 miles from the coast ... ... 5 years.

No fixed periods are laid down for the painting of steel structures other than girder bridges.

Such structures will be painted as and when necessary, and the entire surface of the structure need not necessarily be painted when only certain parts require it. For instance, the paint on the lower portions of such structures as signal posts and tank staging columns usually fails much earlier than the paint elsewhere on the structure, or the paint on a few cross beams of a staging may suffer due to an overflowing or leaking tank. In such cases the affected part only should be treated, the whole structure being painted only when the paint in general needs renewal, or looks shabby.

22.03 **Paints to be used on Steelwork.**— Three coats of paint shall be applied viz:—
1st Coat — "Minerva" Yellow Chromate Primer, supplied in 5 gallon drums.
2nd and 3rd Coats — "Silveroid" Ready Mixed Aluminium Paint supplied in 5 gallon drums.

Covering Capacities.—

"Minerva" Primer — 700 to 720 square feet per gallon.

"Silveroid" Aluminium Paint — 900 square feet per gallon per coat.

22.04 **Sizes of Paint Brushes to be used.**— It is not possible to lay down rigid instructions regarding the sizes of brushes to be used in painting the various parts of steel structures.

Obviously a large size of brush is desirable for the large plain surfaces of a plate girder web but the same size of brush would be wasteful of paint if used for painting small rounds or angles.

In general the greater the area of the plain surface to be covered the larger the brush that can be used. The use of a very large brush on surfaces broken by rivet heads, or on small sections such as 2 inch angles, is uneconomical in paint, but to use a small brush on a large flat uninterrupted surface is uneconomical in labour.

The following is offered as a guide. The suggested sizes may be departed from in the light of experience:—

(i) Large flat surfaces such as the sides of water tanks, and webs of plate girders — Oval — No. 8/0; Flat — 4″.

(ii) Surfaces broken by closely spaced rivet heads, angle bracings of bridges and tank staging. — Oval — No. 6/0; Flat — 3″.

(iii) Small Angles and M.S. Rounds up to about 1½ inches diameter — Round — No. 12; Flat — 2″.

In no circumstances may pieces of cloth or sacking be used in lieu of brushes.

22.05 **Preparation of Surface.**— No chemicals of any kind whatever shall be used for the removal of old paint and rust.

The whole of the surface to be painted, whether it be the entire structure or a part thereof, will be scraped with steel scrapers.

Excellent paint scrapers can be made from old unserviceable flat files, or they may be made from pieces of 1″ or 1½″ M.S. Flat, not less than 3/16 inch thick, bent through ninety degrees at one end and having the two ends sharpened.

All "dead" paint, or paint not in intimate contact with the surface of the steel, will be removed by means of the scraper. In awkward places such as around close spaced rivet heads, chipping with a light hammer may be necessary.

Old paint which does not come off under the scraper or the hammer need not be removed.

When the entire surface has been scraped, it will be wire brushed, and this will be followed by brushing down with a soft brush such as a dry white-wash sisal brush, to remove dust and loose paint. This latter brushing should be done from the top of the structure downwards.

All prepared surfaces to be wiped with sacking moistened with raw linseed oil to ensure the removal of dust, particles of rust, etc., and to prevent oxidisation during the period elapsing before the new paint is applied.

This completes the preparation of the surface, and it must be remembered that it is a very important part of the process of painting.

No paint shall be applied until the cleaned surface has been inspected and passed by a responsible supervisor as suitable for painting.

22.06 **Application of the Paint.**— Painting must not be carried out in foggy or wet weather. Surfaces to be covered must be absolutely dry before any paint is applied.

When the container is opened the paint must be thoroughly stirred with a wooden paddle until all solids are in suspension.

After stirring, the paint should be decanted into smaller containers for the use of the painters. These smaller containers should be provided with wire handles.

The paint in the small containers should be stirred frequently, and small wooden paddles must be provided to each painter for this purpose.

No "Thinners" of any kind may be added to either the primer or the aluminium paint. The original containers should be opened only when the

surface is ready for painting. If a drum is found to contain paint which after stirring, is too thick for easy application, the drum should be re-sealed as far as possible, and a report made to the Bridge Engineer stating when it was received, when it was opened, and the number of the issue note under which it was received.

(a) *Yellow Chromate Primer*:—

This must be applied as soon as possible after the cleaning of the surface is completed.

Round or oval brushes must be used and the paint must be well rubbed into the surface.

(b) *"Silveroid" Aluminium Paint*:—

(i) First Coat:—

The first coat of aluminium paint must not be applied until the primer coat is thoroughly dry. The primer should dry out in about 48 hours, but it is advisable to wait four days or even more before applying the aluminium paint.

In all cases the primer coat must be inspected and passed before the painters are allowed to apply the first coat of aluminium paint.

Flat or oval brushes must be used in applying the first coat of aluminium paint and it should be well brushed into the priming coat.

(ii) Second Coat:—

The second coat of aluminium paint must not be applied until the first coat is thoroughly dry.

It should be applied with flat brushes in long gentle strokes, to avoid brush marks.

22.07 **Special Note regarding painting Bridges.**— The attention of all Permanent Way Inspectors is drawn to the absolute necessity of thoroughly cleaning and painting of the surfaces under the sleepers in bridges where timber sleepers rest direct on the girder flanges or on the stringers.

Metal surfaces under timber sleepers are particularly liable to corrosion, and in painting a bridge such surfaces must be regarded as the most important part of the job.

Lifting or sliding the sleepers in order to gain access to the steel surface under them is always tedious and sometimes difficult, but if it is not done, the most vulnerable part of the structure will have been missed.

22.08 **Marking the Date of Painting.**—

(a) Bridges and Viaducts — dates of completion of painting to be marked

clearly in white on the web of plate girders and on the bottom boom of triangulated spans at the Mombasa, Dar es Salaam and Tanga end on the left side of the line looking in the direction of the mileage.

The dates must also be entered in the Bridge Register; (see Clause 3.08).

(b) Cranes — the date should appear in small figures near the base of the vertical derrick.

(c) Tanks — the painting date must be marked in white figures in such a position that it is clearly visible from the ground on the station side of the tank, or on the side next to the track or thoroughfare if the tank is not at a station.

22.09 **Safety of Workmen.**— The official supervising the painting of girder bridges and other structures must satisfy himself that the scaffolding, ropes, hooks and other gear to be used, are in good condition, and that the labourers thoroughly understand how these materials should be fixed to ensure the safety of their persons.

A headman shall be placed in charge of the labourers whose duty, apart from supervising the quality of the painting, shall be to see to the safety of them and to act as a lookout to give warning of the approach of a train.

When necessary the line should be protected with signals in accordance with Clause 16.13.

22.10 **Special Warning to Painting Staff.**— Most paints contain lead and are poisonous, and it is essential that all men employed on painting work be warned of the danger of eating without scrubbing and washing their hands and faces. They should also do this before leaving the work.

SECTION 23

STAFF

23.01 **Eyesight Tests for Employees.**— The General Manager's Staff Circular No. 13 dated 24th April, 1952 lays down that all employees will be required to have their eyesight tested by a Government Medical Officer on first appointment.

The circular further requires that the undermentioned employees of the Engineering Department undergo an **annual eyesight test for colour and vision** with the aid of a "Dot Block" and coloured wools:—

Permanent Way Inspector.
Sub Permanent Way Inspector.
Signal Foreman.
Motor Driver.
Trolley Man.
Ganger.

District Engineers should refer to the circular and arrange for the tests, details of which are given therein, to be regularly carried out.

23.02 **Safeguarding Labour on Works.**— A railway servant must, at all times, exercise care in the performance of his duties. He must not expose himself unnecessarily to danger and he must, as far as possible, prevent his fellow servants from exposing themselves and others to danger.

The following are points which are of particular importance neglect of which have resulted in serious and even fatal accidents.

Dangerous Excavations: —

Engineers and their supervisory works staff must take steps to ensure that all excavations, where necessary, are adequately timbered in the interests of safety. In particular, excavation in narrow trenches should be adequately timbered if exceeding 5 feet in depth, unless the work is in rock, hard murrum or similar strata, the stability of which is not in doubt. Precautions must be taken to ensure that spoil heaps are not deposited too close to the excavations.

Labour on Earthworks: —

It is the duty of all Supervisors (Inspectors of Works, Permanent Way Inspectors, Sub Permanent Way Inspectors, Guards of Engineering Trains etc.) to ensure that no dangerous excavations are made that in no circumstances must a working face be under-cut or labour allowed to work in holes and burrows with an overhang of earth. Carelessness and the non-observance of simple commonsense precautions have resulted in loss of life.

Mobile Cranes, Excavators and similar Plant working near Overhead Power Lines: —

In all instances where mobile cranes, mechanical shovels and similar plant are required to work in the vicinity of overhead electric power lines and such work is liable to bring the machine nearer to the power lines than a distance

equivalent to the length of the jib plus the overall length of the base machine, arrangements must be made to ensure that the power in the overhead lines is cut off for the duration of the work.

In the case of rubber tyred equipment, arrangements should be made to earth the machine, preferably by means of a length of heavy electric cable connected to the machine at one end and a metal stake driven into the ground at the other.

All applications for power to be cut off must be made in writing to the electricity supply authority concerned and written confirmation obtained from such authority, before the work commences, that the power has been cut off.

Workshops: —

Goggles must be provided for the use of operators of all high speed grinding, crushing, cutting and planing machines.

Every possible step must be taken to protect operators and labourers from belt races, dynamos and other machines which constitute a danger to life and limb. This can usually be effected through the medium of cages and other similar forms of protectors.

Workshop supervisors must familiarise themselves with the Factories Ordinance applicable to the particular territory and ensure that the safety precautions laid down are complied with. Notices must be clearly displayed in all workshops outlining the precautions to be taken.

Use of Gin Poles between Tracks: —

Where it is necessary to erect a gin pole between railway tracks for the purpose of lifting any article and to guy it to the two tracks, care must be taken to definitely block the lines to traffic and display red flags during the time that a lift is in progress and for so long as the guys are attached to the tracks.

Work on Bridges and other High Structures: —

Where the operations require the workmen to be especially careful against falling off a structure they should be provided with safety belts.

In special circumstances such as deep water, danger from crocodiles, and the moving of heavy articles, consideration should also be given to the use of safety nets.

Ropes used for the support of stagings should never be tied to the track rails where they may be severed by a train or trolley.

Also see Clause 22.09 concerning bridge painting and the precautions to be taken.

Labour on Engineering Trains: —

The attention of all Supervisors of Engineering Trains is particularly

directed to Instruction 266 in SECTION VIII of the General Appendix to the Working Time Table and General Rules.

Where there is an Engineering Supervisor in addition to a Guard, the former will be held jointly responsible for the safety of the labourers employed on the train.

Labour in Permanent Way Gangs: —

When a section gang is working on the track the "G" Gang Boards must be displayed; see Clause 16.20.

In the interests of safety all Permanent Way Staff should be warned to stand well clear of the line during the passing of trains; also not to sit on or near the track when sheltering from rain.

When detonators (fog signals) are placed on the rails the signalman should be cautioned to stand well clear of them during the passage of a train.

Gangs working in busy yards should, where the circumstances warrant it, have one man deputed for the sole purpose of acting as a lookout for the gang.

Work on Level Crossings: —

See paragraphs 3 and 4 of Clause 7.15. The men deputed to display flag signals to road vehicles shall also act as lookouts for the men working on the level crossing.

Use of Tools and the Handling of Materials: —

Supervisors shall see that all tools are safe such as handles are sound and securely fitted, hammer and chisel ends are not frayed causing pieces to break away. When using a hammer no person should be in the line of the man striking the hammer.

Wherever possible heavy materials should be moved on skids, and rail tongs, bars and ropes used. Sufficient men should always be provided when handling heavy materials.

Labour during Lightning: —

The fact that it is dangerous to carry any large metal object, such as a mortar pan or bar, when lightning is in the immediate vicinity, should be explained to the illiterate members of the staff.

Labour in or near Crocodile infested Lakes and Rivers: —

Supervisors of labour working in or near crocodile infested lakes and rivers are responsible for seeing that the labourers are supplied with an adequate water supply under conditions of perfect safety. This can usually be best effected through the medium of a pump.

In the case of men working of necessity in water the supervisor will take all possible precautions, such as the posting of lookouts to protect the men.

Supervisors should prohibit bathing in crocodile infested lakes and rivers.

23.03 **Line Inspections of the Districts.**— The District Engineer should endeavour to inspect his district at least once every three months, travelling as much as possible by trolley and taking with him the Assistant Engineer and Permanent Way Inspector.

He should make it his duty to check the strengths and attendance of gangs and other labour, inspect the store rooms of supervisory staff and stocks of permanent way materials.

He should particularly get to know the subordinate supervising staff and assess their capabilities.

An Assistant Engineer shall share the District Engineer's duties and responsibilities with regard to all work and transactions with which he may be entrusted. He shall spend as much time as possible on line, make frequent inspections by trolley with the supervisory staff, regularly check muster rolls of the staff, and generally act as the eyes and ears of the District Engineer.

23.04 **Duties and Responsibilities of Permanent Way Staff.**— Permanent Way Inspectors and Sub Permanent Way Inspectors must make themselves fully conversant with the General Rules and the General Appendix to the Working Time Table and General Rules, as affecting their duties and responsibilities.

Many of the regulations therein affect Gangers, and the Inspectors should instruct them in their duties and responsibilities.

Permanent Way Inspector: —

A Permanent Way Inspector is responsible for the maintenance, in a safe and efficient condition, of Way and Works on his section, in accordance with the existing special technical regulations and instructions, and for reporting any defect, which he cannot remedy, to his superior officer.

By Way and Works is meant the running lines and sidings comprising the railways and the structures, bridges, tunnels, waterways, embankments, and the like, upon or adjacent to the running or other railway lines. The term also includes such signalling described in SECTION 19, for which the Signal Engineer and his supervisors are not responsible.

No work of any sort which interferes with the track, other than normal work, may be carried out without the knowledge and consent of the District Engineer or Assistant Engineer.

A Permanent Way Inspector is required to aim at a high standard of track maintenance and to always observe safety regulations both in the interests of the travelling public and himself.

He is responsible for the discipline of the servants employed under him, for seeing that all such servants have a thorough knowledge and clear understanding of the duties assigned to them, and that they carry out such duties

properly and efficiently.

He is expected to travel over every part of his section at least once a week, making his inspections by foot, by trolley and by engine, and the direction and time of his inspections should be varied and not become routine.

In the event of him being engaged for an extended time on any special work, he must, with due sense of his responsibility, make the time to travel over his section.

He will maintain a diary to enable him to account for his movements and activities each day.

He will not leave his section without the permission of the District Engineer or Assistant Engineer, and before departing from his headquarters on duty must leave, with his clerk or with the official in charge of his home station, an advice of his intended movements.

Sub Permanent Way Inspector: —

It is the duty of a Sub Permanent Way Inspector to assist his Permanent Way Inspector in his activities and to work to his instructions within the sub-section in his charge. The regulations above for the Permanent Way Inspector shall therefore be read and shall be held to apply generally to the Sub Permanent Way Inspector.

He is required to trolley over his length at least twice a week, and is expected to spend some time with one or more gangs daily, to watch the men at work and to instruct each individual member.

Ganger: —

See paragraph 2 of Clause 23.04.

No one who has not previously been promoted to the rank of Keyman will be eligible for appointment as Ganger.

Appointments to the rank of Ganger are to be made with due regard to ability and seniority.

District Engineers are responsible that all vacancies are filled by the most suitable men on the districts and not simply by the nominee of the Permanent Way Inspector of the section on which the vacancy occurs.

To ensure that this will be done, the District Engineer will maintain registers of Gangers and Keymen and all vacancies as they occur will be reported to the District Engineer.

The ability of a member of a particular tribe to obtain harmonious working on any particular section must be given careful consideration.

The Ganger shall, in the event of the Keyman being absent, depute a suitable man from the gang to perform the daily inspection of the track.

Each Ganger shall be held responsible to the Permanent Way Inspector f the safety of all tools, imprest materials and rations issued to his gang. To and rations shall be kept under lock and key. **No tools shall be left over-nig on the line at the site of work.**

It is the duty of the Ganger to see that his Landie is kept at all times in clean and sanitary condition, and he shall be responsible for good discipl among his men and their families.

The practice of gangmen living in neighbouring villages or towns should b stopped by all possible means as it leads to irregularity in working hour Furthermore it is necessary that they be available to deal with an emergenc or for patrolling the track in heavy rainfall and flooding.

There is much that the Engineers and Inspectors can do to make the sectio gang camps more comfortable e.g. prompt attention to roof and other repair the water supply, planting of shade trees, and encouraging cultivation of foo crops for the personal use of the men in accordance with Clause 4.14.

Keyman: —

Permanent Way Inspectors must clearly explain to each Ganger an Keyman that:—

(a) It is the Keyman's primary duty to patrol the whole of his section i both directions each day, excluding Saturdays, Sundays, public hol days and the other days when he is relieving the Ganger.

(b) He should report to the Ganger, any defect in the track which require early attention.

(c) He should inspect openings and report any unusual defects or obstruc tions.

(d) The patrol of his section in both directions each day should not permi of his having any spare time to carry out weeding etc.

(e) He should be in possession of the following Tools:—

One keying hammer.
Two spanners.
One red and one green hand flag.
~~Four detonators.~~ 19 ~~52~~ G.R. 234 PARA XVI ,, dele

The Ganger will of course carry out all the above duties to the full on the days in which he carries out the patrol.

23.05 Exchange of Duties of Gangers and Keymen.— To enable the Ganger to super vise his gang length frequently and to provide efficient training for the Keyma the following procedures shall be adopted.

Saturday Morning.

The Ganger and the Keyman will each check track levels on the respecti

and alterations for additional or reduced track and turnouts, if any, must be shown therein.

23.11 **Extra Gangs.**— The basic rating and additional factors for gang strengths have been carefully compiled and include an element for absenteeism, savings on which may not be used by the District Engineer for the appointment of extra gangs.

Extra gangs charged to the A. II(a) (i) track maintenance vote shall be controlled by the Chief Engineer to whom application shall be made in June and December of each year.

Extra gangs charged to A. II(i) (d) — earthworks, and to works done against sanctioned estimates are within the powers of the District Engineer.

TABLE 23.09A

BASIC RATING OF NORMAL PERMANENT WAY GANGS

Section of Railway	Men Per Mile	Section of Railway	Men Per Mile
Mombasa — Nakuru	2	Tanga — Korogwe	1½
Nakuru — Kampala	1¾	Korogwe — Moshi	1½
Kampala — Kasese	1½	after stone ballasting	1¾
after stone ballasting	1¾	Moshi — Arusha	1¾
Kisumu Branch	1½		
Nanyuki Branch	1½	Dar es Salaam — Morogoro	1½
Voi/Moshi Branch	1½	Morogoro — Kigoma	1¾
after stone ballasting	1¾	Mwanza Branch	1½
Magadi Branch	1¾	after stone ballasting	1¾
Thomson's Falls Branch	1¾	Mpanda Branch	1¾
Solai Branch	1¾		
Butere Branch	1¾	Ruvu — Mnyusi	1¾
Kitale Branch	1¾		
Soroti Branch	1¾		
Namasagali Branch	1¾	Southern Region Railway	1¾

BASIC RATING FOR STATION YARDS

Station	Men Per Mile	Station	Men Per Mile
Mombasa and Port	2	Tanga	1½
Voi	1½	Moshi	1½
Nairobi	2		
Nakuru	1¾	Dar es Salaam	2
Kisumu	1¾	Morogoro	1½
Eldoret	1½	Dodoma	1½
Tororo	1½	Tabora	1½
Jinja	1½	Kigoma	1½
Kampala	1½	Mtwara	1½

For all other station yard gangs . . . 1¼ men per mile.

Note: (a) The number of men per mile is exclusive of the Ganger and Keyman.

(b) Where section gang lengths are in kilometres they must be converted to "miles" by multiplying the former by $\frac{5}{8}$ to two decimal places.

(c) On long sidings where separate gangs are provided, e.g. the Kilembe Mines Siding, the basic rating shall be 1¼ men per mile.

TABLE 23.09B

PERMANENT WAY GANG STRENGTH RATING

I **Basic Rating without Extra Factors.**

For the men per mile excluding Ganger and Keyman, on the different sections of the Railway, see TABLE 23.09A.

II **Factors to be used in assessing Additional Men.**

Normal Section Gangs.		*Equivalent miles of Plain Track*
Plain Track	Actual length.	
Curvature in plain track over 4 degrees sharpness	1,000 Lft./Track	= 0.05
2nd Loops and Sidings	1,000 Lft./Track	= 0.07
Turnouts	Each	= 0.04
Exceptionally bad sub-grade extending over more than half the gang length	1 additional man to the Gang.	

Station Yard Gangs.		
All plain track	Actual length.	
Turnouts	Each	= 0.04
Scissors Crossover	Whole	= 0.16

Note: (a) In computing the number of men using the basic rating, with or without the additional factors, over 0.33 man to be taken as 1 man.

(b) Plain track is exclusive of the space occupied by a turnout, i.e. it is measured to the end of the stock rail on the one side and to the end of the crossing on the other side.

Example. Normal 4 mile section with basic rating of 2 men per mile; 5 Turnouts; 3,000 ft. of Sidings; 4,000 ft. of curvature over 4 degrees.

	Equivalent Miles
Plain Track	4.00
5 Turnouts x 0.04 each	0.20
3,000 ft. Sidings x 0.07 per 0/00 ft. ...	0.21
4,000 ft. Curves x 0.05 per 0/00 ft. ...	0.20
	4.61

Number of men for the Gang 2 x 4.61 = 9.22 = 9 men.

SECTION 24

HEALTH AND SANITATION

24.01 **Responsibility for Sanitation.**— The Engineering Department is directly responsible for the cleanliness and satisfactory sanitary conditions of all fixed property and land owned by the Railway Administration.

24.02 **Health Inspectors.**— The Health Inspector attached to each Engineering District is directly under the District Engineer for instructions, discipline and pay.

A Senior Health Inspector is attached to the Chief Engineer for line duties and will advise the latter on health organisation and staff matters and generally on the work carried out by the staff. For this purpose the Senior Health Inspector shall make periodical inspections of all Districts as required by the Chief Engineer.

24.03 **Principal Duties of a Health Inspector:—**

(a) He must make periodical inspections of the District as required by the District Engineer or the Senior Health Inspector and report all cases where nuisances exist and make suggestions for the improvement of conditions. He must appreciate that his functions are not entirely reporting and inspecting and that wherever possible he must remedy faults or have them remedied by the local authority.

(b) He must make himself acquainted with all rules, regulations and circulars on health matters issued by the Administration and generally see that they are enforced and carried out. He should report to the District Engineer with a copy to the Senior Health Inspector, any non-observance of these rules. He should also make himself conversant with by-laws issued by the local Health Authority of his district.

(c) He should report to the District Engineer with a copy to the Senior Health Inspector, any case of insanitary conditions on land or property adjacent to that of the Railway Administration, so that representations can be made to the proper authority.

(d) He should exterminate rats, bats, and bees on Railway property and for this purpose he will be supplied by the District Engineer such staff and appliances as the latter shall allow.

(e) He shall take steps to exterminate ticks, and other carriers of disease which may exist on the Administration's property and for this purpose he will be supplied by the District Engineer with such staff and appliances as the latter considers necessary.

(f) He shall exterminate wood borers, termites and such other insects which may be found damaging Railway property.

(g) He shall particularly endeavour to prevent the breeding of mosquitoes on Railway property and shall be provided with such staff and appliances for

the work as the District Engineer shall think fit.

(h) He shall inspect all the Administration's water supplies and take steps against pollution.

(i) He shall assist the fumigating officers of the Operating Department as and when required.

(j) He shall inspect at intervals all labour camps, whether permanent or temporary, and report on their condition to the District Engineer with a copy to the Senior Health Inspector. He should also be prepared at any time to advise Department Officers and Contractors regarding the siting of camps. He should acquaint himself with the rules and regulations issued by the Labour Department relating to labour camps and ensure that they are enforced.

(k) If instructed to do so by the District Engineer he will take charge of sanitary gangs for specific works.

(l) He shall inspect each month all food stored in Relief Vans and carry out instructions issued by the Chief Engineer from time to time as regards condemnation of unwholesome food and submission of reports. In case of food stuffs on sale in Dak Bungalows, Hotels and Restaurant Cars, the Health Inspector shall deal with these as follows:—

Perishable food stuffs found by him to be unwholesome shall be destroyed forthwith and a certificate, showing the amount condemned should be sent immediately to the Superintendent-in-Charge, Catering, copies of the certificates being sent to the District Engineer and the Senior Health Inspector. In the case of tinned food, the tins should be sent to the Superintendent-in-Charge, Catering, with a certificate that the food is unwholesome and should be destroyed; copies of such certificates being sent to the District Engineer and the Senior Health Inspector.

(m) He shall inspect all vendors' stalls at stations and ports and enforce regulations as laid down by the Administration and the Licensing Authorities of the Government for the sale of food on such premises.

(n) He shall do no medical work such as inoculation and vaccination except under special instructions issued by the Medical Department with the cognisance of the District Engineer. This does not, of course, refer to First Aid work in the case of emergencies.

(o) In the event of any infectious disease breaking out in the District, the Health Inspector shall take immediate preventive measures and shall report the matter by telegram to the District Engineer, Senior Health Inspector and local Health Authorities. He will, if necessary, also alert a neighbouring District.

(p) A Health Inspector has no authority to enter into negotiations or correspondence with any health, medical or other authority, or with representatives of other Railway Departments. This may only be done through the District Engineer.

(q) No work in the nature of altering septic tanks or sewage systems is to be carried out by the Health Inspector without prior sanction from the District Engineer.

(r) A Health Inspector has no authority to use insecticides, disinfectants and Anti-malarial oil which have not been approved by the Chief Engineer.

(s) A Health Inspector shall hold such stocks of drugs and dressings as may be necessary for the recoupment of First Aid boxes.

(t) The Health Inspector must submit to the District Engineer at the beginning of each month, with a copy to the Senior Health Inspector, a report showing the work carried out by him during the previous month; and shall keep both officials informed of his intended movements.

24.04 **Sanitation Precautions applicable to all Camps and Stations.**— All combustible rubbish shall be burnt in an incinerator or in a heap, and other materials such as tins, bottles and similar odds and ends shall be removed and buried in a refuse pit.

Where water borne sewage is not provided, night soil shall be buried in a trench, separate to the refuse pit, and covered with a good layer of soil immediately to prevent fly breeding.

The refuse pit and night soil trench shall be dug by the Engineering Department and located at suitable distances away from dwelling and station premises.

The earth spoil from the pit and trench shall be heaped nearby to permit of it being pulled back as cover.

To prevent mosquito breeding all borrow pits and stagnant pools shall be drained or filled up. Where this cannot be immediately done kerosene oil should be applied to the surface, once a week, on every collection of water in or near station premises and dwellings.

Open drains shall be properly graded and vegetation cleared to permit of the water flowing.

All rank vegetation in the vicinity of station premises and dwellings shall be cleared and kept permanently down.

Useless bush and weeds must be cut down and all such refuse burnt to prevent rotting.

24.05 **Ground Water Tanks.**— The ground tanks provided for each camp, gang landie and wayside station shall be large enough to contain an ample supply of water throughout the interval between consecutive water trains.

They should be sunk into the ground, properly maintained and protected against leakage and undue evaporation.

See Clause 18.05.

24.06 **Stations.**— Sanitation is under the charge of the Station Master but Engineers and their Inspectors must take every opportunity to inspect the premises and see that the precautions mentioned in Clauses 24.04 and 24.05 and the instructions given below are carried out.

All drains, except at those stations where the Engineering Department undertakes the work, must be kept clear of obstructions by station staff. Any alteration in the course of earth drains which may seem desirable must be referred to the District Engineer's staff.

Latrine floors must be cleaned thoroughly and frequently, lavatory seats scrubbed and latrine pans washed with disinfectant. Walls shall be limewashed whenever necessary.

Where cesspools exist these shall be emptied periodically and treated with disinfectant.

Rubbish from passenger trains shall be collected and refuse and nightsoil disposed of as laid down in Clause 24.04.

Where sewage disposal is by septic tank the Health Inspector must be consulted before any cleaning and disinfectant is used.

24.07 **Gang Landies.**— Sanitation is the responsibility of the Permanent Way Inspector and Gangers with the assistance, when necessary, of the Health Inspector.

Dwellings, huts and their surroundings shall be kept clean and sanitary as laid down in Clause 24.04, and the workmen and their families must be induced to use the latrines and refuse pits provided.

24.08 **Labour Camps.**— Each territory has its own laws which lay down the standard of housing construction and accommodation to be provided and the requirements for sanitary control, medical care, water supply, etc.

Apart from departmental inspection, the Labour Officers carry out independent inspections and report independently.

Engineers and Health Inspectors must keep themselves informed on the territorial laws and instructions issued by the Chief Engineer.

The siting of large camps should be selected in conjunction with the Health Inspector, and particular attention paid to Clauses 24.04 and 24.05.

The staff must be prevented by all possible means from having their wives and families in temporary camps.

24.09 **Disinfestation of Quarters.**— See Volume II for the instructions concerning disinfestation and the schedule of charges for work carried out.

24.10 **Reporting Outbreaks of Illness.**— The Permanent Way Inspector or other official in charge shall immediately report to the District Engineer, and where necessary the nearest Medical Officer, any case of suspected infectious disease occurring at a Landie or in a Labour Camp. At a station the Station Master is required to deal with this matter.

SECTION 25

PORTS AND HARBOURS

25.01 **Check Railing in Port and Harbour Areas.**— Check rails will be fitted to tracks within Port and Harbour areas, as follows:—

(a) All tracks on the wharf apron will be check railed.

(b) The track immediately adjacent to the loading platform of transit sheds, together with the next adjacent track, to be check railed.

(c) Tracks in stacking ground areas will not normally be check railed, but the surfacing of the area is to be sloped down immediately adjacent to the running rail to provide flange clearance.

(d) Approach tracks to the tracks on the wharf face, where both road and rail traffic is expected to be heavy, e.g. the space between transit sheds on the wharf, shall be check railed.

Secondhand rail will normally be used for the checking.

Any cases not covered by the above to be referred to the Chief Engineer.

25.02 **Floating Craft — Maintenance and Care.**— All craft on the Lake Ports must be slipped annually for hull inspection, chipping and repainting.

In view of the high rate of corrosion, steel craft at Coastal Ports should be slipped at six monthly intervals. It is realised however that this may not always be possible where craft such as floating cranes and pile drivers are stationed at Ports where facilities for slipping are non-existent and in these cases the periods between slipping may be prolonged, provided that:—

(a) Such period does not exceed one year.

(b) An underwater inspection is carried out by a competent officer.

Due to the presence of Teredo Worm, wooden craft at Coastal Ports should be slipped or beached at four monthly intervals for hull inspection and repainting where necessary.

The hulls and bulkheads (where applicable) of all craft must be inspected every three months by a responsible officer deputed by the District or Resident Engineer, and all leaks noted and attended to immediately.

A record must be kept by the District Engineer, Resident Engineer or Engineer in Charge, of all slippings and he will be responsible for notifying the Plant and Workshops Engineer when such slipping has been carried out. A duplicate record will be maintained by the Plant and Workshops Engineer.

The original record of slipping must accompany the craft on full transfer to another District or Construction Project.

In the case of lighters and pontoons with part decking and sounding wells must be checked daily and any excess readings reported to the responsible officer.

All winch gears, pulleys, sheaves and the like must be lubricated weekly with a suitable multi-purpose grease as a protection against wear and corrosion.

When the craft is laid up for any period all working parts must be heavily coated with grease.

25.03 **Certificate of Tests and Examination of chains, rings, hooks, shackles, slings, boilers etc.**— The District Mechanical Engineer must be approached prior to slipping in connection with the carrying out of tests in order that he may issue the necessary certificates to comply with the Factories Ordinance.

25.04 **Watch and Ward.**— Where necessary to comply with Port Regulations a trained seaman must be on board at all times the craft is afloat whether in use or not. Where craft are moored to a buoy or left alongside a quay unattended, the moorings must be inspected daily.

25.05 **Transfer.**— On transfer to another District or Construction a list of all equipment together with test certificates, spare part books, plans and manuals must accompany the craft.

25.06 **Maintenance Dredging at Coast Ports.**— The maintenance of correct dredged depths as originally designed is the responsibility of the Engineering Department. This covers the maintenance of correct depths:—

(a) alongside berths;

(b) on the approaches to the berths;

(c) in harbour basins generally;

(d) on the entrance channels to harbours.

The responsibility includes the periodic soundings along all berths and at all shallow areas, and the maintenance of full and proper records of the soundings. A report must be submitted by December of each year for inclusion in the Chief Engineer's Annual Report.

Where large areas have to be covered a form of sweep should be used. This can be carried out by suspending at the required depth a length of braced rail or light framed girder from two launches, the two launches proceeding slowly on each other's beams, i.e. with the rail or girder suspended between them and sweeping the area concerned. The presence of high spots would be indicated by pulls on the suspension wires. It is important to ensure that the sweep is kept at the correct depth and due allowance made for tides; and also that the whole area is covered by a series of overlapping runs. High areas found by sweeping must be sounded and plotted in detail.

In certain cases check soundings may be required at shorter intervals but these will be dealt with in accordance with the circumstances of each case.

Where soundings show sufficient silting to require dredging it is the responsibility of the District Engineer to initiate action. He will inform the Port

Manager or Harbour Master that such dredging is necessary and arrange for the work to be done, and for the berth to be cleared as necessary so as to interfere with the operation of the port as little as possible. In such cases, charted soundings should be supplied to the Port Manager.

The ultimate responsibility for the disposal of spoil will be with the District Engineer, but in all cases the disposal site will be fixed in consultation with the Marine Department. Where no agreement can be made locally the case should be referred to the Chief Engineer.

SECTION 26

MISCELLANEOUS

26.01 **Experiments and Experiment Register.**— A register of experiments is maintained by the Chief Engineer, who will decide for which experiment a record sheet shall be prepared.

The District Engineer will be supplied with a copy of the experiment sheet and will be required to report periodically on the progress of the experiment.

On the conclusion of an experiment the sheet will be closed with a suitable endorsement.

For experiments in connection with any part of the Permanent Way see Clause 13.04.

26.02 **Indemnities in respect of Works near Railway Track.**— Before any work is carried out over, under or in the vicinity of the railway track by any Government department, Local Authority or other authorised body, it is necessary that a suitable indemnity shall first have been obtained.

This indemnity may be part of a Wayleave Agreement or it may be in the form of a special agreement.

As soon as it is decided to permit any Authority to carry out works near the track, the Chief Engineer must be notified so that the appropriate agreement may be signed **before the work commences.**

26.03 **Movement of Dead or Disabled Locomotives.**— Instructions on the action to be taken are contained in the Working Time Table and Section IV of the General Appendix to the Working Time Table and General Rules; and Engineers, Permanent Way Inspectors and Sub Permanent Way Inspectors should clearly understand them.

This department is particularly affected when a locomotive has suffered damage to its wheels or suspension, or has other defects which may affect the weight distribution. Severe damage to the track may be caused if the instructions for moving such a locomotive are not correctly carried out. **This applies specially to 59 Class locomotives.**

The more important details of the instructions are:—

(a) Where possible, side rods must be left in place. If removed or if the locomotive has suffered damage to its wheels or suspension or has other defects which may affect its weight distribution then its movement will be the subject of special arrangements as laid down in the General Appendix to the Working Time Table and General Rules.

(b) A disabled locomotive which has suffered damage to its wheels or suspension, or has other defects which may affect the weight distribution must not be moved until arrangements have been agreed between the District Mechanical and Engineering Officers. If, however, such a

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locomotive becomes disabled in a section it may be moved at slow speed to the nearest station where it can be stabled in order to clear the line. Subsequent movements must only be made under the special arrangements mentioned above.

(c) The following instructions apply particularly to a 59 Class locomotive having a defective tyre.

(i) The locomotive shall be steamed out of section at 5 m.p.h.

(ii) The damaged wheel shall be packed up at the nearest station and the side rods dismantled as necessary.

(iii) All water shall be dropped from both front and rear tanks.

(iv) The locomotive shall be taken to the Loco Depot as a dead engine accompanied by the Permanent Way Inspector. A speed restriction of 15 m.p.h. will normally be imposed but this may be reduced at the Permanent Way Inspector's discretion.

26.04 Preparation of Drawings by District Offices.— All drawings prepared by Districts shall comply with the following instructions:—

(a) The north Point "N" must be shown.

(b) In the case of stations, sidings and similar layouts the direction of adjoining stations must be shown thus:—

"From....." "To....."

For quick and easy recognition the names of the major stations rather than the lesser known smaller ones should be quoted. Similar indications in the case of roads are also helpful. Mileages should be indicated. The "Down" direction, i.e. Mombasa, Tanga, Dar es Salaam, should normally be on the left hand side of a drawing.

(c) The scale of drawing should be clearly stated, and any scale in excess of 8 feet to the inch should be drawn on the plan.

Scales shown on plans in this manner are very helpful and essential when plans are photostated to reduced scales.

(d) All drawings must be given a drawing number and the District of origin and date must be shown. Any letter or document (estimates particularly) accompanying drawings must quote the relevant drawing numbers. The names of structures, buildings, machines, etc. shown on drawings should not be referred to by alternative names in correspondence and estimates.

(e) Drawings should be of standard sizes. Small drawings should be foolscap size 13" x 8 " or 13" deep and any reasonable length to fold a width of 8". This facilitates their filing with correspondence. The margin for filing should not be forgotten.

SECTION 27

MEASURES, WEIGHTS, CONVERSION FACTORS

LINEAR MEASURE.

British Units			Metric Units		
12 inches	=	1 foot	10 millimetres	=	1 centimetre
3 feet	=	1 yard	10 centimetres	=	1 decimetre
5½ yards	=	1 rod, pole or perch	10 decimetres	=	1 metre
			10 metres	=	1 dekametre
4 poles	=	1 chain (66 ft.)	10 dekametres	=	1 hectometre
10 chains	=	1 furlong	10 hectometres	=	1 kilometre
8 furlongs	=	1 mile			
100 links	=	1 chain			
6 feet	=	1 fathom			

Metres	Yards	Feet	Inches	Centi-metres	Milli-metres
1	1.0936	3.2808	39.3701	100	1000
0.9144	1	3	36	91.44	914.4
0.3048	0.3333	1	12	30.48	304.8
0.0254	0.0278	0.0833	1	2.54	25.4
0.01	0.0109	0.0328	0.3937	1	10
0.001	0.0011	0.0033	0.0394	0.1	1

Miles	Kilometres	Furlongs	Chains (66 ft.)	Rods, poles or perches	Metres
1	1.6093	8	80	320	1609.344
0.6214	1	4.971	49.7097	198.839	1000
0.125	0.2012	1	10	40	201.168
0.0125	0.0201	0.1	1	4	20.1168
0.0031	0.005	0.025	0.25	1	5.0292
0.0006	0.001	0.005	0.0497	0.1988	1

Miles	Yards	Feet	Metres
1	1760	5280	1609.344
0.00057	1	3	0.9144
0.00019	0.3333	1	0.3048
0.00062	1.0936	3.2808	1
1 Nautical mile = 1.1515 miles = 6080 feet.			

SQUARE MEASURE

Square Metres	Square Yards	Square Feet	Square Inches	Square Centi-metres	Square Milli-metres
1	1.196	10.7639	1550	10000	1000000
0.83613	1	9	1296	8361.3	836130
0.0929	0.1111	1	144	929.03	92903
0.00065	0.00077	0.00694	1	6.4516	645.16
0.0001	0.00012	0.00108	0.155	1	100
—	—	0.00001	0.0016	0.01	1

Hectares	Acres	Square Rods or Poles	Square Yards	Square Metres
1	2.47105	395.369	11959.9	10000
0.40469	1	160	4840	4046.86
0.00253	0.00625	1	30.25	25.2929
0.00008	0.00021	0.03306	1	0.8361
0.0001	0.00025	0.03951	1.196	1

40 square rods = 1 rood
4 roods = 1 acre

Square Miles	Square Kilo-metres	Hectares	Acres	Square Chains	Square Rods or Poles
1	2.58999	258.999	640	6400	102400
0.3861	1	100	247.105	2471.05	39536.9
0.00386	0.01	1	2.47105	24.7105	395.369
0.00156	0.00405	0.40469	1	10	160
0.00016	0.0004	0.04047	0.1	1	16
0.00001	0.00003	0.00253	0.00625	0.0625	1

CUBIC MEASURE AND CAPACITY

Cubic Centi-metres	Cubic Inches	Cubic Feet	Cubic Yards	Cubic Metres
1	0.06102	0.00004	—	—
16.3871	1	0.00058	0.00002	—
28317	1728	1	0.03704	0.02832
—	46656	27	1	0.76455
—	61024	35.3147	1.30795	1

Pints	Quarts	Imperial Gallons	Litres or Cubic Deci-metres	Cubic Feet
1	0.5	0.125	0.5683	0.02007
2	1	0.25	1.1365	0.04014
8	4	1	4.546	0.16054
1.7598	0.8799	0.22	1	0.03532
49.831	24.9153	6.2288	28.3161	1

Imperial Gallons	Litres or Cubic Decimetres	Cubic Metres	Cubic Yards
1	4.546	0.00455	0.00595
0.22	1	0.001	0.00131
219.969	1000	1	1.30795
168.178	764.55	0.76455	1

1 U.S. gallon = 0.833 Imperial gallon.

WEIGHT MEASURE

Grams	Ounces	Pounds	Kilograms	Quarters
1	0.03527	0.00221	0.001	0.00008
28.3495	1	0.0625	0.02835	0.00223
453.592	16	1	0.45359	0.03571
1000	35.274	2.20462	1	0.07874
12701	448	28	12.7006	1

Pounds	Quarters	Hundred-weights	Tons (2240 lbs)	Short Tons (2000 lbs.)	Tonnes (metric)
1	0.03571	0.00893	0.00045	0.0005	0.00045
28	1	0.25	0.0125	0.014	0.0127
112	4	1	0.05	0.056	0.0508
2240	80	20	1	1.12	1.01605
2000	71.42857	17.8571	0.89286	1	0.90718
2204.62	78.73643	19.6841	0.98421	1.10231	1

CONVERSION FACTORS

WEIGHTS

1 pound per foot	=	1.4882 kilograms per metre.
1 kilogram per metre	=	0.672 pounds per foot.
1 pound per yard	=	0.4961 kilograms per metre.
1 kilogram per metre	=	2.0159 pounds per yard.
1 pound per cubic inch	=	1728 pounds per cubic foot.
1 pound per cubic foot	=	0.00058 pounds per cubic inch.
1 pound per cubic foot	=	16.0185 kilograms per cubic metre.
1 kilogram per cubic metre	=	0.0624 pounds per cubic foot.
1 pound per cublic yard	=	0.5933 kilograms per cubic metre.
1 kilogram per cubic metre	=	1.6855 pounds per cubic yard.
1 pound per gallon	=	0.0998 kilograms per litre.
1 kilogram per litre	=	10.0221 pounds per gallon.

STRESSES AND PRESSURES

1 pound per square inch	=	0.0703 kilograms per square centimetre.
1 kilogram per square centimetre	=	14.2233 pounds per square inch.
1 pound per square inch	=	0.0643 tons per square foot.
1 ton per square foot	=	15.5556 pounds per square inch.
1 pound per square foot	=	4.8824 kilograms per square metre.
1 kilogram per square metre	=	0.2048 pounds per square foot.

WATER PRESSURES

1 pound per square inch	=	2.3067 head of water in feet.
1 foot head of water	=	0.4335 pounds per square inch.

SPEEDS

1 mile per hour	=	1.6093 kilometres per hour.
1 kilometre per hour	=	0.6214 miles per hour.
1 mile per hour	=	1.4667 feet per second.
1 foot per second	=	0.6818 miles per hour.
1 knot	=	1.1515 miles per hour.
1 mile per hour	=	0.8684 knots.

TEMPERATURE (Fahrenheit and Centigrade).

$$F^\circ = \frac{C^\circ \times 9}{5} + 32$$

$$C^\circ = \frac{(F^\circ - 32) \times 5}{9}$$

RAINFALL

1 inch on 1 acre = 3630 cubic feet = 22610 gallons.

1 inch on 1 square mile = figures for 1 acre multiplied by 640.

1 cubic foot per second (cusec)	=	6.23 gallons per second.
	=	374 gallons per minute.

WEIGHTS OF METALS

METAL	Lbs. per cu. in.	Lbs. per cu. ft.
Aluminium, cast	0.093	160
Aluminium, wrought	0.097	168
Brass, cast and sheet	0.303	524
Bronze, gunmetal and phosphor	0.318	550
Copper, cast	0.315	545
Copper, wrought	0.323	558
Graphite and Plumbago	0.076	131
Iron, cast	0.260	450
Iron, wrought	0.278	480
Lead, cast	0.409	707
Lead, sheet	0.417	720
Mercury	0.490	847
Spelter	0.255	440
Steel, cast	0.283	490
Steel, mild	0.283	490
Tin	0.263	455
Zinc, cast	0.258	446
Zinc, sheet	0.260	450

WEIGHTS OF LIQUIDS

Pounds per gallon = 10 x specific gravity.

Pounds per cubic foot = 62.3 x specific gravity.

LIQUID	Specific Gravity	Lbs. per Gallon	Lbs. per cu. ft.
Water, fresh (see note below)	1.000	10.00	62.3
Water, salt	1.027	10.27	64
(ICE.)	0.921	—	57.4
Benzol	0.885	8.85	55
Castor Oil	0.970	9.70	61
Creosote	1.108	11.08	69
Fuel, aviation turbine	0.795	7.95	50
Linseed Oil, raw	0.930	9.30	58
Linseed Oil, boiled	0.940	9.40	59
Milk	1.031	10.31	64
Methylated Spirit (denatured alcohol)	0.810	8.10	46
Oil, diesel	0.851	8.51	53
Oil, fuel	0.925	9.25	58
Oil, gas	0.836	8.36	52
Oil, lubricating	0.925	9.25	58
Oil, petroleum	0.878	8.78	55
Paraffin (Kerosene)	0.817	8.17	51
Petrol	0.743	7.43	46
Tar	1.204	12.04	75
Turpentine	0.866	8.66	54

Note: The following approximate values for Fresh Water are sufficiently accurate for all normal calculations.

1 gallon weighs 10 pounds.
1 cubic foot contains $6\frac{1}{4}$ gallons.
1 cubic foot weighs $62\frac{1}{2}$ pounds.

WEIGHTS OF WOODS

Species	Lbs. per Cu. ft.
Ash, European	44
Azobe, (African Oak-West Africa)	65
Beech, European	46
Camphor, East Africa	38
Cedar, East Africa	34
Cypress, East Africa	28
Douglas Fir, (Oregon Pine)	33
Eucalyptus, (Blue Gum-East Africa)	53
Greenheart, Kenya	57
Greenheart, S. America	65
Iroko, (West Africa-Mvuli of East Africa)	41
Jarrah, Australia	53
Lloliondo (Elgon Olive)	50
Mahogany — Africa	35
Mueri	45
Muhimbi (Uganda)	54
Muhuhu	60
Muninga	40
Musharagi	55
Mvuli (Iroko of West Africa)	41
Oak, European	45
Olive, East Africa	57
Olive, Elgon (Lloliondo)	50
Pine, pitch	42
Pine, Oregon (Douglas Fir)	33
Pine, yellow deal	27
Pinus radiata, East Africa	33
Podo	32
Teak, Burma	41
Teak, Rhodesia	57
Walnut, European	41
White deal	29

WEIGHTS OF VARIOUS SUBSTANCES

MISCELLANEOUS	Lbs. per Cu. ft.
Asbestos	150
Asphalt, rock and as laid	144
Bitumen	90
Caustic Soda	88
Cork, slab	12
Cork, granular	7½
Cotton waste	11
Flax and Hemp	24
Glass	163
India Rubber	60
Leather, variable	50
Paper, average	50
Pitch	75
Soap, variable	60
Sulphur	125
Tallow	59
Tar macadam	144
White Lead	195
CONCRETE, BRICKWORK, ETC.	
Brick, common (no mortar)	100
Brick, fire (no mortar)	140
Brickwork, heavy pressed	140
Brickwork, medium	125
Brickwork, common	114
Cement, Portland loose	90
Cement, set	140
Cement plaster 1:3	144
Cement Concrete, brick	115
Cement Concrete, broken stone	144
Cement Concrete, clinker	95
Cement Concrete, coke breeze	70
Concrete reinforced	
2% steel	150
5% „	165
10% „	185
Lime, ground	60
Lime mortar	102

EARTH, STONE ETC.	Lbs. per Cu. ft.
Ashes	40
Ballast (see slag and stone below)	—
Chalk, solid	150
Chalk, broken	80
Charcoal	25
Clay, dry loose	65
Clay, hard	150
Coal, loose	55
Coke	35
Earth, dry loose	90
Earth, rammed	100
Earth, wet	100
Gravel, dry	110
Sand, dry loose	105
Sand, damp	110
Sand, very wet	125
Rock filling, dry	112
Basalt, solid	165
Basalt, broken	100
Granite, solid	165
Granite, broken	100
Limestone, solid	135
Limestone, broken	85
Sandstone, solid	140
Sandstone, broken	90
Quartz, solid	165
Slag, solid	170
Slate, solid	180

WIRE AND SHEET METAL GAUGES AND WEIGHTS

Imperial Standard Wire Gauge — abbreviation SWG.
Birmingham Gauge for Hoops and Sheets — abbreviation BG.
In the larger sizes it is usual to obtain mild steel as round bars and flats.

SWG. No.	Diameter in Inches	Equivalent Fraction of an inch	Weight in pounds per 100 yards	BG. No.	Thickness in Inches	Equivalent Fraction of an inch	Weight in pounds per sq. foot.
3/0	.372	3/8	110.80	3/0	.500	1/2	20.40
2/0	.348	11/32	98.93	2/0	.445	7/16	18.16
0	.324		84.03	0	.396	13/32	16.16
1	.300	5/16	72.04	1	.353		14.40
2	.276	9/32	60.97	2	.315	5/16	12.85
3	.252	1/4	50.85	3	.280	9/32	11.42
4	.232		43.07	4	.250	1/4	10.20
5	.212	7/32	35.97	5	.223	7/32	9.10
6	.192	3/16	29.43	6	.198	3/16	8.08
7	.176		24.77	7	.176		7.18
8	.160	5/32	20.45	8	.157	5/32	6.41
9	.144		16.59	9	.140		5.70
10	.128	1/8	13.12	10	.125	1/8	5.10
11	.116		10.80	11	.111		4.54
12	.104		8.63	12	.099		4.04
13	.092	3/32	6.76	13	.088	3/32	3.60
14	.080		5.11	14	.079		3.20
15	.072		4.15	15	.070		2.85
16	.064	1/16	3.29	16	.063	1/16	2.55
17	.056		2.50	17	.055		2.27
18	.048	3/64	1.83	18	.050		2.02
19	.040		1.27	19	.044	3/64	1.80
20	.036		1.03	20	.039		1.60
21	.032	1/32	0.82	21	.035		1.42
22	.028		0.63	22	.031	1/32	1.28
23	.024		0.46	23	.028		1.14
24	.022	1/64	0.39	24	.025	1/64	1.01

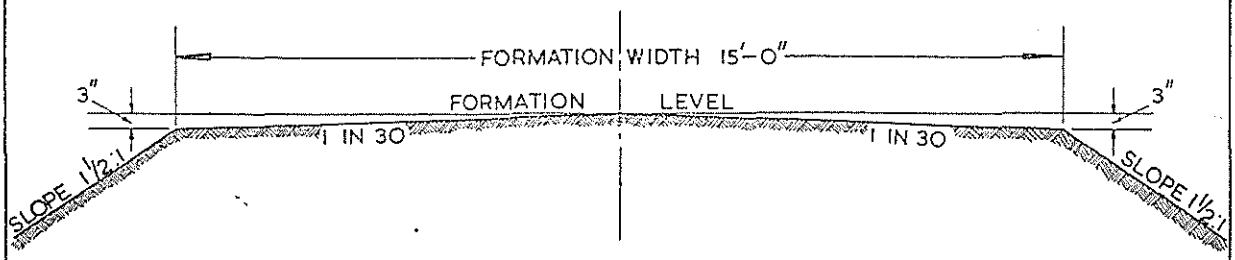
Gauges 4/0 to 7/0 in the large sizes and 25 to 50 in the small sizes have been omitted.

Gauges 4/0 to 15/0 in the large sizes and 25 to 52 in the small sizes have been omitted.

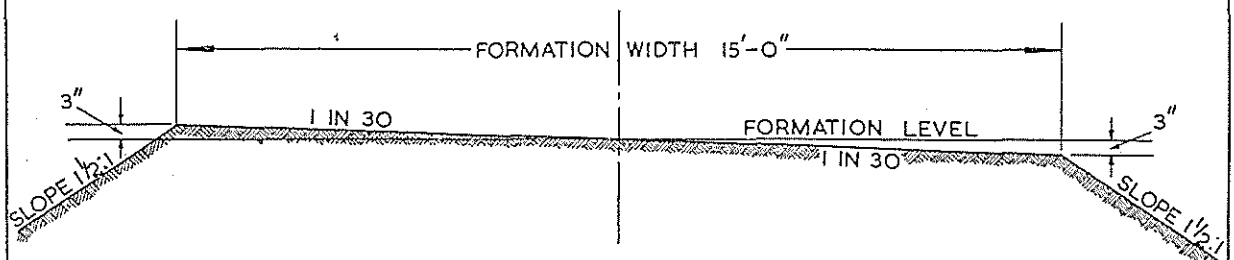
ANNEXURES

ANNEXURE I

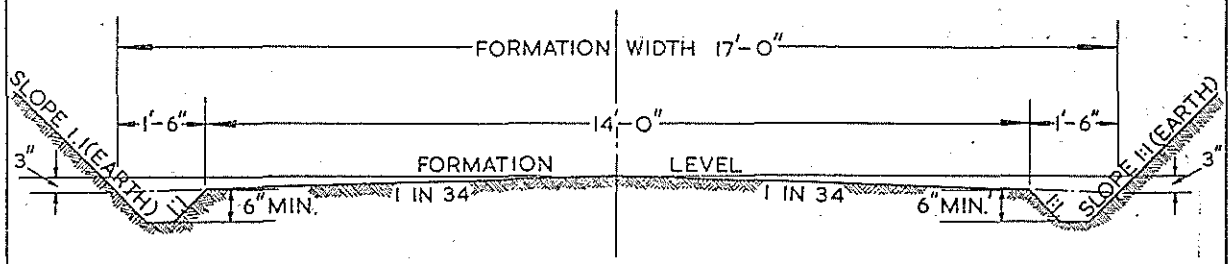
TYPE CROSS—SECTIONS OF FORMATION



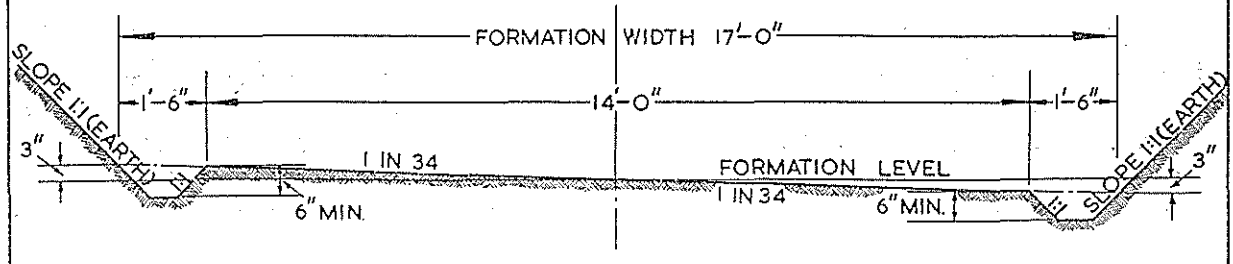
BANK—STRAIGHT TRACK



BANK—CURVED TRACK



CUTTING—STRAIGHT TRACK



CUTTING—CURVED TRACK

NOTE – 1. THE CROSS—FALL OF THE FORMATION ON CURVES IS TO BE TO THE INSIDE AS SHOWN.

2. IN LONG CUTTINGS, A LEVEL GRADE LINE FOR THE RAILWAY SHOULD BE AVOIDED TO FACILITATE DRAINAGE.

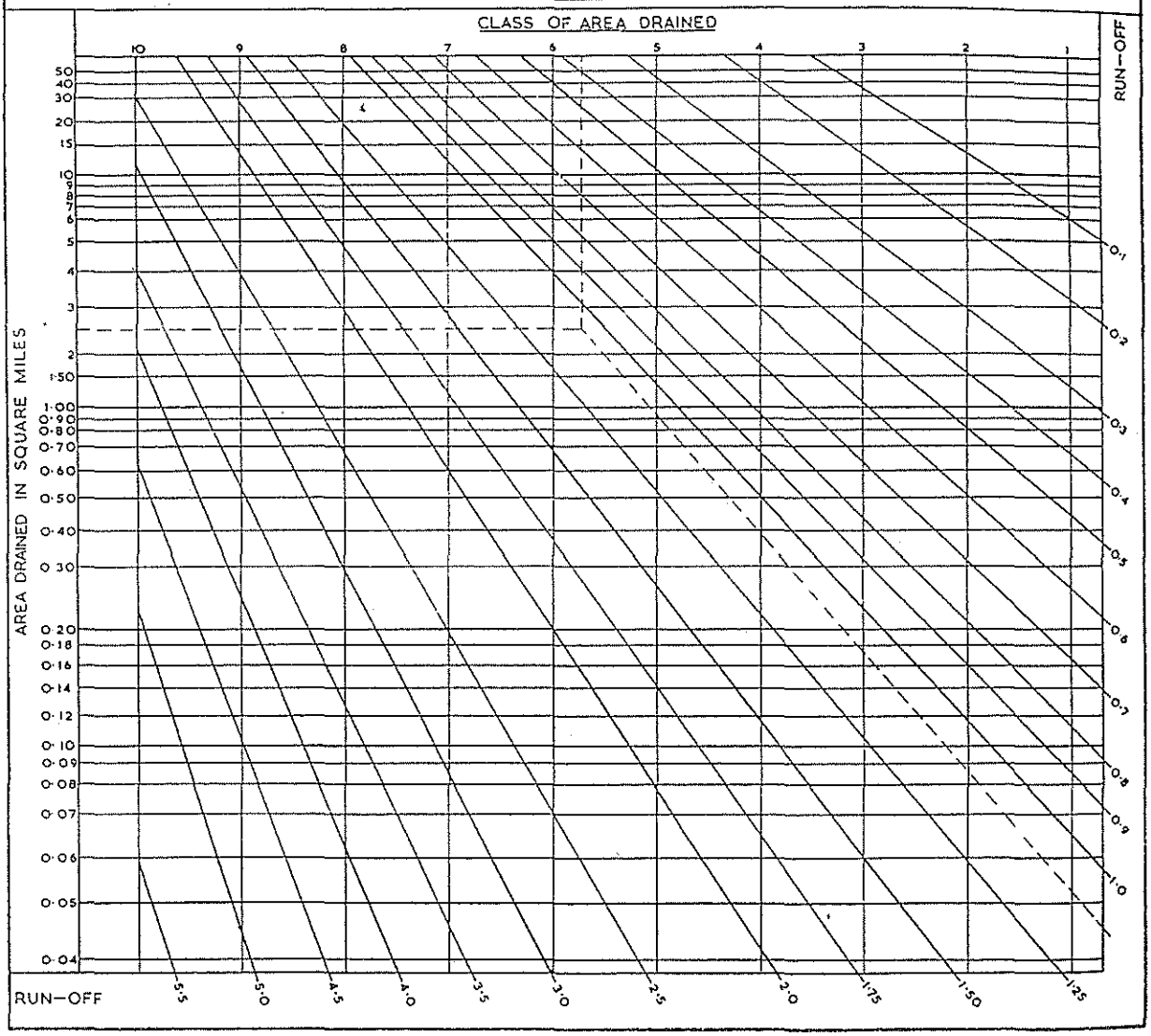
3. IN ROCK CUTTINGS WHERE THE FORMATION IS LEFT ROUGH WITH HOLES, THESE MUST BE FILLED IN AND LEVELLED WITH HARD BROKEN STONE. IN SUCH CASES EARTH, SHALE, AND SOFT ROCK MUST NOT BE USED.

ANNEXURE 2

BRIDGE AND CULVERT OPENINGS

DIAGRAM NO 1

RUN-OFF IN INCHES PER HOUR

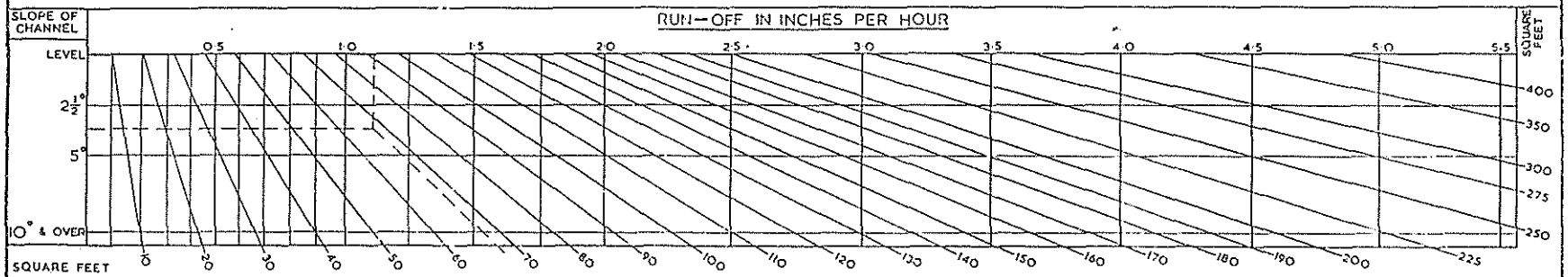


BRIDGE AND CULVERT OPENINGS

DIAGRAM 1.A. CLASS OF AREA DRAINED

SOIL	UNITS	SLOPE	UNITS	PROTECTION	UNITS	SHAPE	UNITS
DEEP	0·25	FLAT	0·25	FOREST	0·25	LONG	0·25
MEDIUM	0·75	GENTLE	0·75	SCRUB	0·75	BALLOON	0·75
SHALLOW	1·50	MIXED	1·50	GRASS	1·25	EGG	1·50
ROCKY	2·50	STEEP	2·50	BARE	2·50	FAN	2·50

DIAGRAM 2 SQUARE FEET OF OPENING REQUIRED PER SQUARE MILE OF DRAINAGE AREA



INSTRUCTIONS

① DECIDE UPON THE 'CLASS OF AREA DRAINED' BY ADDING UP THE 4 UNITS OBTAINED FROM THE VARIOUS HEADS IN DIAGRAM I.A. THE SUM OF THESE UNITS WILL VARY FROM 1 TO 10

② FIND THE CATCHMENT AREA DRAINED IN SQUARE MILES

③ USING DIAGRAM 1, PLOT THE TWO VALUES OBTAINED FROM ① & ② ABOVE. WHERE THESE TWO VALUES INTERSECT, DRAW A LIGHT PENCIL LINE PARALLEL TO THE ADJACENT DIAGONAL LINES UNTIL IT CUTS THE 'RUN—OFF' SCALE

④ HAVING READ THE RUN—OFF IN INCHES, USE THIS VALUE IN DIAGRAM 2, FIRST DECIDING ON A SUITABLE VALUE FOR THE SLOPE OF THE CHANNEL.

EXAMPLE—SEE DOTTED LINES ON DIAGRAMS

① SOIL—DEEP, SLOPE—MIXED, PROTECTION—BARE, SHAPE—EGG. FROM DIAGRAM I.A., THE CLASS OF AREA DRAINED = 0·25 + 1·50 + 2·50 + 1·50 = 5·75

② AREA TO BE DRAINED = 2·5 SQUARE MILES

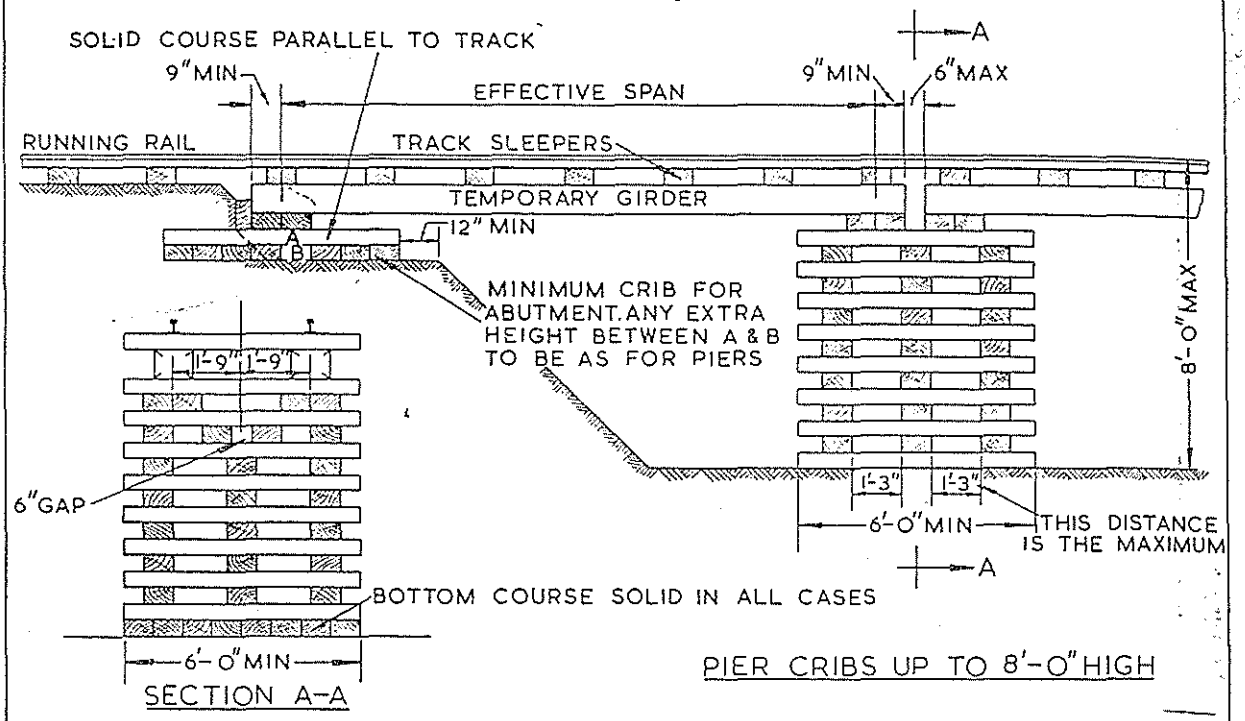
③ RUN—OFF IN INCHES PER HOUR = 1·10 (DIAGRAM 1.)

④ SLOPE OF CHANNEL = 3·5°

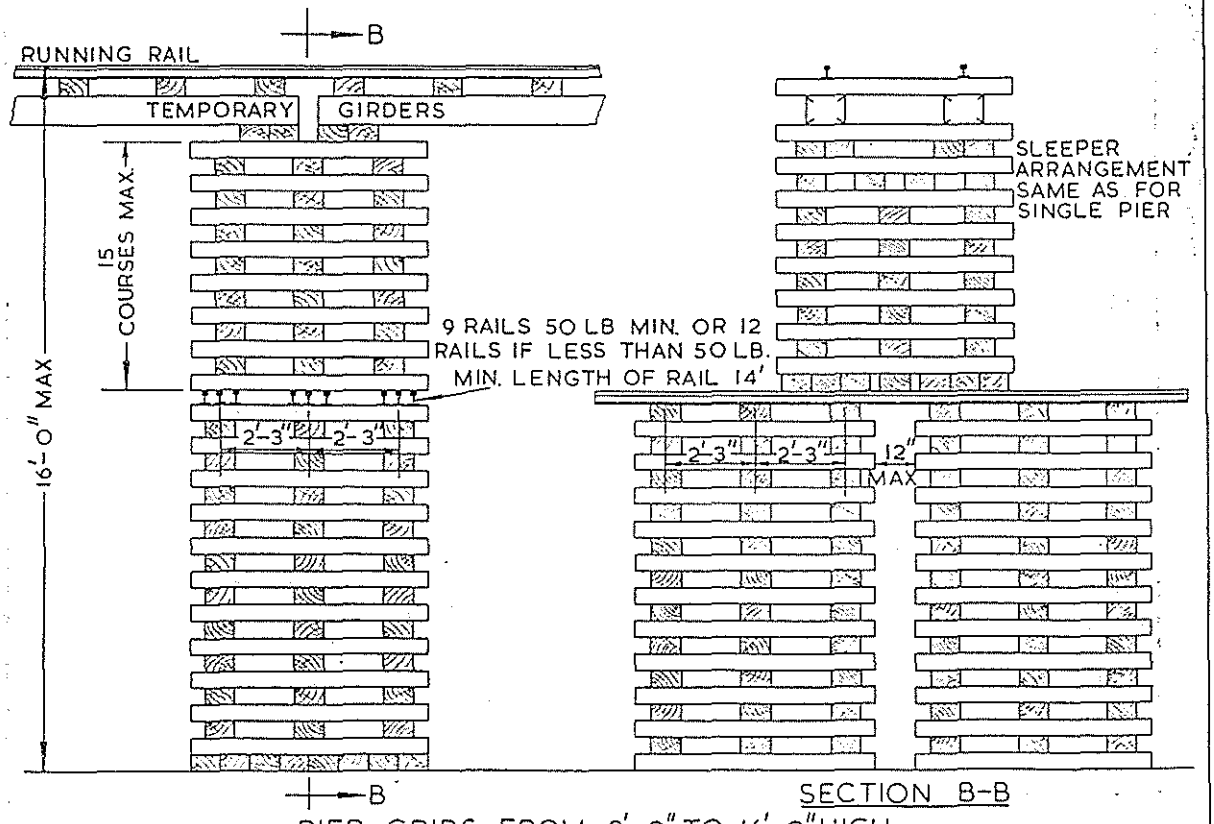
∴ THE AREA OF OPENING REQUIRED = 68 SQUARE FEET PER SQUARE MILE DRAINED = 68 X 2·5 = 170 SQUARE FEET

ANNEXURE 3

SLEEPER CRIBS FOR TEMPORARY BRIDGES



PIER CRIBS UP TO 8'-0" HIGH

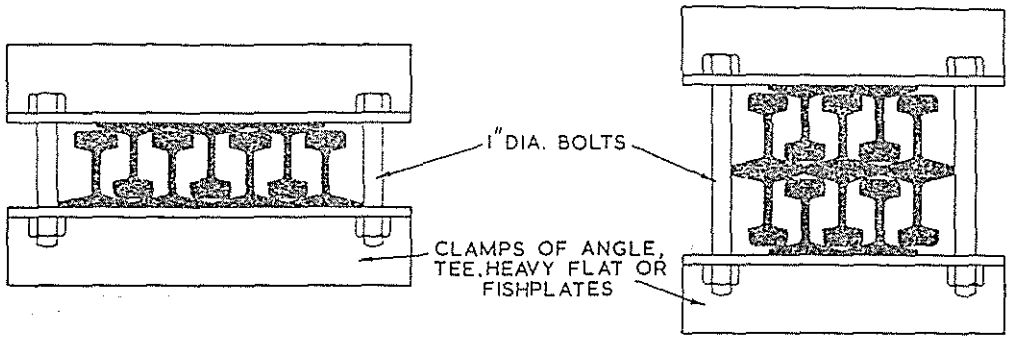


PIER CRIBS FROM 8'-0" TO 16'-0" HIGH

NOTE :- 1. SPEED IS TO BE LIMITED TO 10M.P.H. ON CRIB BRIDGES.
2. FOR GIRDER DETAILS SEE ANNEXURE 4.
3. IN WOOD SLEEPER CRIBS, THE SLEEPERS SHALL BE SHIMMED WITH WEDGES, AND SPIKES LIBERALLY USED TO PREVENT THE DISPLACEMENT OF SLEEPERS & RAILS.
4. G.H.S.C., G.L.S.C & G.H.S.T. STEEL SLEEPERS, WHICH HAVE NO CANT, ARE WELL SUITED FOR CRIBS AND SHOULD BE USED WHEN AVAILABLE.

ANNEXURE 4

TEMPORARY RAIL GIRDERS



TYPICAL SINGLE ROW CLUSTER

TYPICAL DOUBLE ROW CLUSTER

EFFECTIVE SPAN IN FEET	NUMBER OF RAILS IN EACH GIRDER (TWO GIRDERS PER TRACK)						
	FOR AXLE LOADS UP TO 13 TONS				FOR AXLE LOADS OVER 13 TONS		
	GHST	50 OBS 50 NS 45 R. BS 45 OBS GLSC	60 N. BS 60 R. BS 55 R. BS 55 OBS GHSC	80 R. BS 80 OBS 75 R. BS	50 OBS 50 NS	60 N. BS 60 R. BS 55 R. BS 55 OBS GHSC	80 R. BS 80 OBS 75 R. BS
UP TO 8	7(S)	5(S)	5(S)	3(S)	10(D)	5(S)	5(S)
OVER 8 TO 12	14(D)	14(D)	10(D)	5(S)	14(D)	14(D)	7(S)
OVER 12 TO 15	UNSUITABLE	UNSUITABLE	10(D).	7(S)	UNSUITABLE	14(D)	10(D)

S = SINGLE ROW D = DOUBLE ROW

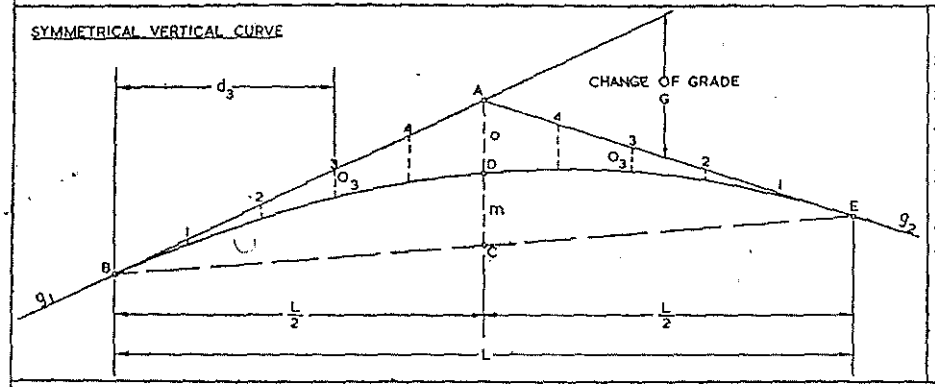
NOTES

1. FOR DETAILS OF EFFECTIVE SPAN AND SLEEPER CRIBS, SEE ANNEXURE 3.
2. THE GIRDERS ARE DESIGNED FOR 13 UNITS B.S. METRE GAUGE LOADING (TYPE R.A.2) FOR AXLE LOADS UP TO 13 TONS, AND FOR 59 CLASS GARRATT LOCOMOTIVE FOR AXLE LOADS OVER 13 TONS.
3. THE RAILS SHALL BE FREE FROM CRACKS, SPLITS, EXCESSIVE WEAR, AND HEAVY CORROSION. ONLY ONE TYPE OF RAIL SHALL BE USED IN MAKING UP A PAIR OF GIRDERS.
4. THE MINIMUM LENGTH OF RAIL SHALL BE THE EFFECTIVE SPAN PLUS $1\frac{1}{2}$ FEET.
5. WHERE MORE THAN ONE SPAN OPENING IS TO BE PROVIDED, THE GIRDERS MAY BE CONTINUOUS OVER ONE OR MORE PIER SUPPORTS.
6. THE GIRDERS SHALL BE SPIKED TO THE SUPPORTING TIMBERS, AND CLAMPS SHALL BE PROVIDED AT 2 PER GIRDER UP TO 8 FEET SPAN AND 3 PER GIRDER FOR SPANS OVER 8 FEET. THE CLAMP BOLTS SHALL BE KEPT TIGHT TO INCREASE THE FRICTION BETWEEN THE LAYERS OF RAILS.
7. THE WOOD TRACK SLEEPERS SHALL BE ATTACHED TO THE GIRDERS WITH HOOK BOLTS ENGAGING ON THE UNDERSIDE OF THE OUTSIDE RAILS.
8. SPEED OF TRAINS SHALL BE LIMITED TO 10 M.P.H.

ANNEXURE 5

VERTICAL CURVE — PARABOLIC

SYMMETRICAL VERTICAL CURVE



GENERAL FORMULAE

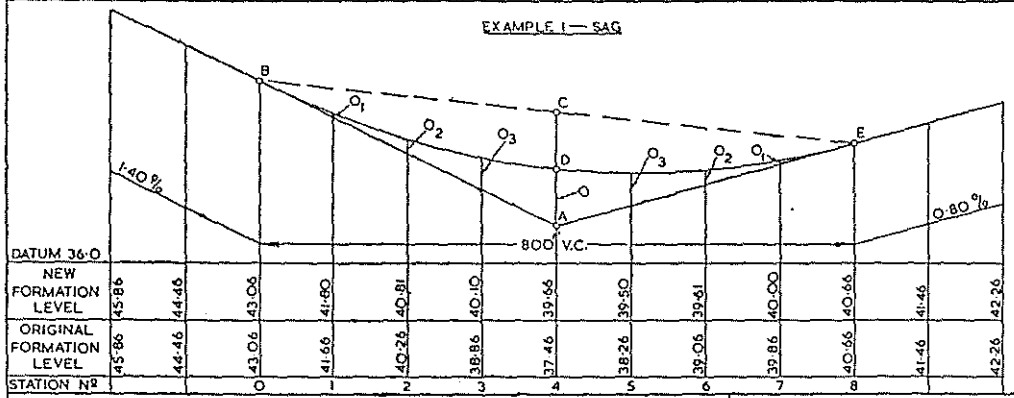
1. 100 ft STATIONS — 1, 2, 3 etc.
2. LENGTH OF VERTICAL CURVE = 'L' IN EVEN NUMBER OF STATIONS. 'BE' = 'L' approximately
3. CHORD 'BE' IS INTERSECTED AT 'C' BY A VERTICAL LINE FROM THE VERTEX 'A'.
4. ELEVATION OF 'C' = $\frac{1}{2}$ (ELEVATION 'B' + ELEVATION 'E')
5. ELEVATION OF 'D' = $\frac{1}{2}$ (ELEVATION 'A' + ELEVATION 'C')
6. POINT 'D' IS MIDWAY BETWEEN 'A' AND 'C'; THUS o = m
7. CHANGE OF GRADE AT THE VERTEX = G = ALGEBRAIC DIFFERENCE OF THE TWO GRADES g_1 & g_2 IN PER CENT.
8. RATE OF CHANGE OF GRADE = $\frac{100G}{L}$ (AVERAGE)
9. NUMBERED OFFSETS FROM THE GRADE LINE TO THE VERTICAL CURVE VARY AS THE SQUARES OF THE HORIZONTAL DISTANCES FROM 'B' OR FROM 'E'

EXAMPLE — $O_3 = O\left[\frac{d_3 \text{ SQUARED}}{\frac{L}{2} \text{ SQUARED}}\right]$

LENGTH OF CURVE

CHANGE OF GRADE 'G' IN PER CENT			SAGS		SUMMITS	
			FEET	STATIONS	FEET	STATIONS
LESS THAN		0·50	200	2	200	2
0·50	TO	0·99	400	4	400	4
1·00	TO	1·99	600	6	400	4
2·00	TO	2·99	800	8	600	6
3·00	TO	3·99	1000	10	600	6
4·00	AND	OVER	1200	12	800	8

EXAMPLE 1 — SAG



CALCULATIONS

CHANGE OF GRADE PER CENT = 1·40 + 0·80 = 2·20
LENGTH OF VERTICAL CURVE REQUIRED = 800 FT.
ELEVATION 'A' = 37·46

ELEVATION 'C' = $\frac{B+E}{2} = \frac{43·06+40·66}{2} = 41·86$

ELEVATION 'D' = $\frac{A+C}{2} = \frac{37·46+41·86}{2} = 39·66$

O = ELEVATION 'D' − ELEVATION 'A' = 2·20

$O_1 = \frac{2·20 \times 100 \times 100}{400 \times 400} = \frac{2·20}{16} = 0·14$

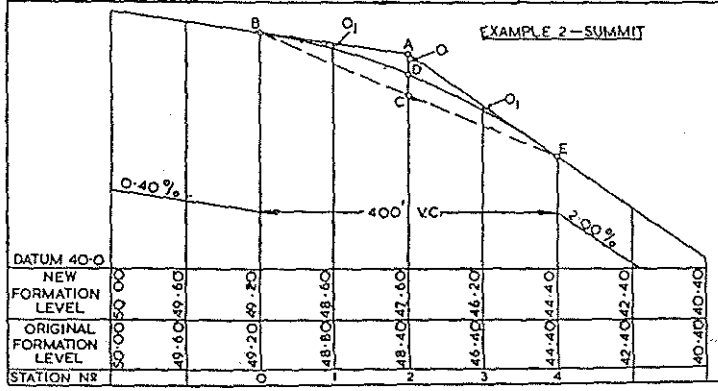
$O_2 = \frac{2·20 \times 200 \times 200}{400 \times 400} = \frac{2·20}{4} = 0·55$

$O_3 = \frac{2·20 \times 300 \times 300}{400 \times 400} = \frac{19·80}{16} = 1·24$

FORMATION LEVELS

STATION 1 = 41·66 + 0·14 = 41·80
" 2 = 40·26 + 0·55 = 40·81
" 3 = 38·86 + 1·24 = 40·10
" 4 = 37·46 + 2·20 = 39·66
" 5 = 38·26 + 1·24 = 39·50
" 6 = 39·06 + 0·55 = 39·61
" 7 = 39·86 + 0·14 = 40·00

EXAMPLE 2 — SUMMIT



CALCULATIONS

CHANGE OF GRADE PER CENT = 2·00 − 0·40 = 1·60
LENGTH OF VERTICAL CURVE REQUIRED = 400 FT.
ELEVATION 'A' = 48·40

ELEVATION 'C' = $\frac{B+E}{2} = \frac{49·20+44·40}{2} = 46·80$

ELEVATION 'D' = $\frac{A+C}{2} = \frac{48·40+46·80}{2} = 47·60$

O = ELEVATION 'A' − ELEVATION 'D' = 0·80

$O_1 = \frac{0·80 \times 100 \times 100}{200 \times 200} = \frac{0·80}{4} = 0·20$

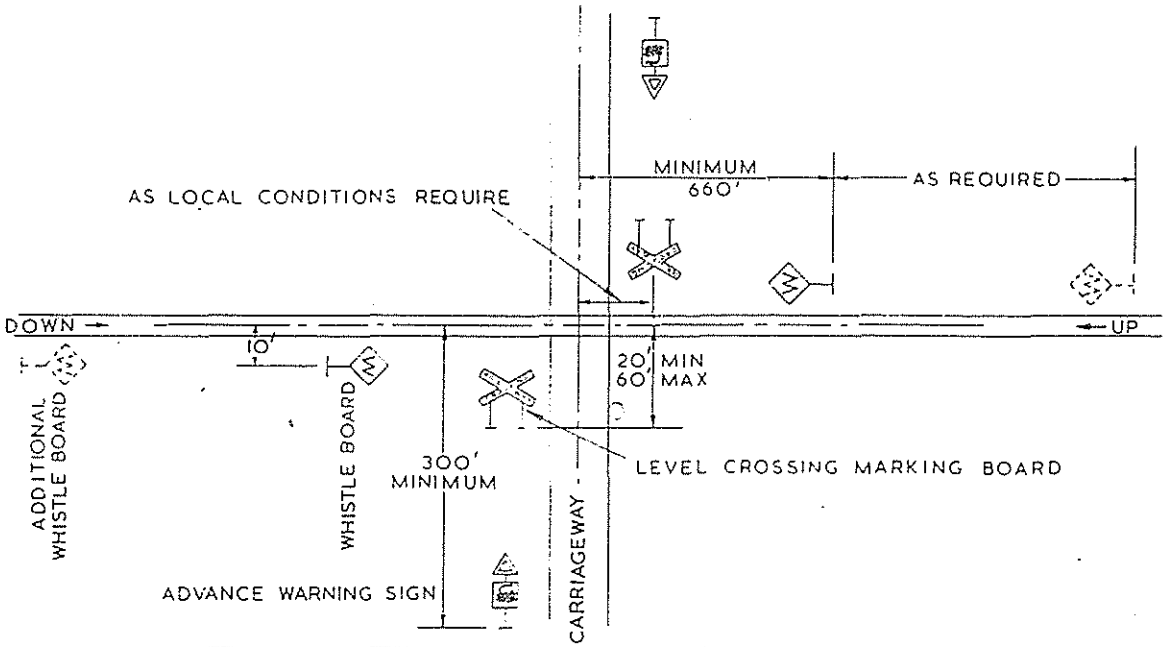
FORMATION LEVELS

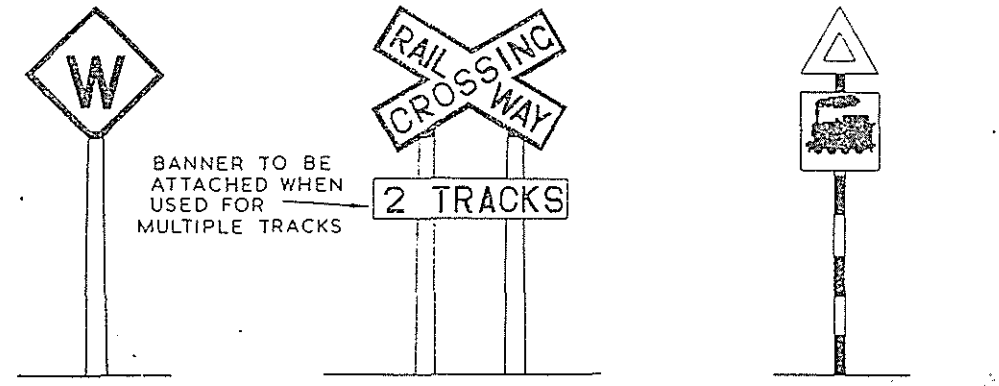
STATION 1 = 48·80 − 0·20 = 48·60
" 2 = 48·40 − 0·80 = 47·60
" 3 = 46·40 − 0·20 = 46·20

ANNEXURE 6

LEVEL CROSSINGS

TYPICAL GENERAL ARRANGEMENT OF WARNING SIGNS





WHISTLE BOARD

LEVEL CROSSING MARKING BOARD

ADVANCE WARNING SIGN

COLOURS ON SIGNS

(FACING TRAFFIC)

SIGN	BOARD	POSTS
WHISTLE BOARD	2" WIDE BLACK BORDER BLACK LETTER ON YELLOW GROUND	YELLOW
LEVEL CROSSING MARKING BOARD	1 3/4" WIDE RED BORDER RED LETTERS ON WHITE GROUND BANNER BLACK LETTERS ON WHITE GROUND	WHITE
ADVANCE WARNING SIGN	TRIANGLE — 4" WIDE RED SYMBOL — BLACK ON YELLOW GROUND	BLACK/ WHITE

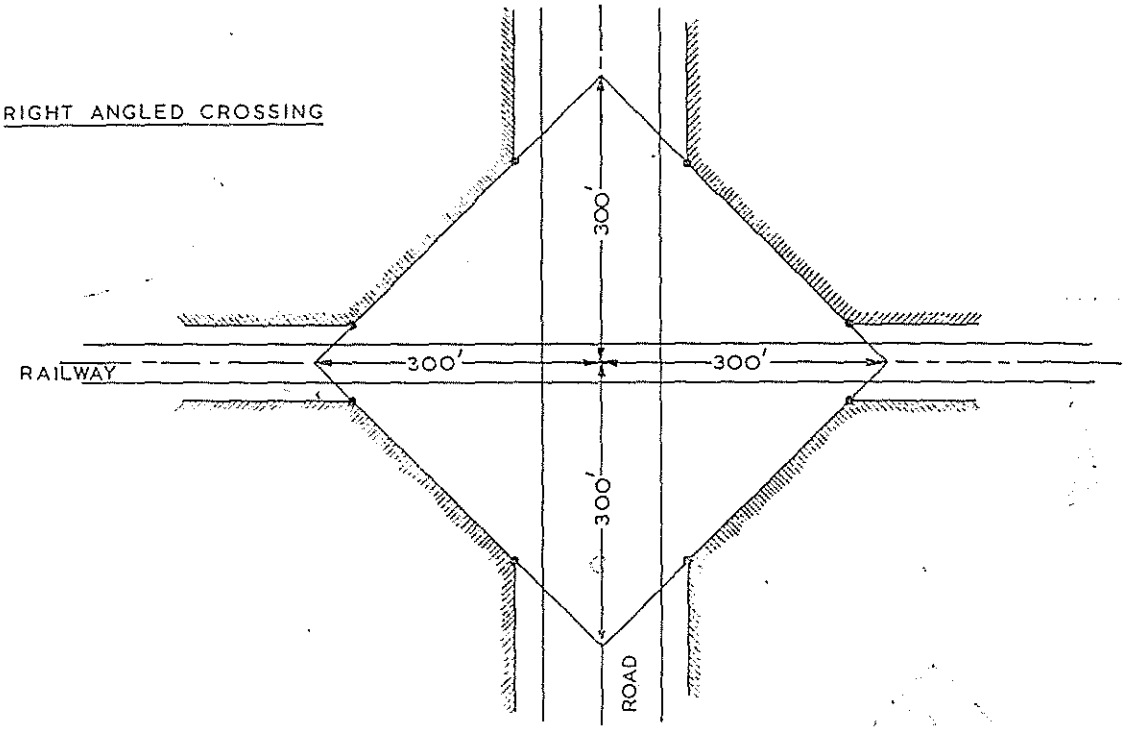
NOTE:- THE REVERSE SIDES OF THE BOARDS AND POSTS WILL BE PAINTED BLACK.

ANNEXURE 7

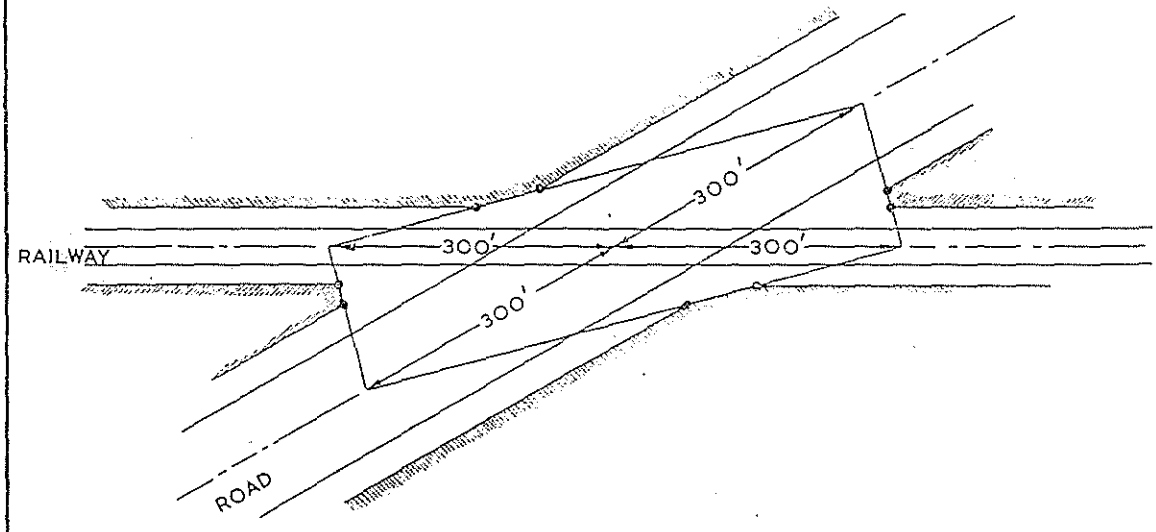
LEVEL CROSSINGS

AREAS OF CLEAR VISIBILITY – ROAD TO RAILWAY

RIGHT ANGLED CROSSING



SKEW CROSSING

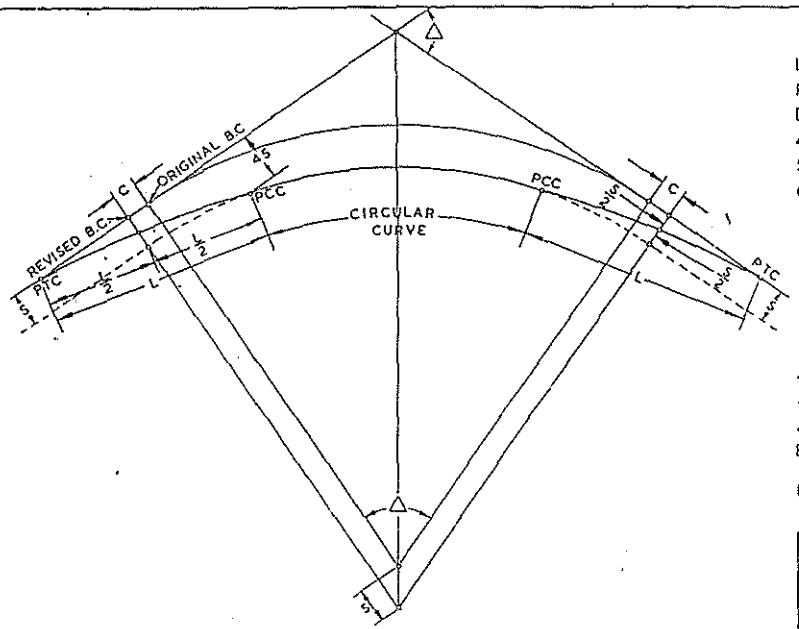


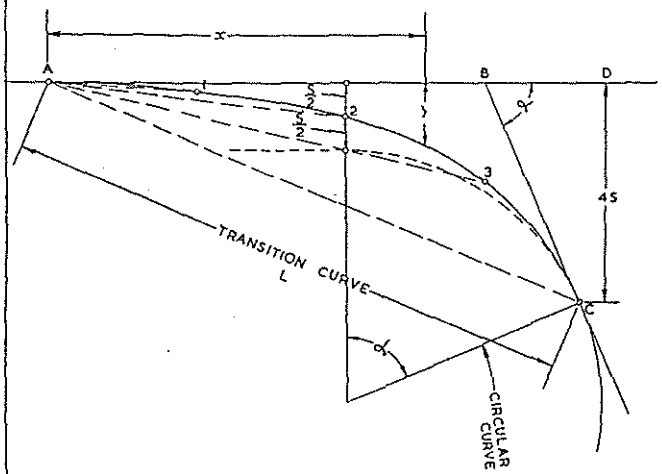
NOTE :- THE AREAS WITHIN THE RECTANGLES ARE THE MINIMUM DESIRABLE AREAS OF CLEAR VISIBILITY FROM ROAD TO RAILWAY.

• DENOTE WHITE MARKERS OF UNSERVICEABLE RAILS, STEEL SLEEPERS OR OTHER PERMANENT MATERIALS.

ANNEXURE 8

TRANSITION CURVE – CUBIC PARABOLA





L = Length of Transition Curve – See Table
R = Radius of Circular Curve in Feet = $\frac{5730}{D}$
D = Degree of Circular Curve = $\frac{5730}{R}$
Δ = Intersection Angle
S = Shift = $\frac{L^2}{24R}$ DC = $\frac{L^2}{6R}$ = 4S
C = The distance between original B.C. and revised B.C. = S tan $\frac{\Delta}{2}$

Offsets from the Tangent

At Station 1 $y = \frac{1}{16}S$ At Station C $y = 4S$
" " 2 $y = \frac{1}{2}S$ The Offset 'y' at any other Distance 'x'
" " 3 $y = \frac{27}{16}S$ from 'A' = $\frac{x^3}{6LR}$

Angle DBC = $\alpha = \frac{28.65L}{R}$ = 0·005 DL in degrees & decimals
Angle DAC = $\frac{1}{3}\alpha$
Angle BCA = $\frac{2}{3}\alpha$
BD = $\frac{DC}{\tan\alpha}$
BC = $\frac{DC}{\sin\alpha}$

Tangential Angles for the Transition Curve on 4 equal chords

Angle BA1 = $\frac{\alpha}{48}$
" BA2 = $\frac{\alpha}{12}$
" BA3 = $\frac{3\alpha}{16}$
" BAC = $\frac{\alpha}{3}$

Degree of Curve	Radius in Feet	Designed Max Speed M.P.H.	Designed Max Cant Ins	'L' in Feet	Max. Cant Gradient 1 in – Ft	'S' in Feet	Angle α ° ′ ″	Tangential Angles from Station A BA1 ° ′ ″	BA2 ° ′ ″	BA3 ° ′ ″	BAC ° ′ ″
1	5730	60	1	100	100·0	0·07	0–30–00	0–00–38	0–02–30	0–05–38	0–10–00
2	2865	60	2	140	70·0	0·29	1–24–00	0–01–45	0–07–00	0–15–45	0–28–00
3	1910	55	3	160	53·3	0·56	2–24–00	0–03–00	0–12–00	0–27–00	0–48–00
4	1432	50	3	160	53·3	0·74	3–12–00	0–04–00	0–16–00	0–36–00	1–04–00
5	1146	45	3	140	46·7	0·71	3–30–00	0–04–23	0–17–30	0–39–23	1–10–00
6	955	40	3	140	46·7	0·86	4–12–00	0–05–15	0–21–00	0–47–15	1–24–00
7	819	35	3	140	46·7	1·00	4–54–00	0–06–08	0–24–30	0–55–08	1–38–00
8	716	35	3	140	46·7	1·14	5–36–00	0–07–00	0–28–00	1–03–00	1–52–00
9	637	30	3	140	46·7	1·28	6–18–00	0–07–53	0–31–30	1–10–52	2–06–00
10	573	30	3	140	46·7	1·43	7–00–00	0–08–45	0–35–00	1–18–45	2–20–00
11	521	30	3	140	46·7	1·57	7–42–00	0–09–38	0–38–30	1–26–38	2–34–00
12	477	25	2¼	120	53·3	1·26	7–12–00	0–09–00	0–36–00	1–21–00	2–24–00
13	441	25	2¼	120	48·0	1·36	7–48–00	0–09–45	0–39–00	1–27–45	2–36–00
14	409	20	1½	100	66·7	1·02	7–00–00	0–08–45	0–35–00	1–18–45	2–20–00
15	382	20	1¾	100	57·1	1·09	7–30–00	0–09–23	0–37–30	1–24–23	2–30–00
16	358	20	1¾	100	57·1	1·16	8–00–00	0–10–00	0–40–00	1–30–00	2–40–00

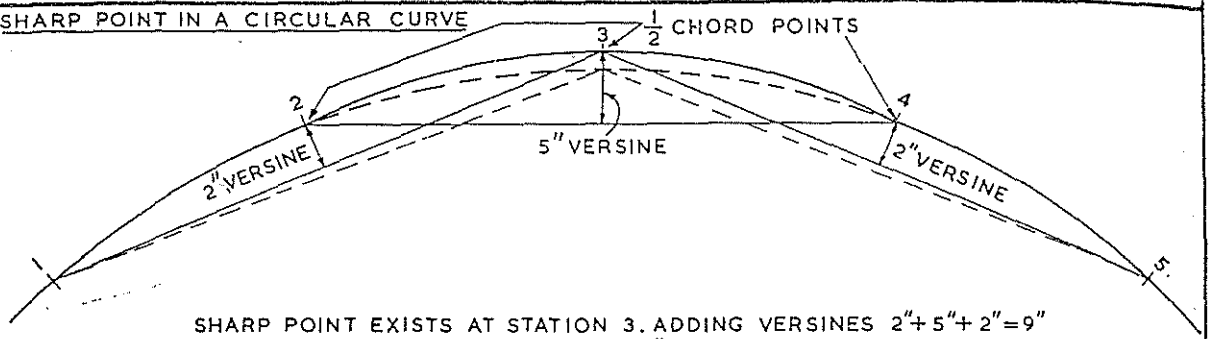
NOTE – The speeds shown above are probable future maxima for Rail Cars, and are included to show their relation to the Lengths of Transition Curves required. Actual maximum permissible speeds & cants are laid down in Special Instructions.

ANNEXURE 9

CORRECTING CURVATURE IRREGULARITIES

(AVERAGING THREE VERSINES)

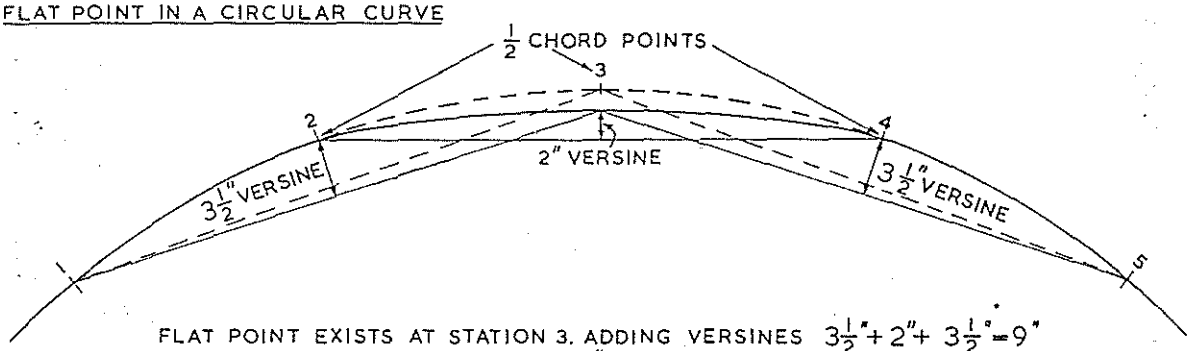
SHARP POINT IN A CIRCULAR CURVE



SHARP POINT EXISTS AT STATION 3. ADDING VERSINES 2"+ 5"+ 2"=9"
DIVIDING BY 3, AVERAGE VERSINE = 3"
PULL IN TRACK AT STATION 3 BY 2". THEN CORRECTED CURVE WILL BE AS DOTTED LINE, & VERSINES AT STATIONS 2,3 AND 4, WILL EACH BE 3"

NOTE THAT THE TRACK AT STATIONS 2 & 4 DOES NOT MOVE.

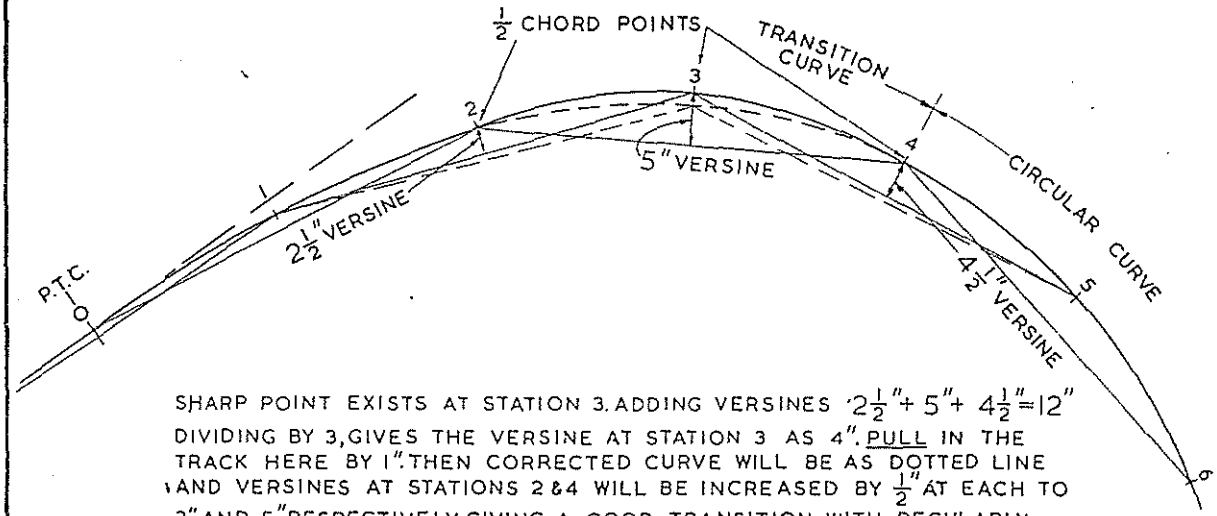
FLAT POINT IN A CIRCULAR CURVE



FLAT POINT EXISTS AT STATION 3. ADDING VERSINES $3\frac{1}{2}"+2"+3\frac{1}{2}"=9"$
DIVIDING BY 3, AVERAGE VERSINE = 3"
PUSH OUT TRACK AT STATION 3 BY 1". THEN CORRECTED CURVE WILL BE AS DOTTED LINE, & VERSINES AT STATIONS 2,3 AND 4, WILL EACH BE 3"

NOTE THAT THE TRACK AT STATIONS 2 & 4 DOES NOT MOVE.

SHARP POINT IN A TRANSITION CURVE

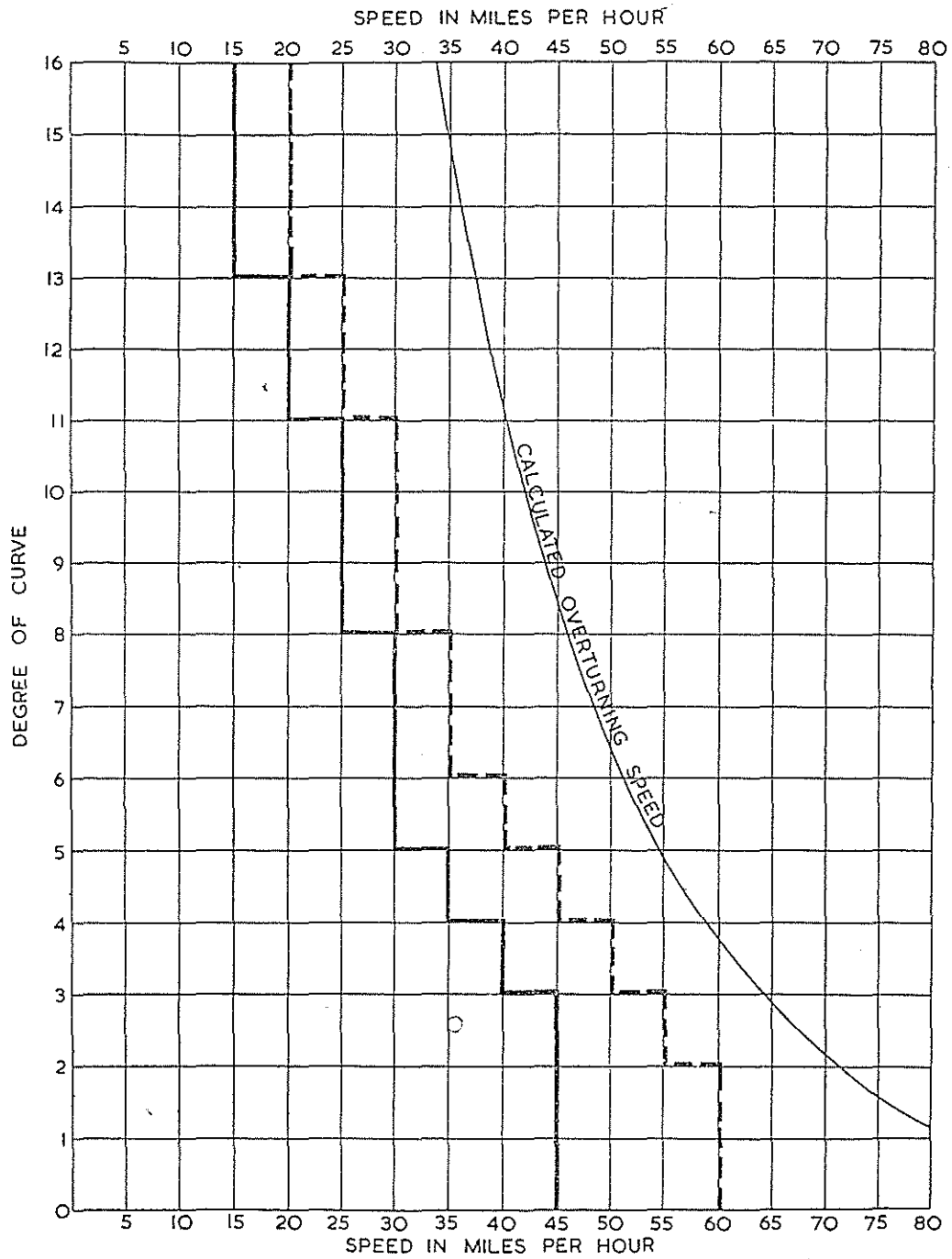


SHARP POINT EXISTS AT STATION 3. ADDING VERSINES $2\frac{1}{2}"+5"+4\frac{1}{2}"=12"$
DIVIDING BY 3, GIVES THE VERSINE AT STATION 3 AS 4". PULL IN THE TRACK HERE BY 1". THEN CORRECTED CURVE WILL BE AS DOTTED LINE AND VERSINES AT STATIONS 2 & 4 WILL BE INCREASED BY $\frac{1}{2}"$ AT EACH TO 3" AND 5" RESPECTIVELY, GIVING A GOOD TRANSITION WITH REGULARLY INCREASING VERSINES OF 3", 4" & 5".

NOTE THAT THE TRACK AT STATIONS 2 & 4 DOES NOT MOVE.

ANNEXURE 10

SPEEDS ON CURVES



NOTE – 1. THE CURVE REPRESENTS THE CALCULATED OVERTURNING SPEEDS FOR ROLLING STOCK HAVING A MAXIMUM HEIGHT OF CENTRE OF GRAVITY ABOVE RAIL LEVEL OF 74".

2. THE HEAVY STEPPED LINE SHOWS THE MAXIMUM SPEED AUTHORISED WHERE TRACK CONDITIONS ETC., PERMIT.

3. THE BROKEN STEPPED LINE REPRESENTS PROBABLE FUTURE MAXIMA FOR ANY SUITABLY DESIGNED RAIL CAR WITH LOW CENTRE OF GRAVITY.

ANNEXURE II

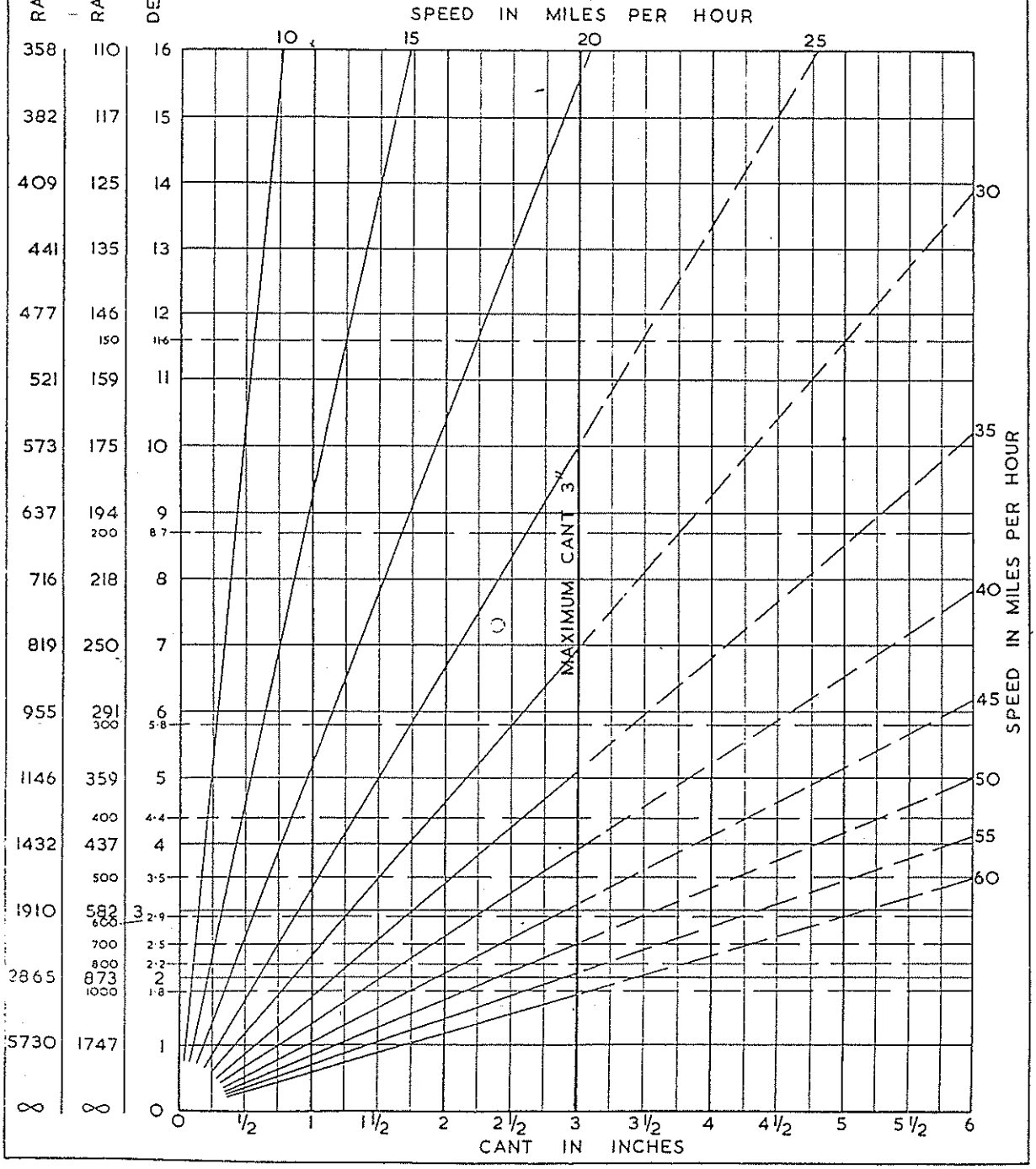
EQUILIBRIUM CANT FOR METRE GAUGE

$E = 0{\cdot}00048\ DV^2$

WHERE E = CANT IN INCHES

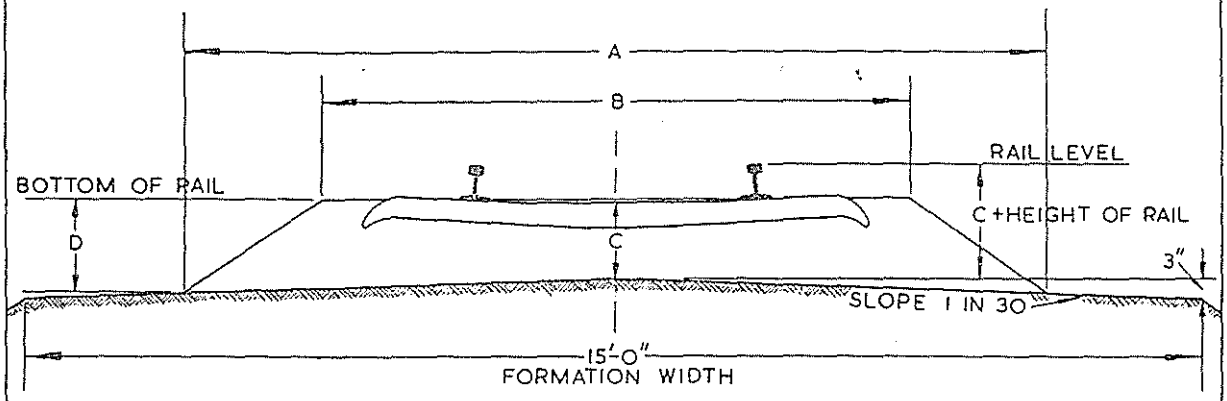
D = DEGREE OF CURVE

V = SPEED IN MILES PER HOUR



ANNEXURE 12

STONE BALLAST SECTIONS – NEW CONSTRUCTION
STEEL SLEEPERS



	RAIL SECTION	LENGTH OF SLEEPER	FULL SECTION					8 INCH DEPTH				
			CUBIC FEET PER MILE	DIMENSIONS				CUBIC FEET PER MILE	DIMENSIONS			
				A	B	C	D		A	B	C	D
GROUP 1	95 N. BS	6'–9"	55,000	11'–3"	7'–9"	12"	14"					
	80 R. BS	6'–6"	50,000	11'–0"	7'–6"	"	"					
	80 OBS	"	"	"	"	"	"					
	75 R. BS	"	"	"	"	"	"					
GROUP 2	60 N. BS	6'–3"	45,000	10'–3"	7'–0"	11"	13"	32,000	9'–6"	7'–0"	8"	10"
	60 R. BS	"	"	"	"	"	"	"	"	"	"	"
	55 R. BS	"	"	"	"	"	"	"	"	"	"	"
	55 OBS	"	"	"	"	"	"	"	"	"	"	"
	56·12 GHSC	"	"	"	"	"	"	"	"	"	"	"
GROUP 3	50 OBS	6'–0"	45,000	10'–0"	6'–9"	11"	13"	31,000	9'–3"	6'–9"	8"	10"
	50 NS	"	"	"	"	"	"	"	"	"	"	"
	45 R. BS	6'–1"	"	"	"	"	"	"	"	"	"	"
	43·14 GLSC	"	"	"	"	"	"	"	"	"	"	"
	40·32 GHST	6'–3"	"	"	"	"	"	"	"	"	"	"

GROUP 4

GROUP 5

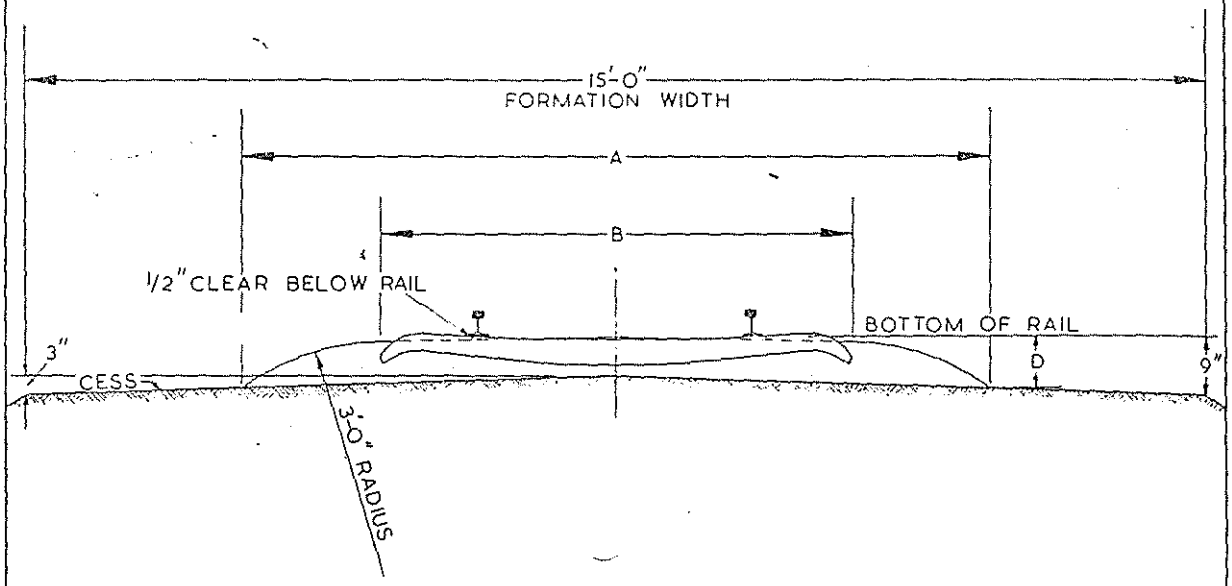
NOTE :– WHERE RAIL JOINTS HAVE BEEN WELDED, THE DIMENSIONS 'A' & 'B' ARE TO BE INCREASED BY 6 INCHES.

FOR WELDED RAIL JOINTS, ADDITIONAL BALLAST REQUIRED PER MILE, IS AS FOLLOWS :–

GROUP 1. — 3200 C.FT.
GROUP 2. — 3000 C.FT.
GROUP 3. — 3000 C.FT.
GROUP 4. — 2500 C.FT.
GROUP 5. — 2500 C.FT.

ANNEXURE 13

EARTH BALLAST SECTION
STEEL SLEEPERS



RAIL SECTIONS	DIMENSION			QTY PER LINEAL FOOT OF TRACK
	A	B	D	
60LB. & UNDER	9'-6"	6'-0"	8"	5·75 C.FT
OVER 60LB	10'-6"	7'-0"	8"	6·50 "

NOTE:- 1. THE SAME SECTION SHOULD BE ADOPTED WHERE QUARRY FINES ARE USED AS BALLAST.

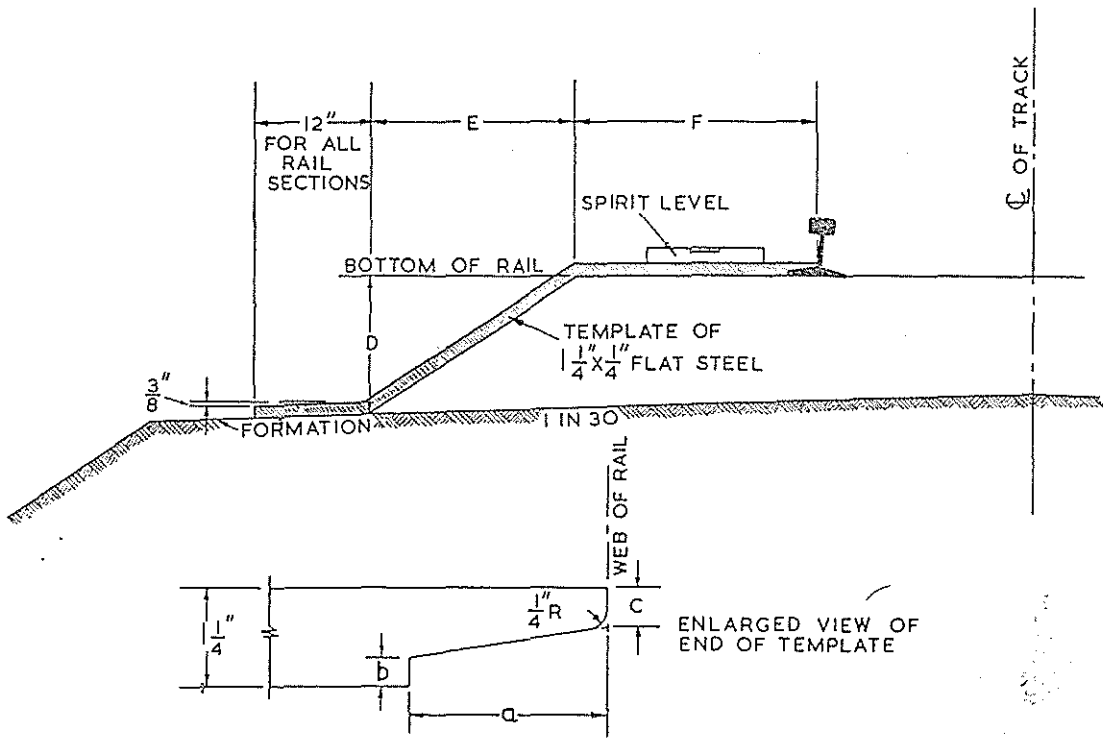
2. THE TOP IS CAMBERED AND THE SHOULDERS ARE ROUNDED TO ENSURE GOOD DRAINAGE.

3. THE BALLAST MUST BE KEPT CLEAR OF THE RAILS AND SLEEPER FASTENINGS.

ANNEXURE 14

TEMPLATE FOR STONE BALLASTED TRACK

(WIDTH OF BALLAST & FORMATION DEPTH)



BASED ON BALLAST SECTIONS IN ANNEXURE 12

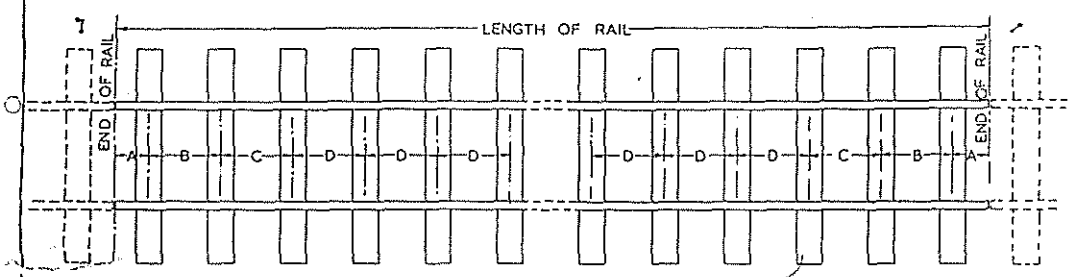
ALL DIMENSIONS IN INCHES

RAIL SECTION	FULL SECTION			8 INCH DEPTH			END OF TEMPLATE		
	F	E	D	F	E	D	a	b	c
95N. BS	25	21	14				2 1/2	3/8	1/2
80R.BS; 80 OBS 75R. BS	23 1/2	21	14				2 3/8	3/8	5/8
60N. BS; 60R.BS 55R. BS; 55 OBS 56·12 GHSC	21	19 1/2	13	21	15	10	2	3/8	5/8
50 OBS ; 50 NS 45R. BS; 43·14 GLSC 40·32 GHST	19 1/2	19 1/2	13	19 1/2	15	10	1 3/4	3/8	3/4

NOTE :– WHERE RAIL JOINTS HAVE BEEN WELDED, THE DIMENSION 'F' IS TO BE INCREASED BY 3 INCHES.

ANNEXURE 15

SLEEPER SPACING FOR STRAIGHT TRACK



GENERAL INSTRUCTIONS

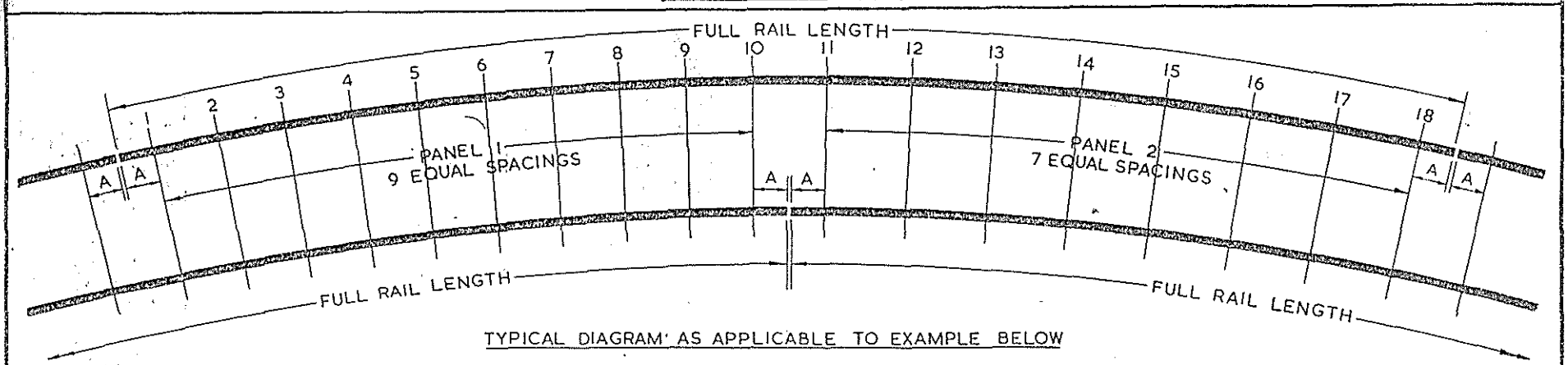
1. FOR SLEEPER ARRANGEMENTS WITH STAGGERED RAIL JOINTS IN CURVED TRACK SEE ANNEXURE 16.
2. THE SLEEPER DENSITIES TO BE USED IN NEW CONSTRUCTIONS AND RELAYINGS, SHALL BE DECIDED BY THE CHIEF ENGINEER
3. SEE ANNEXURE 25 FOR LENGTHS OF SPECIAL SHORTS, CONSIDERABLE QUANTITIES OF WHICH ARE FROM TIME TO TIME RELEASED FROM TRACK PREVIOUSLY LAID WITH SQUARE JOINTS ON CURVES. IN RELAYING SUCH RAILS IN STRAIGHT TRACK, THEY SHALL BE MATCHED FOR LENGTH, AND THE DIFFERENCE FROM NORMAL LENGTH SHALL BE ADJUSTED IN THE SLEEPER SPACINGS 'B' AND 'C' AT EACH END OF THE RAIL.

RAIL SECTION	NORMAL RAIL LENGTH	NUMBER PER RAIL	NUMBER PER MILE	SPACING IN INCHES A	B	C	D	SECTIONS WHERE LAID	REMARKS
95N. BS	40'-0"	18	2376	9	23	26	28	MOMBASA–NAIROBI	SPECIAL SPACING
	37'-6"	17	2394	9	22	26	28	"	STANDARD 'SHORTS'
	35'-0"	16	2414	9	21	26	28	"	"
	32'-6"	15	2437	9	20	26	28	"	"
80R BS	40'-0"	18	2376	9	23	26	28	NAIROBI — ELDORET	TO SUIT CIRCUMSTANCES AT THE TIME
	"	17	2244	9	24	27	30	BUKONTE–JINJA	MAIN LINE STANDARD
	"	16	2112	9	23	32	32		2nd LOOPS & IMPORTANT SIDINGS
	"	15	1980	10	32	33	33		MINOR SIDINGS
80 OBS	40'-0"	17	2244	9	24	27	30	TORORO – KAMPALA	MAIN LINE STANDARD
	"	16	2112	9	23	32	32	ELDORET – TORORO	TO SUIT CIRCUMSTANCES AT THE TIME, ALSO 2nd LOOPS & IMPORTANT SIDINGS
	"	15	1980	10	32	33	33		MINOR SIDINGS
75R BS	36'-0"	16	2347	9	25	28	28	NAIROBI– NAKURU, TORORO— KAMPALA	MAIN LINE STANDARD
	"	15	2200	9	27	30	30		2nd LOOPS & IMPORTANT SIDINGS
	"	14	2054	10	30	32	32		MINOR SIDINGS
60R BS	40'-0"	18	2376	9	23	26	28	FORT TERNAN — KISUMU RUVUI— MSUA	SPECIAL FOR WEAK SUB-GRADE
	"	17	2244	9	24	27	30	NAKURU—FORT TERNAN TANGA LINE, CENTRAL LINE AND S.R RLY	MAIN LINE STANDARD MAIN LINE, 2nd LOOPS AND IMPORTANT SIDINGS
	37'-6"	16	2253	"	"	"	"		
	35'-0"	15	2263	"	"	"	"		
	32'-6"	14	2275	"	"	"	"		
	40'-0"	15	1980	10	32	33	33		MINOR SIDINGS

RAIL SECTION	NORMAL RAIL LENGTH	NUMBER PER RAIL	NUMBER PER MILE	SPACING IN INCHES A	B	C	D	SECTIONS WHERE LAID	REMARKS
55R BS & 55 OBS	30'-0"	13	2288	11	22	27	30	KILOSA – MIKUMI	MAIN LINE STANDARD
	"	12	2112	11	29½	31	31		2nd LOOPS & IMPORTANT SIDINGS
	"	11	1936	11	33	34	34		MINOR SIDINGS
50 OBS	30'-0"	13	2288	9	24	27	30	KAMPALA – KASESE	MAIN LINE STANDARD
	"	12	2112	9	27	32	32	VOI – KAHE	2nd LOOPS & IMPORTANT SIDINGS
	"	11	1936	10	34	34	34		MINOR SIDINGS
50 NS	30'-0"	15	2640	9	21	25	25	JINJA – MBULAMUTI	TO SUIT CIRCUMSTANCES AT THE TIME
	"	13	2288	9	24	27	30	KAMPALA – KASESE	MAIN LINE STANDARD
	"	12	2112	9	27	32	32	VOI – KAHE	2nd LOOPS & IMPORTANT SIDINGS
	"	11	1936	10	34	34	34		MINOR SIDINGS
50 OBS & 50 NS	28'-6" 2 HOLE PLATE	12	2223	5½	28	29	31		
	28'-6" 4 HOLE PLATE	12	2223	9	27	30	30		
50 NS	2 X 20'-3" SPECIAL CROPPED	8	—	6	33	33	33		
		8	—	6	33	33	33		
50 ASCE	33'-0"	13	2080	9	29	32	32		
45R BS	30'-0"	13	2288	11	22	27	30	MWANZA BRANCH	MAIN LINE STANDARD
	"	12	2112	11	29½	31	31		OTHER LINES
56·12 GHSC	32'-9¾" (10 m)	14	2254	9¾	24⅞	29½	29½	KILOSA — MIKUMI	MAIN LINE STANDARD
		13	2093	9¾	27⅛	32	32		2nd LOOPS & IMPORTANT SIDINGS
		12	1932	9¾	34	34	34		MINOR SIDINGS
43·14 GLSC	29'-6⅜" (9 m)	13	2310	10⅜	26¾	28	28	MWANZA BRANCH	MAIN LINE STANDARD
		12	2133	10⅜	30⅛	30⅜	30⅜		OTHER LINES
40·32 GHST	32'-9¾" (10m)	13	2093	8½	28⅜	32	32	CHILUNGULA – MASASI	MAIN LINE STANDARD
		12	1932	8½	34⅛	34¼	34¼		OTHER LINES

SLEEPER SPACING FOR CURVED TRACK

WITH STAGGERED JOINTS



TYPICAL DIAGRAM AS APPLICABLE TO EXAMPLE BELOW

1. THE METHOD OF ARRANGING THE RAILS FOR STAGGERED JOINTS ON CURVES IS EXPLAINED IN THE TEXT. AS ONLY ONE RAIL OF STANDARD LENGTH IS CUT, THE 2 PANEL LENGTHS VARY PROGRESSIVELY ALONG THE CURVE, THE DIFFERENCE BEING GREATEST AT THE BEGINNING & END OF THE CURVE, AND EQUAL LENGTH PANELS HALF WAY ALONG THE CURVE.

2. BECAUSE THE RAIL JOINTS MUST BE CLOSELY SUPPORTED, AND AS THERE ARE THREE JOINTS TO A RAIL LENGTH, AT LEAST ONE ADDITIONAL SLEEPER PER RAIL LENGTH IS REQUIRED OVER THE <u>STANDARD</u> ARRANGEMENT ON STRAIGHT TRACK. THE STANDARD FOR CURVES SHALL BE :-

   95 lb. TRACK — 1 ADDITIONAL SLEEPER FOR ALL DEGREES OF CURVES.
   80 lb. TRACK — 1 " " " CURVES UP TO 6 DEGREES. 2 ADDITIONAL SLEEPERS FOR CURVES OVER 6 DEGREES.
   OTHER RAIL SECTIONS — 1 " SLEEPER FOR ALL DEGREES OF CURVES.

3. THE SLEEPERS ON EACH SIDE OF THE RAIL JOINT SHALL BE LAID AT THE 'A' SPACING FOR STRAIGHT TRACK. FOR THE REMAINDER OF EACH PANEL, DISTRIBUTE THE SLEEPERS SO AS TO OBTAIN NEARLY THE SAME SPACING IN EACH OF THE PANELS. THESE INTERMEDIATE SLEEPERS SHALL BE EQUALLY SPACED.

   EXAMPLE :- 80 lb. TRACK — RAIL 40 FT. — CURVE 6 DEGREES — 18 SLEEPERS PER RAIL — 'A' SPACING 9"

	<u>PANEL 1</u>	<u>PANEL 2</u>
LENGTH	20'-0"	17'-0"
SLEEPERS	10	8
INTERMEDIATE SPACINGS	$26\frac{5}{8}$" (9 SPACES)	$29\frac{1}{8}$" (7 SPACES)

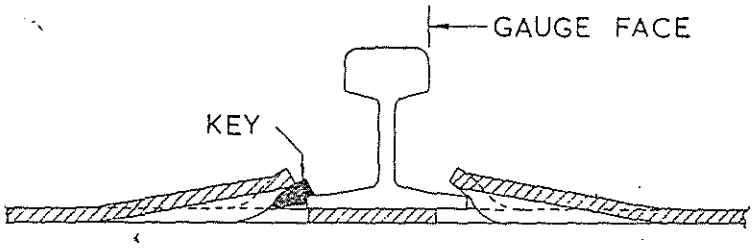
4. WHERE AN <u>ODD</u> NUMBER OF SLEEPERS PER RAIL LENGTH IS TO BE USED e.g. 19, THE SITUATION ARISES $\frac{1}{2}$ WAY ALONG THE CURVE WHERE BOTH PANELS ARE OF EQUAL LENGTH OR VERY NEARLY SO. IN THIS CASE AN EQUAL NUMBER OF SLEEPERS i.e. 9 & 9, SHALL BE LAID IN EACH PANEL

ANNEXURE 16

ANNEXURE 17

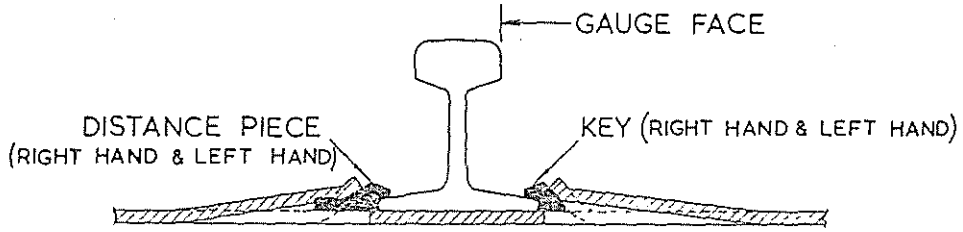
GAUGE SETTING ON STEEL SLEEPERS

LUG TYPE WITH SINGLE KEY FOR 55 OBS; 50 OBS & 50 NS RAILS



KEY		GAUGE	KEY	
OUTSIDE	INSIDE		INSIDE	OUTSIDE
KEY	—	NORMAL	—	KEY
—	KEY	$+\frac{3}{4}$" 55 OBS	—	KEY
—	KEY	$+\frac{5}{8}$" 50 OBS AND 50 NS	—	KEY

LUG TYPE WITH KEY & DISTANCE PIECE FOR 55 R. BS; 55 OBS & 45 R. BS RAILS

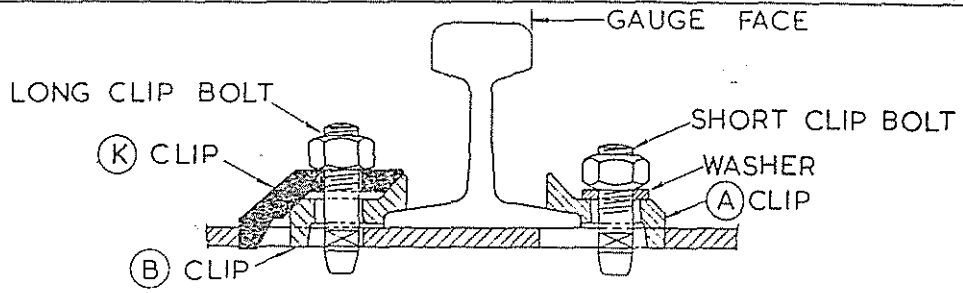


COMPONENT		GAUGE	COMPONENT	
OUTSIDE	INSIDE		INSIDE	OUTSIDE
D.P.	KEY	NORMAL	KEY	D.P.
KEY	D.P.	$+\frac{1}{4}$"	KEY	D.P.
KEY	D.P.	$+\frac{1}{2}$"	D.P.	KEY

ANNEXURE 18

GAUGE SETTING ON STEEL SLEEPERS

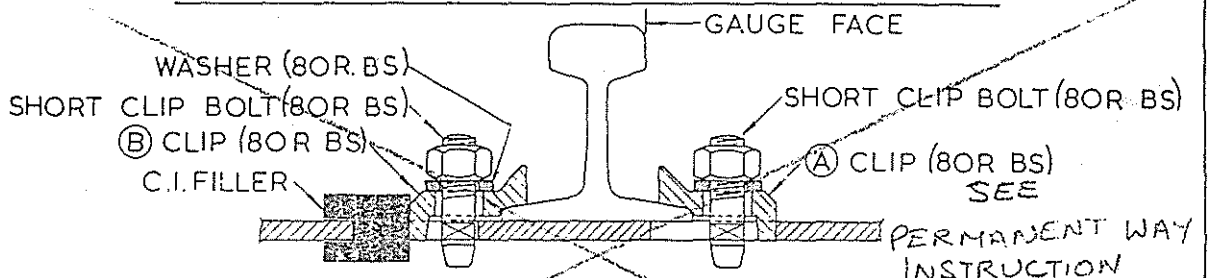
'K' TYPE FOR 95N BS: 80R BS: 60R BS & 60N BS RAILS



NOTE
FOR GAUGE CONVERSION TO 3'-6", 'K' CLIPS MOVED TO INSIDE OF TRACK

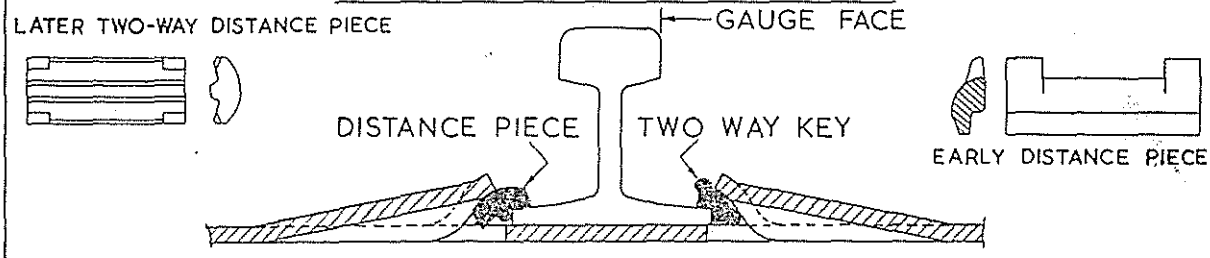
CLIP		GAUGE	CLIP	
OUTSIDE	INSIDE		INSIDE	OUTSIDE
K/B	A	NORMAL	A	K/B
K/A	B	$+\frac{1}{4}$"	A	K/B
K/A	B	$+\frac{1}{2}$"	B	K/A

75R BS RAIL ON 80 R BS 'K' TYPE SLEEPER



CLIP		GAUGE	CLIP	
OUTSIDE	INSIDE		INSIDE	OUTSIDE
B	A	NORMAL	A	B
A	B	$+\frac{1}{4}$"	A	B
A	B	$+\frac{1}{2}$"	B	A

80 OBS LUG TYPE SLEEPER

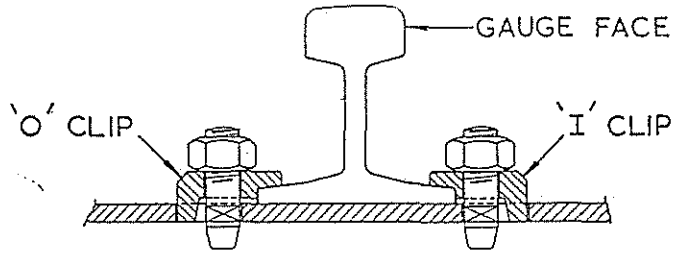


COMPONENT		GAUGE	COMPONENT	
OUTSIDE	INSIDE		INSIDE	OUTSIDE
D.P.	KEY	NORMAL	KEY	D.P.
KEY	D.P.	$+\frac{3}{8}$"	KEY	D.P.
KEY	D.P.	$+\frac{3}{4}$"	D.P.	KEY

ANNEXURE 19

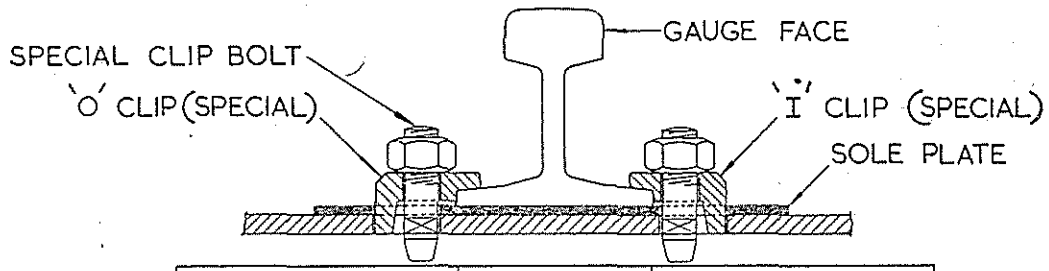
GAUGE SETTING ON STEEL SLEEPERS

CLIP & BOLT 'F' TYPE FOR 80 OBS; 50 OBS; 50 NS & 50 ASCE RAILS



CLIP		GAUGE	CLIP	
OUTSIDE	INSIDE		INSIDE	OUTSIDE
O	I	NORMAL	I	O
I	O	+ 1/4"	I	O
I	O	+ 1/2"	O	I

CLIP & BOLT 'F' TYPE WITH SOLE PLATE FOR 80 OBS; 75R. BS; 50 OBS & 50 NS RAILS



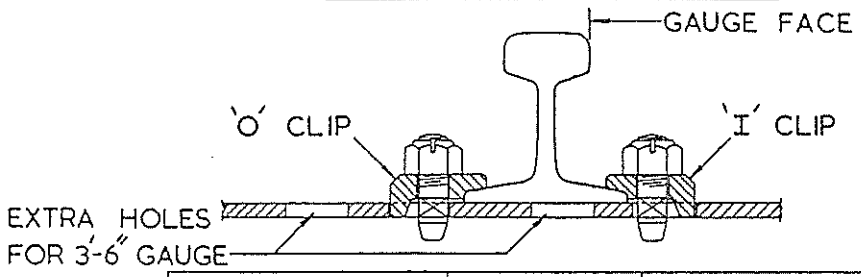
NOTE :-
GAUGE WIDENING FOR 50NS RAILS WILL BE :- 5/16" AND 5/8" INSTEAD OF 1/4" AND 1/2"

CLIP		GAUGE	CLIP	
OUTSIDE	INSIDE		INSIDE	OUTSIDE
O	I	NORMAL	I	O
I	O	+ 1/4"	I	O
I	O	+ 1/2"	O	I

ANNEXURE 20

GAUGE SETTING ON STEEL SLEEPERS

CLIP & BOLT TYPE (TANGANYIKA) FOR 55R.BS & 45R.BS RAILS

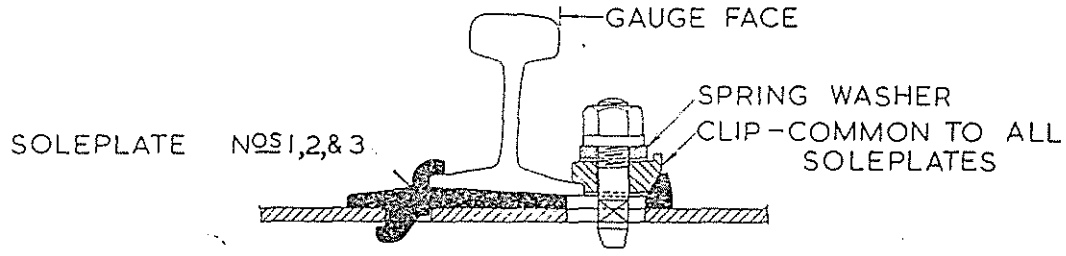


CLIP		GAUGE	CLIP	
OUTSIDE	INSIDE		INSIDE	OUTSIDE
O	I	NORMAL	I	O
I	O	+ 1/4"	I	O
I	O	+ 1/2"	O	I

ANNEXURE 21

GAUGE SETTING ON STEEL SLEEPERS

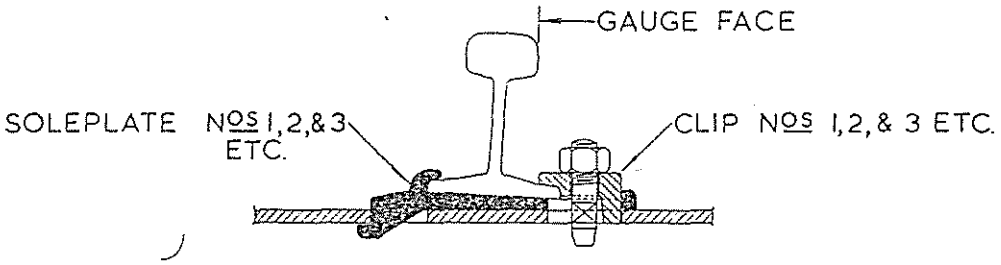
56·12 GHSC RAIL



LEFT RAIL SOLEPLATE Nº	GAUGE	RIGHT RAIL SOLEPLATE Nº
3	NORMAL	3
2	+ 5/16" (8mm)	3
2	+ 1/2" (13mm)	2
1	+ 3/4" (18mm)	2
1	+ 15/16" (23mm)	1

NOTE – GAUGE WIDENING EXCEEDING 1/2" IS NOT NORMALLY TO BE USED

43·14 GLSC RAIL & 40·32 GHST RAIL

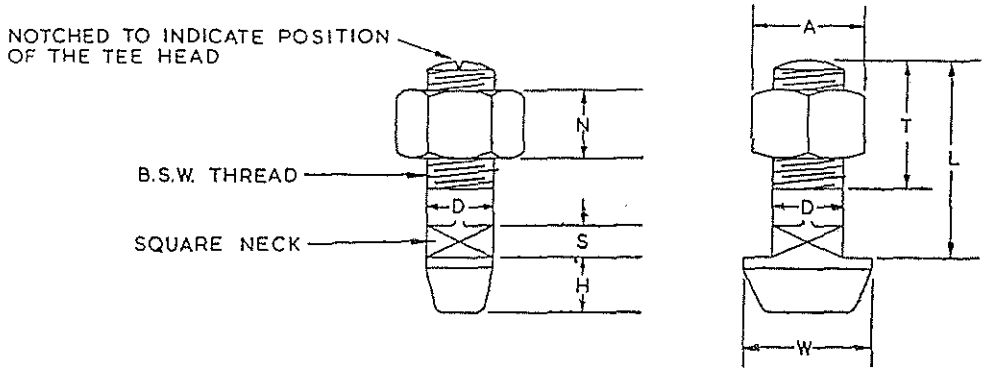


	LEFT RAIL		GAUGE	RIGHT RAIL	
	SOLEPLATE Nº	CLIP Nº		SOLEPLATE Nº	CLIP Nº
GLSC	3	1	NORMAL	1	3
	3	1	+ 3/16" (5 mm)	2	2
	2	2	+ 3/8" (10mm)	2	2
	2	2	+ 9/16" (15mm)	3	1
	1	3	+ 13/16" (20mm)	3	1
	0	4	+ 1" (25mm)	3	1
GHST	3	1	NORMAL	1	3
	3	1	+ 3/16" (5 mm)	2	2
	3	1	+ 3/8" (10mm)	3	1
	2	2	+ 9/16" (15mm)	3	1
	1	3	+ 13/16" (20mm)	3	1

NOTE – GAUGE WIDENING EXCEEDING 9/16" IS NOT NORMALLY TO BE USED

ANNEXURE 22

TEE HEAD CLIP BOLTS FOR SLEEPERS



ALL DIMENSIONS IN INCHES

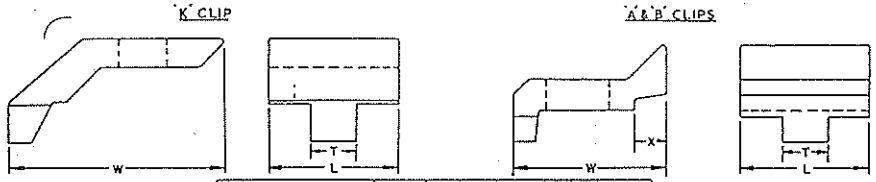
RAIL SECTION	TYPE OF SLEEPER	L	D	T	S	H	W	NUT TYPE	NUT N	NUT A	REMARKS
95N. BS ; 80R. BS	'K' (LONG)	$3\frac{1}{8}$	$\frac{7}{8}$	$1\frac{5}{8}$	$\frac{13}{32}$	$\frac{11}{16}$	$1\frac{5}{8}$	EVERTITE (HEX)	$\frac{7}{8}$	$1\frac{7}{16}$	
" "	'K' (SHORT)	$2\frac{1}{2}$	"	"	"	"	"	"	"	"	INTERCHANGEABLE
75R. BS	'K' (80R.) WITH C.I. FILLER	"	"	"	"	"	"	"	"	"	INTERCHANGEABLE
80 OBS	'F'	$2\frac{7}{16}$	"	$1\frac{3}{8}$	"	"	"	"	"	"	INTERCHANGEABLE
80 OBS	REPRESSED WITH SOLE PLATE	$2\frac{5}{8}$	"	$1\frac{1}{4}$	"	"	"	"	"	"	INTERCHANGEABLE
75R. BS	"	"	"	"	"	"	"	"	"	"	INTERCHANGEABLE
60N. BS ; 60R. BS	'K' (LONG)	$2\frac{3}{4}$	$\frac{3}{4}$	$1\frac{3}{8}$	$\frac{3}{8}$	$\frac{9}{16}$	$1\frac{7}{16}$	"	$\frac{3}{4}$	$1\frac{1}{4}$	NUTS ARE INTERCHANGEABLE
" "	'K' (SHORT)	$2\frac{3}{16}$	"	"	"	"	"	"	"	"	NUTS ARE INTERCHANGEABLE
50 OBS ; 50NS	'F'	$1\frac{7}{8}$	$\frac{3}{4}$	$1\frac{3}{16}$	$\frac{5}{16}$	$\frac{9}{16}$	$1\frac{7}{16}$	"	"	"	NUTS ARE INTERCHANGEABLE
" "	'F' - SOLE PLATE	$2\frac{1}{4}$	"	$1\frac{3}{8}$	"	"	"	"	"	"	NUTS ARE INTERCHANGEABLE
55R. BS	'F' (TANGANYIKA)	$2\frac{1}{8}$	$\frac{3}{4}$	$1\frac{3}{8}$	$\frac{1}{2}$	$\frac{9}{16}$	$1\frac{7}{16}$	IBBOTSON (HEX)	$\frac{7}{8}$	$1\frac{5}{16}$	NUTS ARE INTERCHANGEABLE
45R. BS	"	"	$\frac{11}{16}$	"	$\frac{11}{32}$	"	"	PLAIN HEX. WITH SPRING WASHER	$\frac{11}{16}$	$1\frac{3}{16}$	
56·12 GHSC	GERMAN	$3\frac{1}{8}$	$\frac{3}{4}$	$1\frac{3}{4}$	$\frac{19}{32}$	$\frac{5}{8}$	$1\frac{9}{16}$	SPECIAL HEX. NUT SPRING WASHER	$1\frac{1}{16}$	$1\frac{5}{16}$	
"	FOR BRITISH MAKE	$2\frac{1}{2}$	"	$1\frac{1}{4}$ BSW	$\frac{1}{2}$	$\frac{9}{16}$	$1\frac{7}{16}$	EVERTITE (HEX)	$\frac{3}{4}$	$1\frac{1}{4}$	SPRING WASHER NOT REQUIRED
43·14 GLSC & 40·32 GHST	GERMAN	$2\frac{1}{8}$	$\frac{5}{8}$	$1\frac{3}{16}$	$\frac{21}{32}$	$\frac{9}{16}$	$1\frac{3}{8}$	PLAIN HEX.	$\frac{5}{8}$	$1\frac{3}{32}$	
"	FOR BRITISH MAKE	"	"	" BSW	"	"	"	EVERTITE (HEX)	$\frac{5}{8}$	$1\frac{3}{32}$	

NOTE - THE CLIP BOLT OF THE 31 25 GLST SLEEPER CAN BE USED WITH THE GLSC & GHST SLEEPERS

ANNEXURE 22A

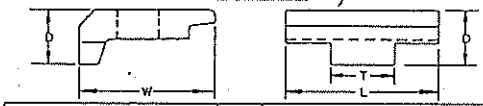
CLIPS FOR STEEL SLEEPERS

'K' TYPE SLEEPER



RAIL SECTION	TYPE OF CLIP	DIMENSIONS IN INCHES W	L	T	X	HOLE
95N.BS; 80 R.BS	K	$4\frac{7}{32}$	$2\frac{1}{2}$	$\frac{7}{8}$	—	$\frac{15}{16}$ ROUND
" "	B	3	"	"	$\frac{5}{8}$	$1\frac{1}{4}\times\frac{15}{16}$ OVAL
" "	A	"	"	"	$\frac{7}{8}$	"
60N.BS; 60R.BS	K	$4\frac{7}{32}$	$2\frac{1}{8}$	$\frac{3}{4}$	—	$\frac{13}{16}$ ROUND
" "	B	3	"	"	$\frac{5}{8}$	$1\frac{1}{8}\times\frac{13}{16}$ OVAL
" "	A	"	"	"	$\frac{7}{8}$	"

'F' TYPE SLEEPER



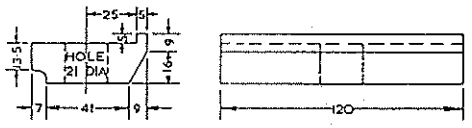
RAIL SECTION	TYPE OF CLIP	DIMENSIONS IN INCHES W	L	T	D	HOLE
80 OBS	O	$2\frac{11}{16}$	3	$1\frac{1}{4}$	$1\frac{9}{32}$	$\frac{15}{16}$ ROUND
"	I	$2\frac{7}{16}$	"	"	"	"
" WITH SOLE PLATE	O	$2\frac{11}{16}$	3	$\frac{7}{8}$	$1\frac{9}{16}$	$\frac{15}{16}$ ROUND
" "	I	$2\frac{7}{16}$	"	"	"	"
75R.BS WITH SOLE PLATE	O	$2\frac{13}{16}$	$2\frac{1}{2}$	$\frac{7}{8}$	$1\frac{9}{16}$	$\frac{15}{16}$ ROUND
" "	I	$2\frac{1}{2}$	"	"	"	"
50 OBS	O	$2\frac{3}{8}$	$3\frac{1}{2}$ *	$1\frac{1}{4}$	$1\frac{1}{16}$	$\frac{13}{16}$ ROUND
"	I	$2\frac{1}{8}$	" *	"	"	"
" WITH SOLE PLATE	O	$2\frac{3}{8}$	$2\frac{1}{2}$ *	$1\frac{1}{4}$	$1\frac{5}{16}$	$\frac{13}{16}$ ROUND
" "	I	$2\frac{1}{8}$	"	"	"	"
50NS	O	$2\frac{5}{8}$	3 *	$1\frac{1}{4}$	$1\frac{1}{16}$	$\frac{13}{16}$ SQUARE NOW ROUND
"	I	$2\frac{5}{16}$	" *	"	"	
" WITH SOLE PLATE	O	$2\frac{5}{8}$	$2\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{5}{16}$	$\frac{13}{16}$ ROUND
" "	I	$2\frac{5}{16}$	"	"	"	"

* LATER SUPPLIES HAVE THE DIMENSION 'L' REDUCED TO $2\frac{1}{2}$"

CLIP & BOLT TYPE SLEEPER (TANGANYIKA)

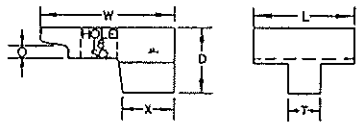
55R.BS	O	$2\frac{1}{2}$	$3\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{7}{32}$	$\frac{13}{16}$ SQUARE
"	I	$2\frac{1}{4}$	"	"	"	"
45R.BS	O	$2\frac{5}{8}$	$1\frac{3}{4}$	$\frac{5}{4}$	$1\frac{1}{16}$	$\frac{3}{4}$ ROUND
"	I	$2\frac{1}{8}$	"	"	"	"
45 OBS RAIL ON SOLB F TYPE SLEEPER; CAST IRON CLIPS $\frac{7}{8}$" THICK	O	$2\frac{7}{16}$	$2\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$\frac{13}{16}$ ROUND
	I	$2\frac{3}{16}$	"	"	"	"

GHSC GERMAN SLEEPER



THE ONE SIZE OF CLIP IS USED WITH SOLE PLATES NOS 1, 2 & 3

FOR GERMAN SLEEPERS OTHER THAN GHSC



RAIL SECTION	CLIP NO	DIMENSIONS IN MM. W	L	T	D	O	X
43·14 GLSC	1	52	50	16	32	5·9	11
	2	57	"	"	"	"	16
	3	62	"	"	"	"	21
	4	67	"	"	"	"	26
40·32 GHST	1	53	50	16	32	3·4	11
	2	58	"	"	"	"	16
	3	63	"	"	"	"	21
31·25 GLST	1	53	50	16	32	4	11
	2	58	"	"	"	"	16
	3	63	"	"	"	"	21

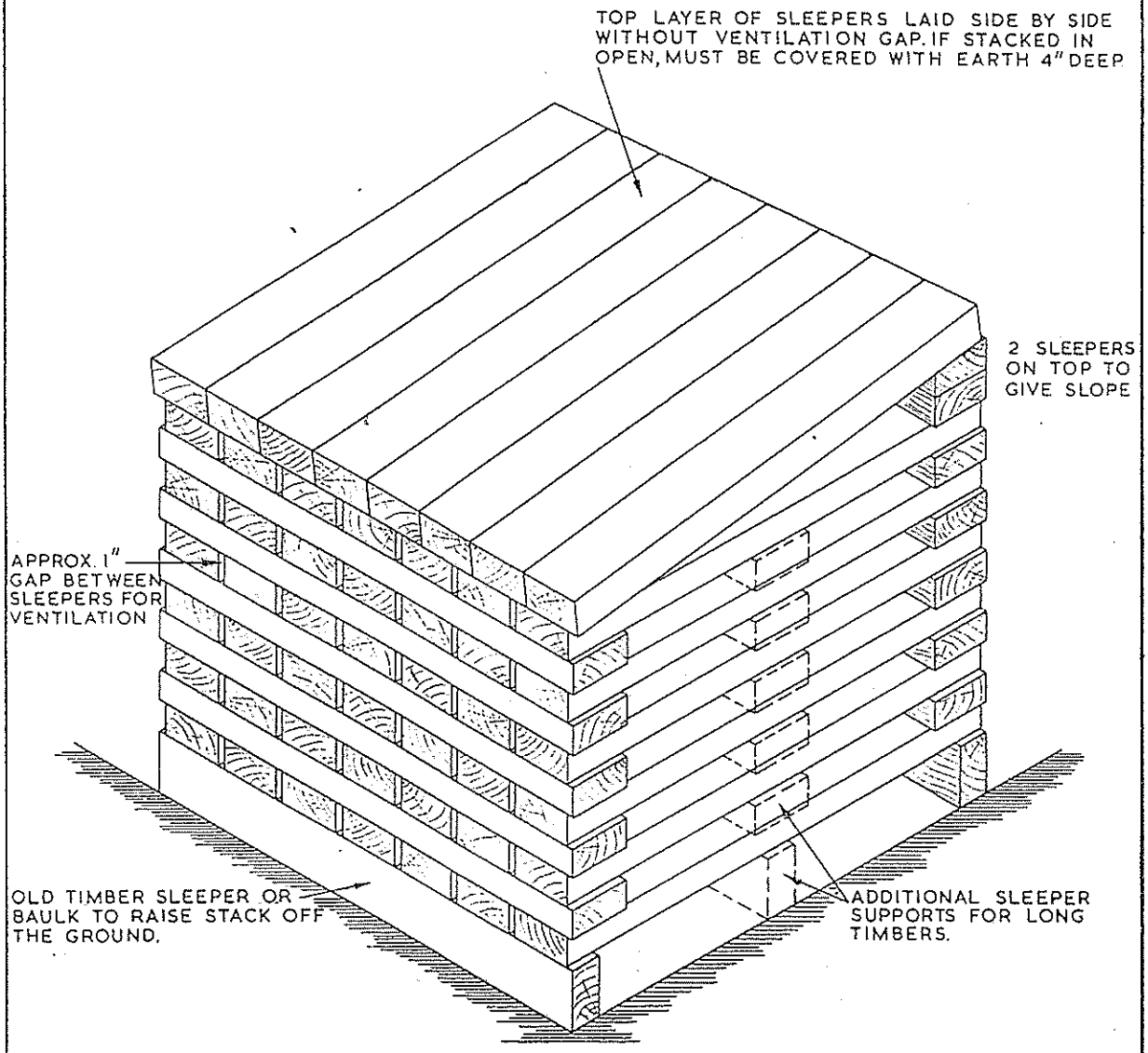
NOTE :-

1. ALL OTHER DIMENSIONS NOT LETTERED ARE THE SAME FOR ALL SIZES OF CLIPS AND FOR ALL RAIL SECTIONS.
2. THE DIFFERENCE IN THE DIMENSION 'O' AND THE SLOPE OF THE LIPS OF THE GHST & GLST CLIPS IS SO SMALL THAT THE CLIPS CAN BE CONSIDERED AS INTERCHANGEABLE.
3. THE CLIPS ARE ONLY IDENTIFIABLE FROM EACH OTHER (FOR THE SAME RAIL SECTION) FROM THE DIMENSION 'X' AND THE NUMERAL 1, 2, 3 OR 4 STAMPED ON THE CLIP.

MM	INS
3·4	$\frac{1}{8}$
4	$\frac{5}{32}$
5	$\frac{3}{16}$
5·9	$\frac{7}{32}$
7	$\frac{9}{32}$
9	$\frac{11}{32}$
11	$\frac{7}{16}$
13.5	$\frac{17}{32}$
16	$\frac{5}{8}$
18	$\frac{23}{32}$
21	$\frac{13}{16}$
25	1
26	$1\frac{1}{32}$
32	$1\frac{1}{4}$
41	$1\frac{5}{8}$
50	$1\frac{31}{32}$
52	$2\frac{1}{16}$
53	$2\frac{3}{32}$
57	$2\frac{1}{4}$
58	$2\frac{9}{32}$
62	$2\frac{7}{16}$
63	$2\frac{15}{32}$
67	$2\frac{5}{8}$
120	$4\frac{23}{32}$

ANNEXURE 23

STACKING WOODEN SLEEPERS

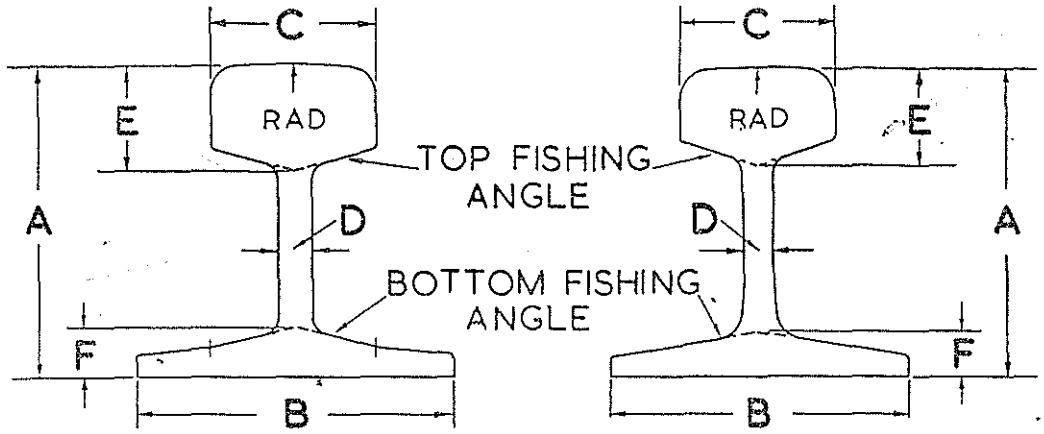


NOTE:-

WHERE SLEEPERS ARE SPECIALLY HELD FOR AIR SEASONING INSTRUCTIONS ON THE METHOD OF STACKING SHALL BE OBTAINED FROM THE CHIEF ENGINEER.

ANNEXURE 24

PRINCIPAL DIMENSIONS OF RAILS



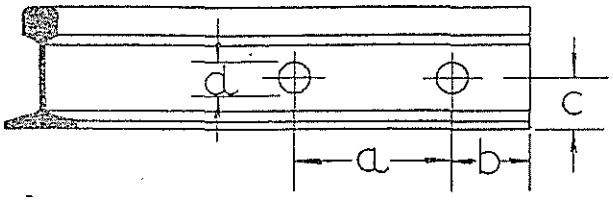
TYPE 1
WITH CHANGE OF ANGLE IN THE FLANGE

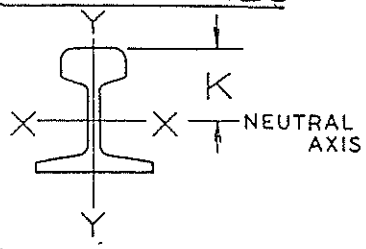
TYPE 2
WITHOUT CHANGE OF ANGLE IN THE FLANGE

RAIL SECTION LBS PER YARD	TYPE	DIMENSION (INCHES)						FISHING ANGLE		RADIUS OF TABLE (INS)
		A	B	C	D	E	F	TOP 1 IN___	BOTTOM 1 IN___	
95 N BS	1	$5\frac{13}{16}$	$5\frac{1}{2}$	$2\frac{3}{4}$	$\frac{35}{64}$	$1\frac{25}{32}$	$1\frac{1}{32}$	2·75	2·75	9
80R BS	2	$5\frac{1}{4}$	5	$2\frac{1}{2}$	$\frac{17}{32}$	$1\frac{39}{64}$	$\frac{49}{64}$	3	6	9
80 OBS	1	5	5	$2\frac{1}{2}$	$\frac{35}{64}$	$1\frac{19}{32}$	$\frac{27}{32}$	4	4	12
75R BS	2	$5\frac{1}{16}$	$4\frac{13}{16}$	$2\frac{7}{16}$	$\frac{33}{64}$	$1\frac{9}{16}$	$\frac{47}{64}$	3	6	9
75 ASCE	2	$4\frac{13}{16}$	$4\frac{13}{16}$	$2\frac{15}{32}$	$\frac{17}{32}$	$1\frac{27}{64}$	$\frac{27}{32}$	4·33	4·33	12
60N BS	1	$4\frac{1}{2}$	$4\frac{5}{16}$	$2\frac{1}{4}$	$\frac{7}{16}$	$1\frac{13}{32}$	$\frac{7}{8}$	2·75	2·75	12
60R BS	2	$4\frac{1}{2}$	$4\frac{5}{16}$	$2\frac{1}{4}$	$\frac{7}{16}$	$1\frac{13}{32}$	$\frac{21}{32}$	3	6	9
55R BS	2	$4\frac{5}{16}$	$4\frac{1}{8}$	$2\frac{5}{32}$	$\frac{27}{64}$	$1\frac{11}{32}$	$\frac{5}{8}$	3	6	9
55 OBS	1	$4\frac{1}{8}$	$4\frac{1}{8}$	$2\frac{5}{32}$	$\frac{7}{16}$	$1\frac{23}{64}$	$\frac{43}{64}$	4	4	12
50 OBS	1	$3\frac{15}{16}$	$3\frac{15}{16}$	$2\frac{1}{16}$	$\frac{13}{32}$	$1\frac{5}{16}$	$\frac{41}{64}$	4	4	12
50NS	1	4	$3\frac{1}{2}$	2	$\frac{7}{16}$	$1\frac{27}{64}$	$\frac{43}{64}$	3·73	3·73	15
50 ASCE	2	$3\frac{7}{8}$	$3\frac{7}{8}$	$2\frac{1}{8}$	$\frac{7}{16}$	$1\frac{1}{8}$	$\frac{11}{16}$	4·33	4·33	12
45R BS	2	$3\frac{7}{8}$	$3\frac{3}{4}$	$1\frac{31}{32}$	$\frac{3}{8}$	$1\frac{7}{32}$	$\frac{9}{16}$	3	6	9
45 OBS	1	$3\frac{3}{4}$	$3\frac{3}{4}$	$1\frac{31}{32}$	$\frac{25}{64}$	$1\frac{15}{64}$	$\frac{39}{64}$	4	4	12
56·12 GHSC	1	$4\frac{17}{32}$	$3\frac{15}{16}$	$2\frac{9}{32}$	$\frac{25}{64}$	$1\frac{19}{64}$	$\frac{45}{64}$	4	4	9
43·14 GLSC	1	$4\frac{9}{64}$	$3\frac{23}{64}$	$1\frac{13}{16}$	$\frac{5}{16}$	$1\frac{7}{32}$	$\frac{19}{32}$	4	4	7
40·32 GHST	2	$3\frac{27}{32}$	$3\frac{15}{64}$	$1\frac{57}{64}$	$\frac{23}{64}$	$1\frac{15}{64}$	$\frac{37}{64}$	4	4	7
31·25 GLST	1	$3\frac{1}{2}$	$2\frac{3}{4}$	$1\frac{1}{2}$	$\frac{19}{64}$	$1\frac{9}{64}$	$\frac{5}{8}$	2·25	2·25	7

ANNEXURE 25

RAIL LENGTHS, HOLING AND PROPERTIES





RAIL SECTION	LENGTHS			DIMENSIONS IN INCHES				AREA IN SQ. INS.	DIMENSION 'K' IN INCHES	MOMENT OF INERTIA IN IN^4		SECTION MODULUS IN IN^3	
	NORMAL	STANDARD SHORTS	SPECIAL SHORTS	a	b	c	d			X–X	Y–Y	X–X	Y–Y
95N BS	40′	37′-6″; 35′	–	$4\frac{1}{2}$	$2\frac{1}{8}$	$2\frac{17}{32}$	$1\frac{1}{4}$	9·331	3·03	43·10	8·65	14·23	3·15
		& 32′-6″	–	″	″	″	″						
80R BS	40′	AS FOR 95N BS	–	4	$1\frac{7}{8}$	$2\frac{13}{64}$	$1\frac{1}{8}$	7·856	2·74	29·47	6·28	10·75	2·55
80 OBS	40′	–	39′-7½″	$4\frac{1}{2}$	$2\frac{1}{8}$	$2\frac{1}{8}$	$1\frac{3}{16}$	7·85.	2·60	26·36	6·88	10·38	2·75
75R BS	36′	33′	–	4	$1\frac{7}{8}$	$2\frac{1}{8}$	$1\frac{1}{8}$	7·349	2·61	25·36	5·57	9·72	2·30
75 ASCE	36′	33′; 30′	–	4	$1\frac{31}{32}$	$2\frac{1}{8}$	$1\frac{1}{8}$	7·40	2·41	22·94	5·36	9·33	2·23
60N BS	40′	37′-6″; 35′	–	4	$1\frac{7}{8}$	$1\frac{63}{64}$	1	6·03	2·33	16·52	4·19	7·07	1·94
		& 32′-6″	–	″	″	″	″						
60R BS	40′	AS FOR 60N BS	–	4	$1\frac{7}{8}$	$1\frac{7}{8}$	1	5·89	2·31	16·26	3·69	7·04	1·75
55R BS	30′	–	29′-10″ & 29′-8″	4	$1\frac{7}{8}$	$1\frac{51}{64}$	1	5·407	2·21	13·71	3·10	6·22	1·50
55OBS	″	–	AS FOR 55R BS	4	$1\frac{7}{8}$	$1\frac{23}{32}$	$\frac{15}{16}$	5·377	2·06	12·73	3·10	6·15	1·50
50 OBS	30′	–	–	4	$1\frac{7}{8}$	$1\frac{5}{8}$	$\frac{15}{16}$	4·90	1·98	10·19	2·39	5·15	1·20
50 NS	30′	–	–	4	$2\frac{7}{8}$	$1\frac{5}{8}$	$\frac{15}{16}$	4·91	2·00	10·10	2·10	5·05	1·20
50 NS	–	● 28′-6″ 20′-3″	–	SEE	NOTE	″	″						
50 ASCE	33′	30′	–	4	$1\frac{31}{32}$	$1\frac{23}{32}$	$\frac{15}{16}$	4·90	1·975	9·80	2·39	4·90	1·20
45R BS	30′	–	29′-10″ & 29′-8″	4	$1\frac{7}{8}$	$1\frac{39}{64}$	$\frac{15}{16}$	4·416	1·98	9·00	2·05	4·55	1·11
45 OBS	30′	–	–	4	$1\frac{7}{8}$	$1\frac{9}{16}$	$\frac{15}{16}$	4·427	1·87	8·55	2·05	4·55	1·11
56·12GHSC	10m 32′-9¾″	–	32′-7⅞″ & 32′-5″	$4\frac{3}{4}$	$2\frac{7}{16}$	$1\frac{31}{32}$	$1\frac{1}{16}$	5·61	2·44	15·38	2·93	6·30	1·50
43·14GLSC	9m 29′-6⅜″	–	29′-1⅝″ & 29′-4″	$4\frac{3}{4}$	$2\frac{1}{2}$	$1\frac{3}{4}$	1	4·0	1·96	10·0	1·52	4·60	0·90
40·32GHST	10m 32′-9¾″	9m 29′-6⅜″	32′-7¼″ & 32′-5¾″	$3\frac{15}{16}$	$1\frac{11}{16}$	$1\frac{21}{32}$	1	3·95	1·87	7·66	1·51	3·89	0·94
		8m 26′-3″	–	″	″	″	″						
31·25GLST	10m 32′-9¾″	–	–	$3\frac{7}{16}$	$1\frac{19}{32}$	$1\frac{1}{2}$	$\frac{25}{32}$	3·10	1·73	5·55	0·74	3·14	0·42

NOTE : ● THESE 50 NS RAILS WERE CROPPED. THE 20′-3″ LENGTHS WERE DESIGNED TO BE BUTTED TO FORM 40′-6″ WITH "b" HOLING OF $1\frac{7}{8}$″ ONE END & $2\frac{15}{16}$″ THE OTHER END.

2 THE TABLE EXCLUDES SOME FOREIGN RAILS FOR WHICH NO DETAIL DRAWINGS ARE AVAILABLE.

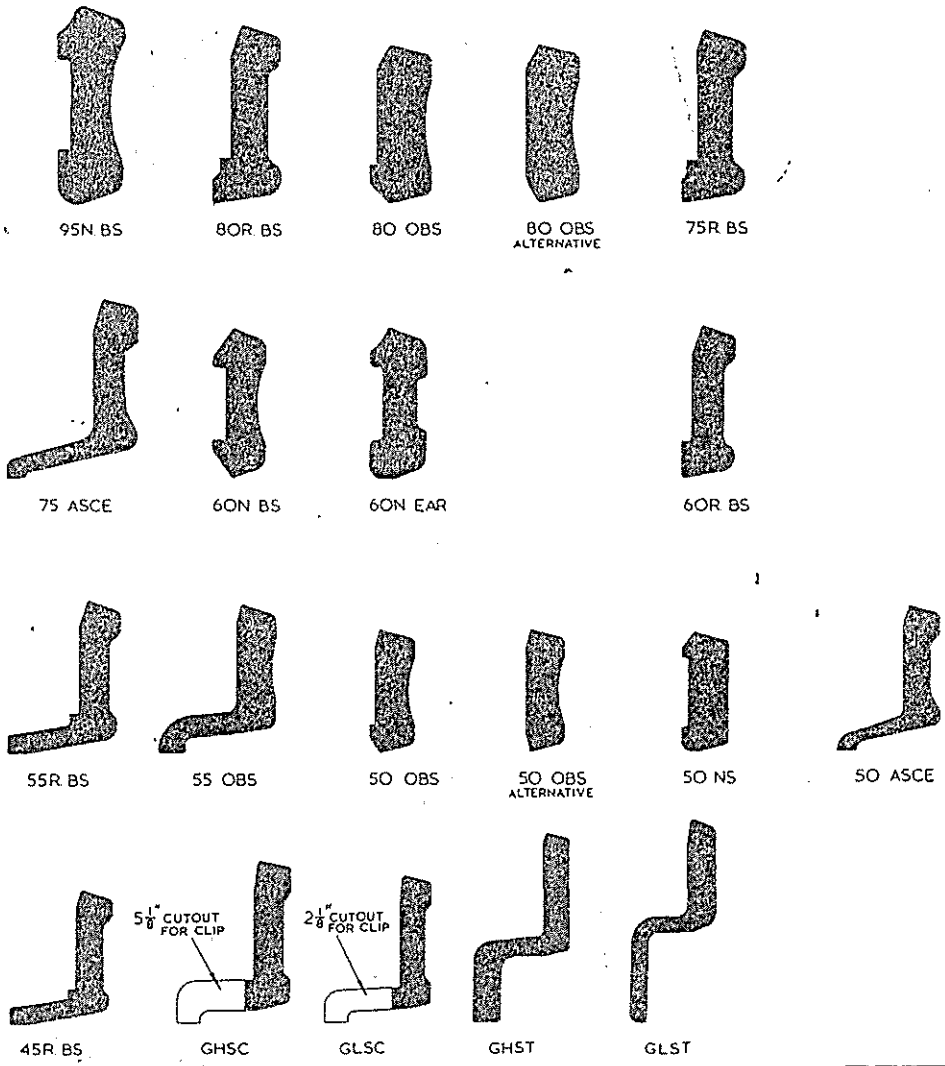
ANNEXURE 25A

FISHPLATES

DIMENSIONS AND FEATURES FOR IDENTIFICATION

RAIL SECTION	LENGTH IN INCHES	OVERALL DEPTH INCHES	BOLT HOLE PITCH IN INCHES	SIZE OF HOLE INCHES	SHAPE OF HOLE	SPECIAL FEATURES
95N. BS	18	$3\frac{31}{32}$	$4\frac{1}{2}$ $4\frac{1}{2}$ $4\frac{1}{2}$	$1\frac{1}{16}$	ROUND	
80R. BS	16	$3\frac{5}{8}$	4 4 4	$\frac{15}{16}$	"	
80 OBS	18	$3\frac{3}{16}$	$4\frac{1}{2}$ $4\frac{1}{2}$ $4\frac{1}{2}$	$1\frac{1}{16}$	"	
80 OBS ALTERNATIVE	"	"	" " "	$1 \times \frac{5}{16}$	PEAR	REVERSIBLE
75R. BS	16	$3\frac{1}{2}$	4 4 4	$\frac{15}{16}$	ROUND	
75 ASCE	16	$3\frac{9}{16}$	4 $4\frac{1}{8}$ 4	$1 \times \frac{1}{4}$	OVAL	ANGLE TYPE
"	10	"	$4\frac{1}{8}$	"	"	"
60N. BS	16	3	4 4 4	$\frac{13}{16}$	ROUND	REVERSIBLE
60N. EAR	"	"	" " "	"	"	
60R. BS	"	$3\frac{1}{16}$	" " "	"	"	
55R. BS	"	$3\frac{3}{32}$	" " "	"	"	ANGLE TYPE
55 OBS	"	$2\frac{31}{32}$	" " "	$\frac{13}{16} \times 1\frac{3}{32}$	PEAR	"
50 OBS	"	$2\frac{1}{2}$	" " "	$\frac{13}{16}$	ROUND	
"	10	"	4	"	"	
50 OBS ALTERNATIVE	16	"	4 4 4	"	"	REVERSIBLE
50 NS	18	$2\frac{7}{16}$	4 6 4	"	"	
"	10	"	4	"	"	FOR CROPPED RAILS
50 ASCE	16	$2\frac{15}{16}$	4 $4\frac{1}{8}$ 4	$\frac{7}{8} \times 1\frac{1}{8}$	ALTERNATE ELLIPTICAL & ROUND	HOLES IDENTICAL FOR ALL PLATES
45R BS	"	$2\frac{3}{4}$	4 4 4	$\frac{3}{4}$	ROUND	ANGLE TYPE
56·12 GHSC	$27\frac{3}{16}$	$3\frac{3}{8}$	$4\frac{3}{4}$ $5\frac{1}{8}$ $4\frac{3}{4}$	$\frac{27}{32} \times 1\frac{1}{4}$	OVAL	ANGLE TYPE
43·14 GLSC	"	$3\frac{1}{32}$	" " "	$\frac{7}{8} \times 1\frac{1}{16}$	OUTER PLATE HAS OVAL HOLES & INNER PLATE ROUND HOLES	"
40·32 GHST	$14\frac{15}{16}$	$3\frac{29}{32}$	$3\frac{15}{16}$ $3\frac{17}{32}$ $3\frac{15}{16}$	$\frac{7}{8} \times 1\frac{1}{16}$		ANGLE TYPE WITH DEEP SKIRT
31·25 GLST	$13\frac{19}{32}$	$4\frac{3}{16}$	$3\frac{7}{16}$ $3\frac{7}{16}$ $3\frac{7}{16}$	$\frac{23}{32} \times \frac{29}{32}$	OVAL	"

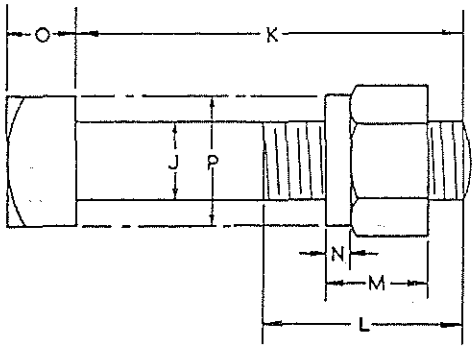
END PROFILES



ANNEXURE 26

FISHBOLTS AND NUTS

B.S.W. SCREW THREAD



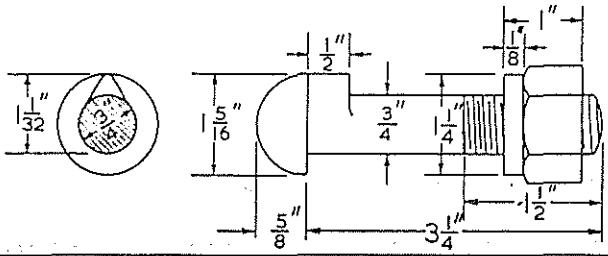
FOR DIA. OF BOLT HOLE IN RAIL AND SPACING OF HOLES SEE ANNEXURE 25.

※ THE DIMENSIONS SHOWN ARE FOR THE ORIGINAL TYPES. SEE ANNEXURE 26A FOR STANDARD TYPES NOW BEING SUPPLIED.

ALL DIMENSIONS ARE IN INCHES

RAIL SECTIONS		95N. BS	80 OBS ※	80R. BS 75 R. BS	60N. BS 60R. BS 55 R. BS	50 OBS 50 NS ※	45R. BS
DIA. OF BOLT HOLES IN FISHPLATE	–	$1\frac{1}{16}$	$1\frac{1}{16}$	$\frac{15}{16}$	$\frac{13}{16}$	$\frac{13}{16}$	$\frac{3}{4}$
DIA. OF BOLT	J	1	1	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{11}{16}$
LENGTH OF BOLT	K	$4\frac{13}{16}$	$4\frac{5}{8}$	$4\frac{5}{16}$	$3\frac{3}{4}$	$3\frac{5}{8}$	$3\frac{5}{16}$
LENGTH OF SCREWED PORTION OF BOLT	L	$2\frac{7}{16}$	$2\frac{1}{4}$	$2\frac{1}{8}$	$1\frac{7}{8}$	$1\frac{3}{4}$	$1\frac{11}{16}$
OVERALL THICKNESS OF NUT	M	$1\frac{5}{16}$	$1\frac{3}{8}$	$1\frac{5}{32}$	1	1	$\frac{29}{32}$
THICKNESS OF NECK ON NUT	N	$\frac{5}{16}$	$\frac{3}{16}$	$\frac{9}{32}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{7}{32}$
THICKNESS OF HEAD	O	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{49}{64}$	$\frac{21}{32}$	$\frac{9}{16}$	$\frac{39}{64}$
WIDTH ACROSS FLATS OF HEX. NUT ; SQ. HEAD OF BOLT & DIA. OF NECK ON NUT	P	$1\frac{11}{16}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{5}{16}$	$1\frac{1}{4}$	$1\frac{3}{16}$

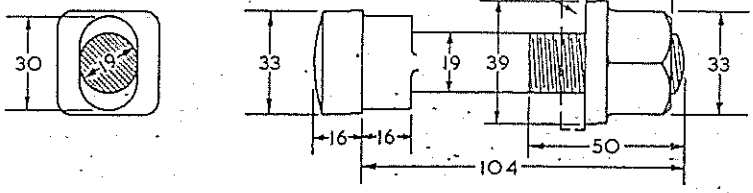
55 OBS



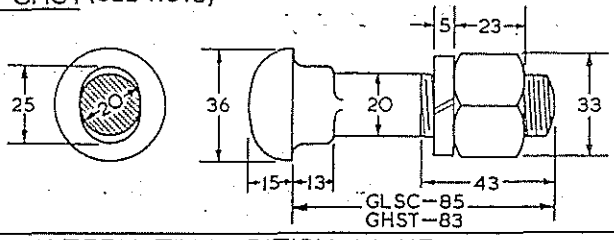
B.S.W. SCREW THREAD

FOR NEW SUPPLIES USE THE 50 OBS/50 NS BOLT AS TABLED ABOVE.

56·12 GHSC (SEE NOTE)



43·14 GLSC & 40·32 GHST (SEE NOTE)



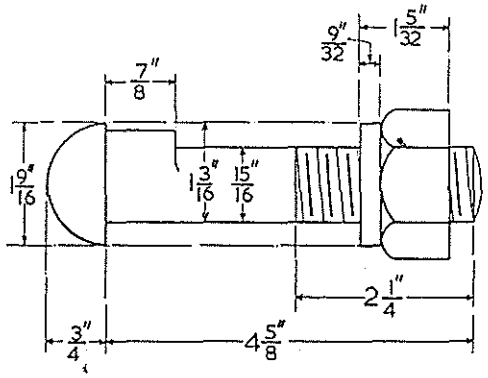
ALTERNATIVE BRITISH MAKE

RAIL SECTION	BOLT LENGTH	DIA	NECK	NUT	THREAD	SPRING WASHER
GHSC	4"	$\frac{3}{4}$"	AS IN DRAWINGS ABOVE	HEXAGONAL AS FOR 60R. BS	B.S.W.	TYPE 'C'–SINGLE COIL GIRDER SECTION TO BS. 1802 : 1951
GLSC & GHST	$3\frac{1}{4}$"	$\frac{3}{4}$"				

M.M.	INS.
5	$\frac{3}{16}$
7	$\frac{9}{32}$
13	$\frac{1}{2}$
15	$\frac{19}{32}$
16	$\frac{5}{8}$
19	$\frac{3}{4}$
20	$\frac{25}{32}$
23	$\frac{29}{32}$
25	1
30	$1\frac{3}{16}$
33	$1\frac{5}{16}$
36	$1\frac{13}{32}$
39	$1\frac{17}{32}$
43	$1\frac{11}{16}$
50	2
83	$3\frac{9}{32}$
85	$3\frac{11}{32}$
104	$4\frac{3}{32}$

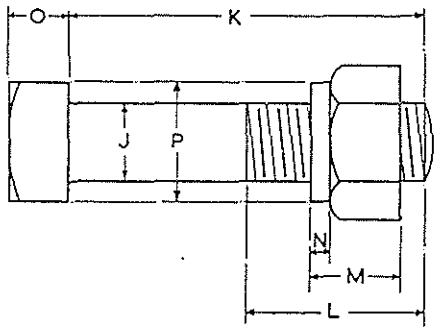
ANNEXURE 26A

FISHBOLTS AND NUTS



B. S.W. SCREW THREAD. STANDARD HEX. NUT 1 1/2" ACROSS FLATS AS FOR 80 R. BS & 75R. BS 7/8" DIA. FISHBOLT.

PEAR NECK BOLT FOR 80. OBS ALTERNATIVE DESIGN FISHPLATE



B. S.W. SCREW THREAD

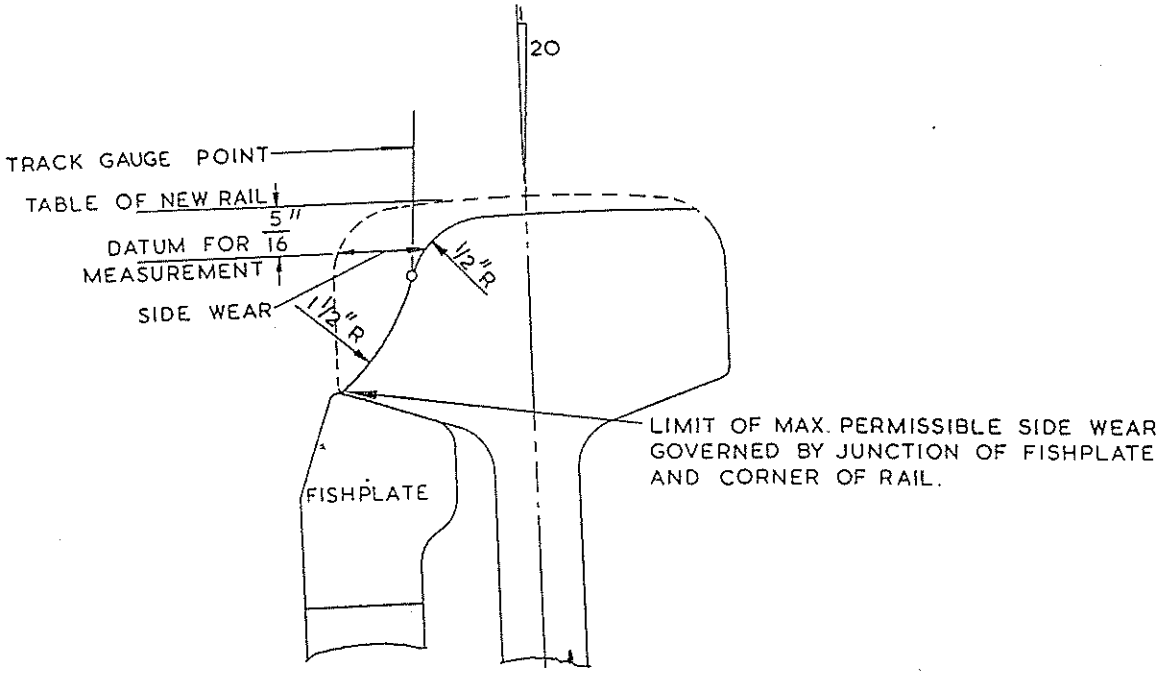
ALL DIMENSIONS ARE IN INCHES

RAIL SECTIONS		80. OBS	55. OBS 50. OBS 50. NS
DIA. OF BOLT	J	1	3/4
LENGTH OF BOLT	K	4 1/2	3 1/2
LENGTH OF SCREWED PORTION OF BOLT	L	2 1/4	1 3/4
OVERALL THICKNESS OF NUT	M	1 5/32	1
THICKNESS OF NECK ON NUT	N	9/32	1/4
THICKNESS OF HEAD	O	49/64	21/32
WIDTH ACROSS FLATS OF HEX. NUT; SQ HEAD OF BOLT & DIA. OF NECK ON NUT	P	1 1/2	1 5/16

NOTE:-
TO SUIT THE 80. OBS. FISHPLATE THE STANDARD HEX. NUT FOR 80R.BS & 75R.BS 7/8" DIA. FISHBOLT IS USED.

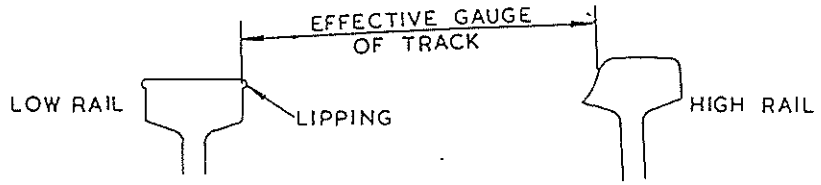
ANNEXURE 27

MAXIMUM PERMISSIBLE SIDE WEAR OF RAILS ON CURVES



NOMINAL SECTION OF RAIL LBS/YD	MAX. PERMISSIBLE SIDE WEAR IN INCHES	LOSS OF WEIGHT LBS/YD	PERCENTAGE LOSS ON NOMINAL WEIGHT OF RAIL
95N BS	11/16	8·9	9·4
80R BS	9/16	7·2	9·0
80 OBS	5/8	7·7	9·6
75R BS	1/2	6·3	8·4
60N BS	5/16	4·0	6·7
60R BS	3/8	5·4	9·0
55R BS	3/8	4·6	8·4
55 OBS	7/16	5·3	9·7
50 OBS	3/8	4·5	9·0
50 NS	3/8	4·5	9·0
45R BS	5/16	4·1	9·1
56·12 GHSC	3/8	5·0	8·9
43·14 GLSC	5/16	3·8	8·8
40·32 GHST	5/16	3·5	8·7

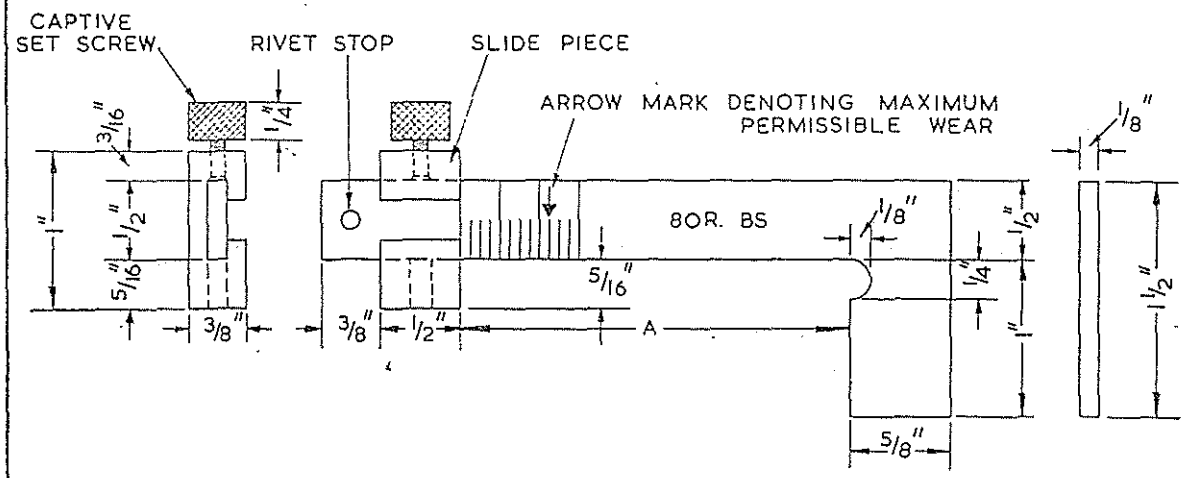
METHOD OF MEASURING GAUGE WITH SIDE WORN RAILS



MEASURE THE GAUGE TO THE POINT ON THE HIGH RAIL WHERE THE CORNER RADIUS MEETS THE SLOPE OF WEAR & EXCLUDE ANY LOW RAIL LIPPING. WHEN THE SIDE WEAR HAS REACHED HALF THE MAXIMUM AMOUNT SHOWN IN THE TABLE ABOVE, THE TRACK GAUGE SHALL BE CORRECTED BY MOVING EITHER THE LOW OR HIGH RAIL INWARDS, AS THE SLEEPER FASTENINGS PERMIT.

ANNEXURE 28

GAUGE FOR MEASURING SIDE WEAR IN RAILS



NOTE :- 1. THE GAUGE TO BE MADE IN BRASS AND STAMPED FOR THE PARTICULAR RAIL SECTION.

2. THE GRADUATIONS TO BE IN SIXTEENTHS OF AN INCH.

RAIL SECTION	DIMENSION 'A' IN INCHES	ARROW MARK AT ___SIXTEENTHS
95 N. BS	$2\frac{23}{32}$	11
80R. BS	$2\frac{15}{32}$	9
80 OBS	$2\frac{1}{2}$	10
75 R. BS	$2\frac{13}{32}$	8
60N. BS	$2\frac{1}{4}$	5
60R. BS	$2\frac{1}{4}$	6
55 R. BS	$2\frac{5}{32}$	6
55 OBS	$2\frac{5}{32}$	7
50 OBS	$2\frac{1}{16}$	6
50 NS	$1\frac{31}{32}$	6
45R. BS	$1\frac{31}{32}$	5
56·12 GHSC	$2\frac{9}{32}$	6
43·14 GLSC	$1\frac{13}{16}$	5
40·32 GHST	$1\frac{7}{8}$	5

TYPICAL MAINTENANCE PROGRAMME FOR SECTION GANGS ON STONE BALLASTED TRACK

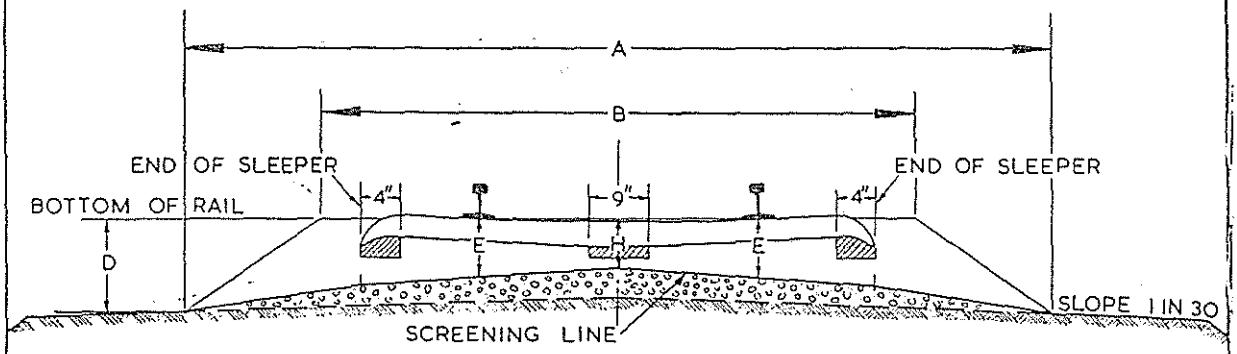
	ITEM OF WORK	QUOTA PER ANNUM	COLD SEASON			WARM WEATHER	SHORT RAINS		HOT SEASON				LONG RAINS		
			JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	
1	THROUGH PACKING & DRESSING	WHOLE GANG LENGTH													
2	OILING CLIP BOLTS OF STEEL SLEEPERS	HALF GANG LENGTH													
3	LUBRICATING FISHPLATES & FISHBOLTS	HALF GANG LENGTH													
4	SCREENING BALLAST & MAKING UP CESS	ONE MILE MINIMUM													
5	CLEARING, CUTTING DRAINS & WATERWAYS	ALL													
6	OVERHAULING SWITCHES & CROSSINGS	ALL													
7	SLACKS & MISCELLANEOUS WORKS	—	AS REQUIRED												

NOTE:- FOR PROGRAMME ITEMS 1 & 4, THE GANGS SHOULD WORK OUTWARDS FROM THEIR SECTION LIMITS IN ORDER TO OBTAIN CONTINUOUS LENGTHS OF COMPLETED TRACK; E.G. GANGS 1 & 2 SHOULD WORK AWAY FROM EACH OTHER FROM THEIR JUNCTION AT MILE 4. GANGS 3 & 4 WILL DO LIKEWISE FROM MILE 12 AND SO ON.

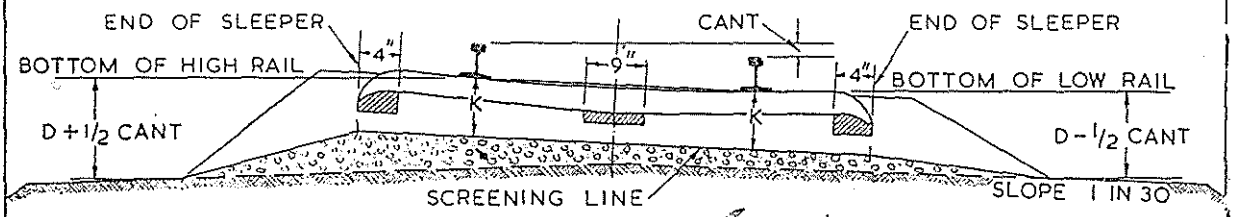
ANNEXURE 29

ANNEXURE 30

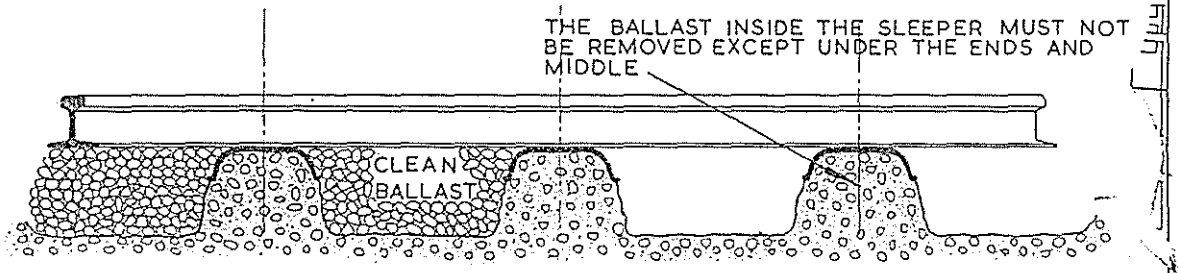
SCREENING STONE BALLASTED TRACK
STEEL SLEEPERS



STRAIGHT & CURVED TRACK WITH CANT UP TO 1¼ INCHES



CURVED TRACK WITH CANT EXCEEDING 1¼ INCHES



LONGITUDINAL SECTION AT RAIL

NOTE :- FOR DIMENSIONS 'A', 'B' & 'D' OF ANY PARTICULAR RAIL SECTION, SEE ANNEXURE 12.

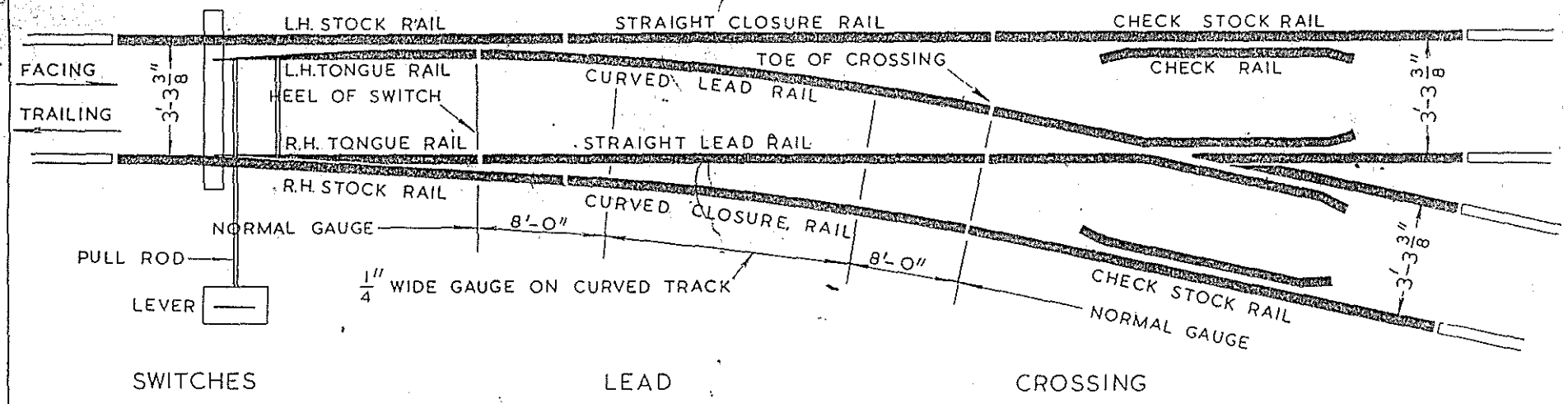
THE SCREENING DIMENSIONS FOR ALL RAIL SECTIONS ARE :-

	'E'	'H'	'K'
FULL SECTION OF BALLAST	9"	7½"	9"
8" DEPTH OF BALLAST	7½"	6	7½"

THE BALLAST INSIDE THE SLEEPER MUST NOT BE REMOVED, EXCEPT UNDER THE ENDS AND MIDDLE SHOWN ▨, WHICH IS TO PREVENT END AND CENTRE BINDING. THESE GAPS MUST BE LIGHTLY PACKED.

THE COMPLETED SPACES MUST BE REFILLED WITH CLEAN BALLAST BEFORE CLOSING WORK FOR THE DAY.

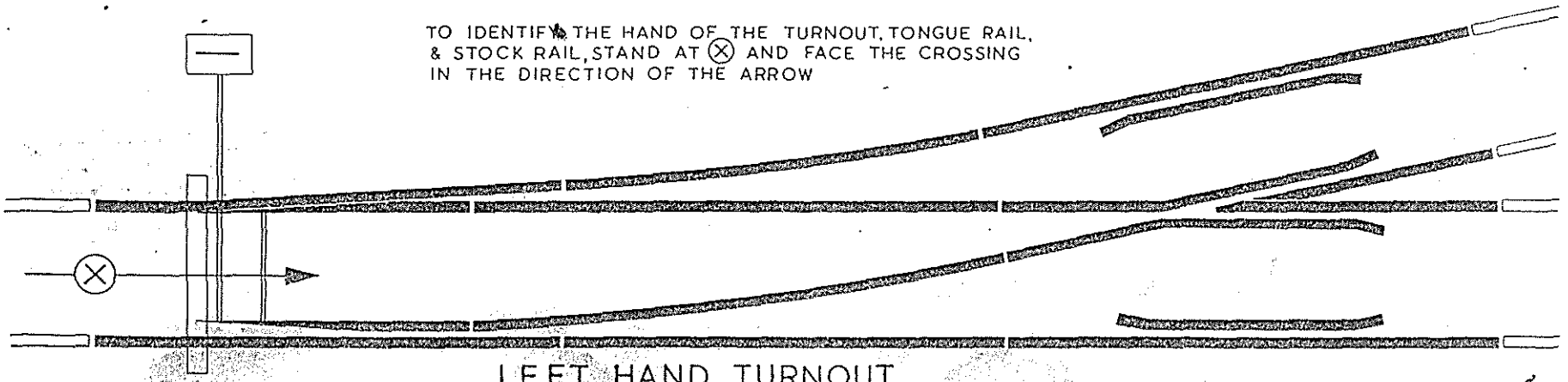
NAMES OF PARTS OF A TURNOUT



RIGHT HAND TURNOUT

NOTE:- PART NAMES FOR A LEFT HAND TURNOUT ARE THE SAME AS FOR A RIGHT HAND TURNOUT

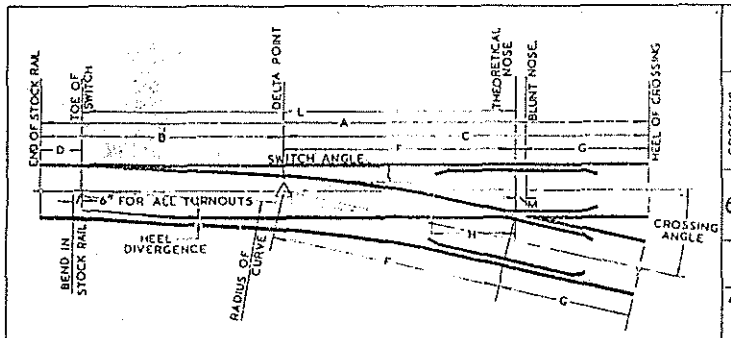
TO IDENTIFY THE HAND OF THE TURNOUT, TONGUE RAIL, & STOCK RAIL, STAND AT ⊗ AND FACE THE CROSSING IN THE DIRECTION OF THE ARROW



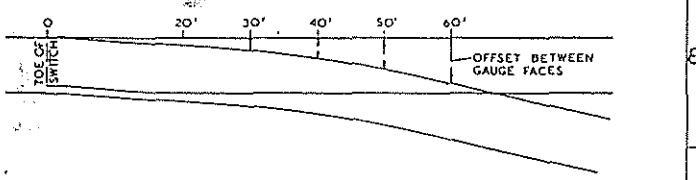
LEFT HAND TURNOUT

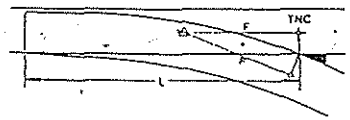
ANNEXURE 33

ANNEXURE 34

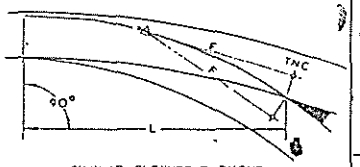


SETTING TURNOUT CURVE BY PERPENDICULAR OFFSETS FROM THE MAIN TRACK

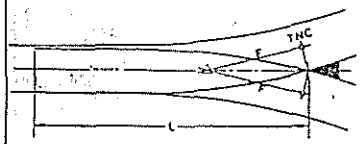




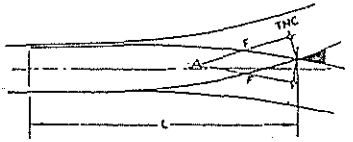
TURNOUT FROM STRAIGHT



SIMILAR FLEXURE TURNOUT



SYMMETRICAL SPLIT TURNOUT



UNSYMMETRICAL SPLIT TURNOUT

NOTE - IN TURNOUTS FROM CURVES, THE LEAD 'L' & OFFSETS FOR SETTING THE CURVE, WILL BE THE SAME AS FOR A TURNOUT FROM STRAIGHT TRACK.

SEE TEXT FOR LOCATING THE DELTA POINT.

LEADING DIMENSIONS OF TURNOUTS

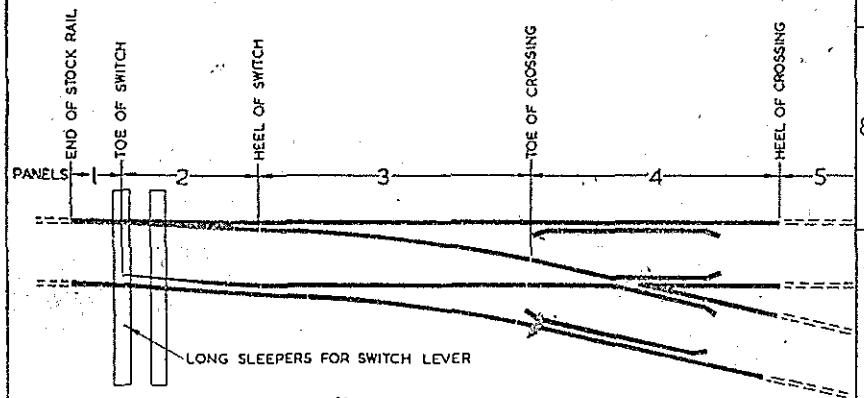
CROSSING Nº	SECTION OF RAIL	RADIUS OF CURVE	TYPE OF SWITCH	TYPE OF WING RAIL	SWITCH ANGLE	CROSSING ANGLE	LENGTH OF STOCK RAIL	LENGTH OF TONGUE RAIL	HEEL DIVERGENCE	CHECK RAIL	DIMENSION L	A	B	C	D	F	G	H	M ins	OFFSET FOR CURVE AT 20' (IN INCHES)	30'	40'	50'	60'
6 3/4	50 NS	230	LOOSE HEEL	STRAIGHT	1 55 25	8 25 37	18	9	3 1/4	10-6	39-3	50-9	29-11 1/2	30-9 1/2	3	22-3 1/2	8-6	4-4	3	11 1/2	23 1/2			
	50 NS	290	"	CURVED	"	"	"	"	"	"	41-9	53-3	22-5 1/2	"	"	"	"	6-0	"	10 1/2	21 1/2			
	50 OBS	290	"	"	1 57 24	"	"	"	3 1/2	10-11	"	57-5 1/2	"	34-11 1/2	"	"	12-8 1/2	7-3 1/2	2 1/2	10 1/2	21 1/2			
	80 OBS	290	"	"	2 15 20	"	16	9	4 1/2	"	40-3	56-0 1/2	20-11 1/2	35-1	"	"	12-9 1/2	7-0 1/2	4 1/2	11	123/4			
7 1/2	50 NS ●	351	"	"	1 26 33	7 35 41	18	12	3 3/8	10-6	49-8 3/8	60-6 3/8	28-0	32-6 3/8	3	24-8 3/8	7-10	6-2	3 1/2	7 1/2	14 1/2	25 1/2		
	50 OBS ●	351	"	"	1 28 03	"	"	"	3 1/2	13-11	49-6 3/8	65-3	27-9 1/2	32-5 1/2	"	"	12-6 3/8	7-3	3 1/2	7 1/2	14 1/2	25 1/2		
	60R BS ●	344	FLEXIBLE 'A'	"	1 11 37	"	29	24	6 1/2	13-4	50-9	63-10 1/2	29-0 1/2	34-9 1/2	"	"	10-11 1/2	7-0	3 1/2	—	13 1/2	24 1/2		
	75R BS	350	LOOSE HEEL	"	1 40 00	"	19	12	4 1/4	13-11	48-2 1/2	64-1 1/2	26-6 1/2	37-7 1/2	"	"	12-11 1/2	7-0	5 1/2	8 1/2	16	27 1/2		
	80R BS	350	"	"	1 41 29	"	"	"	4 1/4	"	48-0 1/2	63-10 1/2	26-3 1/2	37-6 1/2	"	"	12-10 1/2	7-0	4 1/2	8 1/2	16	27 1/2		
	80R BS ●	358	FLEXIBLE 'C'	"	1 11 37	"	29	24	7	13-4	49-6	62-8	27-9 1/2	34-10 1/2	"	"	10-2	7-0	4	—	14 1/2	25 1/2		
8 1/2	50 NS	396	LOOSE HEEL	STRAIGHT	1 55 25	6 42 35	18	9	3 1/4	10-6	46-3	57-0	21-3 1/2	35-8 1/2	3	27-11 1/2	7-9	6-3	3	9 1/2	18 1/2	30 1/2		
	50 NS	362	"	"	1 26 33	"	"	12	"	"	51-3	62-0	26-3 1/2	"	"	"	"	"	"	7	14 1/2	24 1/2		
	50 NS ●	454	"	CURVED	"	"	"	"	"	"	53-10	64-8	28-10 1/2	35-9 1/2	"	"	7-10	6-2	3 1/2	6 1/2	13 1/2	22 1/2		
	50 OBS ●	454	"	"	1 28 03	"	"	"	3 1/2	13-11	53-9	69-6	28-9 1/2	40-8 1/2	"	"	12-9	7-2 1/2	3 1/2	7	13 1/2	22 1/2		
	60R BS ●	465	FLEXIBLE 'A'	"	1 11 37	"	29	24	6 1/2	13-4	53-3 1/2	66-5 1/2	28-3 1/2	38-1 1/2	"	"	10-11 1/2	7-0	3 1/2	—	13 1/2	22 1/2		
	75R BS	455	LOOSE HEEL	"	1 40 00	"	19	12	4 1/4	13-11	52-0 1/2	68-0 1/2	27-0 1/2	40-11 1/2	"	"	12-11 1/2	7-0	6 1/2	7 1/2	14 1/2	24 1/2		
	80 OBS	454	"	"	1 41 29	"	"	"	4 1/4	"	51-10	67-8 1/2	26-10 1/2	40-10 1/2	"	"	12-10 1/2	6-11 1/2	5 1/2	"	14 1/2	24 1/2		
	80R BS	454	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"		
	80R BS ●	462	FLEXIBLE 'D'	"	1 11 37	"	29	24	6 1/2	13-4	53-11 1/2	67-2 1/2	29-0	38-2 1/2	"	"	10-2 1/2	7-0	4 1/2	—	13 1/2	22 1/2		
	95N BS ●	459	FLEXIBLE 'G'	"	"	"	35-4	28	8 1/2	14-0	54-8 1/2	70-0	32-0 1/2	37-11 1/2	5-4	"	9-11 1/2	7-0	4 1/2	—	12 1/2	21 1/2		
12	50 NS	815	LOOSE HEEL	STRAIGHT	1 26 33	4 45 49	18	12	3 1/2	10-6	64-3	77-9	27-9 1/2	49-11 1/2	3	39-5 1/2	10-6	5-0 1/2	6	6 1/2	11 1/2	17 1/2	25 1/2	
	50 NS ●	948	"	CURVED	"	"	"	"	"	"	67-0	80-6	30-6 1/2	"	"	"	"	6-1	5 1/2	6 1/2	11 1/2	17	24 1/2	
	50 OBS ●	950	"	"	1 28 03	"	"	"	3 11/16	13-11	66-8	82-6 1/2	30-2 1/2	52-3 1/2	"	"	12-10 1/2	7-11 1/2	4 1/2	6 1/2	11 1/2	17 1/2	24 1/2	
	50 OBS	925	"	"	1 15 28	"	21	14	"	"	70-0	85-10 1/2	33-6 1/2	"	"	"	"	"	"	—	9 1/2	14 3/4	21 1/2	
	60R BS ●	954	FLEXIBLE 'B'	"	1 11 37	"	29	24	5 1/2	13-4	67-11 1/2	83-4 1/2	31-6 1/2	51-10 1/2	"	"	12-5 1/2	7-0	5 1/2	—	10 1/2	16 1/2	23 1/2	
	75R BS	966	LOOSE HEEL	"	1 40 00	"	19	12	4 1/2	13-11	64-2 1/2	80-4 1/2	27-8 1/2	52-7 1/2	"	"	13-2 1/2	6-9	9	7 1/2	12 1/2	18 1/2	26 1/2	
	75R BS	910	"	"	1 15 00	"	23	16	"	"	71-10	88-0 1/2	35-4 1/2	"	"	"	"	"	"	—	9 1/2	14 1/2	20 1/2	
	80 OBS	968	"	"	1 41 29	"	19	12	4 1/2	"	64-0	80-1	27-6 1/2	52-6 1/2	"	"	13-1	"	7	7 1/2	12 1/2	19	26 1/2	
	80R BS	968	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	
	80 OBS	910	"	"	1 16 06	"	23	16	"	"	71-6	87-7	35-0 1/2	"	"	"	"	"	"	—	9 1/2	14 1/2	20 1/2	
	80R BS	910	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	—	—	"	"	
	80R BS ●	948	FLEXIBLE 'E'	"	1 11 37	"	29	24	5 1/2	13-4	68-6 1/2	84-1	32-1 1/2	51-11 1/2	"	"	12-6 1/2	7-0	6 1/2	—	10 1/2	16	23	
	95N BS ●	941	FLEXIBLE 'H'	"	"	"	35-4	28	7 1/16	14-0	69-2	87-7	35-0 1/2	52-6 1/2	5-4	"	13-1	"	6 1/2	—	10 1/2	15 1/2	22 1/2	
16	80R BS ●	1786	FLEXIBLE 'F'	"	"	3 34 35	29	24	5 1/2	14-4	83-9 1/2	100-0	34-2 1/2	65-9 1/2	3	52-6 1/2	13-2 1/2	"	8 1/2	—	9	13 1/2	18 1/2	23 1/2
	95N BS ●	1782	FLEXIBLE 'J'	"	"	"	35-4	28	6 1/2	14-0	83-9 1/2	102-4 1/2	36-0 1/2	65-9 1/2	5-4	"	13-3 1/2	"	8 1/2	—	9	13	18	23 1/2

TANGANYIKA TYPE TURNOUTS

7	45R BS	301	LOOSE HEEL	CURVED	1 28 47	8 07 48	18	12	3 1/2	9-0	47-2 1/2	59-3 1/2	27-7 1/2	31-8	3-6	23-1	8-7	5-2	2 1/2	7 1/2	15 1/2	28		
	43-14GLSC	327	"	"	2 58 Approx	"	18-4 1/2	10-6	6 1/2	8-2 1/2	36-2 1/2	47-3 1/2	16-9 1/2	30-6 1/2	3-7 1/2	"	7-5 1/2	6-8 1/2	2 1/2	—	—	—		
8	45R BS	454	"	CURVED	1 28 47	7 07 30	18	12	3 1/2	9-0	51-3 1/2	63-7 1/2	28-5 1/2	35-2 1/2	3-6	26-4 1/2	8-10 1/2	5-5 1/2	3 1/2	7 1/2	13 1/2	22 1/2		
	55 OBS	310	"	STRAIGHT	1 33 16	"	"	"	3 1/2	"	47-5 1/2	59-10 1/2	24-7 1/2	35-2 1/2	"	"	8-10 1/2	5-5 1/2	3 1/2	7 1/2	16	28 1/2		
	55R BS	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"		
	56-12GHSC	312	"	"	1 43 Approx	"	19-8 1/2	13-11	4 1/2	9-10 1/2	50-11 1/2	65-7 1/2	27-10 1/2	37-9 1/2	3-3 1/2	"	11-5 1/2	5-11 1/2	2 9/16	—	—	—		
8 1/2	60R BS	331	JOGGLED	STRAIGHT	1 33 41	6 42 35	21-7 1/2	13	4 1/2	9-0	49-4	64-2 1/2	26-1 1/2	38-1 1/2	4-9	27-11 1/2	10-1 1/2	6-5 1/2	3 1/2	—	15	26 1/2		
	S.P. RLY.		STOCK																					
10	55 OBS	527	LOOSE HEEL	STRAIGHT	1 33 16	5 42 38	18	12	3 1/2	9-0	55-6 1/2	67-11 1/2	26-1 1/2	41-10	3-6	32-10 1/2	8-11 1/2	5-1 1/2	4 1/2	7 1/2	13 1/2	22		
	55R BS	642	"	CURVED	"	"	"	"	"	"	58-6 1/2	70-7 1/2	29-2	41-5 1/2	"	"	8-7	7-7 1/2	"	7 1/2	12 1/2	20 1/2		

NOTE:- 1 LINEAR DIMENSIONS ARE IN FEET & INCHES
2 TURNOUTS MARKED ● ARE THE CURRENT STANDARDS

WOOD SLEEPERS FOR TURNOUTS



NOTE:- 1. THE TURNOUTS TABULATED ARE THOSE SHOWN IN ANNEXURE 34 AND IN THE SAME ORDER THEREIN.

2. FOR DETAILED SLEEPER SPACING REFER TO DRAWING QUOTED.

3. WHEN RAIL TYPE SLEEPERS ARE USED TO CARRY THE SWITCH LEVER OR INTERLOCKING GEAR, DEDUCT 2 Nº X 11'-0" WOOD SLEEPERS FROM THE QUANTITY SHOWN IN THE TABLE.

4. WOOD SLEEPERS OF THE SIZES SHOWN IN THE TABLE, TOGETHER WITH BEARING PLATES, CAN BE USED TO REPLACE STEEL SLEEPERS IN TANGANYIKA TYPE TURNOUTS.

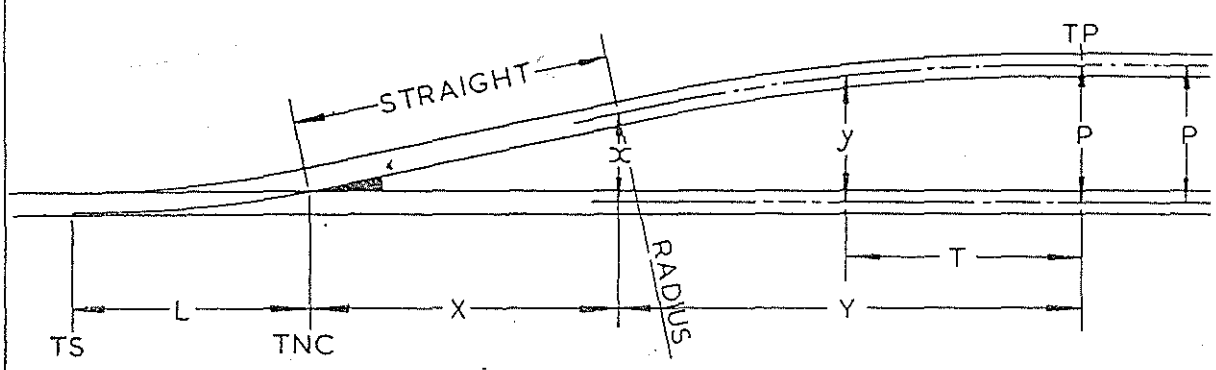
CROSSING Nº	SECTION OF RAIL	DRAWING Nº	NUMBER OF SLEEPERS IN					NUMBER OF EACH SIZE (10" X 5" SECTION)						TOTAL Nº OF SLEEPERS	TOTAL IN CUBIC FEET
			PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5	TYPE 1 6 FT.	TYPE 2 7 FT.	TYPE 3 8 FT.	TYPE 4 9 FT.	TYPE 5 10 FT.	TYPE 6 11 FT.		
6 3/4	50 NS	5154	1	5	11	6	2	4	6	4	3	3	5	25	73
	50 NS	3781/R	1	5	13	6	3	4	7	4	4	3	6	28	82
	50 OBS	3780/R	1	5	12	9	1	4	7	4	4	3	6	28	82
	80 OBS	3779/R	1	5	12	9	1	4	7	4	4	3	6	28	82
7 1/2	50 NS ⊕	6333	1	6	13	6	2	5	7	5	3	3	5	28	80
	50 OBS ⊕	6779/R	1	6	13	9	1	6	6	5	4	3	6	30	87
	60R. BS ⊕	6727	1	10	11	8	1	3	10	5	5	3	5	31	90
	75 R BS	6090/R	1	6	13	9	1	6	6	5	4	3	6	30	87
	80R BS	5940/R/1	1	6	13	9	1	6	6	5	4	3	6	30	87
	80R BS ⊕	6737	1	10	11	8	1	1	11	6	5	3	5	31	91
8 1/2	50 NS	5154	1	5	15	5	3	5	6	5	4	4	5	29	84
	50 NS	5154	1	6	15	5	3	5	7	5	4	3	6	30	87
	50 NS ⊕	3781/R	1	6	15	6	3	5	7	5	4	4	6	31	91
	50 OBS ⊕	3780/R	1	6	14	9	1	5	7	5	4	4	6	31	91
	60R. BS ⊕	6727	1	10	12	8	1	3	10	6	5	3	5	32	92
	75 R BS	6108/R	1	6	15	9	1	6	7	5	4	4	6	32	93
	80 OBS	3779/R	1	6	14	9	1	5	7	5	4	4	6	31	91
	80R BS	3779/R	"	"	"	"	"	"	"	"	"	"	"	"	91
	80R BS ⊕	6737	1	10	12	8	1	1	12	6	5	3	5	32	93
	95 N. BS ⊕	Z.13609/1	2	12	11	8	—	2	14	5	4	4	4	33	94
12	50 NS	5154	1	6	19	7	3	5	9	6	5	5	6	36	105
	50 NS ⊕	3781/R	1	6	20	7	4	5	9	7	6	5	6	38	111
	50 OBS ⊕	3780/R	1	6	19	9	3	5	9	7	6	5	6	38	111
	50 OBS	5385	1	7	20	9	3	6	9	7	7	5	6	40	116
	60R. BS ⊕	6727	1	10	18	9	1	3	14	7	6	5	4	39	111
	75 R BS	6112/1R	1	6	20	9	3	5	9	8	6	5	6	39	114
	75 R BS	6112/2R	1	8	21	9	3	7	10	8	6	5	6	42	120
	80 OBS	3779/R	1	6	19	9	3	5	9	7	6	5	6	38	111
	80R BS	3779/R	"	"	"	"	"	"	"	"	"	"	"	"	111
	80 OBS	3779/R	1	8	20	9	3	7	9	8	6	5	6	41	118
	80R BS	3779/R	"	"	"	"	"	"	"	"	"	"	"	"	118
	80R BS ⊕	6737	1	10	19	9	2	1	15	8	6	6	5	41	119
	95 N. BS ⊕	Z.13609/1	2	12	17	9	—	2	15	8	6	5	4	40	114
16	80R BS ⊕	8043/2	1	10	25	9	—	1	17	9	7	7	4	45	130
	95 N. BS ⊕	8039/1	2	12	24	9	—	2	17	9	8	7	4	47	135

TANGANYIKA TYPE TURNOUTS

7	45 R BS	Z.2430/1	1	6	15	6	1	4	7	5	4	3	6	29	85
	43·14GLSC	TR.2637/1/2	1	5	8	7	1	2	6	3	4	3	4	22	65
8	45 R BS	Z.3194/3	1	6	16	6	1	5	5	5	4	5	6	30	89
	55 OBS	Z.3892/1	1	6	13	6	2	4	7	4	4	3	6	28	82
	55 R BS	Z.10029/1	"	"	"	"	"	"	"	"	"	"	"	"	82
	56·12 GHSC	TR.83	1	7	14	8	1	3	9	5	4	4	6	31	91
8 1/2	60R BS S.P. RLY.	Z.12142	2	7	14	8	1	6	7	5	4	4	6	32	93
10	55 OBS	Z.3861/1	1	6	17	6	3	4	6	6	5	5	7	33	99
	55 R BS	Z.2923/1	1	6	17	7	1	6	8	6	5	4	3	32	90

ANNEXURE 36

TURNOUT TO PARALLEL TRACK



DIMENSIONS WHEN P = 14′–0″

CROSSING NUMBER N	X	Y	T	∞	y	RADIUS IN FEET	FACTOR K
	THESE DIMENSIONS IN FEET AND INCHES						
$6\frac{3}{4}$	50–$4\frac{1}{2}$	43–$11\frac{1}{2}$	22–$1\frac{1}{4}$	10–$9\frac{1}{4}$	13–$2\frac{1}{4}$	300	6·54
7	50–$3\frac{1}{2}$	49–6	24–$10\frac{1}{2}$	10–$5\frac{3}{4}$	13–$1\frac{1}{2}$	350	6·82
$7\frac{1}{2}$	57–3	46–3	23–$2\frac{3}{4}$	10–$11\frac{1}{4}$	13–$2\frac{3}{4}$	350	6·37
8	57–$10\frac{1}{4}$	55–$9\frac{3}{4}$	28–$0\frac{1}{4}$	10–$6\frac{1}{4}$	13–$1\frac{1}{2}$	450	6·77
$8\frac{1}{2}$	61–$10\frac{3}{4}$	58–5	29–$3\frac{3}{4}$	10–7	13–$1\frac{3}{4}$	500	6·72
10	72–$4\frac{1}{2}$	69–$7\frac{3}{4}$	34–11	10–$6\frac{1}{4}$	13–$1\frac{1}{2}$	700	6·76
12	89–$2\frac{1}{4}$	78–$10\frac{1}{2}$	39–6	10–$8\frac{1}{2}$	13–$2\frac{1}{4}$	950	6·57

Y, T AND RADIUS ARE THE SAME FOR ALL SPACINGS OF TRACKS.

FOR ANY OTHER SPACING, X = N (P – FACTOR K)

FOR ANY CHANGE IN P, AN EQUAL CHANGE OCCURS IN ∞ AND y.

FOR L SEE LEADING DIMENSIONS OF TURNOUTS.

EXAMPLE :– P = 14′–6″ ; N = 12

X = 12 (14·5 – 6·57)

= 12 x 7·93

= 95·16 FT = 95′–2″

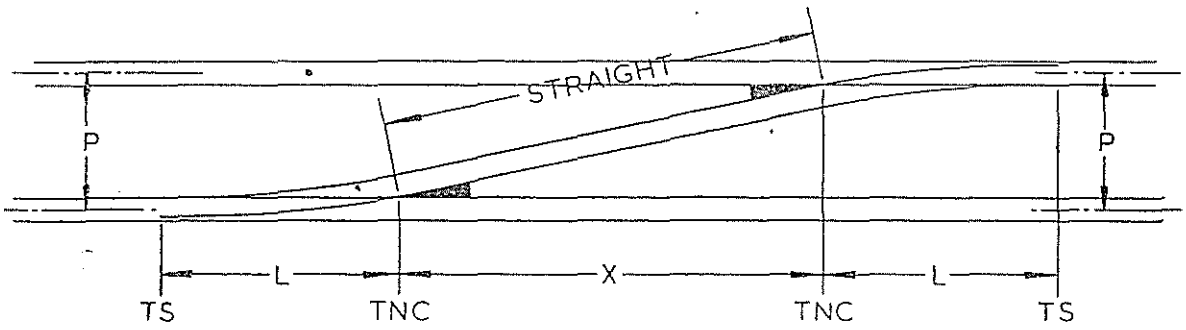
∞ = 6″ + 10′–$8\frac{1}{2}$″ = 11′–$2\frac{1}{2}$″

y = 6″ + 13′–$2\frac{1}{4}$″ = 13′–$8\frac{1}{4}$″

ANNEXURE 37

CROSSOVER TO PARALLEL TRACKS

WITH SAME NUMBER CROSSINGS



DIMENSIONS WHEN P = 14′-0″

CROSSING NUMBER N	X FT. INS.	FACTOR K
$6\frac{3}{4}$	49 — $11\frac{1}{2}$	6·599
7	51 — 10	6·596
$7\frac{1}{2}$	55 — $6\frac{3}{4}$	6·592
8	59 — $3\frac{1}{2}$	6·588
$8\frac{1}{2}$	63 — $0\frac{1}{4}$	6·585
10	74 — $2\frac{1}{2}$	6·579
12	89 — $1\frac{1}{4}$	6·574

FOR ANY OTHER SPACING, X = N (P − FACTOR K)

X DOES NOT ALTER IF THE RAIL SECTIONS IN THE TWO TRACKS DIFFER.

FOR L SEE LEADING DIMENSIONS OF TURNOUTS

EXAMPLE :- P = 14′-6″ ; N = $8\frac{1}{2}$

X = 8·5 (14·5 − 6·585)

= 8·5 x 7·915

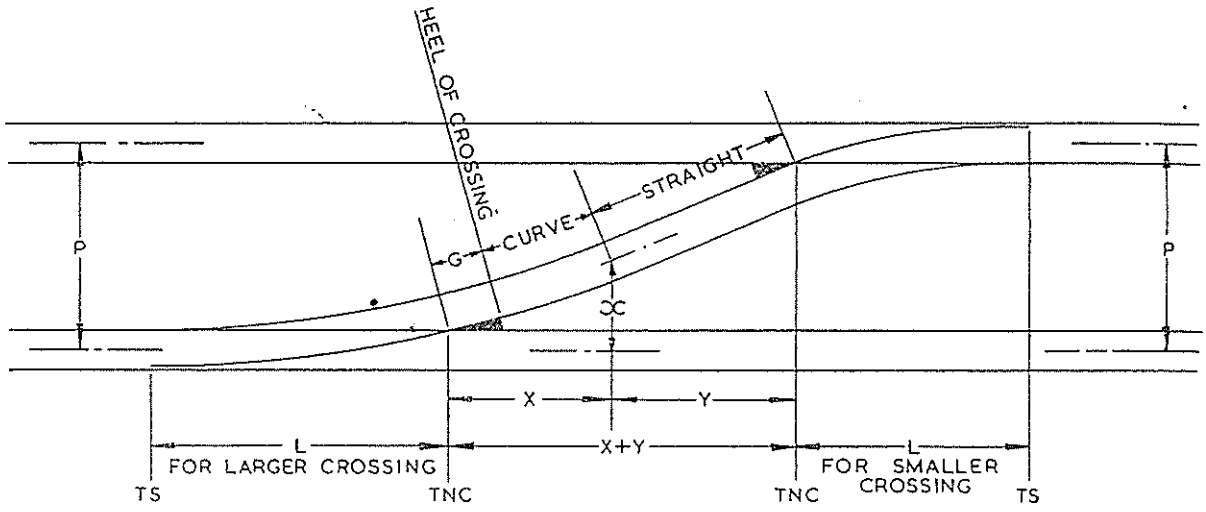
= 67·278 FT

= 67′-$3\frac{1}{4}$″

ANNEXURE 38

CROSSOVER TO PARALLEL TRACKS

WITH DIFFERENT NUMBER CROSSINGS



DIMENSIONS WHEN P = 14′−0″

CROSSING NUMBERS	ASSUMED 'G' IN FEET	CONNECTING RADIUS IN FEET	X FT. INS.	℅ FT. INS.	Y FT. INS.
$7\frac{1}{2}$ — $6\frac{3}{4}$	13	400	18 — 5	5 — $9\frac{1}{2}$	33 — $1\frac{1}{4}$
$8\frac{1}{2}$ — $6\frac{3}{4}$	13	500	27 — 7	6 — $9\frac{1}{4}$	26 — 7
8 — 7	12	450	19 — $6\frac{1}{4}$	5 — $9\frac{3}{4}$	24 — $3\frac{1}{2}$
$8\frac{1}{2}$ — $7\frac{1}{2}$	13	500	20 — $4\frac{1}{2}$	5 — 9	37 — $1\frac{3}{4}$
10 — 7	9	650	36 — $0\frac{1}{2}$	7 — $5\frac{3}{4}$	22 — 7
10 — 8	9	650	24 — $8\frac{3}{4}$	5 — $11\frac{1}{2}$	37 — $11\frac{1}{2}$
12 — 7	13	750	56 — $7\frac{1}{4}$	9 — $3\frac{3}{4}$	9 — $9\frac{1}{2}$
12 — $7\frac{1}{2}$	13	850	54 — $6\frac{3}{4}$	8 — $10\frac{1}{2}$	13 — $8\frac{1}{2}$
12 — 8	13	950	51 — 9	8 — 5	18 — $4\frac{1}{2}$
12 — $8\frac{1}{2}$	13	950	44 — $4\frac{3}{4}$	7 — $6\frac{1}{4}$	27 — $0\frac{1}{2}$
12 — 10	13	950	28 — $5\frac{1}{2}$	5 — $9\frac{1}{2}$	49 — $2\frac{3}{4}$

FOR ANY OTHER SPACING, X ; ℅ ; G AND THE CONNECTING CURVE ARE CONSTANT, BUT Y IS INCREASED BY THE DIFFERENCE IN SPACING FROM 14′−0″ MULTIPLIED BY THE SMALLER NUMBER CROSSING.

X+Y DOES NOT ALTER IF THE RAIL SECTIONS IN THE TWO TRACKS DIFFER.

FOR L SEE LEADING DIMENSIONS OF TURNOUTS

EXAMPLE – P = 14′−6″ ; CROSSINGS 12 TO $7\frac{1}{2}$

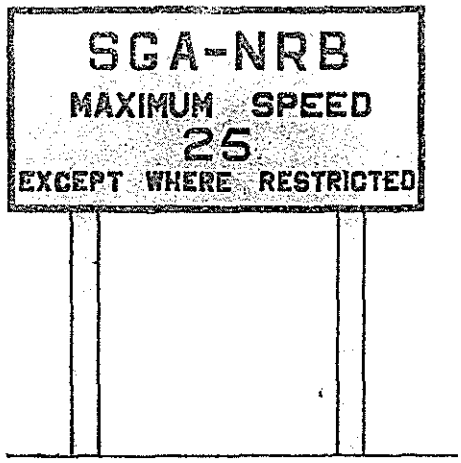
X = 54′−$6\frac{3}{4}$″

℅ = 8′−$10\frac{1}{2}$″

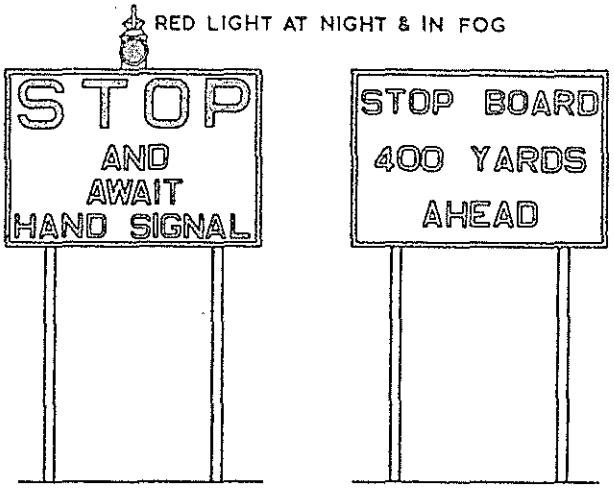
Y = 13′−$8\frac{1}{2}$″ + (6″ × $7\frac{1}{2}$) = 17′−$5\frac{1}{2}$″

STANDARD SIGN BOARDS

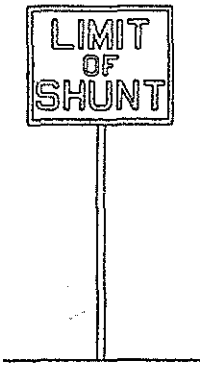
PERMANENT WARNING BOARDS



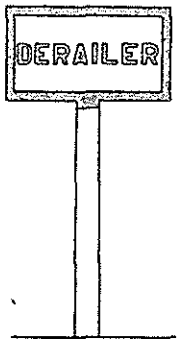
MAXIMUM SPEED BOARD
(ERECTED AT STATION)



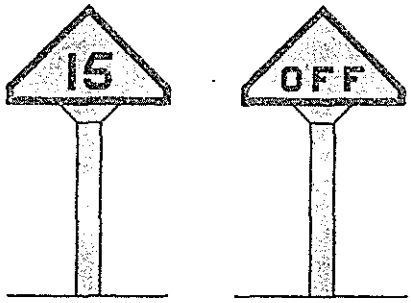
STOP BOARDS



LIMIT OF SHUNT BOARD

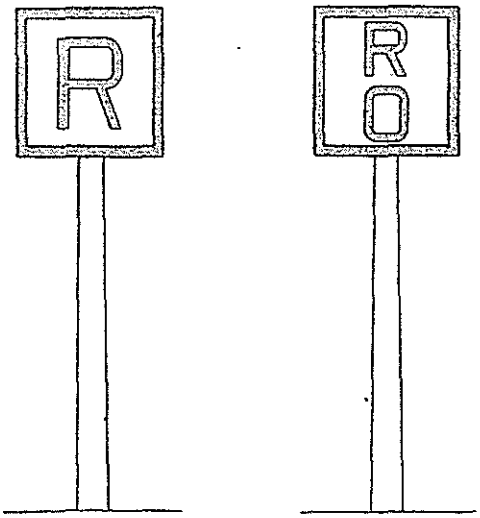


DERAILER BOARD

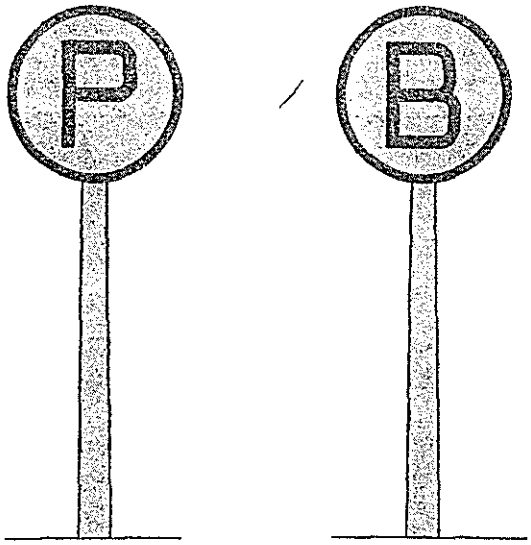


COMMENCEMENT SPEED RESTRICTION BOARDS
SPEED ON FRONT — 'OFF' ON BACK

END



RETAINER BOARDS



FACING POINTS BETWEEN STATIONS

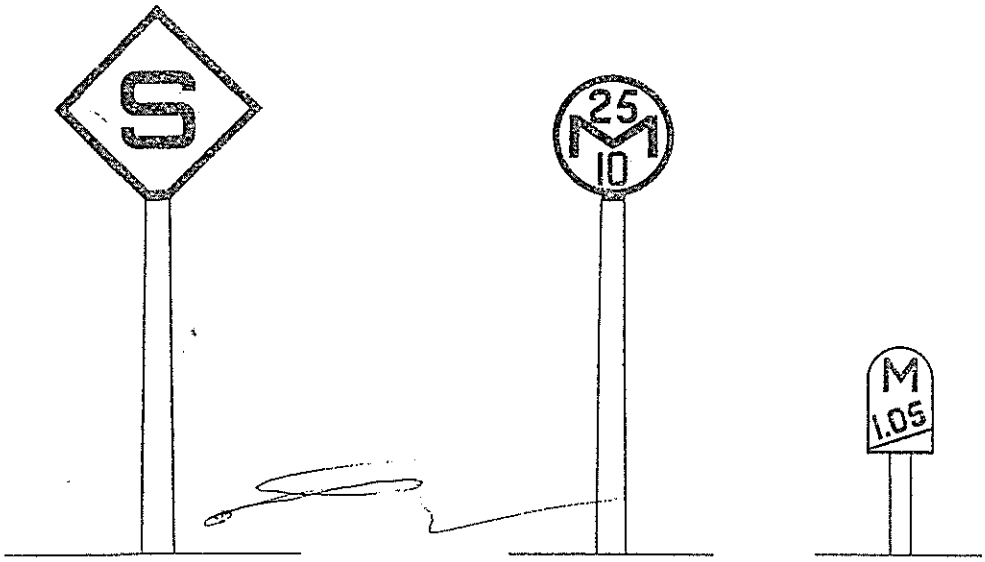
BOULDER BOARD

FOR GENERAL NOTES SEE ANNEXURE 39A

ANNEXURE 39A

STANDARD SIGN BOARDS

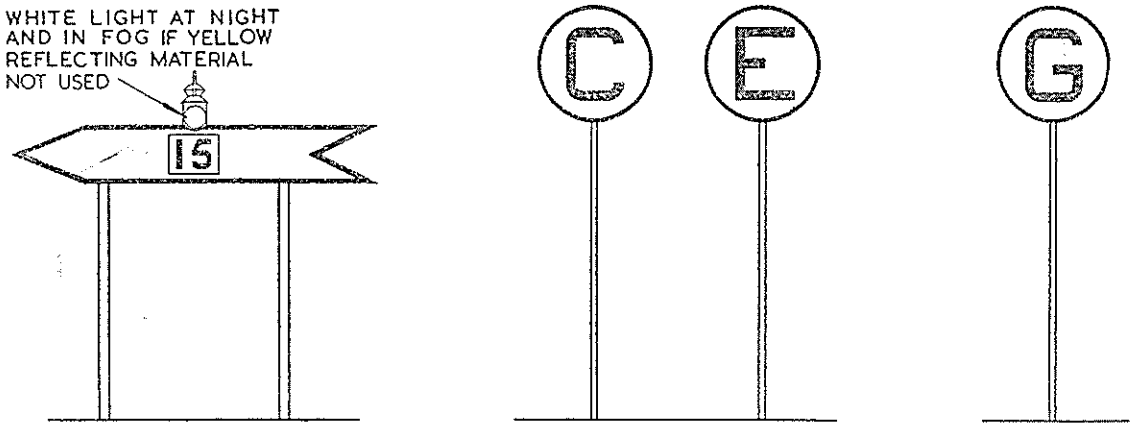
PERMANENT WARNING BOARDS



SIGNAL WARNING BOARD

MOMENTUM GRADE BOARDS

TEMPORARY WARNING BOARDS



CAUTION BOARD

COMMENCEMENT (FRONT) — END (BACK)

('C' MAY BE PAINTED ON ONE FACE & 'E' ON REVERSE FACE)

GANG BOARD

NOTES:-

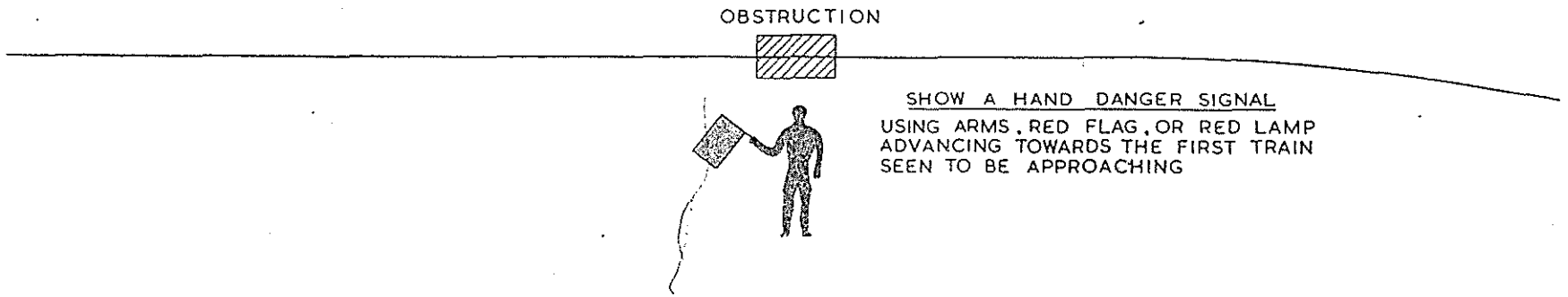
1. THE COLOURS FOR THE BACKS & POSTS WILL BE THE SAME AS USED ON THE BACKGROUNDS OF THE FACES. VIZ. YELLOW OR WHITE AS SHOWN
2. FOR CONSTRUCTION DETAILS OF THE BOARDS, SEE TYPE DRAWINGS
3. FOR REGULATIONS CONCERNING THE USE OF THE BOARDS, SEE GENERAL RULES.
4. FOR LEVEL CROSSING SIGNS, SEE ANNEXURE 6

PROTECTION OF SINGLE LINE IN AN EMERGENCY

DIAGRAM I

IMMEDIATE ACTION

GENERAL RULE ~~205~~ 203 (a) II

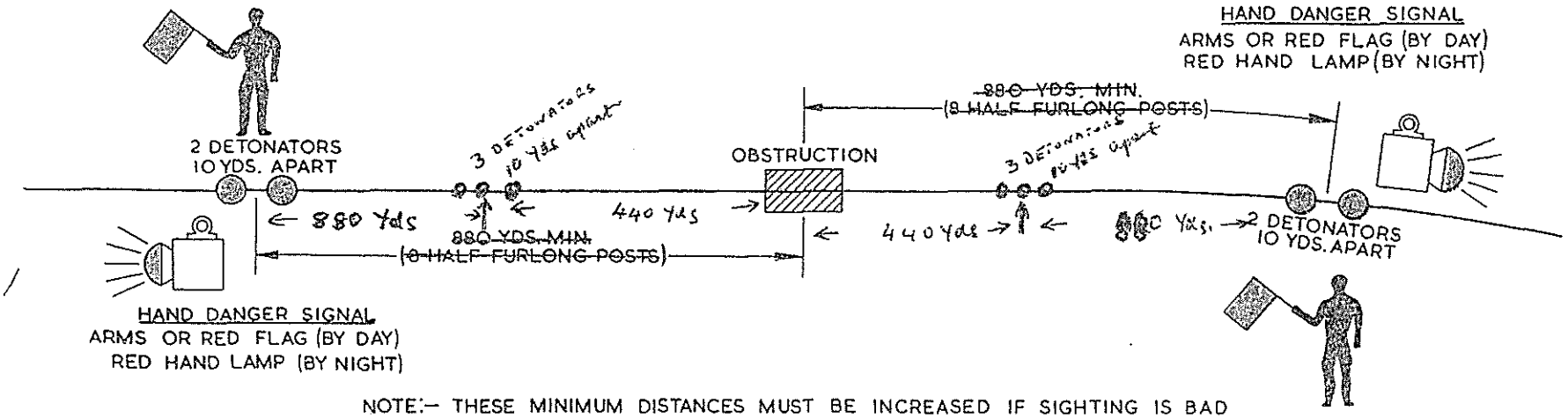


SHOW A HAND DANGER SIGNAL
USING ARMS, RED FLAG, OR RED LAMP
ADVANCING TOWARDS THE FIRST TRAIN
SEEN TO BE APPROACHING

DIAGRAM II

FULL PROTECTION

GENERAL RULES ~~208 & 209~~ 204 & 206



NOTE:— THESE MINIMUM DISTANCES MUST BE INCREASED IF SIGHTING IS BAD

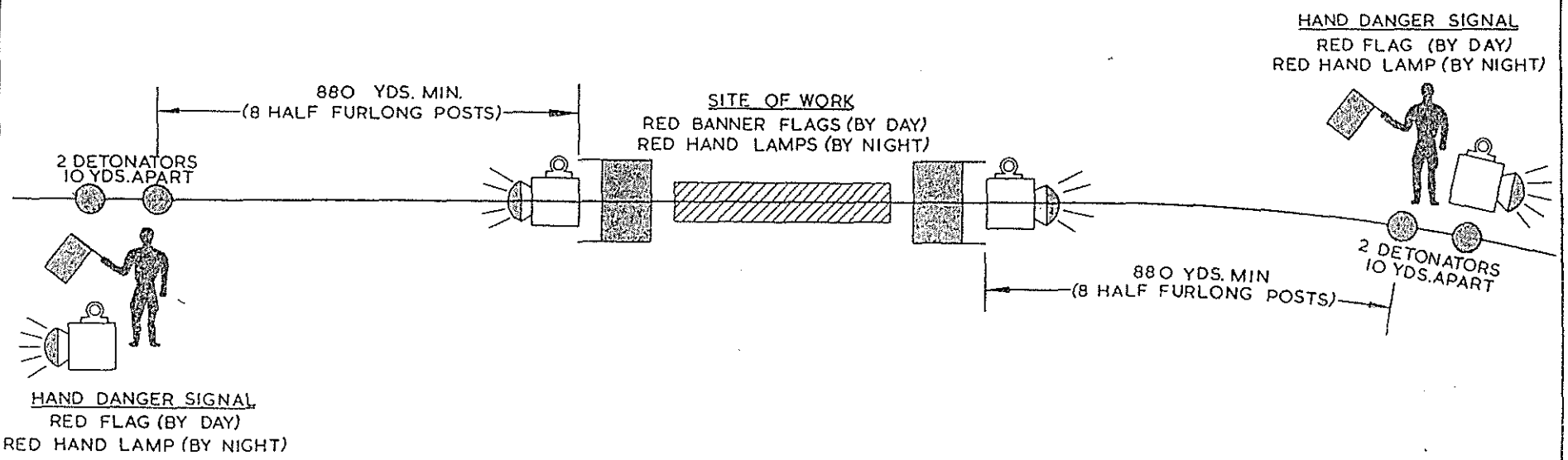
ANNEXURE 40

PROTECTION OF LINE RENDERED UNSAFE DURING ENGINEERING WORK

GENERAL RULES ~~415 & 416~~ 241 & 242.

DIAGRAM III

THIS PROTECTION IS NORMALLY ARRANGED BY P.W.I. OR S.P.W.I. WHEN COMPLETE OCCUPATION OF LINE IS REQUIRED.



NOTE :- 1. IF, FOR ANY REASON, THE DRIVER OF AN APPROACHING TRAIN WOULD HAVE A RESTRICTED VIEW OF THE HAND DANGER SIGNAL, PROTECTION MUST BE CARRIED OUT BEYOND THE 880 YARDS MINIMUM DISTANCE. 242 c

2. WHERE A TUNNEL IS CLOSE TO THE WORK, GENERAL RULE 240 D ~~416(d)~~ APPLIES.

3. FOR PROTECTION WITHIN THE LIMITS OF A STATION, GENERAL RULE ~~416(e)~~ 240(E) APPLIES.

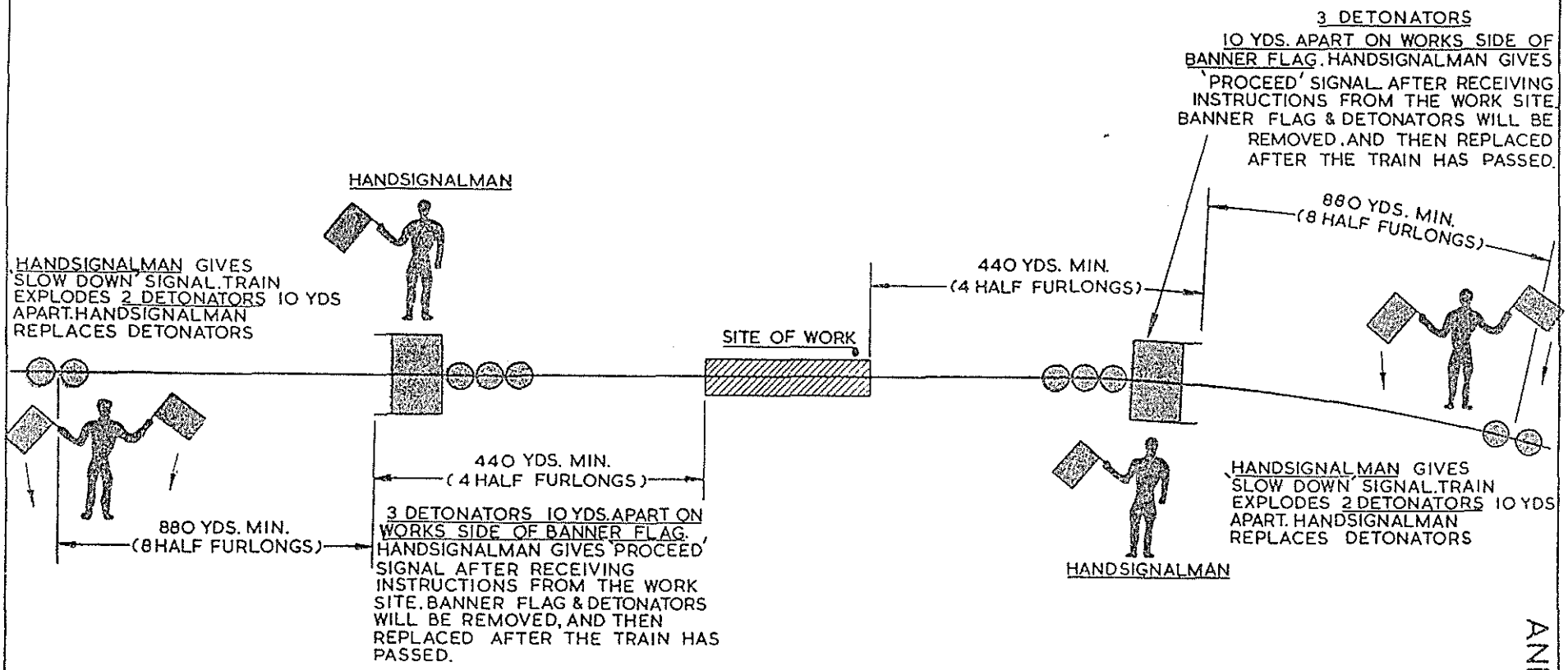
ANNEXURE 41

PROTECTION OF LINE RENDERED TEMPORARILY UNSAFE DURING ENGINEERING WORK

GENERAL RULE ~~423~~ 243

DIAGRAM V

TO BE USED IN DAYLIGHT ONLY



NOTE:- 1. IF, FOR ANY REASON, THE DRIVER OF AN APPROACHING TRAIN WOULD HAVE A RESTRICTED VIEW OF THE HANDSIGNALS OR BANNER FLAG, PROTECTION MUST BE CARRIED OUT BEYOND THE MINIMUM DISTANCE SPECIFIED. 243(D)

2. WHERE A TUNNEL IS CLOSE TO THE WORK, GENERAL RULE ~~423(b)(v)~~ APPLIES.

3. FOR PROTECTION WITHIN THE LIMITS OF A STATION, GENERAL RULE ~~423(b)(vi)~~ APPLIES.

243 (E)

ANNEXURE 43

INDEX

A before a number indicates ANNEXURE, T a TABLE.

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