

Title: **SPECIFICATION FOR
FABRICATION STEELWORK
USED IN ESKOM TRANSMISSION
LINES**

Unique Identifier: **LES1561**

Alternative Reference
Number: **N/A**

Area of Applicability: **Engineering**

Documentation Type: Specification

Revision: 1

Total Pages: 11

Next Review Date: **February 2023**

Disclosure
Classification: **Controlled Disclosure**

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1. Scope

This specification will cover the manufacture of lattice steel towers for ESKOM HV Transmission Lines. The 529 A and 518 series will be used as examples. This specification will be used in a RFI in order to determine tower manufacturing capability

2. Normative references

The following documents contain provisions that, through reference in the text, constitute requirements of this specification. At the time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below. Information on currently valid national and international standards and specifications can be obtained from the Information Centre and Technology Standardization Department at Megawatt Park, Johannesburg, South Africa.

ASCE Standard 10: Design of Latticed Steel Transmission Structures. Published by the American Society of Civil Engineers.

SANS 10280-2017, Overheads power lines for conditions prevailing in South Africa. Published by the South African Bureau of Standards

Occupational Health and Safety Act 85 of 1993, incorporating the 2003 Construction Regulations. Published by South African Government Press, under auspices of the Department of Labour.

SANS 50025 / EN10025, Hot rolled products of structural steel. Published by the South African Bureau of Standards

SANS 121 / ISO 1461, Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods. Published by the South African Bureau of Standards

DIN 7990, Steel hexagon head bolts for structural steel bolting, for supply with hexagon nuts.

TRMSCAAC 6 : The Standard for the Construction of Overhead Power Lines

2.1 General

All steel sections and plates shall conform to the requirements of EN 10025, unless otherwise indicated. Bolts and nuts shall conform to DIN 7990, with some modifications as indicated. All ferrous materials shall be suitable for hot dip galvanizing.

2.2 Material Quality

The following material grades shall be utilized:

Steel sections	S355JR
Plates (less than 19mm thick)	S355JR
Plates (greater than 19mm thick)	S355J0 NOTE: FOR BETTER WORKABILITY
Bolts	Grade 6.8 to ISO898
Nuts	Grade 6
Washers and packers	Grade S275JR

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Impact properties in the longitudinal direction of all structural materials shall be determined for grade S355JR material greater than 19mm in thickness in accordance with the Charpy V-notch test. Charpy V-notch requirements at a minimum, shall meet the requirements of 27 J absorbed energy at room temperature.

Silicon and Phosphorous content of steel is limited as follows¹:

“Aluminium Killed Steel”: Silicon (Si) = 0.01 to 0.04%, Phosphorous (P) < 0.015% maximum

“Silicon Killed Steel”: Silicon (Si) = 0.15 to 0.25% and Phosphorous (P) < 0.02% maximum

2.3 Forms and shapes of hot rolled steel products:

The towers shall be constructed with hot rolled steel angle sections and plates readily available of the South Africa market as described in the Southern African Steel Construction Handbook.. .

Any other forms or shapes required shall be readily available of the South African market and in accordance with the Southern African Steel Construction Handbook published by the Southern African Institute of Steel Construction.

2.4 Fasteners

Bolts dimensions shall conform to DIN 7990, but with thread length equal to 1.5 x diameter and washers having thickness of 3mm or 5mm depending on tower type (depending on tower type). Nominal washer dimensions are indicated below:

Bolt diameter (mm)	Nominal washer diameters (mm)		Washers thickness (mm)
	Outside	Inside	
Ø16	30	18	3/5
Ø20	37	22	3/5
Ø24	44	26	3/5

Equivalent square washers may be utilized. Maximum of two washers per bolt.

The minimum bolt diameter shall be 16mm.

Refer to TRSMCAAC 6 for details of Fall Arrest Anchor Appendix B which is now used instead of step bolt indicated on drawing.

¹ HDGSA Hot Dip Galvanized Information Sheet No.4

2.5 Manufacture and supply of tower fasteners

- 1.1 Manufacture of standard hexagonal head bolts with nuts and plain round washers (3mm or 5mm thick - as indicated on drawings)
- 1.2 Manufacture of anti-vandal fasteners (not sure which type)
- 1.3 Manufacture round headed step bolts with two hexagonal nuts. (not sure which type)
- 1.4 Manufacture round or square packing washers
- 1.5 Hot-dipped galvanizing of all fastener components
- 1.6 Packing, bundling and labelling of fasteners according to tower articles.

3. Corrosion protection

The towers shall be utilized in all environments, from coastal regions to inland areas. All tower material shall be hot dip galvanised to SANS ISO 1461. The fabricator shall ensure that combinations of "Aluminium Killed Steel" and "Silicon Killed Steel" on the same structure will not prevent the minimum specified thickness of galvanising from being achieved.

Double dipping shall not be allowed.

4. Tower Drawings

Drawings shall be submitted to the manufacturer:

Interpretation of Drawings

- Typical Eskom fabrication drawings show tower parts in an assembled state.
- Not all tower faces are always shown - often notes indicate how other faces are to be fabricated in relation to the view shown.
- Parts lists are sometimes indicated on the drawings and other times are separate documents.
- To ensure accurate interpretation of drawings it is strongly recommended that single piece drawings are prepared of all tower parts

Mass of tower articles

The calculations of mass for angles and other rolled shapes shall be in accordance with the mass per metre listed in the latest edition of the "South African Steel Construction Handbook" published by the South African Institute of Steel Construction. All plate material shall be based on a mass density of 7 850kg/m³. Lengths used to determine mass of members shall be based on the detailed lengths shown on the final, accepted shop drawings and not on the "ordered overall lengths". Material lost from clips, back-cuts, blocks, holes etc., shall not be deducted from the mass of a member or plate. Of the above-calculated mass, 3,5% of the uncoated material shall be used for the mass of the zinc coating (galvanising).

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5. Fabrication of Towers

5.1 General

- a) All parts of structures shall be fabricated in accordance with the dimensions, arrangements, sizes, weights, thicknesses and material quantities indicated on the workshop detail drawings and generally carried out in accordance with ACSE 10-97 and SABS 1200H unless indicated otherwise herein. Workmanship and finish shall be equal to the best modern practice for transmission tower work. Pieces having the same mark shall be interchangeable. Members shall be straight.
- b) All parts of the structure shall be neatly finished and free from kinks or twists. All holes, blocks and clips shall be made with sharp tools and shall be clean-cut without torn or ragged edges.
- c) Shearing and cutting shall be neatly and accurately done. Cuts shall be clean without drawn or ragged edges. Particular care shall be taken in the edge finish of plates subjected to large bending moments or large bends in fabrication.
- d) Redundant material on gusset plates shall be removed.
- e) All holes in structural steel less than 18mm thick may be punched to full size unless otherwise noted on the accepted drawings. Holes shown on the drawings as drilled holes, and all holes in structural steel 18mm or more in thickness, shall be drilled or sub punched and reamed. All holes shall be clean cut and without torn or ragged edges. All burrs resulting from reaming or drilling shall be removed. All holes shall be cylindrical and perpendicular to the member. Where necessary, to avoid distortion of the holes, holes close to the points of bends shall be made after bending. The use of a torch for cutting holes shall not be permitted.

For punching holes to full size, the diameter of the punch shall not be more than 2mm larger than the nominal diameter of the bolt, and the diameter of the die shall not be more than 2mm larger than the diameter of the punch.

- f) For sub-punching, the diameter of the punch shall be 6mm smaller than the nominal diameter of the bolt, and the diameter of the die shall not be more than 3mm larger than the diameter of the punch. Sub punching for reamed work shall be such that after reaming, no punched surface shall appear in the periphery of the hole.
- g) Where holes are reamed or drilled, the diameter of the finished hole shall not be greater than the nominal diameter of the bolt, plus 2mm.
- h) All holes shall be spaced accurately in accordance with the drawings and shall be located on the gauge lines. The maximum allowable variation in hole spacing, from that indicated on the drawings for all bolt-holes, shall be 1mm. Misdrilled or mispunched holes may not be refilled by welding.
- i) Traceability between fabricated components and mill test certificates for mechanical characteristics and chemical composition shall be maintained at all times.

See 5.2. Tower Manufacturing TRMSCAAC rev6

5.2 Bending

- a) All forming or bending during fabrication, shall be only done according to methods accepted by the *Project Manager*, such that will prevent embrittlement or loss of strength in the material being worked. The technical requirements for hot and cold forming are as follows:

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- i) Only the direct resistance heating method shall be used.
 - ii) The length of the section to be heated shall be clearly marked on the section, and heating equipment set accordingly.
 - iii) The required bending tool shall be ready on the bending press with checking jigs available at all times.
 - iv) A dry run shall be made first to check that all systems are operational and that the proper tools are used.
 - v) Material shall be uniformly heated over the required length, to a temperature of between 750°C to 900°C. Oxidation of the material shall be minimised.
 - vi) Heated material shall be inserted into the bending press and formed while the temperature is still within the specified range.
 - vii) Formed material shall be checked immediately to ensure that they have been formed correctly.
 - viii) Formed material shall be left to cool naturally.
 - ix) Re-checks shall be made with the appropriate jigs when material is cold.
- b) If more than one bend is required on a section, the operation shall be repeated for each bend. Repeated heating of a bend position shall not be allowed.
 - c) New bends shall not deform the bend previously made.
 - d) For bending limitations on the flaring of flanges on angle sections, refer to the *Project Manager*. Any other bending of angle sections must be done hot.
 - e) Cold bending limitations on plates are as follows:

Plate thickness	Maximum deviation angle
Up to 12mm	14°
14 to 22mm	7°

A minimum bend radius of 8mm shall apply for above table. Cold bending is not allowed for plates in excess of 22mm thickness.

See 5.2. Tower Manufacturing TRMSCAAC rev6

5.3 Marking

- a) All separate tower members and parts shall be hard stamped before galvanizing with the following marking: Manufacturers identification, tower code and member identification number as indicated on the workshop and erection drawings.
- b) Marking shall be done by stamping the marks into the metal with numerals or letters of 10mm minimum height. The marking shall be consistently in the same relative location near the ends on all pieces. No other marking shall be used.
- c) The a manufacturer's identification marking shall consist of a minimum of three letters and shall be of the same height as the tower code and member identification number. Acceptance of the marking shall be obtained prior to usage.
- d) Where high strength steel is used, an additional letter H shall be stamped immediately after the member identification number. Member theft issues?? Replace by TRMSCAAC

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5.4 Manufacture and Supply of Tower Angle Sections and Plates

Procurement of raw materials

- Steel angle and plates quality shall be SANS 50025 Grade 355JR unless otherwise stated in the project specification
- Hexagonal head bolts shall be M12, M16, M20 or M24 Grade 6.8 to ISO 898. The thread length shall be 1.5 times the bolt diameter.
- Nuts shall be Grade 6 to ISO 898
- Round flat washers and packing washers shall be of grade S275JR to SANS 50025 Grade S275JR
- All tower materials shall be suitable for hot dipped galvanizing to SANS 121
- Over and above normal procedures, the mechanical strength of all materials shall be verified by testing samples taken from raw materials delivered to the fabrication premises.

Fabrication of steel angles

- Cutting angle sections ranging from L45x45x3 and L200x200x24 angle sections according to lengths indicated on drawings
- Punching and / or drilling $\varnothing 13.5\text{mm}$, $\varnothing 17.5\text{mm}$, $\varnothing 21.5\text{mm}$ or $\varnothing 26\text{mm}$ at different back-marks along the length of the cut angles, as indicated on drawings
- Stamping the part with a part number and manufacturer's identification code
- Where indicated on drawings, cutting, notching or clipping the ends of the angles to ensure members fit together without clashing in their assembled state.
- Where indicated on drawings, opening or closing of flanges (under hot conditions) to ensure proper fit in their assembled state.

Fabrication of steel plates

- Guillotine cutting of thinner plates according to dimensions indicated on drawings
- Flame cutting of thicker plates according to dimensions indicated on drawings
- Punching and / or drilling of $\varnothing 13.5\text{mm}$, $\varnothing 17.5\text{mm}$, $\varnothing 21.5\text{mm}$ or $\varnothing 26\text{mm}$ holes in plates as indicated on drawings and depending on material thickness.
- Bending of plates as indicated on drawings, mostly under hot conditions (only small angles may be bent cold)

Packing, bundling, strapping and labelling of angles and plates

- Packing, bundling and strapping of all tower parts according to tower article, for example the tower peak will be in one bundle and the tower beam could consist of two bundles.

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See 5.2. Tower Manufacturing TRMSCAAC rev6

5.5 Galvanising

Galvanising shall be in accordance with ISO 1461. All tower members shall be suitably straightened after galvanizing without causing damage to the galvanizing surface or to the member itself. No curved, bent or twisted members will be accepted.

All Galvanizing of angle and plates

- Hot dipped galvanizing of all fabricated angles and plates to SANS 121.
- If duplex coating is required it will be stated in the project specification.

possible care shall be taken to avoid damaging the zinc coating in transit or during tower assembly or erection.

5.6 Welding

For components of sufficient complexity to require welding, permission must first be obtained from the *Project Manager*. If permission is granted, the *Contractor* shall submit his manufacturing procedure to the *Project Manager* for acceptance before manufacturing commences.

5.7 Testing and inspection

- a) The *Project Manager* reserves the right to inspect the work, and witness tests at any stage during manufacture.
- b) Witnessed tests to SABS 1431 may require samples of steel from the *Contractor's* stockpile.
- c) The *Project Manager* or the SA Bureau of Standards may make tests, to ensure satisfactory quality of the galvanising.
- d) Certificates shall be obtained proving compliance with all aspects of material quality, manufacture and galvanising.

5.8 fabrication Tolerances

Fabrication tolerances shall be according to SABS1200H and TRMSCAAC 6 and as indicated below, whichever the smaller.

a) On overall length of any member	± 1 mm
b) On member straightness	
a. Members up to 100 x100	0.4% of length
b. Members above 100 x 100	0.2% of length
c) On specified ungalvanized hole diameter (on the punch side when punched)	+ 0.3mm / - 0 mm
d) Maximum taper in punched opening out to die side; increase in specified hole diameter where t = thickness of metal	Larger of 0.8mm or t/10

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e) On centres of holes in a group	± 1 mm
f) On centres of groups of holes	± 1.5 mm
g) On back marks	± 1 mm
h) On distance from end of bar to centre of nearest hole	± 1 mm
i) On corner cuts, notches, flanges cuts, etc. a. Angles up to 100 x 100 b. Angles above 100 x 100	± 1 mm +3mm / - 2mm

Fabrication tolerances are not to be considered cumulative.

5.9 Prototype Assembly

Before the start of mass production, the complete structure (with all its legs and body extensions), of each tower type, in an ungalvanized state, is assembled at the fabrication premises. This is done to confirm the correct interpretation of drawings and the accuracy of drawings and manufacturing processes. It is normally sufficient to assemble two or three faces of the tower.

All towers shall be test assembled in the shop to the extent necessary to ensure accurate fit in the field. Prototype assembly shall include all tower components including all body and leg extensions. Assembly procedure shall demonstrate that each section fits the adjacent section.

A Prototype Assembly Report shall summarize the findings of the prototype assembly and all necessary modifications to the members.

See 5.2.12 TRMSCAAC rev6

6. Development team

The following people were involved in the development of this document:

- Loris Manferdini - Towers and Foundations Specialist
- Chandresh Juggernaut - Senior Structural Engineer

Appendix B -Technical schedules A / B and deviation schedule for RFI

Enquiry No.: _____ Tenderer's name: _____

Technical schedules A and B

Manufacturing of lattice steel towers for Eskom HV Lines

Schedule A: Purchaser's specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

Ref.	Description	Unit	Schedule A	Schedule B
	Manufacturing Capability			
	Current projects and complexity			
	Tonnage per month			
	Machinery			
	Detailing Capability			
	Draftsman cv's			
	Software packages 3d modelling and part drawings			
	529 A and 518 series			
	Galvanising			
	Bath size (or letter from galvanizer)			
	Prototyping (assembly team)			

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