GLOBALSANTAFE CORPORATION

RACK PHASE DIFFERENCE (RPD) GUIDELINES

MARINE SERVICES - HOUSTON

DOCUMENT STATUS

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0	01/16/04	Initial Issue	S. Nowak
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2	8/09/05	General Revision and Update To Entire Document Expand Management Guidance	S. Nowak / M. Lawson

1.0 Introduction

Section Overview
Document Purpose *Who, What, Where, When & Why* *Terminology*

1.1 Document Purpose

This document addresses jack-up leg Rack Phase Difference (RPD) on rigs with triangular legs. The purpose of this document is to provide GlobalSantaFe personnel with carefully researched information and guidance based on experience, enabling them to apply that knowledge, and take actions which yield predictable results where RPD management is concerned.

While the contents of this document are based on research and experience, it is important to note that every situation involving RPD is somewhat unique. In order to provide our entire fleet with the best information available, it important that Marine Services - Houston is consulted when there are questions concerning RPD, and also advised when RPD is encountered and addressed. This will enable updates to this guidance so that we can share the lessons learned.

1.2 Who, What, Where, When & Why

1.2.1 ***What*** is RPD?

Rack Phase Difference, commonly referenced by the acronym RPD, is the measurable difference in the vertical position of the chords relative to one another within an individual leg.

1.2.2 ***When*** does RPD occur?

RPD occurs due to an uneven loading of the leg chords when the spud can is eccentrically supported, or when the spud can is subject to a lateral (horizontal) load.

1.2.3 ***Why*** is RPD significant?

The uneven loading in a leg which causes RPD, also results in large loads being transferred to the leg's diagonal braces. If the RPD becomes too large, the braces will buckle.

1.2.4 ***Where*** does RPD stem from?

RPD typically occurs on locations with a disturbed or uneven seabed, resulting in eccentric bearing support of the leg's spud can, or causing the can to move horizontally.

High RPD is likely in situations with:

- Pre-existing spud can holes
- Sloping seabed
- Uneven seabed
- Uneven seabed due to scour
- Leg splay
- Rapid penetration

1.2.5 ***Who*** (which rigs) are subject to RPD?

Simply put, RPD has the potential to occur with any leg type, however some leg designs are more susceptible to RPD than others. Typically this includes most legs which use rack chocks, as they have been designed with lighter braces since most of the storm loading is intended to be supported through the chords. A leg design which does not use rack chocks is typically a stiffer design and is usually less susceptible to RPD, but there are trade-offs. The leg design more susceptible to RPD is generally lighter and experiences less loads from environmental forces, resulting in higher variable loads in both afloat and elevated conditions.

1.3 Terminology

- *Brake release*: The process where the loads on jacking motors and their pinions are decreased by controlled releasing of the brakes.
- *Bearing area*: The contact area between the spud can and the seabed.
- *Eccentric loading*: The condition where the center of the bearing area does not coincide with the center of the spud can, causing unequal leg chord loading.
- *High chord*: The leg chord within an individual leg which is positioned vertically higher relative to the other chords.
- *IC jacking system*: IC is the acronym for "independent chord", referring to systems that have the option to jack chords independently as well as together.
- *Leg splay*: The condition which exists when a leg is misaligned from a straight vertical orientation with the leg well.
- *Leg attitude*: A general term used to describe the leg orientation within the guides.
- *Low chord*: The leg chord within an individual leg which is positioned vertically lower relative to the other chords.
- *Lower guide*: The lower leg support structure. The position of the lower guide varies between rig designs, but it is generally located in the leg well between the main deck and the hull bottom.
- *Offset*: A lateral (horizontal) shift of the spud can. Leg splay results when a spud can is offset.
- *Opposed pinions*: An arrangement where pinions engage rack on two sides of the same chord.
- *Pre-existing spud can hole*: Refers to a hole or depression created by the spud can of another rig which was previously placed on the location.
- *Rack chock*: Fixation device that engages with the leg rack, transferring the loads on the hull to the leg chords.
- *Rack gauge*: A tool with the same shape as the leg rack for taking RPD reference measurements from the top of the jack case.
- *Rapid penetration*: When the leg's depth of penetration in the seabed is increased suddenly.
- *Relative spud can direction*: The direction toward which the bottom of the spud can is pointing when the leg is misaligned from a vertical position due to eccentric loading.
- *Reverse RPD*: A situation where RPD is intentionally imposed on the leg with the vertical relative position of the chords opposite to the direction expected to occur from seabed contact.
- *Rig tilting*: A situation where the rig is intentionally placed out of level.

- *SC jacking system*: SC is the acronym for "simultaneous chord", referring to systems that only have the capability to jack all chords at the same time.
- *Scour*: This condition occurs when the supporting sand or soil is eroded from the underside of the spud can. Scour is typically a result of exposure to high currents.
- *Sloping seabed*: Exists on locations with a variable water depth between the legs.
- *Uneven seabed*: A general description for locations with undulations on the surface of the sand or soil.
- *Un-opposed:* An arrangement where pinions only engage rack on one side of the chord.
- *Upper guide*: The upper leg support structure at the top of the jack case.

2.0 RPD Classification

RPD occurrences may be divided into three basic categories:

Section Overview
Sloping Seabed
Uneven Seabed
Leg Offset (Splay)

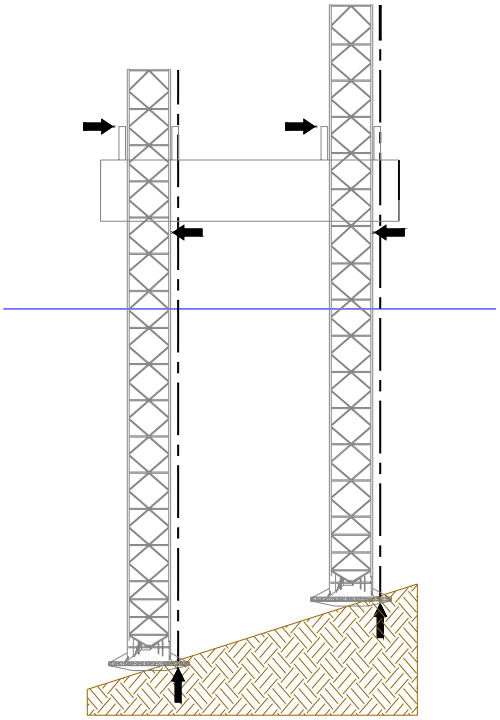
2.1 Sloping

RPD is prevalent on a sloping seabed with hard soil. In these cases, the spud can is likely to be eccentrically supported, meaning the center of the bearing surface does not coincide with the center of the spud can. When this occurs, the downward force exerted on the leg is not aligned with the reaction force from the seabed. This creates a moment, which is restrained by an opposing reaction through the leg's upper and lower guides.

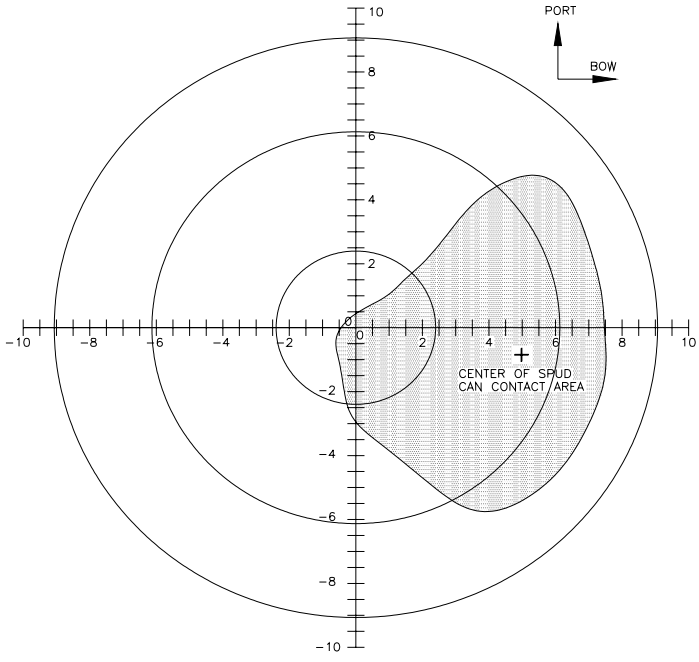
(Sloping seabed illustrations are shown on the next page.)

2.1.1 Slope Illustrations

- Figure 2.1.1a: Force Diagram (Slope)



- Figure 2.1.1b: Spud Can Bearing Diagram



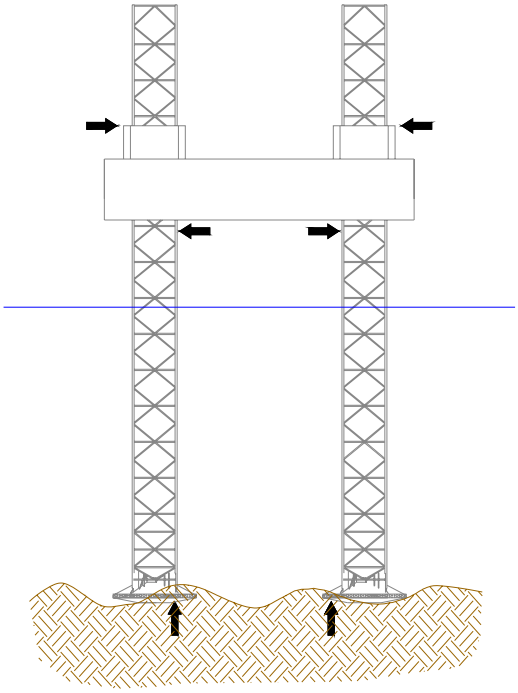
2.2 Uneven Seabed

With an uneven seabed, the spud can is again subject to eccentric support along the bottom of the can. The localized support with this type of seabed is sometimes referred to as "hard" spots, which also results in uneven loading of the spud can. Similar to the condition found on a sloping seabed, the downward force exerted on the leg is not aligned with the reaction force from the seabed. This creates a moment, which is restrained by an opposing reaction through the leg's upper and lower guides.

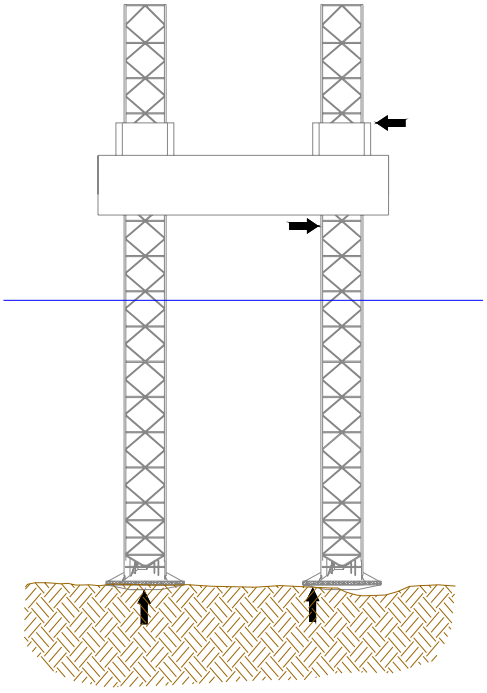
(Uneven seabed illustrations are shown on the next page.)

2.2.1 Uneven Seabed Illustrations

- Figure 2.2.1a: Force Diagram (Uneven Seabed)



- Figure 2.2.1b: Uneven Seabed Due To Scour



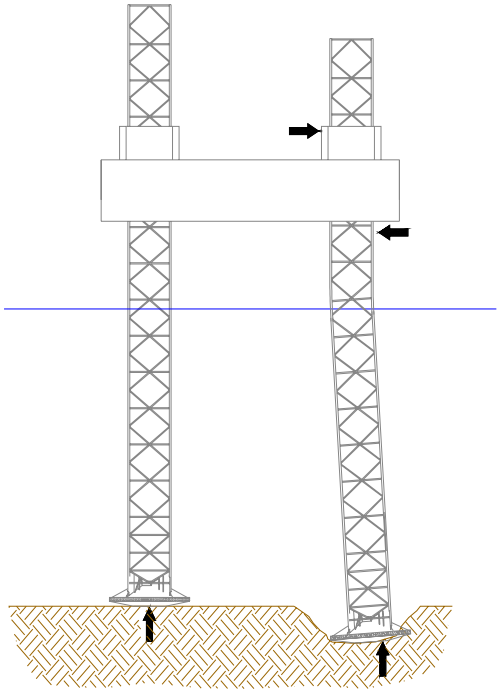
2.3 Leg Offset (Splay)

When the spud can is subject to a lateral (horizontal) or sideways load, this will also result in RPD. Similar to the other categories of RPD, the offset of the spud can results in misalignment between the downward force exerted on the leg and reaction force from the seabed. While all three categories produce a uneven loading in the leg, this case is easy to visualize as a large bending load due to a sideways force.

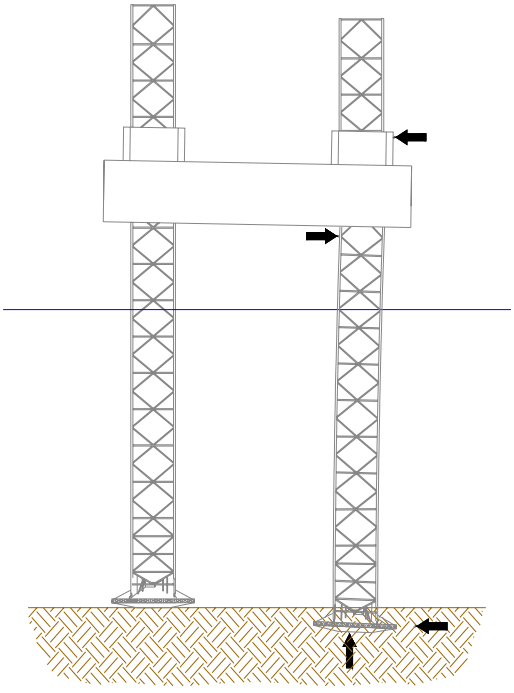
(Leg offset illustrations are shown on the next page.)

2.3.1 Leg Offset (Splay) Illustrations

- Figure 2.3.1a: Offset Due To Pre-existing Hole



- Figure 2.3.1b: Offset Due To Rapid Penetration



3.0 RPD Global Mechanics

Section Overview
Leg Attitude in Guides
Relative Spud Can Direction
Global Mechanics Illustrations

3.1 Leg Attitude In Guides

In the absence of external forces, a jack-up leg supported by the jacking system hangs vertically centered in the guides without contact between the leg rack and the guides. As mentioned previously, when a leg is subjected to bending loads, restraint is provided by the leg's upper and lower guides. The orientation of the leg within the guides is often referred to as "leg attitude". Besides the RPD reading, the leg attitude is another indicator that is evaluated in order to determine the effect of forces on the leg. On rigs without automatic RPD readouts, leg attitude is a valuable tool for the leg supervisor to monitor in between manual RPD readings.

3.2 Relative Spud Can Direction

Regardless of the cause of the RPD (previous holes, slope, ripple, splay, or rapid penetration), the displacement of the chords in the vertical plane with respect to one another indicates the direction of the spud can movement relative to the leg well. This relative direction with respect to the normal or vertically centered leg position can be determined from the RPD measurements. There is an Excel program available from the Marine Services department which yields the spud can direction vectors for given RPD measurements.

3.3 Global Mechanics Illustrations

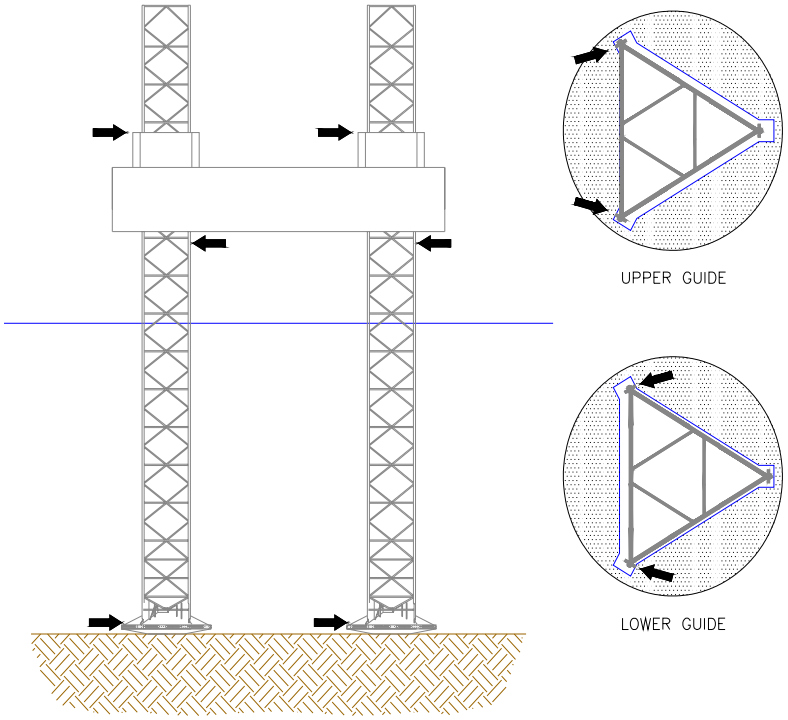
3.3.1 Spud Can / Leg Attitude Diagram ("A" Chord High)

3.3.2 Spud Can / Leg Attitude Diagram ("A" Chord Low)

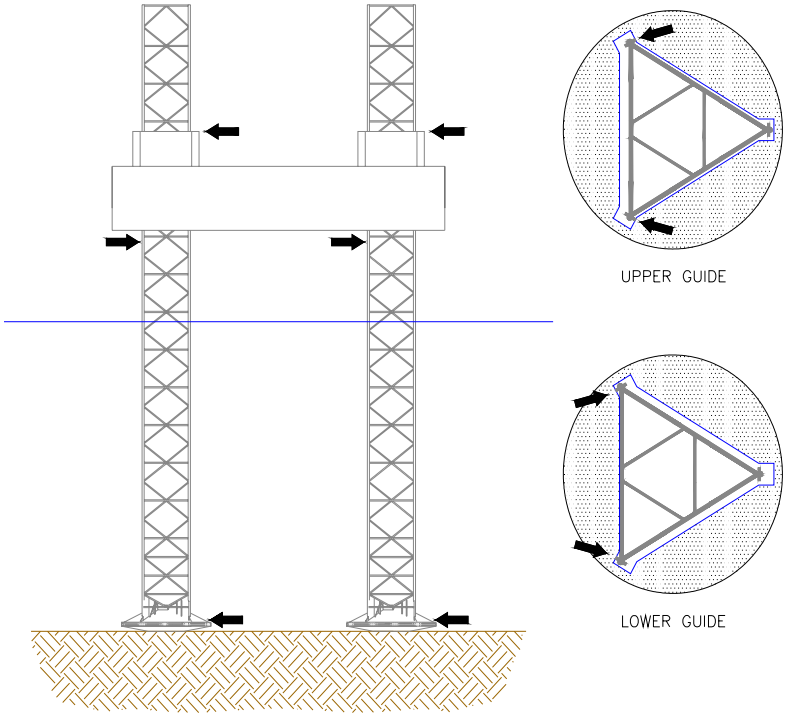
3.3.3 Spud Can / Leg Attitude Diagram (Profile View)

Note: Due to a different guide contact configuration, the diagrams in this section are not applicable to the Marathon LeTourneau 52C class rig.

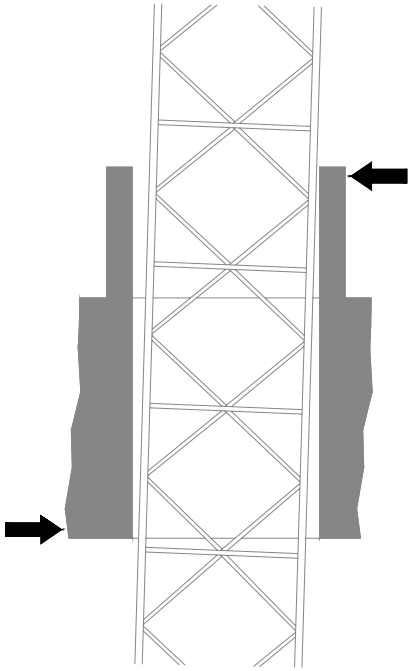
- Figure 3.3.1: Spud Can / Leg Attitude Diagram ("A" Chord High)



- Figure 3.3.2: Spud Can / Leg Attitude Diagram ("A" Chord Low)



- Figure 3.3.3: Spud Can / Leg Attitude Diagram (Profile View)



4.0 RPD Limits

Section Overview
Analysis Methodology
RPD – Effect On Elevated Load Limits
Specific RPD Limits For Rig Types

4.1 Analysis Methodology

4.1.1 General

The RPD limits are calculated for both the jacking and storm survival conditions using finite element analysis software with representative detailed models of individual leg and jacking system for each design.

4.1.2 Jacking

This is done assuming a single leg chord is restrained by modeled pinions, while the other two chords are held with reaction forces equal to a third of the elevated leg load on each. This configuration simulates a condition where the pinion loads equalize through pinion slippage, allowing the leg to rotate and generate RPD. Larger values of RPD are then generated by increasing the eccentricity of the applied force until the load utilization for a leg member (chord or brace) exceeds the allowable limit.

4.1.3 Storm Survival

For those rigs with rack chocks, this configuration assumes the rack chocks are installed with the leg restrained in a rotated position to model the quantity of RPD. Loads equivalent to the applicable "storm loads" are applied to the detailed leg model, as well as loads to account for the additional leg bending moment generated by the leg inclination equivalent to the level of installed RPD. Chord and brace strength checks are performed for each condition to calculate the limiting RPD for different water depths.

4.2 RPD – Effect On Elevated Load Limits

When a rig is set-up on location, the allowable values for elevated loads stipulated in the operating manual nomograms remain valid provided that the RPD is maintained within the limits specified in section 4.3.

4.3 Specific RPD Limits For Rig Types

The following RPD limits listed for the different classes of rigs are applicable for both the jacking and storm survival modes.

4.3.1 Rig Class: Friede & Goldman MOD II
Rig Names: Main Pass I; Main Pass IV; Rig 127, Rig 134; Rig 136
RPD Limit: 75 mm (3.0")

4.3.2 Rig Class: Marathon LeTourneau 52C
Rig Names: Rig 103; Rig 105
RPD Limit: 75 mm (3.0")

4.3.3 Rig Class: Modec C-45
Rig Names: Rig 124
RPD Limit: 75 mm (3.0")

4.3.4 Rig Class: Friede & Goldman MOD V
Rig Names: Monarch; Monitor; Magellan
RPD Limit: 75 mm (3.0")

4.3.5 Rig Class: Friede & Goldman JU2000
Rig Names: Constellation I; Constellation II
RPD Limit: 95 mm (3.75")

4.3.6 Rig Class: Friede & Goldman MOD VI
Rig Names: Galaxy I; Galaxy II; Galaxy III
RPD Limit: 125 mm (5.0")

5.0 Measurement of RPD

Section Overview
Automatic Measurement
Manual Measurement
Rack Gauge
Tips for Measuring RPD
Measurement Stages

5.1 Automatic Measurement

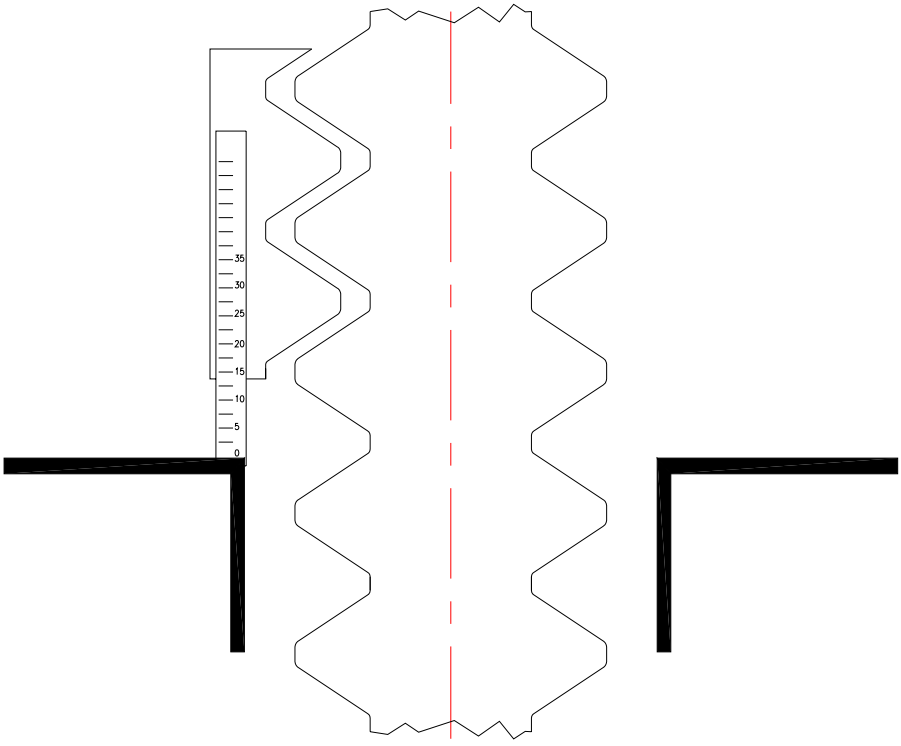
Some rigs are equipped with automatic RPD measurement systems. These systems have the advantage of providing real time information during the jacking process. Manual RPD readings do not provide this same level of constant readings since jacking operations must be stopped to take measurements. This real time detection shortens the response time for stopping the jacking operation which will minimize the RPD growth. Since there are various systems in use, personnel aboard rigs with automatic measuring systems should familiarize themselves with the manufacturer's operating instructions.

<u>Operations Note</u>: The calibration of automatic RPD measuring systems can drift. Therefore, it is important to make regular manual measurement checks to compare and tune the system.

5.2 Manual Measurement

Manual measurement of RPD is typically accomplished by measuring the distance from the top of the jack case to a fixed point on a rack gauge (see section 5.3). When engaged with the leg rack, the gauge must be placed at the same level on each chord. In other words, the same rack teeth on each chord must be used as the reference point for measurement. This distance is measured and recorded for each chord on a leg. The readings between chords on an individual leg are subtracted to find the RPD value. The chords with the largest differential are recorded as the "maximum" RPD. Figure 5.2.1 illustrates a typical measurement at a chord for determining RPD.

Figure 5.2.1 – Chord Measurement For Determining RPD



<u>Operations Note</u>: It is very easy to make an RPD reading error by using different rack teeth from one chord to another chord. Therefore, it is important to make sure the same rack teeth on each chord are used as reference points for measurement. Brace intersections or horizontals serve as good reference points for this purpose.

5.3 Rack Gauge

The rack gauge must be designed to match the size and spacing of the leg rack for each rig. While there are existing gauges that are not fitted with fixed rulers, it is recommended that each rig modify or obtain gauges that have fixed rulers. This style of gauge allows measurements to be taken more safely by placing the measurement reference point in a position that is easy to view, avoiding the need to bend over excessively, kneel or lie down to obtain a reading. Also, if the rack gauge is not symmetrical, then it should be clearly marked to indicate the top from the bottom. Figure 5.3.1 is a photo of a rack gauge for the Constellation I which is fitted with the fixed ruler.

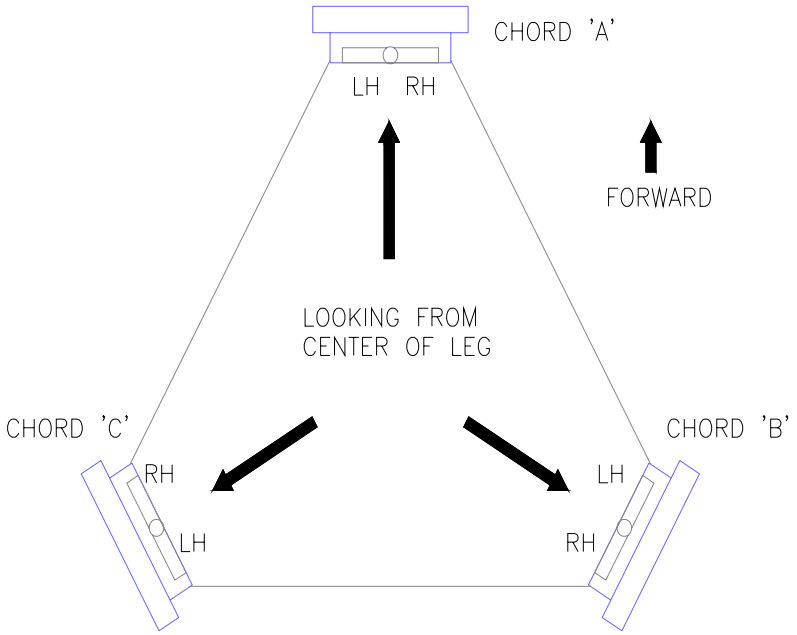
Figure 5.3.1 – Picture of Rack Gauge

5.4 Tips For Measuring RPD

5.4.1 On opposed pinion jacking systems, there are rack teeth on each side of the chord. Since the RPD measurement is taken with reference to the leg rack, the option exists to use either side of the chord. It does not matter whether the reading is taken from the right hand (RH) or the left hand (LH) side of the chord, however in order to ensure consistency with the RPD measurements, the same side of the chord should be used for each set of readings. This needs to be covered in jacking pre-task meetings so that all legs use the same side of the chord..

5.4.2 Diagram of Chord and Rack Designation

This diagram illustrates the convention for designating the left hand (LH) and right hand (RH) side of each chord. It also provides the typical designation of the chords on a triangular leg.



5.4.3 The measurement of the RPD can be made with tapes in imperial units, or with metric or derrick tapes which provide base 10 graduations. Either the derrick tape or the metric system is preferred in order to simplify the reading, recording, and calculating process for determining RPD. Both the derrick and metric tape are measurement systems which do not require translation into decimal form for recording in the Excel based RPD log. This reduces the chances of errors in the measuring and recording process.

5.4.4 As mentioned in paragraph 5.4.1, measuring on one side of the chord is considered acceptable. However, when the guide's wear plates show appreciable wear yielding significant gap clearance, then it is recommended to take readings on both sides of the chord and an average of those readings used for calculating RPD.

5.4.5 The accuracy of the RPD relies on a consistent reference point for the measurements. This means the tops of all jack cases should be surveyed to identify any vertical height differential. If any variation is found, shims should be installed on top of the jack case on both sides of each chord to make them all exactly the same height. The shims should be sized and installed to make all jack cases equal to the highest jack case within a given leg. Photos shows a properly installed shim.

5.5 Measurement Stages

The measurement to determine RPD shall be taken on a regular basis. While RPD may be taken at any time personnel think it is necessary to ensure proper leg alignment is maintained, as far as practicable, RPD measurements should be taken at the following stages of the move operation:

- Afloat prior to lowering the legs (after rack chocks have been removed)
- Afloat with the legs just off the seabed prior to pinning
- After legs are pinned
- After each 5' reduction in draft
- At zero air gap
- At preload air gap
- During preload process when making jacking adjustments to counter settling
- At 10' above the preload air gap
- At suitable intervals as the rig is elevated to the drilling air gap, i.e. 5', 10', or 15' (See Operations Note)

<u>Operations Note</u>: When initially elevating to the drilling air gap, a smaller interval, i.e. 5' should be used. Based on the observed trend for the RPD readings, this jacking interval may be increased if there are no appreciable increases in RPD.

6.0 Management of RPD

Section Overview
Management of RPD – General
Jacking System Types
RPD Management Methods
Removal of RPD While Afloat
Controlling RPD While Setting Up / Elevating on Location
Managing RPD While Taking a Rig Off Location

6.1 Management of RPD - General

6.1.1 This document, "Rack Phase Difference (RPD) Guidelines covers the essential information needed to understand, measure, and manage RPD when a rig is placed on location.

6.1.2 As indicated in section 1.1, it is important to note that every situation involving RPD is somewhat unique. It is also important to recognize that RPD management for some operations is not a routine event. Therefore, in order to provide our entire fleet with the best information available, and provide appropriate operational consultation, it is important to involve Marine Services - Houston when RPD is encountered in the various elevated modes. Also, from the long term perspective, this will ensure a consistent approach and allow the sharing of lessons learned.

6.1.3 The various seabed conditions that cause RPD have been addressed in section 2 and section 3. Although the RPD that occurs while placing a rig on location may be caused by sliding, interaction with previous holes or rapid penetration, it is not the intent of this document to cover in detail the rig moving practices associated with these issues, but rather to address the measures required only in so far as RPD is concerned.

<u>Operations Note</u>: In pre-task meetings, it is important to emphasize with all personnel, particularly those involved with activities at each leg station, that it is important to call a "time out" if they have any concerns about the operation.

6.1.4 One of the most critical stages for monitoring RPD occurs in the process of setting the rig up on location. Besides avoiding potentially damaging leg stress, the early detection of RPD prevents an operation from proceeding too far into the set-up process, where it generally becomes more challenging to manage RPD by changing the spud can interaction with the seabed.

6.1.5 It would be worthwhile to highlight the effect soils properties have on the process. As readers are aware, much can be written on just the subject of soils, so the emphasis here is to highlight the general differences or limitations available to the rig mover when managing RPD in hard soils versus soft soils. In general, locations with a hard seabed and minimal penetration, there is very limited potential for manipulating the seabed while elevated. In the case with a hard seabed, RPD is typically eliminated by re-seating the spud can. If RPD is monitored closely, prior to applying full bearing pressure, there can be some limited ability for manipulating the seabed, also commonly referred to as "stomping" or "pre-forming". It does not mean RPD is impossible to alter in various stages of the elevating process, however personnel should be aware that manipulation of the seabed in advanced stages of the move process are more likely to succeed on locations with softer soil types that maintain some degree of pliability. That being said, whether a location has soils characterized as hard or soft, the best chances for managing and eliminating RPD occur in the initial stages of setting up on location.

<u>Operations Note</u>: As far as practicable, avoiding RPD should be a key objective when placing a rig on location. The most common method of avoiding RPD involves lifting the spud can, removing RPD and reseating the spud can while the hull is still afloat or with the rig lightly pinned.

6.2 Jacking System Types

There are two basic categories of jacking systems, namely simultaneous or independent chord jacking. The simultaneous chord (SC) jacking system only allows the option of jacking all three chords of the leg at the same time. The independent chord (IC) jacking system provides options to jack chords simultaneously or move chords individually. With the independent chord jacking system, the chords may be jacked either up or down. Throughout the discussion in this section, the two types of jacking systems will be referred to as SC (simultaneous chord) and IC (independent chord).

6.2.1 Simultaneous Chord Jacking System

The SC jacking system is very limited in terms of the options available for managing RPD. Since this system does not have the feature for independent chord jacking, the only viable option available for adjusting chords is by means of releasing brakes on selected chords in a controlled manner.

Rig Class with SC Jacking System:

F&G MOD II
Modec C-45
MLT 52

6.2.2 SC Jacking System (RPD Management Methods)

The following RPD management methods are available on an SC jacking system:

- Reseating / Zero RPD
- Changing Chord Loads
  - Brake Release
- Rig Tilting

6.2.3 Independent Chord Jacking System

Besides brake release, the IC jacking system features independent chord jacking for altering the vertical relationship between chords. The panels for jacking chords independently are located on the main deck at each leg chord. On these panels, there are two options, elevating the hull or raising the leg (lowering the hull). For either option, when performing independent chord jacking, the system is regulated to provide reduced power levels.

Rig class with IC Jacking System:

F&G MOD V
F&G MOD VI
F&G JU2000

6.2.4 IC Jacking System (RPD Management Methods)

The following RPD management methods are available on an SC jacking system:

- Reseating / Zero RPD
- Changing Chord Loads
  - Brake Release
  - Independent Chord Jacking
- Rig Tilting

<u>Operations Note</u>: As far as practicable, when making any RPD adjustments, the hull should be maintained as level as possible.

6.3 RPD Management Methods

This section contains general descriptions for the management methods listed in 6.2.2 and 6.2.4 for the IC and SC jacking systems. More detailed steps for each method and the phase of the operation at which they are applied are contained in the sections that follow.

Operations Note: ***All references made to releasing of the jacking system brakes imply a controlled intermittent process whereby excessive momentum is avoided.***

6.3.1 Reseating / Zero RPD

Reseating describes the process of lifting the leg from the seabed and placing it back again. In some cases, the RPD in the leg will be relieved as it is lifted from the seabed without the need for manual adjustments. The ability for RPD to self correct will vary from rig to rig depending on the motor slip characteristics and the distance the leg is jacked. If the RPD is not sufficiently reduced through the jacking process, then manual adjustments are required to correct the RPD.

6.3.2 Changing Chord Loads - Brake Release

Brake release describes the process where the brakes on selective motors are intermittently released in order to redistribute loads on the jacking system. When brakes are adjusted or released, this causes the pinions to rotate and alter the chord position, which also redistributes the loads on each of the chords. Releasing of the brakes is a relatively quick method for altering RPD, however it is difficult to quantify the effectiveness of the adjustment, therefore it often involves a “trial and error” approach. With repeated experience on a particular jacking system, a rig mover should eventually develop a feel for the level of adjustment needed to effect optimum changes.

6.3.3 Changing Chord Loads - Independent Chord Jacking

As mentioned, in addition to the brake release method, the IC jacking system provides the ability to make changes in individual chords. The jacking panels for performing this operation offer choices for elevating the hull at a particular chord or lifting the chord itself. Which method is used depends on the RPD correction that is desired, and to some degree, it is also a function of whether the hull is partially afloat or elevated. The application of each technique will be detailed further in this section. On the IC jacking system, there are also multiple options for the brake release function. Controls exist to either release brakes on an individual basis or a simultaneous release of all motor brakes on a particular chord. Some jacking systems also offer a "re-torque" function, which allows controlled adjustments of jacking motors by selecting the level of load each motor holds.

6.3.4 Reverse RPD

Reverse RPD describes the process where RPD is intentionally imposed on the leg. With this process, the vertical relative position of the chords are placed opposite to the direction expected to occur from seabed contact. Similar to the brake release methods, the exact degree of reverse RPD that is required will vary between locations and soil types. Although it is considered a trial and error process, a general rule of thumb is to apply a reverse RPD correction that is equivalent to or slightly greater than the unwanted RPD that is occurring from contact with the seabed.

6.3.5 Rig Tilting

The guidance in this document clearly spells out that managing RPD and alteration of the interaction between the spud can and the seabed stand the best opportunity of success with a controlled process during the initial spud can seating and subsequent maneuvers to reseat when minimal bearing pressure has been exerted by the rig. While this holds true for a majority of the cases, there are instances, especially in softer soils where RPD management is required in advanced stages of the set up process. If there are changes that occur during advanced stages of the preloading operation, rig tilting may be applied. While rig tilting is a viable option of manipulating the seabed, its use should be considered only when all of the options to independently change chord loads have proven ineffective. The degree to which the soil is impacted depends on the ability it has for being remolded. A problem with this method is that it is difficult to dictate the exact inclination required to achieve the desired results. Caution should be exercised in order to avoid over correction of the spud can / seabed

interaction with excessive inclination. It is better to apply a stepped process, whereby the inclination is gradually increased after measuring the results between attempts.

Note: If rig tilting is required as the only remaining option to alter the effects of RPD, it is recommended that Marine Services - Houston is contacted to discuss the preferred approach.

<u>Operations Note</u>: Rig tilting should not be attempted if the penetration versus bearing pressure plot indicates there is any possibility for rapid leg runs.

6.4 Removal of RPD While Afloat

As specified in Section 5, RPD readings shall be taken while the rig is afloat, both prior to lowering the legs, as well just prior to pinning the legs on the seabed. If there is any residual RPD in the legs, it needs to removed.

6.4.1 Removal of RPD Afloat – SC Jacking System

Prior to lowering the legs or pinning the seabed, the RPD is removed with the following steps:

- ► Release brakes on high chord(s) until the RPD is 25mm (1") or less
- ► Jack the leg up 2' or more
- ► Jack the leg down 2' or more
- ► Take RPD readings (repeat process as required until all RPD has been released)

6.4.2 Removal of RPD Afloat – IC Jacking System

The IC jacking system offers options to perform this task. The brake release method described above for the SC jacking system is one option. The procedures for using the brake release method are the same as described above for the SC system. The other recommended approach on an IC system involves hull elevating on the high chords. With the "hull elevating" method, RPD afloat is removed with the following steps:

- ► On the high chord(s), elevate hull using individual chord jacking until the RPD is 25mm (1") or less
- ► Jack the entire leg down 2' or more
- ► Jack the entire leg up 2' or more
- ► Take RPD readings (repeat process as required until all RPD has been released)

Alternatively, if two of the chords are the at the same level and one chord is lower, the low chord may be lifted using the "leg up" function with the following steps:

- ► On the low chord(s), elevate leg using individual chord jacking until the RPD is 25mm (1") or less
- ► Jack the entire leg up 2' or more
- ► Jack the entire leg down 2' or more
- ► Take RPD readings (repeat process as required until all RPD has been released)

Operations Note: ***The instructions for jacking the entire leg following a correction assume the residual RPD remaining in the leg is still biased in the same direction. In other words, the chord(s) which were higher remain so, although the difference between chords is less. If the manual RPD correction has reversed the relative position of the chords, rendering the high chord as the low chord, then jacking the entire leg in a direction opposite to that specified may provide a more effective correction.***

6.5 Removal of RPD While Setting Up / Elevating On Location

This section covers the various options for managing RPD after the rig is pinned and during the elevating process.

6.5.1 Reseating / Zero RPD

Whether or not there is any penetration associated with a location, there are likely to be some changes in the contact area between the can and seabed each time it is lifted and reseated. When a rig is pinning the seabed or penetrating the seabed while elevating and reducing the rig's draft, RPD shall be monitored at the stages listed in section 5.5. If the RPD measurements indicate an increasing trend or approach the limits specified in section 4.3, then the jacking operation should be stopped and actions taken to reduce the RPD. In order to reduce the RPD, the leg should be lifted a couple of feet. On a hard seabed location with virtually no penetration, this usually involves lifting the leg from the seabed. On locations where there is some degree of penetration, the first attempt should involve lifting the leg a few feet, then reseating. If necessary, the leg may be lifted an additional distance, and raised clear of the seabed if eventually required. In both cases, if there is residual RPD in the leg after it is lifted or extracted, it should be removed in accordance with the procedures in section 6.4 prior to being reseated.

Reseating / Zero RPD Step Overview:

Method A: Leg Is Extracted Clear of the Seabed

- ► Method A for SC Jacking System: See section 6.4.1
- ► Method A for IC Jacking System: See section 6.4.2
  - Take RPD readings
  - Repeat process as required
  - Re-pin leg
  - Resume jacking to elevate rig

Method B: Leg Is Partially Extracted From Seabed

Note: The corrections required for this condition are not always immediately obvious. The method of correction will depend on whether the leg weight is being supported entirely by the pinions or partially supported by the seabed. Since most rigs do not have pinion load monitoring systems, this is typically determined by observation of the kilowatt gauges on the main jacking panel during the jacking process.

(Leg Weight Supported Entirely on the Pinions)

► Method B1 for SC Jacking System: See section 6.4.1
► Method B1 for IC Jacking System: See section 6.4.2

Note: This is the same process as applied in Method A above.

(Leg Weight Supported by the Seabed)

► Method B2 for SC Jacking System:
- Release brakes as required on low chord(s)
- Jack hull up 2' or more
- Take RPD Readings
- Repeat process as required

► Method B2 for IC Jacking System:

Again, the method described above for the SC jacking system is one option. The adjustment can also be made by elevating the hull on the high chord as follows:

- On the high chord(s), elevate hull using individual chord jacking until the RPD is 25mm (1") or less
- Jack hull up 2' or more
- Take RPD Readings
- Repeat process as required

6.5.2 Reverse RPD

Once it is evident which chord persists at being the high chord when attempting to seat the spud can, a method referred to as reverse RPD may be used on the IC jacking systems. Reverse RPD is a term used to describe the process of altering the leg RPD to impose a different chord relationship than the leg desires to take. This is accomplished using the independent chord jacking feature of the IC system. Reverse RPD is applied with the leg just off the seabed prior to reseating the spud can. When the leg is then lowered back to the seabed and pinned using the main jacking panel, the chord with the reverse RPD is forced to take a higher initial load than the other chords, with the objective of changing the spud can / seabed interface to improve the bearing contact area / penetration on that side of the can.

6.5.3 Changing Chord Loads – Brake Release

As mentioned in 6.3.2, the brake release method involves an intermittent release of the brakes on selective motors in order to redistribute loads on the jacking system.

► Brake Release for both SC & IC Jacking Systems:
- Release brakes as required on low chord(s)
- Jack hull up 2' or more
- Take RPD Readings
- Repeat process as required

Note: When the process is repeated it may be attempted at the new elevation or the hull may need to be lowered depending on exact phase of the set-up process. Deciding whether or not to reposition the hull will also be dependent on the estimated chord loads and effectiveness the correction has on the RPD.

6.5.4 Brake Release Followed by Additional Loading

In some cases, it may be advantageous to selectively apply additional loads to a high chord following the alteration of RPD in the elevated condition. This means that additional loading is applied without jacking the leg after making the RPD correction. This practice is most commonly used during the preloading process and is achieved by tailoring the tank filling sequence to concentrate the initial loading at the high chord(s).

6.5.5 Changing Chord Loads – Independent Chord Jacking

Besides controlled releasing of the brakes, the chord loads at a leg can be altered on an IC jacking system by either using the "hull elevating" or "chord lifting" features available on the individual chord jacking consoles. On those systems that have the "re-torque" feature mentioned in section 6.3.3, it provides a third alternative for independent chord jacking to alter chord loading on a leg.

Hull Elevating: This function is applied on the high chord. When the hull is elevated on a single chord, it increases loads on that chord with the aim of driving the chord, attempting to position it at a similar relative position with the jacking structure as the other chords. As previously described, the independent chord hull elevating feature is typically power limited, so it can only be utilized at stages of the set up process where a portion of the hull is still waterborne.

Chord Lifting: This function originally exists as a means for jogging the legs to remove or insert rack chocks in the afloat mode. Consequently, the power limitations typical for this feature render it impractical in the elevating / setting up phase of a rig move unless the hull is substantially waterborne near the floating draft.

Re-torque: If provided, the re-torque feature is a valuable option for controlled alteration of loading on a chord. The use of the motor re-torque function allows the user to individually control each motor on a chord and regulate the degree of power exerted by that motor, typically displayed as a percentage. It also works in either direction to increase or decrease motor torque. Although the operation is somewhat slower than using the chord specific IC jacking or brake release functions, it permits finer control by offering the ability to perform the adjustments in stages.

6.5.6 Rig Tilting

The process of rig tilting to alter the RPD in the set-up process is explained in section 6.3.5. Although it is listed as an option, it should be reserved as one of the last techniques to apply after exhausting the other recommended methods detailed in these guidelines. It is also recommended that Marine Services - Houston is contacted to discuss the preferred approach should rig tilting be attempted.

6.5.7 Leg Attitude Correction

When the maneuvering process is completed and a rig is considered to be in the final position at a location, as far as practicable, prior to the preload process, each leg of the rig should be lifted and RPD adjusted (zeroed) one by one as the other two legs remain pinned. This will allow the leg to assume the most reasonable vertical attitude and remove any splay that may be present as a result of the final positioning process where it is typical to rely on leg engagement with the seabed. On some locations with hard bottoms, this procedure may not always be possible to employ if swell conditions are marginal.

6.6 Managing RPD While Taking a Rig Off Location

The methods listed below are the options which are available to deal with RPD when encountered while jacking down and removing a rig from a location. Since RPD issues in this operational mode usually involve large air gaps and could potentially produce higher brace loadings involving jacking operations over a longer leg section, it is important to consult with Marine Services – Houston for assistance and detailed input.

- Incremental Jacking
  - Brake Release
  - Independent Chord Jacking

- Rig Tilting
  - Lean In – Pin Rotation
  - Lean Away – Can Fixed

7.0 Other Recommendations

Section Overview
Preloading - Single Leg / Staged
Tide Considerations
A Word About Weather Windows

7.1 Preloading

7.1.1 Preference For Single Leg Preloading

With rigs prone to RPD, unless preloading on a location with a very hard bottom and minimal penetration, or where there is reasonable certainty that there will be no additional gains in penetration from the initial with the preload process, all preloading operations should be conducted on a single leg basis. The single leg preload process is the safest way to preload and provides the most control during settling. One of the principal benefits of the single leg preload process is the ability to work with the other two legs which are not currently being preloaded. In other words, the single leg preload process provides the ability to jack on the legs not undergoing preload so that any settling which takes place can be "followed" with these legs by lowering the hull.

7.1.2 Staged Preloading

If the preloading process is altering the interface between the spud can and the seabed in a manner that would cause an increase in the RPD, this change is not usually apparent until the rig is jacked. Since manipulation of the seabed is more likely to succeed while the soil still maintains some degree of pliability, it may be advantageous to adopt a staged preload plan that permits jacking operations prior to applying the full preload bearing pressure to the seabed.

If the rig makes significant additional penetration gains as a result of the preload process, then staged preloading occurs naturally since ballast is typically removed and the rig jacked to reposition at the preload elevation. The difficulty in deciding whether or not to apply a staged preload occurs on locations where there are minimal gains in penetration as a result of the preload process. While there is no way to know for certain whether a location requires a staged preload, as a general rule, a staged preload is recommended when

considerable RPD management was required to position the rig at the preload elevation. If a decision is taken to use a staged preload plan, it is recommended to apply preload in two or three stages. At the completion of each stage, the preload is dumped to reduce the rig weight to that which permits jacking operations. The rig is then elevated two feet and again lowered back to the preload elevation and RPD readings taken and recorded.

Operations Note: ***During all preloading operations, it is very important to keep the hull as level as possible. This is accomplished by "following" any settling which occurs on the leg being preloaded by lowering the hull on the other two legs. If the rig is allowed to incline, it could adversely affect leg RPD.***

7.2 Tide Considerations

On locations with strong tidal streams, it is recommended that RPD prone rigs are placed on location during slack tide periods. The placement of the rig on location while a strong current is exerting a force on the hull could increase the potential for misalignment between the spud can with respect to the leg well. This misalignment could result in leg splay, causing an increase in RPD.

7.3 A Word About Weather Windows

Bear in mind that when defining weather windows in the development of your rig move procedures, if RPD is anticipated, then consideration will need to be given to allowing longer than normal periods of suitable conditions for the move on location process. This is due to the high probability of sustained periods with the hull in the water at various drafts.