

Section IV

(previously Section III of Oregon OSHA's Technical Manual)

SAFETY HAZARDS

CHAPTER 1: [OILWELL DERRICK
STABILITY: GUYWIRE
ANCHOR SYSTEMS](#)

CHAPTER 2: PETROLEUM REFINING
PROCESSES

CHAPTER 3: PRESSURE VESSEL
GUIDELINES

CHAPTER 4: INDUSTRIAL ROBOTS AND
ROBOT SYSTEM SAFETY

All information within this section and chapter has been reproduced from the Oregon OSHA Technical Manual (circa 1996) unless otherwise stated within the "Chapter Revision Information", located at the beginning of each chapter.

SECTION IV: CHAPTER 1

OIL WELL DERRICK STABILITY: GUYWIRE ANCHOR SYSTEMS

Chapter Revision Information:

- *This chapter was previously identified as Section III, Chapter 1 in Oregon OSHA's circa 1996 **Technical Manual**. The section number was modified from Section III to Section IV in March 2014 to provide uniformity with federal OSHA's Technical Manual (OTM).*
- *In March 2014, the chapter's multilevel listing format was modified from an alphanumeric system to a roman numeral system.*
- *In March 2014, several figures were updated for clarity. All content remains the same.*

SECTION IV: CHAPTER 1

OIL WELL DERRICK STABILITY: GUYWIRE ANCHOR SYSTEMS

TABLE OF CONTENTS

I.	<u>INTRODUCTION</u>	4
	A. Casual Factors	4
	B. Industry Recommendations	4
	C. Application	5
II.	<u>TYPES OF GUYWIRE ANCHORS</u>	5
	A. Manufactured Anchors	5
	B. Shop-Made Anchors	5
III.	<u>STABILITY CONSIDERATIONS</u>	6
	A. Foundation	6
	B. Guywires	6
	C. Guywire Anchors	7
IV.	<u>OBSERVATIONS, DIRECTIONS, and CONCLUSIONS</u>	8
	A. Visual Observations	8
	B. Support Manual	9
	C. Conclusion	10
V.	<u>BIBLIOGRAPHY</u>	10

I. Introduction

Work-over Rigs are most type devices that vary significantly from crane or other boom (mast) type equipment. Work-over Rigs experience constant and varying dynamic loading conditions. They are subjected to various compression forces, along with jarring and wind loading. Other forces induced by pipe, tubing, etc. being stacked in the derrick and workers aloft on the derrick platform, as well as an ever-changing number of lateral and vertical forces are also present. Because of a work-over rig's dynamic environment, the health and safety of the operation is dependent upon the stability of the rig and its guy anchor system.

A. Causal Factors

There is no specific OSHA standard that addresses the stability of derricks in the oilwell drilling and servicing industry, see Figure IV:1-1. But because of the fatality record there is a need for a guideline detailing the type of temporary stability systems according to the type of soil and its holding capacity, methods of installing guywire anchors, integrity of the system, and acceptable parameters in lieu of actual pull testing should be established.

Investigation into each fatal incident has determined that the cause of the upset was component failure rather than total system failure. This clearly illustrates the fact that the integrity of the system is no sounder than its weakest component.

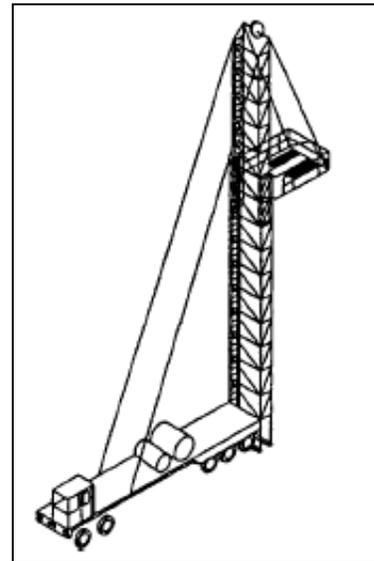


Figure IV:1-1. Oilwell Servicing Derrick

B. Industry Recommendations

The American Petroleum Institute (API) in its Specification 4E "Specification for Drilling and Well Servicing Structures" sets forth a "Recommended Guying Pattern General Conditions."

The Association of Oilwell Servicing Contractors. (AOSC) in its publication "Recommended Safe Procedures and Guidelines for Oil and Gas Well Servicing" recommends the same guying patterns as are set forth in API Specification 4E.

Though not present in the AOSC publication the API Specification 4E provides a Recommended Guyline Anchor Spacing and Load Chart. This is discussed in detail in the *Guidelines on the Stability of Well Servicing Derricks*.

There has been considerable progress within the industry to design procedures to assure the integrity of the stability system without the necessity of conducting individual pull tests on each of the anchors.

C. Application

This chapter is intended to form the basis of a minimum safety guideline, for the use of Temporary Guywire Anchor Systems on derricks, in the oil well drilling and servicing industry.

Recommended procedures, practices, equipment, and requirements have been developed based on availability, capability, adaptability, dependability, and reliability of the various types of systems.

II. Types of Guywire Anchors

A. Manufactured Anchored

There are four basic types of manufactured anchors. The screw or helix anchor, expanding plate anchor, flat plate anchor, and the pivoting anchor. Holding capacity of these anchors varies; detailed information on holding capacity, comparison charts with illustrations, and characteristics specific to each design may be found in Section 2 of the support manual.

When installed in conformance with manufacturer specifications and evidence thereof is provided, this would satisfy the requirement for individual pull testing.

CAUTION: It should continually be emphasized that the anchor is only one component of the Rig Stability System (RSS).

Screw- (helix-) type anchors have a direct correlation between anchor capacity and the torque required to install the anchor. Following the manufacturer's specific recommendations as to torquing, with proof thereof, is a valid method of determining anchor holding capacity. Torquing according to manufacturer's specifications is an acceptable nonpull-test method of determining anchor capacity.

B. Shop Made (In-house Fabricated) Anchors

These anchors should be designed by a registered engineer and conform to accepted engineering practices. Written procedures shall be established for installation.

These manufactured anchors should be proof tested for structural integrity and holding capacity. Records shall be maintained of test protocols and holding capacity based on soil type.

Individual pull testing will not be required if anchors are installed in accordance with written procedures. Proof thereof will be required of installation protocols and proof-tested holding capacities.

III. Stability Considerations

A. Foundation

The area should be graded, leveled and maintained so that oil, water, drilling fluid, and other fluids will drain away from the working area.

Safe Bearing Capacity shall be determined from the use of an appropriate table, soil core test, penetrometer test, flat-plate test, or other suitable soil test. When surface conditions are used to determine bearing capacity, care must be exercised to insure that the soil is homogeneous to a depth of at least twice the width of supplemental footing used to support the concentrated load.

Supplemental footing shall be provided to distribute the concentrated loads from the mast and rig support points. The manufacturer's load distribution diagram will indicate these locations. In the absence of a manufacturer's diagram, the supplemental footing shall be designed to carry the maximum anticipated hook load, the gross weight of the mast, the mast mount, the traveling equipment, and the vertical component of guywire tension under operational loading conditions. These footings must also support the mast and mast weight during mast erection.

Wellhead cellars present special foundation considerations. In addition to the obvious of collecting water and fluids that can seep into the ground, cellars also require unique mast support considerations. These should be analyzed by a qualified person to insure that an adequate mast foundation is provided.

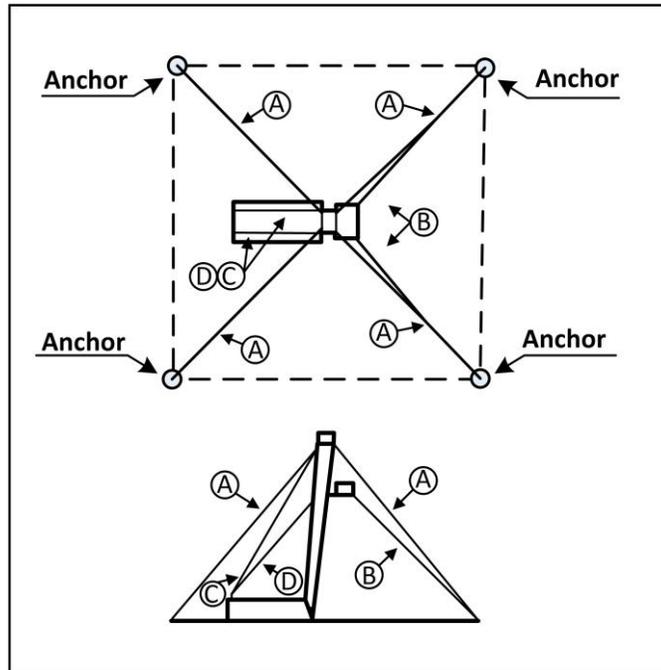
Small settlements (soil subsidence) at the beginning of rig-up is considered normal. External guywires should never be used for plumbing the mast. Rig foundations, guywire anchors and guywire tension should be checked at each tower (shift) change.

B. Guywires

All guywires, as indicated by the manufacturer's diagram, should be in position and properly tensioned prior to commencing any work. In the absence of manufacturer recommendations, or where mast manufacturer's recommendations cannot be implemented, the diagram in Figure IV:1-2 may be used.

Other guying patterns may be used; however, they must be based on sound engineering principles as determined by a qualified person. These recommendations should be posted on the mast in a weatherproof container and should state the loading conditions for which they were prepared. Guywires should be 6x19 or 6x37 class, regular lay, made of improved plow steel (IPS) or better with independent wire-ropes (IWRC) and not previously used for any other application. Double saddle clips should be used, and wire rope should be installed in accordance with the manufacturer's recommendations. In the absence of manufacturer recommendations, API RP 9B shall be followed.

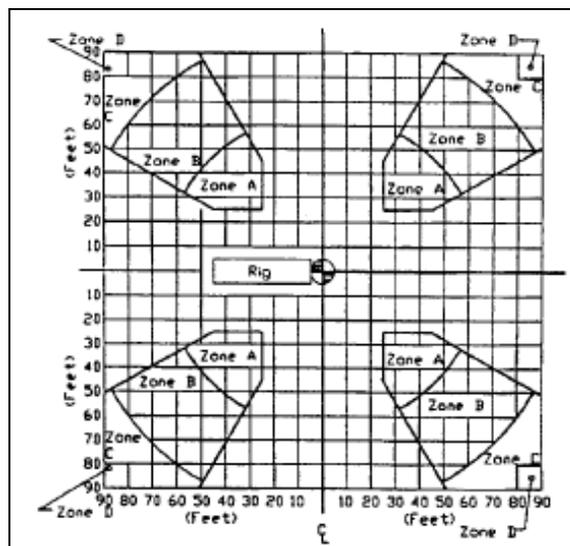
Figure IV:1-2. Anchor Location Diagram



C. Guywire Anchors

The mast manufacturer's recommendations shall be followed. In the absence of manufacturer recommendations the location diagram, Figure IV:1-3, may be used.

Figure IV:1-3. Recommended Anchor Locations



Each zone requires an anchor of different holding capacity. If anchors are located in more than one zone, then all anchors should be of the capacity required for the greater capacity zone. For example, if one anchor is located in "ZONE C" and the remaining anchors are located in "ZONE

D," all anchors shall meet the holding capacity specified in the chart for "ZONE C." See Figure IV:1-4.

Figure IV:1-4. **Anchor Capacity Requirements for Each Zone**

Anchor Capacity (Tons)			
Zone	Double Mast	Single Mast	Post Mast
A	156	7.0	7.0
B	11.5	5.0	5.0
C	9.0	5.0	5.0
D	7.4	5.0	5.0

Anchor Capacities shown assume the following:

1. Adequate foundation support for mast and carrier.
2. Adequate crown-to-carrier internal load guys.
3. Maximum wind load – 70 mph.
4. Maximum hook load, as described elsewhere in this chapter.
5. Full rod and tubing setback (N/A for Pole unit).

IV. Observations, Directions and Conclusions

A. Visual Observations

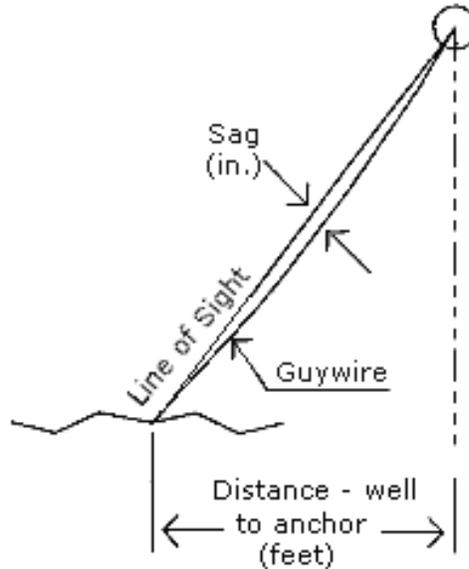
There are characteristic visual observations that can serve as indicators of rig stability. They include, but are not limited to, the following:

- The foundation supports the rig, substructure, and all applied loads while in an operational mode, without excessive movement. Basically in a level and plumb configuration.
- No large movement is observable between the mast support structure and the rotary/setback support structure when the slips are set and the load is removed from the mast, or vice versa.
- The empty travel block hangs plumb with the centerline of the wellbore and the mast support structure remains level.
- The mast support structure and/or substructure does not lean to one side more than the other when the load is applied. The guywire on one side becomes noticeably taut while the guywire on the opposite side becomes slack.

- The guywire anchor(s) show(s) no visible signs of movement during the loading and unloading of the system while in operational mode.

The chart presented in Figure IV:1-5 may be used as a guide to the pretensioning of guywires. This method is commonly referred to as the Catenary Method (guywire sag method).

Figure IV:1-5. Catenary Method



Distance Well to anchor (ft)	Guywire Sag (inches)					
	Pole Mast		Single Mast		Double Mast	
	Tubing Board Guy	Crown-Ground Guy	Tubing Board Guy	Crown-Ground Guy	Tubing Board Guy	Crown-Ground Guy
40	-	4	4	4	6	5
60	-	6	8	6	12	8
80	-	10	15	10	17	11
100	-	14	22	14	26	15
120	-	18	32	18	32	21
Pre tension (Pounds)	500	1000	500	1000	500	1000

B. Support Manual

The support manual, entitled Guideline on the Stability of Well Servicing Derricks, is divided into work sections and Intended to supplement this chapter. It provides a detailed analysis of existing guides and standards along with state-of-the-art developments.

Section 3 provides the direction and guidance necessary to evaluate and select the proper system to assure rig stability.

Section 4 discusses the installation of guywire anchor systems. It is extremely important to point out that stability is dependent on the entire system, and not on a single component.

In the absence of support documentation or manufacturer specifications, Section 6 sets forth the criteria for performing effective pull testing. It further identifies what would be acceptable in lieu of actual pull testing.

C. Conclusion

No set of observations or recommendations should be so restrictive or subjective as to preclude the use of innovative approaches to derrick stability systems. Properly designed substructures and base beams have been used effectively and safely as anchorages for guywires.

Engineering calculations based on sound engineering principals may also be used as evidence of an acceptable alternative to pull testing. Dead weight of equipment, fabricated components (i.e., padeyes) and other appurtenances are all considerations in determining rig stability.

The derrick manufacturer's specifications and recommendations should be the preferred and primary means of determining derrick stability.

Guywire anchors, newly installed according to the manufacturer's specifications, may be used without the requirement for actual pull testing (This would qualify as meeting the criteria as an acceptable alternative to pull testing). If, however, there is a change in conditions, e.g., frozen ground to thawed ground, or if use of the anchor has been interrupted, the anchor shall be pull tested, with documentation thereof, prior to being placed back in service.

V. Bibliography

American Petroleum Institute (API). 1988. *Specification 4E: Specification for Drilling and Well Servicing Structures*. API: Washington, D.C.

Association of Oilwell Servicing Contractors (AOSC). 1988. *Recommended Safe Procedures and Guidelines for Oil and Gas Well Servicing*. AOSC: Dallas.

International Association of Drilling Contractors (IADC). 1990. *Accident Prevention Manual*. IADC: Houston.

International Association of Drilling Contractors. 1979. *Drilling Manual*. IADC: Houston.

Scardino, A. J. 1990. *Guidelines on the Stability of Well Servicing Derricks*. Sigma Associates Ltd.: Pass Christian, MS.