YARRA TRAMS
March 2000

TRAM OVERHEAD CONSTRUCTION

SPECIFICATIONS

2.0

SINCLAIR KNIGHT MERZ

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1. Part A - General

A TRAM ELECTRICAL SAFETY AND OPERATING RULES

All work shall be carried out in accordance with the Tram Electrical Safety and Operating Rules and in accordance with the relevant rules and regulations of other Network Operators and Authorities with assets in the vicinity of these works.

B WORK METHODS

Work may be undertaken under live line or dead line conditions as appropriate to the activity being performed. In all cases labour resources shall be appropriately trained and qualified for the work being performed.

No connection to the existing electrical system shall be made without the express and written approval of the Superintendent.

C HOLD POINTS

Hold points are those points beyond which the work may not proceed without review by the Superintendent.

Hold points are identified by the letters **HP** in the left margin and by bold text print.

HP **Work shall not commence until all the appropriate preparation works have been carried out and the consent to proceed is obtained from the Superintendent.**

The review by the Superintendent of a hold point will not relieve the Contractor of responsibility for satisfactory execution or performance of the work.

Text which is bolded but not identified by the letters **HP** in the left margin is not a hold point. These are specified obligations on the Contractor requiring the review or approval of the Superintendent. They are bolded for ease of identification.

D DESIGNS BY THE CONTRACTOR

Apart from the Drawings supplied, the Contractor shall prepare at his own expense all other drawings (Contractor's shop drawings) which are required for the completion of the Contract.

Such Contractor's shop drawings shall conform in all respects with the sizes and dimensions of the Principal's Engineering Drawings, to the satisfaction and approval of the Superintendent. Contractor's shop drawings shall show all details, sizes, dimensions, etc.

The Contractor shall submit for the written approval of the Superintendent, 5 prints of each of the Contractor's shop drawings.

Any material ordered or work done by the Contractor before his drawings or any amendments thereto have been approved shall be at the Contractor's risk.

The Contractor shall bear full responsibility for the accuracy, correctness and practicability of all details shown on the Contractor's shop drawings used in the work, and their general approval by the Superintendent shall not relieve the Contractor of this responsibility.

E QUALITY OF WORKMANSHIP

In general the works shall be carried out in accordance with the standard Specifications and Codes of Practice specifically noted in this Specification or on the Drawings.

The Contractor shall furnish appropriately trained and qualified labour necessary to carry out the works in a proper and workmanlike manner and shall complete the works to the true intent and meaning of the Specification and to the satisfaction of the Superintendent.

F SURPLUS AND SCRAP MATERIAL

The Contractor shall direct his employees to adhere to the following instructions:

- All scrap material, debris etc., remaining after the completion of a task shall be cleaned up daily.
- Short lengths of wire shall not be left on site.
- Yarra Trams will nominate any materials which it wishes to retain and they shall advise the delivery site for these materials. The remainder of materials shall be disposed of by the Contractor.

G SURVEY WORKS

The Contractor shall undertake a site survey to enable confirmation of the relative values of the control points provided by Yarra Trams, and to enable the set out for the construction of the tramway track to an accuracy of +/- 3mm.

The Superintendent shall provide the Contractor with drawings and sufficient survey information in order to set out the works, ie. Bench Marks, control

points (at least one control point for every 200 metres of trackwork) and drawings for the proposed contract works.
Track alignments shall be established from co-ordinates and bearings supplied on design drawings. Any discrepancies between new and existing alignments at the extents of works shall be reported to the Supervisor for clarification.

The Contractor is to ensure that chainages are marked out on site at 10 metre intervals and at tangent points.

The Contractor shall be required to confirm all relative values and report any discrepancies of the Reduced Level and co-ordinates of such points which shall be provided by Yarra Trams.

H SETTING OUT AND DIMENSIONS

The Contractor shall, as soon as practicable and before commencing any work under the Contract including work provided by the Principal or Superintendent, check all dimensions and measurements and satisfy himself that they are correct for the specified purpose and that they conform to the requirements of the Contract.

If the Contractor discovers any error he shall immediately notify the Superintendent and request rectification thereof.

Failure of the Contractor to so check such dimensions or measurements or to inform the Superintendent of an error in due time before incurring any associated expense or delay, shall prohibit the Contractor from claiming for any additional expenses or extension of time arising from such error.

If the Contractor commences any work in relation to the Contract, the Contractor shall be deemed to have accepted all such details as being entirely workable, practicable and appropriate for the intended purpose.

The Contractor shall make good at his own expense any defect due to a discrepancy which has not been brought to the notice of the Superintendent for clarification.

I PERMITS AND APPROVALS FOR WORKS

The Contractor shall provide at least four weeks written notice to the Superintendent of intention to commence any electrical works included in this Contract. Tram Occupation Costs shall be borne by the Principal.

The Contractor shall be responsible for obtaining the necessary permits, including the electrical permit 'Switching Certificate' from the relevant Authorities and for paying all of the associated fees.

The Contractor shall ensure that none of his operations in connection with the Works interferes with the tram traffic operations except in those areas in which the Contractor has written authorisation to occupy.

The Contractor shall arrange:

(i) to obtain all necessary road opening permits, which may affect times of working, traffic constraints, either through traffic or parking restrictions.

(ii) to obtain approvals for and install all necessary road closures required for the safe completion of the works. These shall be subject to the approval of the local councils and/or VicRoads and the Superintendent.

The Contractor shall obtain the necessary permits from the City of Melbourne, Parks and Gardens Department, for the trimming of trees in close proximity with Yarra Tram assets.

All such permits shall be at the expense of the Contractor, and shall be deemed to be included within the Contract Sum.

Time to arrange and obtain such permits shall be included within the Contract Period for completion of the Contract works, and no claim shall be entertained for any delays which the Contractor may encounter in obtaining such permits.

J PROTECTION FROM TRAM TRAFFIC

The Contractor shall provide, at his own cost, protective barriers around all excavations.

The Contractor shall be responsible for and shall provide the necessary protection against tram traffic, including all signs, and the provision of flagmen, without cost to the Principal, unless otherwise specified.

A flagman shall be provided who is equipped with a whistle or equivalent warning device. The flagman will activate the device such that adequate time is given for workmen to clear the site safely prior to the tram arriving.

The Contractor, his employees and sub-contractors shall not remain, nor shall any vehicle, plant or object be permitted to be placed within 1.5 metres of the rail of any tram track with tram traffic on it, without approval of the Superintendent.

The stability of existing tram tracks and overhead support structure must not be prejudiced by the operations of the Contractor, and the Contractor and his

employees shall obey absolutely all instruction given by the Superintendent in order to maintain stability.
The Contractor shall carry out all works on, or adjacent to the tram tracks in such a manner as not to cause interference to the view of any tram driver or crew of any traffic signals.

K TRAFFIC MANAGEMENT

The Contractor shall note that public safety is to be regarded of paramount importance at all times and to this end work shall not be permitted to proceed in the absence of sufficient suitable barricades, signs or lights.

The Contractor shall so conduct the operations as to minimise obstruction and interference to the public and shall not have under construction any greater length or amount of work than can be managed properly with due regard to the operational requirements of the public.

The Contractor shall organise the traffic management in such a way as to maintain any public transport replacement services.

Peak road traffic shall not be stopped by the works. The Contractor shall provide a minimum of one traffic lane in each direction at all times.

Work shall have minimal disturbance to roadside parking, and access to private and commercial properties shall be maintained. Any disruptions are to be approved by the relevant councils. Approvals to be forwarded to the Superintendent seven (7) days prior to proposed restriction being enforced.

Existing roads lying outside the area being worked shall remain unrestricted and open to vehicular and pedestrian traffic at all times, unless approval is obtained from the Superintendent for occasional temporary traffic restrictions.

The Contractor shall, at his expense and without further or other order, provide, employ and maintain suitable and adequate barricades, fences, traffic control devices, warning lamps, and flagmen and all other protection measures necessary. All detours are to be signposted as per VicRoads standards. Where applicable, signs indicating "Road Works Ahead" will be required on all approaches to the work, sufficiently far away to give adequate advance warning and, in addition, appropriate "Part Road Closed", "Road Closed", "Detour" and "Do Not Follow Trams" signs must be placed as necessary. Advance warning signs, which state as a minimum:

"Tramway Works Ahead ..... Road, Between ..... and ..... Streets
Start ..... 200x Finish 200y
Long Delays Expected - Use Alternative Route"

All signs are to be in accordance with the Australian Standards Numbers 1742 (Manual of Uniform Traffic Control Devices) and 1743 (Road Signs). They are to be clean, in good condition and must be erected in a firm upright position.

Warning lights shall be of the electrical flashing type approved by, and located at intervals to the satisfaction of, the Superintendent.

The Contractor shall arrange obtaining VicRoads approvals and forward them together with a layout plan showing all proposed traffic control measures to the Superintendent at least seven (7) days prior to work taking place.

The signs shall be erected no later than 7 days prior to the commencement of works.

The Contractor shall also arrange at his expense, notices to be placed in daily and local newspapers advising the general public of road closures. Such notices to include details of locations of road closures, suggested alternative routes and detours and hours of closures.

All pedestrian and road crossings are to be reinstated and made safe for pedestrian and vehicular traffic by the completion of each shift. These locations must have appropriate barricades and signage in place until safe for use.

The Contractor shall be responsible to ensure that a safe pedestrian access to existing buildings and facilities, private and retail is maintained at all times. All fencing or signposting necessary for the protection of pedestrians will be erected by the Contractor.

The Contractor shall ensure that the adopted and agreed traffic management procedures are safe and adhered to at all times. If the Superintendent considers the protection measures employed or the maintenance thereof to be inadequate, he may order the employment of such additional protection measures or maintenance as he deems necessary, and in the event of the Contractor neglecting to comply with such order, the Superintendent may arrange for additional protection measures or maintenance at the expense of the Contractor and the cost thereof may be deducted from any moneys then due or thereafter becoming due to the Contractor or deposited by him under this Contract. Any work required by the Superintendent for the protection of pedestrians shall be carried out immediately.

The implied satisfaction of the Superintendent with any protection measures employed by the Contractor or by the Superintendent shall in no way relieve the Contractor of the responsibility for the provisions of this Clause. The Contractor shall provide extra plant, signs and material necessary to deal with any emergency.

L LIGHTING

The Contractor shall provide any necessary temporary lighting between sunset and sunrise.

All protective lighting in the vicinity of the tracks and at the track level shall be to the satisfaction of the Superintendent.

M RELOCATION OF SERVICES

The Contractor shall conduct a survey of underground services and assets prior to commencing work to:-

- ensure the safety of personnel,
- maintain the integrity of existing underground services and assets,
- determine if any services or assets need altering or relocating to enable the works to be carried out.

The Contractor shall inform the Superintendent as soon as he becomes aware of the need to alter or relocate any services and shall advise the Superintendent of details of the proposed alteration or relocation.

All costs of alteration or relocation of services will be borne by the Principal.

The time of alteration of any such services will be dependent on the requirements of the Authorities concerned and it shall be the Contractor's responsibility to organise his work program accordingly.

N TEMPORARY WORKS

Any temporary works provided by the Contractor shall be properly designed and constructed for the safe operation of the function they will be required to perform.

All aspects of the design of any temporary structures required to support constructional loads shall comply with the current Australian Standard, Specifications and Codes where such exist, or, in their absence, with British or American Standard Specifications and Codes of Practice.

Any temporary or additional works provided by the Contractor shall be adequate for the purpose and shall be properly designed and constructed for the load which they will be required to carry.

Details of any temporary or additional works proposed by the Contractor shall be forwarded to the Superintendent for approval at least 7 days before intended works.

Any approval of the temporary works by the Superintendent shall not relieve the Contractor of any of his responsibilities for work under the Contract.

O PLANT AND EQUIPMENT

The Contractor shall supply and deliver to the site all necessary equipment and shall provide all tools, plant and any other equipment which may be necessary to complete the works. Maintenance records of all plant and equipment shall be available for inspection by the Superintendent prior to use.

Prior to use of any electrical equipment or appliance on the works the particular item shall be presented to the Superintendent for inspection. The Contractor shall maintain in his site office a register of such items, including the date and Superintendent's signature confirming such inspection.

The use of explosives or explosive powered devices by the Contractor, shall be subject to the prior approval of the Superintendent.

The use of mobile plant and equipment near tracks and overhead shall conform with the procedures and guidelines outlined in Attachment 'D' "Procedures for working on Yarra Trams facilities".

P TREE TRIMMING

Tree trimming shall be carried out by appropriately trained tree cutting personnel in such a manner as to ensure the safety of the public, the tree cutters, other employees in the vicinity and the protection of the tree, Yarra Trams assets as well as other assets around the tree. The trimming shall be carried out in accordance with the regulations of the local council.

2. Part B - Technical Specification

2.1 Overall System Specification

The ultimate measures of Overhead System performance are service performance, reliability and maintenance requirements.

The sections of overhead designed, built or rehabilitated to this Specification shall not contribute any incidents that cause delays to trams.

2.2 General System Specification

2.2.1 Mechanical

2.2.1.1 Safety Factors

A safety factor of 3 to 1 over the allowable loading shall apply.

Any fitting inserted in line with strained conductors or support spans shall be stronger than the conductor or the span to which it is attached.

Fittings which are under tension and which are subject to wear (e.g. splice ears and trolley wire tensioner) shall not during their projected life fail at a strain which is less than 2/3 of the Ultimate Tensile Strength of the new conductor and span material with which they are used.

2.2.1.2 Corrosion prevention

Adequate long term corrosion protection shall be provided as follows:

- With the exception of corrosion-resistant steels such as stainless, all ferrous parts shall be hot-dip galvanised upon completion of all fabrication processes.
- Unless a corrosion-resistant material is specified, all bolts, nuts and washers which are of over M10 size shall be hot-dip galvanised.
- All bolts, nuts and washers which are less than M10 size shall be made of a corrosion resistant material such as stainless steel or other material approved by the Superintendent.
- Dissimilar metals which would promote galvanic corrosion shall not be used in close proximity.

2.2.1.3 Wear Resistance

The fittings shall be constructed from such material and in such a manner to provide projected life delivery in service with minimum maintenance requirements.

2.2.1.4 Composite Materials

Composite materials shall

a) Be stabilised against Ultra-Violet Radiation.
b) Be resistant to chemicals that might be encountered in their operating environment.
c) Provide adequate electrical insulation levels.

d) Not sustain combustion.
e) Have good wear characteristics if subject to wear.
f) Be capable of withstanding electric arcing without deterioration.
g) Have low moisture absorption characteristics.
h) Have high impact resistance.
i) Aesthetic considerations.

2.2.1.5 Projected Life

It is envisaged that the overhead fittings and systems shall be designed for a minimum projected life of 30 years.

2.2.2 Electrical

The nominal voltage of the Tram Traction system is 600 volts d.c.. However, the system is constantly raising to 720 volts or greater due to regeneration

2.2.2.1 Conductor Sizes

Conductor sizes shall be determined by both mechanical and electrical ratings, protection and strength considerations.

Deviations from standard sizes in general use, as listed in Table B, shall be made only after both mechanical and electrical considerations have been made and permission has been sought from and granted by the Superintendent.

2.2.2.2 Insulation Levels

All insulators shall be rated for operation at 900V d.c. as a minimum.

All attachments to the poles or other structures shall be at least double insulated from live parts.

All the support spans shall be insulated in such a manner that, should they break, live parts will be maintained at a height no less than 3m above ground level.

2.2.2.3 Electrical Clearances

All electrical clearances from any conductor or part energised at 600V d.c., shall be in accordance with the Electrical Safety Act 1998 and the Tram Electrical Safety and Operating Rules and PTC Forms No. D19 and D522. (see Attachments A and B).

2.2.2.4 Electrical Separations

The relative position and separations between conductors and circuits shall be in accordance with the Electricity Supply and Construction Regulations and Electrical Works Protection Regulations (latest amendment).

2.2.2.5 Current carrying Capacity

The current carrying capacity of switches or isolators shall not be less than that of the largest equivalent cross sectional area of conductor/s connected to each of its terminals.

Fittings utilised to join conductors or to provide electrical connection or tapping shall have a resistance less than the equivalent length of conductor.

2.2.2.6 Cleaning and Greasing of Current Carrying Connections

All joint assemblies which are designed to permit the transfer of current from one conductor to another shall be prepared as follows and to the satisfaction of the Superintendent:

The conductors, clamps and fittings shall be thoroughly dried and then cleaned with a suitable scratch brush to remove all dirt and surface oxide from the conducting surfaces of the joint.

Before the clamps are tightened, a liberal film of Shell Ensis CB compound or other acceptable electrical jointing compound shall be applied to the conducting surfaces to seal the joint against moisture ingress.

2.2.3 Interfacing with Existing Equipment

The integrity of items that are not to be replaced but are worked upon or handled in the process of installing / replacing mating parts or assemblies shall be preserved when installing a new system or rehabilitating an existing system. The Contractor shall exercise 'due care' and take the necessary steps to ensure the integrity of these items is not jeopardised.

During the process of trolley wire tensioning, the relative position of components and wire stagger at other locations shall not be affected adversely. Prior to terminating in any fittings, the trolley wire tension is to be checked by the Superintendent.
Special care shall be exercised at cable connections and supports.

2.3 Overhead Line Geometry

2.3.1 Structure Gauge

The structure gauge specified in Drawing P.15556 shall be observed for all works associated with this Contract.

2.3.2 Trolley Wire Heights

All trolley wire heights shall be referred to rail level.

2.3.2.1 Trolley Wire Height on Straight Track

Where there are no restrictions such as bridges, civil engineering works or electrical separations the height of the trolley wire shall be 5.64m at the support points (taken at 20 degrees Celsius).

The tolerance on the trolley wire height shall be +0, -75mm under these conditions.

Where the trolley wire is suspended under bridges or inside buildings and the 5.64m height cannot be met, then the distance between the bridge underside and the trolley wire shall not exceed 170mm.

The absolute minimum trolley wire height shall not be less than 3.6m.

The tolerance of heights below 5.64m shall be 25mm.

2.3.2.2 Trolley Wire Sag

The sag of the trolley wire shall be in accordance with the Tension / Sag table (Reduced Tension) for fixed tension design Table C.
The tolerance for the sag shall be 25mm.

2.3.2.3 Change in Trolley Wire Levels

The desired max. trolley wire gradient shall be determined by the formula below:

Desired max. Gradient = 1 in (5 X Ruling Speed in km/h).
The absolute maximum gradient shall be 1 in 75.

Loss of contact, defined as separation between the current collection equipment and the trolley wire and fittings, shall not exceed 1% at normal service speeds.

2.3.3 Trolley Wire Offset and Stagger

A mirror gauge shall be correctly utilised to set the trolley wire offset with respect to the centre line of the track.

2.3.3.1 Tangent track (Straight Track)

On tracks converted to pantograph running, the stagger shall alternate on either side of the centre line in a zigzag pattern reaching a maximum offset of 230mm from the centre line before crossing back to the other side, as illustrated in Attachment C.

2.3.3.2 Curved track (Fixed System)

The trolley wire shall be offset towards the centre of the curve at the ears in accordance with Table D but unless the curve radius is very large, no attempt should be made to introduce trolley wire stagger.

2.4 Other requirements

2.4.1 Dual Running

On the same section of line, all fittings referred to in this contract and used shall facilitate running of trams fitted with either trolley pole or pantograph current collectors.

The design and installation procedure for the fittings shall ensure smooth transition from trolley wire to fitting.

For pantograph passage, a flat surface shall be provided over the entire length of the fitting.

The runner / clamp piece of any fitting attached or clamped to the trolley wire shall not exceed 20mm in width and shall be installed such that a trolley shoe without carbon will adequately clear the fitting during its passage.

2.4.2 Compatibility of Fittings

All components, fixtures and fittings used shall be fully compatible with existing fittings.

No modification or work on mating parts shall be required for assembly. New parts shall be fully interchangeable with existing parts.

2.4.3 Assembly Methods

All components shall be assembled in a manner which ensures that fasteners are tightened to the correct torque and they will not work loose due to vibration or other factors. However, it shall be possible to dismantle fittings for adjustment, maintenance or replacement.

For proprietary items the manufacturer's installation procedure and Specification shall be adhered to. All such details shall be provided to the Superintendent prior to implementation of the Contract. Thread locking compounds shall not be used.

2.5 Drawings and Documentation

In general drawings of the fittings will be supplied to the Tenderer as detailed in the Drawing Table for this Specification.

Where Drawings are not supplied then Yarra Trams will provide samples at the Tenderer's request.

2.6 Alternative Designs and Materials

The use of alternative designs and/or materials may be considered if it can be demonstrated that the alternative fitting's performance is equivalent to or

better than the specified fitting and that it complies with all Clauses of this Specification in the Section headed "Other Requirements".

The alternative design shall not necessitate the use of any additional complex tools other than those expected to be used for the fitting specified.

Request for such approval shall be submitted to the Superintendent in writing together with supporting evidence of the benefits of the alternative.

No alteration in design or material shall be implemented unless approved by the Superintendent in writing.

3. Component and Assembly Details

3.1 Poles

3.1.1 General

Where specified, galvanised steel poles shall be used to support the overhead system.

In some instances the location and number of poles to be installed are dictated by external factors such as planning process and the presence of underground services or encumbrances. If the position given on concept drawings interferes with any of the above and necessitates the relocation of the pole, the revised position shall not vary from the original in a way that jeopardises the layout of the network.

These issues shall be considered in determining the location of the poles.

The poles shall be constructed from two diameters of circular hollow steel section in accordance with table A. No assets shall be attached to the poles for a minimum period of 7 days after pole installation.

3.1.2 Pole Erection

3.1.2.1 Hole Excavation

A survey of underground assets shall be conducted by the Contractor prior to commencing excavation and underground services shall be 'proved' prior to pole installation.

The minimum distance between two poles shall be such that the structural stability of either pole and/or its footing is not adversely affected.

For each pole, a bored hole, of uniform diameter throughout the entire depth, 200mm deeper than the embedment depth specified on the relevant pole drawing shall be provided.

For standard span poles, a 380mm diameter auger shall be used. For standard anchor poles, a 460mm diameter auger shall be used.

The diameter of the hole shall always be at least 100mm greater than the diameter of the pole.

3.1.2.2 Pole Setting

A red gum base plate, 300 x 240 x 40mm, shall be laid at the bottom of the hole.

The pole shall be installed with the depth mark and identification plate facing the roadway.

The depth mark shall be 1.4m above rail level.

A concrete mix of 25 MPa minimum strength shall be placed and then compacted to fill the voids between the pole and the earth surrounding the pole.

After setting the pole rake, the surface of the concrete at the pole base shall be crowned and neatly finished to ensure no pooling of water at the pole/concrete interface.

3.1.2.3 Rake of Poles

Poles shall rake opposite to the direction of strain application.

Where loads are applied in more than one direction the pole shall rake opposite to the direction of the resultant strain.

Poles shall be set with the following rakes:

Steel Poles:	Anchor	1 in 40 rake
	Span	1 in 60 rake

3.1.3 Back Anchors

If the ground where the pole is embedded is unstable or if the load to be applied to a pole exceeds the design load of the pole a back anchor shall be applied as directed by the Superintendent. To be effective, the back guy shall act as near as possible in the opposite direction to the resultant strain acting on the pole.

The back anchor shall transfer part of the pole load to adjacent pole/s or structure/s via an 11mm, 6X25(12/6+6/1) RHOL 1 WRC G2070, Galvanised 'Tirfor' wire rope. The wire rope shall be insulated, at both ends, from the pole/s and structure/s by inserting GY2 porcelain strain type insulators at 1750mm from the point of attachment on to the pole or structure. Anchor bands to Drawing O923 shall be used to attach the wire rope to the pole.

Where the guy wire crosses above or below trolley wire or other bare conductor or fittings, which could become energised, the wire rope shall in addition to the GY2 insulators be insulated from the pole or structure via a 200mm disc insulator to Drawing No. D3771. The disc insulator shall be attached to the pole using a 300mm length of 13mm regular link proof coil chain and an anchoring band to Drawing No. O923. Additional GY2 insulators shall be installed on either side of the apparatus that can become energised to limit the length of the back anchor wire that can become accidentally energised. Preformed helical terminations shall be used to terminate the steel wire rope incorporating galvanised steel thimbles where necessary.

3.1.4 Pole Inspection and Testing

The following procedures shall serve as guidelines only and consideration might be given to supplementing these inspections by subjecting certain

poles to controlled lateral load tests as might be experienced when the trolley shoe disengages and its pole entangles the supporting network or cross span.

3.1.4.1 Timber Poles

The surface of the pole shall be examined for any damage, splits or rots.

The circumference of the pole shall be sound tested. Any dead, hollow or flat sounds may be potential indicators of problems.

The region around the pole base is to be excavated to a depth of 300mm and inspected for termite activity or timber rot.

Since internal deterioration commonly occurs in the "swell" region which ranges from just above ground level to approximately 150mm below it, an 16mm diameter inspection hole shall be drilled near the base. The borings shall be examined for any rot and termites. If detected, another inspection hole shall be drilled to confirm that the first observation was not localised and to establish the extent of decay and the residual strength.

The inspection hole shall be filled with a "Polesaver Rod" PS14 diffusable preservative (14mm diameter and 125mm long) and then sealed with a tapered plug.

3.1.4.2 Steel Poles

The surface of the pole shall be examined for any damage, corrosion and rust.

The region around the pole base is to be excavated to a depth of 150mm and inspected for damage, corrosion and rust spots.

Puncture tests are to be performed on suspect poles. If any suggestion exists that corrosion may be a problem further down the pole, the excavation shall continue until a clear corrosion-free area is obtained.

Poles which are in good condition and less than 15 years old need not be inspected.

3.1.4.3 Concrete Poles

The surface of the pole shall be examined for any damage, cracks and rust stains.

3.1.4.4 Inspection Records

Following inspection, the surface of the steel pole shall be suitably prepared and then painted with two coats of zinc rich organic priming paint which shall conform to AS 2204.

The excavation at the base of the pole shall then be backfilled and the site cleaned up.

Where the pole is found to be unserviceable, the road side pole surface shall be marked with an "X", using paint spray can or brush.

An inspection disc showing the month and year of inspection shall be affixed to each pole at shoulder height and on the road side.

Details of each inspection shall be recorded in the Inspection Test Record Log.

3.2 Lighting Arms

Installation of the lighting arms onto the poles shall occur at least seven days after pole installation.

A 3mm diameter galvanised steel soft wire (fencing wire) shall be used to provide a draw wire for the arms to allow installation of the lighting cable through each of the arms. Also, a length of the same draw wire shall be provided through the centre of the pole to enable the lighting cable to be pulled up through the hollow section of the pole entering through the 50mm. hole drilled 500mm from ground level.

All lighting fittings and associated wiring must be double insulated from the pole.

3.3 Trolley Wire Support via Straight Steel Cross Span

3.3.1 General Specification Steel Cross Span

Where there is no curvature in the track, straight support spans shall be constructed using 6mm steel wire rope to Specification TMO/04/07/92, GY1 strain insulators to Specification TMO/03/07/92 and reel type insulators to Drawing No. O7364.

The wire rope shall be terminated using preformed terminations to Specification TMO/05/07/92 or swaged fittings.

The swaged fittings shall be aluminium alloy for machine swaging or copper for hand swaging and shall be sized to suit 6mm wire rope.

Swaged terminations shall not fail at a load lower than the minimum breaking load of the wire rope.

The construction of straight cross spans shall be carried out as per Drawings No. O14-292 pole-to-pole support, O14-293 pole-to-wall support and O13-294 wall-to-wall support.

3.3.2 Detailed Steel Cross Span Construction (Refer Drawings)

The steel wire rope cross-span shall be composed of 6 No. lengths of 6mm wire rope, 5 No. GY1 insulators and 2 No. reel insulators.

The 2 No. innermost lengths of steel wire rope are to be of standard length and are to be joined midway between the trolley wires through the centre insulator.

Their outer ends shall be threaded through the primary insulators and swaged.

Their inner ends shall be threaded through the centre insulator and swaged.

The distance between the centres of the primary insulators shall be 5000mm for standard track centres of 3.353m.

The intermediate lengths of the steel wire rope shall join the primary insulator to the secondary insulator on both sides of the cross-span. Their length varies with the width of the road.

The intermediate lengths of the steel wire rope shall be terminated on both sides by using preformed helical terminations threaded through the primary and secondary insulators.

The outermost lengths of the cross-span are constructed as follows:

A reel insulator shall be connected to the attachment point using the shackle plate arrangement shown on Drawing No. O7364 and a 1/2" galvanised bolt x 2".

The reel insulator and shackle plates shall be manufactured to Drawing No. O7364.

At a distance of 1500mm from the centre of the reel insulator the secondary insulator shall be attached via 6mm steel wire rope.

One end of the wire rope shall be wrapped around the reel insulator and swaged.

The other end of the wire rope shall be threaded through the secondary insulator and swaged.

Starting at the end of the hanger, the cross span shall slope upwards from the horizontal and towards the pole or wall attachment.

This upward gradient shall be approximately 1 in 10 for 81sq.mm. trolley wire and 1 in 7 for 129 sq.mm. trolley wire.

3.3.3 Pole Attachments

The reel insulator shall be attached to the pole via its shackle plates onto a standard type pole band to Drawing No. O.6897 Type 2, sized to fit the diameter of the pole.

3.3.4 Wall Attachments

All existing wall attachments shall be proof tested by the application of a load of 18kN. A load cell or equivalent equipment shall be utilised to measure the load.

Wall attachments that withstand the designated proof load shall be re-used subject to the Superintendent's approval.

New wall attachments shall be tested as per existing wall brackets but only when the manufacturer's specified curing time for the chemical anchor has elapsed, and prior to the attachment of any other loads.

All new and replacement wall attachments shall be to Drawing No. O14-308.

The reel insulator of the cross span or pull-off shall be attached to the wall attachment. In some instances it may be necessary to incorporate a 'D' shackle to enable the reel insulator to be attached.

If a shackle is used it shall have a minimum breaking load of 20 kN or a Working Load Limit of 12 kN.

Any wall attachment that fails the proof test shall be replaced.

3.3.5 Suspension Systems for Cross Span Support

3.3.5.1 Hanger and Ear Suspension

An adjustable span hanger to Drawing No. O13-983 shall be used to attach the line ear to the steel cross span with two stainless steel 'U' bolts.

On straight spans, the hanger horn shall always point towards the nearest pole and shall be adjusted to ensure that the ear sits vertically. On curve networks, the horn side of the hanger shall always point towards the inside of the curve.

The trolley wire shall be suspended from the support span utilising a 250mm (10") line ear, Fandstan Part No. 91231 or South Eastern Transit Part No. 12000, attached to the adjustable span hanger through a 3/4" stainless steel stud and a brass nut fitted with a stainless steel spring washer.

On straight spans, the line ears shall be oriented so their main body faces towards the centre of the road and the clamping plate faces the roadside. On curves, the line ears shall be orientated with the ear screws facing toward the

outside of the curve so that the (stronger) main body faces the inside of the curve.

3.3.5.2 Single Pendulum or Double Pendulum

The Single Pendulum (or Double Pendulum) assemblies, supported on cross spans shall be in accordance with Drawings No.O14-500 and Q6049.

3.3.6 Trolley Wire Stagger

On tracks converted to pantograph running, the stagger shall be on a 230mm either side of centre line pattern, as illustrated in Attachment C. A mirror gauge shall be correctly utilised to set the trolley wire offset with respect to the centre line of the track.

3.4 Trolley Wire Support via Boom Tube

Supported on boom tubes, the installation of the Single Pendulum or Double Pendulum or Pull-off Arm elastic suspension assemblies shall be in accordance with Drawings No.O14-545 (typical), Q6059, Q6060, O14-362 (or O14-637 if applicable) and O14-531 and shall conform to the following:

3.4.1 Boom Tube

The boom tube shall be manufactured to Drawing No. F12075.

The material shall be welded mild steel tube, 60.3mm outside diameter, 5.4mm wall thickness to A.S. 1163 or alternatively refrigerant pipe, with the same dimensions.

The boom tube shall be hot dipped galvanised to A.S. 1650.

The inside diameter of the tube shall not be less than 47.0mm after galvanising.

The external finish shall be smooth and free of 'run off'.

For each location, the length of the boom shall be appropriate to the overhead support / track layout geometry.

3.4.2 Boom Tube Insulation

The boom tube shall be connected to and insulated from the pole by a polymeric strut type insulator to Drawing No. D3373, Reference D3373/2 or D3373/3.

The insulator shall have the following characteristics:

- Mechanical
  - Minimum Tensile Breaking Load 40kN
  - Minimum Compression Failing Load 40kN

– Minimum Bending Breaking Load	270kN
□ Electrical	
– Minimum Creepage Distance	370mm
– Power Frequency Wet Withstand Voltage	50kV
– Impulse Withstand Voltage (12/50 us wave)	125kV

3.4.3 Boom Tube Tie

The boom tube tie shall be constructed from Parafil rope, 2 Tonne minimum breaking load, to Drawing No. D4465, Reference D4465/2.

The Parafil rope tie shall be terminated in accordance with Drawing No. D4466.

The termination used shall be to Drawing No. D4464, Reference D4464/201 or D4464/204, or approved equivalent.

The boom tube tie shall be attached to the boom tube via a boom connector bracket, manufactured to Drawing No. D4953, retained and located on the boom tube by two 'U' bolts to Drawing No. D3933, Reference D3933/1.

3.4.4 Boom Tube Attachment to Pole

Two pole band assemblies shall be attached to each pole to enable the attachment of the boom tube and the boom tube tie.

For Centre Pole with Back-to-Back Single Track Cantilever Arms, the band assembly shall be to Drawing No. D5076.

For Single Cantilever, the band assembly shall be to Drawing No. D5075.

The boom tube insulator shall be attached to the lower band assembly pivot. The boom tube tie shall be attached to the upper band assembly pivot.

The pole band shall be sized to suit the pole diameter for each location.

3.4.5 Suspension Systems for Boom Tube Support

3.4.5.1 Single Pendulum Fittings (Panto Only Operation)

In this specification Kummler & Matter single pendulum components are listed. Equivalent compatible alternative designs of single pendulum can be submitted for approval.

A primary insulator shall electrically insulate the boom tube from the trolley wire.

The insulator shall have a minimum wet flashover voltage of 8kV.

The K&M insulator, Part No. 850 D 431 1 or an approved equivalent shall be utilised.

The insulator shall be attached to the boom tube by using two boom tube collars to Drawing No.O14-547.

A galvanised steel Eye Nut, K&M Part No. 845 E 202 or approved equivalent, with a 5/8" thread shall be attached to the insulator.

A 4mm diameter galvanised steel Hanger (Pendulum Cable), 500mm long as measured eye to eye, shall be attached to the eye nut including a nylon thimble K&M Part No. 856 D 719 1.

A 10mm diameter stainless steel bow, K&M Part No. 872 D 1050 III, shall be threaded through the lower eye of the hanger. A nylon thimble, K&M Part No. 856 D 719 1, shall be included.

On each side of the bow a trolley wire clip, K&M Part No. 872 E 1308, shall connect the trolley wire to the bow.

On the bow the points of clip attachment shall be knurled to ensure there is no relative movement between the clips and the bow.

The assembly shall be adjusted to ensure the trolley wire seats horizontally and is without any twists, or kinks.

The Manufacturer's installation and adjustment instructions for the single pendulum equipment shall be followed.

3.4.5.2 Double Pendulum Fittings (Dual Operation)

In this specification Kummler & Matter double pendulum components are listed. Equivalent compatible alternative designs of double pendulum can be submitted for approval.

A primary insulator shall electrically insulate the boom tube from the trolley wire.
The insulator shall have a minimum wet flashover voltage of 8kV.
The K&M insulator, Part No. 850 D 431 1 or an approved equivalent shall be utilised.

The insulator shall be attached to the boom tube by using two boom tube collars to Drawing No.O14-547.

An upper hanger, K&M Part No. 838 D 136 or approved equivalent, with a 5/8" thread shall be attached to the insulator.

2 No. 4mm diameter stainless steel Hangers (Pendulum Cable), K&M Part No. 848 D 328/2, 500mm long as measured eye to eye, shall be attached to the upper and lower hangers, the lower hanger being K&M Part No. 838 D 140.

On each side of the lower hanger rod, a trolley wire clamp, K&M Part No. 838 D 134, shall connect the trolley wire to the rod.

The assembly shall be adjusted to ensure the trolley wire seats horizontally without any twists, or kinks.

The Manufacturer's installation and adjustment instructions for the double pendulum equipment shall be followed.

3.4.5.3 Pull Off Arm Fittings (Dual Operation)

In this specification Kummler & Matter pull-off arm components are listed. Equivalent compatible alternative designs of pull-off arm can be submitted for approval.

A primary insulator shall electrically insulate the boom tube from the trolley wire.
The insulator shall have a minimum wet flashover voltage of 8kV.
The K&M insulator, Part No. 850 D 431 1 or an approved equivalent shall be utilised.

The insulator shall be attached to the boom tube by using two boom tube collars to Drawing No.O14-547.

An eye nut, K&M Part No. 845 E 202 or approved equivalent, with a 5/8" thread shall be attached to the insulator.

1 No. 4mm diameter galvanised steel Suspension Wire, similar to K&M Part No. 848 D 328/1, 500mm long as measured eye to eye, shall be attached to the eye nut at one end and to the Pull-off Arm, K&M Part No. 846 C 240 111, at the other. To form the suspension wire, a short loop is made at each end of the wire and machine crimped after making the connections to the components. To prevent slippage of the wire under load, each free end is bent back over the finished crimp.

At the free end of the pull-off arm, a trolley wire clamp, K&M Part No. 850 B 348 1, shall connect the trolley wire to the arm.

The assembly shall be adjusted to ensure the trolley wire seats horizontally without any twists, or kinks.

The Manufacturer's installation and adjustment instructions for the single pendulum equipment shall be followed.

3.5 Trolley Wire Support Beneath Bridges and within Depot Buildings

Where trolley wire is installed below a structure such as a bridge or within a depot building, provision shall be made to ensure that the current collector cannot bridge electrically the trolley wire and the structure. This is achieved by the installation of troughing made from insulating material. The troughing also protects the trolley pole current collector from sustaining impact damage should it disengage from the trolley wire.

The troughing needs to be attached to the bridge or building with some type of framework or brackets. It is desirable that the height of the supporting framework be as compact as possible so that the standard trolley wire heig of 5.64 metres can be maintained. The framework shall be designed to

- ensure that the troughing is solidly supported and its joints are level and straight
- prevent inadvertent earthing or flashover of resilient fitting mounts

There are circumstances where the bridge superstructure is more than 1 metre above the trolley wire and the trolley wire beneath is adequately supported. A road overpass with large girders spaced along the trolley wire direction is an example. In such cases, alternative protection shall be provided by the installation of durable sheeting (e.g. special plastic or marine ply) adequately affixed so that it maintains a lateral coverage of 1.2 metres on each side of the trolley wire. No earthed fastenings are to project below the inverted insulated surfaces of the insulators.

3.5.1 Troughing

The fibreglass troughing shall be manufactured in 3 m lengths from a sampl supplied.

In order to meet the design requirements the fibreglass troughing shall:

- be electrically insulating against a 600V d.c. nominal working voltage.
- be UV stabilised (gelcoat UV stabilised).
- not support combustion (fire retardant resin).
- have high resistance to impact.
- have good surface finish, especially the inside.

The fibreglass walls of the troughing shall have a minimum thickness of 6mm.

Two lengths of galvanised steel "Unistrut" channel shall be inserted at the back of the troughing to provide means of supporting it onto a structure above and join a number of lengths to form one continuous length. The "Unistruts" shall be 41mm by 21mm with a wall thickness of 2.5mm and shall run the full length of the troughing.

To protect the troughing side walls against impact, steel plate ribs 50mm wide by 3mm thick shall be formed to follow the profile of the side wall. The ribs shall be spaced at 500mm intervals and shall be welded to the "Unistrut". The steel ribs shall be embedded in the fibreglass in a manner that ensures there are no protrusions on the inside of the troughing whilst maintaining a minimum fibreglass cover of 4mm on each side of the steel plate. The plate shall extend horizontally 75mm from the "Unistrut" channel at the upper end of the wall of the troughing. To ensure proper keying between the fibreglass and the steel plates a number of 5mm holes shall be drilled on the plate.

The troughing installation shall be level and without sag.

Individual troughing lengths shall be joined together using 2 No. 40 x 12 steel flats x 185 long and 4 No. M12 hexagon headed bolts per flat.

The troughing shall protrude a minimum distance of 600mm beyond each side of the bridge.

3.5.2 Troughing Support

The ends of consecutive lengths of troughing shall be butted together and a pair of galvanised steel plates shall be used to splice the "Unistrut" channels of consecutive lengths of troughing. Each plate shall be attached to the "Unistrut" channel of each butted length of troughing by using two M10 screws and spring loaded "Unistrut" nuts.

Troughing should not have an unsupported span length of more than 1000mm. At intervals not exceeding 1.0m, the troughing shall be supported from the support frame structure above, by bolting to each of its encased "Unistrut" channels. In recent years, a method of achieving this was to use a 75SHS central steel spine with transverse flats welded to its upper and lower surfaces at intervals appropriate for fixing to the superstructure (upper) and for adequate troughing support (lower).

To support the troughing beneath bridges, a steel framework spine shall be designed for attachment to the underside of the bridge. The frame shall be galvanised and have attachment for troughing support at intervals of not more than 1.0 metres. This frame can be attached by any of the methods described below

i) <u>Steel bridge girders approximately perpendicular to the trolley wire</u>

Z" type brackets are to be fabricated. Essentially each bracket comprises a piece of 40 x 12 flat bent so that each end is horizontal and parallel and there is a short vertical step between. The height of the step is to be less than the thickness of the flange. The lower level has 2 No. 14mm. diameter holes drilled for M12 bolts. The brackets are erected with the underside of the upper level atop the beam flange so that when the bolts through the lower

level holes to the troughing are tightened, the troughing "Unistruts" will bear firmly beneath the underside of the flange.

ii) Steel Bridge Girders approximately parallel to the trolley wire

A suitable attachment detail for the "Z" type brackets shall be provided. This might consist of a series of steel flats or angles which are firmly clamped or fastened to the flanges of the girders.

Note: Welding is not permitted. No drilling of bridge members or any other modification is permitted without the written approval from the Manager, PTC Structural Engineering or from the owner of the bridge. **This instruction shall not be ignored.**

The troughing shall be attached to the angle flange or flat by using "Z" type (step) brackets or by bolting directly to these.

iii) Concrete Bridges

A suitable attachment detail shall be provided. This might consist of a steel flat which is sufficiently wide to straddle the troughing and which has another short length of flat welded to each end to " step" the plate. The lower dropped plate has 2 No. M14 holes drilled for M12 bolts into the "Unistruts" and the (upper level) end plates shall be drilled for attachment to the concrete bridge soffit. The height of the step must be such that the M12 bolt heads do not bear directly against the bridge soffit.

Note: Prior to any fabrication or field works, approval to attach to any part of the bridge must be obtained from the Manager, PTC Structural Engineering or from the owner of the bridge. **This instruction shall not be ignored.**

3.5.3 Elastic Support Arms (Resilient Fittings)

Under structures the trolley wire shall be supported by elastic support arms. The elastic support arms shall be attached to the underside of the troughing.

For the standard trolley wire height of 5.64 m, the spacing of the elastic support arm shall be 6m. Where the height of the trolley wire drops to below 5.64 m, the spacing of the elastic support arms shall be less than

6m to compensate for the increased upward force exerted by the current collector of the tram. If the track beneath is curved, the spacing of the elastic support arms shall be reduced to a spacing of not more than 2 metres.

The elastic support arm shall be attached to the troughing via the cranked plate supplied with it.

At the point of installation 2 No. 18mm diameter holes shall be drilled at 105mm centres through the upper wall along the longitudinal centreline of the troughing. A spreader plate is manufactured by drilling 2 No. 18mm diameter holes at 105mm centres for M16 bolts in a steel plate of dimensions 80 x 3 x 210. To prevent rotation the inserted bolts are welded to the plate which is then fibreglass coated for electrical insulation purposes. The bolts from the spreader plate are inserted through the holes in the troughing and through the cranked plate beneath the troughing and the entire assembly tightened by using the nuts and spring washers supplied.

The bolts used to secure the elastic support arms to the troughing shall be kept clear, by a minimum distance of 80mm, from any part that can electrically bridge the structure which supports the troughing. The holes shall also be clear from the steel troughing ribs by a minimum of 100mm.

The trolley wire clips supplied with the elastic support arm shall be fitted with the countersunk or counter-bored head bolts with Allen key drive. To accomodate trolley pole current collectors, the overall width of the clamp in the assembled condition, with 129 mm^2 trolley wire, shall not exceed 20mm.

Generally, the resilient fitting shall be installed with the main support arm pointing in the direction of tram travel. Each end fitting shall be installed such that the trolley wire support point projects beyond the end of the troughing. Thus, since the first resilient fitting encountered by an approaching tram is an end fitting, its orientation would be non-standard i.e. point opposite to the direction of tram travel.

3.6 Crossovers

To enable trams to move from one tram track to another a crossover system is used.
The three basic variations of crossovers are:

a) Left Hand Crossover
b) Right Hand Crossover
c) Scissor Crossover (Combination of Left and Right Hand)

Whilst it is usual to have 4 No. poles to support the crossover, a greater number may be required depending on the location and offset of the poles and the width of the track centres. Drawing No. O14-951.

3.7 Dual Running

The overhead crossover for dual running shall comprise two frogs joined by a piece of trolley wire running centrally over the curved track joining the two parallel tracks as per Drawing No. O14-951 which depicts a Left Hand Crossover.

To compensate for any cross over trolley wire sag and to maintain the two converging trolley wires and the frog at the same height both trolley wires shall be supported 2m from the point of convergence of these wires on the frog. This is to provide for smooth trolley pole and pantograph running. These supports shall be provided by forming a 'crossover support square' (which is really a rectangle) as shown in Drawing No. O14-951.

The frogs shall be installed as specified in the Section of this Specification dealing with frogs.

The frog shall be sized to suit the trolley wire and of the correct direction for the given crossover.

3.7.1 Pantograph Only

To accommodate pantograph transition at the point of converging tracks the converging trolley wires above them are crossed.

At the intersection point of the trolley wires a Contact Bar Type 1 Assembly to Drawing No. O14-572 shall be used.

The crossover trolley wire shall run centrally over the curved track within the limits of the pantograph pan running surface, the stagger limits being +/- 230 mm.

At the point of intersection the crossover trolley wire shall cross above the main wire.

The intersecting trolley wires shall be adjusted to ensure smooth pick up of incoming trolley wire by the pantograph.

About 1200mm from the point of intersection of the trolley wires forming the contact bar cross spans shall be provided. The trolley wire shall be supported from the cross span with feeder ears.

The straight and intersecting trolley wires shall be connected electrically utilising a jumper wire assembly as per the trolley wire equaliser at both intersections.

The crossing trolley wire shall extend past the reach of a pantograph pan and then it shall be terminated on adjacent poles utilising 11mm, 6X25(12/6+6/1) RHOL 1 WRC G2070 galvanised 'Tirfor' wire rope.

A preformed helical termination threaded through a GY2 insulator shall be attached to the end of the trolley wire.

The wire rope shall be attached to the pole as described below:

An anchor band to Drawing No. O923 shall be attached to the pole.

A 300mm long piece of 13mm galvanised steel chain shall connect the anchor band to a 200mm glass disc insulator to Drawing No. D3771.

A clevis thimble to Drawing No. D3121 shall be used to attach the wire rope to the disc insulator.

A GY2 strain insulator shall be incorporated at approximately 1.75m from the attachment point of the disc insulator.

The wire rope shall be terminated with galvanised steel preformed helical terminations using galvanised steel thimbles where necessary.

3.8 Turnouts

In some locations, such as at the terminus, the two tracks merge into one.

This is called a turn out and could be described as a single ended crossover.

The converging wire shall be broken into a series of short chords to closely follow the track curve, supported and located on a network.

3.8.1 Dual Running

At the intersecting point, the two wires shall be run in parallel. Where the turnout is not located at a terminus, a frog assembly shall be installed as per crossover detail.

3.8.2 Pantograph Only

At the intersecting point a contact bar Type 1 assembly shall be installed as per crossover detail.

The curved wire shall cross over the straight wire.

See Drawing No. O14-544 Detail B for a typical pantograph-only turnout.

3.9 Frogs

Above track points a frog shall be utilised to guide the trolley pole in the desired direction.

The frog shall be right or left hand to suit the application. The tips shall be sized to suit the size of the trolley wire being used.

3.9.1 Installation Requirements

The frog shall be adjusted to sit centrally between the rails using a mirror gauge and shall be levelled in both the longitudinal and transverse directions.

The frog shall also be adjusted to provide a smooth interface with the trolley wire.

The frog shall be located and supported at adjacent poles by additional wire rope restraints (frog legs).

To compensate for any cross over trolley wire sag and to maintain the two converging trolley wires and the frog at the same height, for smooth pantograph running, a span wire shall be installed across both wires at 2m from the point of convergence of these wires on the frog.

The frog shall be provided with guard bars, located between the legs of the frog, to ensure the trolley pole shoe does not become entangled in the frog.

Initially, the centre of the frog shall be located 4115mm beyond the toe of the points. This distance may have to be adjusted for each individual location to ensure correct trolley pole shoe tracking without loss of contact. (Toe of the points is the location where the single end of the point switch casting is welded to the rail). The position of the frog relative to the track switch is critical to the correct operation of the frog in service.

Where non standard track design turnout angles are present, the frog position will have to be determined by trial and error. This situation is undesirable for construction and for emergency maintenance requirements. It is recommended that non standard splays be avoided wherever possible.

The frog shall be attached to the trolley wire via a frog back as per Drawing No.O14-405. The frog back shall be attached to the trolley wire with 'U' bolts.

The converging wire shall be threaded through the frog back opening provided and a 400mm tail shall be left to allow adjustment of the frog location. This tail shall be bent upwards.

The frog shall be restrained and supported by 'frog legs' as shown on Drawing No.O14-304.

3.10 Crossing Pans

Where tracks intersect, crossing pans are required to facilitate crossing over of trolley wires.

The angle of the crossing pan shall correspond correctly to the angle of intersection of the tracks. The angles of crossing pan ranges from 15 degrees to 90 degrees, generally in 5 degree steps.

Crossing pans from 15 degrees to 35 degrees are the Yarra Trams standard crossing pan.

Crossings from 40 degrees to 89 degrees are manufactured to Fandstan Drawing No. FE3089-1-AE. (AE signifies the specified angle).

Crossing pans that are 90 degrees are to Fandstan Drawing No. FE3109-1.

3.10.1 General Installation Requirements for Crossing Pans

The intersecting wires cross above the crossing pan and shall be bent ('crowed') correctly to ensure the crossing pan does not distort during the installation process.

The crossing pan shall be adjusted to sit level in both the longitudinal and transverse directions.

The crossings shall be located centrally to the track crossings (using a mirror gauge).

The crossing shall be installed and adjusted to provide a smooth interface with the trolley wire and shall provide a smooth passage for pantographs without loss of contact. The crossing shall provide correct trolley pole tracking without loss of contact.

The crossing pans shall be supported via a dedicated support network located above the pans and connected to the pans via galvanised chains.

3.10.2 Installation for 15 Deg to 35 Deg Crossings

A 'U' bolt shall be used to hold the two trolley wires together at the point of intersection for registration. The crossing shall be placed below the intersecting trolley wires. The crossing pan shall be attached to the trolley wire by the clamping plate provided at each end of the crossing assembly. The downward force exerted by the clamping plate shall bring the trolley wire lower surface in line with the running surface of the crossing for smooth transition of trolley poles and pantographs.

For crossing pans from 15 degrees to 35 degrees, cross span wires shall not be attached directly to the crossing. The crossing shall be located between cross spans. To compensate for any cross over trolley wire sag and to maintain the two intersecting trolley wires and the crossing pan at the same height, for smooth pantograph running, a span wire shall be installed across both wires at 2 metres from the intersection point of the wires on the crossing pan.

3.10.3 Installation for 45 Deg to 90 Deg Crossings

Fandstan type crossings 45 degrees to 90 degrees shall be fitted with crossing backs. The crossing back shall be supplied with 3 links of chain which is connected to a bullring that sits horizontal. The crossing back is suspended centrally above the track crossings from 3-4 pull-offs (legs) spanning radially from the bull ring to support and locate the crossing back

from adjacent poles. A 'U' bolt shall be used to hold the crossing trolley wires and the crossing back together to provide trolley wire registration. The crossing shall be attached to the installed crossing back via 8 No. socket screws. The trolley wire jacking screws located at each end of the crossing back shall be used to bring the running surface of the trolley wire to the same level or slightly below the running surface of the crossing. This should be done to ensure smooth transition of trolley poles and pantographs from the trolley wire to the crossing and vice versa in all directions of travel.

The pull offs (legs) shall be made using 6mm galvanised wire rope. The pull off legs shall be attached to the pole, terminated and insulated in the manner described for the curve network. A GY1 insulator shall be inserted at a distance of 1500mm away from the bull ring used to support the crossing back and at appropriate positions wherever these legs pass across live conductors in more complex installations.

3.11 Trolley Wire

3.11.1 Installation Requirements

The trolley wire installed shall be straight, free of kinks, twists and other defects and the cross section profile shall not be deformed along the entire length of the wire.

3.11.2 Trolley Wire Specification

The trolley wire shall be cadmium copper wire and shall conform in all aspects with Specification No. 17/OH/04/96.

The profile of the trolley wire shall be as per Drawing No. O6887.

3.11.3 Trolley Wire Sizes

There are two standard trolley wire sizes utilised by Yarra Trams. They are 81 sq mm and 129 sq mm.

For each location, the size of the trolley wire to be used shall be specified by Yarra Trams. In general, 129 sq.mm. trolley wire is to be used as the standard.

3.11.4 Trolley Wire Termination

Copper Preformed Helical Terminations shall be utilised for the termination of trolley wire.

The termination shall be matched to the trolley wire correctly. Terminations to be used shall be as per table below:

PREFORMED HELICAL TERMINATIONS FOR TROLLEY WIRE

TROLLEY WIRE X-SECTION	TROLLEY WIRE O.D.	STRANDED EQUIVALENT CONDUCTOR	MANUFACTURER	PART NO.
129 sq.mm.	13.4mm	19/2.75mm. 13.75mm. dia.	FANNER PLP	CFG-138
			ALM DULMISON	CDE1375
81 sq.mm.	10.77mm	7/3.5mm. 10.5mm. dia.	FANNER PLP	CFG-105
			ALM DULMISON	CDE10000

The trolley wire shall be terminated to the designated pole(s) or structure(s) using 11mm, 6x25 (12/6+6/1) RHOL 1 WRC G2070 galvanised 'Tirfor' wire rope, as described below:

1) An anchor band to Drawing No. O923 shall be attached to the pole.

2) A 300mm long piece of 13mm proof coil regular link galvanised steel chain shall connect the anchor band to a 200mm glass disc insulator to Drawing No. D3771.

3) A clevis thimble to Drawing No. D3121 shall be used to attach the wire rope to the disc insulator.

4) In each leg anchoring the trolley wire a GY2 strain insulator shall be incorporated at approximately 1.75m from the attachment point to the disc insulator.

5) The preformed helical termination attached to the trolley wire shall be threaded through a GY2 insulator. The Tirfor wire of the anchoring leg shall be attached to the trolley wire via the GY2 insulator.

6) The wire rope shall be terminated with galvanised steel preformed helical terminations using galvanised thimbles where applicable.

Standard trolley wire termination arrangements are shown on Drawings No. O14-579 and O14-580.

3.12 Trolley Wire Splicing (Joining)

The trolley wire shall be run with the minimum number of joints.

To join two lengths of trolley wire the splice ears utilised shall be of a proven design, comply with Specification TMO/02/06/92 and shall be approved by Yarra Trams.

The transition from trolley wire to the splice shall be smooth in both directions.

The surface where pantographs and trolley poles run shall be smooth and flat.

The Fandstan or South Eastern Transit in-line 5 screw splice ear (or approved equivalent), sized correctly for the trolley wire being joined, shall be used.

3.13 Trolley Wire Current Equaliser

To bridge the up and down trolley wires, a trolley wire equaliser shall be installed every five poles / bays.

The jumper shall comprise a feeder ear attached to each trolley wire and connected via a length of 185sq.mm. double insulated flexible cable (specified in the Clause "Feeder tap to trolley wire cable") which is supported on an independent Parafil cross span located above the standard cross span. The arrangement is shown on Drawing No. O14-606.

The flexible cable shall be supported on the cross span by wrapping, in a spiral form, 1.5 sq mm, 7/0.50mm insulated copper building wire over the entire supported length.

Where there are section insulators supported on the span where the current equaliser is to be installed the cable of the current equaliser is electrically connected to the trolley wire by being attached to the section insulator main casting thus eliminating the need for a feeder ear.

3.14 Trolley Wire Anchoring for Sharp Radius Curves

Straight runs of trolley wire are tensioned to a higher tension than that for trolley wire on curves.

To compensate for this differential in tension, a trolley wire anchor shall be installed to transfer the tension imbalance to adjacent poles. For the lower tension of trolley wire applied in this instance the 6mm steel wire rope utilised for the cross spans should be used.

Each trolley wire anchor assembly shall consist of two separate legs anchored to poles on either side of the track. Typical legs assembly is shown on Drawing No. O14-599. The wire rope tension members shall be attached to the pole in the same manner as the standard cross spans via a standard pole band to Drawing No. O6897 and a shackle insulator assembly to Drawing No. O7364.

In each trolley wire anchor leg GY1 strain insulators shall be incorporated at approximately 1.5m from attachment points of the trolley wire anchor bar and the reel type insulator at the pole.

Additional insulators will be required where the anchor wire runs above other live conductors.

The wire rope shall be terminated with aluminium or copper swaged ferrules or galvanised steel preformed helical terminations, using galvanised steel thimbles where applicable.

The detensioner installation shall be provided with guard bars, located between the legs of the anchoring arrangement, to ensure the trolley pole shoe does not become entangled.

3.14.1 Trolley Wire Anchor Assembly (Hanger & Ear Suspension)

Each anchor assembly comprises a galvanised steel anchor bar to Drawing No. O7466, two standard 10" line ears, a hanger to Drawing No. O13-983, an 8mm alloy Dee shackle, quality grade S and a 12mm bull ring. The male line ears are attached to the anchor bar with 3/4" brass nuts each fitted with a spring washer. The hanger shall be attached to the ear closest to the bent end of the anchor bar via the 3/4" screw. The shackle shall be threaded through the bull ring and attached to the 7/16" diameter hole of the anchor bar. The legs (pull offs) transferring the tension to adjacent poles shall attach to the bull ring.

The assembly shall be located on a cross span. If this is not possible, as a less preferred alternative, the assembly shall be installed on a centre between cross spans (i.e. mid pole bay) with span anchors to locate it.

3.14.2 Trolley Wire Anchor Assembly (Pendulum/Pull Off Arm Suspension)

Trolley wire supported by pendulum is tensioned to a higher tension than that for trolley wire supported by fixed cross span system or by curved cantilever with ear and hanger system.

To compensate for this differential in tension, a dual running trolley wire tensioner shall be installed to transfer the tension imbalance to adjacent poles utilising 11mm, 6X25(12/6+6/1) RHOL 1 WRC G2070 galvanised 'Tirfor' wire rope.

Each tensioner assembly shall consist of two separate legs anchored to poles on either side of the roadway. Typical legs assembly is shown on Drawing O14-315. The angle between the trolley wire and any anchoring leg shall not exceed 45 degrees.

The wire rope tension members shall be attached to the pole as described below:

An anchor band to Drawing No. O923 shall be attached to the pole.

A piece of 13mm galvanised steel chain, 300mm long, shall connect the anchor band to a 200mm diameter glass disc insulator to Drawing No. D3771.

A clevis thimble to Drawing No. D3121 shall be used to attach the wire rope to the disc insulator.

In each trolley wire tensioner leg GY2 strain insulators shall be incorporated at approximately 1.5m from attachment points of the trolley wire tensioner and of the disc insulator. Additional insulators will be required where the anchor leg wire runs above other live conductors.

The wire rope shall be terminated with galvanised steel preformed helical terminations using galvanised steel thimbles where necessary.
The dual running trolley wire tensioner shall be manufactured to Fandstan Drawing No. FE 3084-3 or approved equivalent.

Trolley wire supported by standard hanger and ear suspension is tensioned to a lesser tension than for pendulum suspension and the anchorage detensioning system employed is to be in accordance with PTC Drawing No. O14 - 599.

3.15 Trolley Wire and Boom tube Anchoring (Pendulum/Pull Off Arm)

With pendulum installations the trolley wire and the boom tubes shall be anchored to adjacent poles at 400m intervals so as to minimise the adverse effects of possible trolley wire breaks. (See Drawing No. O14-546.)

3.15.1 Boom Tube Anchoring

At the point of anchoring, the boom tubes of two consecutive poles shall each be anchored to the adjacent poles thus preventing excessive movement of the tubes towards the space between the two consecutive poles.(Boom Anchor Leg).

A steel wire rope tie shall be strung between the boom tubes of the consecutive poles preventing excessive movement of the boom tubes away from each other thus forming an 'Anchoring Catenary'.

The Boom Anchor Legs and Anchoring Catenary shall be made from 11mm, 6X25(12/6+6/1) RHOL 1 WRC G2070 galvanised 'Tirfor' wire rope.

Insulators shall be inserted in line with the Tirfor wire as per Drawing O14-546.

The boom anchor legs shall be attached to the pole as described below:

An anchor band to Drawing No. O923 shall be attached to the pole.

A piece of 13mm galvanised steel chain, 300mm long, shall connect the anchor band to a 200mm glass disc insulator to Drawing D3771.

A clevis thimble to Drawing No. D3121 shall be used to attach the wire rope to the disc insulator.

In each boom anchor leg a GY2 strain insulator shall be incorporated at approximately 1.75m from the attachment point of the disc insulator.

The boom anchor legs and anchoring catenary shall be attached to the boom tube as described below:

Two boom connector brackets, to Drawing No. D4953, shall be attached back to back the boom tube.
A clevis thimble shall be attached to each boom connector bracket.

A GY2 insulator shall be incorporated in the Tirfor wire 1.75m from the boom connector bracket.

The wire rope shall be terminated with galvanised steel preformed helical terminations using galvanised steel thimbles where necessary.

At a distance of 1m on either side from the mid point of the anchoring catenary a GY2 insulator shall be inserted.

At a distance of 2m from the centre of the GY2 insulator a 16mm bull ring, to Drawing No. D3885 Reference D3885/2, shall be included in line with the wire rope. A Rebosio tension type insulator to Drawing No. D3677 shall be connected between the bull ring and the wire rope of the anchoring catenary.

Should an adjacent pole, to which boom tubes are anchored, have inadequate load capacity in the event of wire failure, the pole shall be stabilised by the provision of a back anchor to the next external adjacent pole.

3.15.2 Trolley Wire Anchoring

The trolley wire shall be anchored mid-bay below the Anchoring Catenary. An Arthur Flury splice Part No. 635.012.000 (or approved equivalent) shall be placed on top of the trolley wire mid-way between the consecutive poles where anchoring is to occur.

The short piece of trolley wire utilised to provide the reaction point of the splice shall be replaced with a piece of trolley wire 2m long.

The splice shall be located centrally on the 2m trolley wire length.

A preformed helical termination which has been threaded through a GY2 strain type insulator shall be attached on each end of the 2m trolley wire length.

The 2m trolley wire length shall be bent upwards to enable it to be suspended from the bull ring incorporated in the Anchoring Catenary above via 11mm Tirfor wire.

3.16 Bull Rings

Galvanised steel bull rings shall be utilised where two or more wire rope members in tension (such as pull-offs, lacing or cross spans) act radially through a common point.

There are three sizes currently utilised and they shall be correctly chosen for each application with consideration given to the number of fittings and the magnitude of forces acting at the point where the bull ring is used. With reference to Drawing No. D3883, the following applications are common.

D3885/1 12.7mm thickness, would be used for lacing.
D3885/2 15.9mm thickness, would be used for holding 2 to 3 legs.
D3885/3 12.7mm (heavy duty) thickness, would be used for network spine applications.

Bull rings shall be manufactured in accordance with Drawing No. D3885.

3.17 Curves and Junctions – Fixed System

Span networks shall be erected to provide support and restraint for the tro. wire and all the associated components required to make up the curve or junction.

3.17.1 Span Network

Drawing No.O14-315 shows a typical curve network arrangement. The drawing pertaining to each individual curve and/or crossing shall be consulted to work out the requirements for the specific curve.

All networks including the 'pull-offs' (legs) and the 'lacing' shall be constructed using 6mm steel wire rope to Specification No. TMO/04/07/92.

Insulators, GY1 type, to Specification No. TMO/03/07/92 shall be used for centre, primary and secondary insulation.

The attachment structure or pole shall be insulated from the cross spans by using a reel and shackle type insulator as per Drawing No. O7364. The reel insulator shall be attached to the pole or supporting structure in the same manner as for the straight cross spans.

More than one pull-off span can be attached to the reel insulator. This arrangement shall consist of a 16mm bullring attached to the insulator using 6mm steel wire rope The distance shall be 320mm from the centre of the insulator to the centre of the bull ring. For all pull offs, the distance shall be 1500mm from the centre of the reel insulator to the centre of the secondary insulators.

The number of pull off spans to be attached on each bull ring and reel insulator assembly shall be determined by the loads applied in each specific situation and shall not exceed three.

Spans extending straight across two poles shall be attached to the poles independently from other pull-off spans.

The primary insulators on the inner side of the curve shall follow the rail and they shall be offset towards the centre of the curve by a distance equal to the trolley wire offset which is specified in Table D.

A bull ring, with its centre at a distance of 300mm from the centre of the primary insulator shall be attached to the primary insulator using 6mm steel wire rope on both sides of the curve. The pull-offs and the lacing shall be attached to the bull ring. The primary insulators shall insulate the lacings and pull off spans from the trolley wire and the fittings supporting it.

All wire rope parts of the network shall be terminated using corrosion resistant aluminium alloy or copper swaged fittings or preformed helical terminations to Specification No.TMO/05/07/92.

Generally, the installation shall be machine crimped with machine crimped fittings. Hand crimping with hand crimp fittings shall only be used on single wire support spans which are not under excessive loading.

With the exception of wire rope sections of the network which are shorter than 700mm, at least one end of every wire rope section shall be fitted with a preformed helical termination to provide adjustment. The distance between centre spans on curves shall be in accordance with Table D.

3.17.2 Trolley Wire Suspension

The trolley wire shall be suspended in the manner described for the straight span with the following exceptions:

- The hanger horn shall always point toward the centre of the curve
- The line ear shall be installed with its main body facing toward the centre of the curve.

3.17.3 Trolley Wire Anchoring

A trolley wire anchor shall be installed on each trolley wire at either end of each curve to maintain the tension on the straight section at the approaches to the curve and limit the tension of the trolley wire within the curve. (See detailed description Clause 2.13).

The trolley wire within the curve shall therefore be "floating" and shall have limited tension. This tension must be adequate to ensure that the curve wire remains tight and does not distort whilst preventing excessive "lean" on the hanger ears. Slackness in the curves will not be accepted.

3.17.4 Curves and Crossings

All frogs and crossings used on curves and at junctions shall comply with the relevant clauses in this Specification.

3.17.5 Trolley Wire Offset

A mirror gauge shall be correctly utilised to set the trolley wire offset with respect to the centre line of the track. At the ears, the trolley wire shall be offset towards the centre of the curve in accordance with Table D.

Plumb bobs may be used for construction only where it can be demonstrated that no super-elevation exists on the track

3.18 Section Insulator Assembly

3.18.1 General

Section insulators shall be used to enable electric isolation of sections of the overhead system from adjoining sections.

The insulation runner for the section insulator shall be manufactured from Ertalon material.

The section insulator shall be supported from a standard steel cross span in a manner that enables the section insulator to 'float'.

Where installed adjacent to a bridge, the section insulators shall be of the shear pin type and shall be designed for the particular size of trolley wire in use.

3.18.2 Installation of the Standard PTC Section Insulator

The section insulator shall be supported using a standard steel cross span and an adjustable hanger as per Drawing No. O14-305 for pole to pole support.

The cross span shall be constructed as per the detailed construction of the steel cross span of this Specification with the line ear being replaced with the nominated section insulator.

The P.T.C. section insulators shall be selected as follows:

a) for 81 sq. mm. trolley wire to Drawing No. O12-332
b) for 129 sq. mm. trolley wire to Drawing No. O12-354
c) for 129 sq. mm. to 81 sq.mm. trolley wire Composite Section Insulator to Drawing No. O13-356

The section insulator shall be adjusted to provide a smooth passage to trolley pole and pantograph current collectors.

3.19 Aerial Switch (Isolator)

The aerial switch shall be utilised to enable:

- The bridging and isolation between underground feeder cables and overhead cables.
- The bridging and isolation between two sides of a section insulator.
- The bridging and isolation between two aerial feed cable termination points.
- A bypass feed around an Automatic Sectionalising Switch in case of failure of the Automatic Switch.

Various applications of the aerial switch are shown on Drawing No. O14-630.

The pole on which the aerial switch is mounted shall be bonded to the tracks as per Drawing No. E14-555.

3.19.1 Aerial Switch

The standard switch installed shall be a 1500 Ampere 1000V d.c. Panel Mounted Isolator (switch).

The Manufacturer's Part No. is Multicontact P552-A3-001.

3.19.2 Aerial Switch Operating Gear

The aerial switch operating gear shall comprise:

- An operating handle to Drawing No. O14-312, Items 4, 7 and 9. It shall include a length of 1/2" pipe to suit the height of mounting the switch box at each location.
- The locking band to Drawing No. O14-312 Item 6 (diam. to suit pole)
- The guide band to Drawing No. 014-312 Item 3 (diam. to suit pole)
- The fibreglass upper operating insulated rod to Drawing No. O14-312, Item 2 which shall be sealed with a suitable adhesive at the interface of the fibreglass tube to the steel tongue at the ends to prevent water ingress.
- A locking clamp to Drawing No. O14-312 Item 5.

Assembly of the above components and the aerial switch box onto the pole will be required.

The aerial switch is usually mounted at a height that is as near to the span or aerial component that the switch is servicing as possible. In most cases, the switch is mounted near a cross span attachment point. It is the responsibility of the linesman to assess the pole assets and determine whether it is acceptable to relocate some of these to another position on the pole so that the switch can be thus installed.

To ensure that the switching linkage system does not fail, all mechanical linkages must have split pins or other suitable devices installed.

3.19.3 Aerial Switch Box

The Aerial switch box comprises the backing plate and the front cover.

The backing plate shall incorporate a wooden 'V' block.

The switch assembly shall be attached to the backing plate of the switch box.

All the counter bored holes accommodating bolt heads or nuts shall be filled with electrical insulating material that will inhibit moisture ingress once the fasteners have been fully tightened.

The front cover shall be manufactured from fire retardant fibreglass and it shall incorporate a commercially available, corrosion resistant, adjustable type toggle latch.

The Switch box shall be mounted on the pole using two bands to Drawing No. O14-312 Item 1.

The switch shall include a visual indicator to identify the location of the blade within the box.

3.19.4 Existing Aerial Switch Boxes Containing Asbestos

Where the existing aerial isolator switch box contains asbestos within its interior provision shall be made to exclude the presence of such material. This is achieved by removal of the existing aerial isolator switch and replacing it with the installation of a new fibreglass aerial isolator.

With regard to the handling of asbestos, the Contractor is required to submit to Yarra Trams a procedure for approval. A typical procedure is attached.

3.20 Surge Diverter (Arrester)

3.20.1 Surge Diverter Characteristics

The diverter shall have the following characteristics:

Rated Voltage	1kV dc / 2kV dc	
Nominal Discharge Current	10kA	
Permissible Short Circuit	20kA/0.2s	
Pressure relief	Class 4	
Manufacturer's Part Number	Bowthorpe	HE60MC07

With 3 No. 13mm dia. mounting holes on 162 P.C.D. and fitted with a pig tail indicator lead.

3.20.2 Mounting and Connecting Details

The surge diverter shall be mounted above other tram assets.

The diverter shall be insulated to a level of 10kV from the pole or structure to which it is attached. The installation of the surge diverter on a wooden cross arm is shown on Drawing No. O14-312. The surge diverter mounting bracket, shown on Drawing No. O14-814A, accepts either the Bowthorpe or Siemens type.

The earth terminal of the diverter shall be connected to a rail bond by a continuous length of single core, annealed, stranded copper cable. The cable shall have a cross sectional area of 70 sq.mm. with no less than 19 strands. The level of insulation shall be 0.6/1 kV and the outer sheath shall be heavy duty, resistant to chemicals (petro-chemicals especially), shall not sustain combustion and shall be stabilised against Ultra-violet Radiation.

The cable shall comply with AS 3147 and its outer sheath shall be Black or Grey in colour.

One end of the cable is connected to the earth terminal of the surge diverter via a crimped type terminal lug having a stud hole to accept a 10mm screw.

The other end shall be connected by 'Cadweld' to the 91/2.14mm bare conductor of a standard track bond which has been welded to the rail (See Drawing No. E14-557). Where the cable emerges from the ground onto the pole it shall be enclosed in a 25mm. hot dip galvanised steel conduit for protection. The conduit shall be extended to a minimum height of 3m above the ground level. The conduit shall be attached to the pole by a 19mm stainless steel strap in at least three positions. The cable extending above the conduit shall also be supported on the pole using 19mm stainless steel strap at intervals not exceeding 2 metres. However, to prevent the stainless steel band cutting into the cable sheathing and insulation at the point of attachment, a rubber or PVC cover with a minimum thickness of 5mm shall be placed and secured between the band and the cable sheath. The cover shall extend for a minimum distance of 30mm from either edge of the band.

The positive terminal of the surge diverter shall be connected via a single core, annealed, tinned, finely stranded copper cable to whatever is being protected e.g. feeder cable, trolley wire, etc. The cable shall have a cross sectional area of 16sq.mm. and shall have no fewer than 224 strands.

The level of insulation shall be 1.8/3 kV and the outer sheath shall be heavy duty, resistant to chemicals (petro-chemicals especially), shall not sustain combustion and shall be stabilised against Ultra-violet Radiation. The cable shall comply with Standard IEC 502 and its outer sheath shall be Black or Grey in colour.

If the Bowthorpe diverter is utilised its disconnector device shall be used for the positive connection and will indicate, by tail lead blow off when there has been a lightning strike, the operation of the diverter. The diverter must be suitably mounted to ensure that this tail lead cannot come into contact with other metallic components or conductors.

The manufacturer's installation instructions shall also be consulted for the arrester being used.

The pole on which surge diverters are mounted shall be bonded to the track as per Drawing No. E14-557.

3.21 Section Insulator Bridging via an Aerial Switch

To enable power feed from the adjacent electrical section, in case of power supply loss, quick electrical bridging across section insulators is provided via an aerial switch in certain locations. The aerial switch shall be installed onto one of the poles supporting the section insulator. Flexible, 185 sq.mm. feeder tap to trolley wire cable shall be used to make the necessary connections.

A cable shall connect one end of the switch to one side of the section insulator closest to the switch. A current equaliser shall connect this end of the section insulator closest to the aerial switch to the same end of the second section insulator.

Another cable shall connect the other end of the aerial switch to the other side of the section insulator closest to the aerial switch. Again, a current equaliser shall connect this end of the section insulator closest to the aerial switch to the same end of the second section insulator.

All the flexible cables shall be supported along their entire length onto a 2-tonne Parafil cross span located above the standard cross span in the same manner as the feeder tap to trolley wire. The flexible cable shall be supported from the Parafil by wrapping, in a spiral form, 1.5 sq.mm., 7/0.50mm insulated copper building wire over the entire supported length. To prevent unravelling in the event of cable end strand failure, lock ties shall be installed at 1m intervals.

The flexible cables shall be kept clear from the pole or conductive fittings attached to the pole.

3.22 Aerial Feeder Cables

3.22.1 Aerial Power Feeder Conductors (Cables)

Aerial Power Feeder Cables shall be 400 sq.mm., 91/2.36mm, hard drawn, bare, concentric, copper conductor.

The feeder shall be supported on SLP/11/180 pin type porcelain insulators, to A.S. 2947 .1-.3, fitted to wooden cross - arms. The feeder cable shall be held onto the insulator by a cable tie made from a 3.15mm solid, annealed copper wire.

The pins used to attach the insulators to the cross arm shall be to AS 1154.2.

The wooden cross arms shall be manufactured to:

Drawing No. 014-427 for one or two feeder arrangement.

Drawing No. 014-428 for three or four feeder arrangement.

The cross arm shall be attached to the pole using a 'U' Band to Drawing No. O9563 and steadied by two cross arm braces manufactured to:

- Drawing No. O13-195 for the two feeder cross arm.
- Drawing No. O13-196 for the four feeder cross arm.
- The braces shall be attached to the pole, below the cross arm by a pole band fitted with a 1/2" B.S.W. stud to Drawing No. O13-490.

3.22.2 Aerial Power Feeder Conductor Termination

The feeder conductor shall be terminated using copper preformed helical terminations.

A clevis thimble shall be inserted through the loop of the termination fitting. The clevis thimble shall be attached to two 200mm glass disc insulators to Drawing No. D3371.

A 300mm length of 13mm galvanised chain shall connect the insulators to the pole via:

- A 4 Feeder Cable Anchor Cross Arm manufactured to Drawing No. D4938 where 3 or 4 conductors are to be terminated. The cross arm shall be assembled as per Drawing No. Q4135.

or

- A 2 Feeder Cable Anchor Cross Arm manufactured to Drawing No. D4950 where 1 or 2 conductors are to be terminated. The cross arm shall be assembled in a similar way to Drawing No. Q4135.

or

- An Anchor Band to Drawing No. O923 where a single feeder conductor has to be terminated and it is practical to use this arrangement.

If the cables terminated on either side of the pole need to be electrically connected, a short length of 400 sq.mm., annealed copper, double insulated

cable shall be used. At each end a 400 sq.mm. tinned copper crimp type lug which has a 20mm stud hole shall be fitted.

Also a 'tail' of each bare terminated conductor, protruding through the preformed helical termination, shall be fitted with the same lug.

The insulated cable shall sag under the cross arms to form a jumper between the cables being connected. A 3/4" galvanised steel bolt shall be used to connect the lugs.

3.22.3 Aerial Power Feeder Conductor Joining

A crimped type full tension copper sleeve shall be used to join feeder cables.

A specially designed crimped type full tension copper sleeve shall be used to join 400 sq.mm. concentric feeder cables to existing feeder cables that have a cross section / configuration other than 400 sq.mm. concentric i.e. 323 sq.mm. or 400 sq.mm. (equivalent) rope lay and 323 sq.mm. concentric.

The mechanical strength of the sleeves shall be in accordance with A.S. 1154.1.

The feeder cables shall be tensioned in accordance with Table B.

3.22.4 Feeder Taps

3.22.4.1 Feeder Tap to Trolley Wire General Specification

Feeder taps shall be utilised to connect 600V d.c. power feeder cables, to the trolley wire at predetermined locations.

The distance between successive feeder taps is dependent on the type and number of trams likely to be in the section at the same time, the location of tram stops and the pertaining terrain. This distance shall be specified for each location on systems design drawings.

However, the distance between feeder taps shall not exceed 500m.

Feeder tap points shall be located in line with a pole.

The tap to trolley wire cable shall be supported along its entire length onto a 2-tonne Parafil cross span located above the standard cross span as per Drawing No. 14-605. The flexible cable shall be supported from the parafil by wrapping, in a spiral form, 1.5 sq.mm., 7/0.50mm insulated copper building wire over the entire supported length.

The feeder tap to trolley wire cable shall be kept clear from the pole or conductive fittings attached to the pole.

A separate feeder tap shall be provided for each trolley wire. the feeder tap shall be 185mm² cross section.

3.22.4.2 Underground Feeder Cable Taps

Feeder taps connecting to an underground feeder cable shall be connected to the feeder using an electro-tinned crimp type terminal lug designed for 185 sq.mm. cable and provided with a 20mm. stud hole.

An aerial switch (isolator) shall be used to enable isolation of the feeder tap from the underground feeder and act as a terminal block for the feeder tap to trolley cable and the underground cables.

3.22.4.3 Feeder Tap Terminal (T Clamp) to Overhead Feeder Cable.

Feeder tap terminals shall be attached to the hard drawn bare aerial feeder conductor to provide termination for the feeder tap to trolley cable.

The terminal shall be attached close to the cross arm.

The tap terminal (clamp) shall be manufactured to Drawing No. O792 and sized correctly for the size of the feeder conductor to which it is attached.

Surfaces in contact with conductors or fittings that provide current path shall be tin plated.

3.22.4.4 Feeder Ears

Fanstan feeder ear Part Number 91211 or the South Eastern Transit feeder ear Part No. 12050 shall be used.

The feeder ear clamps onto the trolley wire.

The tap to trolley cable attaches to the feeder ear via a crimped lug at the connection tabs provided for this purpose.

Where the feeder tap to trolley wire is installed at a span supporting section insulators, the feeder tap cables shall be electrically connected to the trolley wire by being attached to the section insulator main casting.

3.22.4.5 Feeder Tap to Trolley Wire Cable

The feeder tap to trolley cable shall be a single core, annealed, finely stranded, copper, double insulated, highly flexible cable. It shall have a cross sectional area of 185 sq.mm. and shall have no fewer than 2500 strands.

The level of insulation shall be O.6/1 kV and the outer sheath shall be heavy duty, resistant to chemicals (petro-chemicals especially), shall not sustain combustion and shall be stabilised against Ultra-violet Radiation.

The cable shall comply with A.S. 3147 and its outer sheath shall be Black, Grey or Orange in colour.

3.22.5 Cross Arm Replacement

Where timber cross arms have been installed on poles for a period of time, they are subject to rot, splitting, cracking and the results of fair wear and tear. Consequently, some in-service timber cross arms will need to be replaced with new. The installation of a new cross arm on the pole shall be such that its position is appropriate to the surrounding assets. It is usual to place the new arm in a similar position to that of the arm which it is to replace except where unusual conditions exist.

3.23 Electrolysis Feeder Conductor Support

The aerial electrolysis feeder conductor shall be supported on SLP/11/180 pin type porcelain insulators, to AS 2947.1-3, fitted to wooden cross-arms. The feeder cable shall be held onto the insulator by a cable tie made from a 3.15mm solid, annealed copper wire. The pins used to attach the insulators to the cross arm shall be to AS 1154.2.

The wooden cross arms shall be manufactured to:

- Drawing No. 014-427 for one or two feeder arrangement.
- Drawing No. 014-428 for three or four feeder arrangement.

The cross arm shall be attached to the pole using a 'U' Band to Drawing O9653.

The cross arm shall be steadied by two cross arm braces manufactured to:

- Drawing No. O13-195 for the two feeder cross arm.
- Drawing No. O13-196 for the four feeder cross arm.

The braces shall be attached to the pole, below the cross arm by a pole band fitted with a 1/2" B.S.W. stud to Drawing No. O13-490.

3.24 Supervisory Cable – Aerial Support

3.24.1 Support of supervisory Cable on Pole

The supervisory cable shall be supported on poles utilising shackle porcelain insulators type SHLV8.

The insulator shall be attached to a 'Band-it' stainless steel sign mounting bracket by a 5/16" stainless steel set screw.

The set screw is inserted through the back of the bracket and screwed all the way onto the bracket. The insulator shall be secured onto the bracket using a stainless steel washer and nut.

The complete assembly is then attached to the pole using a 19mm stainless steel strap and buckle.

At the point of cable support the galvanised wire bearer (catenary), incorporated in the cable, shall be separated from the cable for a length of 150mm. Care shall be taken to ensure the cable or its insulation are not damaged.

The separated bearer wire shall be suspended over the insulator. The cable and the bearer wire shall be secured to the insulator by a cable tie made from 1.5 sq.mm. insulated building wire. The building wire shall hold the bearer wire and the cable together in a manner that prevents the bearer parting fr the cable further than the 150mm. described above.

3.24.2 Support of Supervisory Cable on Parafil Cross Span

In some situations it is necessary to run the supervisory cable remote from the pole line. The supervisory cable shall be supported on a two tonne Parafil cross span located above the standard steel cross span. The supervisory cable shall be located no less than 2 metres from the primary insulator and nearest the pole or wall support.

At the point of cable support, the galvanised wire bearer (catenary), incorporated in the cable, shall be separated from the cable for a length of 50mm. Care shall be taken to ensure the cable or its insulation are not damaged. A 'U' bolt to Drawing No. O13-983 shall be inserted between the separated bearer wire and the supervisory cable. The Parafil cross span shall be placed within the 'U' bolt, also. A 40x40x6mm galvanised plate, with 2No. 8mm diameter holes, centrally located at 20mm apart shall be used to clamp the bearer wire and Parafil wire rope together. The cable and the bearer w shall be secured to each other by a cable tie made from an 1.5 sq.mm. insulated building wire in a manner that prevents the bearer parting from the cable further than the 50mm described above.

The supervisory cable height shall be kept to a maximum, especially at road intersections, and shall be kept well clear of the possible deviations and deflections of a detached tram pole.

3.24.3 Underground Supervisory Cable Installation

The Supervisory cable shall be installed in 50mm conduits in the manner specified for the underground feeder cables. A higher level of care shall be exercised to prevent damage to the supervisory cable given that its lower mechanical strength and thinner insulation.

3.24.4 Supervisory Cable Protection on Pole

When the supervisory cable emerges from underground onto a pole it shall be enclosed in a 25mm hot dip galvanised steel conduit for protection. The conduit shall be extended up to the junction box. In at least two positions,

the conduit shall be attached to the pole by a 19mm stainless steel strap.

3.24.5 Supervisory Cable Connection

All connections of the supervisory cables shall be made in junction boxes attached to a pole at a height 3-4 metres above ground level. Joints shall not be made within the cable. The cable glands of the junction box shall be sized to suit the supervisory cable used.

The junction box shall be manufactured to Drawing No. E13-355.

On the poles adequate spare cable shall be left to enable connections at the predetermined locations. The cable ends shall be sealed against moisture ingress by a heat shrink type end cap.

The supervisory cable connections shall be effected by PTC staff.

At the substation, the supervisory cable shall be brought and secured onto the pole nearest to the substation or into the substation pit allowing adequate spare cable to enable connections inside each substation.

3.25 Testing and Reinstatement of Pole Bonds

HP For poles that carry sectionalising switches the pole bond cable shall not be disconnected unless the sectionalising switch is isolated and the permission of the Superintendent has been obtained.

To test the pole bond, the bond conductor shall be disconnected at the pole. The conductor resistance shall be measured between the pole terminal lug and the rail.

The test shall be conducted by a qualified electrical tradesperson or Technical Officer.

The equipment as well as the method utilised to perform the test shall be approved by the Superintendent.

The results of the bond testing shall be submitted in writing to the Superintendent.

The location, pole number, original cable resistance reading, final pole bond resistance reading after reinstatement shall be included in the test results.

Depending on the test results obtained, one of the following procedures shall be undertaken:

- **If the cable resistance exceeds 1 (one) Ohm then:**
  If the pole carries underground feeder cables, an aerial switch or a

sectionalising switch then a new 70 sq.mm double insulated conductor shall be run between the pole and the rail as per Drawing No. E14-555. On completion of the cable installation the resistance between the pole and the rail shall be retested and shall not exceed 1 Ohm.

- **If the cable resistance does not exceed 1 (one) Ohm then:**
  The cable bond connections shall be reinstated at the pole as per Drawing No. E14-555.

  On completion of the cable installation the resistance between the pole and the rail shall be retested and shall not exceed 1 Ohm.

- **Poles with Surge Diverter**
  If the pole carries a surge diverter, an additional 70 sq.mm. double insulated cable shall be run between the pole and the rail as per Drawing No. E14-557 to connect the surge diverter earth directly to the rail. The installation shall be carried out as described in the section dealing with surge diverters.

  On completion of the cable installation the resistance between the surge diverter earth cable and the rail shall be retested and shall not exceed 1 Ohm.

Any road opening permit and service proving that may be necessary for the installation of new pole bonds or Surge Diverter connections shall be obtained by the contractor. Any roadway or footpath excavated for new pole bond installation or Surge Diverter connection shall be reinstated to a standard that is acceptable to the local authorities and/or VicRoads as applicable.

All bond cables shall be installed to a minimum depth of 450mm and shall be protected by PVC protection shields or other suitable means.

All bonds must be inspected by Yarra Trams prior to reinstatement.

4. Acceptance, Inspection and Testing

A number of acceptance tests and inspections shall be arranged by the Contractor to be performed in the presence of the Superintendent or special groups delegated by him to observe the inspection and/or tests as outlined in this clause.

Any defects and/or non compliances shall be rectified by the Contractor at his expense.

The Contractor shall be present at all of these inspections/tests. All defects and/or non compliance with this Specification and/or the stated test standards shall be given to the Contractor in writing by the Superintendent to make correct at the Contractor's expense.

4.1 Static Inspection and Measuring

After installation, the following inspections shall be made by the Contractor in the presence of the Superintendent and the measurements specified herein shall be recorded.

The components of the system shall be checked to see if they have been installed in accordance with the Specification, drawings, written instructions and to the satisfaction of the Superintendent.

4.1.1 Cross Span and Other Trolley Wire Support Assemblies

The Cross Span and other trolley wire support assemblies shall be checked to confirm that they have been installed to the specified drawings and Specification.

The slope of the cross span shall be checked.

4.1.2 Trolley Wire Height, Sag, Stagger and Offset

The trolley wire parameters below, together with the temperature at the time of measurement, shall be checked by the Contractor in the presence of the Superintendent and the results shall be recorded to ensure conformance with the Specification. A copy of the results shall be given to the Superintendent.

The trolley wire height with respect to track shall be measured at each support point.

The trolley wire sag shall be measured at the middle of each trolley wire span.

The trolley wire stagger shall be measured with a mirror gauge at each cross span.

The trolley wire offset shall be measured with a mirror gauge at each support point.

4.1.3 Section Insulators, Frogs, Crossings and Splices

After installation section insulators, frogs, crossings and splices shall be adjusted so that

a) Their running surface under static conditions is at the same height above the running surface of the rails as the trolley wire at that point.

b) Their running surfaces are parallel to the track and there is a smooth transition from trolley wire to fitting.

c) They will allow trolley poles and pantographs to traverse these fittings without impact.

The Superintendent shall be the judge of acceptable performance in this regard.

Tests will be performed utilising trams with pantographs exhibiting different levels of pantograph wear.

4.1.4 Electrical Clearances and Separations

The clearances and separations of the electrical conductors and fittings shall be checked.

The assembly shall be Megga tested with a minimum resistance of 1 meg-ohm per kilometre.

HP The new system shall not be energised or connected to the existing electrical system and a test tram shall not be run without written appro[illegible] from the Superintendent.

An "Approval to Place Electrical Equipment in Service" shall be submitted two days prior to placement in service.

4.2 Dynamic Testing – Test Tram

After completion of all works and before service trams can run on the new works, the following inspections and tests shall be carried out.

The Contractor shall make arrangements through the Superintendent for a test tram to be run through the section at normal operating speeds. The test shall be carried out when the ambient temperature is in the range 10 to 30 degrees Celsius.

4.2.1 Loss of Contact (Arcing)

Loss of contact shall not exceed 1%, otherwise the works shall be rejected (Measured at normal service speed).

4.2.2 Stagger, Offset and Height

Measurements recorded and or observed shall be in accordance with this Specification.

4.2.3 Carbon Pantograph Pan and Trolley Pole Operation

Carbon pantograph pans and trolley pole current collectors shall pass through the sections, both directions, without impact damage, pantograph blow off, or pole dewiring.

4.2.4 Section Insulators, Crossings, Frogs and Splices

All the above fittings as well as incoming wires shall be 'picked' up without undue impact as judged by the Superintendent.

4.3 Electrical Testing

The Superintendent may order electrical testing of a section by the Electrical Testing Section of Yarra Trams.

HP Permanent power shall not be restored to the trolley wire until consent to proceed is obtained from the Superintendent.

Permanent power shall not be restored to the trolley wire until all tests as specified above has been completed and approved by the Superintendent.

Table A - Standard PTC Poles for Overhead Support

Description	Specification	Section		PTC Drawing No.
		Upper	Lower	
Span Pole (6.5 kN/11m)	11/OH/04/92	219.1x8.2CHS x5m	273.1x9.3CHS x6m	014-349
Anchor Pole (12 kN/11m)	12/OH/04/92	273.1x9.3CHS x5m	323.9x9.5CHS x6m	014-350
Centrally Mounted Span & Lighting Pole (8 kN/14m)	13/OH/04/93	219.1x8.2CHS x6m	273.1x9.3CHS x8m	014-339
Anchor Pole with Dual Cantilever Capacity (17 kN/14m)	14/OH/04/93	273.1x9.3CHS x6m	323.9x12.7CHS x8m	014-346
Anchor Pole for Tensioned Small Radius Curves (22 kN/12m)	15/OH/04/93	273.1x9.3CHS x4m	323.9x12.7CHS x8m	014-375
Span Pole Base Mounted for Spread Footing (6.5 kN/9m)	16/OH/04/93	219.1x8.2CHS x5m	273.1x9.3CHS x4m	014-376

Note: The 11m poles are for standard span and anchoring applications.

Table B - Overhead Cables and Conductors

DESCRIPTION	NOM. CROSS - SECTIONAL AREA		CONDUCTOR MATERIAL	CONSTRUCTION No of strands/size		NOM O.D.	REMARKS
	sq.in..	q.mm.		IMPERIAL	METRIC	mm.	
Aerial Feeder Cable	0.6	400 Eqv	Hard Drawn Copper	91/.093"	91/2.36mm	25.96	Bare
Aerial Feeder Cable	0.5	300 Eqv	Hard Drawn Copper	61/0.103"	61/2.62mm	23.58	Bare
Aerial Electrolysis Cable	0.3	200 Eqv	Hard Drawn Copper	37/0.103"	37/2.62mm	18.3	Bare
Aerial Electrolysis Cable (New)	0.28	181	Hard Drawn Copper		37/2.5mm	17.5	Rail Overhead Catenary Conductor
Trolley Wire	0.126	81	Cadmium Copper	Solid	Solid	10.76	To Drg. 06887
Trolley Wire	0.2	129	Copper Tin Bearing	Solid	Solid	13.46	To Drg. 06887 & Spec10/Oh/01/91
Aerial Switch And Bolted Connection Cable	0.6	400 Eqv	Annealed Copper		61/2.85mm	35	Pvc/Red/Pvc Black 0.6/1kv Insul
Feeder Tap To Trolley Cable	0.3 Eqv	185	Annealed Copper		5510/0.2mm	31.6	Uv Resist. Rubber 0.6/1kv Double Insul. Grey Or Black
Pole Bond And Surge Diverter Earth Cable	0.1	70 Eqv	Annealed Copper		19/2.14mm	13.5	Pvc/Red/Pvc Black 0.6/1kv Insul
Underground Electrolysis Feeder		120	Annealed Copper		37/2.03mm	20.4	Pvc/Pvc 0.6/1kv
Electrolysis Potential Leads		2.5	Annealed Copper		71/0.067mm	10	2 Core Pvc/Pvc 0.6/1kv
Underground Screened Feeder Cable	0.6	400eqv	Annealed Copper		61/2.85mm	39	1 Core, Xlpe Insul 37 Wire Screen, Pvc Sheath
Supervisory Cable (Telephone Aerial Cable)		0.64	Annealed Copper	10 Pair (0.9mm)		15.5	Polyethylene Aluminium Foil Screened With Galv. Bearer Wire
				20 PAIR (0.9mm)		21.3	
				30 PAIR (0.9mm)		25.6	

Table C - Temperature - Sag - Tension

FOR TIN BEARING TROLLEY WIRE - 129mm5 10kN Max. TENSION

WIRE TEMPERATURE EC	15 m SPAN SAG mm	kN	20 m SPAN SAG mm	kN	25 m SPAN SAG mm	kN	30 m SPAN SAG mm	kN	35 m SPAN SAG mm	kN
0	32	10.0	56	10.0	88	10.0	127	10.0	172	10.0
5	36	8.7	64	8.8	100	8.8	143	8.9	193	8.9
10	42	7.5	75	7.6	115	7.7	163	7.8	218	7.9
15	51	6.3	88	6.4	133	6.6	186	6.8	246	7.0
20	62	5.1	104	5.4	154	5.7	212	6.0	277	6.2
25	76	4.2	124	4.6	179	4.9	242	5.3	310	5.6
30	94	3.4	147	3.8	206	4.3	273	4.7	345	5.0
35	113	2.8	171	3.3	234	3.8	304	4.2	380	4.5
40	133	2.4	195	2.9	262	3.4	336	3.8	416	4.2
45	153	2.1	219	2.6	290	3.0	367	3.5	450	3.8
50	171	1.9	241	2.3	417	2.8	397	3.2	484	3.6

Table D - Offset Of Trolley Wire And Centre Span Distance

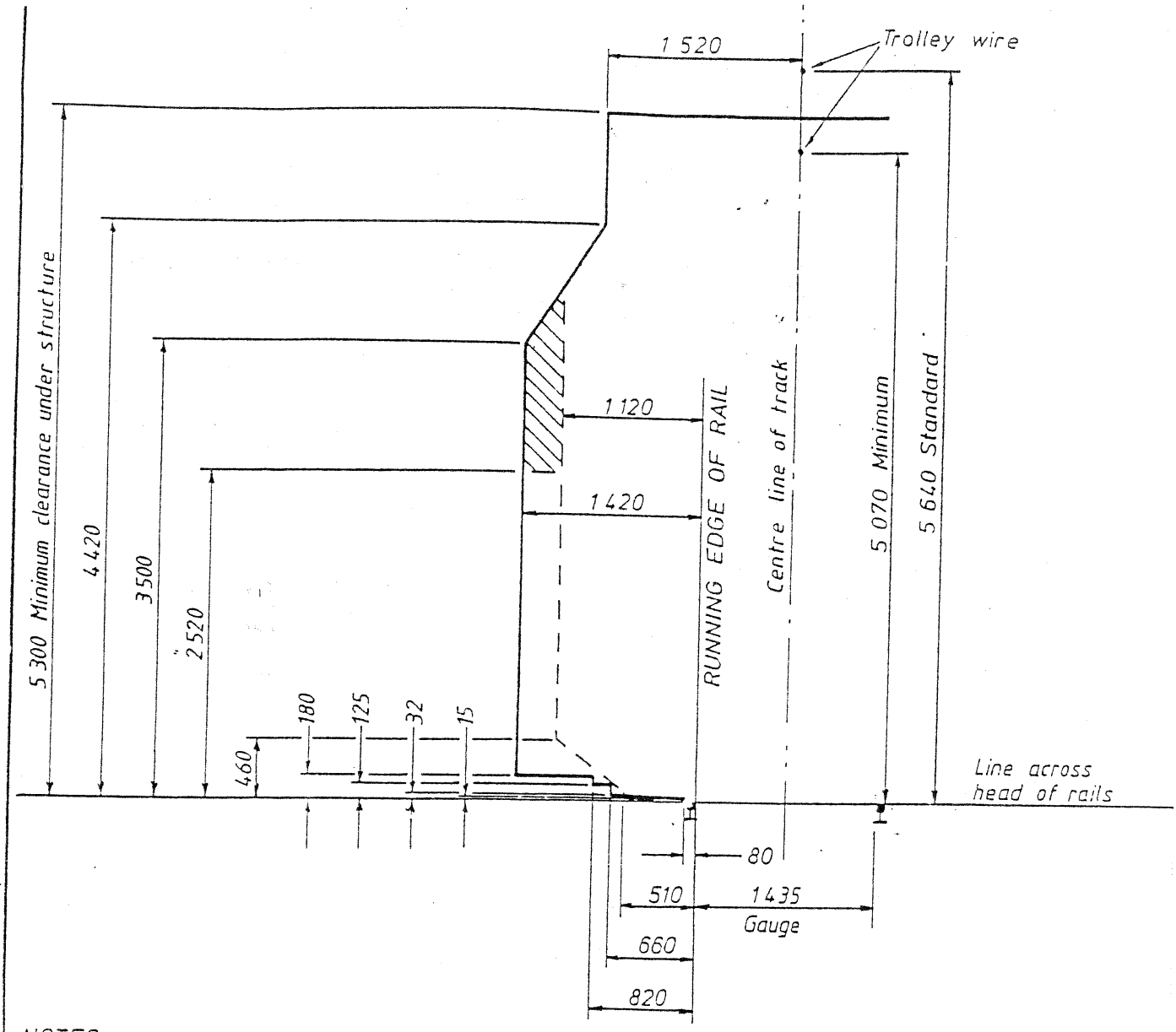
RADIUS OF CURVE		OFFSET OF TROLLEY WIRE		DISTANCE BETWEEN CENTRE SPANS	
ft	m	in	mm	ft	m
50	15	8	200	7	2.1
60	18	7.5	190	8	2.4
70	21	6.25	160	9	2.7
80	24	5	125	10	3.0
90	27	4.5	115	11	3.4
100	30	4	100	12	3.7
125	38	3	75	13	4.0
150	46	2.375	60	14	4.3
200-300	60-90	1.5-0.75	40-20	18	5.5
300-400	90-120	0.75-0.25	20-5	19	5.8
500	150	0	0	20	6.1
750	230	0	0	25	7.6
1000	305	0	0	33	10.2
1500-2000	460-610	0	0	50	15.5
OVER 2000	OVER 610	0	0	100	30.5

NOTE: i) Trolley wire Offset is towards the centre of curve.
ii) Equivalent conversions have been rationalised.

Table E - Overhead Work Standard Drawings

The following Drawings have been included with the Specification

TITLE	DRG NO.	REV
Clevis Thimble Details	D 3121	C
Insulator Polymeric, Tension (Rebosio Type)	D 3677	
Disc Insulator 200mm Diameter (Glass)	D 3771	
Bull Rings Component, Style Variable	D 3885	A
'U' - Bolts Components, Style Variable	D 3933	A
Parafil Rope Termination Fittings	D 4464	
Parafil Rope Component, Style Variable	D 4465	
2 Tonne Parafil Tie With Clevis Termination Fitting Assembly, Length Variable	D 4466	
Anchor Cross Arm For (4) Feeder Cables On Circular Poles Component, Non-Variable	D 4938	A
Anchor Cross Arm For (2) Feeder Cables On Circular Poles Component, Non-Variable	D 4950	
Pole To Track Bonding	E14-555	A
Feeder Tap Terminal Clamp To Pole	O 792	H
Anchoring Bands	O 923	B
Trolley Wire Cross Sections 129mm5/81mm5	O 6887	D
Pole Bands	O 6897	B
5" Reel Insulator & Shackle For Spans	O 7364	E
Double Anchor Bar	O 7466	A
"U" Band (For Cross Arm)	O 9653	C
0.126 Section Insulator For Use With Carbon Insert Collector Shoe - General Arrangement	O12-332	D
0.2 Section Insulator General Arrangement	O12-354	B
Cross Arm Brace – 2 Feeder Arm	O13-195	
Cross Arm Brace – 4 Feeder Arm	O13-196	
0.2 & 0.126 Combination Section Insulator For Carbon Insert Collector Shoe General Arrangement	O13-356	D
Pole Band, Cross Arm Brace	O13-490	
Limits For Decorations Tramway Poles & Span Wires	O13-625	B
Hanger (For Line Ear)	O13-983	E
Straight Cross Span Assembly In Steel From Wall To Pole	O14-293	
Overhead Wiring – Typical Anchoring - Layout Details For Cross Over	O14-304	B
Section Insulator Assembly Cross Span From Wall To Pole	O14-306	
General Arrangement Feeder Tap To Trolley	O14-309	
Aerial Switch Operating Mechanism & Surge Diverter Mounting	O14-312	
Surge Diverter Mounting Bracket	O14-314	A
Overhead Wiring Curve Network	O14-315	
Steel Span Pole 6.5kn/11m	O14-349	F
Steel Anchor Pole 12kn/11m	O14-350	F
Frog Erection Detail	O14-405	
Dual Running Trolley Wire Tensioner	O14-406	
2 Feeder Wooden Cross Arms	O14-427	B
4 Feeder Wooden Cross Arms	O14-428	B
Single Pendulum Trolley Wire Support Assembly, Style Variable	O14-500	
Kummler & Matter Single Pendulum Fittings	O14-532	A
Cross Contact Bar - Type 1 Assembly	O14-572	
Standard Single Trolley Wire Termination	O14-579	A
Standard Single Trolley Wire Termination V-Pull	O14-580	A
Standard Dual Trolley Wire Termination	O14-581	A
Trolley Wire Anchor - Low Tension	O14-599	A
Feeder Tap To Trolley Wire Cable Support On Independent Parafil Cross Span	O14-605	
Current Equaliser Cable Support On Independent Parafil Cross Span	O14-606	
2 Feeder Wooden Cross Arms For Turning Insulators	O14-673	A
4 Feeder Wooden Cross Arms For Turning Insulators	O14-674	A
Anchor Cross Arm 4 Feeder Cables For Use On Circular Poles Assembly, Style Variable	Q 4135	
Minimum Clearances To Structures For Tramways	P15556	



NOTES

1. The full line shows the minimum clearance required for any permanent construction. (Traffic signals, safety zones and separation bars excepted)
2. The hatched area shows the minimum clearance required for traffic signals.
3. The broken line shows the minimum clearance required for temporary construction subject to prior arrangement with the Authority and with special operating precautions.
4. The clearances are for straight track only and an additional lateral distance, varying up to 0·6m, is required on curves. This additional distance can be obtained from the Authority on request.

SCALE IN MILLIMETRES

HOR 0 500 1000 1500 2000

VER 0 500 1000 1500 2000

MINIMUM CLEARANCES TO STRUCTURES FOR TRAMWAYS

METROPOLITAN TRANSIT AUTHORITY OF VICTORIA

23·5·87 DATE	a. a. Nelson GROUP MANAGER - TRAM & BUS ENGINEERING		
DRAWN F.E. 11-8-86	CHECKED 4·3·87	PASSED	APPROVED K.C.P. 4·3·87
SCALE 1:50	P.15556		

Attachment 'A' - General Conditions Governing Attachments to the Corporation's Poles and Aerial Crossings of the Tramway Overhead Network

9. Where illuminated signs or notices are proposed, it is essential that applications for permission to install electrical installations definitely specify the pole or poles concerned. It is emphasised that, owing to possible corrosion hazards, permission for such installations may be withheld.

10. Any electrical installation shall comply with all relevant sections of the State Electricity Commission's wiring regulations and shall be carried out by a registered electrical contractor or a recognised electricity supply authority.

11. If metal sheathed cables are employed, the sheath shall be completely insulated from all steel poles.

12. All earthed metal parts of electrical installations attached to steel poles shall be completely insulated from the pole. The pole shall not be used as an earthing medium.

13. Where S.E.C. regulations demand that an electrical installation be earthed, an earth stake shall be buried at least 1830 mm (6 feet) from the base of steel poles and clear of the concrete base of wood poles.

C. HIGH VOLTAGE LINES.

14. The attachment of high voltage overhead lines to the Corporation's steel poles is not permitted.

15. High voltage overhead lines may be attached to the Corporation's wooden poles provided a minimum clearance of 1830 mm (6 feet) from any of the Corporation's overhead lines is maintained under all conditions.

16. All high voltage overhead lines crossing tram tracks shall have a minimum clearance of 8230 mm (27 feet) above the tram rails.

D. LOW VOLTAGE LINES.

17. All low voltage lines attached to the Corporation's poles shall be so placed that where possible a clearance of 1220 mm (4 feet) from any of the Corporation's overhead lines is maintained. The minimum permissible clearance under all conditions is 610 mm (2 feet).

18. All low voltage lines crossing tram tracks shall have a minimum clearance of 7010 mm (23 feet) above the tram rail.

19. All low voltage lines crossing tramway cables shall be insulated. Bare aerial crossings are not acceptable.

ATTACHMENT A

Form No. D.19

(Revised October, 1992)

PUBLIC TRANSPORT CORPORATION

GENERAL CONDITIONS GOVERNING ATTACHMENTS TO THE CORPORATION'S POLES AND AERIAL CROSSINGS OF THE TRAMWAY OVERHEAD NETWORK.

No attachment shall be made to any overhead equipment which is the property of the Corporation without prior approval (in writing) of the Corporation.

A. GENERAL.

The following general conditions shall apply to any proposed attachments to poles:-

1. The Authority for whom the attachment is made shall accept full responsibility for any accident caused by the existence of the attachment and shall indemnify the Corporation against all claims for damage resulting from the presence of the attachment.

2. The authority for whom the attachment is made shall maintain it in a condition acceptable to the Corporation.

3. Attachments shall be positioned that no obstruction is presented to the Corporation's stop sign, pole numbers, notices or overhead equipment.

4. Attachments shall be made by means of bands or brackets. Drilling of poles will not be permitted except as agreed for the fixing of extensions. All metal fittings shall be galvanised.

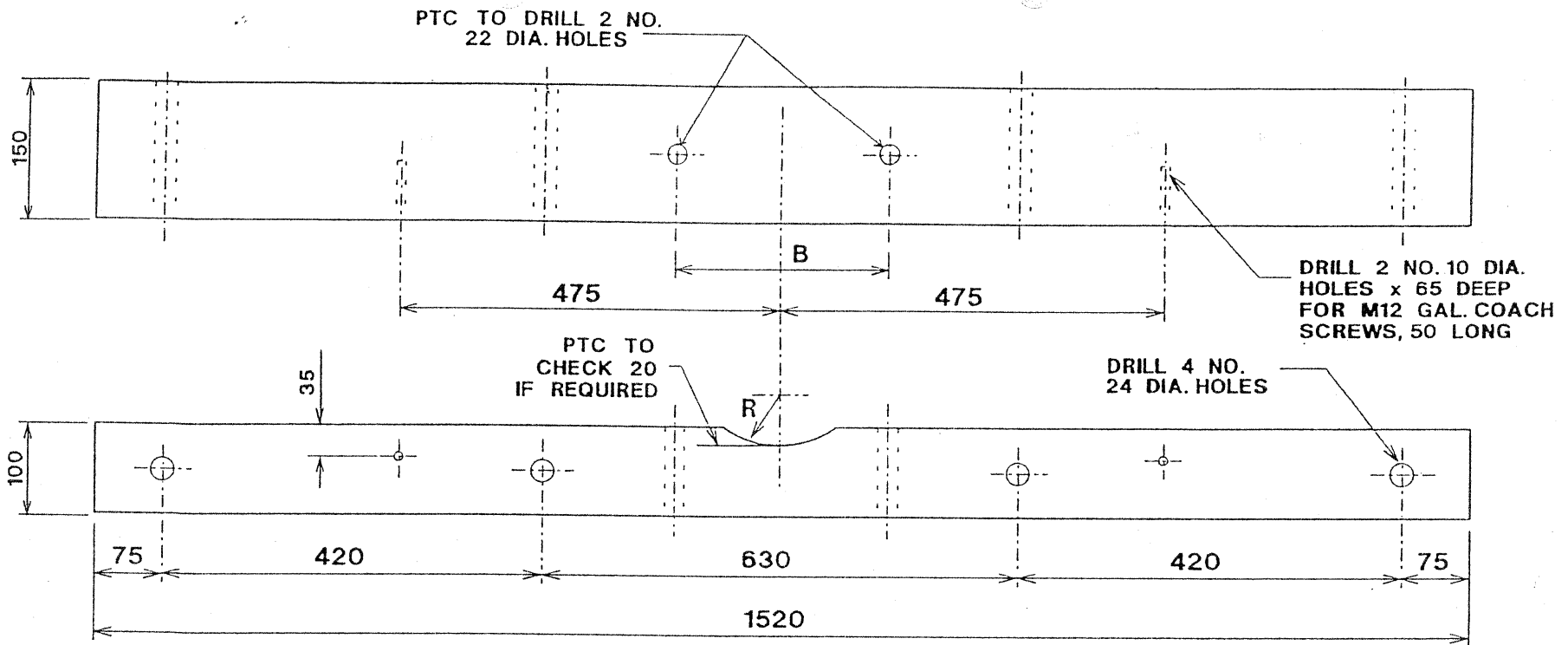
5. The Corporation reserves the right to demand the removal of any attachment to its poles and such removal shall be effected within 30 days of written request.

B. SIGNS AND NOTICES.

6. Direction signs, traffic signs and safety notices are the only types permissible.

7. All proposals shall have the prior approval of the relevant Municipal Authority.

8. The minimum mounting height shall be 3050 mm (10 feet) above a roadway or 2450 mm (8 feet) above a footway. The sign shall not project more than 457 mm (1 foot 6 inches) from the pole unless the bottom of the sign is at least 5500 mm (18 feet) above the roadway.



COMPONENT REFERENCE DRG. NO. O14-674	DIA. OF POLE		R		B	
	in	mm	in	mm	in	mm
O14-674/114	4 ½	114	2 ¼	60	5 ¼	135
O14-674/140	5 ½	140	2 ¾	70	6 ¼	160
O14-674/165	6 ½	165	3 ¼	85	7 ¼	185
O14-674/191	7 ½	191	3 ¾	95	8 ¼	210
O14-674/219	8 ⅝	219	4 ⅜	110	9 ⅜	240
O14-674/241	9 ½	241	4 ¾	120	10 ¼	260
O14-674/273	10 ¾	273	5 ⅜	140	11 ½	295

REFERENCE ITEM	DRG. NO.
2 feeder cross-arms. For Turning Insulators	O14-673
Brace	O13-195
U-Bolt	O9653

MATERIAL:

IRON BARK OR SPOTTED GUM
STRESS GRADE F22,
VISUAL GRADE SELECT
TO A.S. 1720.

AMENDMENTS				
REV	DATE	DESCRIPTION	DRAWN	APP'D

DESIGN ENGINEER

CHECKED

D. Nankivell
J D TINKLER
DRAWN

DESIGNED

PTC ENGINEERING SERVICES GROUP

4 FEEDER WOODEN CROSS-ARMS

FOR TURNING INSULATORS

MGR TRAK INFRASTRUCTURE DESIGN

SCALE HORIZONTAL
VERTICAL

DATUMS COORDINATES
LEVELS

INDEX No	COMPUTER No	DRAWING No
		O14-674A

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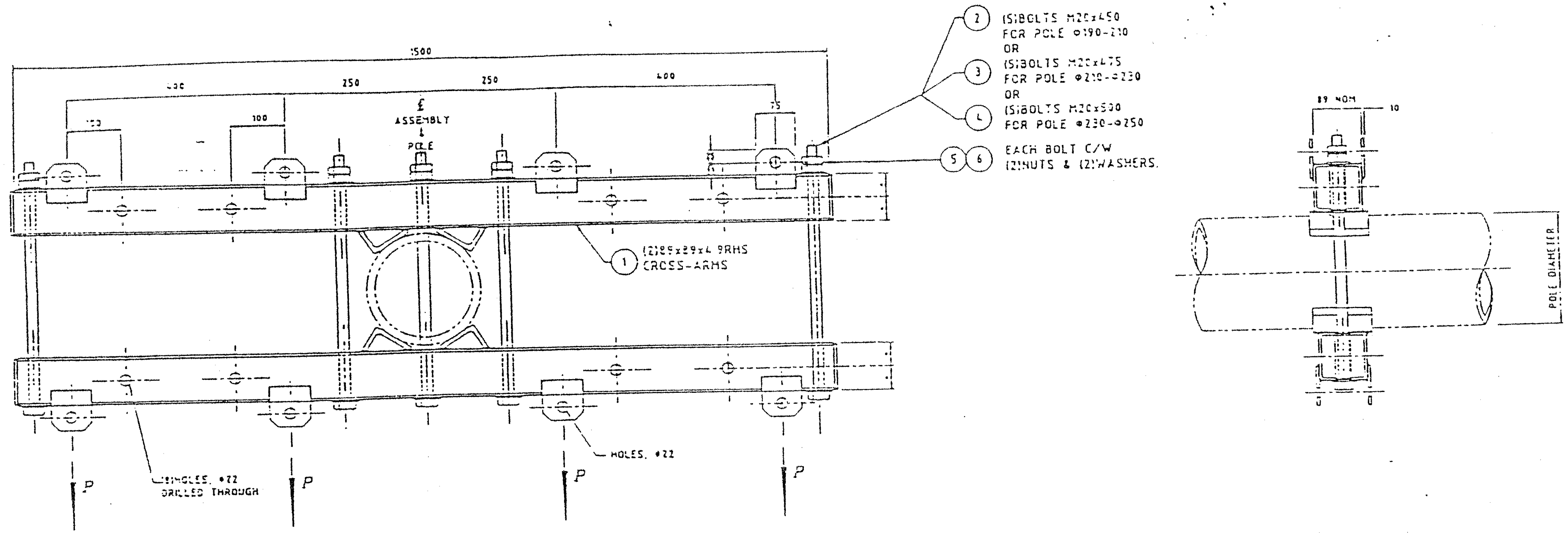


ASSEMBLY REFERENCE No.Q4135/"N"

ON ALL DATA SHEETS OR CROSS SECTIONS EACH ASSEMBLY TO THIS DRAWING SHALL BE DENOTED BY A SEPARATE REFERENCE.

A REFERENCE NUMBER IS OBTAINED FROM THE TABLE ON THIS DRAWING.

SETTING-UP NOTES

FLAT WASHERS SHALL BE INSERTED UNDER ALL BOLT HEADS AS SHOWN

KING BOLT AND ADJACENT BOLTS TO BE TIGHTENED FIRST. GAP BETWEEN RHS's SHALL BE THE SAME AT BOTH ENDS OF THE CROSS-ARMS

ON NO ACCOUNT ARE THE END BOLTS TO BE OVERTIGHTENED. GAP BETWEEN RHS's SHALL NOT BE DECREASED BY MORE THAN 5mm ON TIGHTENING.

NUTS SHALL BE TIGHTENED AGAINST EACH OTHER AFTER ASSEMBLY. BOLT THREAD AT NUT INTERFACE TO BE CENTRE PUNCHED OR PEENED OVER TO ENSURE NUTS CANNOT WORK LOOSE.

LOADING NOTES

MAXIMUM HORIZONTAL LOAD "P" ON EACH PAIR OF LUGS IS 8kN @ 20°C

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.

QUANTITIES Q4135/3 POLE Φ230-Φ250	QUANTITIES Q4135/2 POLE Φ210-Φ230	QUANTITIES Q4135/1 POLE Φ190-Φ210	REMARKS	MATERIAL REFERENCE	SUB/ASSEMBLY OR COMPONENT	DESCRIPTION	ITEM No.
10	10	10	GALVANIZED MILD STEEL	[illegible]	C	WASHER, FLAT ROUND TO SUIT M20	6
10	10	10	TO AS1111 & AS1214 COMMERCIAL GRADE	[illegible]	C	NUT,M20	5
5	-	-	TO AS1111 & AS1214 COMMERCIAL GRADE	[illegible]	C	BOLT,M20x500 LONG.	4
-	5	-	TO AS1111 & AS1214 COMMERCIAL GRADE	[illegible]	C	BOLT,M20x475 LONG	3
-	-	5	TO AS1111 & AS1214 COMMERCIAL GRADE	[illegible]	C	BOLT,M20x450 LONG.	2
2	2	2	FABRICATED 89x89x4.9 RHS MASS [illegible] kg	[illegible]	C	CROSS-ARM	1

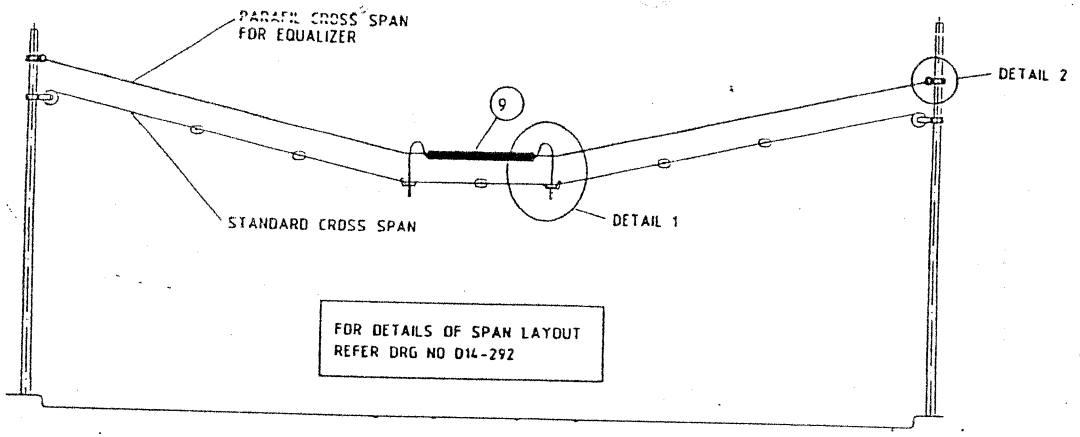
REV'N	DATE	DESCRIPTION	REV'D	CHK'D	[illegible]

DESIGNED TRW · DRAWN A. CALVANO · DESIGN CHECK · DRAFTING CHECK · COMPUTER CAD/3 · DRAFTING PASS · DESIGN PASS

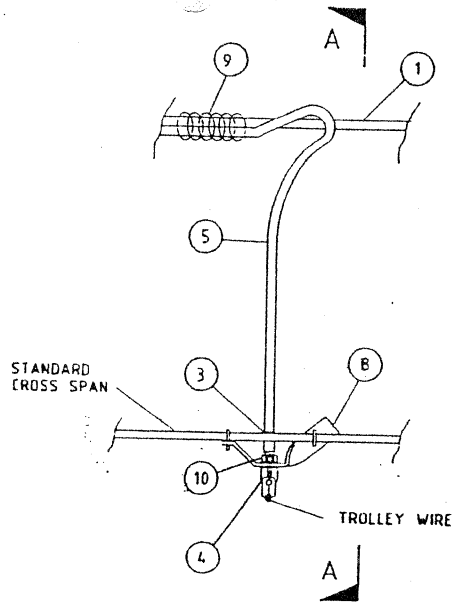
P.T.C.

ANCHOR CROSS-ARM
4-FEEDER CABLES.
FOR USE ON CIRCULAR POLES

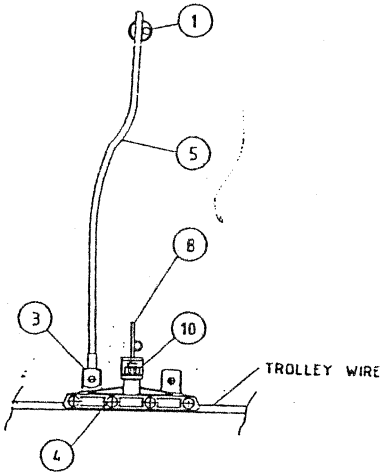
DATE MARCH/93
SCALE N.T.S.
BOOK TRAN. FITTINGS
A2 DRAWING No. Q4135 REV.



ELEVATION

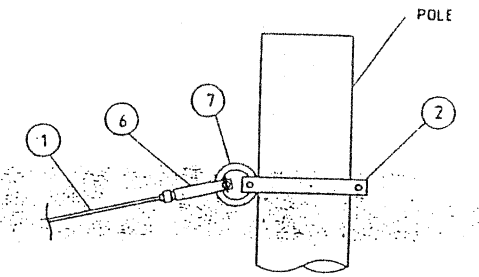


DETAIL 1



VIEW A - A

QUANTITIES	REMARKS	MATERIAL REFERENCE.	SUB/ASSEMBLY OR COMPONENT.	DESCRIPTION	ITEM No.
1		D4465/2	C	2 TONNE PARAFIL CROSS SPAN	1
2		06897/D	C	POLE BAND	2
2	STUD HOLE 12mm		C	LUG,COPPER, CRIMPED (TINNED) FOR 185 sq mm CABLE	3
2	FANOSTAN 91211 OR SOUTH EASTERN TRANSIT 12050		C	10" MALE FEEDER EAR ASSEMBLY -3/4"	4
1	DOUBLE INSULATED (SYNTHETIC RUBBER) COPPER CABLE			CABLE - EQUALIZER, 185 sq mm 5510/0.2mm, FLEXIBLE	5
2		D4466	C	PARAFIL TERMINATION FITTING	6
2		D3885/1	C	BULL RING- 63.5 INSIDE DIA	7
2	WITH 1/2" BSW "U" BOLT	D13-983	SA	HANGER	8
1	INSULATED COPPER BUILDING WIRE, GALVANIZED		C	TIE, CABLE TO PARAFIL, 15sq mm, 7/0.5mm	9
2	NUT TO SUIT MALE FEEDER EAR		C	3/4" BRASS NUT	10



DETAIL 2

AMENDMENTS				
REV	DATE	DESCRIPTION	DRAWN	APP'D

DESIGN ENGINEER

CHECKED

J.D.TINKLER
DRAWN

DESIGNED

PTC ENGINEERING SERVICES GROUP

CURRENT EQUALISER CABLE SUPPORT ON INDEPENDENT PARAFIL CROSS SPAN FROM POLE TO POLE

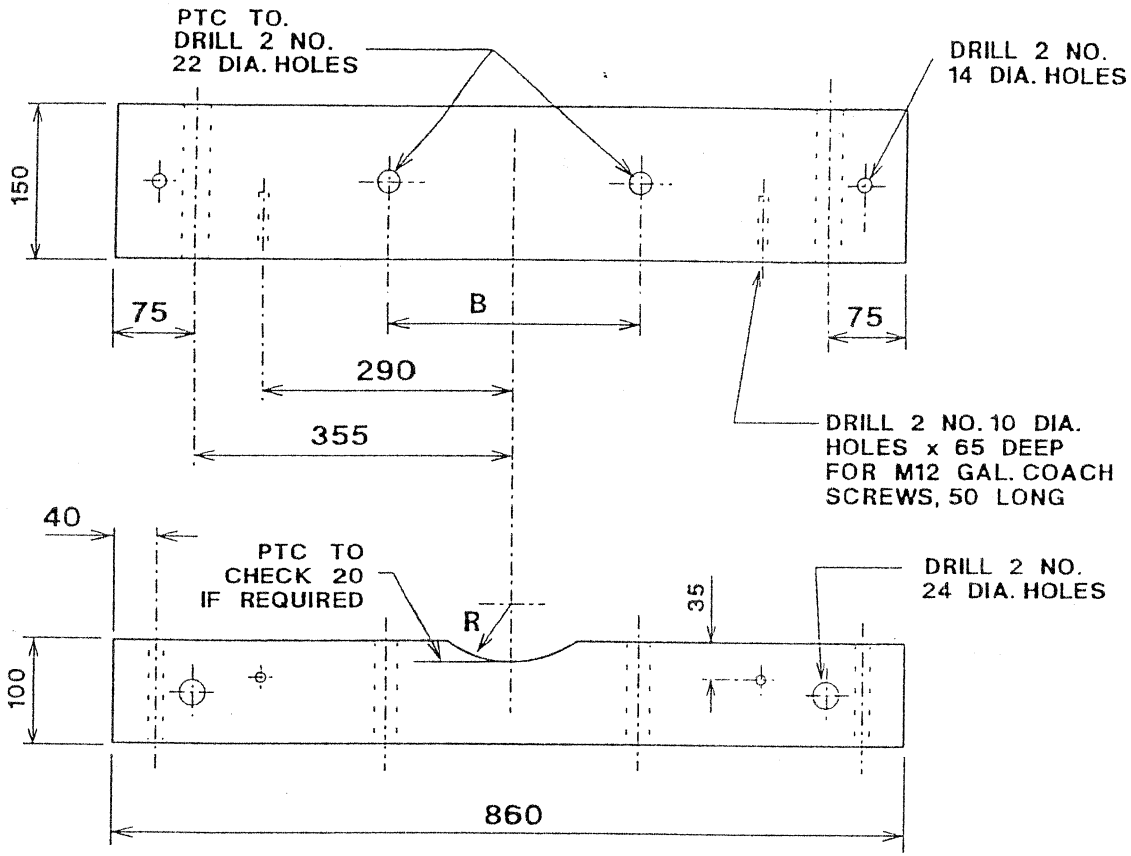
B. Held 17/11/94
MGR. TRAM INFRASTRUCTURE DESIGN

SCALE HORIZONTAL
VERTICAL

DATUMS COORDINATES
LEVELS

INDEX No	COMPUTER No	DRAWING No
		014-606

n: drawings/stand/ceesp.dgn Nov. 17, 1994 14:17:40



COMPONENT REFERENCE DRG. NO. O14-673	DIA. OF POLE		R		B	
	in	mm	in	mm	in	mm
O14-673/114	4 ½	114	2 ¼	60	5 ¼	135
O14-673/140	5 ½	140	2 ¾	70	6 ¼	160
O14-673/165	6 ½	165	3 ¼	85	7 ¼	185
O14-673/191	7 ½	191	3 ¾	95	8 ¼	210
O14-673/216	8 ½	216	4 ¼	110	9 ¼	235
O14-673/219	8 ⅝	219	4 5/16	110	9 ⅜	240
O14-673/241	9 ½	241	4 ¾	120	10 ¼	260
O14-673/244	9 ⅝	244	4 13/16	125	10 ⅜	265
O14-673/267	10 ½	267	5 ¼	135	11 ¼	290
O14-673/273	10 ¾	273	5 ⅜	140	11 ½	295
O14-673/292	11 ½	292	5 ¾	145	12 ¼	310

REFERENCE ITEM	DRG. NO.
4 feeder cross-arms. For Turning Insulators	O14-674
Brace	O13-195
U-Bolt	09653

MATERIAL:

IRON BARK OR SPOTTED GUM
STRESS GRADE F22,
VISUAL GRADE SELECT
TO A.S. 1720.

AMENDMENTS

REV	DATE	DESCRIPTION	DRAWN	APP'D
A	24/5/97	LENGTH INCREASE FOR FEEDER CLEARANCE	A R D	

DESIGN ENGINEER

CHECKED
D. Nankervis
J D TINKLER
DRAWN

PTC ENGINEERING SERVICES GROUP

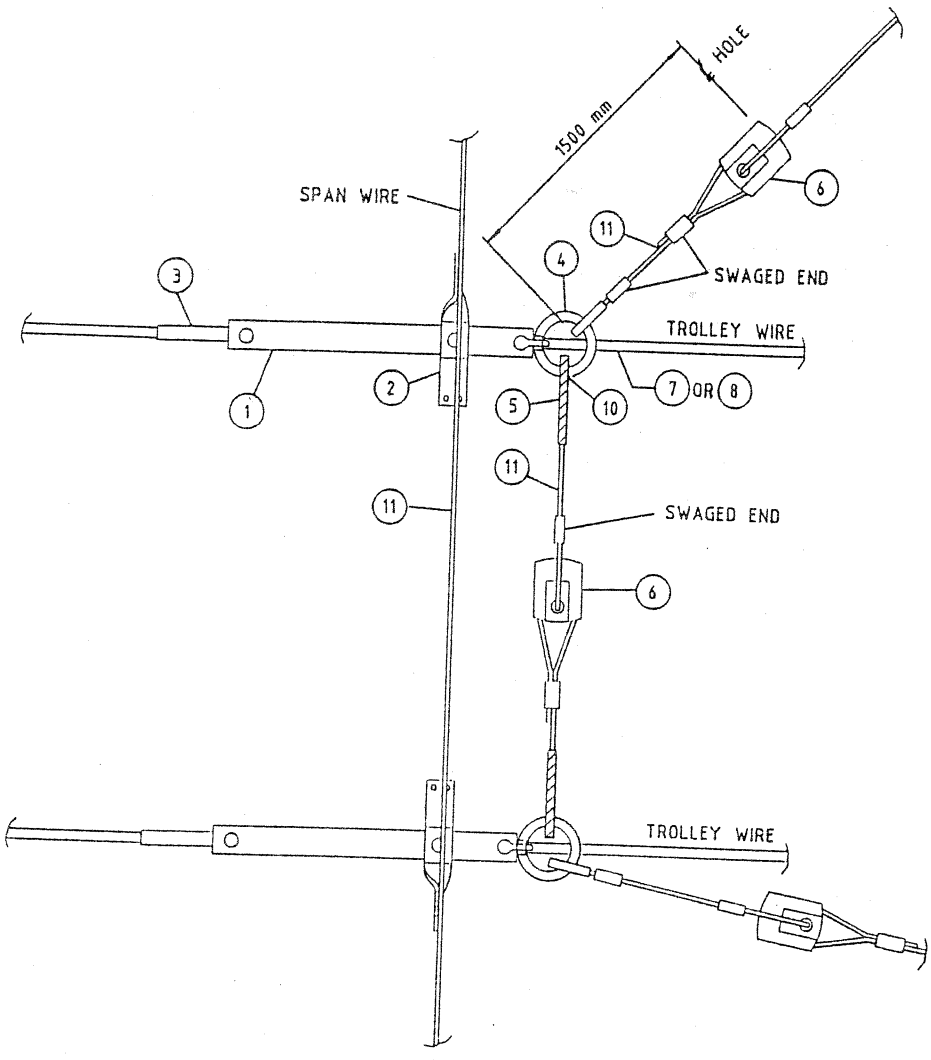
2 FEEDER WOODEN CROSS-ARMS
FOR TURNING INSULATORS

MGR TRAM INFRASTRUCTURE DESIGN

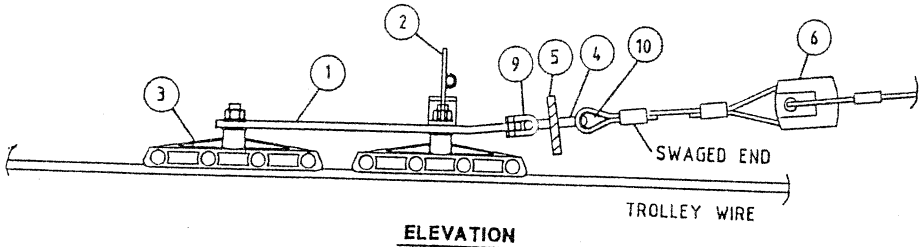
SCALE HORIZONTAL
VERTICAL

DATUMS COORDINATES
LEVELS

INDEX No | COMPUTER No | DRAWING No O14-673A



PLAN



ELEVATION

QUANTITIES	REMARKS	MATERIAL REFERENCE	SUB/ASSEMBLY OR COMPONENT	DESCRIPTION	ITEM NO.
2	GALVANIZED	07466	C	DOUBLE ANCHOR BAR	1
2	WITH 0.25" BSW 'U' BOLT	013-983	SA	HANGER	2
4	SOUTH EASTERN TRANSIT PART NO. 12000 OR FANSTAN P/ NO. 91231	—	SA	LINE EAR- MALE	3
2	COMPONENT, STYLE VARIABLE	D3885/1	C	BULL RING	4
2	TERMINATION DEAD END (GALVANIZED STEEL)	D3214/25	C	PREFORMED HELICAL TERMINATION	5
3	STRAIN INSULATOR GY1 (PORCELAIN)	—	C	INSULATOR GY1	6
—	129 sq mm	06887	C	TROLLEY WIRE	7
—	81 sq mm	06887	C	TROLLEY WIRE	8
2	AS 2741 TYPE PIN & NOM.		C	DEE SHACKLE	9
4	GALVANIZED STEEL	D2868	C	THIMBLE	10
—	SPEC. TMO/04/07/92 VARIABLE	—	—	STEEL WIRE ROPE 6mm	11

APPLICATION: TENSION REDUCTION ON CURVES.

ORIGINAL SIGNED BY B. HELD 7/11/94
MGR. TRAM INFRASTRUCTURE DESIGN

SCALE HORIZONTAL N.T.S.
VERTICAL

DATUMS COORDINATES
LEVELS

INDEX No. COMPUTER No. DRAWING No. 014-5994

PTC ENGINEERING SERVICES GROUP

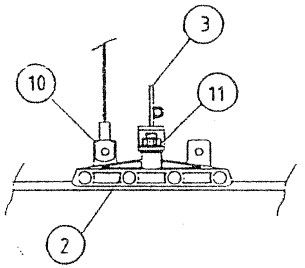
TROLLEY WIRE ANCHOR (LOW TENSION) HANGER & EAR ONLY

D.J. JOWETT DESIGN ENGINEER
D.J. JOWETT CHECKED
J.D. TINKLER DRAWN
DESIGNED

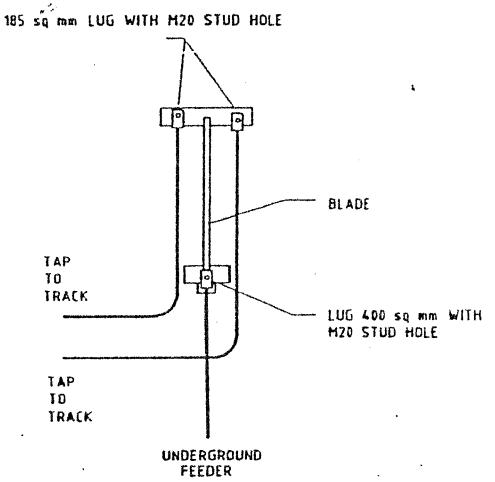
AMENDMENTS

REV	DATE	DESCRIPTION	DRAWN	APP'D
A	2/10/95	LINE EAR NO INCREASED, TITLE AMENDED TO HANGER & EAR	J. TINKLER	

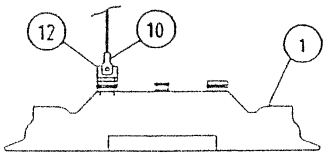
/drawings/stand/drwg.dgn Oct 7 1996 16:25:04



DETAIL 1



SWITCH DETAIL



DETAIL 2

FEEDER EAR TAP TO TROLLEY - 014-605/1

SECTION INSULATOR TAP TO TROLLEY - 014-605/2

ASSEMBLY REFERENCE 014-605/1	ASSEMBLY REFERENCE 014-605/2	REMARKS	MATERIAL REFERENCE	SUB/ASSEMBLY OR COMPONENT	DESCRIPTION	ITEM No
—	2	REFER DRGS NO. 012-332 OR 012-354 OR 013-356		C	SECTION INSULATOR	1
2	—	FANDSTAN 91211 OR SOUTH EASTERN TRANSIT 12050		C	10" MALE FEEDER EAR ASSEMBLY -3/4"	2
2	2	WITH 3/4" BSW "U" BOLTS	013-983	SA	HANGER	3
1	1		D4466	C	PARAFIL TERMINATION FITTING	4
1	1		D3885/1	C	BULL RING- 63.5 INSIDE DIA.	5
2	2		D6897/D	C	POLE BAND	6
2	2	INSULATED COPPER BUILDING WIRE, GALVANIZED		C	TIE, CABLE TO PARAFIL, 1.5sq mm, 7/0.5mm	7
1	1		D4465/2	C	2 TONNE PARAFIL CROSS SPAN	8
2	2	185 sq mm CABLE 0.6/1kV DOUBLE INSULATED (GREY OR BLACK) TAP TO TROLLEY			INSULATED CABLE	9
2	2	STUD HOLE 12mm		C	LUG,COPPER, CRIMPED (TINNED) FOR 185 sq mm CABLE	10
2		NUT TO SUIT MALE FEEDER EAR		C	3/4" BRASS NUT	11
—	2	ELECTRICAL CONNECTION	014-607	C	SECTION INSULATOR ADAPTOR	12

AMENDMENTS				
REV	DATE	DESCRIPTION	DRAWN	APP'D

DESIGN ENGINEER

CHECKED

J.D.TINKLER
DRAWN

PTC ENGINEERING SERVICES GROUP

FEEDER TAP TO TROLLEY FROM UNDERGROUND CABLE THROUGH AERIAL SWITCH

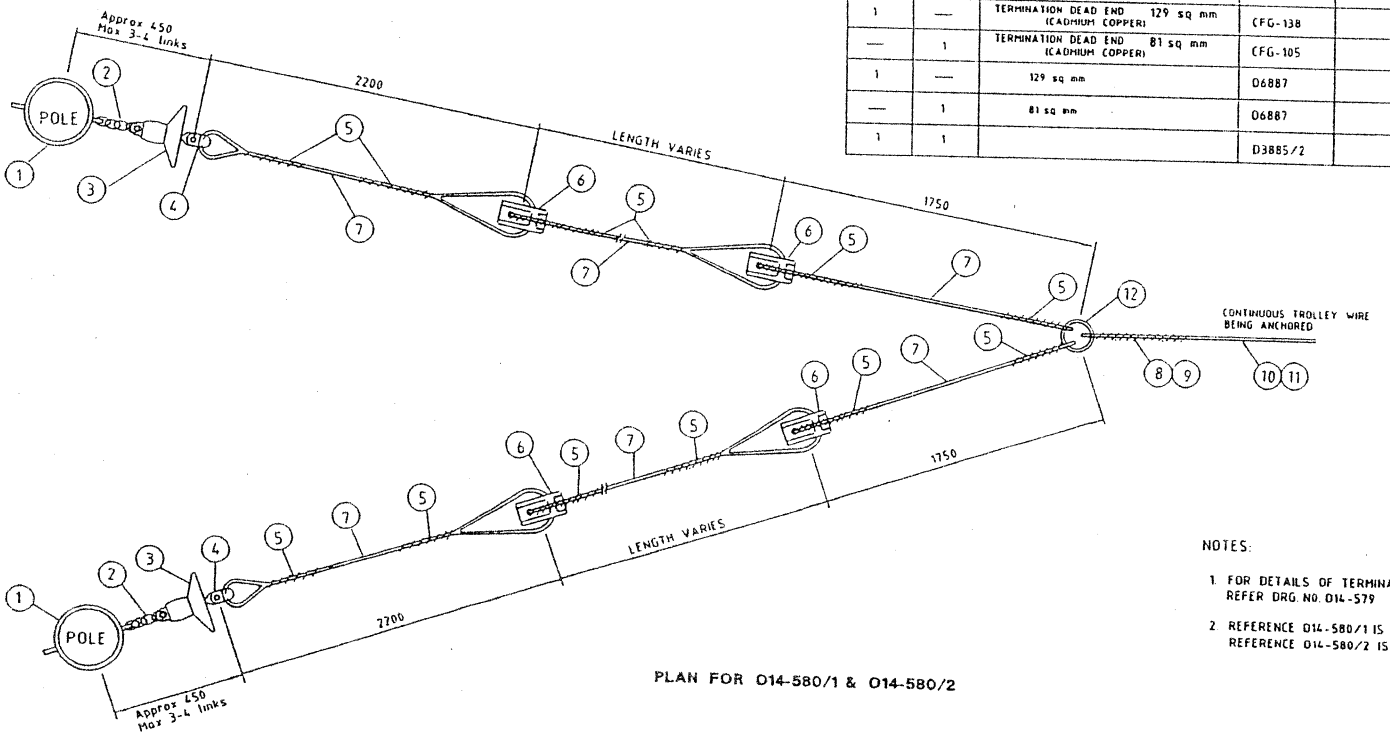
15/12/94
MGR. TRAM INFRASTRUCTURE DESIGN

SCALE HORIZONTAL
VERTICAL

DATUMS COORDINATES
LEVELS

INDEX No	COMPUTER No	DRAWING No
		014 60

ASSEMBLY REFERENCE						
014-580/1	014-580/2	REMARKS	MATERIAL REFERENCE	SUB/ASSEMBLY OR COMPONENT	DESCRIPTION	ITEM NO.
2	2		0923	S/A	ANCHOR BAND	1
2	2	13mm STEEL GALVANIZED 300mm LONG TENSILE	——	C	CHAIN, PROOF COIL, REGULAR LINK	2
2	2	INSULATOR GLASS 200mm	D3771	S/A	INSULATOR 8" DISC	3
2	2		D3121	C	CLEVIS THIMBLE	4
12	12	TERMINATION DEAD END (GALVANIZED STEEL)	D3214/25	C	PREFORMED HELICAL TERMINATION	5
4	4	STRAIN INSULATOR GY2 (PORCELAIN)	——	C	INSULATOR GY2	6
6	6	TIRFOR WIRE 11mm LENGTH VARIABLE	——	C	ANCHOR CATENARY WIRE	7
1	——	TERMINATION DEAD END 129 sq mm (CADMIUM COPPER)	CFG-138	C	PREFORMED HELICAL TERMINATION	8
——	1	TERMINATION DEAD END 81 sq mm (CADMIUM COPPER)	CFG-105	C	PREFORMED HELICAL TERMINATION	9
1	——	129 sq mm	D6887	C	TROLLEY WIRE	10
——	1	81 sq mm	D6887	C	TROLLEY WIRE	11
1	1		D3885/2	C	BULL RING	12



PLAN FOR O14-580/1 & O14-580/2

NOTES:

1. FOR DETAILS OF TERMINATION COLINEAR WITH TRACK CENTRELINE REFER DRG. NO. 014-579
2. REFERENCE 014-580/1 IS FOR 129 sq mm TROLLEY WIRE. REFERENCE 014-580/2 IS FOR 81 sq mm TROLLEY WIRE.

AMENDMENTS				
REV	DATE	DESCRIPTION	DRAWN	APP'D
A	10/12/97	Dimension from disc insulator to pole was 600	A.R.D	

DESIGN ENGINEER

CHECKED

J.D.TINKLER
DRAWN

DESIGNED

PTC ENGINEERING SERVICES GROUP

STANDARD SINGLE TROLLEY WIRE TERMINATION V-PULL

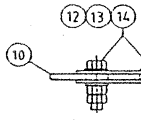
MGR. TRAM INFRASTRUCTURE DESIGN

SCALE HORIZONTAL
VERTICAL

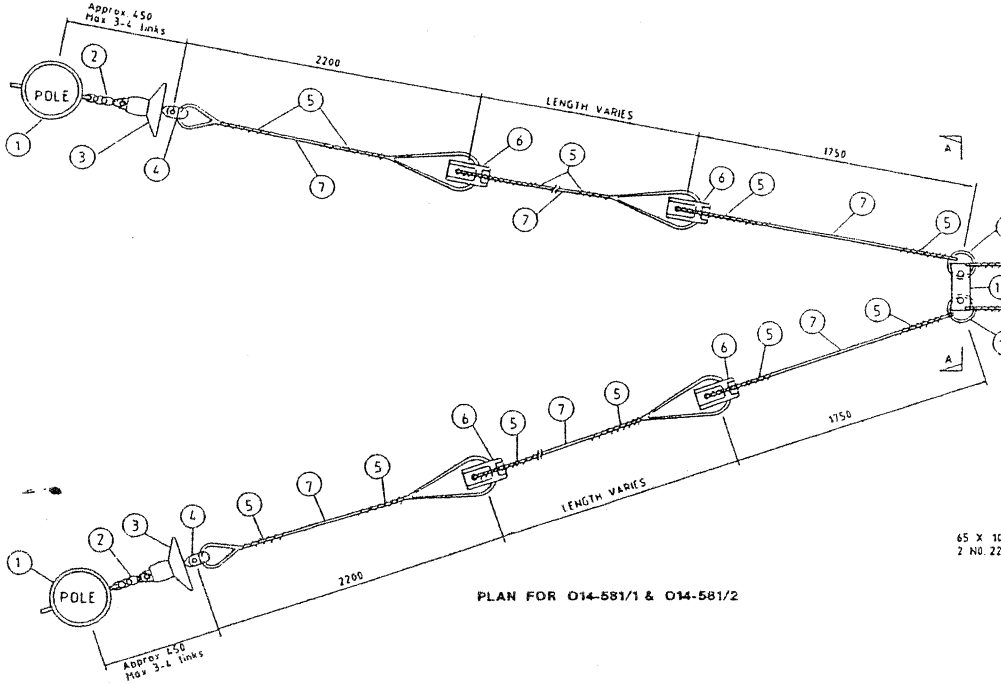
DATUMS COORDINATES
LEVELS

INDEX No	COMPUTER No	DRAWING No
		014-580A

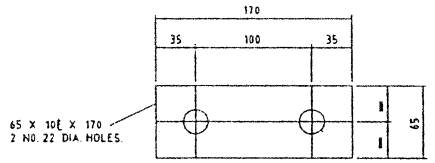
ASSEMBLY REFERENCE						
014-581/1	014-581/2	REMARKS	MATERIAL REFERENCE	SUB/ASSEMBLY OR COMPONENT	DESCRIPTION	ITEM NO
2	2		0923	S/A	ANCHOR BAND	1
2	2	13mm STEEL GALVANIZED 300mm LONG TENSILE	——	C	CHAIN, PROOF COIL, REGULAR LINK	2
2	2	INSULATOR GLASS 200mm	D3771	S/A	INSULATOR 8" DISC	3
2	2		D3121	C	CLEVIS THIMBLE	4
12	12	TERMINATION DEAD END (GALVANIZED STEEL)	D3214/25	C	PREFORMED HELICAL TERMINATION	5
4	4	STRAIN INSULATOR GY2 (PORCELAIN)	——	C	INSULATOR GY2	6
6	6	TIRFOR WIRE 11mm LENGTH VARIABLE	——	C	ANCHOR CATENARY WIRE	7
1	—	TERMINATION DEAD END 129 sq mm (CADMIUM COPPER)	CFG-138	C	PREFORMED HELICAL TERMINATION	8
—	1	TERMINATION DEAD END 81 sq mm (CADMIUM COPPER)	CFG-105	C	PREFORMED HELICAL TERMINATION	9
1	1		D3885/2	C	BULL RING	10
2	2	65 X 4Ł X 170		C	CLAMP PLATE	11
2	2	BOLT M20 X 80 GAL	D4452/20080		COMMERCIAL GRADE AS1111 & AS1214	12
4	4	WASHER TO SUIT M20 BOLT	D4450/2011			13
4	4	NUTS GAL	D4451/2011			14
1	—	129 sq mm	06887	C	TROLLEY WIRE	15
—	1	81 sq mm	06887	C	TROLLEY WIRE	16



SECTION A - A



PLAN FOR 014-581/1 & 014-581/2



CLAMP PLATE MK CP - 2 NO OFF
ITEM NO. 10

NOTES:

1. FOR DETAILS OF V - PULL TERMINATION REFER DRG. NO. 014-580
2. REFERENCE 014-581/1 IS FOR 129 sq mm TROLLEY WIRE. REFERENCE 014-581/2 IS FOR 81 sq mm TROLLEY WIRE.

AMENDMENTS				
REV	DATE	DESCRIPTION	DRAWN	APP'D
A	10/12/97	Dimension from disc insulator to pole was 600	A.R.D.	

DESIGN ENGINEER

CHECKED

J.D TINKLER
DRAWN

DESIGNED

PTC ENGINEERING SERVICES GROUP

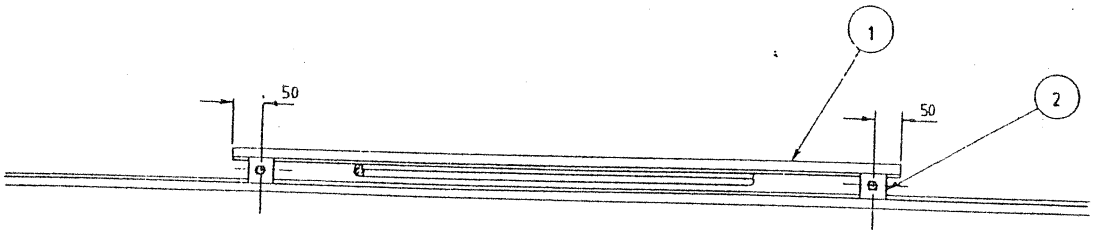
MGR. TRAM INFRASTRUCTURE DESIGN

STANDARD DUAL TROLLEY WIRE TERMINATION

SCALE HORIZONTAL
VERTICAL

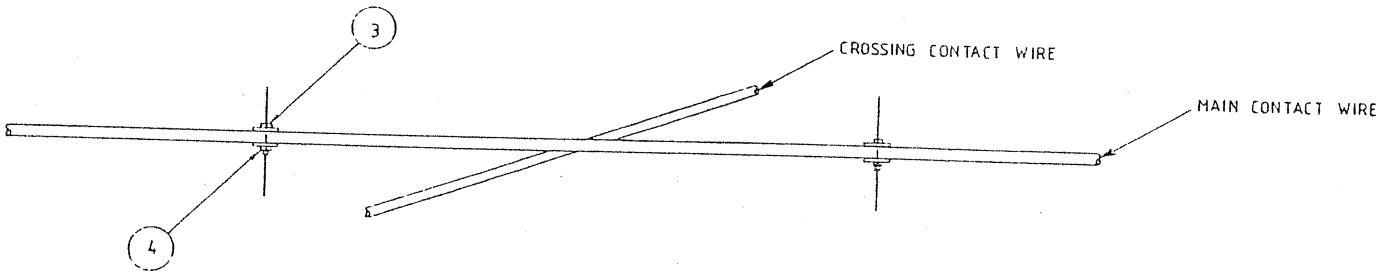
DATUMS COORDINATES
LEVELS

INDEX No.	COMPUTER No.	DRAWING No.
		014-581A



NOTES:

1. ITEM 1 SHALL BE 129sq mm TROLLEY WIRE WITH LENGTH OF 950mm
2. ITEM 2 SHALL BE A FLURY CONTACT SPLICE TYPE S.N.C.B./S.N.C.F. THAT HAS BEEN CUT INTO SINGLE BOLT LENGTHS.
3. THE POSITIONING OF ITEM 1 SHALL BE IN SUCH A WAY THAT IN THE TEMPERATURE RANGE 0-40 DEG. C THE CROSSING WIRE SHALL NOT RETARD THE LONGITUDINAL MOVEMENT OF THE MAIN WIRE.
4. ITEMS 3 & 4 ARE SUPPLIED WITH ITEM 2 BY THE MANUFACTURER.



ITEM	DESCRIPTION	MATERIAL	REMARKS	NO.
4	LOCKING NUT, M10	S.S.	REFER NOTE 4	2
3	BOLT M10, 35 LONG HEX. HEAD.	S.S.	REFER NOTE 4	2
2	CONTACT SPLICE, FLURY TYPE	CU. ALLOY	REFER NOTE 2	2
1	CROSS CONTACT BAR	CU	REFER NOTE 1	1

AMENDMENTS				
REV	DATE	DESCRIPTION	DRAWN	APP'D

DESIGN ENGINEER

CHECKED

J TINKLER
DRAWN

DESIGNED

PTC ENGINEERING SERVICES GROUP

MGR. TRAM INFRASTRUCTURE DESIGN

CROSS CONTACT BAR TYPE 1 ASSEMBLY

SCALE HORIZONTAL
VERTICAL

DATUMS COORDINATES
LEVELS

INDEX No.	COMPUTER No.	DRAWING No.
		014-572

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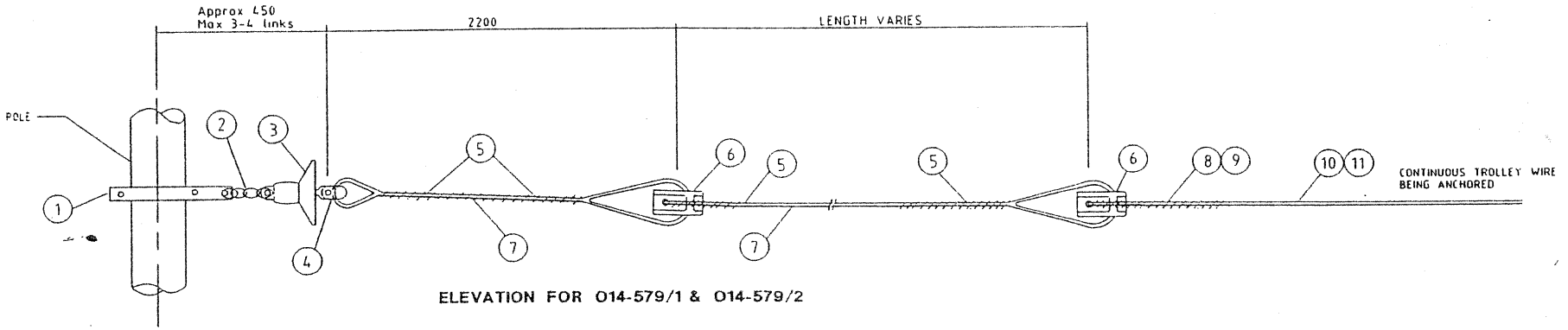
ASSEMBLY REFERENCE						
014-579/1	014-579/2	REMARKS	MATERIAL REFERENCE	SUB/ASSEMBLY OR COMPONENT	DESCRIPTION	ITEM NO
1	1		0923	S/A	ANCHOR BAND	1
1	1	13mm STEEL GALVANIZED 300mm LONG TENSILE	——	C	CHAIN, PROOF COIL, REGULAR LINK	2
1	1	INSULATOR GLASS 200mm	D3771	S/A	INSULATOR 8" DISC	3
1	1		D3121	C	CLEVIS THIMBLE	4
4	4	TERMINATION DEAD END (GALVANIZED STEEL)	D3214/25	C	PREFORMED HELICAL TERMINATION	5
2	2	STRAIN INSULATOR GY2 (PORCELAIN)	——	C	INSULATOR GY2	6
2	2	TIRFOR WIRE 11mm LENGTH VARIABLE	——	C	ANCHOR CATENARY WIRE	7
1	——	TERMINATION DEAD END 129 sq mm (CADMIUM COPPER)	CFG-138	C	PREFORMED HELICAL TERMINATION	8
——	1	TERMINATION DEAD END 81 sq mm (CADMIUM COPPER)	CFG-105	C	PREFORMED HELICAL TERMINATION	9
1	——	129 sq mm	06887	C	TROLLEY WIRE	10
——	1	81 sq mm	06887	C	TROLLEY WIRE	11



ELEVATION FOR 014-579/1 & 014-579/2

NOTES:

1. FOR DETAILS OF V- PULL TERMINATION REFER DRG. NO. 014-580
2. REFERENCE 014-579/1 IS FOR 129 sq mm TROLLEY WIRE.
   REFERENCE 014-579/2 IS FOR 81 sq mm TROLLEY WIRE.

AMENDMENTS				
REV	DATE	DESCRIPTION	DRAWN	APP'D
A	10/12/97	Dimension from disc insulator to pole was 600	A.R.D.	

DESIGN ENGINEER

CHECKED

J D TINKLER
DRAWN

DESIGNED

PTC ENGINEERING SERVICES GROUP

STANDARD SINGLE TROLLEY WIRE TERMINATION (CO-LINEAR)

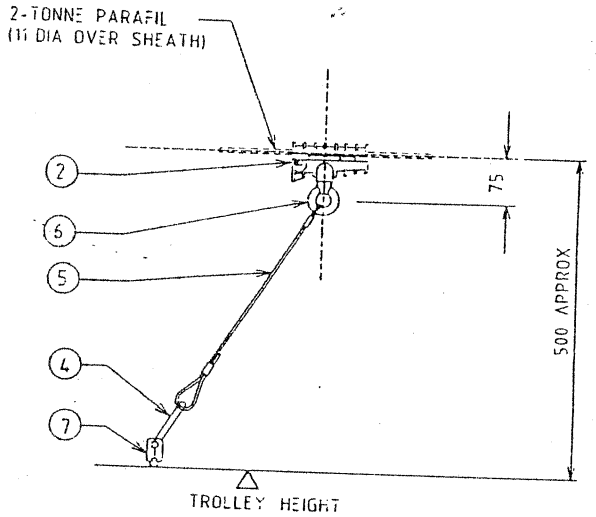
MGR. TRAM INFRASTRUCTURE DESIGN

SCALE HORIZONTAL
VERTICAL

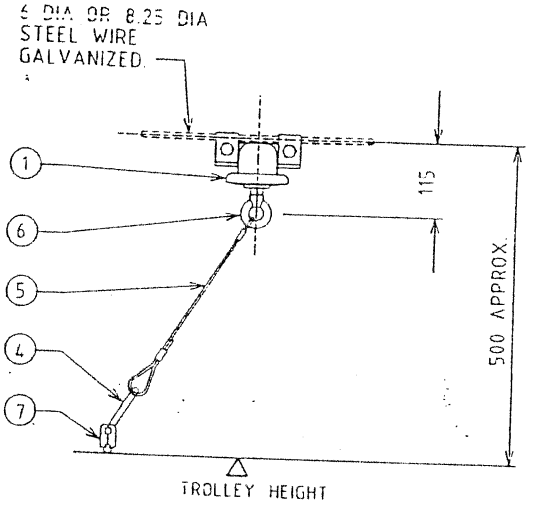
DATUMS COORDINATES
LEVELS

INDEX No	COMPUTER No	DRAWING No
		014-579A

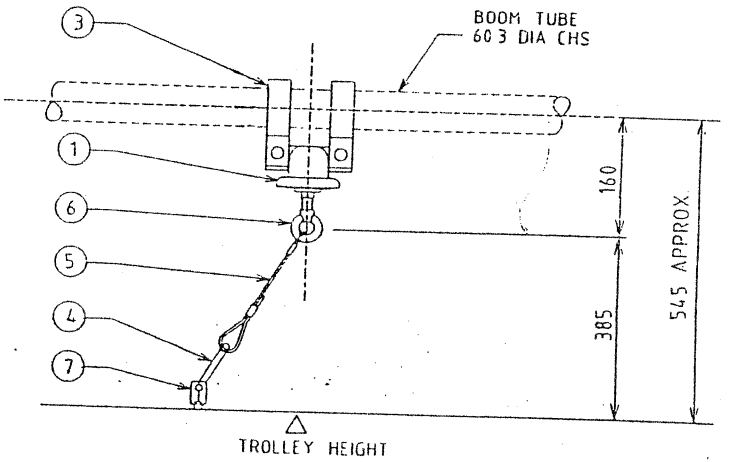
Co-linear



PENDULUM ON PARAFIL CROSS SPAN.
REFERENCE 014-500/1



PENDULUM ON STEEL CROSS SPAN.
REFERENCE 014-500/2



PENDULUM ON CANTILEVER.
REFERENCE 014-500/3

REFERENCE No.014-500/"N"

NOTES -

1 ON ALL DATA SHEETS OR CROSS SECTIONS, EACH ASSEMBLY TO THIS DRAWING SHALL BE DENOTED BY A SEPARATE REFERENCE

2 ALL DIMENSIONS ARE IN MILLIMETRES UNLESS STATED OTHERWISE

3 PENDULUM CABLE FORMED AS 500mm C/C OF EYES

014-500/3	014-500/2	014-500/1	REMARKS	MATERIAL REFERENCE	SUB/ASSEMBLY OR COMPONENT	DESCRIPTION	ITEM No
			ASSEMBLY REFERENCE 014-500/"N"				
1	1	1	K+M No 872 E 1308	014-532/6	S-A	TROLLEY WIRE CLAMP	7
1	1	1	K+M No 845 E 202	014-532/4	S-A	EYE NUT	6
1	1	1	K+M No 848 D 328/11	014-532/3	C	PENDULUM CABLE L = 650	5
1	1	1	K+M No 872 D 1050	014-532/5	C	HANGER ROD	4
2	-	-	DRG NO 014-547	014-547	S-A	BOOM CLAMP	3
-	-	1	K+M No 882 E 1584 1	014-532/2	S-A	PARAFIL ROPE CLAMP	2
1	1	-	K+M No 850 D 4311	014-532/1	S-A	SUPPORT INSULATOR	1

QUANTITIES

AMENDMENTS				
REV	DATE	DESCRIPTION	DRAWN	APP'D
A	19/7/94	ONE HOLE BOOM CLAMP NUT	JDT	
B	11/7/95	OVERALL LENGTH OF CABLE L = 650	JDT	

DESIGN ENGINEER

CHECKED

J TINKLER
DRAWN

DESIGNED

PTC ENGINEERING SERVICES GROUP

ORIGINAL SIGNED BY
JB HELD 21/7/94
MGR. TRAM INFRASTRUCTURE DESIGN

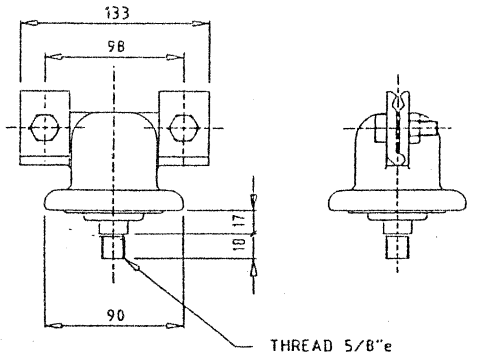
SINGLE PENDULUM TROLLEY WIRE SUPPORT ASSEMBLY, STYLE VARIABLE

SCALE HORIZONTAL
VERTICAL

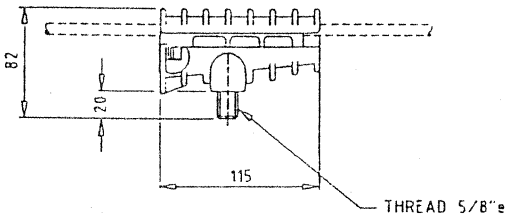
DATUMS COORDINATES
LEVELS

INDEX No | COMPUTER No | DRAWING No
014-500 B

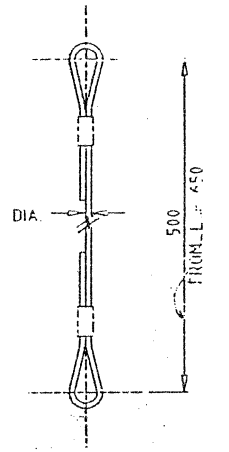
n:\drawings\stand\a5049sp.dgn Aug. 15. 1995 09:27:37



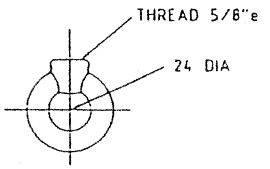
SUPPORT INSULATOR
REFERENCE 014-532/1



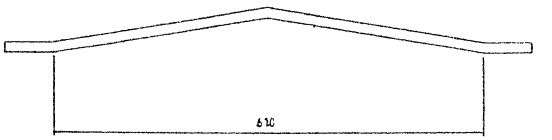
PARAFIL ROPE CLAMP
REFERENCE 014-532/2



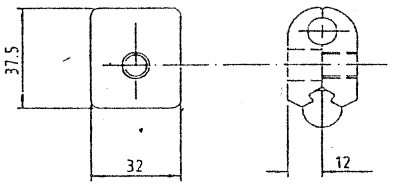
PENDULUM CABLE
REFERENCE 014-532/3



EYE NUT
REFERENCE 014-532/4



HANGER ROD
REFERENCE 014-532/5



TROLLEY WIRE CLAMP
REFERENCE 014-532/6

REFERENCE NO. 014-532/"N"

NOTES:-

1 ON ALL DATA SHEETS OR CROSS SECTIONS EACH ITEM TO THIS DRAWING SHALL BE DENOTED BY A SEPARATE REFERENCE

2 ALL MATERIAL MANUFACTURED AND SUPPLIED BY KUMMLER & MATTER AG (FAHRLEITUNGSBAU), HOHLSTRASSE 176, POSTFACH CH-8026 ZURICH, SWITZERLAND

3 ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED

QTY	REMARKS	MATERIAL REFERENCE	SUB/ASSEMBLY OR COMPONENT	DESCRIPTION	ITEM No
1	K+M No.872 E 1308	014-532/6	S-A	TROLLEY WIRE CLAMP	6
1	K+M No 872 D 1050 111	014-532/5	C	HANGER ROD	5
1	K+M No.845 E 202	014-532/4	C	EYE NUT	4
1	K+M No 848 D 328/11 (L =650)	014-532/3	S-A	PENDULUM CABLE.	3
1	K+M No 882 E 1584 1 (SUITABLE FOR 11 DIA ROPE)	014-532/2	S-A	PARAFILE ROPE CLAMP	2
1	K+M No.850 D 4311	014-532/1	S-A	SUPPORT INSULATOR.	1

AMENDMENTS				
REV	DATE	DESCRIPTION	DRAWN	APP'D
A	11/7/95	OVERALL LENGTH CABLE GIVEN	J.D.T	

D J JOWETT
DESIGN ENGINEER

CHECKED

J.D.TINKLER
DRAWN

DESIGNED

PTC ENGINEERING SERVICES GROUP

D. Hall 15/8/95
MGR, TRAM INFRASTRUCTURE DESIGN

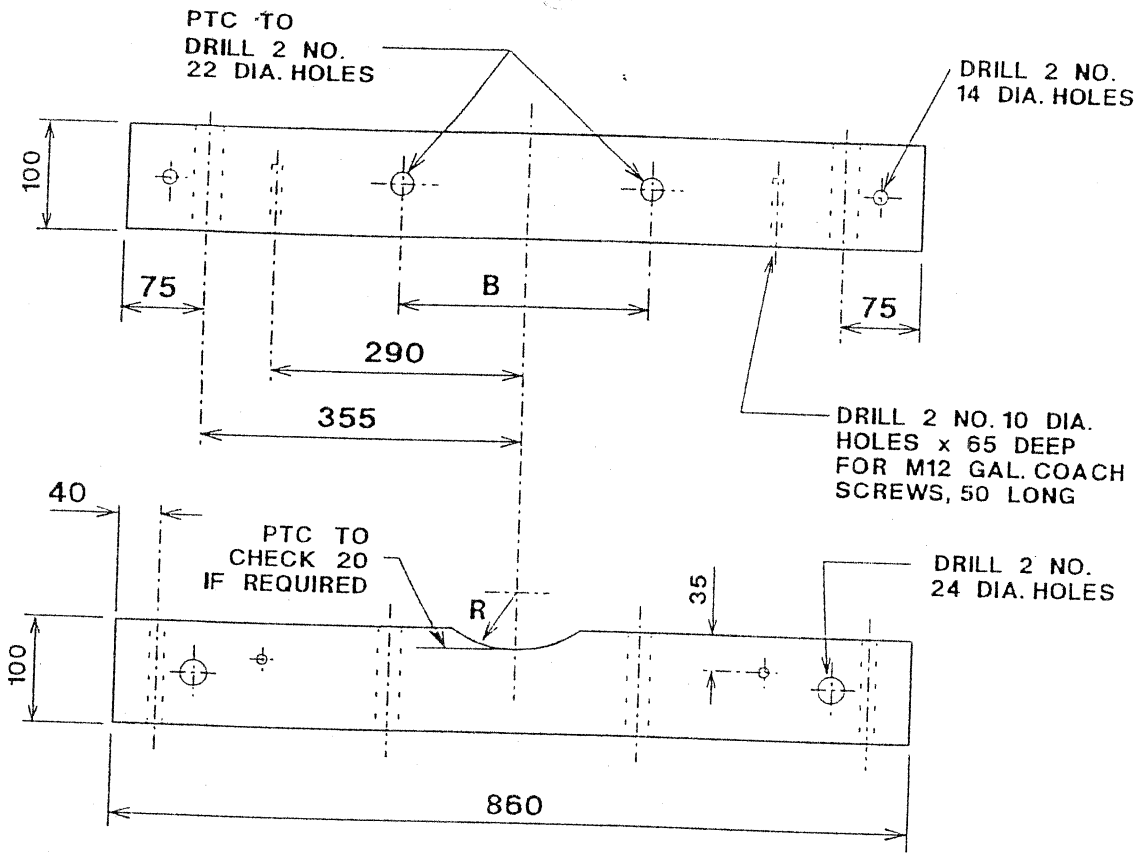
KUMMLER & MATTER
SINGLE PENDULUM FITTINGS

COMPONENTS, STYLE VARIABLE

SCALE HORIZONTAL NTS
VERTICAL

DATUMS COORDINATES
LEVELS

INDEX No | COMPUTER No | DRAWING No 014-532A



COMPONENT REFERENCE DRG. NO. O14-427	DIA. OF POLE		R		B	
	in	mm	in	mm	in	mm
O14-427/114	4 ½	114	2 ¼	60	5 ¼	135
O14-427/140	5 ½	140	2 ¾	70	6 ¼	160
O14-427/165	6 ½	165	3 ¼	85	7 ¼	185
O14-427/191	7 ½	191	3 ¾	95	8 ¼	210
O14-427/216	8 ½	216	4 ¼	110	9 ¼	240
O14-427/219	8 ⅝	219	4 5/16	110	9 ⅜	240
O14-427/241	9 ½	241	4 ¾	120	10 ¼	260
O14-427/244	9 ⅝	244	4 13/16	125	10 ⅜	265
O14-427/267	10 ½	267	5 ¼	135	11 ¼	290
O14-427/273	10 ¾	273	5 ⅜	140	11 ½	290
O14-427/292	11 ½	292	5 ¾	145	12 ¼	310

REFERENCE ITEM	DRG. NO.
4 feeder cross-arms.	O14-428
Brace	O13-195
U-Bolt	O9653

MATERIAL:

IRON BARK OR SPOTTED GUM
STRESS GRADE F22,
VISUAL GRADE SELECT
TO A.S. 1720.

NOTE: THIS DRG. SUPERSEDES DRG. O13-461.

AMENDMENTS

REV	DATE	DESCRIPTION	DRAWN	APP'D
A	13/11/95	HOLE SIZE AND REFERENCE TABLE	JDT	
B	14/5/97	LENGTH INCREASE FOR FEEDER CLEARANCE	ARD	

DESIGN ENGINEER

CHECKED
J D TINKLER
DRAWN

DESIGNED

PTC ENGINEERING SERVICES GROUP

2 FEEDER WOODEN CROSS-ARMS

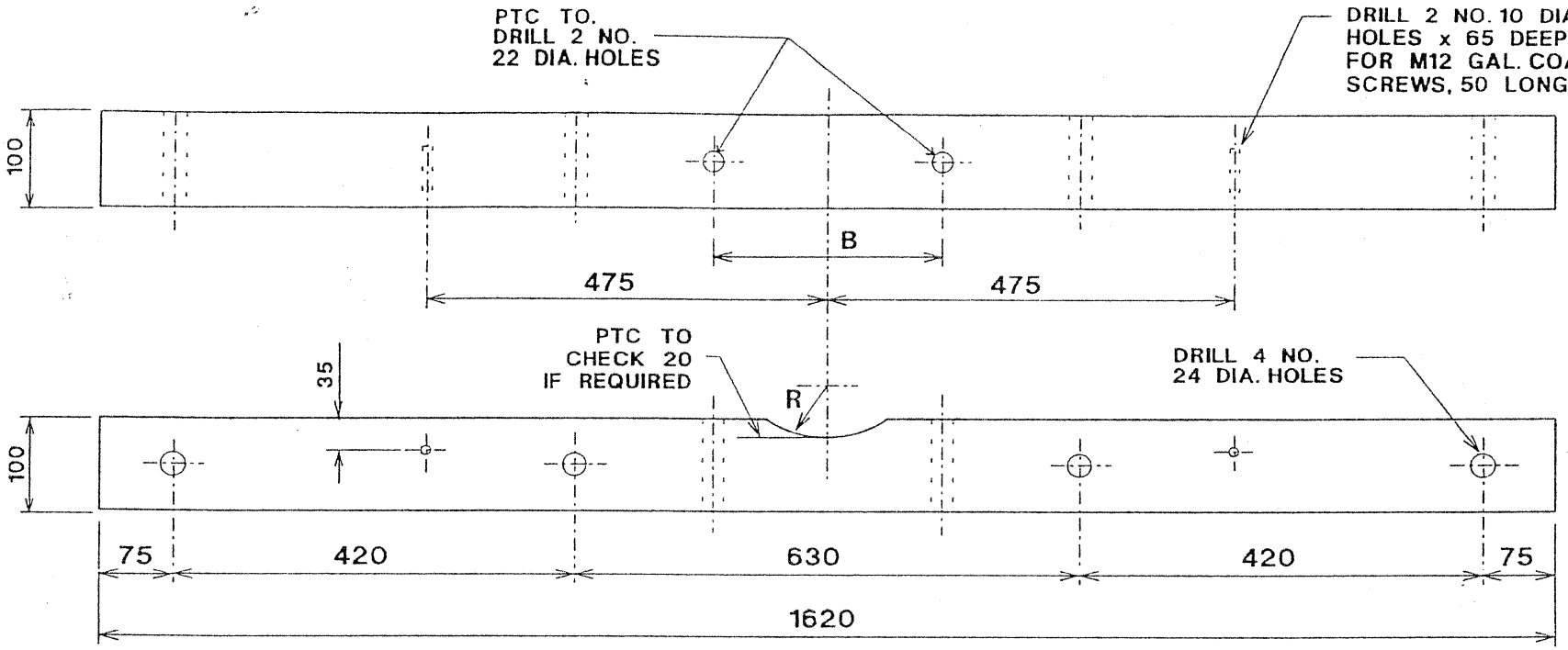
MGR TRAM INFRASTRUCTURE DESIGN

SCALE HORIZONTAL
VERTICAL

DATUMS COORDINATES
LEVELS

INDEX No | COMPUTER No | DRAWING No O14-4278

n:/drawings/scand/o14427.dgn May. 14. 1997 15:28:17



COMPONENT REFERENCE DRG. NO. O14-428	DIA. OF POLE		R		B	
	in	mm	in	mm	in	mm
O14-428/114	4 ½	114	2 ¼	60	5 ¼	135
O14-428/140	5 ½	140	2 ¾	70	6 ¼	160
O14-428/165	6 ½	165	3 ¼	85	7 ¼	185
O14-428/191	7 ½	191	3 ¾	95	8 ¼	210
O14-428/219	8 ⅝	219	4 ⅜	110	9 ⅜	240
O14-428/241	9 ½	241	4 ¾	120	10 ¼	260
O14-428/273	10 ¾	273	5 ⅜	140	11 ½	295

REFERENCE ITEM	DRG. NO.
2 feeder cross-arms.	O14-427
Brace	O13-195
U-Bolt	O9653

MATERIAL:

IRON BARK OR SPOTTED GUM
STRESS GRADE F22,
VISUAL GRADE SELECT
TO A.S. 1720.

NOTE: THIS DRG. SUPERSEDES DRG. O13-462.

AMENDMENTS				
REV	DATE	DESCRIPTION	DRAWN	APP'D
A	13/11/95	HOLE SIZE AND REFERENCE TABLE	J D T	
B	14/5/97	LENGTH INCREASE FOR FEEDER CLEARANCE	A R D	

DESIGN ENGINEER

CHECKED
D. Nankervis
J D TINKLER
DRAWN

DESIGNED

PTC ENGINEERING SERVICES GROUP

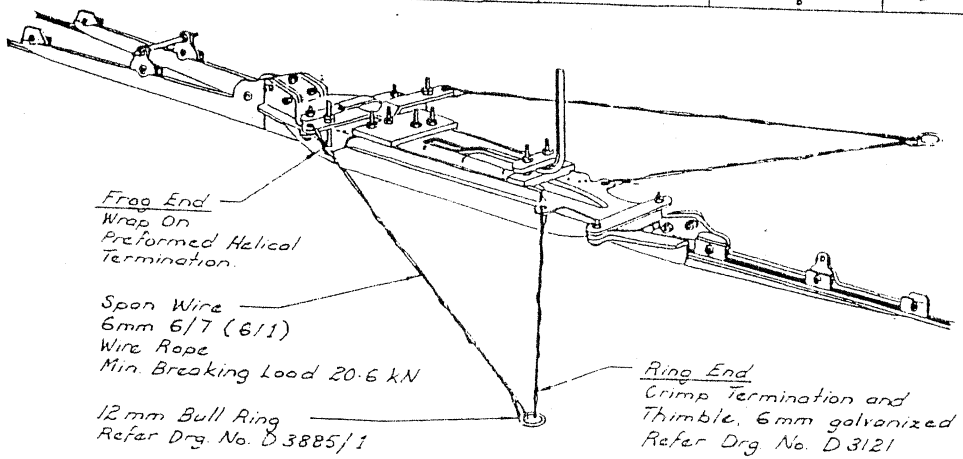
4 FEEDER WOODEN CROSS-ARMS

MGR TRAM INFRASTRUCTURE DESIGN

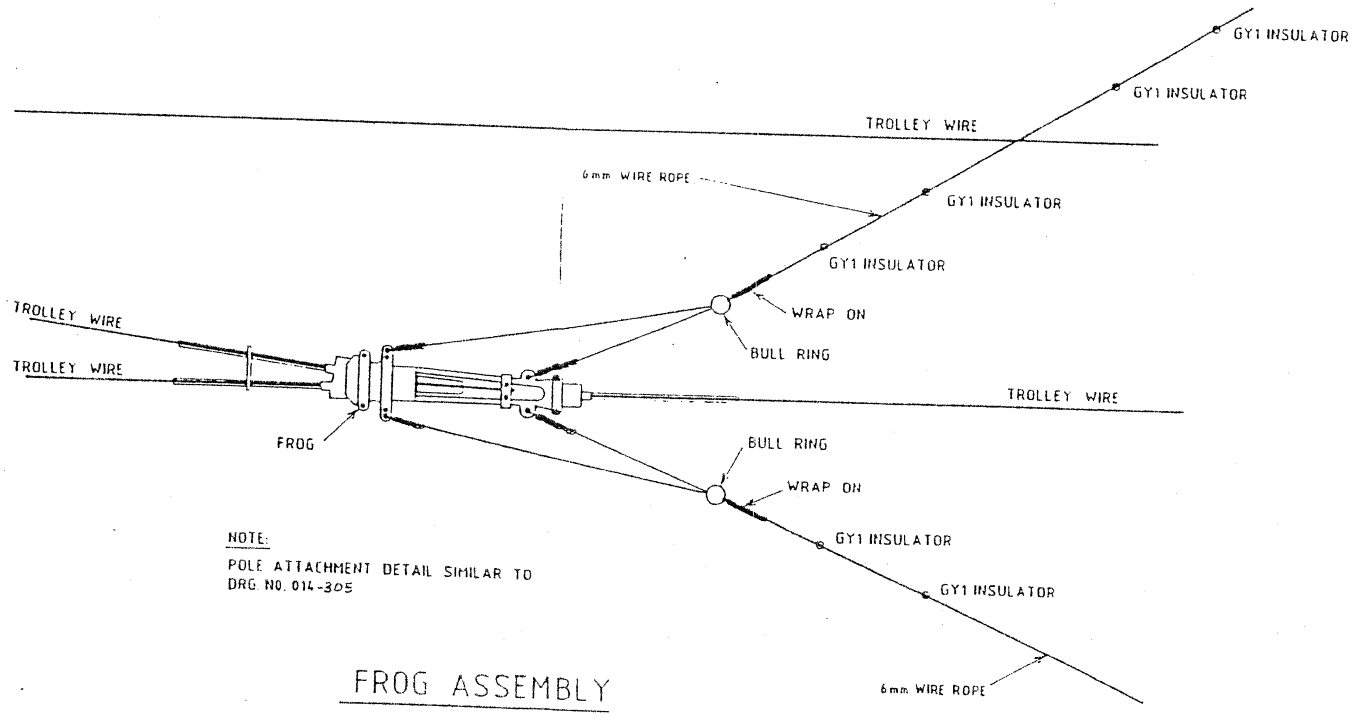
SCALE HORIZONTAL
VERTICAL

DATUMS COORDINATES
LEVELS

INDEX No | COMPUTER No | DRAWING No: O14-4288



FROG PAN BACK AND LEGS



NOTE:

POLE ATTACHMENT DETAIL SIMILAR TO
DRG. NO. 014-305

FROG ASSEMBLY

NOTES	LINES	REFERENCES
	RAIL JOINT — TRAFFIC SIGNAL CONTROLLER SWAGEY POINT — TRAMWAYS HWY TRANSITION POINT — ELECTRICITY B SURVEY STATION — TRAFFIC SIGNAL POLE DRAINAGE PIT — ELECTRICITY POLE SEWER PIT OR MANHOLE — ELECTRIC LIGHT POLE ELECTRICITY SUPPLY PIT — OVER-HEAD ELECTRICITY TRAFFIC SIGNAL PIT — UNDER GROUND ELECTRICITY UNCLASSIFIED UTILITY — GAS SIGN — TELECOM TELECOM PIT OR PILLAR — WATER STOP OR WATER VALVE	

AMENDMENTS				
REV	DATE	DESCRIPTION	DRAWN	APP'D

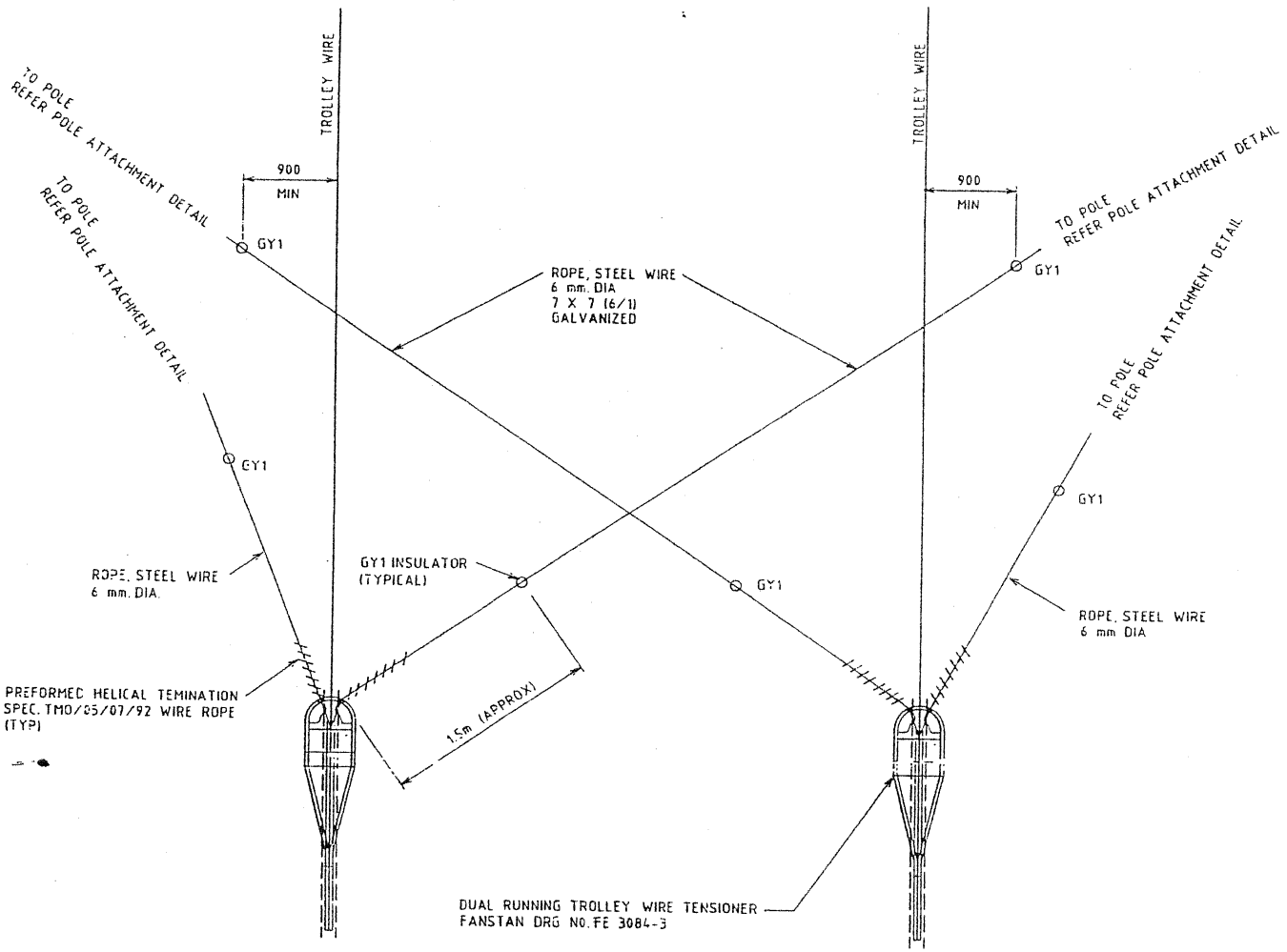
TRAM INFRASTRUCTURE DESIGN ENGINEERS
J.D TINKLER

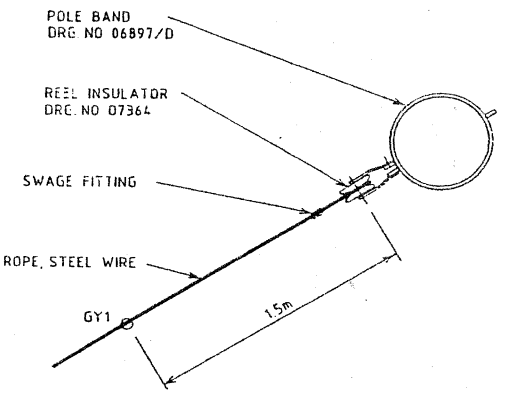
PTC TRAM INFRASTRUCTURE GROUP

FROG ERECTION DETAIL

MARKED - TRAM WYCOMBE

SCALE 1:10 N.T.S





POLE ATTACHMENT DETAIL

AMENDMENTS				
REV.	DATE	DESCRIPTION	DRAWN	APP'D
A	19/7/94	SINGLE DISC INSULATOR SHOWN, CHAIN SPEC.	J.D.T.	
B	9/7/96	WIRE ROPE, GY1, REEL INSULATOR ADDED	J.D.T	

ORIGINAL SIGNED BY
D. JOWETT ON 21/7/94
TRAM O/H DESIGN ENGINEER

J.DTINKLER
DRAWN

D.J.JOWETT
DES

PTC TRAM INFRASTRUCTURE GROUP

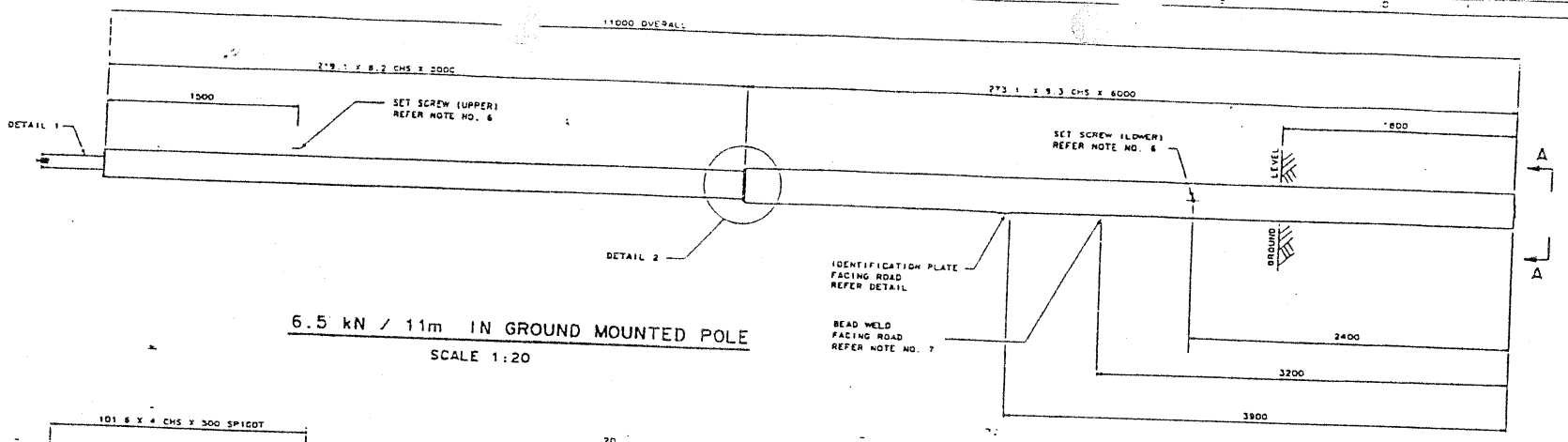
DUAL RUNNING TROLLEY WIRE TENSIONER

ORIGINAL SIGNED BY
B.HELD ON 21/7/94
MANAGER - TRAM OVERHEAD

SCALE HORIZONTAL
VERTICAL

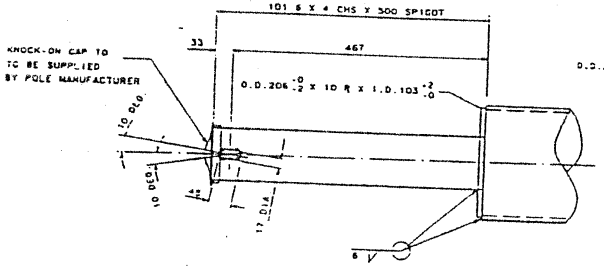
DATUMS COORDINATES
LEVELS

INDEX NUMBER | DRAWING NUMBER | REV
B



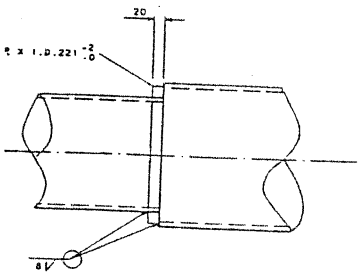
6.5 kN / 11m IN GROUND MOUNTED POLE

SCALE 1:20



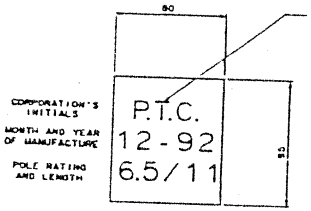
DETAIL (1)

SCALE 1:5



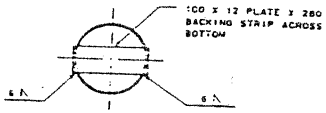
DETAIL (2)

SCALE 1:5



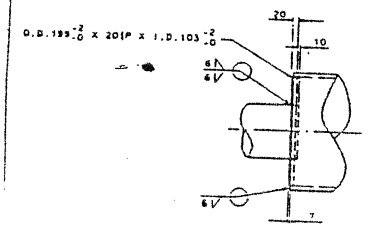
IDENTIFICATION PLATE

N.T.S.



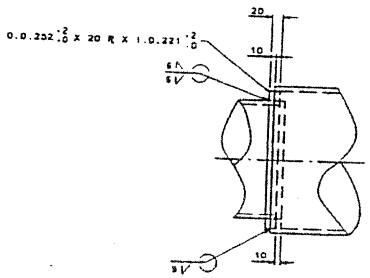
VIEW A - A

SCALE 1:10



OPTIONAL JOINT DETAIL 1A

N.T.S.

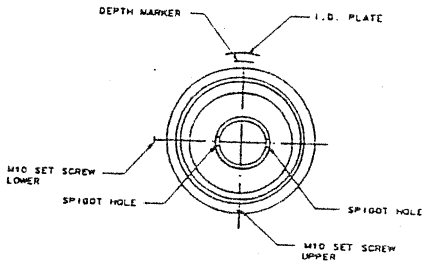


OPTIONAL JOINT DETAIL 2A

N.T.S.

NOTE:

OPTIONAL JOINT DETAIL 1A AND OPTIONAL JOINT DETAIL 2A MAY BE SUBSTITUTED FOR THE CORRESPONDING JOINTS IN DETAIL 1 AND DETAIL 2 RESPECTIVELY. THIS OPTION ENABLES THE TOP JOINT RING TO BE CUT FROM THE SURPLUS MATERIAL DERIVED FROM THE CENTRE JOINT RING CUTTING PROCESS.



ORIENTATION DETAIL

N.T.S.

GENERAL NOTES:

1. ALL STEEL PLATES TO CONFORM TO AS 3678 GRADE 250 U.O.N.
2. ALL CIRCULAR HOLLOW SECTIONS TO CONFORM TO AS 1163 GRADE C350
3. ALL FILLET WELDS TO BE 6mm CONTINUOUS U.O.N. AND ARE TO CONFORM TO AS 1554, PART 1, CATEGORY D.P. U.O.N.
4. ALL SHARP EDGES AND BURRS TO BE REMOVED.
5. ALL STEEL TO FULLY HOT DIP GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH AS 1650
6. 8.5 DIA. HOLE TAPPED M10 AFTER GALVANIZING C/W M10 X 25 LONG SET SCREW (BOND).
7. HORIZONTAL BEAD WELD 75mm LONG FACE ONLY FOR DEPTH MARKER.

BOTTOM	LEGEND	SPECIFICATION

AMENDMENTS				
REV	DATE	DESCRIPTION	DRAWN	APP'D
A	3/3/93	ORIENTATION OF SPIGOT HOLES	J.D.T.	
B	17/3/93	LOCATION OF LOWER SET SCREW	J.D.T.	
C	21/7/93	IDENTIFICATION PLATE	J.D.T.	
D	16/8/93	DATE OF MANUFACTURE JOINT OPTION	J.D.T.	
E	24/10/94	SPIGOT HOLES AND JOINT DETAIL	J.D.T.	
F	8/11/94	SET SCREW (LOWER) NOW 240	J.D.T.	

ORIGINAL DRAWN BY DAVID HICKS
TEAM SYSTEMS DESIGN ENGINEER

ORIGINAL DRAWN BY DONALD JOWETT
DRAWN: J.D.TINKLER
DESIGN: D.J.JOWETT

PTC TRAM INFRASTRUCTURE GROUP

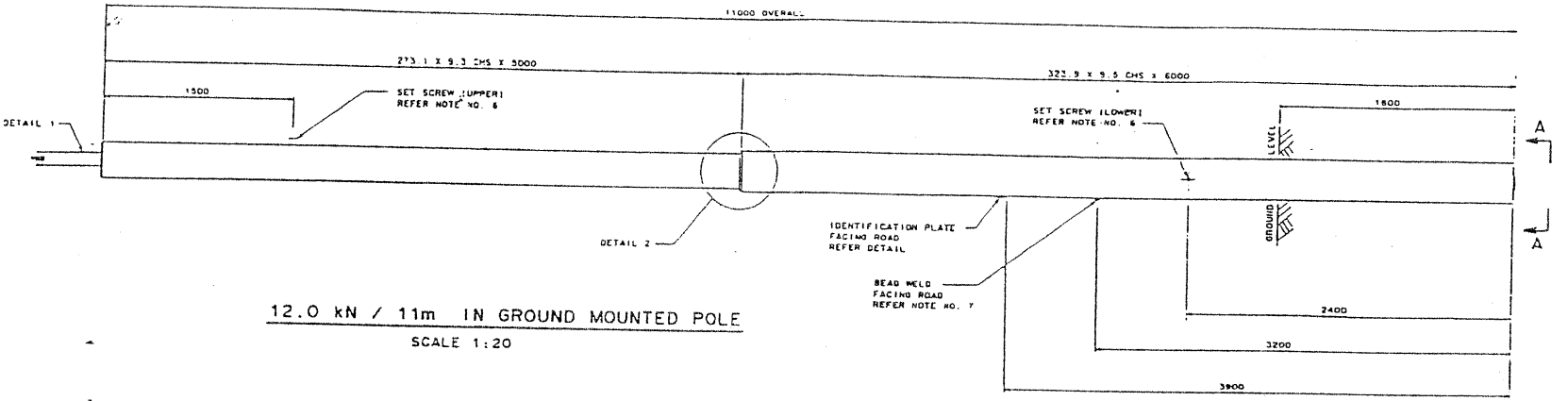
STEEL SPAN POLE
(6.5kN/11m)

ORIGINAL SIGNED BY CHRIS HICKS
MANAGER - TRAM SYSTEMS

SCALES: HORIZONTAL 1:20
VERTICAL
DATUMS: COORDINATES
LEVELS

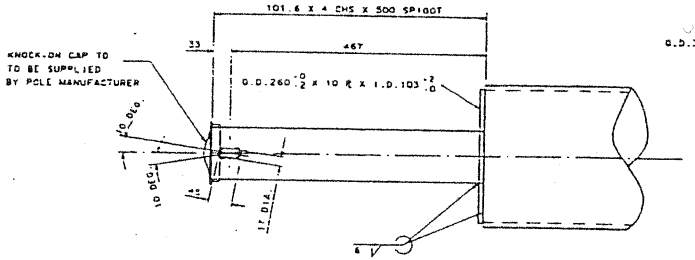
INDEX NUMBER | DRAWING NUMBER: 014-349 | REV: F

drawings/knox/o14-349.dgn Nov 9 1994 10:16:12



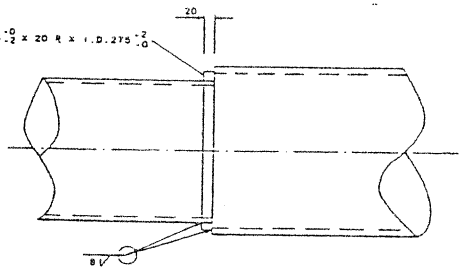
12.0 kN / 11m IN GROUND MOUNTED POLE

SCALE 1:20



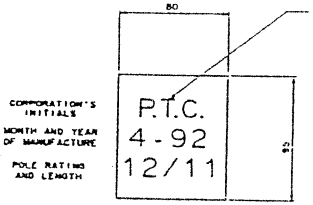
DETAIL (1)

SCALE 1:5



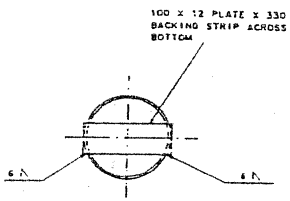
DETAIL (2)

SCALE 1:5



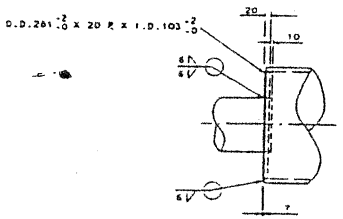
IDENTIFICATION PLATE

N.T.S.



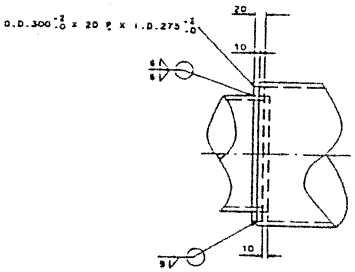
VIEW A - A

SCALE 1:10



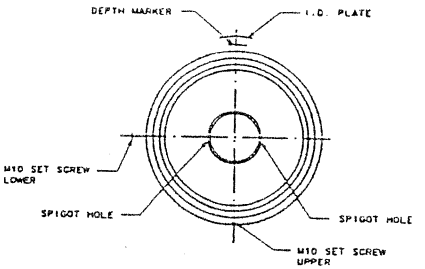
OPTIONAL JOINT DETAIL 1A

N.T.S.



OPTIONAL JOINT DETAIL 2A

N.T.S.



ORIENTATION DETAIL

N.T.S.

NOTE:

OPTIONAL JOINT DETAIL 1A AND OPTIONAL JOINT DETAIL 2A MAY BE SUBSTITUTED FOR THE CORRESPONDING JOINTS IN DETAIL 1 AND DETAIL 2 RESPECTIVELY. THIS OPTION ENABLES THE TOP JOINT RING TO BE CUT FROM THE SURPLUS MATERIAL DERIVED FROM THE CENTRE JOINT RING CUTTING PROCESS.

GENERAL NOTES:

1. ALL STEEL PLATES TO CONFORM TO AS 3678 GRADE 250 U.O.N.
2. ALL CIRCULAR HOLLOW SECTIONS TO CONFORM TO AS 1163 GRADE C350
3. ALL FILLET WELDS TO BE 5mm CONTINUOUS U.O.N. AND ARE TO CONFORM TO AS 1554. PART 1. CATEGORY G.P. U.O.N.
4. ALL SHARP EDGES AND BURRS TO BE REMOVED.
5. ALL STEEL TO FULLY HOT DIP GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH AS 1650
6. 8.5 DIA. HOLE TAPPED M10 AFTER GALVANIZING C/W M10 X 25 LONG SET SCREW (BONDING).
7. HORIZONTAL BEAD WELD 75mm LONG FACE ONLY FOR DEPTH MARKER.

NOTING	LEGEND	SUPERSEDED

NOT	DATE	DESCRIPTION	DRAWN	CHKD
A	3/3/93	ORIENTATION OF SPIGOT HOLES	J.D.T.	
B	17/3/93	LOCATION OF LOWER SET SCREW	J.D.T.	
C	21/7/93	IDENTIFICATION PLATE	J.D.T.	
D	19/8/93	DATE OF MANUFACTURE, JOINT OPTION	J.D.T.	
E	14/10/93	SPIGOT HOLES AND JOINT DETAIL	J.D.T.	
F	9/11/94	SET SCREW (LOWER) NOW 2400	J.D.T.	

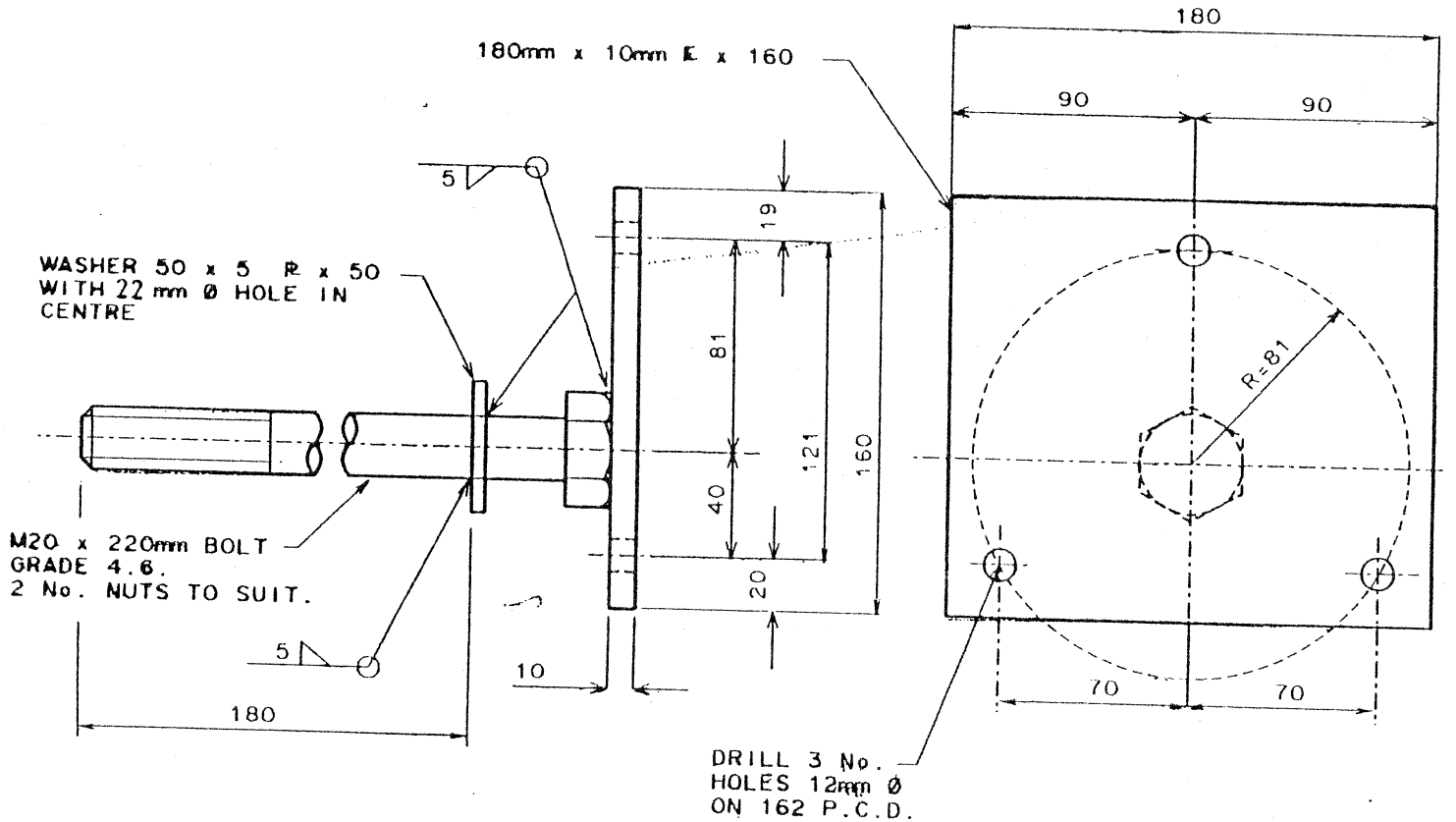
ORIGINAL DRAWN BY HAND (DRAFT)
TRAM OPTIONS NOTED | INITIALS
ORIGINAL SIGNED BY HAND (DRAFT)
CHECKED
J.D.TINKLER
DESIGNED
D.J.JOWETT
APPROVED

PTC TRAM INFRASTRUCTURE GROUP

STEEL ANCHOR POLE
(12kN/11m)

ORIGINAL SIGNED BY OWEN HICKS
MANAGER - TRAM OVERHEAD

SCALES HORIZONTAL	1:20
VERTICAL	
DATUMS COORDINATES	
LEVELS	
INDEX NUMBER	DRAWING NUMBER 014.350 REV F



PLEASE NOTE: ALL DIMENSIONS ARE IN MILLIMETRES

HOT DIPPED GALVANISED TO A.S. 1650.

NOTE: DO NOT SCALE OFF DRAWING, IF IN DOUBT ASK.

PLOTDATE:

REVISION		APPROVED
A	MOUNTING PLATE HAS BEEN OFF-SET FROM CENTER - LINE OF BOLT.	16-3-93 DATE
		DRAWN
		DESIGNED

PTC TRAM INFRASTRUCTURE GROUP

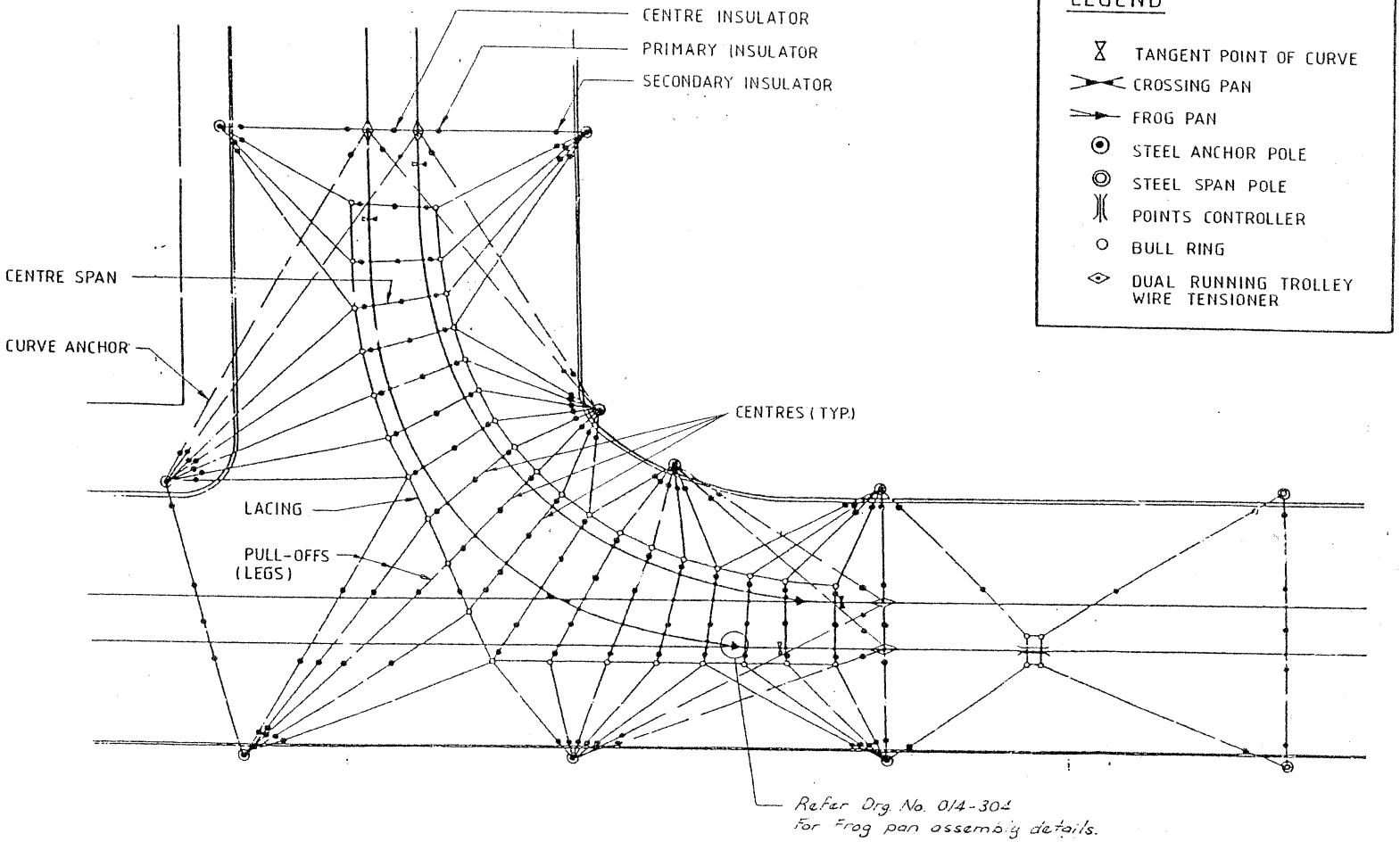
SURGE DIVERTER MOUNTING BRACKET

MANAGER TRAM INFRASTRUCTURE DEV.

SCALE: HORIZONTAL 1:2
VERTICAL

DRAWING NUMBER 014-814

REV A



LEGEND

- TANGENT POINT OF CURVE
- CROSSING PAN
- FROG PAN
- STEEL ANCHOR POLE
- STEEL SPAN POLE
- POINTS CONTROLLER
- BULL RING
- DUAL RUNNING TROLLEY WIRE TENSIONER

IN SERV	REV'N	DATE	DESCRIPTION	REV'D	C'KD	C.E.	S.O.E.	MGR. ELEC.

DESIGNED

DRAWN J.D.T

CHECKED

PTC

OVERHEAD WIRING

CURVE NETWORK

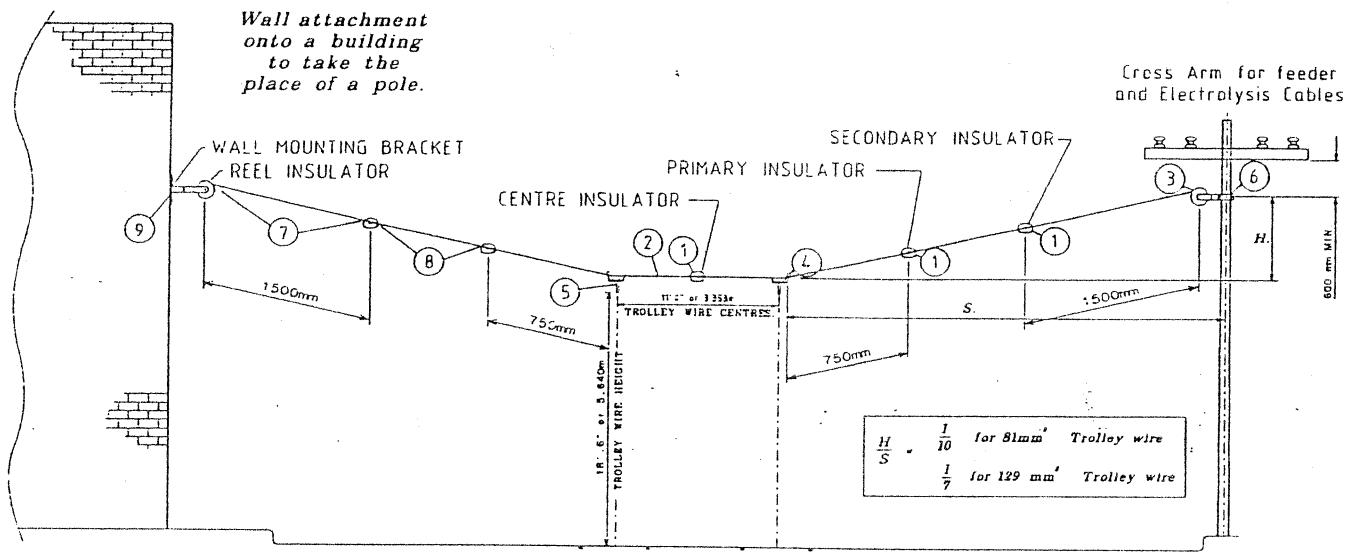
TRAM O/H DESIGN EN

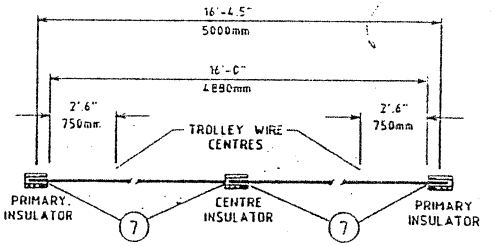
DATE

SCALE

IN SERVICE

A2 DRAWING NO 014





COMPONENT REFERENCES

Quantities	DRG. No.	Rev.	Reference	Assembly	Description	Remarks	Item
5				Component	Strain Insulator GY1.	Spec. TMO/03/07/92.	1
1				Component	Steel Wire Rope 6mm	Spec. TMO/04/07/92. Variable length	2
2	07364			Sub-Assembly	Reel Insulator		3
2	013-983			Sub-Assembly	Hanger	With 0.25" BSW 'U' Bolt	4
2			Fandstan P/No. 91231	Sub-Assembly	Line Ear,- Male	With 0.75" BSW Brass Nut & Springwasher	5
1	06897		06897/D	Sub-Assembly	Pole Band, Slit type	Type 2 - Split Type	6
8				Component	Swage Fitting 6mm	Aluminium or Copper	7
4				Component	Preformed Helical Termination	Spec. TMO/05/07/92. for 6mm Wire Rope	8
1	014-308			Component	Wall Mounting Bkt.		9
							10
							11
							12

014-293/1 Assembly Reference

NOTE: DO NOT SCALE OFF DRAWING, IF IN DOUBT ASK.

NOTES

LEGEND

⊕	RAIL JOINT	TSC	TRAFFIC SIGNAL CONTROLLER
↑	TANGENT POINT	○	TRAMWAYS OHP
⌒	TRANSITION POINT	ES	ELECTRICITY & OHP
⌂	SURVEY STATION	⊕	TRAFFIC SIGNAL POLE
⊞	DRAINAGE PIT	○	ELECTRICITY POLE
○	SEWER PIT OR MANHOLE	○	ELECTRIC LIGHT POLE
⊠	ELECTRICITY SUPPLY PIT	—e—	OVER-HEAD ELECTRICITY
⊠	TRAFFIC SIGNAL PIT	—e—	UNDER GROUND ELECTRICITY
⊠	UNCLASSIFIED UTILITY	—g—	GAS
—	SIGN	—t—	TELECOM
TC	TELECOM PIT OR PILLAR	—w—	WATER
○	STOP OR WATER VALVE	—s—	SEWER
⊕	FIRE HYDRANT OR PLUG	—d—	DRAINAGE

REFERENCES

AMENDMENTS

REV	DATE	DESCRIPTION	DRAWN	APPD

APPROVED
CHECKED
S. Armbrust
DRAWN
DESIGNED

PTC TRAM INFRASTRUCTURE GROUP

STRAIGHT CROSS SPAN ASSEMBLY IN STEEL. FROM WALL TO POLE.

MANAGER TRAM INFRASTRUCTURE GROUP

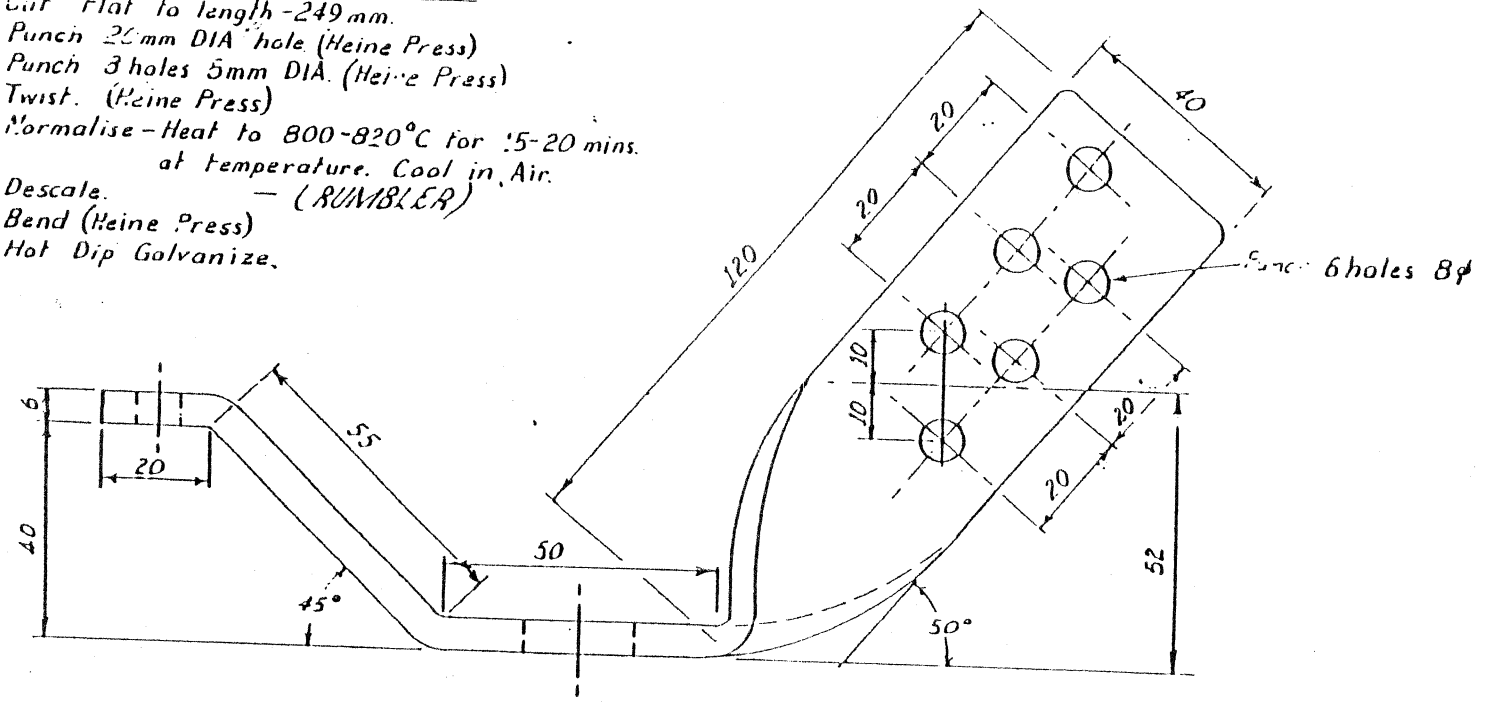
SCALE: HORIZONTAL NOT TO SCALE
VERTICAL

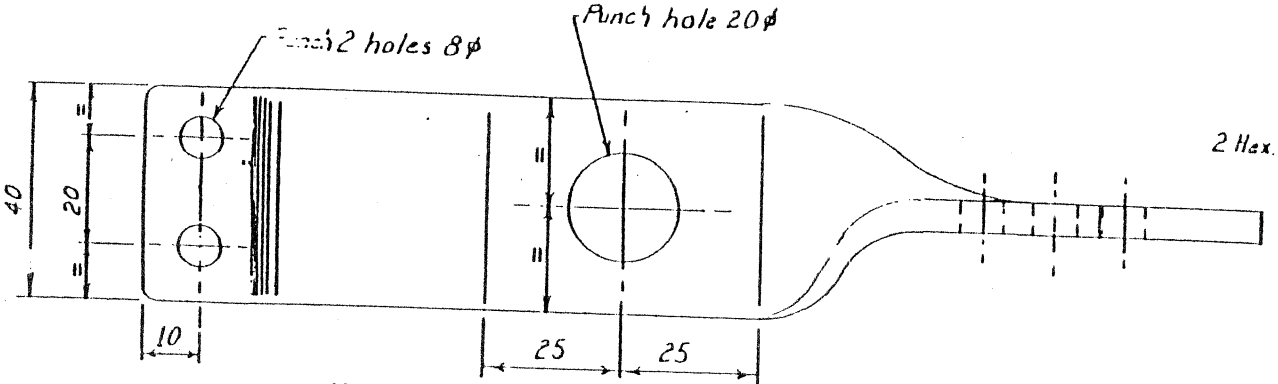
DRAWING NUMBER 014-293 REV.

d/spe Oct. 994 31

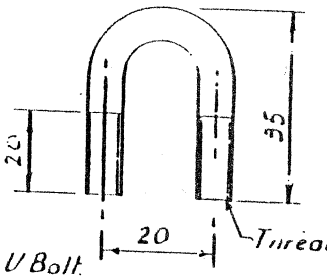
Manufacturing Procedure

1. Cut Flat to length -249 mm.
2. Punch 20mm DIA hole (Heine Press)
3. Punch 3 holes 5mm DIA. (Heine Press)
4. Twist. (Heine Press)
5. Normalise - Heat to 800-820°C for 15-20 mins. at temperature. Cool in Air.
6. Descale. — (RUMBLER)
7. Bend (Heine Press)
8. Hot Dip Galvanize.





Matl :- 40 × 6 × 249 Black MS Flat, Cut Length 249.
Finish :- Hot Dip Galvanized.



2 Hex. SS Nyloc nuts per U Bolt

U BOLT

2 off per hanger
Matl :- 1" ϕ Free Cutting SS
Cut Length 76

Dimensions in millimetres unless otherwise stated.

ZONE	REF	REVISION	BY	CKD	DATE
E		Thread was 15 mm	SS		16-11-84
D	8	Matl was 6mm DIA	GDeL		30-6-82
C	7	REVISED	RDT		24/11/81
A	1	Manf Proc. added	GDeL		16-5-80

REFERENCE
"U" BOLT - SEE DANOBAT OPERATION SHEETS Nº W3977 & W4142

HANGER

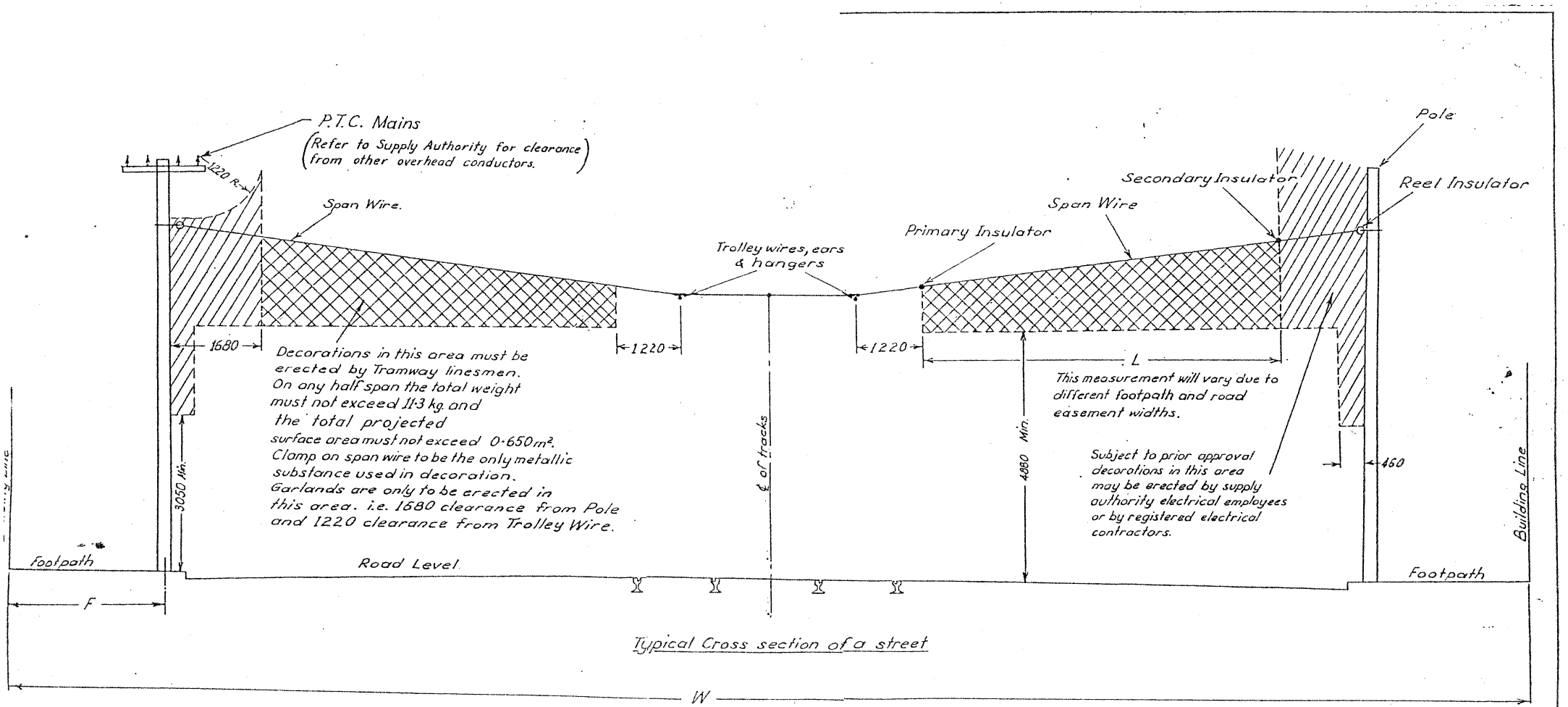
Supersedes X1756

METROPOLITAN & METROPOLITAN TRAMWAYS BOARD

DATE		CHIEF ENGINEER	
DRAWN 11-5-79 G DeL	CHECKED R.S.M.L.	PASSED V.T.	APPROVED

013-983 A B E

SCALE 1:1



Typical Cross section of a street

$L = \frac{W}{2} - F - 4580$

NOTE:- All dimensions are in millimetres.

Garlands info. added G.D.e.L. 15.3.74
Metricated. G.D.e.L. 15·3·74
Amendments.

Reference
Supersedes 012-162

LIMITS FOR DECORATIONS
TRAMWAY
POLES & SPAN WIRES

MELBOURNE & METROPOLITAN TRAMWAYS BOARD

DATE		DEPUTY CHAIRMAN
24-3-71		J.D. Inst.

DRAWN	TRACED	CHECKED	APPROVED	APPROVED
B.T.W.		G.D.e.L.		

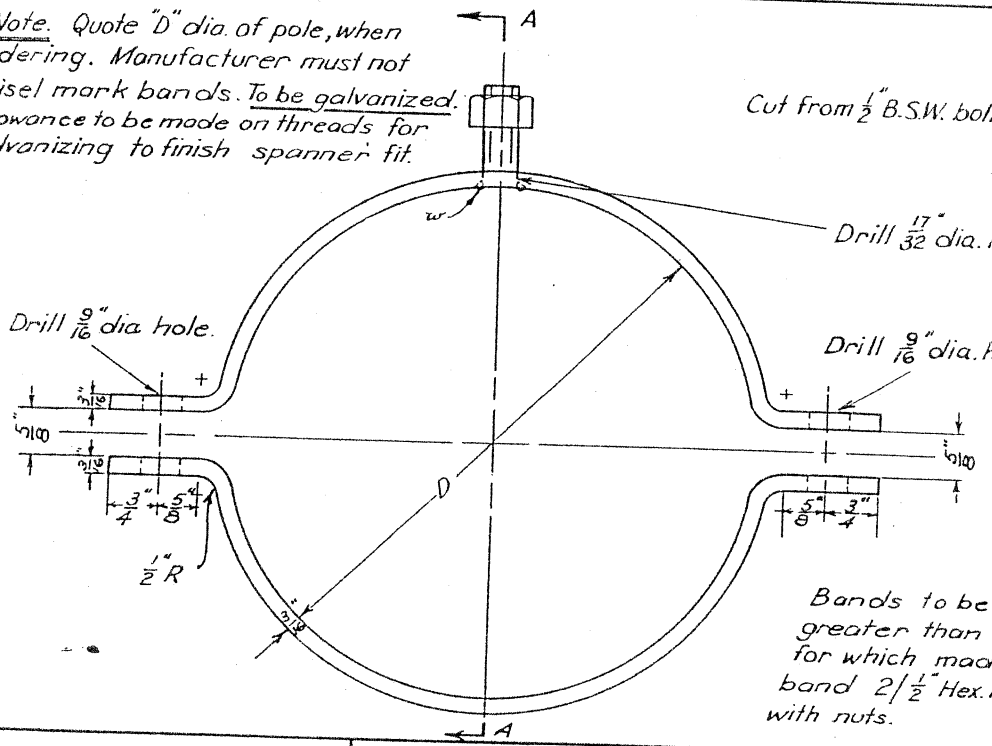
013-625 B

SCALE 1:48

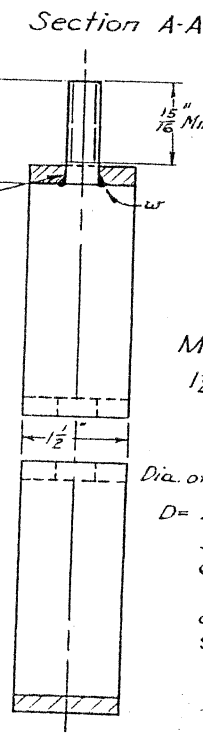
Pole Band
Cross Arm Brace

013-490

Note. Quote "D" dia. of pole, when ordering. Manufacturer must not chisel mark bands. To be galvanized. Allowance to be made on threads for galvanizing to finish spanner fit.



Section A-A



Material
$1\frac{1}{2}" \times \frac{3}{16}"$ M.S.

Dia. of Pole.	Shedule Item.
D= $4\frac{1}{2}"$	70/7
$5\frac{1}{2}"$	70/8
$6\frac{1}{2}"$	70/9
$7\frac{1}{2}"$	70/10
$8\frac{1}{2}"$	70/11
$9\frac{1}{2}"$	70/12

Bands to be open 1/16" to 1/8" greater than the size of pole for which made. Also, off per band 2/1/2" Hex. head bolts 2" long, with nuts.

Amendments.

Reference.

POLE BAND
CROSSARM BRACE

MELBOURNE & METROPOLITAN TRAMWAYS BOARD

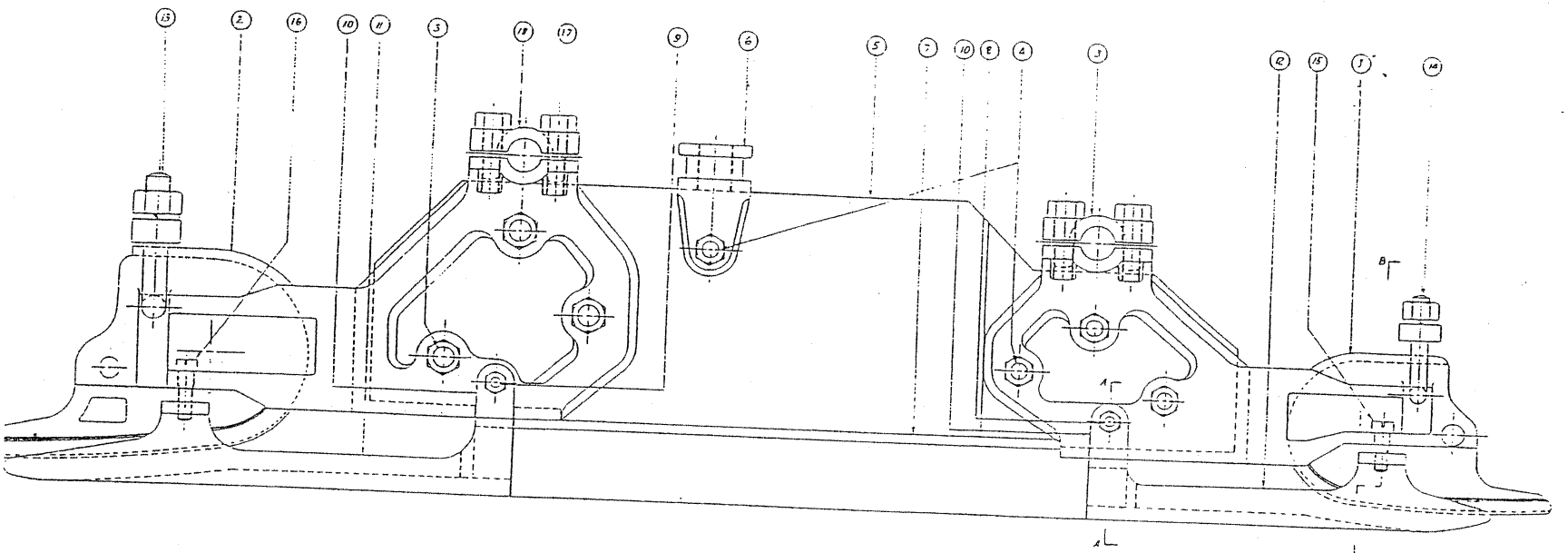
DATE

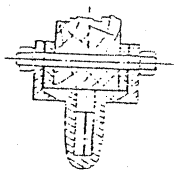
CHIEF ENGINEER

DRAWN	TRACED	CHECKED	PASSED	APPROVED
B.T.W.				

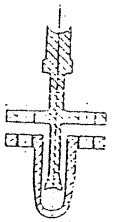
013-490

1/2 full size

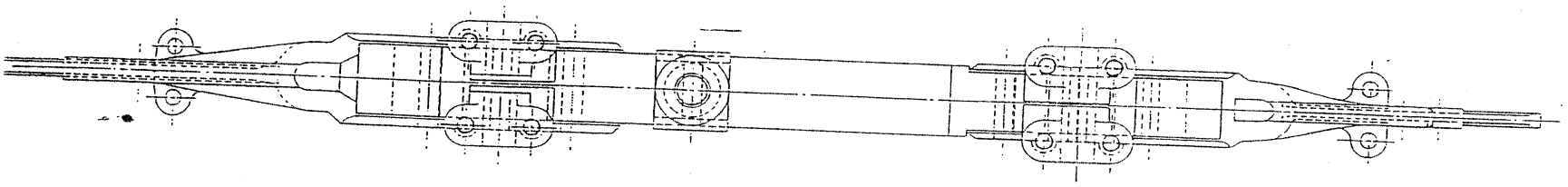




SECTION A-E



SECTION B-B



ITEM No	MATERIAL	No. OFF PER INSULATOR	Drg No
18	Jumper Clamp (Gunmetal)	2	012-287
17	3/8" B.S.W. x 1" Cadi. Screw c/w Spring Washer	8	
16	Chase Head Screws 1/4" B.S.W. x 1 1/2"	2	
15	Chase Head Screws 5/16" B.S.W. x 1"	2	
14	5/8" B.S.W. U Bolt c/w Main Nuts & Spring Washers	1	012-335
13	12" B.S.W. U Bolt c/w Plate, Nuts & Spring Washers	1	012-353
12	End Runner 0.126 (Gunmetal)	1	012-338
11	End Runner 0.2 (Gunmetal)	1	012-360
10	Runner Clip	4	013-749
9	1" B.S.W. x 3 1/4" S.S. Threaded Rod	1	012-359
8	1" B.S.W. x 3" S.S. Threaded Rod	1	012-336
7	Insulation Runner 0.2 / 0.126	1	012-330
6	Suspension Saddle (Gunmetal)	1	014-204
5	Insulating Beam	1	012-330
4	1/2 B.S.W. x 2 1/2" S.S. c/w Nut washer & Spring Washer	1	014-203
3	7/16 B.S.W. x 3" S.S. c/w Nut washer & Spring washer	4	
2	Main Casting 0.2 Trailing (Gunmetal)	3	
1	Main Casting 0.126 Trailing (Gunmetal)	1	012-360

REFER NEW TABLE

14	Mild Steel (Bolt)	1	102-330
13	Mild Steel (Plate)	1	102-3531
12	Gunmetal	1	102-338
11	Gunmetal	1	102-360
10	Gunmetal	14	102-3371
9	[illegible]	2	102-330
8	Mild Steel	1	013-7561
7	Gunmetal	1	102-2901
6	Cast Iron	1	102-2501
5	Manganese Bronze	3	102-2561
4	Manganese Bronze	3	102-3561
3	Gunmetal	4	102-2871
2	Gunmetal	1	102-3321
1	Gunmetal	1	102-3351
	Material		Material / Drg No

For material list refer Drg No. X1455

Complete Assembly Sch/Item 68/209

REFERENCE

-2 & -126 COMBINATION
SECTION INSULATOR
FOR CARBON INSERT COLLECTOR SHOE
GENERAL ARRANGEMENT

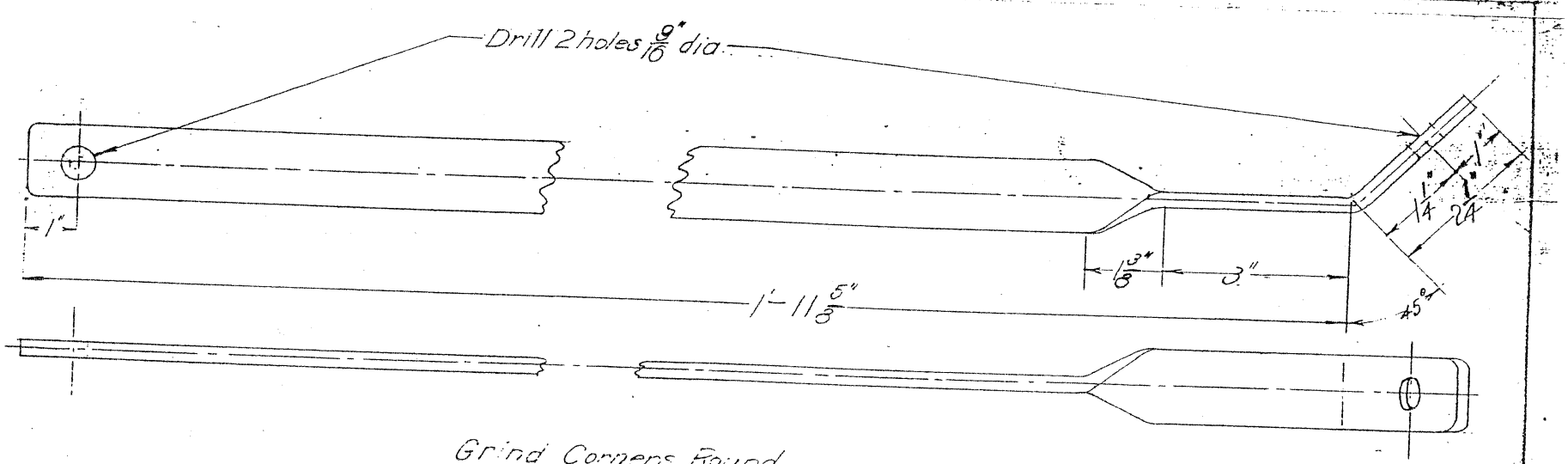
MELBOURNE & METROPOLITAN TRAMWAYS BOARD

013-356 A B C D

SCALE Full Size

Cross Arm Brace
4 Feeder Arm

013-196



Material: 1/4" x 1" MS
To be Galvanized

S/Sch 70/149

Amendments	Reference

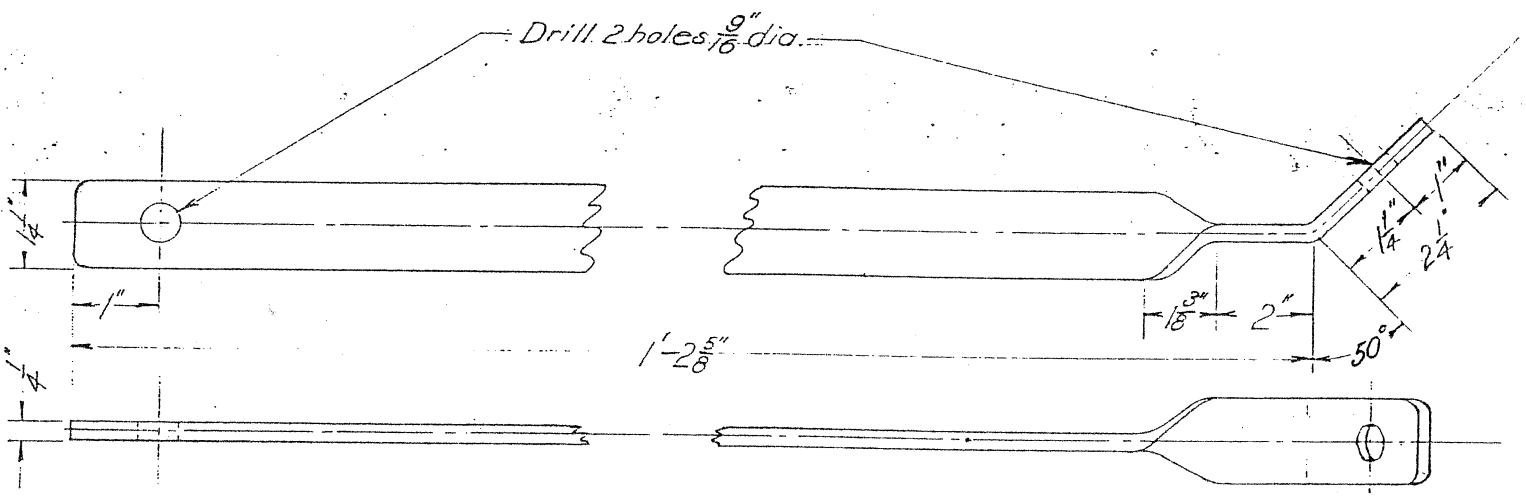
CROSS ARM BRACE
4 FEEDER ARM

MELBOURNE & METROPOLITAN TRAMWAYS BOARD

DATE	CHIEF ENGINEER
1-6-62	
DRAWN BWM	TRACED BWM/BL
013-196	
SCALE 1/2 Size	

Cross Arm Brace - 2 Feeder Arm

013-195

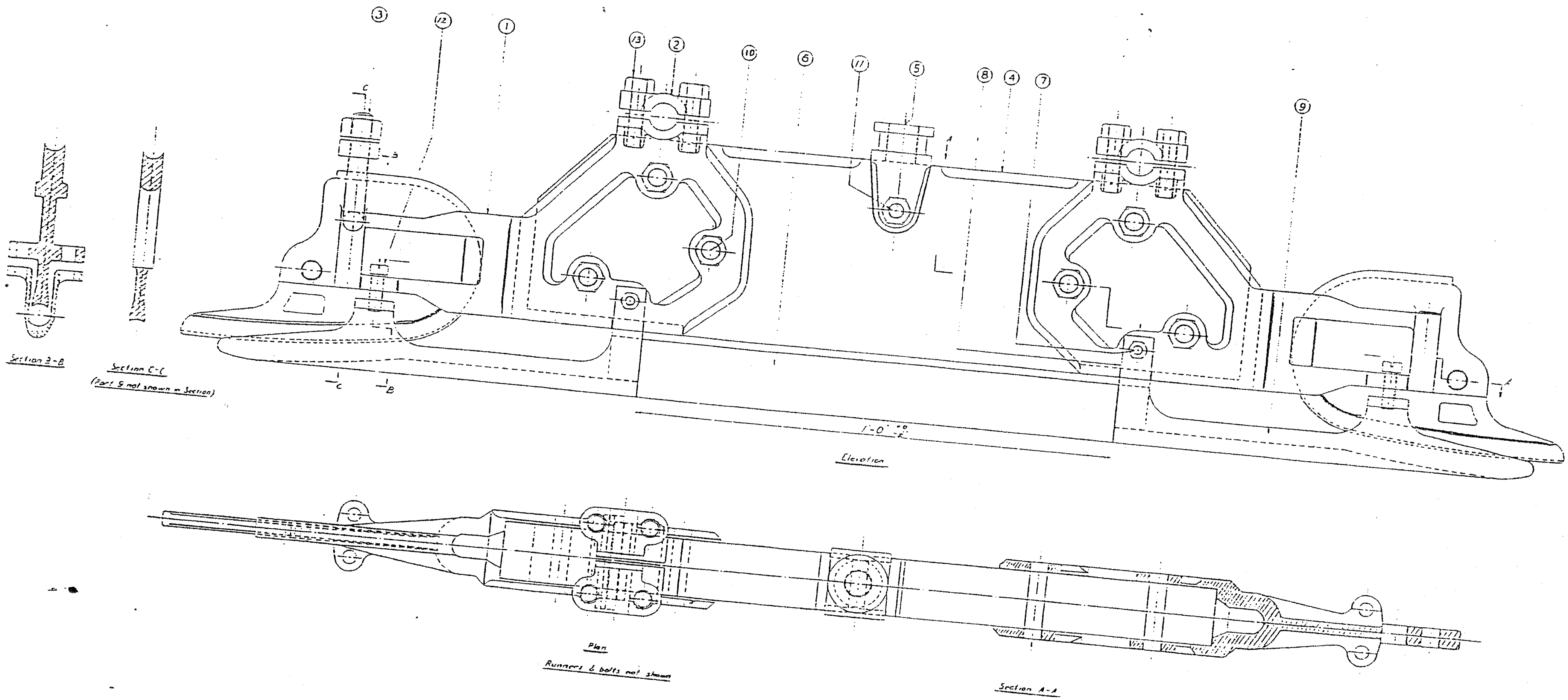


Grind Corners Round

Material: 1/4" x 1/4" M.S.
To be Galvanized

S/Sch 70/148

Reference	CROSS ARM BRACE 2 FEEDER ARM	BOURNE & METROPOLITAN TRAMWAYS BOARD DATE 4-6-62 CHIEF ENGINEER DRAWN B.H.V. TRACED CHECKED PASSED APPROVED 013-195 SCALE 1/2 Size
Amendments		



Item No	Material	No off per insulator	Drg No
13	3/8" BSW x 1" Cap Screw c/w Spring washer	8	—
12	5/16" BSW x 1¼" Cheese head Screw Zinc Plated	4	—
11	3/8" BSW x 2½" c/w Nut, Washer & Spring washer	1	—
10	5/16" BSW x 3" SS c/w Nut Washer & Spring washer	6	012-356
9	End Runner O2 (Gunmetal)	2	012-360
8	Runner Clip	4	013-749
7	¼" BSW x 3⅞" SS Threaded Rod c/w Nuts & Spring Washers	2	—
6	Insulation Runner O2	1	014-202
5	Suspension Saddle (Gunmetal)	1	012-290
4	Insulating Beam	1	014-201
3	½" BSW "U" Bolt c/w Plain Nuts & Spring washer	2	012-353
2	Jumper Clamp (Gunmetal)	4	012-287
1	Main Casting O2 Trolley (Gunmetal)	2	012-355

FOR MATERIAL LIST REFER DRG No X1253
Complete Assembly Schedule & Item No 66/205

REFERENCE
Replaces - Same number
Supersedes Drg 012 255

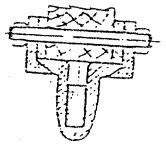
0·2 SECTION INSULATOR FOR USE WITH CARBON INSERT COLLECTOR SHOE GENERAL ARRANGEMENT

REFER NEW TABLE

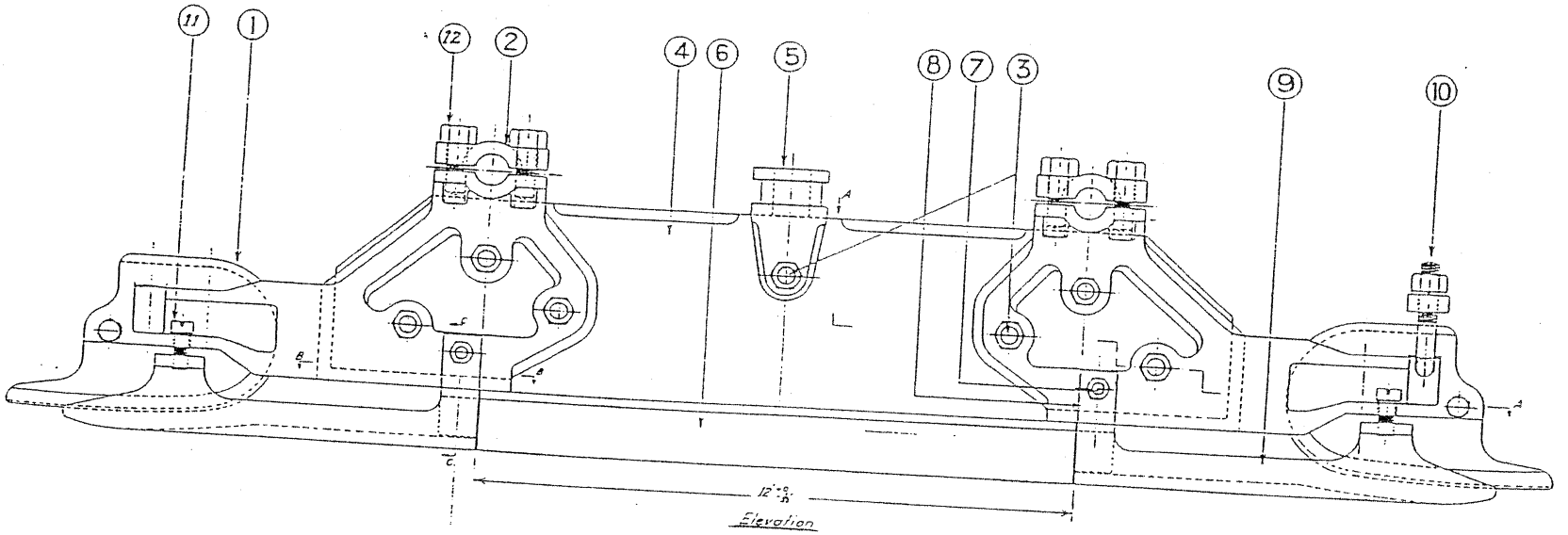
No	Material		Drg No
10	Aluminium Bronze	16	012-356
9	Gunmetal	12	012-360
8	Gunmetal	14	013-749
7	Mild Steel	2	012-359
6	Bran Graded Sheet	11	013-754
5	Gunmetal	1	012-290
4	[illegible]	12	012-357
3	IMS [illegible]	12	012-353
2	Gunmetal	14	012-287
1	Gunmetal	12	012-355

MELBOURNE & METROPOLITAN TRAMWAYS BOARD

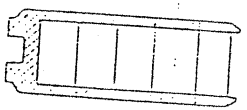
7631468



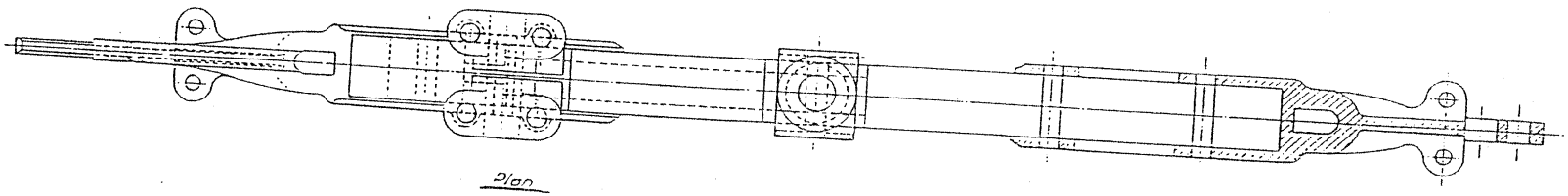
Section C-C



Elevation



Section B-B



Plan

Section A-A

12	[illegible]	8	
11	[illegible]	4	
10	[illegible]	1	
9	[illegible]	2	012-338
8	[illegible]	2	012-338
7	[illegible]	4	013-745
6	[illegible]	1	
5	[illegible]	1	OM-200
4	[illegible]	1	012-280
3	[illegible]	1	OM-195
2	[illegible]	1	
1	[illegible]	2	012-255

REFER NEW TABLE

16	Mild Steel	2	012-338
9	Gunmetal	2	012-338
8	Gunmetal	4	013-745
7	MILD STEEL	1	012-336
6	Resin Bonded Sheet	1	013-755
5	Gunmetal	1	012-280
4	Spotted Gum or Teak	1	012-338
3	Aluminium Bronze	6	012-288
2	Gunmetal	1	012-255
1	Gunmetal	2	012-338

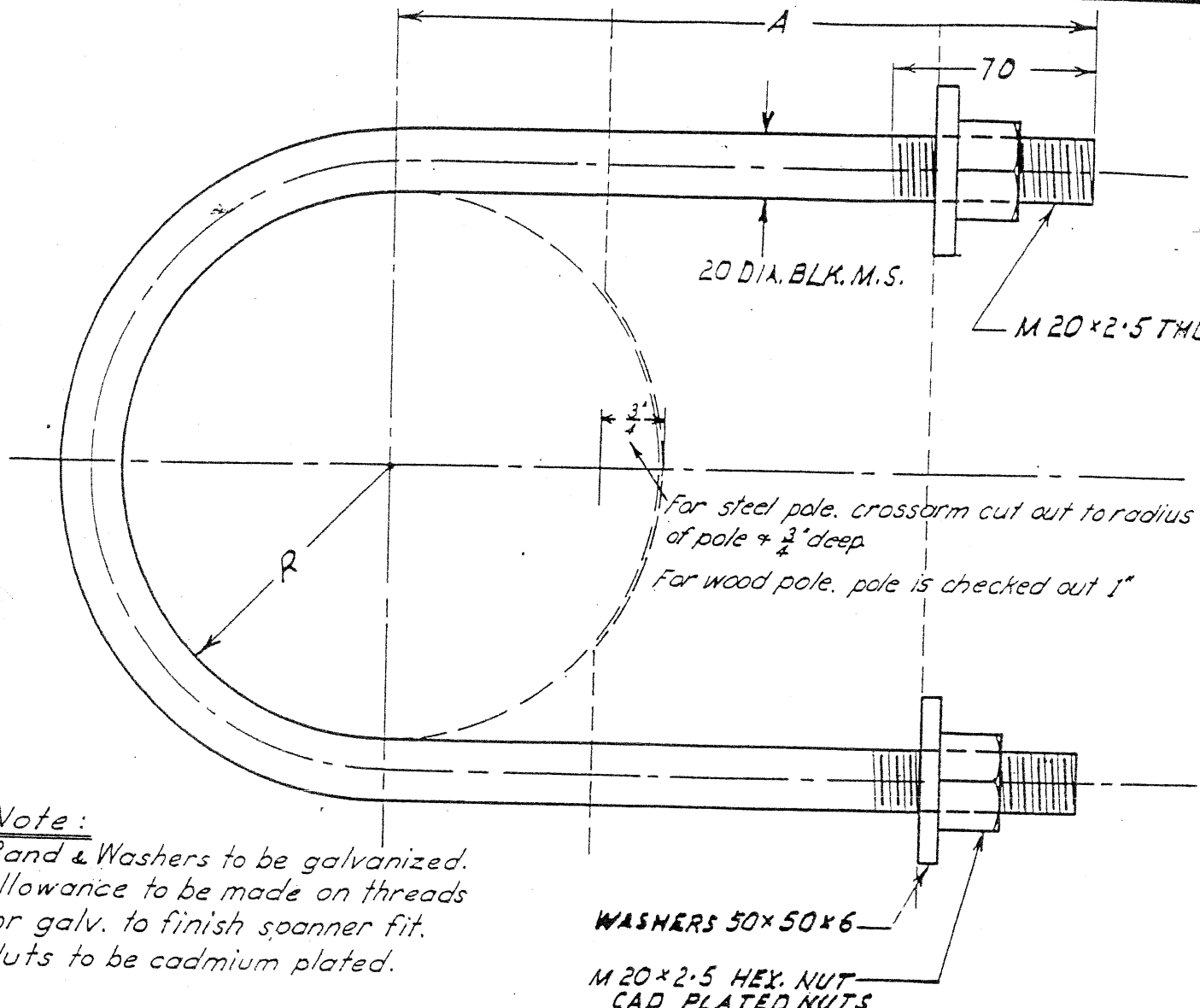
FOR MATERIAL LIST REFER DRG. No. X1685/1

COMPLETE ASSEMBLY SERIES 6 ITEM No. 20

126 SECTION INSULATOR

FOR USE WITH

MELBOURNE & METROPOLITAN TRAMWAYS BOARD



Note:
Band & Washers to be galvanized.
Allowance to be made on threads for galv. to finish spanner fit.
Nuts to be cadmium plated.

	Dia. of Pole.	R mm	A mm	SCH./ITEM
Steel Poles	4½"	2¼" (57)	7½" (190)	70/179
	5½"	2¾" (70)	8" (200)	/180
	6½"	3¼" (83)	8½" (215)	/181
	7½"	3¾" (95)	9" (230)	/182
	8½"	4¼" (108)	9½" (240)	/183
	9⅝"	4 13/16" (122)	10" (255)	/178
Wood Pole	9½"	4¾" (121)	10" (255)	/184
	10½"	5¼" (133)	10½" (270)	/185
	11½"	5¾" (146)	11" (280)	/186

DIA. OF POLE TO BE QUOTED WHEN ORDERING.

REV. C-METRICATED
Revision B 13·3·68 D.E.W.
Note extended to cover washers & nuts.
5/8" Φ Pole included in table. Second line added to Title.

C- 3·6·80
Revision ~~A~~. 7·8·62.

20mm U Bands for 6×4 H.W. Crossarms on Steel or Wood Poles

MELBOURNE & METROPOLITAN TRAMWAYS BOARD

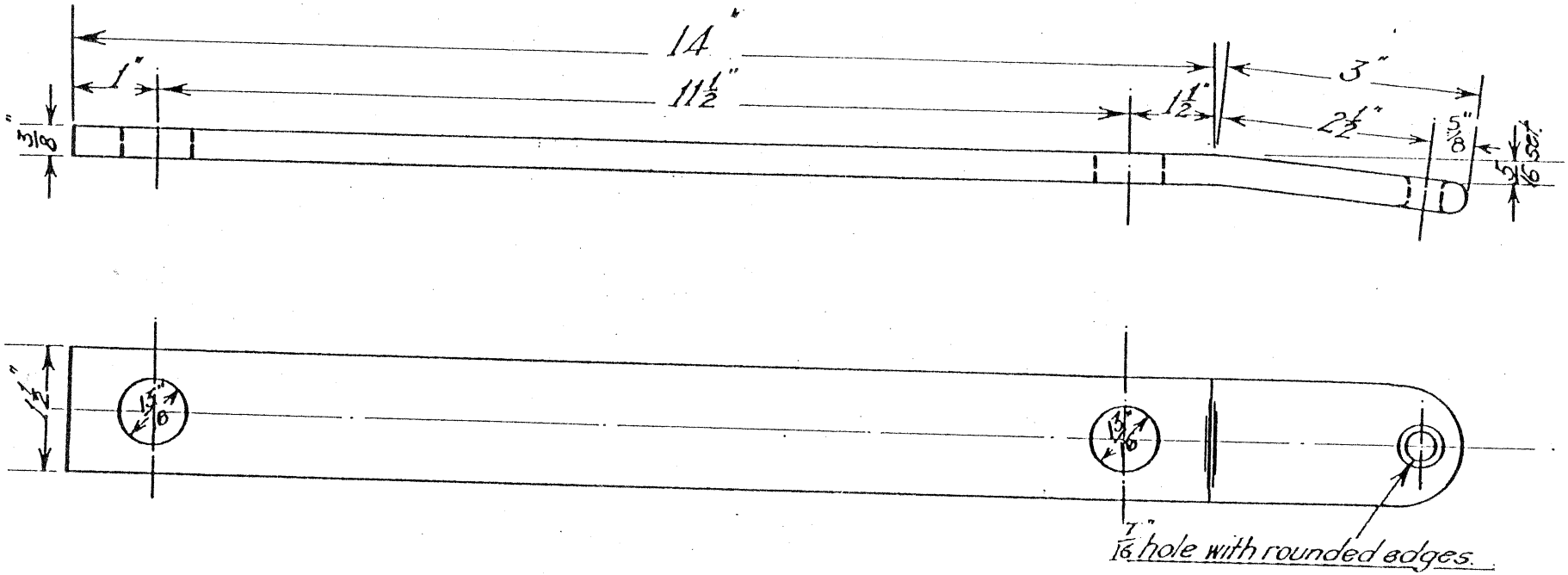
Date 2nd·10·43 Engineer.

Drawn	Traced	Checked	Passed
W. W.	19-10-43		30-10-43

Scale

MELBOURNE & METROPOLITAN TRAMWAYS BOARD

Double Anchor Bar



Out of 1½" x ⅜" M.S. galvanized.

Rev.	Date	Description	Drawn	Appd
A	4·10·41	End hole dia. & end distance amended	[illegible]	[illegible]

MELBOURNE & METROPOLITAN TRAMWAYS BOARD

Date | Chief Engineer.

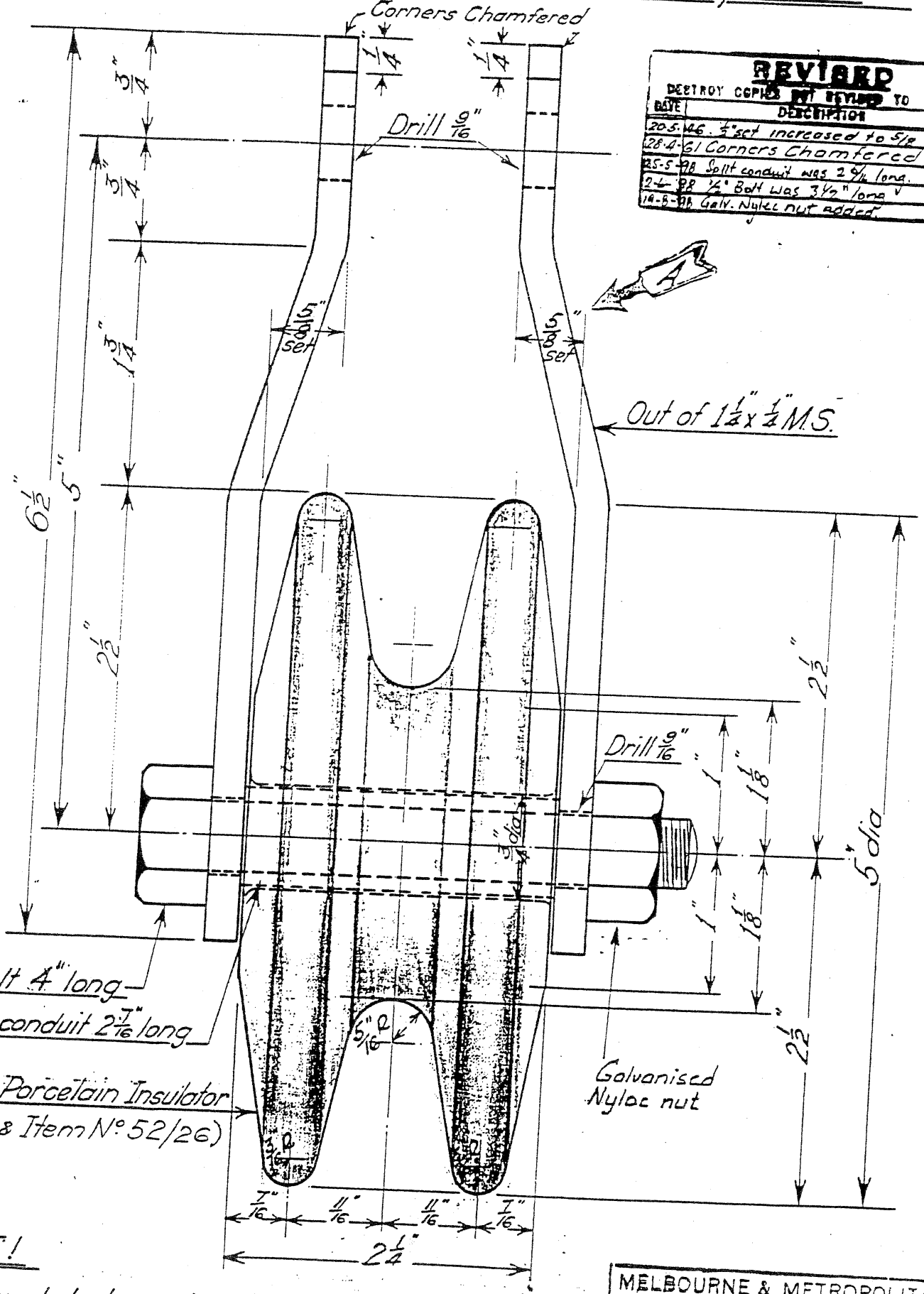
Drawn [illegible] 5·9·36 | Traced | Checked [illegible] | Passed

Scale Half Full Size

07465

...TRAMWAYS BOARD

5" Reel Insulator & Shackle for Spans



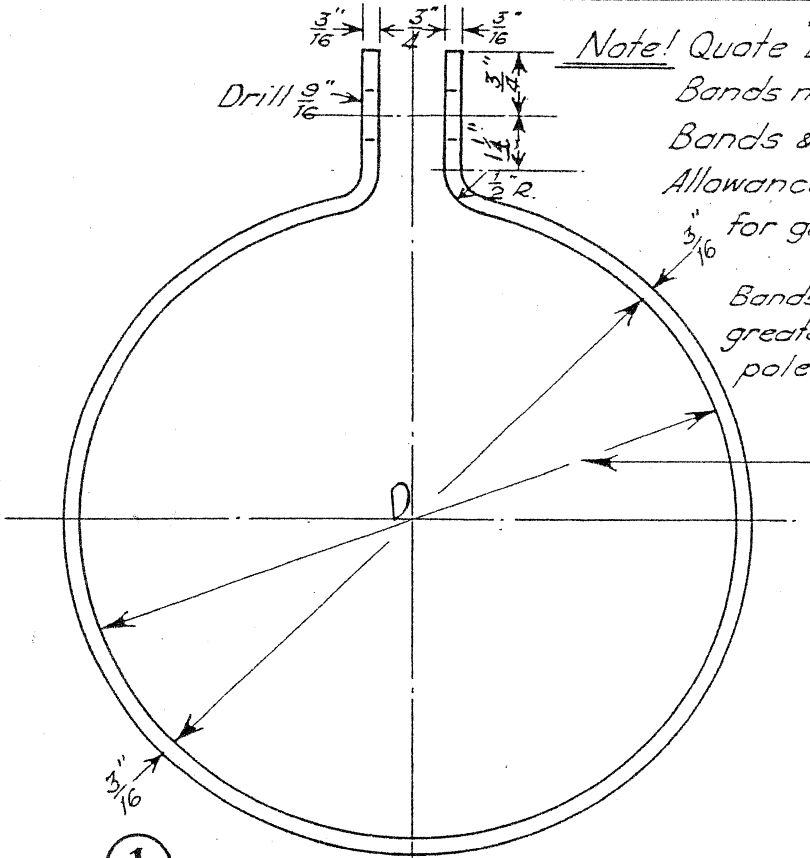
REVISED		
DATE	DESCRIPTION	LETTER
20-5-46	4" set increased to 5/8	A
28-4-61	Corners Chamfered.	B
25-5-78	Split conduit was 2 3/4" long.	C
2-6-78	1/2" Bolt was 3 1/2" long	D
14-8-78	Galv. Nylac nut added.	E

NOTE!

Metal work to be galvanized. Allowance to be made threads for galv to finish spanner fit.

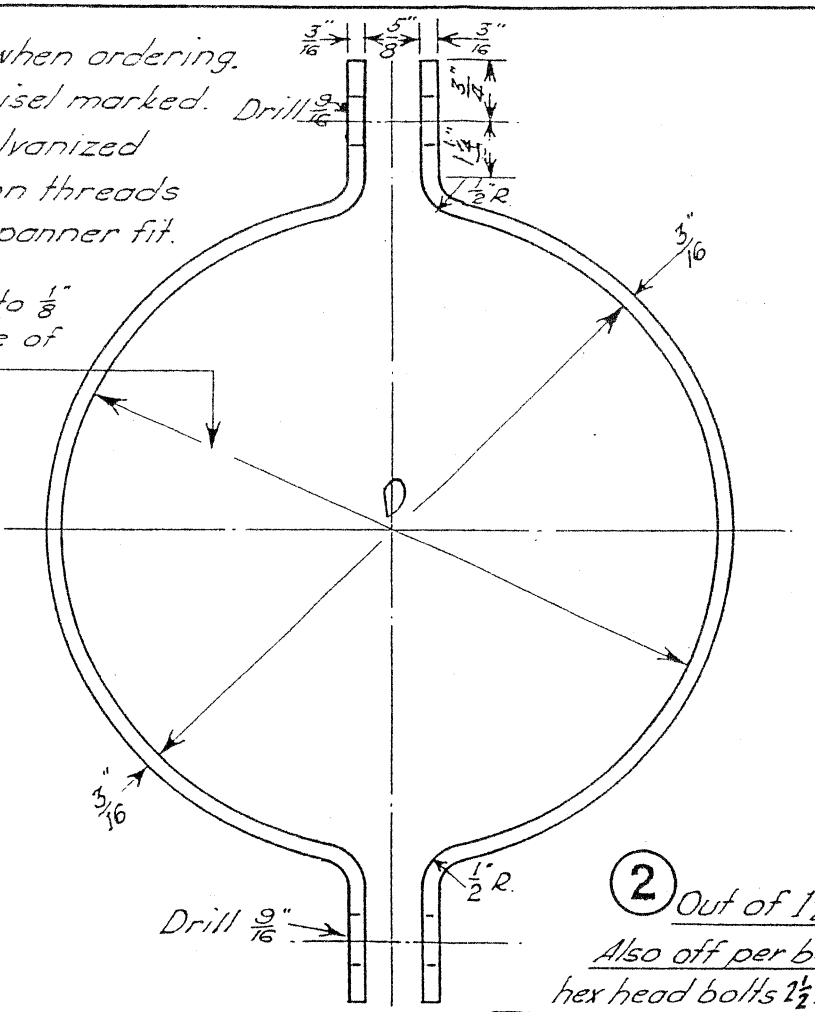
Shackle :- Sch. No 68 Item No 170

MELBOURNE & METROPOLITAN TRAMWAYS BOARD			
Date 26-10-55.	Chief Engineer.		
Drawn	Traced 26-5-36	Checked 27.5	Passed
Scale Full Size	0736 4 E		27.5



Note! Quote "D" dia of pole when ordering.
Bands must not be chisel marked.
Bands & bolts to be galvanized
Allowance to be made on threads for galv. to finish spanner fit.

Bands to be open 1/16" to 1/8" greater than the size of pole quoted



(1) Out of 1½" x 3/16" M.S.
Also off per band 1 1/2" hex head bolt 2½" long with nut (Galv.)

(2) Out of 1½" x 3/16" M.S
Also off per band 2 1/2
hex head bolts 2½" long & nu

A - 2½" Bolt was 2" 7-11-1997
B - 1¼ Dimension was 5/8" 25-5-1998.

REFERENCE
Retraced same No

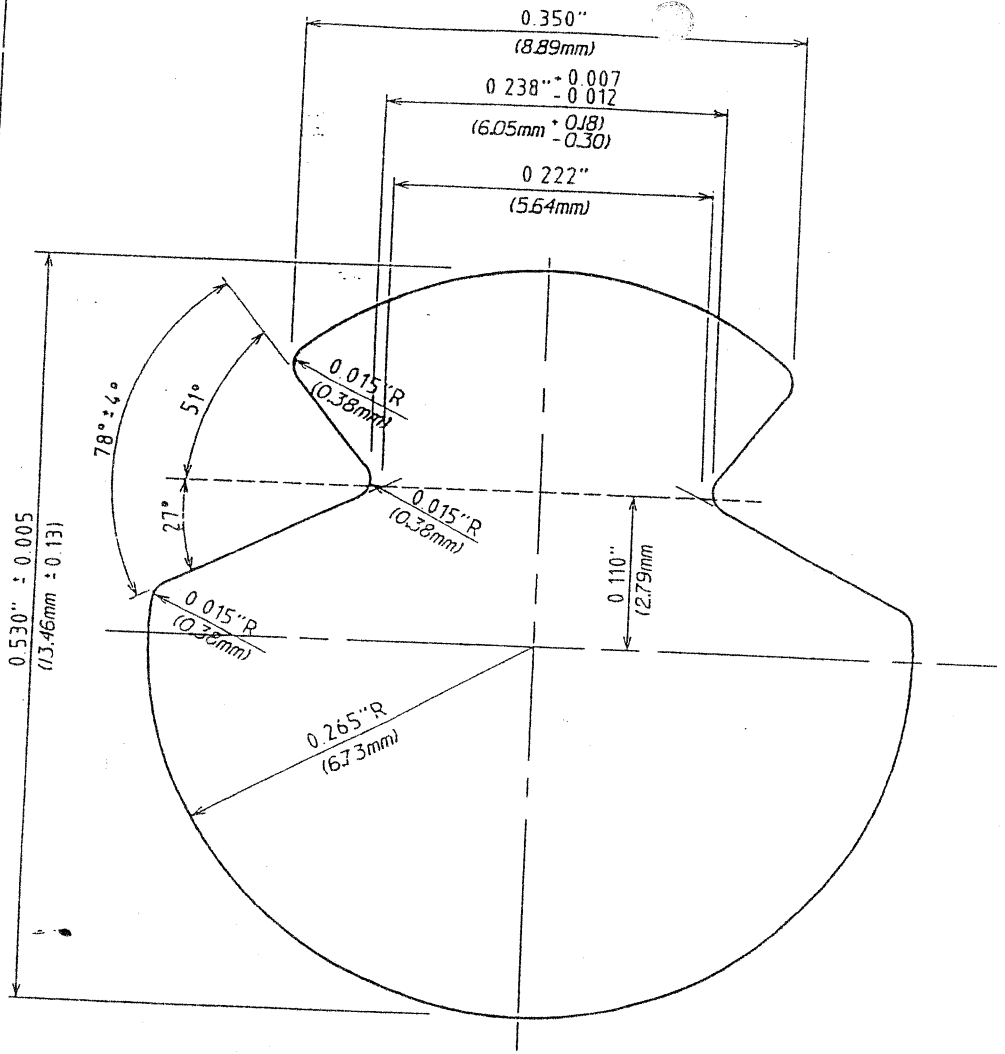
POLE BANDS.

MELBOURNE & METROPOLITAN TRAMWAYS BOARD

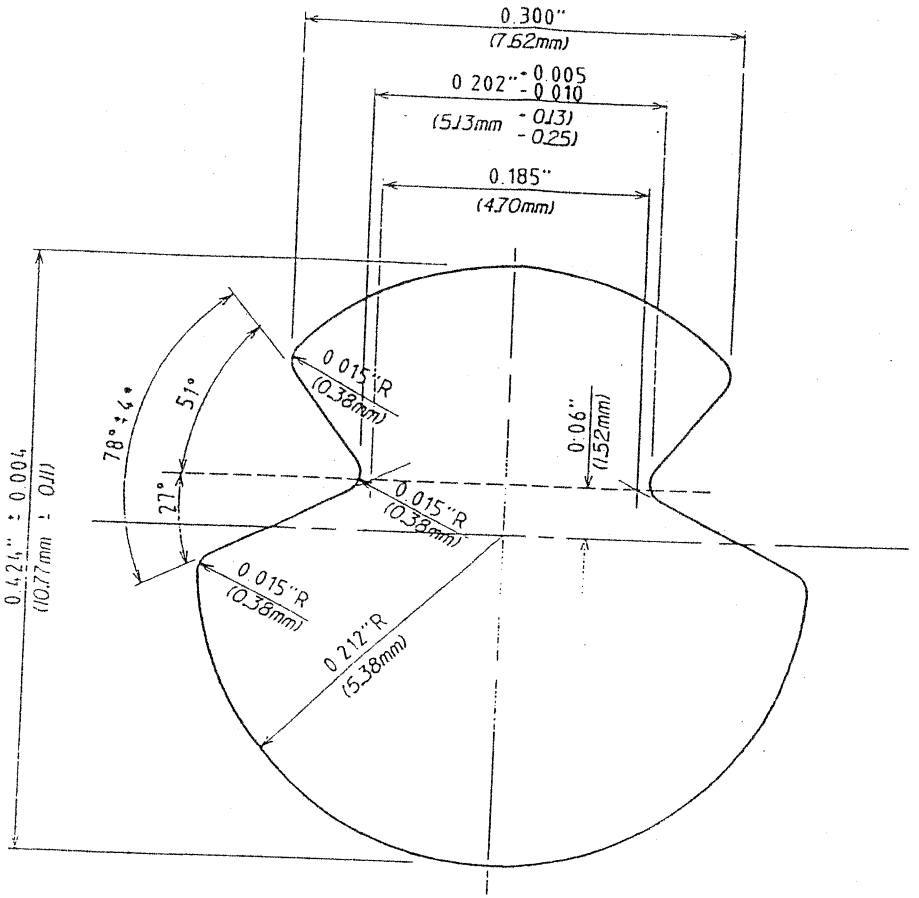
DATE				
16/12/57	F. R. Kelly for CHIEF ENGINEER			
DRAWN	TRACED	CHECKED	PASSED	APPROVED
	27-11-57			

06897 | A | B

SCALE, Nil.



SECTION AREA 0.2 sq.in.
(129 sq. mm)



SECTION AREA 0.126 sq.in.
(81 sq. mm)

AMENDMENTS				
REV	DATE	DESCRIPTION	DRAWN	APP'D
C	9/9/93	REDRAWN AND METRICATED ON CADD	J D T	
D	24/10/95	TOLERANCES REMOVED	J D T	

TRAM O/H DESIGN ENGINEER

CHECKED

J.D.TINKLER
DRAWN

D

PTC TRAM INFRASTRUCTURE GROUP

MANAGER - TRAM OVERHEAD

TROLLEY WIRE CROSS SECTIONS
0.2 sq.in / 0.126 sq.in.
(129 sq. in.) / (81 sq. in.)

SCALE HORIZONTAL VERTICAL 10:1

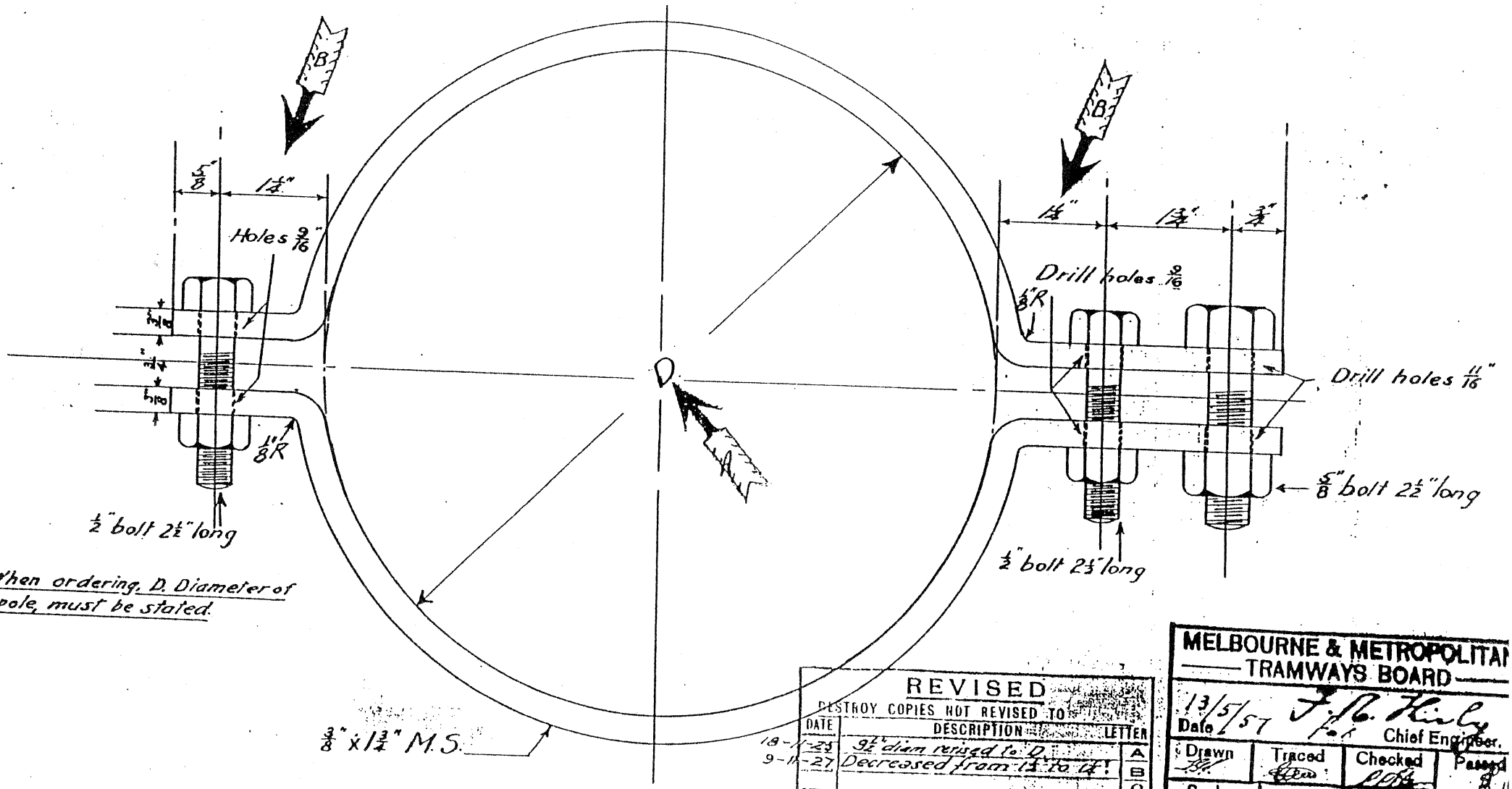
DATUMS COORDINATES LEVELS

INDEX NUMBER | DRAWING NUMBER | REV

MELBOURNE & METROPOLITAN TRAMWAYS BOARD

SPLIT POLE BAND FOR USE IN BACK ANCHORINGS.

To be galvanized. Allowance to be made on threads for galv to finish spanner fit.



REVISED
DESTROY COPIES NOT REVISED TO

DATE	DESCRIPTION	LETTER
18-1-23	9½" diam revised to D	A
9-1-27	Decreased from 1¾ to 1¼	B
		C
		D
		E

MELBOURNE & METROPOLITAN TRAMWAYS BOARD

Date 13/5/57 F.A. Kirby Chief Engineer.

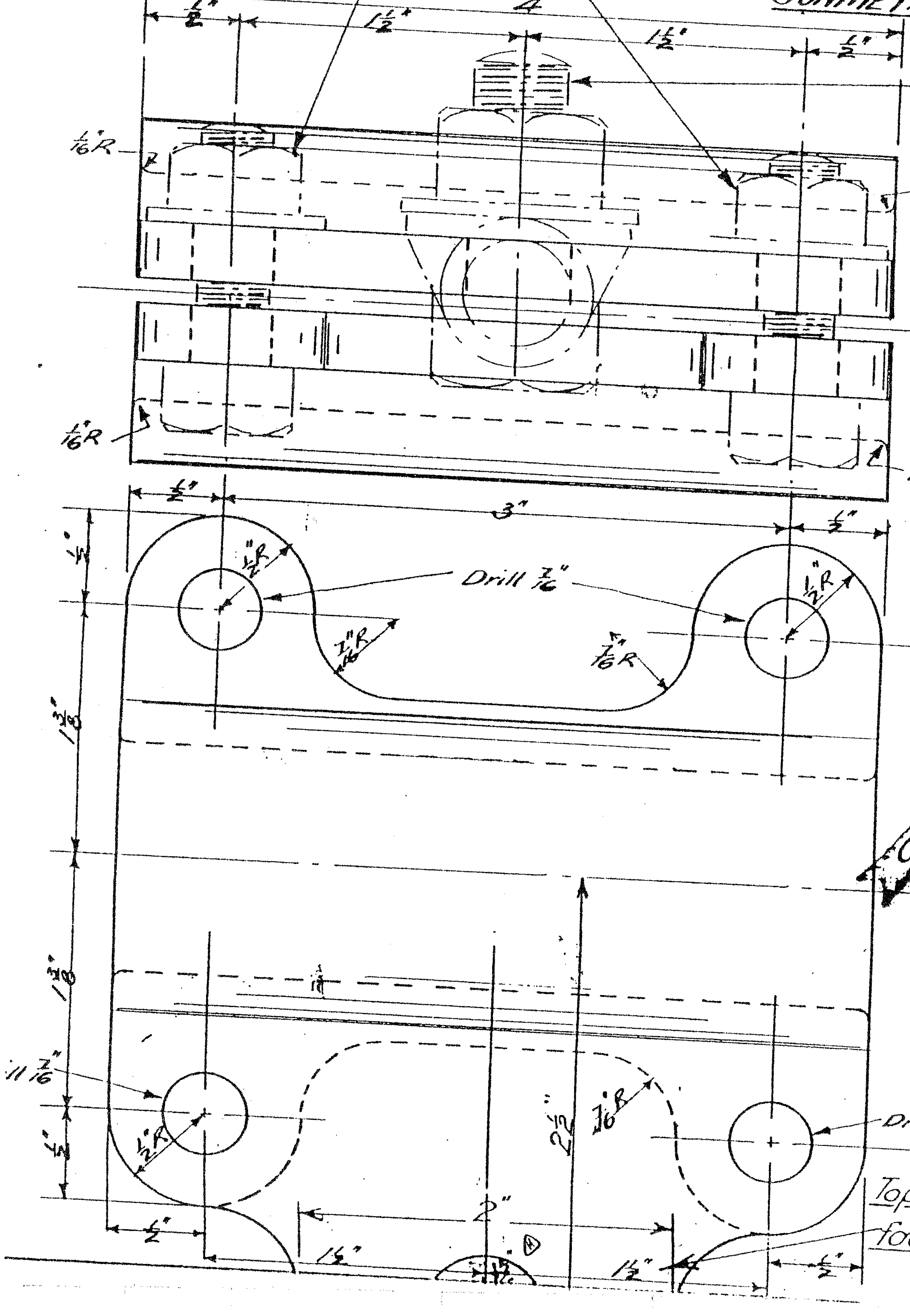
Drawn	Traced	Checked	Passed

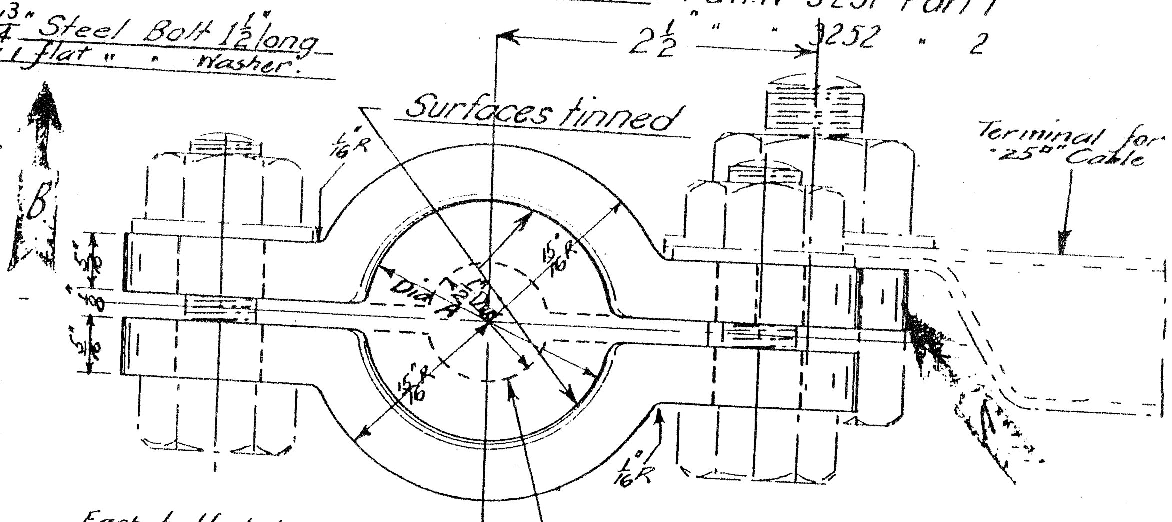
Scale Half/Full Size

0923

MELBOURNE & METROPOLITAN TRAMWAYS BOARD

GUNMETAL TERMINAL FOR FEEDER TAP
Patt. Nº 3251 Part 1
" " 3252 " 2





Each half to be cast to dotted lines shown. A to be machined as specified on order when fitting is bolted together and packing pieces in 1/8" drawn. (F)

Note! Size of Terminal to be stamped on castings. For different sizes of cable A varies as follows:-

·6 Rope lay A = 1 3/16"	·5 Concentric A = 5/8"
·5 " " A = 1 1/16"	·3 " " A = 3/8"
·3 " " A = 7/8"	·6 " " A = 1 3/32
	·2 " A = 5/8

COMPOSITION OF GUNMETAL	
COPPER	88%
ZINC	2%
TIN	10%

Note! Steel bolts & nuts ~~& nuts~~ to be galvanized. Allowance to be made on threads for galvanizing to finish spanner fit. (D)

·3 Folio Nº 7/1143
·5 Folio Nº 7/1144
·6 Folio Nº 7/1145

17.12.90	15/16 WAS 11/16, 3/4" BOLT WAS 5/8 φ	H

REVISED
DESTROY COPIES NOT REVISED TO

DATE	DESCRIPTION	LETTER
20.9.28	Lip to take Terminal made Larger	A
10.4.34	5/8 Steel bolt in place of 1/2 Gunmetal	B
10.11.34	Measurements decreased 1/16"	C
25.6.36	Lip to be faced & tinned	D
25.11.36	Additional measurement for ·6 con.	E
16.5.50 / 14.12.62	Size to stamped on castings / ·2 Con Cable	F / G

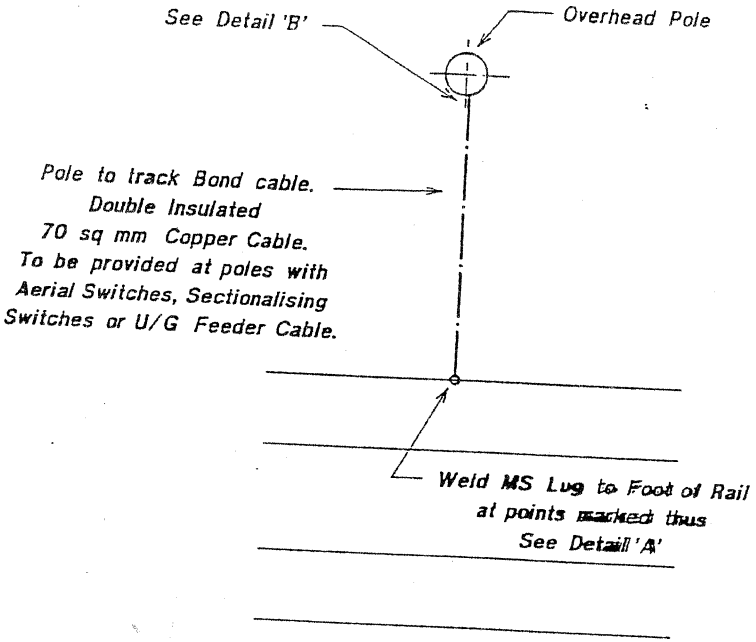
MELBOURNE & METROPOLITAN TRAMWAYS BOARD

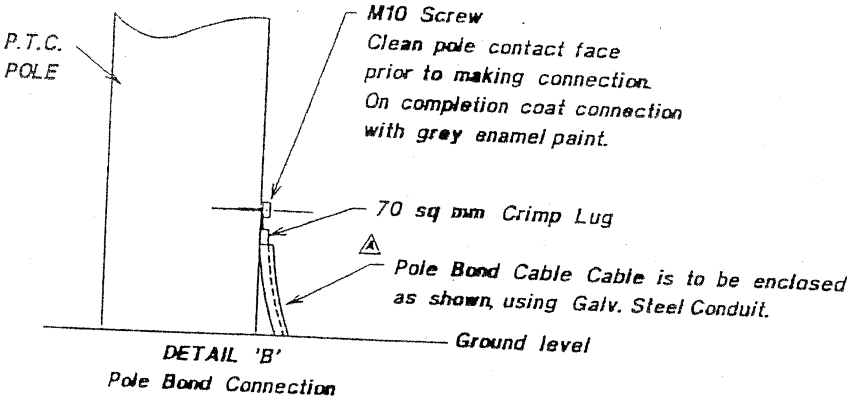
[signature] Chief Engineer.

Date 7.11.23.

Drawn	Traced	Checked	Passed
N.M.H.	N.M.H.	[signature]	[signature]

Scale



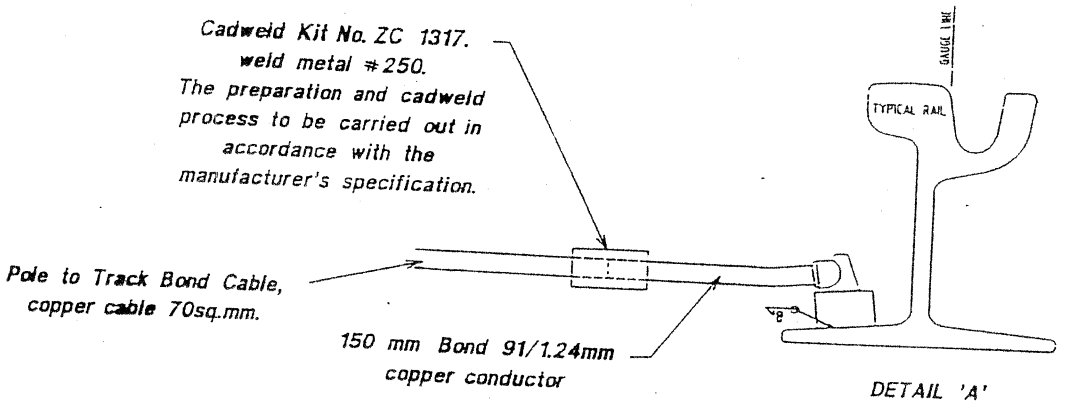


DETAIL 'B'
Pole Bond Connection

Note:

1.. All cables must have minimum cover of 750mm under the roadway from the edge of track apron to the kerb

2.. Attention is to be paid to the condition and cleanliness of the cable ends being connected.



DETAIL 'A'

AMENDMENTS					
REV.	DRAWN	DATE	DESCRIPTION	APP'D	
A	DMAN	3-2-95	Pole bond enclosure added.	B.Held	

APPROVED

CHECKED
D. Nankervis
27-5-94.
DRAWN

DESIGNED

P.T.C ENGINEERING SERVICES GROUP

B. Held 3/2/95
MGR. TRAM INFRASTRUCTURE DESIGN

POLE TO TRACK BONDING MAINTENANCE WORK

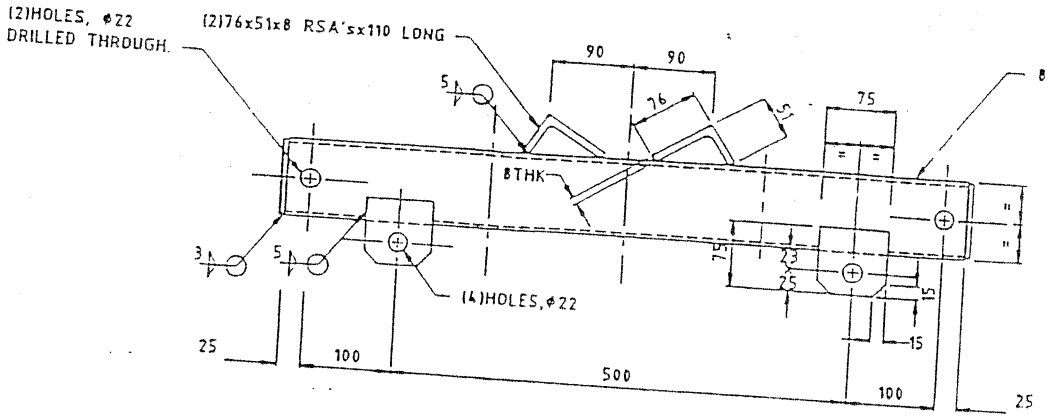
SCALE:
HORIZONTAL NOT TO
VERTICAL SCALE

DRAWING NUMBER E14-555

REV. A

PLOTDATE:

I:/bonds/e14555.dgn Feb. 3, 1995 14:39:30



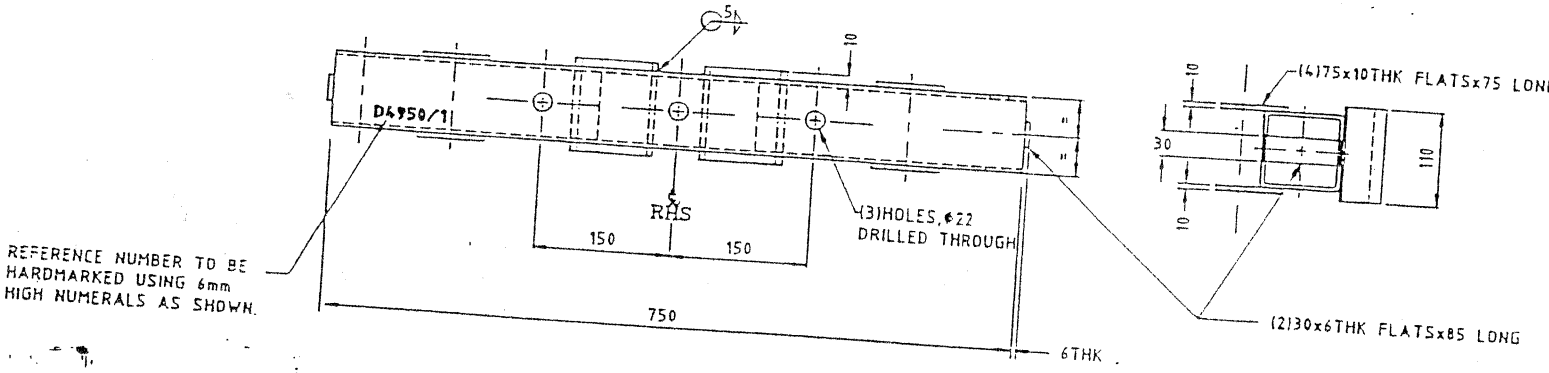
MATERIAL:- RHS TO AS1163 GRADE 250 (OR HIGHER)
RSA & FLAT TO AS1204 GRADE 250

WELD:- SIZE & TYPE AS SHOWN. TO BE IN ACCORDANCE WITH AS1554 TYPE SP

SHARP EDGES TO BE REMOVED PRIOR TO GALVANIZING

FINISH:- HOT DIPPED GALVANIZED TO AS1650 AFTER FABRICATION

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED



REFERENCE No. D4950/1

MASS = 11.9kg.

	REV'N	DATE	DESCRIPTION	REV'D	CHKD.	SECT.	HOR MPSES

PREPARED BY OVERHEAD DESIGN 1991.

DESIGNED TRW	DRAWN A.CALVANO
DESIGN CHECK	DRAFTING CHECK RF
CORRES CAD/3.	DRAFTING PASS
DESIGN PASS	

P.T.C.

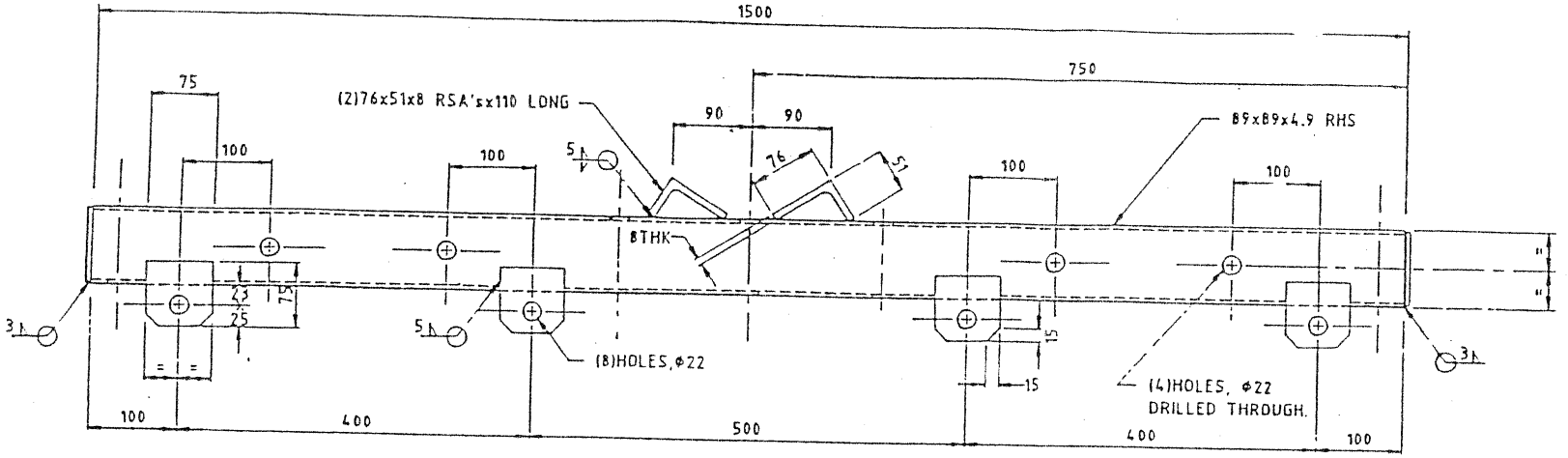
ANCHOR CROSS-ARM FOR (2) FEEDER CABLES ON CIRCULAR POLES.

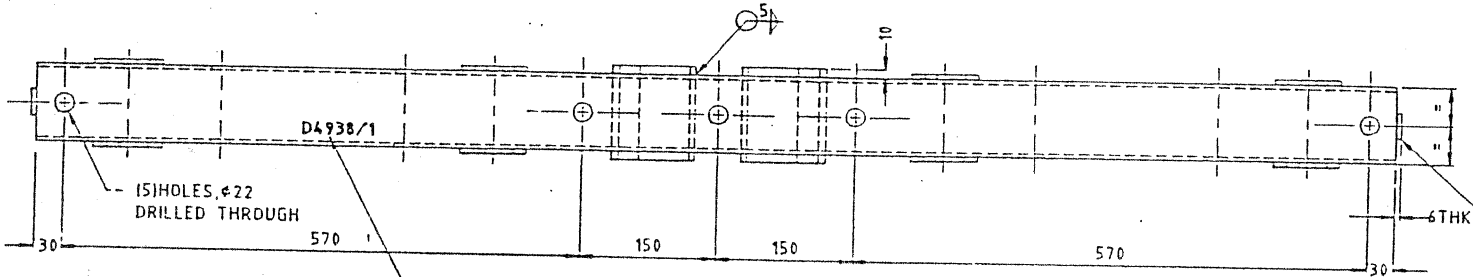
MANAGER POWER SYSTEMS ENG. SUPPORT.

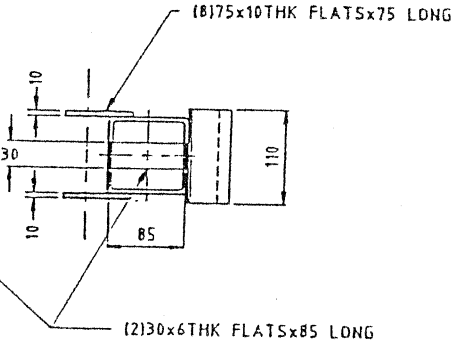
DATE MAY/91

SCALE N.T.S.

INDEX T&B FITTINGS







MATERIAL:- RHS TO AS1163 GRADE 250 (OR HIGHER)
RSA & FLAT TO AS1204 GRADE 250

WELD:- SIZE & TYPE AS SHOWN. TO BE IN ACCORDANCE WITH AS1554 TYPE SP

SHARP EDGES TO BE REMOVED PRIOR TO GALVANIZING

FINISH:- HOT DIPPED GALVANIZED TO AS1650 AFTER FABRICATION

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED

REFERENCE No. D4938/1

MASS = 22.2kg.

	REV'N	DATE	DESCRIPTION	REV'D	CHK'D.	SECT.	MGR MPSES
	A	MAY/91	TAB HOLES WERE Φ18,(4)Φ22 HOLES ADDED.	TRW			

DESIGNED TRW	DRAWN A.CALVAND
DESIGN CHECK	DRAFTING CHECK RF
CORRES CAD/3.	DRAFTING PASS
DESIGN PASS OVERHEAD DESIGN ENGINEER	

P.T.C.

ANCHOR CROSS-ARM FOR (4) FEEDER CABLES ON CIRCULAR POLES.

COMPONENT, NON-VARIABLE

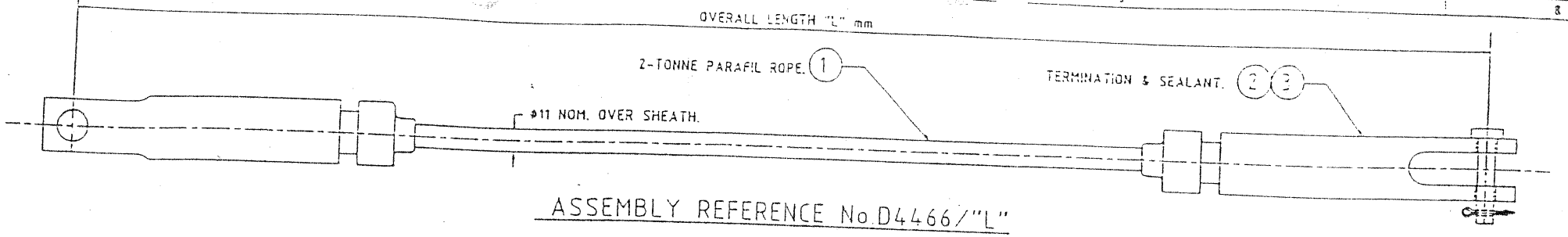
MANAGER POWER SYSTEMS ENG. SUPPORT.

DATE MARCH/91

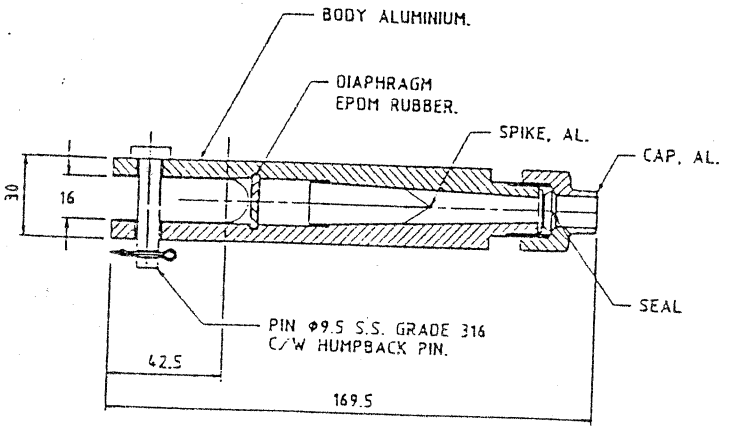
SCALE N.T.S.

INDEX T&B FITTINGS

A3 | DRAWING No. D4938 | REV. A



ASSEMBLY REFERENCE No.D4466/"L"



PARAFIL TERMINATION DETAIL
(PARAFIL ROPE OMITTED)

ALLOCATION AND LOADING.

ON ALL DATA SHEETS OR CROSS SECTIONS EACH ASSEMBLY TO THIS DRAWING SHALL BE DENOTED BY A SEPARATE REFERENCE.

AN ASSEMBLY REFERENCE NUMBER IS OBTAINED BY COMBINING THE DRAWING NUMBER WITH THE OVERALL LENGTH "L" EXPRESSED AS A NUMBER OF MILLIMETRES.

MAXIMUM TENSILE LOAD = 6.5 kN(WLL)

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.

ASSEMBLY INSTRUCTIONS.

REQUIRED LENGTH OF PARAFIL IS "L"-75mm

CAP, SEAL AND TERMINATION BODY TO BE THREADED ON ROPE BEFORE TRIMMING OUTER SHEATH.

TRIM SHEATH 52mm (LENGTH OF SPIKE) FROM END OF PARAFIL BY A A SINGLE CIRCUMFERENTIAL CUT. CORE DAMAGE TO BE AVOIDED BY LIMITING CUT DEPTH TO 90% OF SHEATH THICKNESS AND FLEXING TO SEVER REMAINING PART.

HOLD PARAFIL VERTICALLY SUCH THAT CORE FIBRES CASCADE EVENLY OVER ROPE AND TERMINATION BODY. REST TIP OF SPIKE IN CENTRE OF CORE WITH LIGHT FINGER PRESSURE THEN DRAW BOTH CORE FIBRES AND SPIKE INTO THE TERMINATION BODY.

TAP SPIKE FIRMLY HOME WHILE PULLING FIRMLY ON THE ROPE. CHECK THAT OUTER SHEATH IS NOT TRAPPED WITH SPIKE BY ROTATING ROPE ±30°

POSITION SEAL AND SCREW CAP TO TERMINATION BODY, FINGER TIGHT ONLY. COVER END OF SPIKE AND EXPOSED CORE WITH SILICON RUBBER COMPOUND AND INSERT DIAGRAM.

QTY	REMARKS.	MATERIAL REFERENCE	SUB. ASSY OR COMPONENT	DESCRIPTION.	ITEM NO
AS REQ'D	LOCTITE SUPERFLEX OR SIMILAR.		C	SILICON RUBBER SEALANT	3
2	SUPPLIED BY SOUTH EASTERN TRANSIT PTY LTD TO DRAWING SEA 3003	D4464/2	S-A	TERMINATION.	2
"L"-75	SUPPLIED BY NYLEX, MENTONE.	D4465/2	C	2-TONNE PARAFIL ROPE.	1

PREPARED BY O/H DESIGN 1990

	REV'N	DATE	DESCRIPTION	REV'D	CHK'D.	SECT.	MGR ASES

DESIGNED TRW	DRAWN A.CALVANO
DESIGN CHECK	DRAFTING CHECK
CORRES CAD/3.	DRAFTING PASS
DESIGN PASS	

P.T.C.

2-TONNE PARAFIL TIE WITH CLEVIS TERMINATION FITTINGS.

ASSEMBLY LENGTH VARIABLE

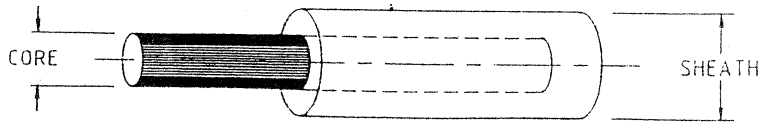
MANAGER POWER SYSTEMS ENG. SUPPORT

DATE 19/11/90

SCALE N.T.S.

INDEX TRAM FITTINGS.

DRAWING No. REV.



PARAFIL PARTICULARS.	UNITS	COMPONENT REFERENCES.		
		D4465/1	D4465/2	D4465/5
NOMINAL BREAKING LOAD.	TONNE	1	2	5
WORKING LOAD LIMIT (F of S 3)	kN	3.2	6.5	16.3
PARAFIL TYPE.	-	A	A	A
MATERIAL, CORE.	-	TERYLENE	TERYLENE	TERYLENE
MATERIAL, SHEATH.	-	POLYETHYLENE	POLYETHYLENE	POLYETHYLENE
NOMINAL DIAMETER OVER SHEATH.	mm	8.5	11.0	17.0
NOMINAL DIAMETER OVER CORE.	mm	5.3	7.5	12.0
CSA OF CORE FIBRES.	mm^2	15.94	31.88	79.7
WEIGHT.	N/m	0.530	0.893	2.158
ULTIMATE TENSILE STRESS.	kN/mm^2	0.6166	0.6166	0.6166
ELASTIC MODULUS.	kN/mm^2	12	12	12
USAGE.		TRAM	TRAM	RAIL. TEMPORARY WORKS.

A COMPONENT REFERENCE NUMBER IS OBTAINED FROM THE TABLE ON THIS DRAWING.

PARAFIL ROPE IS MANUFACTURED BY:
ICI LINEAR COMPOSITES (UK) AND CAN BE PURCHASED THROUGH NYLEX PTY LTD, 25 NEPEAN HIGHWAY, MENTONE.

IN GENERAL PARAFIL ROPE IS USED IN THE PERMANENT INFRASTRUCTURE FOR 600Vdc TRAMWAYS AND FOR TEMPORARY WORKS IN THE 1500Vdc RAILWAY ENVIRONMENT. IN EITHER CASE THE ROPE IS USED AS AN INSULATOR AND THUS CUT ENDS MUST BE ADEQUATELY SEALED AGAINST THE INGRESS OF WATER

OILS AND LUBRICANTS SHALL NOT BE USED ON PARAFIL ROPE.

STRESS RELAXATION - FOR ROPE HELD AT A FIXED LENGTH, LOAD RELAXATION WILL LEVEL OFF TO 14% WITHIN 6 DAYS.

ELECTRICAL PROPERTIES:

1200kV IMPULSE WITH WAVE SHAPE 1.2/50µS, LENGTH FOR NO FLASHOVER - DRY ROPE 2200mm
- SURFACE WET ROPE ..... 5800mm.

POWER FREQUENCY WET WITHSTAND 650mm ROPE, 123kV
1280mm ROPE , 245kV
1890mm ROPE, 420kV

FACTORS OF SAFETY.

UNLESS OTHERWISE STATED, MINIMUM FACTORS OF SAFETY SHALL BE AS FOLLOWS:

STATIC GUYS 3
INSPAN TAILS, SPAN WIRES, TERMINATIONS 4
DYNAMIC LOADING 5

PREPARED BY O/H DESIGN 1990

	REV'N	DATE	DESCRIPTION	REV'D	CHKD.	SECT.	MGR PSES

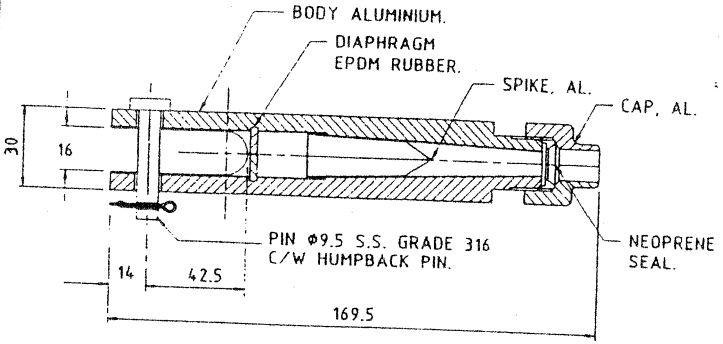
DESIGNED TRW	DRAWN A. CALVANO
DESIGN CHECK	DRAFTING CHECK
CORRES CAD/3.	DRAFTING PASS
DESIGN PASS	

P.T.C.

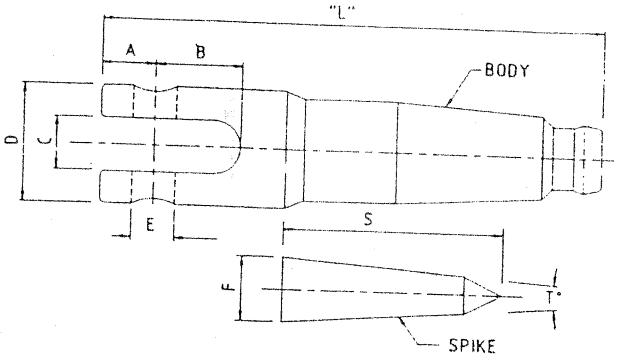
PARAFIL ROPE.

COMPONENT STYLE VARIAB... 3

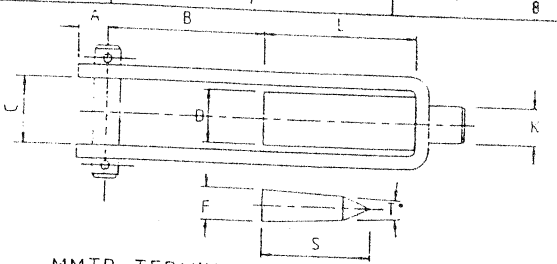
MANAGER POWER SYSTEMS ENG. S...
DATE NOV/90
SCALE N.T.S.
INDEX T/O FITTIN...
DRAWING No. T 165



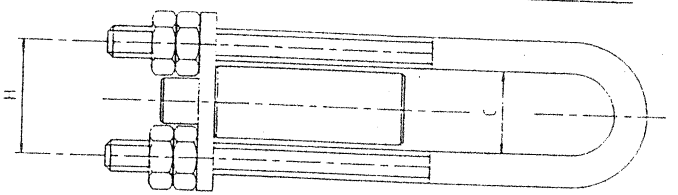
2-TONNE PARAFIL TERMINATION, S. EASTERN TRANSIT PTY LTD. D4464/204



PARAFIL TERMINATIONS, ICI LINEAR COMPOSITES



MMTB TERMINATIONS WITH STIRRUP.



MMTB TERMINATIONS WITH "U"-BOLT.

COMPONENT REFERENCES.

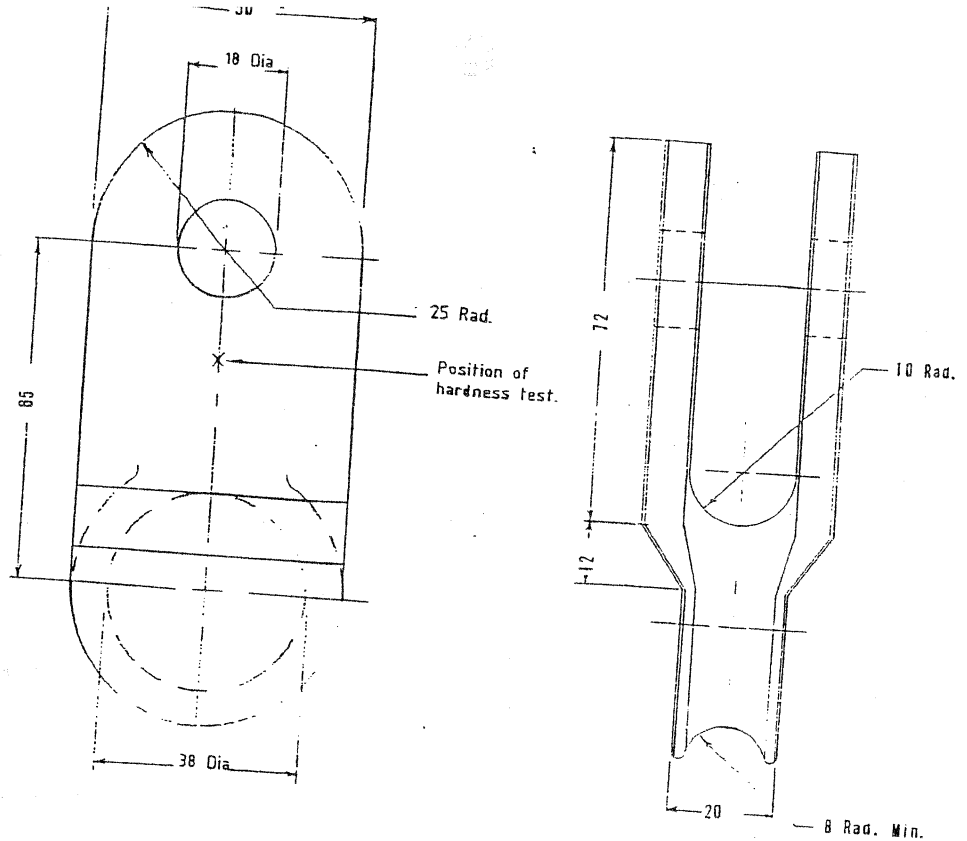
COMPONENT REFERENCE D4464/"N"	DESIGNATED RATING TONNES	WORKING LOAD LIMIT (WLL) kN	DIMENSIONS. A	B	C	D	E	F	S	L	T°	H	K	PIN DIA.	MASS kg.	MATERIALS.	FINISH	REMARKS
D4464/101	1	9.8	10	16	8	22	8	12	40	98	-	-	-		0.100	AL. ALLOY HE30TF. AA6351	ANODISED TO BS 1615 AA 25	ICI LINEAR COMPOSITES
D4464/102	1	9.8	11	58	25	20	11	12	40	56	6	-	14	10		BODY & SPIKE AL. ALLOY ALCAN 6063 STIRRUP & PIN FREE CUTTING STAINLESS STEEL.	ANODISED TO BS 1615 AA 25	MMTB WITH STIRRUP
D4464/103	1	9.8	11	-	29.3	20	11	12	40	56	6	42	14			BODY & SPIKE AL. ALLOY ALCAN 6063 U-BOLT & NUTS M12 COMMERCIAL GRADE ZINC PLATED.	ANODISED TO BS 1615 AA 25	MMTB WITH "U"-BOLT
D4464/201	2	19.6	12	19	10	30	9.6	16	52	123	-	-	-		0.150	AL. ALLOY HE30TF. AA6351	ANODISED TO BS 1615 AA 25	ICI LINEAR COMPOSITES
D4464/202	2	19.6	17	38	30	27	11	16	52	70	5	-	17			BODY & SPIKE AL. ALLOY ALCAN 6063 STIRRUP & PIN FREE CUTTING STAINLESS STEEL	ANODISED TO BS 1615 AA 25	MMTB WITH STIRRUP
D4464/203	2	19.6	17	-	-	27	11	16	52	70	5	-	17			BODY & SPIKE AL. ALLOY ALCAN 6063 U-BOLT & NUTS M12 COMMERCIAL GRADE ZINC PLATED.	ANODISED TO BS 1615 AA 25	MMTB WITH "U"-BOLT
D4464/204	2	19.6	14	42.5	16	30				169.5	-	-	-	9.5		AL. ALLOY AS1806-76 SOLUTION TREATED TO TS-TEMPER TENSILE STRENGTH 262MPa MIN.	ANODISED 15-20 MICRON SEMI-HARD INORGANIC GOLD COLOURED PIGMENT	S. EASTERN TRANSIT PTY LTD
D4464/501	5	49.0	20	32	20	44	16	24	82	188	-	-	-		0.48	AL. ALLOY HE30TF. AA6351	ANODISED TO BS 1615 AA 25	ICI LINEAR COMPOSITES

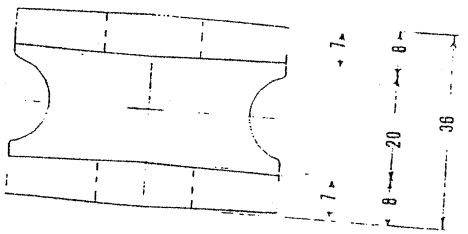
REV'N	DATE	DESCRIPTION	REV'D	CHKD.	SECT.	MGR PSES

DESIGNED TRW	DRAWN A.CALVANO
DESIGN CHECK	DRAFTING CHECK
CORRES CAD/3.	DRAFTING PASS

P.T.C.
PARAFIL ROPE TERMINATION FITTINGS

MANAGER POWER SYSTEMS ENG. SUPPORT
DATE 30/1/91
SCALE N.T.S





VIEW A—A

NOTES:-

1. MATERIAL. SG IRON GRADE 400-250-12 TO AS 1831-1976, OR CAST STEEL GRADE C4-1 TO AS 2074-1977.
2. FINISH, HOT DIPPED GALVANIZED TO AS 1650-1981
3. (a) MINIMUM FAILING LOAD 80kN.
   (b) PROOF LOADING TO 25kN.
4. ALL RADII NOT DIMENSIONED TO BE 1mm.
5. DIMENSION TOLERANCES TO AS 1154. PART 2. 1980 EXCEPT WHERE OTHERWISE STATED.
6. IF AN 18mm CORE SIZE IS NOT AVAILABLE $\frac{11}{16}$ MAY BE USED.
7. TO BE SUPPLIED WITH 16x50mm CUPHEAD PIN (D3495/50) AND 3.6mmx30mm S.S. HUMPBACK SPLIT PIN. TO A.S.1137 PART 1-1981 REF. HP/B.
8. REFER TO METRAIL SPECIFICATION No. E.E.B. 439
9. ALL DIMENSIONS SHOWN ARE IN MILLIMETRES.

REV'N	DATE	DESCRIPTION	REV'D	CHK'D	PASS	APP'D
C	9-7-84	MATERIAL ALTERED, NOTES AMENDED.	P.S. G.M.			
B	30.6.83	ADDED SPEC FOR SPLIT PIN IN NOTE 6	A.I.J.			
A	17 5 83	ADDED SPLIT PIN STATEMENT TO NOTE 6.	JR G.W.			

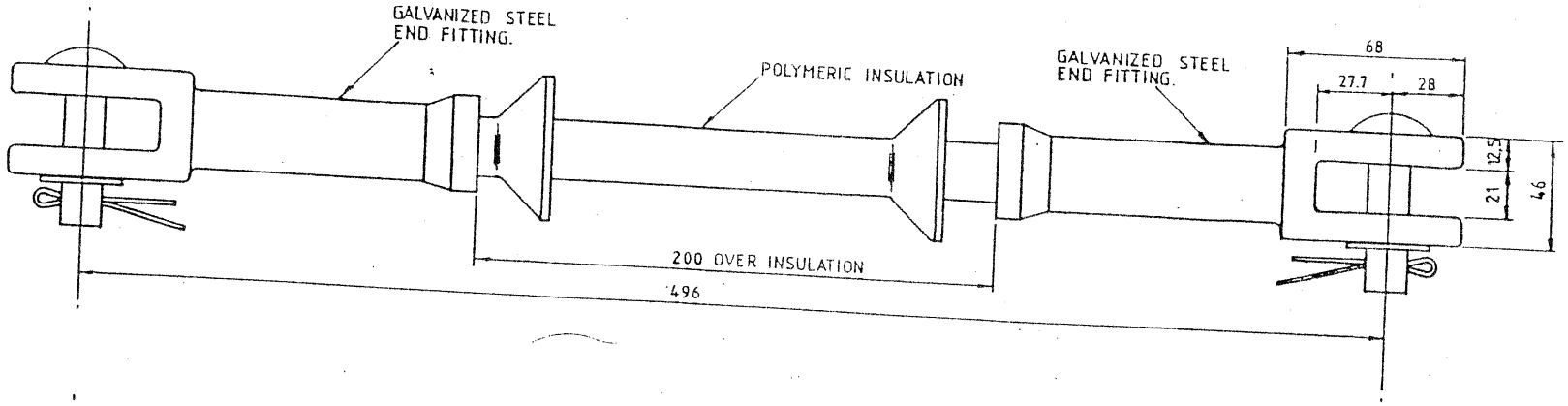
VICTORIAN RAILWAYS
ELECTRICAL ENGINEERING BRANCH

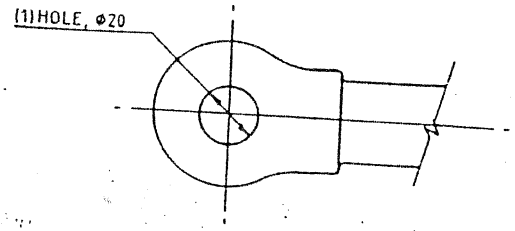
DESIGN		DATE 13-11-80	TRACK & OVERHEAD FITTINGS
DRAWN	MB	SCALE Full Size	CLEVIS THIMBLE DETAILS
	ENG. DSN.	DRG. OFF	
CHECKED		R.F	APPROVED A. Fith C.E.E
PASSED		R.F	D 3121

A B C

The following Drawings have not been included with the Specification

TITLE	DRG NO.	REV
Strut Insulator Polymeric	D 3773	
Boom Connector Bracket Casting, Component, Non-Varible	D 4953	A
0Single Pivot Type Cantilever Arm Bracket Assembly, Diameter Variable	D 5075	B
Back To Back Pivot Type Cantilever Arm Bracket Assembly, Diameter Variable	D 5076	B
Boom Tube O.D. 60.3, Wall 5.4 Component, Length Variable	F 12075	H
Straight Cross Span Assembly In Steel From Pole To Pole	O14-292	
Straight Cross Span Assembly In Steel From Wall To Wall	O14-294	
Section Insulator Assembly Cross Span From Pole To Pole	O14-305	
Section Insulator Assembly Cross Span From Wall To Wall	O14-307	
Centrally Mounted Span & Lighting Pole 8kn/14m	O14-339	E
Anchor Pole With Dual Cantilever Arm Capacity 17kn/14m	O14-346	E
Single Track Cantilever Single Pendulum T.W. Support Assembly, Style Variable	O14-531	
Back-To-Back Single Track Cantilevers Single Pendulum T.W. Support Assembly, Style Variable	O14-545	
Standard Combined Trolley Wire Boom Tube Anchoring	O14-546	A
Boom Clamp For 60.3 Dia. Boom Tube	O14-547	
Current Equalizer Installation On Back-To-Back Catilever Assembly	O14-548	
Tap To Trolley Installation On Back To Back Cantilever Assembly	O14-549	
Section Insulator Support Assembly On Boom Tube	O14-550	





PART PLAN OF END FITTING SHOWN WITH CUPHEAD PIN REMOVED.

REFERENCE No. : D3677/1

NOTES :-

1. INSULATOR MANUFACTURED AND SUPPLIED BY REBOSIO INDUSTRIA ELETTROTECNICA. CAT. NO. I612.
2. MASS :- 2,6kg
3. SUPPLIED WITH 2 No. Φ18 M.S. CUPHEAD PINS, WASHERS AND COPPER SPLIT PINS.
4. CREEPAGE LENGTH = 295mm.
5. POWER FREQUENCY (50Hz) WITHSTAND WET = 55kV DRY = 90kV
6. IMPULSE WITHSTAND = 125kV.
7. ULTIMATE TENSILE LOAD = 135kN.

(NOTES 4 THROUGH 7 FROM MANUFACTURERS CATALOGUE.)

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

PREPARED BY S.O.R.P. 1984

REVN	DATE	DESCRIPTION	REV'D BY	CHECKED	SECT. MANAGER	MANAGER P.E.D
A	30.6.93.	DIMENSION 27.7 ADDED.	T.R.W. A.J.I.			

APPROVALS

GROUP MANAGER RAIL ENGINEERING

DESIGNED S.R.J.	DRAWN S.R.J.
DESIGN CHECK	DRAFTING CHECK
CORRES.	DRAFTING PASS
DESIGN PASS ENG. IN CHARGE	

MetRail

INSULATOR POLYMERIC, TENSION (REBOSIO TYPE)

MANAGER POWER ENGINEERING DEPARTMENT

DATE 28.8.84

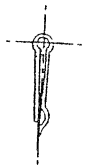
SCALE N.T.S.

INDEX T&D FITTINGS

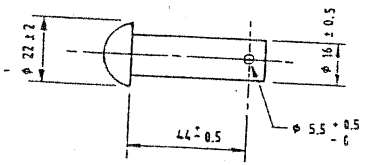
DRN

REFERENCE No. D3771/1

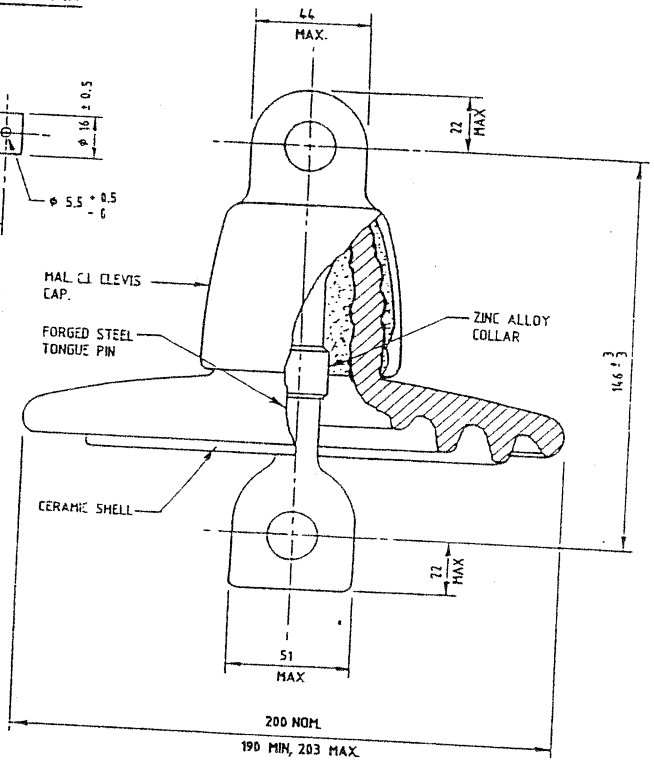
MASS = 2.50 kg.

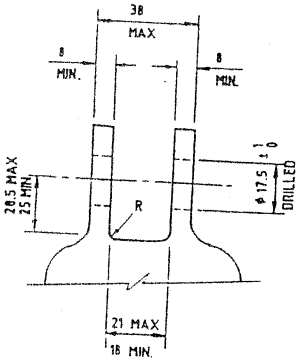


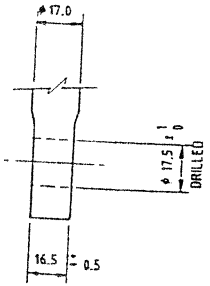
HUMPBACK SPLIT PIN
(STAINLESS STEEL)



CUPHEAD PIN







PHYSICAL SPECIFICATIONS

MATERIAL (SHED)	WET PROCESS PORCELAIN, THOROUGHLY VITRIFIED AND HOMOGENOUS THROUGHOUT
	OR
	TOUGHENED GLASS
(CAP)	MALLEABLE CAST IRON
(PIN)	FORGED STEEL WITH SACRIFICIAL ZINC COLLAR
FINISH	PORCELAIN GLAZE MUNSELL GREY
	ALL FERROUS PARTS HOT DIPPED GALVANIZED TO AS1650 FERROUS SURFACES IN CONTACT WITH CEMENT SHALL BE COATED WITH BITUMASTIC PAINT.

MECHANICAL SPECIFICATIONS

MAXIMUM WORKING LOAD	22kN
FACTOR OF SAFETY	3
MASS	2.50kg.

STANDARDS

AS1137 PART 1
EEB 358B

ELECTRICAL SPECIFICATIONS (VALUES ARE MINIMUM REQUIREMENTS)

POWER FREQUENCY (50HZ) WITHSTAND	DRY	60kV
IMPULSE FLASHOVER VOLTAGE	WET	30kV
		95kV
PUNCTURE VOLTAGE		85kV
PROTECTED CREEPAGE DISTANCE		120mm.
TOTAL CREEPAGE DISTANCE		205mm.

REFERENCE NOTES

THE INSULATOR TO THIS DRAWING IS SUPPLIED WITH A CUPHEAD AND HUMPBACK PIN.

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.

PREPARED BY O/H. DESIGN 1990

REV'N	DATE	DESCRIPTION	REV'D	CHKD	SECT MGR	HGR E.D.

DESIGNED T.R.W.	DRAWN R.H.M.
DESIGN CHECK	DRAFTING CHECK
CORRES	DRAFTING PASS
DESIGN PASS	

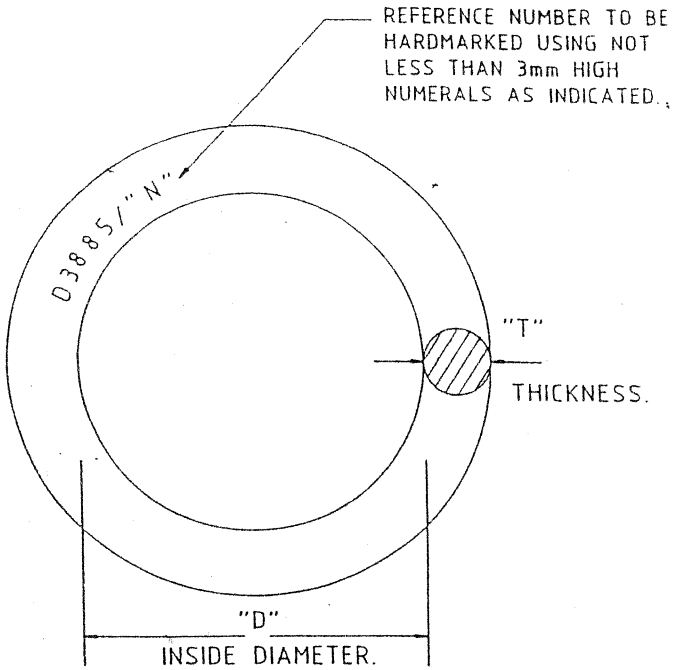
P.T.C.

DISC INSULATOR ϕ 200

COMPONENT, NON VARIABLE

R.A. Brown
MANAGER
TRACTION POWER DESIGN

DATE	APR' 90
SCALE	N.T.S.
INDEX	
DRA... No	R...



COMPONENT REFERENCE TABLE.

COMPONENT REFERENCE D3885/"N"	DIMENSIONS. INSIDE DIA "D"	DIMENSIONS. THICKNESS "T"	WORKING LOAD LIMIT WLL(kN)	MASS kg.	REMARKS.
D3885/1	63.5	12.7	5		MMTB No1 07375B
D3885/2	76.2	15.9	5		MMTB No2 07375B
D3885/3	152.4	12.7	9 8		BULLIVANTS/NOBLES PROPRIETORY ITEM REINFORCED

A COMPONENT REFERENCE NUMBER IS OBTAINED FROM THE ABOVE TABLE.

D3885/1 & D3885/2 SUPERSEDE TRAMWAYS DRAWING 07375B.

RINGS SHALL BE CIRCULAR AND TRUE.

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.

WORKING LOAD LIMIT (WLL) IS TAKEN AS BEING A FACTORED YIELD LOAD FOR THE BULLRING. FOR STATICALLY LOADED BULLRINGS THE WLL SHALL BE YIELD ÷ 3

YIELD LOAD IS TAKEN AS BEING THE VALUE ASSOCIATED WITH THE POINT ON A "LOAD vs. COLLAPSE OF DIAMETER" GRAPH WHERE THERE IS A DISTINCTIVE RATE OF CHANGE OF SLOPE. IT IS NOT THE GENERIC YIELD STRENGTH OF THE MATERIAL.

UNLESS OTHERWISE STATED, THE FOLLOWING FABRICATION DETAILS APPLY:-

MATERIAL: ..... MILD STEEL GRADE 250 IN ACCORDANCE WITH AS1204

FABRICATION: ..... PLAIN ROUND BULLRINGS SHALL BE EITHER FORGED OR CUT FROM SOLID MATERIAL. PROPRIETORY REINFORCED RINGS MAY HAVE SUITABLY WELDED SPOKES.

FINISH: ..... HOT DIPPED GALVANIZED IN ACCORDANCE WITH AS1650 AFTER FABRICATION.

PREPARED BY O/H DESIGN 1990

	REV'N	DATE	DESCRIPTION	REV'D	CHKD.	SECT.	MGR PSES
	A	DEC/91	WLL REDEFINED.	TRW AC			

DESIGNED: TRW	DRAWN: A. CALVANO
DESIGN CHECK: T.R.W.	DRAFTING CHECK: R. F.
CORRES: CAD/3	DRAFTING PASS: W. R. H.
DESIGN PASS: T.R.W. OVERHEAD DESIGN ENGINEER	

P.T.C.

BULL RINGS

COMPONENT, STYLE VARIABLE.

L. A. B.
MANAGER POWER SYSTEMS ENG. SUPPORT

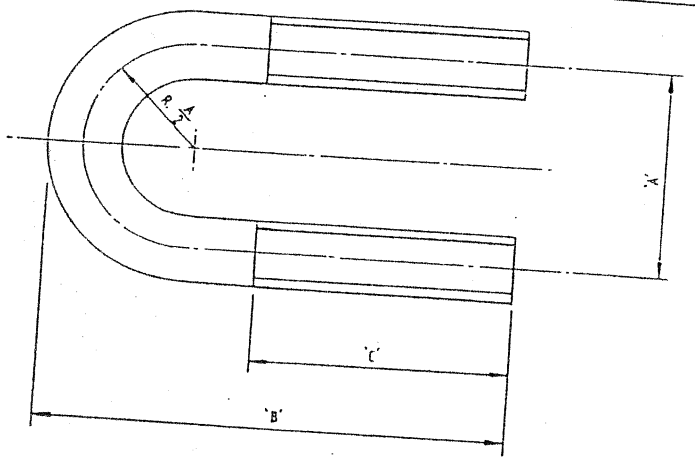
DATE DEC/90

SCALE N.T.S.

INDEX T&B FITTINGS

A3 | DRAWING No. D3885 | REV. A

REFERENCE D3933/'N'	THREAD SIZE	DIMENSIONS (mm.) A	B	C	MASS kg.	MATERIAL.	FINISH	TYPICAL USAGE	REMARKS.
D3933/1	M12	76	105	30		MILD STEEL G250	GALVANIZED TO AS1214	BOOM TUBE FITTING.	WAS F12069.
D3933/2	M12	28	70	45		MILD STEEL G250	GALVANIZED TO AS1214	ANTI-TORSION BRACKET.	
D3933/3	M12	28	50	25		MILD STEEL G250	GALVANIZED TO AS1214	BONDING WIRE TO SPS.	
D3933/4	M10	33	70	35		STAINLESS STEEL G304 OR G316	NATURAL.	CLAMP FOR 240mm.² WIRE.	
D3933/5	M10	29	67	35		STAINLESS STEEL G304 OR G316	NATURAL.	CLAMP FOR 70mm. OR 161mm.² WIRE.	
D3933/6	M10	32		25		STAINLESS STEEL. G304 OR G316	NATURAL.	OFFSET CLEVIS SUSPENSION CLAMP.	(H6388)
D3933/7	M10	48		35		STAINLESS STEEL G304 OR G316	NATURAL.	OFFSET CLEVIS SUSPENSION CLAMP.	(H6457)
D3933/8	M16	120	170	50		MILD STEEL G250	GALVANIZED TO AS 1214	SUPPORT & REGISTRATION STEADY-ARM	



REFERENCE No. D3933/'N'

NOTES:

A COMPONENT REFERENCE NUMBER IS OBTAINED FROM THE TABLE ABOVE.

THREADS ARE TO AS1275 (ISO. COARSE PITCH.)

APPROPRIATE MEASURES SHALL BE TAKEN TO AVOID STRESS RELATED PROBLEMS ASSOCIATED WITH EACH MATERIAL.

THREADS MAY BE ROLLED OR CUT.

FOR REFERENCES OF OTHER FASTENERS SEE
— D4450, WASHERS.
— D4451, NUTS.

THIS DRAWING SUPERSEDES F12069 & F10890 (IN PART)

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.

0 50 100 150mm

PREPARED BY S.O.R.P. 1986

REV'N	DATE	DESCRIPTION	REV'D	CHKD	PASS	NGR P.E.D.
A	10.4.90	TYPE B ADDED. 'B' ON D3933/1 WAS 100mm.	M.S.			
			T.W. D.F.			

APPROVALS

DESIGNED D.A.	DRAWN R.H.M.
DESIGN CHECK	DRAFTING CHECK
CORRES	DRAFTING PASS
DESIGN PASS OVERHEAD ENGINEER	

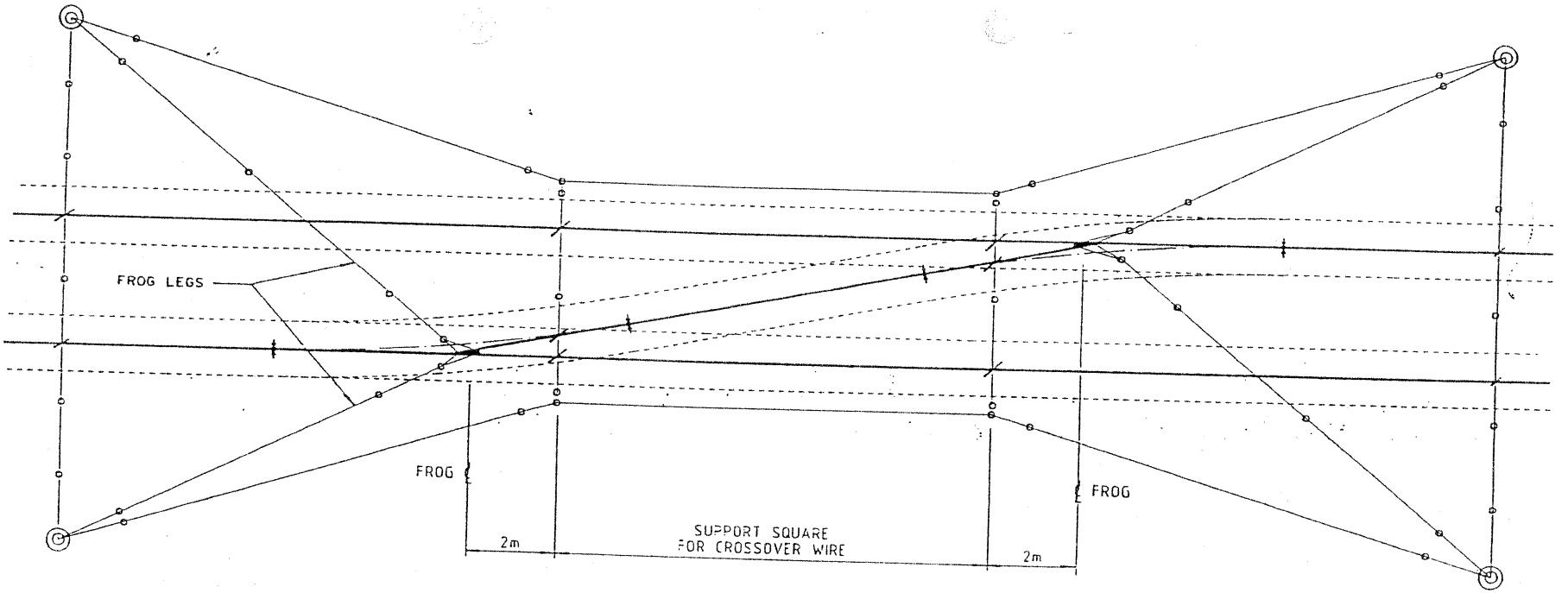
MetRail

U-BOLTS

COMPONENTS
STYLE VARIABLE.

MANAGER
POWER ENGINEERING DEPARTMENT

DATE	JUNE '86
SCALE	N.T.S.
INDEX	T&D. FITTINGS.
A3	DRAWING No D3933
	REV'N A



LEFT HAND CROSSOVER SHOWN

LEGEND

- FROG PAN
- STEEL POLE
- INSULATOR GY1
- HANGER & EAR
- BULL RING

REEL INSULATORS AT POLES NOT SHOWN FOR CLARITY
REFER DRG NO 014-292

AMENDMENTS				
REV	DATE	DESCRIPTION	DRAWN	APP'D
A	8/11/94	GENERAL REVISION UPDATE	J.D.T	
B	4/4/95	FROG LEG NOTE RELOCATED	J.D.T	

ORIGINAL SIGNED BY
D J JOWETT
DESIGN ENGINEER

ORIGINAL SIGNED BY
D J JOWETT
CHECKED

J D TINKLER
DRAWN

DESIGNED

PTC ENGINEERING SERVICES GROUP

OVERHEAD WIRING
TYPICAL ANCHORING

LAYOUT DETAILS FOR CROSSOVER

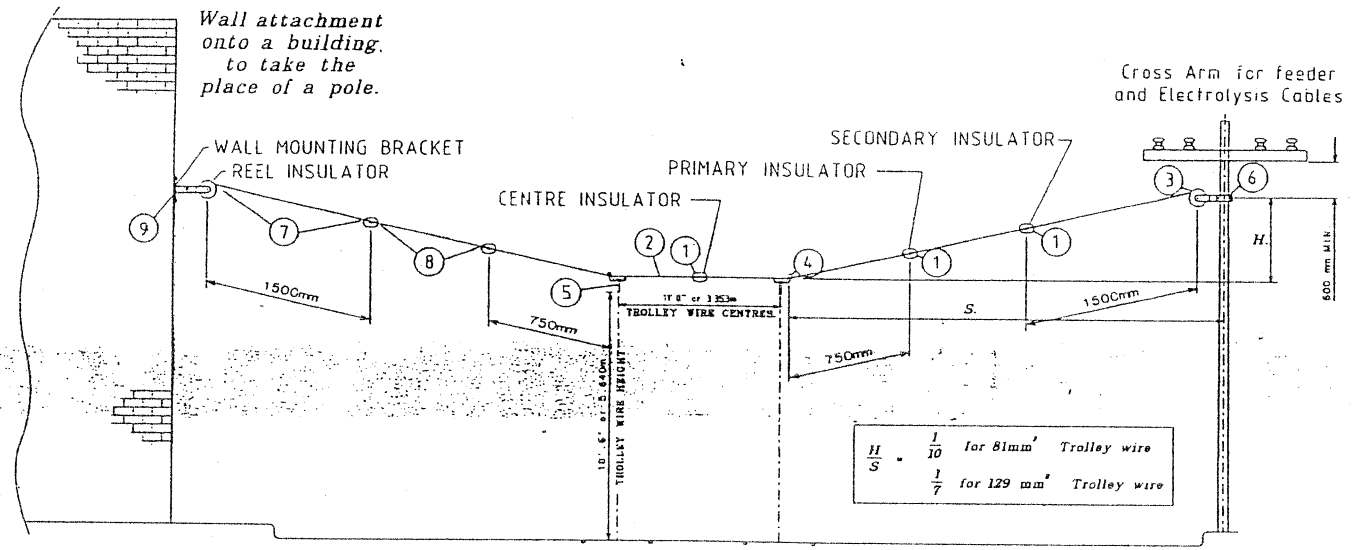
ORIGINAL SIGNED BY
B'HELD 8/11/94
MGR. TRAM INFRASTRUCTURE DESIGN

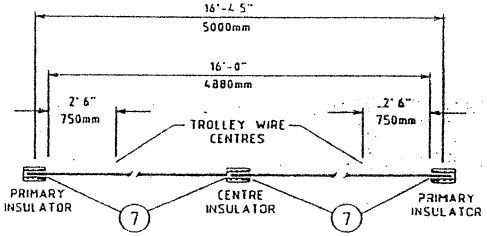
SCALE HORIZONTAL
VERTICAL

DATUMS COORDINATES
LEVELS

INDEX No | COMPUTER No | DRAWING No 014-304B

n:\drawings\dgn\cross.dgn Apr. 6, 1995 10:26:47





COMPONENT REFERENCES

Quantities			DRG. No.	Rev.	Reference	Assembly	Description	Remarks	Item
5	5	5				Component	Strain Insulator GY1.	Spec. TMO/03/07/92.	1
1	1	1				Component	Steel Wire Rope 6mm	Spec. TMO/04/07/92. Variable length	2
2	2	2	07364			Sub-Assembly	Reel Insulator		3
2	2	2	013-983			Sub-Assembly	Hanger	With 0.25" BSW 'U' Bolt	4
		2	012-332			Sub-Assembly	Section Insulator	For 81mm' Trolley wire	5a
	2		012-354			Sub-Assembly	Section Insulator	For 129mm' Trolley wire	5b
2			012-356			Sub-Assembly	Section Insulator	For 81mm' /129mm' Trolley wire	5c
1	1	1	06897		06897/D	Sub-Assembly	Pole Band, Slit type	Type 2 - Split Type	6
8	8	8				Component	Swage Fitting 6mm.	Aluminium or Copper	7
4	4	4				Component	Preformed Helical Termination	Spec. TMO/05/07/92. for 6mm Wire Rope	8
1	1	1	014-308			Component	Wall Mounting Bkt.		9
									10

014-306/1
014-306/2
014-306/3
Assembly Reference

NOTE: DO NOT SCALE OFF DRAWING, IF IN DOUBT ASK.

NOTES

LEGEND

⊕	RAIL JOINT	TSC	TRAFFIC SIGNAL CONTROLLER
t	TANGENT POINT	⊙	TRAMWAYS CHP
]	TRANSITION POINT	⊙	ELECTRICITY B CHP
▲	SURVEY STATION	⊕	TRAFFIC SIGNAL POLE
▦	DRAINAGE PIT	○	ELECTRICITY POLE
○	SEWER PIT OR MANHOLE	☐	ELECTRIC LIGHT POLE
▥	ELECTRICITY SUPPLY PIT	—E—	OVER-HEAD ELECTRICITY
▣	TRAFFIC SIGNAL PIT	—E—	UNDER GROUND ELECTRICITY
▣	UNCLASSIFIED UTILITY	—g—	GAS
—	SIGN	—t—	TELECOM
▭	TELECOM PIT OR PILLAR	—w—	WATER
○	STOP OR WATER VALVE	—s—	SEWER
⊕	FIRE HYDRANT OR PLUG	—d—	DRAINAGE

REFERENCES

AMENDMENTS

REV	DATE	DESCRIPTION	DRAWN	APPD

APPROVED
CHECKED
DRAWN
DESIGNED

PTC TRAM INFRASTRUCTURE GROUP

SECTION INSULATOR ASSEMBLY, CROSS SPAN. FROM WALL TO POLE.

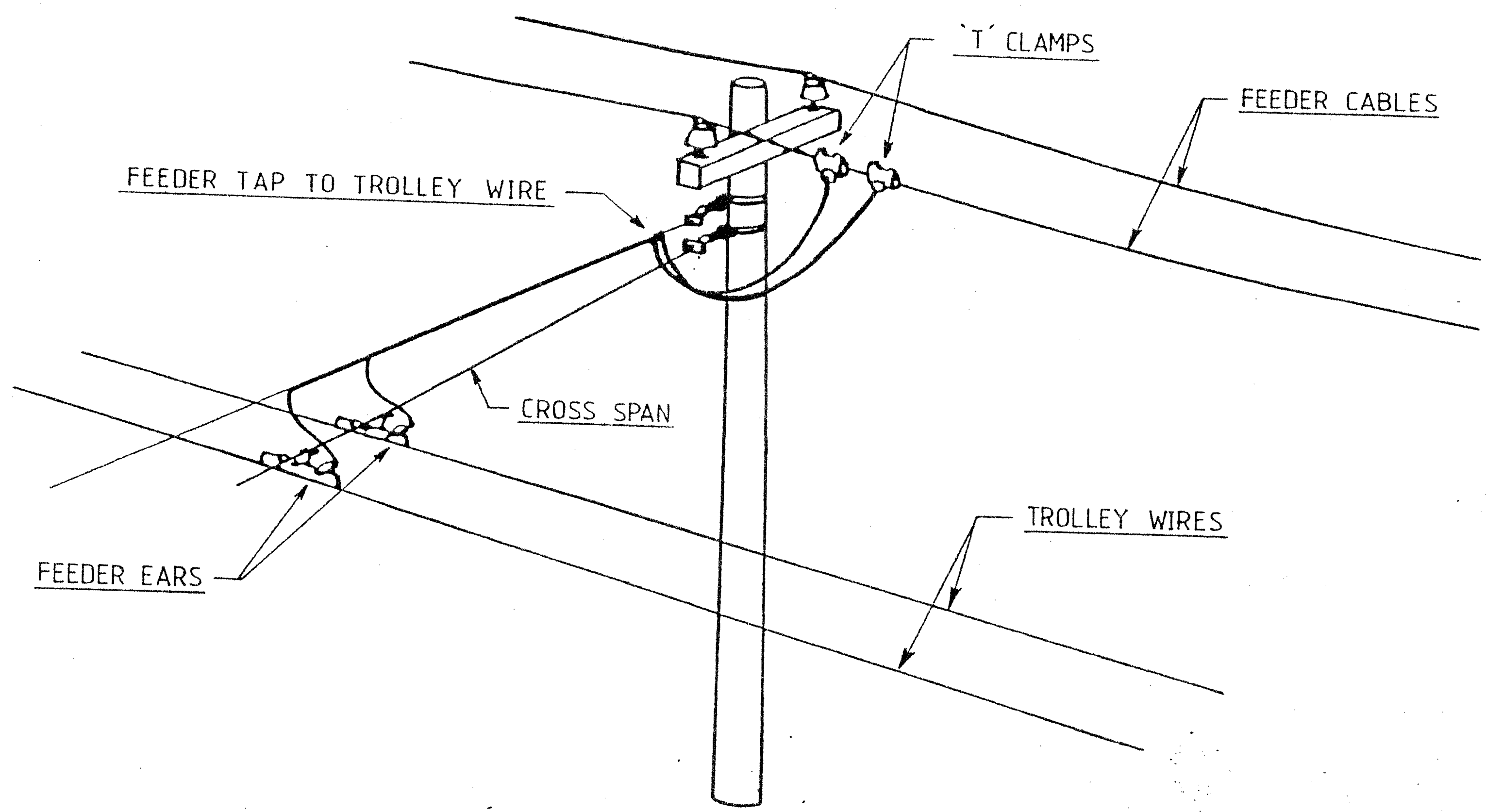
MANAGER TRAM INFRASTRUCTURE GROUP

SCALE: HORIZONTAL NOT TO SCALE
VERTICAL

INDEX NUMBER 014-306 REV.

3/spa Oct 94 7

FEEDER-TAP TO TROLLEY.

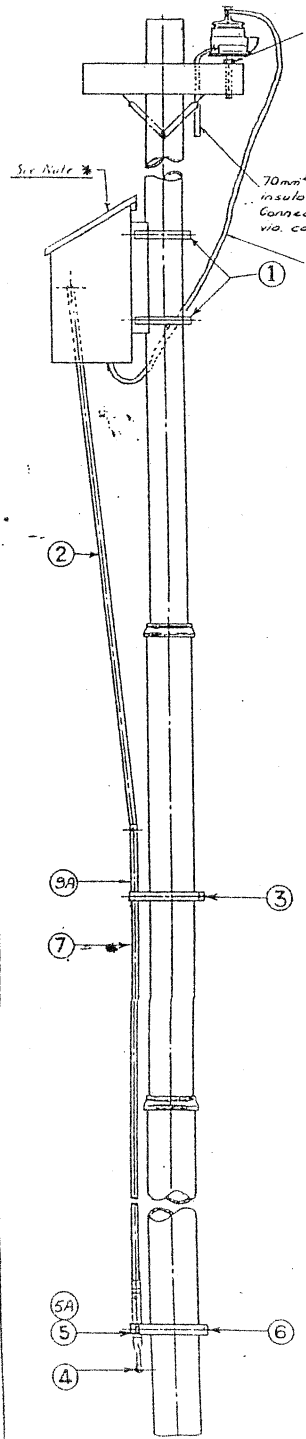


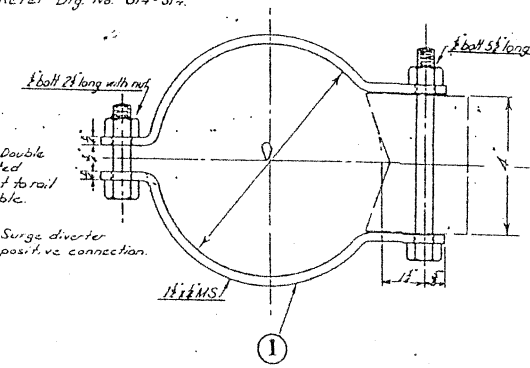
NOTE: DO NOT SCALE OFF DRAWING, IF IN DOUBT ASK.

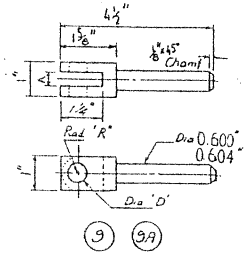
APPROVED	**PTC** TRAM INFRASTRUCTURE GROUP	MANAGER TRAM INFRASTRUCTURE GROUP
CHECKED 8-9-92. DRAWN	GENERAL ARRANGEMENT FEEDER-TAP TO TROLLEY	TRAM INFRASTRUCTURE ENGINEER SCALE: HORIZONTAL VERTICAL
DESIGNED		INDEX NUMBER | DRAWING NUMBER 014-309 | REV.

PLOTDATE:

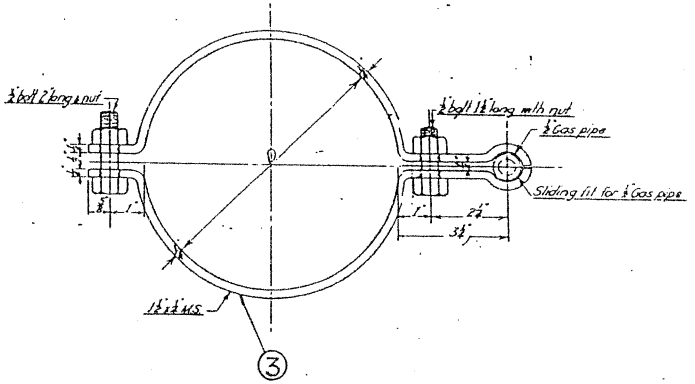
\Hori\...\a3.dgn Sep. 3. 1992 08:27:47

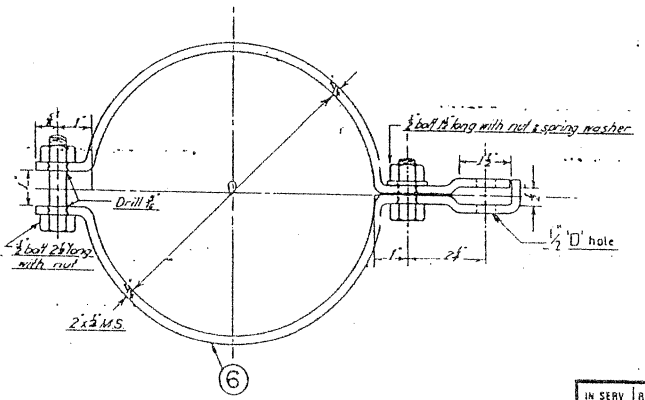






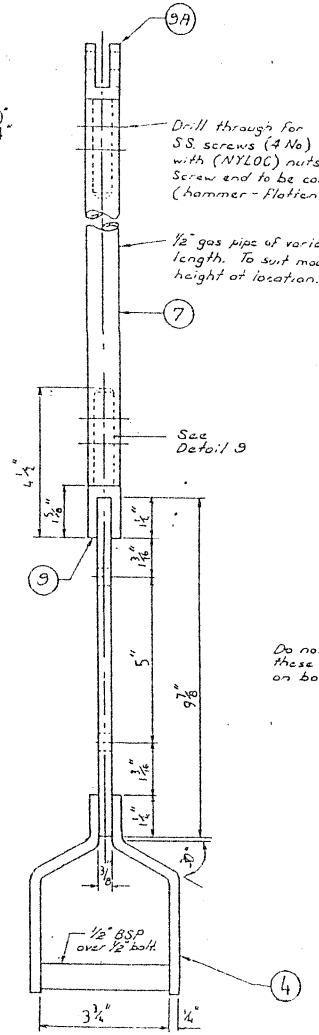
REF	A	R	D
9	7/16"	—	—
9A	5/16"	½"	9/16"

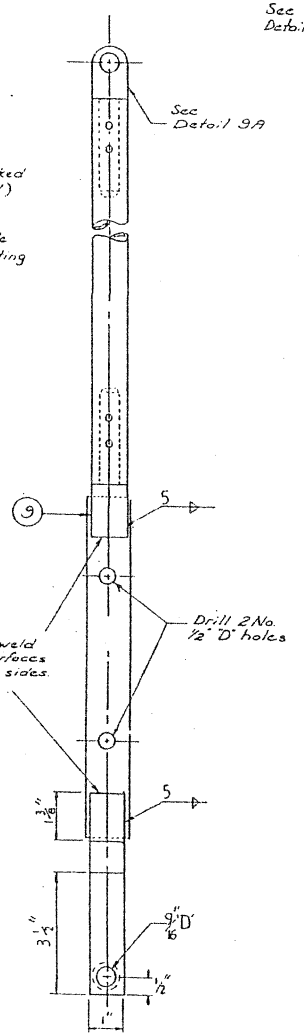


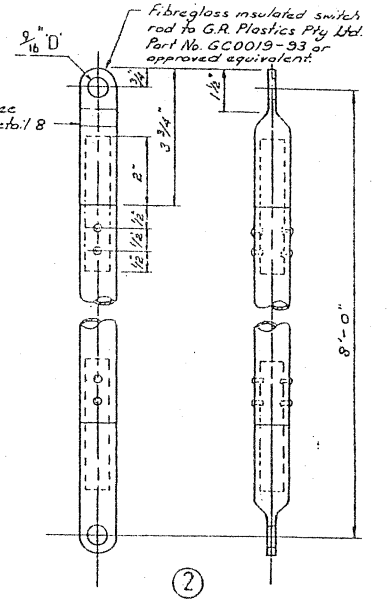


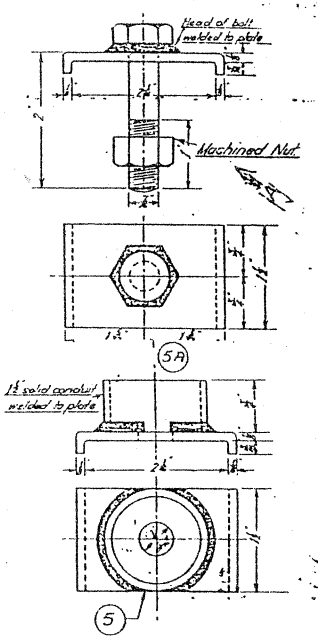
NOTE:
'D' Dia of bands & 'A' length of rod to be stated when ordering
All metal parts to be galvanized. Allowance to be made on threads for galvanizing to finish spanner fit.

Item No. 8 removed.









Projection: First Angle

IN SERV	REV'N	DATE	DESCRIPTION	REV'D	CKD	C E	S D E	MGR SEC

DESIGNED
DRAWN L. CAO
CHECKED
TRAM OVERHEAD DESIGN ENGINEER

PTC TRAM INFRASTRUCTURE

AERIAL SWITCH OPERATING MECHANICS AND

RGE [illegible] R MOU

B.H.
MANAGER TRAM OVERHEAD
DATE
SCALE
IN SERVICE
DRAWING NO A1 '12
REV