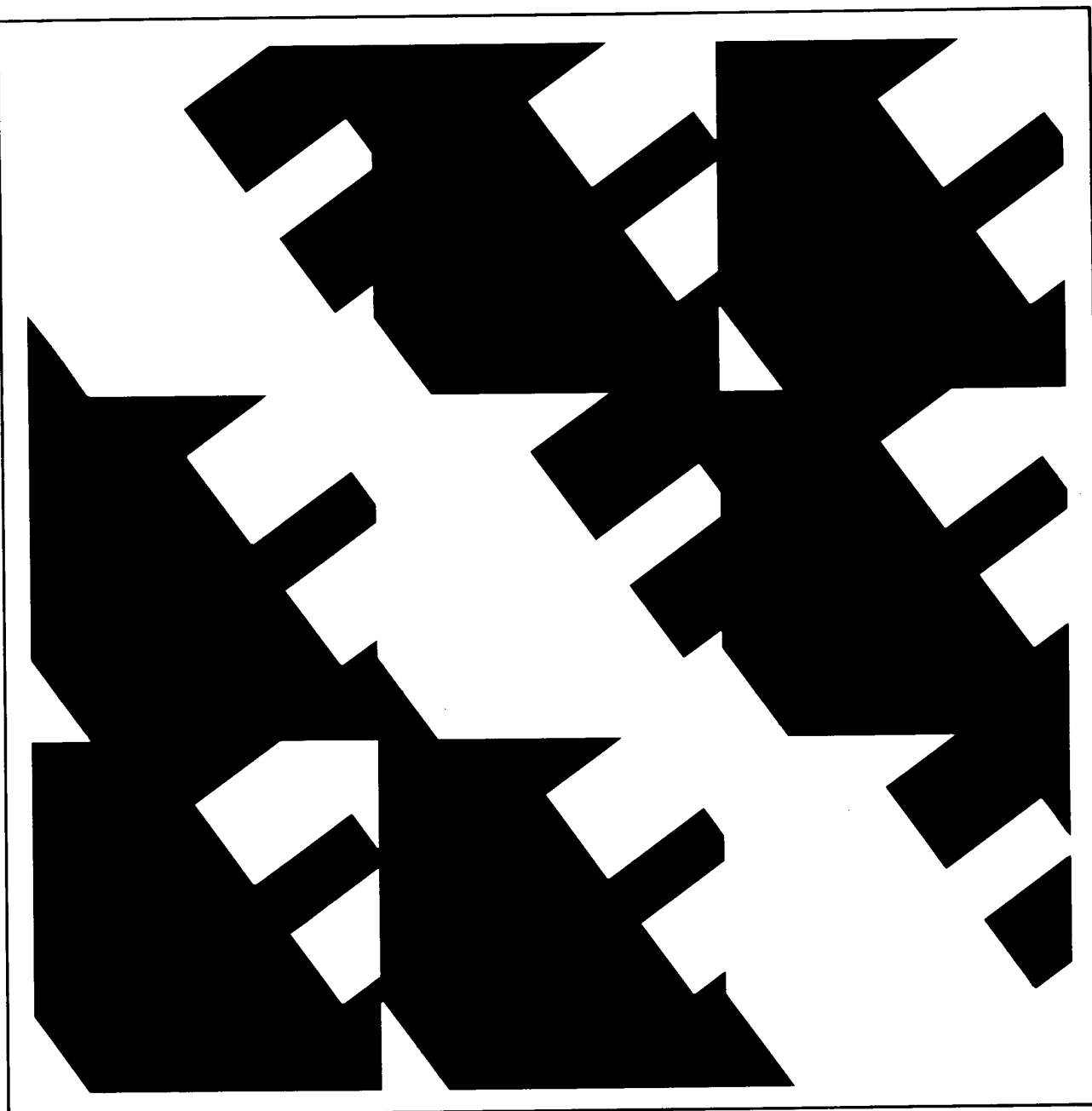


IEEE Guide to the Assembly and Erection of Metal Transmission Structures

IEEE Std 951-1988



Published by The Institute of Electrical and Electronics Engineers, Inc 345 East 47th Street, New York, NY 10017, USA
December 30, 1988

SH12385

IEEE
Std 951-1988

IEEE Guide to the Assembly and Erection of Metal Transmission Structures

Sponsor

**Transmission and Distribution Committee, of the
IEEE Power Engineering Society**

Approved June 9, 1988

IEEE Standard Board

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Foreword

(This Foreword is not a part of IEEE Std 951-1988, IEEE Guide to the Assembly and Erection of Metal Transmission Structures).

This guide is one of several covering all aspects of overhead transmission line construction which are being prepared by the Working Group on Overhead Line Construction. This particular guide presents in one document design and construction considerations for material delivery, assembly and erection of structures and the installation of insulators and hardware.

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IEEE Guide to the Assembly and Erection of Metal Transmission Structures

1. Introduction

1.1 Scope. This guide presents various approaches of good practice which will improve the ability to assemble and erect self-supporting and guyed steel or aluminum lattice and tubular steel structures. This guide covers construction aspects after foundation installation and up to the conductor stringing operation. ANSI/IEEE Std 524-1980 [1].¹

1.2 Purpose. The purpose of this guide is to present in one document design and construction considerations for material delivery, assembly and erection of structures and the installation of insulators and hardware.

1.3 Application. This guide is intended to be used as a reference source for parties involved in the ownership, design and construction of transmission structures. Since methods will be strongly influenced by the nature of each project, various methods that have been successfully employed are presented.

If any of the recommendations contained within this guide are to be adopted, they should be specifically stated in the owner's design and construction specifications. Any legal requirements of national, state, provincial or local regulations must, of course, be observed.

1.4 Legal Disclaimer. The support data for this guide were collected from a great number of sources and believed to be reliable and true.

¹The numbers in brackets correspond to those of the references in Section 3 of this standard.

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The use of trade names is for the information and convenience of the user of this guide and does not constitute an endorsement by the authors.

2. Definitions

constructor. A party who undertakes the assembly and erection of a transmission structure for an owner or an owner who undertakes all or part of a project by himself. Synonymous with contractor, installer, construction agency, construction department.

line designer. A party who develops structure loading criteria, structure types and structure locations based on line routing, maintenance and construction requirements. The line designer should establish design criteria for construction and maintenance which will affect the structure designer and constructor. The line designer could be an owner or an agent acting for the owner.

owner. A party who owns the transmission line during the construction phase of the line and may include a person who acts for or on behalf of an owner as his agent or delegate.

structure designer. A party who designs the structure based on criteria given by a line designer. The structure designer could be an owner, an agent acting for the owner or a fabricator.

3. References

- [1] ANSI/IEEE Std 524-1980, IEEE Guide to the Installation of Overhead Transmission Line Conductors.²
- [2] ASTM A780-80 (1987). Standard Practice for Repair of Damaged Hot-Dip Galvanized Coatings.³
- [3] "Manual of Steel Construction", American Institute of Steel Construction, Inc, 8th ed, 1980.
- [4] IEC Publication 826-3 (1985), 1st ed. Overhead Line Support Loadings, Part 3: Special Loadings.⁴
- [5] W.E. ROSSNAGEL, "Handbook of Rigging for Construction and Industrial Operations", McGraw-Hill, 3rd ed, 1964.

4. Structure Design Considerations

4.1 Construction and Maintenance Loads. The line designer should review and define limits for acceptable methods of construction and maintenance appropriate to the structure types, site conditions, applicable equipment, and skill level of the workers. Structural or other details that relate to the safety of construction and maintenance work should be considered

² ANSI/IEEE publications can be obtained from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018, or from the Service Center, The Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.

³ ASTM publications are available from the Sales Department of American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

⁴ IEC publications are available in the US from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018, USA. The IEC publications are also available from International Electrotechnical Commission, 3 rue de Varembe, Case postale 131, 1211-Geneve 20, Switzerland/Suisse.

in the design of the structure. At the time of line design, the constructor may not have been selected. However, the line designer should consult with knowledgeable constructors and maintenance personnel and utilize his experience to develop a reasonable balance between construction flexibility and efficiency versus cost.

Maximum anticipated loads and their locations that may be applied during construction and maintenance of the line should be specified by the line designer. See IEC Publication 826-3 (1985) [4]. Some of these loading considerations are:

(1) Face panels and partially assembled tower sections will be subjected to dead weight loads, temporary guying loads for stability, worker loads, wind loads and rigging loads during assembly and erection. Reasonable combinations of these loads should be anticipated by the designer and discussed with potential constructors to ensure safety and efficiency and prevent structural damage.

(2) Members on which a worker is expected to climb or stand should be designed for a midspan load of a worker, his equipment and a safety factor which may consider dynamic loads. See IEC Publication 826-3 (1985) [4]. Some construction or maintenance methods may require more than one worker to stand on a particular member.

(3) Portions of a structure may be subjected to additional loads due to one or more workers during construction and maintenance (that is, the end of a cross arm or at a leg splice). These loads, in addition to the normal wire loads anticipated during construction and maintenance, should be considered (see 6.3).

(4) If fall prevention systems are required by the owner, additional facilities should be provided for safety equipment.

(5) Rigging attachment points should be provided for lifting the structure, hoisting insulators and travelers, stringing, clipping in, deadending and maintenance. All of these points should be explicitly identified. A diagram giving the allowable construction loads on the erected structure should be prepared and provided to the constructor.

Particular attention should be given to the following loading conditions:

(a) Rigging methods (see [5]) used in hoisting may multiply the load at the attachment point.

(b) At the beginning and end of each conductor stringing set up, the conductors may be brought down to stringing equipment, anchors or both. The vertical and horizontal components of tension imposed on the structure may become significant at these locations, and failures have occurred on both suspension and deadend structures. The positioning of the stringing equipment or anchors is critical, especially in mountainous terrain (ANSI/IEEE Std 524-1980 [1]).

(c) Various deadending techniques will apply different loads. For example, aerial deadending techniques may impose lower vertical loads than deadending on the ground. Temporary back guying may be required depending on the longitudinal strength and flexibility of the deadend structure and deadending technique used.

In addition, short spans between deadends with high conductor tensions may result in loads in excess of maximum design tensions when the conductor is overpulled during the deadending operation.

4.2 Material Delivery. The design of the structures should consider limits to the length, size, and weight of individual members due to shipping, handling, erection, terrain and equipment restrictions (see 5.4).

4.3 Constructability of Lattice Structures. Construction can be enhanced by a number of considerations, both in the design of the structure and in the detailing of the connections.

It should be noted that these considerations could increase material costs, although these costs may be offset by reduced field costs and improved safety.

(1) Each member should be clearly and permanently marked (that is, stamped). This mark should be legible after any coatings are applied to facilitate identification and possible field replacement. These permanent markings should be visible after the structure is erected. Stencilling with waterproof paint will further facilitate field identification, however, care should be taken to avoid adverse visual impact.

Identification marks may include the following information:

(a) General location of the member in the structure by using a logical numbering sequence;

(b) Structure type

(c) Special material types

(2) When detailing permits, members connected by one bolt at each end may have a spud hole provided at the lower or main leg end. This hole should be indicated as a spud or *no-bolt* hole on the erection drawing. A spud hole is an additional hole into which the tapered tip of a spud wrench or drift pin is inserted in order to facilitate positioning of the member. The spud hole may indicate that the member was detailed slightly short in order to introduce prestress into the member (see 6.2.3). Spud holes in weathering steel should be bolted tight.

(3) Depending on the method of erection, the location of leg and crossarm splices can affect the assembly and future maintenance of the structure. Leg splices located above the crossarm hanger or below the chord of the crossarm (not between them) will facilitate aerial erection as shown in Fig 1. Aerial erection can also be helped if leg splices are located just above horizontal bracing as shown in Fig 3. This helps to maintain proper geometry and structural integrity of the lower body. If the structure is assembled on the ground, the leg splices are often located between the crossarm hanger and crossarm chord as shown in Fig 2.

Crossarm and ground wire peak splices located outside the body of the structure, as shown in Fig 1 may facilitate aerial assembly. In addition, arm and ground wire peaks can be removed or replaced without affecting the integrity of the remaining structure if their splices are located as shown in Fig 1 as opposed to Fig 2.

(4) When tilting up structure sections diagonal braces extending below the main legs can be damaged. Two possible solutions are shown in Figs 4 and 5.

The method shown in Fig 4 is necessary when helicopter erection is planned. The method shown in Fig 5 has the advantage of requiring no additional permanent material.

(5) When butt splices are used on main tower legs, assembly may be facilitated by bolting outside splice plates to the upper leg and inside splice plates to the lower leg as shown in Fig 6.

(6) When using lap splices, assembly and erection with crane and helicopter techniques are facilitated by providing outside splices

when the structure tapers inward as shown in Fig 7.

(7) Design internal tower leg bracing to facilitate its assembly and erection with each main tower leg as shown in Fig 8.

(8) In order to facilitate raising and lowering tools and equipment with handlines, it may be unsuitable to obstruct the interior of the structure by using cross bracing for diaphragm bracing.

(9) Design the tower with a minimal assortment of bolt diameters, types and lengths.

(10) Provide adequate clearance around nuts and bolt heads for wrenches or sockets.

(11) For safety and ease of erection provide a place for a worker to stand below each leg splice. As an example, two step bolt holes could be provided 1.37 m (4 ft-6 in) below each splice for optional step bolts.

(12) The bill of materials should provide an approximate finished (that is, galvanized or

painted) weight of each tower item (that is, members, plates, fills, bolts, and nuts) in order to determine the loads to be lifted.

(13) Provide legible erection drawings. The drawings should show the member mark identification, bolt size, and length, bolt pattern, orientation of angle members and whether a member is inside or outside its connecting member (that is, use hidden lines and detailed or enlarged views). In addition these erection drawings should show the rigging attachment points identified in 4.1 (e).

(14) Fabrication tolerances that are either too restrictive or too liberal can result in increased field costs.

(15) Consideration should be given to the method of locking fasteners. The method selected will influence construction efficiency. Typical methods and devices are lock nuts, lock washers, pal nuts, punched threads, weathering steel, etc.

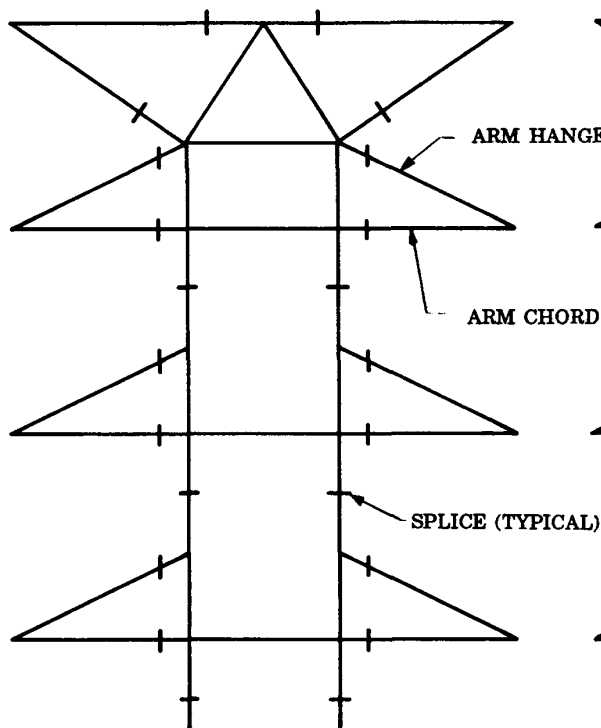


Fig 1

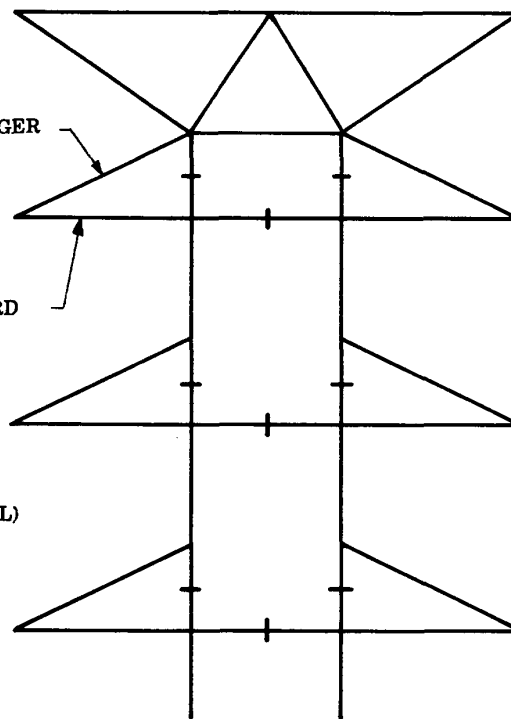


Fig 2