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Specification for Drilling and Well Servicing Structures

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Foreword

a. This specification is under the jurisdiction of the API Committee on Standardization of Drilling and Servicing Equipment.

b. The purpose of this specification is to provide suitable steel structures for drilling and well servicing operations and to provide a uniform method of rating the structures for the petroleum industry.

It is the intent that these specifications be applied to all new designs of all standard steel derricks, special steel derricks, portable masts, and substructures.

c. Products manufactured according to API Standards 4A or 4D may not necessarily comply with all the requirements of this specification. It is the committee's intention that this standard be written to meet the requirements of present and future operating conditions, such as deeper drilling, offshore drilling from floating devices, and the effect of earthquakes, storms, and other adverse operating conditions.

d. The standard is not a text book, but rather a guide by which the manufacturer and user will have a common understanding of the capacities and ratings of the various steel structures for drilling and well servicing operations.

e. Abbreviations used in the text of this standard are as follows:

ABS.....American Bureau of Shipping
 AISC.....American Institute of Steel Construction
 AISI.....American Iron and Steel Institute
 API.....American Petroleum Institute
 ASA.....American Standards Association
 ASTM.....American Society for Testing and Materials
 AWS.....American Welding Society
 SAE.....Society of Automotive Engineers
 USAS.....United States of America Standard
 (Now American National Standard Institute)
 RP.....Recommended Practice

f. Attention Users of this Publication: Portions of this publication have been changed from the previous edition. The location of changes has been marked with a bar in the margin. In some cases the changes are significant, while in other cases the changes reflect minor editorial adjustments. The bar notations in the margins are provided as an aid to users to identify those parts of this publication that have been changed from the previous edition but API makes no warranty as to the accuracy of such bar notations.

NOTE: This edition supersedes the second edition of this specification dated March 1974, and includes editorial revisions.

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SECTION 1

SCOPE

1.1 Coverage. This specification covers steel derricks, portable masts, and substructures that shall be defined as structures suitable for drilling or well servicing. It includes stipulations of materials, loadings, conditions of loading, allowable unit stresses, workmanship and finish, marking and information, inspection and rejection. Recommended practices for maintenance and use of drilling and well servicing structures are included as Appendix A.

1.2 American Petroleum Institute (API) Specifications are published as aids to the procurement of standardized equipment and materials, as well as instructions to manufacturers of equipment or materials covered by an API Specification. These Specifications are not intended to obviate the need for sound engineering, nor to inhibit in any way anyone from purchasing or producing products to other specifications.

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SECTION 2

MATERIAL

2.1 Steel. Structural steel shall conform to one of the applicable ASTM specifications referred to by AISC specifications. Other steels not covered by ASTM may be used provided the chemical and physical properties conform to the limits guaranteed by the steel manufacturer. Structural steel shapes having specified minimum yield less than 33,000 psi and pipe having specified minimum yield less than 35,000 psi shall not be used. The unrestricted acceptance of all steel is not intended, since physical properties are not the sole measure of acceptability. Metallurgical properties, which affect both fabrication and serviceability, must also be considered. Certified mill test reports or certified reports of tests made in accordance with ASTM A6 and the governing specification, shall constitute evidence of conformity with one of the specifications listed.

2.2 Steel Castings. Steel castings shall conform to one of the applicable ASTM specifications referred to in the AISC specifications. Certified reports shall constitute sufficient evidence of conformity with the specification.

2.3 Steel Forgings. Steel forgings shall conform to one of the applicable ASTM specifications referred to in the AISC specifications. Certified reports shall constitute sufficient evidence of conformity with the specification.

2.4 Bolting. Bolting shall conform to one of the applicable ASTM specifications referred to in the

AISC specifications. Foundation bolts shall conform to the physical and metallurgical properties necessary to meet rating conditions and fabrication requirements. Bolts of different physical properties of the same diameter shall not be mixed on the same drilling or servicing structure, to avoid the possibility of bolts of relatively low strength being used where bolts of relatively high strength are required. Certified reports shall constitute sufficient evidence of conformity with the specifications.

2.5 Welding Electrodes. Welding electrodes shall conform to applicable AWS and ASTM specifications referred to in the AISC specifications. Newly developed welding processes shall use welding electrodes conforming to applicable AWS publications. Certified reports shall constitute sufficient evidence of conformity with the specification.

2.6 Wire Rope. Wire rope for guy lines or erection purposes shall conform to API Spec 9A: *Specification for Wire Rope*.

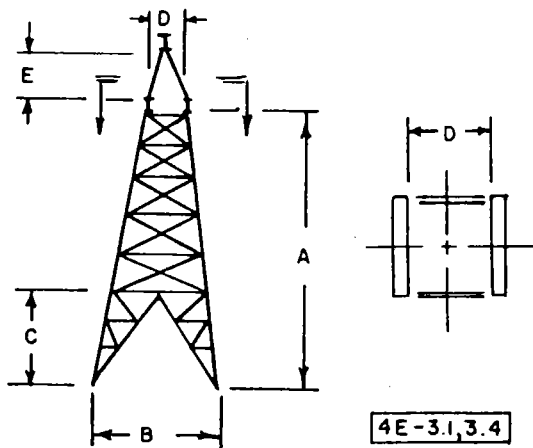
2.7 Solid Round Material. Solid round material shall conform to appropriate SAE or AISI specification for particular type of carbon and alloy steel. Certified reports shall constitute sufficient evidence of conformity with specification.

2.8 New Steels. Available new steels may be used if manufacturer of steel furnishes certified report of physical and metallurgical properties of the new steel.

SECTION 3 DESIGN

Types of Structures

3.1 Standard Derrick. A structure of square cross section that dimensionally agrees with a derrick size shown in Table 3.1, with dimensions as designated in Fig. 3.1.



- A — The vertical distance from the top of the base plate to the bottom of the crown block support beam.
 B — The distance between heel to heel of adjacent legs at the top of the base plate.
 C — The window opening measured in the clear and parallel to the center line of the derrick side from top of base plate.
 D — The smallest clear dimension at the top of the derrick that would restrict passage of crown block.
 E — The clearance between the horizontal header of the gin pole and the top of the crown support beam.

FIG. 3.1
DERRICK DIMENSIONS

3.2 Derrick Window. The derrick window shall be designated as shown in Fig. 3.2. Window arrangement Types A, C, D, and E shall be interchangeable. The sizes and general dimensions of the V window opening and drawworks window opening are as listed in columns 5 and 6, Table 3.1.

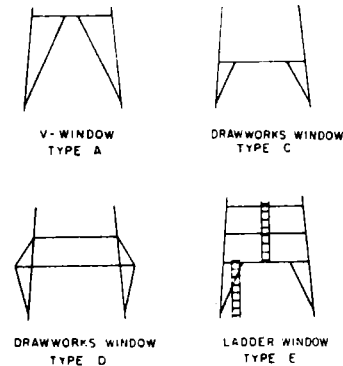


FIG. 3.2
DERRICK WINDOWS

TABLE 3.1
DERRICK SIZES AND GENERAL DIMENSIONS

1	2		3		4		5		6		7	
Derrick Size No.	Height A		Nominal Base Square B		Opening D		V Window Opening C		Drawworks Window Opening C		Gin Pole Clearance E	
	ft	in.	ft	in.	ft	in.	ft	in.	ft	in.	ft	in.
10	80	0	20	0	5	6	23	8	7	6	8	0
11	87	0	20	0	5	6	23	8	7	6	8	0
12	94	0	24	0	5	6	23	8	7	6	8	0
16	122	0	24	0	5	6	23	8	7	6	8	0
18	136	0	26	0	5	6	23	8	7	6	12	0
18A	136	0	30	0	5	6	23	8	7	6	12	0
19	140	0	30	0	7	6	26	6	7	6	17	0
20	147	0	30	0	6	6	26	6	7	6	17	0
25	189	0	37	6	7	6	26	6	7	6	17	0

Tolerances: A, ± 6 in.; B, ± 5 in.; C, $+ 3$ ft, 6 in.; D, ± 2 in.; E, ± 6 in.

3.3 Foundation Bolt Settings. Foundation bolt sizes and patterns are shown in Fig. 3.3. Bolt sizes are minimum and should be increased if stresses dictate larger diameter. Maximum reaction (uplift, compression, and shear) as produced by the standard derrick loadings of Par. 3.34, and foundation bolt size and setting plan shall be furnished, on request, to the original user.

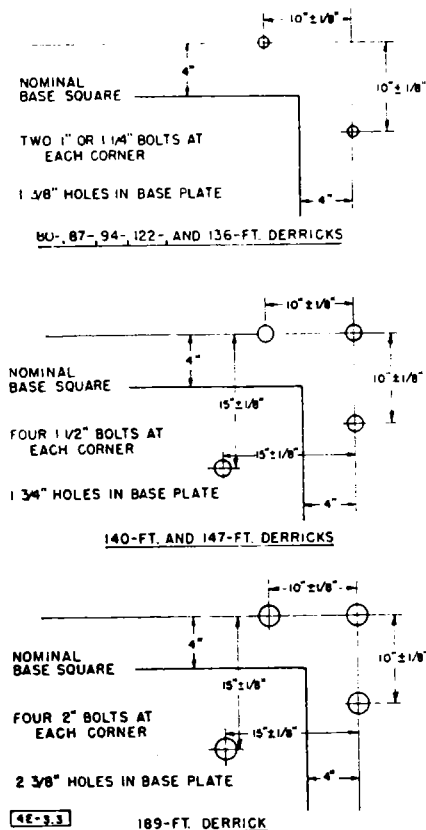
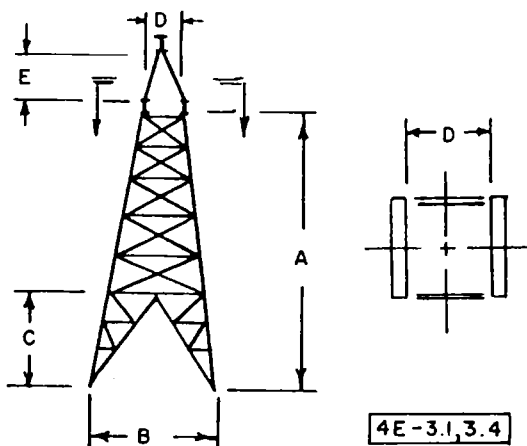


FIG. 3.3
FOUNDATION BOLT PATTERN
FOR DERRICK LEG

3.4 Special Derrick. A structure of square or rectangular cross section, of a dimensional size and capacity rating required by user. Dimensions are as shown in Fig. 3.4.



- A — The vertical distance from the top of the base plate to the bottom of the crown support beam.
- B — The distance between adjacent legs, from heel to heel for angle legs and center to center for round legs, as taken at the top of the base plate. Reference point for describing base dimension of the derrick, for leg section of other than angles or round, shall be specified by manufacturer.
- C — Window opening measured in the clear and parallel to the center line of the derrick side from the top of the base plate.
- D — The smallest clear dimension at the top of the derrick that would restrict passage of crown block.
- E — The gin pole height which is the clear distance between gin pole header and top of crown support beam.

FIG. 3.4
SPECIAL DERRICK DIMENSIONS

3.5 Special Derrick Faces. Face configurations shall be designed to satisfy the functional requirement. Face arrangement shall be the same as standard derrick (par. 3.2) unless otherwise specified by the original user or as required by design. Fig. 3.5 indicates typical faces for special derricks.

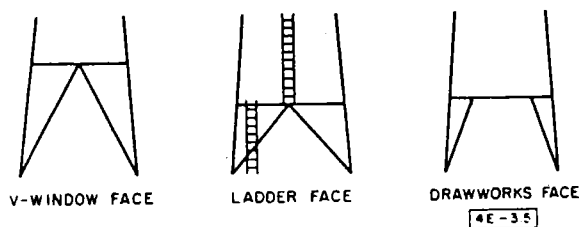


FIG. 3.5
FACE CONFIGURATIONS AND DESIGNATIONS

3.6 Special Derrick Types and Sizes

a. Welded derrick is a structure of square or rectangular cross section having members that are latticed or trussed. It may be made up of welded sub-assemblies field-bolted, pinned, or welded together, and mounted on a substructure. The size of the welded derrick should, where possible, agree with that shown in Table 3.1.

b. Multi-well derrick is usually a structure of square or rectangular cross section having members that are latticed or trussed and may have individual members field-bolted, pinned, or welded together; or may have welded sub-assemblies field-bolted, pinned, or welded together and mounted on a fixed substructure. Change in well location is made by shifting crown block to new well position, without relocating substructure. Height of derrick shall be as required, with the base and top dimensions being governed by number of wells and well spacing.

c. Other derricks are of a configuration and type construction, height, top and base dimensions for mounting on a specific substructure and for use with specific drilling and related equipment.

d. Dynamic derrick is a structure of square or rectangular cross section having members that are latticed or trussed and that may be made up of individual members field-bolted, pinned or welded together, or may be made up of welded sub-assemblies field-bolted, pinned or welded together and mounted upon a substructure on a floating rig. Height of derrick shall be as required with the base and top dimension to meet specific requirements of related equipment, and when applicable all dimensions should be approximately those shown in Table 3.1 for particular derrick size.

3.7 Foundation Bolt Settings. Foundation bolts shall be sized not to exceed stresses in Par. 3.46, *Allowable Unit Stresses*. Ideally, the centroid of foundation bolt group and derrick leg should coincide; however, should the centroid of the foundation bolt group and leg not coincide, the design must take into consideration the additional stress produced by the eccentric condition. Maximum foundation reactions, including magnitudes and directions of uplift, compression, and shear in compatible combinations as produced by Par. 3.35 or Par. 3.36 for applicable derrick type and foundation bolt setting plan shall be furnished to the original user upon his request.

3.8 Portable Mast Without Guylines-Static. A portable mast without guylines is generally a rectangular cross section structure, latticed on three or four sides, of welded, bolted or pinned construction; is assembled at or near ground level; attached to a substructure; is raised as a unit to the drilling position and is not dependent upon external guying for stability.

3.9 Nomenclature of Dimensions, Portable Mast Without Guyline.

a. Height is the vertical distance from top of the working floor level to the lowest member which may contact the traveling block and thereby limit its rise.

b. Top dimension is the distance between adjacent legs, heel to heel for angle legs and center to center for round legs, as measured at the top of the mast just beneath the cap plate for the crown frame.

c. Bottom dimension is the distance between adjacent legs, heel to heel for angle legs and center to center for round legs, as measured at the bottom of the mast.

3.10 Mast Pedestal. The connectors between mast and supporting structure shall be designed so as not to exceed stresses in Par. 3.46, *Allowable Unit Stresses*. Pedestals may be bolted, pinned, or welded to the supporting structure or substructure. Combination of bolts and shear block shall not be used in a connection for the same component of loading.

3.11 Pedestal Bolt Plan. Foundation bolt plan for pedestal shall be provided original user on request. Maximum reactions, including magnitudes and directions of uplift, compression, and shear in compatible combinations, as produced by Par. 3.37 shall be furnished the original user upon his request.

3.12 Portable Mast Without Guylines-Dynamic. Dynamic portable mast without guylines is a rectangular cross section structure latticed on three or four sides, of welded, bolted, or pinned construction, is assembled in horizontal position, attached to a substructure and raised to the drilling position. The mast and substructure are attached to a floating rig. Dimensions, pedestal requirements, and foundation bolt plan for pedestal are as listed in paragraphs 3.9, 3.10, and 3.11 for static portable mast.

3.13 Portable Mast With Guylines. A portable mast with guylines is a structure which requires use of guylines to develop rated capacity or to provide structural stability. Dimensions of the portable mast with guylines are as shown in Fig. 3.6, with nomenclature as follows:

a. The height H of a portable mast with guylines shall be the vertical distance from the wheel or skid ground contact point to the lowest member which may contact the top of, and thereby limit the rise of, the traveling block. It should be recognized that the working clearance will be governed by the elevation of the working floor or substructure level.

NOTE: on single pole masts, height will be the axial distance along the pole from the wheel or skid ground contact level to the crown pin center line.

b. Tilt is the angle measured between the vertical line through centerline of the well and the slope of the mast leg nearest the well.

c. Set up distance S is distance from centerline of well to a designated point on the mast structure defined by the manufacturer to assist in set up of the structure.

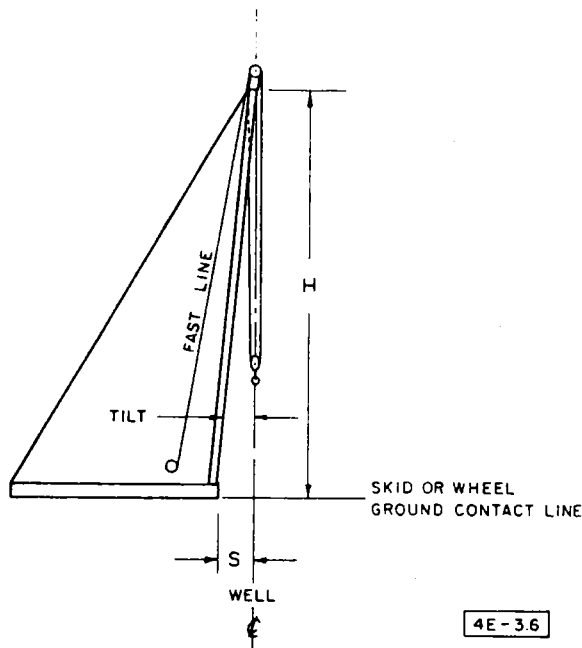


FIG. 3.6

DIMENSIONS OF PORTABLE MAST WITH GUYLINES

3.14 Guyline Diagram. A guyline diagram indicating the guying necessary to realize load capacity, mast stability, and racking stability, shall be provided by the manufacturer. The diagram shall include a recommendation of a guyline pattern and the maximum loads existing in each guyline at design conditions. Because of the variable soil conditions, the user shall be responsible for providing anchorage capable of withstanding the maximum guyline loads where external guys are required. Refer to Appendix A for general guying pattern and for guy anchorage recommendations.

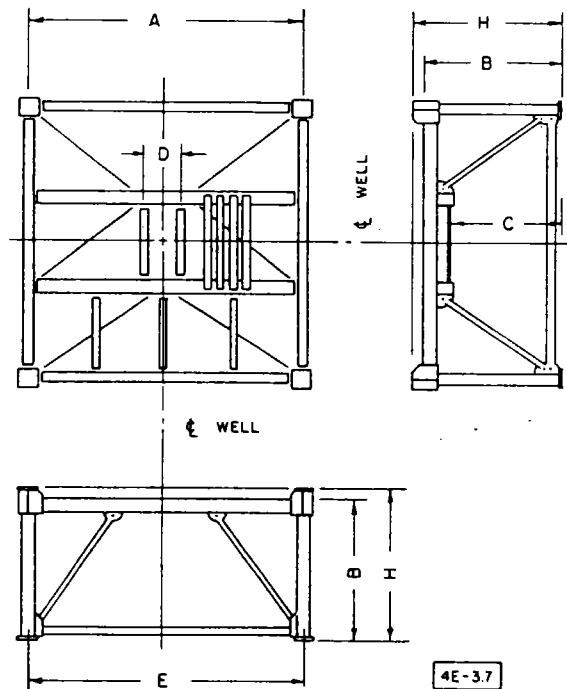
3.15 Load Diagram. The load distribution diagram giving magnitude of load at load bearing points of the base shall be provided by the manufacturer; however, because of variable soil conditions, the user is responsible for providing sufficient bearing areas to support the load shown on the load distribution diagram. Refer to Appendix A for safe bearing capacities of soils and for recommended location preparation (Fig. A.2).

3.16 Structural Mast. Structural mast with guy-lines is a triangular, square, or rectangular cross section, latticed or welded structure. It may consist of more than one section, which may telescope or fold, and which when erected to the working position, is guyed. It may be attached to a wheeled vehicle, skid base, or substructure.

3.17 Pole Mast. Pole mast with guylines is a structure consisting of one or more tubular sections, telescoping or not telescoping, which are the load bearing members. The mast, when erected to working position, is guyed. It may be attached to a wheeled vehicle, skid base, or substructure.

Substructures and other Related Structures

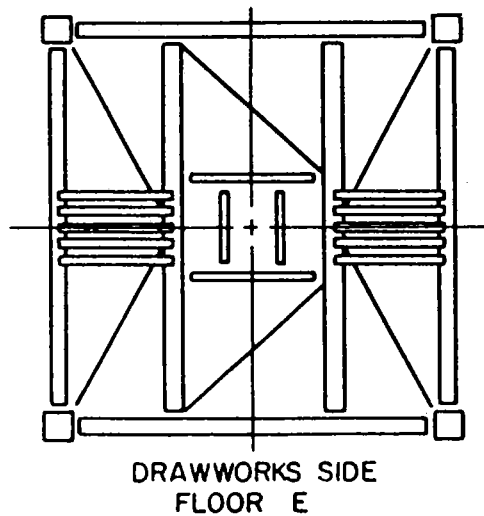
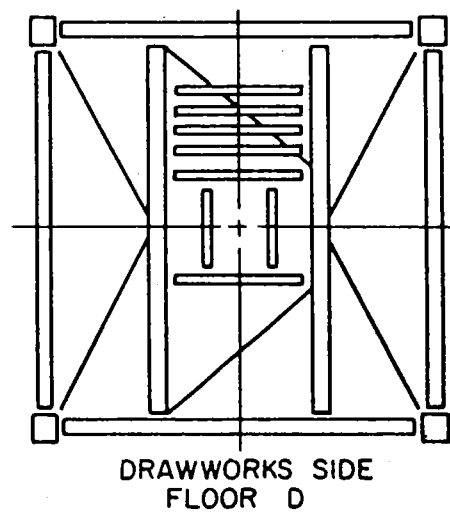
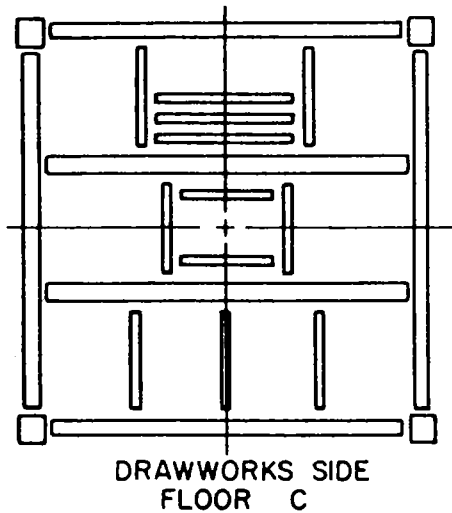
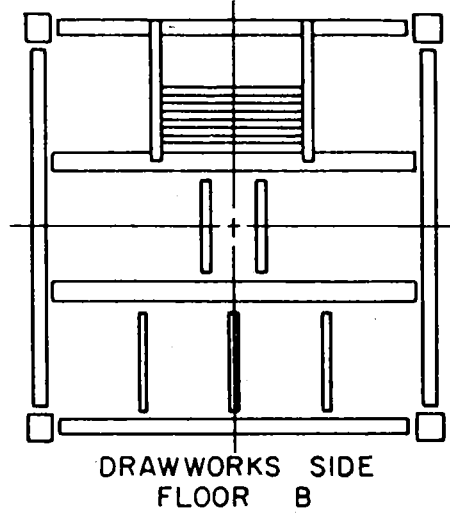
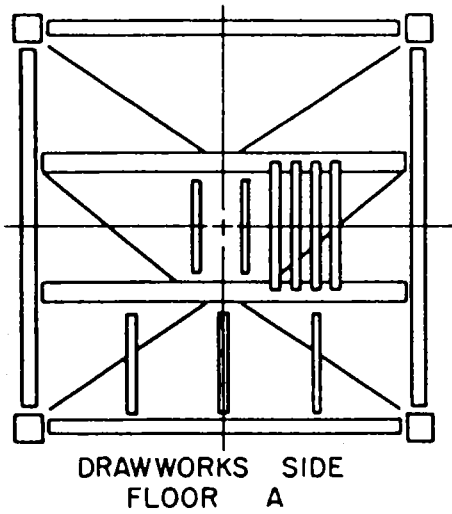
3.18 Girder Type. Girder type substructure for standard or special derrick shall be a structure that supports derrick and interior loads (rotary, setback, and equipment) by means of a structural framing system of beams, girders, and trusses, connected to corner columns.



- A — Derrick base square dimension
- B — Height to top of main framing
- C — Clear height under rotary table support beam
- D — Rotary table support beam spacing 4'-0" unless otherwise specified
- E — Corner column spacing
- H — Post height

FIG. 3.7

TYPICAL GIRDER TYPE SUBSTRUCTURE



4E-3.8

FIG. 3.8

TYPICAL GIRDER TYPE SUBSTRUCTURE FLOOR ARRANGEMENTS

3.19 Post Height. Substructure post height is the vertical distance from the bottom of the corner column base plate to which derrick base plate is attached.

3.20 Floor Sills. Depth of substructure floor sills may be the difference between the Dimension H and B (Fig. 3.7); however, the size and depth of floor sill beams shall be that required to support floor loading condition.

3.21 Foundation Bolts. Foundation bolt setting plan at the top of corner columns is as required for standard derrick (Fig. 3.3) or for special derrick. The corner column's foundation bolt should be sized not to exceed stresses in Par. 3.46, *Allowable Unit Stresses*. Ideally, the centroid of the foundation bolt group and corner column should coincide; however, should the centroid of the foundation bolt group and corner column not coincide, the design must take into consideration the additional stress produced by the eccentric condition.

3.22 Clear Height. Clear height C (Fig. 3.7) shall be specified by the user.

3.23 Special Substructure. Special substructure for special derrick shall be a structure that supports the derrick and interior loadings (rotary, setback, equipment, etc.) by means of a structural framing system of rigid frames, trusses, beams, and girders connected to columns. The foundation bolt setting plan for derrick to substructure is as required by special derrick.

3.24 Anchorage and Support. The anchorage and support of the substructure shall be sized and designed not to exceed stresses in Par. 3.46, *Allowable Unit Stresses*. Original user shall be furnished the magnitude and direction of maximum uplift, maximum compression, maximum shear and maximum moment in compatible combination as produced by loading conditions of Par. 3.39, *Substructure Loading* at point of substructure anchorage to its foundation. It is the responsibility of user to provide proper support.

3.25 Portable Mast Substructure. Substructure for portable mast is that structure upon which the mast is mounted and which supports the drilling equipment, setback, rotary, and other imposed loads. Two types of portable mast substructures are as follows:

a. Box type substructure consists of a pair of separated yet parallel rectangular boxes connected by pinned beams with the boxes having provisions for mounting the mast and for supporting the drilling equipment.

b. Trailer and skid type substructure is structure made up of two or more parallel and connected beams which form a frame upon which the mast is mounted. This frame may be wheel mounted to form a trailer frame or placed directly on the ground as a skid base.

3.26 Vertical Extension. Vertical extension is a structure used beneath the substructure or skid base for increasing floor height and/or for obtaining additional clear height under rotary table support beams.

3.27 Dynamic Mast Substructure. Substructure for dynamic portable mast is that structure upon which the dynamic mast is mounted and which supports drilling equipment, setback, rotary, and other imposed loads and is attached to a floating rig.

3.28 Engine Substructure. Engine substructure is a structure that supports the mechanical power, engines, and compound for drawworks, rotary, and pumps.

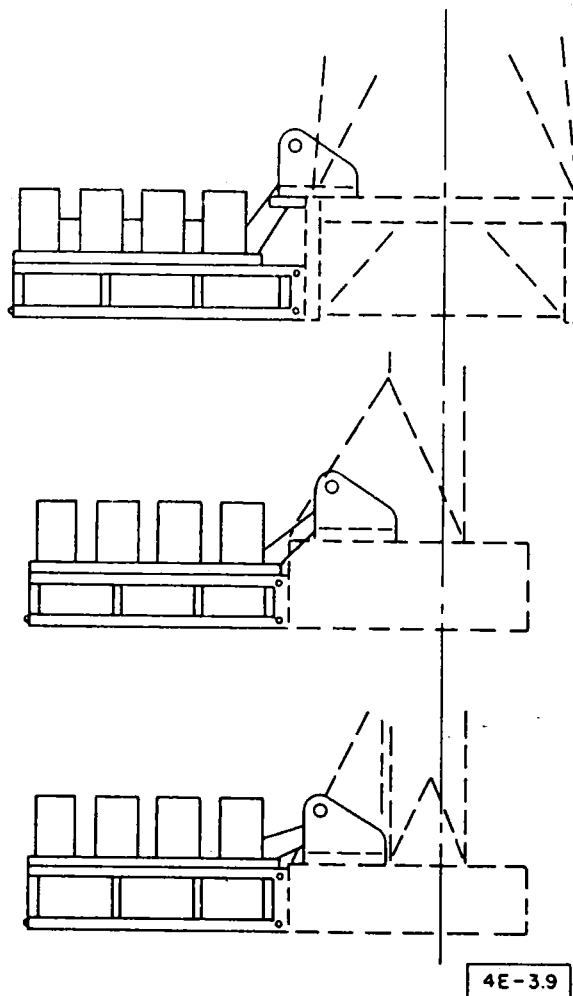


FIG. 3.9

TYPICAL ENGINE SUBSTRUCTURES

3.29 Mast With Guylines. Substructure for portable mast with guylines is that structure which supports rotary load, setback load, other imposed load, or any combination thereof. This structure may be attached to or be independent of the guyed portable mast or mast mount.

3.30 Vertical Extension. Vertical extension is a structure used beneath the substructure or mast mount for increasing the clearance height under the rotary table support beams.

3.31 Floor Platform. Floor platform is a light weight personnel working platform, usually of adjustable height, which may or may not be attached to the mast and is not designed to carry other imposed loads.