METHODS AND SYSTEMS FOR MONITORING DIRECTIONAL DRILLING

ABSTRACT

Various embodiments of the systems and methods for monitoring, for example passively monitoring and controlling, a directional drilling operation are disclosed. In one example, a system regulates access and use of the system based on a user's position in a hierarchy and based on previous commands given by those above the user in the hierarchy. Methods of using predetermined window corridors to keep a well bore on track are discussed. Methods and systems designed to increase accountability and transparency in the drilling operation are discussed. Methods of calculating drilling instructions based on survey data are discussed. Methods of drilling with a mud motor are discussed.
Fig. 1C

Fig. 1D
DIRECTIONAL CONTROL SYSTEMS

BY

DIRECTIONAL CONTROL SYSTEMS INTERNATIONAL (DCSI) INC.

Unit Number - 143

Oil Company: Black Shire Energy Inc. (2a)
Well Name: Black Shire Hz 100 Provost 2-6-38-21 (2b)
DCSI Job Reference Number: 1001 (2c)

As soon as the system is started up it verifies back to the DCSI Main Server if it should be running by the DCSI Unit Number. If there is a break in power or no communication with the DCSI Main Server then the program will automatically move to the Import Well Files Screen. If communication is established with the DCSI Main Server and this unit should be running the DCSI Main Server will automatically download the well file that appears in the start up screen, no data can be edited in this screen. As soon as the operator verifies that the data is correct and hits "OK" the program will move to the next screen.

Fig. 2
Import Well Files
Tab to Move Through Cells

- Import Well Files
  - (3a)
  - When the Import Well Files command is activated the program will move to the location server USB Removable Drive automatically.

- Well File Name & Number
  - (3b)

  Step #1: Insert memory stick with well file in the USB port in location server.
  Step #2: Activate the Import Well Files Command Button in the top left hand corner.
  Step #3: Select the well file to import from the drop box.
  Step #4: Activate the Import Command Button.
  Step #5: Hit "OK".

Fig. 3
<table>
<thead>
<tr>
<th>Oil Company</th>
<th>Well Name</th>
<th>Field</th>
<th>Province / Country</th>
<th>License ID Number</th>
<th>Unique ID Number</th>
<th>Directional Company</th>
<th>Rig &amp; Rig Number</th>
</tr>
</thead>
</table>

Step #1: Check the data, if the data is correct hit "Ok".

Step #2: If the data needs to be edited, edit data then hit "Ok".

Fig. 4
KB Verification
Tab to Move Through Cells
Ground elevation minus cut or fill added to
ground elevation equals New Ground Elevation.
If there is no Cut or Build enter zero (0).

<table>
<thead>
<tr>
<th>Ground Elevation:</th>
<th>(5a)</th>
<th>To Header &amp; All Print Outs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut:</td>
<td>(5b)</td>
<td>Entered here from engineers surveyed data.</td>
</tr>
<tr>
<td>Fill:</td>
<td>(5c)</td>
<td>Entered here from engineers surveyed data.</td>
</tr>
<tr>
<td>Corrected Ground Elevation:</td>
<td>(5d)</td>
<td>Becomes the new ground elevation.</td>
</tr>
<tr>
<td>Rig KB to Ground:</td>
<td>(5e)</td>
<td>Entered here after the Rig KB to ground is measured.</td>
</tr>
<tr>
<td>Corrected KB Elevation:</td>
<td>(5f)</td>
<td>New ground plus Rig KB to ground becomes KB.</td>
</tr>
</tbody>
</table>

Step #1: Check over the data, if the data is correct hit "OK".
Step #2: If the data needs to be edited, edit data then hit "OK".

**EXTREMELY IMPORTANT:**
The KB elevation is used in all the well plan and survey file calculations
"Blue" cells are locked out, "White" can be entered or edited.
**Wall Tie-in Screen**

Tab to move through cells.

The data entered here is used as the tie-in (starting point) for the survey file.

<table>
<thead>
<tr>
<th>Measured Depth:</th>
<th>(6a) Edit Data Here / Used in all prints &amp; file headers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inclination:</td>
<td>(6b) Edit Data Here / Used in all prints &amp; file headers</td>
</tr>
<tr>
<td>Azimuth:</td>
<td>(6c) Edit Data Here / Used in all prints &amp; file headers</td>
</tr>
<tr>
<td>True Vertical Depth:</td>
<td>(6d) Edit Data Here / Used in all prints &amp; file headers</td>
</tr>
<tr>
<td>Sub Sea Depth:</td>
<td>(6e) Comes From KB Elev or a Entered/Edited</td>
</tr>
</tbody>
</table>

**EXTREMELY IMPORTANT:** This section must be filled out and/or verified as soon as the figures are available. They are used to execute the survey file calculations. If there is no North/South or East/West off-sets entered, Zero (0) will be the default.

<table>
<thead>
<tr>
<th>Vertical Section Direction:</th>
<th>(6f)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North/South Off-Set:</td>
<td>(6g)</td>
</tr>
<tr>
<td>East/West Off-Set:</td>
<td>(6h)</td>
</tr>
</tbody>
</table>

Step #1: Check over the data. If the data is correct hit "OK".

Step #2: If the data needs to be edited, edit data then hit "OK".

---

**Fig. 6**
**Password Entry Screen**

Tab to Move Through Cells

List all men on location in appropriate category for well records, even if they do not have an activation code.

<table>
<thead>
<tr>
<th>(7a) Name</th>
<th>(7b) Code</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Company Head Office</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Company Man on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Company Man on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Company Man on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Company Man on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Company Man on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Company Man on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Oil Company Head Geologist</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Geologist on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Geologist on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Geologist on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Geologist on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Geologist on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Geologist on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Directional Coordinator</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Directional Driller on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Directional Driller on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Directional Driller on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Directional Driller on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Directional Driller on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>Directional Driller on Location</td>
<td>6 Digit</td>
<td></td>
</tr>
<tr>
<td>DCSI Representative (Over-Ride Code)</td>
<td>6 Digit</td>
<td></td>
</tr>
</tbody>
</table>

Active password will carry throughout the entire program.

To activate a code:

Step #1: Enter name in appropriate category.
Step #2: Enter a 6 digit code in line with name entry.
Step #3: Hit "OK".

**EXTREMELY IMPORTANT:**

Proceeding active code will always over-ride any codes below it, however the DCSI Over-Ride Code will over-ride all codes and will only be used for editing purposes.

To over-ride or deactivate a code:

Step #1: Re-enter the 6 digit code in line with name entry.
Step #2: Enter a 6 digit code in line with name entry that will become the new active name and code.
Step #3: Hit "OK".

"Blue" cells are locked out, "White" can be entered or edited.
Target & Window Corridor Parameters

Program will automatically change targets when the survey file hole depth gets within a 10m or 32.8ft window above the target measured depth.

Active Well Plan: Plan A

Target #1 (8a)

Check More Than One if Needed.

Reason for Edits (8e)
- Out of Window
- Open/Close Windows
- Off Target
- Target Changed
- Plan Re-Written

Original Target/Windows (8m)

Step #1: Check over the data, if the data is correct hit "OK".

View Targets
- Next Target
- Previous Target

Section Windows (8c)

Edits by Who (8f)
- Head Office
- Co.: Man
- Geology
- Directional

Edit Active Target/Window Set Up (8o)
- Edit Active Target/Window

Step #1: Active Edit Target/Window

Step #2: Select Parameter to be Edited.

Step #3: Only edit the parameters that need to be edited then check off the reasons for edits, and who ordered changes.

Step #4: Enter the active acceptance code then hit "OK".

Comment: 50 Characters (8g)

Default Window Settings:
- Tvd: 2m/6.56ft above, 1m/3.26ft below
- Inc: 2 degs ahead or behind
- Line: 2m/6.56ft right, 2m/6.56ft left
- Az: 2 degs ahead or behind
- Motor/Bha: 30 Drop

Active to re-set windows to default settings. (8d)

"Blue" cells are locked out, "White" cells can be entered or edited.

Active Acceptance Code must be entered in order to accept new well parameters: (8j)

Active Acceptance Code: (8k)

Add Target: Close

Fig. 8
### BHA Information

Tab to Move Through Cells

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth in Hole (m/ft)</td>
<td>(9a) Displayed as a Survey File Comment</td>
</tr>
<tr>
<td>BHA Number</td>
<td>(9b) Displayed on Program Header &amp; as a Survey File Comment</td>
</tr>
<tr>
<td>Bit Manufacturer</td>
<td>(9c) Displayed as a Survey File Comment</td>
</tr>
<tr>
<td>Bit Type (PDC, Tri-Cone)</td>
<td>(9d) Displayed on Program Header &amp; as a Survey File Comment</td>
</tr>
<tr>
<td>Bit Type (bit code)</td>
<td>(9e) Displayed on Program Header &amp; as a Survey File Comment</td>
</tr>
<tr>
<td>Hole Size (mm/inch)</td>
<td>(9f) Displayed on Program Header</td>
</tr>
<tr>
<td>Motor Size (mm/inch)</td>
<td>(9g) Motor Size is a Drop Box (Displayed on Program Header)</td>
</tr>
<tr>
<td>Motor Stabilizer</td>
<td>(9h) Yes [ ] No [ ]</td>
</tr>
<tr>
<td>Motor Setting (deg)</td>
<td>(9i) Motor Setting is a Drop Box (Displayed on Program Header)</td>
</tr>
<tr>
<td>Motor Dogleg (deg)</td>
<td>(9j) Picked Up When Motor Setting is Chosen (Program Header)</td>
</tr>
<tr>
<td>Motor Stabilizer Size</td>
<td>(9k) Motor Stabilizer Size (Remains Here)</td>
</tr>
<tr>
<td>Bit to Gainera (m/ft)</td>
<td>(3) Program Header</td>
</tr>
<tr>
<td>Bit to Sensor (m/ft)</td>
<td>(9m) To Header, Print Data &amp; Used In Survey &amp; Thin Calculations</td>
</tr>
</tbody>
</table>

**Step #1:** Check over the data, if the data is correct hit "OK".
**Step #2:** If the data needs to be edited, edit data then hit "OK".

(9n) (9o)

"Blue" cells are locked out, "White" cells can be entered or edited.

Add Bha [ ] OK [ ]

Appears at Top of Motor Drop Box (all motor sizes)

(9p) Motor Self Entry Command Option

If the operator selects the self entry command option the entry boxes below will appear.

Operator's Option

Motor Setting [ ] Expected Dogleg [ ]

Fig. 9
Survey or Well Plans Data is Displayed Here

Fig. 10
<table>
<thead>
<tr>
<th>Survey</th>
<th>North</th>
<th>South</th>
<th>East</th>
<th>West</th>
<th>Vertical</th>
<th>Tilt</th>
<th>Build</th>
<th>Degred</th>
<th>Course</th>
<th>Time</th>
<th>Tool</th>
<th>Raw Data</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>RG 3G to Ground</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Surface Tie-in Patent at 145.00 meters</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>145.00</td>
<td>145.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>B1321</td>
<td>132.1</td>
<td>132.1</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Fig. 11
<table>
<thead>
<tr>
<th>Data Sheet View</th>
<th>Step #1: Select Data Sheet to View.</th>
<th>Step #2: Hit &quot;OK&quot;.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(12a) Slide Sheets: Time Distribution/ROP: Motor/Shaft Output: Target &amp; Window Edits: Ahead, Behind, Right, Left</td>
<td>(12b) OK</td>
<td></td>
</tr>
</tbody>
</table>
### Average Slide Calculator

**Tab to Move Through Cells**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(13a) Highest Dogleg Required (deg):</td>
<td>Comes From Active Plan</td>
<td>Step #1: Enter the motor setting dogleg from the motor settings or from a motor book.</td>
</tr>
<tr>
<td>(13b) Motor Setting Dogleg (deg):</td>
<td>Manually Entered Here</td>
<td></td>
</tr>
<tr>
<td>(13c) Total Motor Output %:</td>
<td>Calculated</td>
<td></td>
</tr>
<tr>
<td>(13d) Average Single Length (m/ft):</td>
<td>Manually Entered Here</td>
<td>Step #2: Enter the rig average single length, then hit &quot;OK&quot;.</td>
</tr>
<tr>
<td>(13e) Average Slide Per Single (m/ft):</td>
<td>Calculated</td>
<td></td>
</tr>
</tbody>
</table>

### EXTREMELY IMPORTANT:

The average slide per single calculation is only an estimate to give the operator an idea of what the average slide length that will be needed per single to achieve the necessary dogleg at a particular motor setting (motor output).

[Hit Exit to Exit Screen.]

<table>
<thead>
<tr>
<th>(13f) OK</th>
<th>Exit</th>
</tr>
</thead>
</table>

**Fig. 13**
**Email Set-Up Screen**

<table>
<thead>
<tr>
<th>E-Mail Time: 05:30 (14a)</th>
<th>E-Mail Time: 16:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text Files: Surveys (14b)</td>
<td>Text Files: Surveys</td>
</tr>
<tr>
<td>Well Plans</td>
<td>Well Plans</td>
</tr>
<tr>
<td>Sidetrack Plans</td>
<td>Sidetrack Plans</td>
</tr>
<tr>
<td>PDF Files: Surveys (14c)</td>
<td>PDF Files: Surveys</td>
</tr>
<tr>
<td>Well Plans</td>
<td>Well Plans</td>
</tr>
<tr>
<td>Plots &amp; Graphs</td>
<td>Plots &amp; Graphs</td>
</tr>
<tr>
<td>Sidetrack Plans</td>
<td>Sidetrack Plans</td>
</tr>
<tr>
<td>Slide Sheets</td>
<td>Slide Sheets</td>
</tr>
<tr>
<td>Motor/BHA Output</td>
<td>Motor/BHA Output</td>
</tr>
<tr>
<td>Targets &amp; Parameters</td>
<td>Targets &amp; Parameters</td>
</tr>
</tbody>
</table>

**Automatic E-Mail Addresses**

<table>
<thead>
<tr>
<th>email addresses (14d)</th>
<th>email addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>email addresses</td>
<td>email addresses</td>
</tr>
<tr>
<td>email addresses</td>
<td>email addresses</td>
</tr>
<tr>
<td>email addresses</td>
<td>email addresses</td>
</tr>
<tr>
<td>email addresses</td>
<td>email addresses</td>
</tr>
</tbody>
</table>

**E-Mail Time: Every 2 Surveys**

<table>
<thead>
<tr>
<th>Text Files: Surveys</th>
<th>Text Files: Surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well Plans</td>
<td>Well Plans</td>
</tr>
<tr>
<td>Sidetrack Plans</td>
<td>Sidetrack Plans</td>
</tr>
<tr>
<td>PDF Files: Surveys</td>
<td>PDF Files: Surveys</td>
</tr>
<tr>
<td>Well Plans</td>
<td>Well Plans</td>
</tr>
<tr>
<td>Plots &amp; Graphs</td>
<td>Plots &amp; Graphs</td>
</tr>
<tr>
<td>Sidetrack Plans</td>
<td>Sidetrack Plans</td>
</tr>
<tr>
<td>Slide Sheets</td>
<td>Slide Sheets</td>
</tr>
<tr>
<td>Motor/BHA Output</td>
<td>Motor/BHA Output</td>
</tr>
<tr>
<td>Targets &amp; Parameters</td>
<td>Targets &amp; Parameters</td>
</tr>
</tbody>
</table>

**Automatic E-Mail Addresses**

<table>
<thead>
<tr>
<th>email addresses</th>
<th>email addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>email addresses</td>
<td>email addresses</td>
</tr>
<tr>
<td>email addresses</td>
<td>email addresses</td>
</tr>
<tr>
<td>email addresses</td>
<td>email addresses</td>
</tr>
<tr>
<td>email addresses</td>
<td>email addresses</td>
</tr>
</tbody>
</table>

**E-Mail Main DCSI File to DCSI Main Server:**

<table>
<thead>
<tr>
<th>On Demand</th>
<th>Every 6 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default is Every 2 Hours</td>
<td>(14e) Every 4 Hours</td>
</tr>
</tbody>
</table>

The program will automatically generate the selected reports and email them to the addresses listed in each individual email screen.

*Fig. 14*
PROXIMITY PLOTS OR GRAPH COMPARISONS APPEAR AS A LAY OVER ON THE SURVEY FILE WHEN THE PLOTS OR GRAPHS COMMAND IS ACTIVATED

"Blue" cells are locked out, "White" cells can be entered or edited.

Fig. 15
Step #1: Check offline days, nights, or overall well.

Step #2: Check off Bha details for comparison.

Step #3: Check off the graphs for comparison to a maximum of six (6).

Step #4: Hit "OK".

**Table:**

<table>
<thead>
<tr>
<th>Desk</th>
<th>Top Graph Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shift:</td>
<td>Days</td>
</tr>
<tr>
<td>Bha:</td>
<td>Bit Manufacturer</td>
</tr>
</tbody>
</table>

**Graphs:**

| (17c) | Motor/Bha Output | Parameters (Survey %) | Parameters (# Surveys) | Time Break (# Hours) | Rotate vs. Slide (ROP) | Meterage vs. Percentage | Slide, Rotate, Lost TF (%) | Average Connection Time | Slide vs Rotate Comparison % | Planned vs Drilled (Tool Face) |

**Fig. 17**
DATA SHEET APPEARS AS A LAY OVER ON THE SURVEY FILE AFTER A SURVEY IS ENTERED OR EDITED OR WHEN THE DATA TEMPLATES COMMAND IS ACTIVATED.

"Blue" cells are locked out, "White" cells can be entered or edited.

Fig. 19
**Drill Down, Vertical Data Template**

<table>
<thead>
<tr>
<th>(20a)</th>
<th>(20b)</th>
<th>(20c)</th>
<th>(20d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slide</td>
<td>T/F</td>
<td>Drill</td>
<td>On/</td>
</tr>
<tr>
<td>2</td>
<td>(m/ft)</td>
<td>286m</td>
<td>(20e)</td>
</tr>
<tr>
<td>Build/Drop</td>
<td>% Turn</td>
<td>(20f)</td>
<td>(20g)</td>
</tr>
<tr>
<td>67%</td>
<td>33%</td>
<td>0</td>
<td>0.20</td>
</tr>
<tr>
<td>Slide</td>
<td>T/P</td>
<td>Set</td>
<td>(20h)</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.20</td>
</tr>
<tr>
<td>Inc to Target</td>
<td>Az to Target</td>
<td>(20i)</td>
<td>Kick Off Point</td>
</tr>
<tr>
<td>0.20</td>
<td>0.20</td>
<td>2019</td>
<td>(20j)</td>
</tr>
</tbody>
</table>

**IMPORTANT:** Select One in Order to Activate Slide Required

- Book Value Factor
- Avg Last 2 Factor
- Operator's Option
- Slides
- Tool Face

<table>
<thead>
<tr>
<th>(20k)</th>
<th>(20l)</th>
<th>(20m)</th>
<th>(20n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slide</td>
<td>Slide</td>
<td>Tool Face</td>
<td>Slide</td>
</tr>
<tr>
<td>1.75</td>
<td>1.60</td>
<td>314m</td>
<td>(20o)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comments:**
- Bit Trip
- Bore Charged
- Added Comment
- Well Tilted
- Slide Rack Well

Will be added to the Survey File at Depth Selected

**Slide Start Point:** 253.46
Comes From Tally Automatically

**Rotate Ahead:**

**Rotate Start Point:** 253.46
Comes From Tally Automatically

**Bit Extrapolation:**

- Straight Line Bit Extrapolation (20v)
- Add to Survey File with Comment (20w)

"Blue" cells are locked out, "White" cells can be edited or selected.

<table>
<thead>
<tr>
<th>Bit</th>
<th>Depth</th>
<th>Inclination</th>
<th>Azimuth</th>
<th>Tvd</th>
<th>Sub Sea</th>
<th>North/South</th>
<th>East/West</th>
<th>Vertical</th>
<th>Turn</th>
<th>Build</th>
<th>Dogleg</th>
<th>Course</th>
<th>Tool Face</th>
<th>Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>253.46</td>
<td>0.70</td>
<td>133.80</td>
<td>253.40</td>
<td>432.54</td>
<td>-0.59</td>
<td>-0.12</td>
<td>130.88</td>
<td>0.03</td>
<td>1.00</td>
<td>47.50</td>
<td>285.00</td>
<td>0.0%</td>
<td></td>
</tr>
</tbody>
</table>

Bit Extrapolation will only stay in the survey file until the next survey is added.

**Fig. 20**
**Fig. 21**
**Lateral Section Data Template**

**Slide Seen**
- (22a) 2 (m/ft)
- (22b) 30°
- (22c) 67%
- (22d) 33%

**Slide Under**
- (22e) 12 (m/ft)
- (22f) 7 (m/ft)
- (22g) 30°
- (22h) 5 (m/ft)
- (22i) HB
- (22j) Target #: 4
- (22k) Center of SS Corridor: -112.00

**Bit Extrapolation**
- (22aa) OK
- (22bb) Straight Line Bit Extrapolation
- (22cc) Add to Survey File with Comment

**Survey Point**
- Book Value: (22l) 53°
- Survey Point: (22m) 1.50
- Avg Last 2: (22n) 1.04
- Planned Dogleg: (22o) 2.00

**Operator's Option**
- Slide: (22p) 3.77
- Slide: (22q) 1.33
- Slide: (22r) 1.93
- Tool Face: (22s) 20R
- Tool Face: (22t)

**Check if Slide Start Point is taken from Tally**
- (22u) If Not Manually Enter Slide Start Point
- Rotate Single: (22v)
- Rotate Start Point: 1695.00 (22x)

**Comments**
- Sub Sea/Tvd Changed
- Bit Trip
- Added Comment

Will be added to the survey file at depth selected.

**Bit Extrapolation will only stay in the survey file until the next survey is added.**

Fig. 22
As soon as a slide or rotate is selected the Slide/Rotate Control will automatically appear and as soon as End Single is selected the Slide/Rotate Control will disappear.

---

**Slide/Rotate Control**

- **Orient**
- **Lost Tool Face**
- **End Single**
- **Slide**
- **Rotate Single**

**Sliding**

Step #1: Active Orient while orienting tool face.
Step #2: Active Slide when slide is started.
Step #3: Active Rotate when slide is completed and or End Single at kelly down.

**Rotating**

Step #1: Active Rotate when rotate is started.
Step #2: Active End Single at kelly down.
Each new activation will time out the preceding activation.

**Fig. 23**
Fig. 25

### Sub Sea, TVd/Inc Calculation

**Tab to Move Through Cells**

<table>
<thead>
<tr>
<th>Inclination Needed at bit to Change Sub Sea or TVd</th>
<th>Sub Sea or TVd Change At a Given Inclination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rise: (\text{(m/ft)}) (25a)</td>
<td>Inc.: (\text{(deg)}) (25e)</td>
</tr>
<tr>
<td>Drop: (\text{(m/ft)}) (25b)</td>
<td>Distance: (\text{(m/ft)}) (25f)</td>
</tr>
<tr>
<td>Distance: (\text{(m/ft)}) (25c)</td>
<td>Rise: Calculated (25g)</td>
</tr>
<tr>
<td>Inc.: Calculated (25d)</td>
<td>Drop: Calculated (25h)</td>
</tr>
<tr>
<td>At Bit</td>
<td>At Bit</td>
</tr>
</tbody>
</table>

**Step #1:** Enter the rise or drop in Sub Sea or TVd.

**Step #2:** Enter the distance rise or drop will be made in.

**Step #3:** Hit "OK".

"Blue" cells are locked out.

"White" cells can be entered or edited.

Hit "Exit" to Exit Screen

OK Exit

(25i) (25j)
Fig. 26

Step 1: Enter depth to be interpolated, then hit "CR".
Step 2: Add comment if needed; if no comment is added the program will signify that an interpolated survey was added to the survey file.
Step 3: Hit "Insert" to add it to the survey file.
Step 4: Hit "End" to exit screen.

"Red" cells are locked; "White" cells can be entered/edited.
<table>
<thead>
<tr>
<th>Enter Survey</th>
<th>Hole Depth (27a)</th>
<th>Survey Depth (27b)</th>
<th>Inclination (27c)</th>
<th>Azimuth (27d)</th>
<th>Course Length (27e)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1470.54</td>
<td>1456.52</td>
<td>69</td>
<td>9.37</td>
<td>OK</td>
</tr>
</tbody>
</table>

Fig. 27
<table>
<thead>
<tr>
<th>Previous Slide</th>
<th>Edited Slide</th>
</tr>
</thead>
<tbody>
<tr>
<td>(29a) Start Depth:</td>
<td>1470.54</td>
</tr>
<tr>
<td>(29b) (m/ft) Slid:</td>
<td>5.00</td>
</tr>
<tr>
<td>(29c) Tool Face:</td>
<td>30R</td>
</tr>
</tbody>
</table>

Tab to Move Through Cells

Fig. 29
Well Planning Step #1 (Verify)
Tab to Move Through Cells

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Company</td>
<td>Header Screen</td>
</tr>
<tr>
<td>Well Name</td>
<td>Header Screen</td>
</tr>
<tr>
<td>Surface Location</td>
<td>Header Screen</td>
</tr>
<tr>
<td>Field</td>
<td>Header Screen</td>
</tr>
<tr>
<td>Province/Country</td>
<td>Header Screen</td>
</tr>
<tr>
<td>License Number</td>
<td>Header Screen</td>
</tr>
<tr>
<td>Unique ID #</td>
<td>Header Screen</td>
</tr>
<tr>
<td>Directional Co</td>
<td>Header Screen</td>
</tr>
<tr>
<td>Rig &amp; Rig Number</td>
<td>Header Screen</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Well Section</th>
<th>Codes/Mon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical</td>
<td>Header</td>
</tr>
<tr>
<td>Build Section</td>
<td>KB</td>
</tr>
<tr>
<td>Lateral Section</td>
<td>BHA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bit Extrapolation</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>846.13</td>
<td>(31c)</td>
</tr>
</tbody>
</table>

As soon as the Re-Plan Well Command Button is activated this template will appear. If the Bit Extrapolation depth is the depth the new well plan is to be planned from and "YES" is selected then the well planning module will move directly into the well targets template. If "NO" is active and a new depth is entered to start the new well plan the program will consider it as a Siderack and move directly into the Siderack module.

"Blue" cells are locked out, "White" cells can be entered or edited.

Fig. 31
**Well Re-Plan Targets & Window**

**Corridor Parameters**

Program will automatically change targets when the survey file hole depth gets within a 50m or 32.8ft window above the target measured depth.

<table>
<thead>
<tr>
<th>Target #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured Depth</td>
</tr>
<tr>
<td>Sub Sea Depth</td>
</tr>
<tr>
<td>North-South Coordinate</td>
</tr>
<tr>
<td>East-West Coordinate</td>
</tr>
<tr>
<td>Proposed Inclination</td>
</tr>
<tr>
<td>Proposed Azimuth</td>
</tr>
</tbody>
</table>

Check More Than One if Needed.

Reason for Edits (32e)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Out of Window</td>
<td></td>
</tr>
<tr>
<td>Open/Close Windows</td>
<td></td>
</tr>
<tr>
<td>Off Target</td>
<td></td>
</tr>
<tr>
<td>Target Changed</td>
<td></td>
</tr>
<tr>
<td>Plan Re-Written</td>
<td></td>
</tr>
</tbody>
</table>

Current Active Well Plan: Plan #1

**Section Window Corridor Parameters** (32c)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>True Vertical Depth (m/ft)</td>
<td>Above - Below</td>
</tr>
<tr>
<td>Inclination (deg)</td>
<td>Ahead - Behind</td>
</tr>
<tr>
<td>Plan View Line (m/ft)</td>
<td>Right - Left</td>
</tr>
<tr>
<td>Azimuth (deg)</td>
<td>Ahead - Behind</td>
</tr>
<tr>
<td>Motor/Bha Drop (%)</td>
<td>Percentage</td>
</tr>
<tr>
<td>Target Section End Depth</td>
<td>Meters, Feet</td>
</tr>
</tbody>
</table>

Edits by Who (32f)

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hrd Office</td>
</tr>
<tr>
<td>Co. Man</td>
</tr>
<tr>
<td>Geology</td>
</tr>
<tr>
<td>Directional</td>
</tr>
</tbody>
</table>

Comment: 50 Characters

(32g)

If Target Remains the Same Just Hit "Accept".

Windows

- Green = 0% to 25%
- Yellow = 25% to 95%
- Red = 96% to 100%

- Every 50% of Build Section close Tvd windows by 50% (stop at 0.25m/0.82ft).
- Leave as manual function.

Active to re-set window (32d)

- corridors to section default settings. Default

"Blue" cells are locked out, "White" cells can be entered or edited.

(32i) Add Target

(32h) Accept

Fig. 32
Well Planning Step #3 (Data Display)

Tab to Move Through Cells

Oil Company | Header Screen
Well Name | Header Screen
Surface Location | Header Screen
Field | Header Screen
Productions/Country | Header Screen
License Number | Header Screen
Unique ID | Header Screen
Directional Co. | Header Screen
Rig & Rig Number | Header Screen

Shale | Shale Information
Bit Type | Bit Information
Hole Size | Hole Information
Motor Setting | Motor Setting Information
Motor Deployment | Motor Information
Active Well No. | Active Well Information
Active Well File | Active Well File Information
Conversion | Conversion Information
KOP | KOP Information
ICP | ICP Information
TD | TD Information
Leg No. | Leg Information
Hole Size | Hole Information
Angle of Inclination | Angle of Inclination Information
Azimuth | Azimuth Information
Slopes | Slopes Information
Yes/No | Yes/No Information

Surveys | Enter Survey | Edit/View Last Survey | Edit Last Slide/Tally | Slide/Rotate Comparison

Slopes: Slower / Faster

New Well Plan is Displayed Here

"Blue" cells are locked out, "White" cells can be entered or edited.

Fig. 33
Well Planning Step #4 (Proximity Plot)

Oil Company: Will Pick Up From Program Header
Well Name: Will Pick Up From Program Header
Surface Location: Will Pick Up From Program Header
Rig & Rig Number: Will Pick Up From Program Header

Tvd vs Vertical Section
+ = Ahead, - = Below

Plan View (Line)
+ = Right, - = Left

Step #1: Select the wells to plot.
Step #2: Select if previous well window parameters are to be kept.
Note: If Edit Well Window Parameters is selected the program will automatically move to the well windows screen.

The active window parameters will follow the new well plan to give the operator an idea of how they will conform to the new plan, as soon as "Keep Previous Well Window Parameters" is activated.

Step #1: Plot Against: Check as many as needed.
(34a) Original Plan
(34b) Current Active Plan
(34c) New Plan

Accept Exit

If well plan is rejected hit "Exit" to return to the well planning target and windows module.
If the well plan is accepted hit "Accept" and program will automatically move to the activate well plans module.

Fig. 34
<table>
<thead>
<tr>
<th>Active Work &amp; Well Plans</th>
<th>Drill</th>
<th>Side</th>
<th>Track</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well 1</td>
<td>ST 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well 2</td>
<td>ST 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well 3</td>
<td>ST 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well 4</td>
<td>ST 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well 5</td>
<td>ST 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well 6</td>
<td>ST 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well 7</td>
<td>ST 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well 8</td>
<td>ST 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well 9</td>
<td>ST 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well 10</td>
<td>ST 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well 11</td>
<td>ST 11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well 12</td>
<td>ST 12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Step #1:** Check the data. If the data is incorrect, enter the active acceptance code, then hit "OK."

**Step #2:** If the data is not correct, activate the correct well and plan number, then enter the active acceptance code, then hit "OK."

"Blue" cells are locked out, while "red" cells can be entered or edited.

Enter the active acceptance code, then hit "OK."
**Fig. 36**

The figure shows a screen from a software program used for the planning and management of well trajectories. The interface is designed to facilitate the creation and verification of sidetrack steps. The screen includes various fields for inputting data such as depth, azimuth, and other parameters essential for well planning. The user is prompted with options such as 'Yes' and 'No', indicating decisions that need to be made during the sidetrack process. The screen also highlights sections where certain cells are locked out, indicating constraints or predefined parameters that cannot be altered. The layout is structured to guide users through the planning process, ensuring compliance with safety and operational standards.
Sidetrack Step #3 (Interpolation)
"All Cells are Locked Out"

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sidetrack Interpolation Depth</td>
<td>1075.00</td>
</tr>
<tr>
<td>Inclination</td>
<td>Calculated</td>
</tr>
<tr>
<td>Azimuth</td>
<td>Calculated</td>
</tr>
<tr>
<td>True Vertical Depth</td>
<td>Calculated</td>
</tr>
<tr>
<td>Sub Sea Depth</td>
<td>Calculated</td>
</tr>
<tr>
<td>North/-South</td>
<td>Calculated</td>
</tr>
<tr>
<td>East/-West</td>
<td>Calculated</td>
</tr>
<tr>
<td>Vertical Section</td>
<td>Calculated</td>
</tr>
<tr>
<td>Dogleg Severity</td>
<td>Calculated</td>
</tr>
</tbody>
</table>

Comment: Sidetrack Starting Point

Step #1: Verify Interpolation Depth is correct.
Step #2: Select Insert if depth is correct.
Step #3: If depth is wrong hit "Exit" to go back to depth screen to correct depth.

Note: Insert will make interpolated depth the sidetrack tie-in point.

[Buttons: Insert, Exit]
Fig. 39
Program will automatically change targets when the survey file hole depth gets within a 30m or 32.8ft window above the target measured depth.

### Section Window Corridor Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Above</th>
<th>Below</th>
<th>Ahead</th>
<th>Behind</th>
</tr>
</thead>
<tbody>
<tr>
<td>True Vertical Depth (m/ft)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inclination (deg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plan View Line (m/ft)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Azimuth (deg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor/Bus Drop (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target Section End Depth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Edit Target/Window Set Up for Well Planning**

- **Step #1:** Active Edit Target/Window
- **Step #2:** Select Parameter(s) to be Edited.
- **Step #3:** Only edit the parameters that need to be edited then check off the reasons for Edit Target/Window edits, and who ordered changes.
- **Step #4:** Accept, interpolate and display the edited/new target.

If Target Remains the Same Just Hit "Accept".

### Comments

- Green = 0% to 25%
- Yellow = 26% to 95%
- Red = 96% to 100%

"Blue" cells are locked out, "White" cells can be entered or edited.

---

**Fig. 40**
**Fig. 43**

<table>
<thead>
<tr>
<th>Active Well &amp; Plan</th>
<th>Drilled Wells</th>
<th>Siderack Depth: 1075.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan 1</td>
<td>ST 1</td>
<td></td>
</tr>
<tr>
<td>Plan 2</td>
<td>ST 2</td>
<td></td>
</tr>
<tr>
<td>Plan 3</td>
<td>ST 3</td>
<td></td>
</tr>
<tr>
<td>Plan 4</td>
<td>ST 4</td>
<td></td>
</tr>
<tr>
<td>Plan 5</td>
<td>ST 5</td>
<td></td>
</tr>
<tr>
<td>Plan 6</td>
<td>ST 6</td>
<td></td>
</tr>
<tr>
<td>Plan 7</td>
<td>ST 7</td>
<td></td>
</tr>
<tr>
<td>Plan 8</td>
<td>ST 8</td>
<td></td>
</tr>
<tr>
<td>Plan 9</td>
<td>ST 9</td>
<td></td>
</tr>
<tr>
<td>Plan 10</td>
<td>ST 10</td>
<td></td>
</tr>
<tr>
<td>Plan 11</td>
<td>ST 11</td>
<td></td>
</tr>
<tr>
<td>Plan 12</td>
<td>ST 12</td>
<td></td>
</tr>
</tbody>
</table>

**Step #1:** Check the data. If the data is correct, enter the active acceptance code, then hit "OK".

**Step #2:** If the data is not correct, activate the correct well and siderack plan, then enter the active acceptance code and hit "OK".

The program will automatically scroll back the survey file, slide the chart & motor/gbu output to the siderack depth as soon as "OK" is hit.

*Blue cells can be activated.*

Enter the active acceptance code then hit "OK".
### Slide Sheet

<table>
<thead>
<tr>
<th>Bha #</th>
<th>Course Length</th>
<th>Hole Depth</th>
<th>Bit to Sensor Depth</th>
<th>Survey Depth</th>
<th>Inclination</th>
<th>Azimuth</th>
<th>Dogleg</th>
<th>Slide Seen (m/ft)</th>
<th>Planned</th>
<th>Drill Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12.41</td>
<td>633.24</td>
<td>15.00</td>
<td>618.24</td>
<td>6.60</td>
<td>174.30</td>
<td>6.89</td>
<td>6.00</td>
<td>20R</td>
<td>30R</td>
</tr>
<tr>
<td>(44a)</td>
<td>(44b)</td>
<td>(44c)</td>
<td>(44d)</td>
<td>(44e)</td>
<td>(44f)</td>
<td>(44g)</td>
<td>(44h)</td>
<td>(44i)</td>
<td>(44j)</td>
<td>(44k)</td>
</tr>
</tbody>
</table>

### Percentage %

<table>
<thead>
<tr>
<th>Build</th>
<th>Turn</th>
<th>Slide Under (m/ft)</th>
<th>Tool Face Set</th>
<th>Rotate (m/ft)</th>
<th>Slide Factor</th>
<th>Slid</th>
<th>Rotated</th>
<th>% Slid</th>
<th>% Rotated</th>
</tr>
</thead>
<tbody>
<tr>
<td>67.0%</td>
<td>33.0%</td>
<td>12.00</td>
<td>30R</td>
<td>6.41</td>
<td>1.15</td>
<td>6.00</td>
<td>6.41</td>
<td>48.3%</td>
<td>51.7%</td>
</tr>
<tr>
<td>(44l)</td>
<td>(44m)</td>
<td>(44n)</td>
<td>(44o)</td>
<td>(44p)</td>
<td>(44q)</td>
<td>(44r)</td>
<td>(44s)</td>
<td>(44t)</td>
<td>(44u)</td>
</tr>
</tbody>
</table>

**Fig. 44**
<table>
<thead>
<tr>
<th>Time</th>
<th>Distribution/ROP</th>
<th>Time Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>13:30</td>
<td>13:35</td>
</tr>
<tr>
<td>End</td>
<td>13:35</td>
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Fig. 46
### Target & Window Data

| Target # | Depth | Hole | Active | Target | Active Target | Active Target | Survey | Active Target | Active Target | Active Target | Active Target | Active Target | Active Target | Active Target | Active Target | Active Target |
|----------|-------|------|--------|--------|--------------|--------------|--------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|

### Work Sheet Preparation

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<th>Right View</th>
<th>Part View</th>
<th>Assembly</th>
<th>Section</th>
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<th>Edit</th>
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### Fig. 47

- A diagram illustrating the configuration of targets and windows with specific measurements and instructions for build and edit processes.
| #  | Section | Depth  | Inclination | Azimuth | Tvd   | N-S  | E-W  | Inclination | Azimuth | Tvd   | N-S  | E-W  | Inc +/- | Azp +/- | Tvd +/- |
|----|---------|--------|-------------|----------|-------|------|------|-------------|----------|-------|------|------|------|--------|---------|---------|
| 1  | build   | 785.13 | 54.28       | 161.33   | 757.23| -30.38| -23.22| 54.30       | 180.00   | 757.42| -29.61| -23.46| -0.22 | 1.33   | 0.19   |

(45a) (46b) (46c) (46d) (46e) (46f) (46g) (46h) (46i) (46j) (46k) (46l)

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<tr>
<th>Vertical, Drill Down (m/ft)</th>
<th>Build Section (m/ft)</th>
<th>Lateral Section (m/ft)</th>
<th>Percentage Scaling Ahead/Right</th>
<th>Percentage Scaling Behind/Left</th>
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<td>Above/Below</td>
<td>Right/Left</td>
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(48m) (48n) (48o) (48p) (48q) (48r) (48s) (48t) (48u) (48v) (48w) (48x) (48y) (48z) (48aa) (48bb)

Fig. 48
### Fig. 49A

| Motor Size | [inch] | [inch] | [inch] | [inch] | [inch] | [inch] | [inch] | [inch] | [inch] | [inch] | [inch] | [inch] | [inch] | [inch] | [inch] | [inch] | [inch] | [inch] |
|------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 2 7/8      | 77.0   | 8.0    | 1.2    | 1.3    | 3.1    | 8.5    | 1.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    |
| 3 1/2      | 12.7   | 1.3    | 2.5    | 2.6    | 5.3    | 11.7   | 2.5    | 3.6    | 3.6    | 3.6    | 3.6    | 3.6    | 3.6    | 3.6    | 3.6    | 3.6    | 3.6    | 3.6    | 3.6    |
| 3 1/4      | 17.5   | 2.1    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    | 2.2    |
| 3 1/2      | 22.8   | 2.6    | 2.6    | 2.6    | 2.6    | 2.6    | 2.6    | 2.6    | 2.6    | 2.6    | 2.6    | 2.6    | 2.6    | 2.6    | 2.6    | 2.6    | 2.6    | 2.6    | 2.6    |
| 3 1/4      | 27.2   | 3.2    | 3.2    | 3.2    | 3.2    | 3.2    | 3.2    | 3.2    | 3.2    | 3.2    | 3.2    | 3.2    | 3.2    | 3.2    | 3.2    | 3.2    | 3.2    | 3.2    | 3.2    |
| 3 1/2      | 31.6   | 3.9    | 3.9    | 3.9    | 3.9    | 3.9    | 3.9    | 3.9    | 3.9    | 3.9    | 3.9    | 3.9    | 3.9    | 3.9    | 3.9    | 3.9    | 3.9    | 3.9    | 3.9    |
| 3 1/4      | 35.9   | 4.6    | 4.6    | 4.6    | 4.6    | 4.6    | 4.6    | 4.6    | 4.6    | 4.6    | 4.6    | 4.6    | 4.6    | 4.6    | 4.6    | 4.6    | 4.6    | 4.6    | 4.6    |
| 3 1/2      | 40.1   | 5.4    | 5.4    | 5.4    | 5.4    | 5.4    | 5.4    | 5.4    | 5.4    | 5.4    | 5.4    | 5.4    | 5.4    | 5.4    | 5.4    | 5.4    | 5.4    | 5.4    | 5.4    |
| 3 1/4      | 44.3   | 6.4    | 6.4    | 6.4    | 6.4    | 6.4    | 6.4    | 6.4    | 6.4    | 6.4    | 6.4    | 6.4    | 6.4    | 6.4    | 6.4    | 6.4    | 6.4    | 6.4    | 6.4    |
| 3 1/2      | 48.6   | 7.4    | 7.4    | 7.4    | 7.4    | 7.4    | 7.4    | 7.4    | 7.4    | 7.4    | 7.4    | 7.4    | 7.4    | 7.4    | 7.4    | 7.4    | 7.4    | 7.4    | 7.4    |
| 3 1/4      | 52.9   | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    | 8.5    |
| 3 1/2      | 57.2   | 9.7    | 9.7    | 9.7    | 9.7    | 9.7    | 9.7    | 9.7    | 9.7    | 9.7    | 9.7    | 9.7    | 9.7    | 9.7    | 9.7    | 9.7    | 9.7    | 9.7    | 9.7    |
| 3 1/4      | 61.4   | 10.9   | 10.9   | 10.9   | 10.9   | 10.9   | 10.9   | 10.9   | 10.9   | 10.9   | 10.9   | 10.9   | 10.9   | 10.9   | 10.9   | 10.9   | 10.9   | 10.9   |

### Fig. 49B

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### Fig. 49C
### Table

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**Fig. 49D**

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**Fig. 49E**

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**Fig. 49F**
### Fig. 49G

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<th>Motor Size</th>
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<th>Theoretical Dowel (Single Stabilizer &amp; Hole Size</th>
<th>Theoretical Dowel (Two Stabilizers) Hole Size</th>
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<tr>
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### Fig. 49H

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<th>Theoretical Dowel (Single Stabilizer &amp; Hole Size</th>
<th>Theoretical Dowel (Two Stabilizers) Hole Size</th>
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<td>1.2 1.8 2.4</td>
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<td>2.4 3.0 4.0</td>
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### Fig. 49I
### Table 49J

<table>
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<tr>
<th>Metric Size (mm)</th>
<th>Tolerances</th>
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<tbody>
<tr>
<td></td>
<td>Diameter</td>
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### Table 49K

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### Table 49L

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<tbody>
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<td>Diameter</td>
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<tr>
<td></td>
<td>0.75</td>
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<tr>
<td></td>
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</tbody>
</table>

---

**Fig. 49J**

**Fig. 49K**

**Fig. 49L**
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Inch</td>
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<td>13 3/4</td>
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<tr>
<td>9 5/8</td>
<td>244</td>
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Fig. 49M

<table>
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<tbody>
<tr>
<td>Inch</td>
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<td>11 1/4</td>
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<tr>
<td>0.92</td>
<td>2.12</td>
<td>2.1</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Fig. 49N
Fig. 51

Check over the data, if the data is correct hit "OK".
If the data needs to be edited, edit data then hit "OK".

KOP, ICP, TD

Kick Off Point (KOP);
Intermediate Casing Point (ICP);
Total Depth (TD);
Lateral Leg #;
### Extrapolate Ahead

Tab to Move Through Cells

<table>
<thead>
<tr>
<th>[52a]</th>
<th>Hole Depth:</th>
<th>855,00</th>
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</thead>
<tbody>
<tr>
<td>[52b]</td>
<td>Added (m/ft):</td>
<td>(m/ft)</td>
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<tr>
<td>[52c]</td>
<td>Extrapolated Depth:</td>
<td>Calculated</td>
</tr>
<tr>
<td>[52d]</td>
<td>Inclination:</td>
<td>(52n)</td>
</tr>
<tr>
<td>[52e]</td>
<td>Azimuth:</td>
<td>(52o)</td>
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<tr>
<td>[52f]</td>
<td>True Vertical Depth:</td>
<td></td>
</tr>
<tr>
<td>[52g]</td>
<td>Sub Sea Depth:</td>
<td></td>
</tr>
<tr>
<td>[52h]</td>
<td>North/South:</td>
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</tr>
<tr>
<td>[52i]</td>
<td>East/West:</td>
<td></td>
</tr>
<tr>
<td>[52j]</td>
<td>Vertical Section:</td>
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<tr>
<td>[52k]</td>
<td>Dogleg Severity:</td>
<td></td>
</tr>
<tr>
<td>[52l]</td>
<td>Tool Face Drill Off:</td>
<td></td>
</tr>
</tbody>
</table>

Comment:  

---

**Step #1:** Enter the added meters/feet extrapolation to be done for.

**Step #2:** Use the up/down command arrows to change the added depth, inclination, and azimuth to achieve needed well coordinates.

**Step #3:** Hit "Interpolate" to have extrapolation, interpolated into 10m or 30ft intervals and inserted into the survey file.

**Step #4:** Hit "Exit" to exit screen.

*Blue* cells are locked out, *White* cells can be entered or edited.

---

**Fig. 52**
Fig. 53
<table>
<thead>
<tr>
<th>Hole Depth</th>
<th>Warning</th>
<th>Surpassed Warnings</th>
<th>Warnings</th>
</tr>
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<td>Floor</td>
<td>Co. Rep</td>
<td>DD</td>
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<tr>
<td>(54a)</td>
<td>(54b)</td>
<td>(54c)</td>
<td>(54d)</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(54k)</td>
<td>(54l)</td>
</tr>
</tbody>
</table>

Fig. 54
METHODS AND SYSTEMS FOR MONITORING DIRECTIONAL DRILLING

TECHNICAL FIELD

This document relates to methods and systems for monitoring directional drilling.

BACKGROUND

Directional drilling is a challenge due to shortages of skilled workers and the level of difficulty associated with directional drilling. Poorly drilled wells cost oil companies millions of dollars each year. Directional drilling programs like WINSERVE™ provide an interface for entering survey data obtained from survey sensors in the drill string, and for performing calculations associated with drilling. Other programs have been disclosed for steering a drill string through the earth based on sensor feedback. Remote and local operation of drilling is possible with various programs.

SUMMARY

Disclosed is an improved method and system for monitoring and controlling directional drilling.

A control system for one or more aspects of a directional drilling operation, the control system comprising: one or more inputs configured to receive commands; one or more computing units connected to the one or more inputs and having a) a conflict module for determining if a conflict exists between a command received from a first user of a hierarchy of users and a previous command from a relatively higher ranked user of the hierarchy of users, and b) an execution module for executing the command if no conflict exists.

A method of monitoring the progress of a directional drilling operation, the method comprising: measuring a plurality of characteristics of the orientation of a portion of a drill string in the earth; for each measured characteristic, determining, with one or more computing units, if a breach has occurred as indicated by a deviation, beyond a predetermined window, of the measured characteristic from a respective expected characteristic from a predetermined well plan; and initiating an alert event, using the one or more computing units, if one or more breaches are determined.

A method of monitoring the progress of a directional drilling operation through a build portion, the method comprising: measuring, with the one or more computing units, a motor output efficiency by comparing an achieved dog leg or build rate of a mud motor connected to a drill bit in the earth with a respective expected dog leg or build rate of the mud motor; and initiating an alert event, using the one or more computing units, if the motor output efficiency is outside of a predetermined range.

A method of monitoring the progress of a directional drilling operation, the method comprising: measuring the orientation of a portion of a drill string in the earth; determining, with one or more computing units, one or more drilling equipment parameters required to guide the portion of the drill string from the orientation to a selected target on a predetermined well plan; and repeating the measuring and determining stages, in which the selected target is switched to a subsequent target on the well plan when the portion of the drill string comes within a predetermined positive distance of the selected target.

A method of logging decisions made during a directional drilling operation, the method comprising: providing a plurality of users with access to a computing unit interface for monitoring the progress of a directional drilling operation against a predetermined well plan and displaying drilling instructions; receiving at the computing unit interface a change command, from a user of the plurality of users, of a parameter of the computing unit interface, well plan, or drilling instructions; and storing the change command along with a user identifier in a database that cannot be edited by the user from the computing unit interface.

A method comprising: inputting sensor data into one or more computing units, the sensor data obtained from one or more survey sensors monitoring the progress of a directional drilling operation; measuring with the one or more computing units the elapsed time of an event forming part of the directional drilling operation; and outputting from the one or more computing units to a display the elapsed time or a measurement made using the elapsed time.

A method of monitoring the progress of a directional drilling operation, the method comprising: measuring the orientation of a portion of a drill string in the earth; determining, with one or more computing units, one or more drilling equipment parameters required to guide the portion of the drill string from the orientation to a selected intersect point on a predetermined well plan; and repeating the measuring and determining stages, in which the selected target is switched to a subsequent target on the predetermined well plan when the portion of the drill string comes within a predetermined positive distance of the selected target.

A method of monitoring the progress of a directional drilling operation, the method comprising: measuring a plurality of characteristics, of a portion of a drill string in the earth, including at least inclination, azimuth, and a three dimensional position of the portion of the drill string, and in some cases hole depth, and survey depth; comparing each measured characteristic with a respective expected characteristic from a predetermined well plan; and initiating an alert event if one or more measured characteristic deviates from the respective expected characteristic by a predetermined window.

A method for monitoring the progress of a directional drilling operation, the method comprising: using one or more survey sensors, and one or more computing units to measure a plurality of characteristics, of the portion of the drill string in the earth, an expected characteristic of a predetermined well plan, and an actual characteristic of the portion of the drill string in the earth; and initiating an alert event if the expected characteristic deviates from the actual characteristic by a predetermined window.

A method of monitoring the progress of a directional drilling operation, the method comprising: using a plurality of characteristics, of a portion of a drill string in the earth, and one or more computing units to measure a plurality of characteristics, of the portion of the drill string in the earth, an expected characteristic of a predetermined well plan, and an actual characteristic of the portion of the drill string in the earth; and outputting an alert event if the expected characteristic deviates from the actual characteristic by a predetermined window.
[0014] A method of monitoring the progress of a directional drilling operation, the method comprising: measuring a plurality of characteristics, of a portion of a drill string in the earth, including one or more of a position and orientation of the portion of the drill string; for each measured characteristic, assigning a grade associated with major, minor, or no deviation from a respective expected characteristic from a predetermined well plan; outputting the grades to a display; and initiating an alert event if a grade associated with major deviation is assigned.

[0015] A monitoring interface for sensor data obtained from one or more survey sensors monitoring progress of a directional drilling operation, the monitoring interface comprising: one or more inputs configured to receive sensor data; one or more computing units connected to the one or more inputs and having a) an analysis module for comparing characteristics, obtained from the sensor data, of well progress with respective expected characteristics from a predetermined well plan, and b) a lock out module for restricting the one or more inputs or the analysis module if one or more measured characteristic deviates from a respective expected characteristic by a predetermined window.

[0016] A method of monitoring the progress of a directional drilling operation, the method comprising: measuring one or more characteristics, of a portion of a drill string in the earth, including one or more of a position and orientation of the portion of the drill string; comparing with one or more computing units each measured characteristic with a respective expected characteristic from a predetermined well plan; and locking out further comparisons if one or more measured characteristic deviates from the respective expected characteristic by a predetermined window.

[0017] In various embodiments, there may be included any one or more of the following features: The control system is a monitoring system of survey sensor data obtained from one or more sensors monitoring the progress of the directional drilling operation, and in which the one or more computing units comprise an analysis and display module for survey sensor data. The survey sensor data comprises one or more of the survey depth, hole depth, inclination, azimuth, course length, and slide and rotate data. The monitoring system is a passive system for a mud motor directional drilling operation. The command is an enter survey sensor data command. The analysis and display module is configured to compare one or more characteristics of the orientation of a portion of a drill string in the earth, obtained from the survey sensor data, with a well plan. The one or more computing units comprise a well planning module for the directional drilling operation, in which the command is a change well plan command. The change well plan command is a re-plan or sidetrack well command. The analysis and display module is configured to output drilling instructions. The command is a deviation from drilling instructions command. The drilling instructions comprise proposed settings for drilling equipment. The analysis and display module is configured to determine if a breach has occurred as indicated by a deviation, beyond a predetermined window, of a characteristic from a respective expected characteristic from the predetermined well plan. The command is a change predetermined window command. The one or more computing units comprise an alert module for sending an alert to one or more of the users of the hierarchy of users in the event of a predetermined condition. The predetermined condition includes determining a breach in a characteristic across successive iterations of survey data input. The predetermined condition includes completion of a portion of a well. The alert module is configured to send the alert to all users of the hierarchy of users. The previous command is to send an alert to one or more superiors in the hierarchy of users in the event of a predetermined type of command from the first user. The previous command is to wait for superior approval in the event of a predetermined type of command from the first user, in which the conflict module is configured to find a conflict if the predetermined type of command is entered by the first user. The predetermined type of command is a change command. The one or more computing units has an alert module for sending the alert. The predetermined type of command is a change command. A storage medium contains a command database, in which the one or more computing units are configured to store each command in the command database along with an identifier of the respective user initiating the command. The command database is stored in a read-only format. The one or more computing units are configured to store each change command in the command database along with a reason for the change command, and in all cases who initiated the change command. An identification module is present for confirming the identity of a user of the hierarchy of users. The identification module is configured to recognize a user by input by the user of a unique identifier associated with the user. A plurality of user terminals are present, including one or more remote terminals connected to the control system through a network. One or more remote terminals are located at a headquarters of an oil and gas company. The hierarchy of users comprises an oil and gas company representative at or near the top of the hierarchy of users. The methods and systems are for passively monitoring the progress of a mud motor directional drilling operation. The expected characteristics are derived by the one or more computing units from the predetermined well plan based on a length of drill string inserted into the earth. Measuring comprises of one or more of measuring with a survey sensor or processing, with the one or more computing units, survey sensor data. The portion of the drill string comprises a drill bit. Initiating comprises sending an alert to one or more of a plurality of users of the one or more computing units. The plurality of characteristics include inclination, azimuth, and at least one three dimensional coordinate of the portion of the drill string. The plurality of characteristics include hole depth and survey depth. The three dimensional coordinate is true vertical depth. The plurality of characteristics include the three dimensional position of the portion of the drill string. The plurality of characteristics include absolute distance from a predetermined well plan path. The method is carried out throughout the directional drilling operation, in which the plurality of characteristics include one or more of an achieved dog leg or build rate of a mud motor connected to a drill bit on the drill string, and comprising: determining, with the one or more computing units, if a breach has occurred as indicated by a deviation, beyond a predetermined window, of one or both of the achieved dog leg or build rate from a respective expected dog leg or build rate of the mud motor. The method is carried out through one or more of a drill down or vertical section, build section, or lateral section of the well. The three dimensional coordinates include the position of the portion of the drill string projected in a horizontal plane. The method is carried out through a build section of the directional drilling operation, the method comprising repeating the stages, in which the respective predetermined window for one or more characteristics is reduced based on progress through the build section.
The one or more characteristics for which the respective predetermined window is reduced is true vertical depth. The one or more characteristics for which the respective predetermined window is reduced is the position of the portion of the drill string projected in a horizontal plane. The respective predetermined window is reduced in proportion to progress through the build section. The respective predetermined window is reduced at a ratio of 1:1 percentage progress through the build section: percentage reduction. The respective predetermined window is not reduced below a minimum threshold. Determining comprises assigning a grade associated with major, minor, or no deviation, in which a breach corresponds to a major deviation; and the method comprises outputting the grades to a display. The grades are represented on the display by the percentage value of the predetermined window taken up by a deviation of a measured characteristic from the respective expected characteristic. The grades are represented on the display by colors on a spectrum of colors indicating at least no, minor, or major deviation. Repeating the measuring and determining stages with the one or more computing units; and in the event of a predetermined condition, at least partially locking out, with the one or more computing units, one or more users from repeating the measuring or determining stages. The one or more users are locked out at the measuring stage from entering survey sensor data into the one or more computing units. The predetermined condition includes determination of a breach in two successive cycles of measuring followed by determining. The breach found in two successive cycles is a breach of the same characteristic. Unlocking the one or more users on receipt by the one or more computing units of a permission signal initiated by a supervisory user. Initiating comprises initiating if the motor output efficiency falls outside of the predetermined range. Drilling equipment parameters include one or more of inclination, azimuth, tool face setting, slide distance, slide start point, rate of distance, and rate of start point. The directional drilling operation is a mud motor directional drilling operation, and the drilling equipment parameters comprise mud motor parameters. The predetermined positive distance is 10 meters. The change command is to a parameter that is a target on the predetermined well plan. The computing unit interface is configured to determine if a breach has occurred as indicated by a deviation, beyond a predetermined window, of a characteristic, of the orientation of a portion of a drill string, from a respective expected characteristic from the well plan, in which the change command is to the size of the predetermined window. The change command is a command to sidetrack or replan the well plan. Storing comprises storing a reason for the change command. Each of the plurality of users has access to the computing unit interface using a unique code. Repeating the measuring stage; and executing user-initiated edit commands of only the plurality of characteristics measured in the preceding iteration of the measuring stage. The event is drilling time, and the measurement output is rate of penetration. The event is one or more of slide time, rotate time, tool face orientation time, and connection time. Inputting is done by manual entry by one or more users through a computing unit interface. The manual entries include hole depth, inclination, and azimuth, while all other recorded entries are calculated by the program and/or are initiated by the command buttons in the program and these entries are for the most part entered by the drilling contractor's rig floor driller or by the directional driller on location. Inputted entries are only made by one person on location even though the system does enable anyone monitoring the well to initiate an entry. Each computing unit has a central processing unit and associated circuitry and memory.

In various embodiments, there may be included any one or more of the following features listed below.

Well Monitoring: various embodiments of the systems and methods are set up to monitor and ensure that any well that is run is drilled as per the predetermined well parameters and trajectories. This may be accomplished through a standalone wireless system on location that is in communication with a central main server monitoring system that enables oil company executives and supervisors to monitor the well bore progress.

Self-Supervision: various embodiments of the systems and methods give all personnel both on and off the location instant feedback and red line warnings acting as a self-supervising system for the well relating to well trajectory, bit, motor and overall drilling performance and as soon as the predetermined well parameters are breached the system instantaneously sends warning alarms to all personnel on and off location that are monitoring the well.

Safe-Guard Warning System (phase #1): in some embodiments a red line safe-guard warning system is set up in a two stage process when one predetermined well bore parameter is breached a single warning will be sent to everyone on and off location monitoring the well performance allowing the operator on location to evaluate and correct the issue at hand.

Safe-Guard Warning System (phase #2): When related red line warnings are received in two back to back surveys or two related predetermined parameter red lines are received within the same survey the system will prompt the operator to re-plan and re-evaluate the well trajectory by locking out the operator from entering any new surveys and send out a continuous warning signal to all personnel both on and off location that are monitoring the well performance until all personnel acknowledge that the second red line warning was received.

Survey Lock Out: various embodiments of the systems and methods incorporate a survey entry lock out system that remains in place until the well drilling performance is re-evaluated or re-planned and accepted by an oil company representative on the location or remotely by an oil company drilling superintendent through the system's active acceptance coding system set up at the beginning of each well.

Stop Survey Safe-Guard: various embodiments of the systems and methods incorporate a safe-guard self-supervision system that gives the oil companies the necessary information to drill the well properly within the original predetermined well parameters as set out by the oil company.

Thus, the oil company is allowed to monitor the well performance on a continual basis with stop survey parameters in place to give the oil company the needed time to evaluate the drilling performance, the drilling equipment being used to drill the well, the well proposal and re-evaluate the drilling process as a whole including men and equipment allowing them to address any issues that may have arose.

System No-Fault Safe-Guards: various embodiments of the systems and methods have numerous safe guards in place to ensure that no oil company can place blame on the system if a well goes sideways. Numerous safe guards are in place to ensure that the system does not go down; however, if some unforeseen event does shut down the system the oil and directional representatives on location simply revert back to
drilling the well in the same manner as it is being drill now, but without the system to monitor the well’s performance.

Auto Calculate (data templates): various embodiments of the systems and methods incorporate auto calculate data templates that automatically assesses the well bore positioning for every survey entered based against the predetermined active well plan in use and instantaneously calculate what corrections have to be made to keep the well bore on track, for example based on slide seen, tool face drill off, percent (%) of slide in build/drop, percentage (%) of slide in turn, slide (unseen) under the survey point, tool face slide under set at, target number well coordinates that are being calculated against, the book value slide factor, the survey point slide factor and an average slide factor. The data templates may be categorized as Drill Down/Vertical, Build Section and Lateral Section.

Auto Well Bore Positioning: various embodiments of the systems and methods automatically assesses the well bore positioning for every survey entered based against the predetermined active well plan and the active window parameters in use and instantaneously display the results on the program header encompassing for example True Vertical Depth (Tvd), Inclination, Line, Azimuth and the Vertical Section (VS).

Proximity Plots: various embodiments of the systems and methods plot each survey against the predetermined active well plan and window parameters in use and automatically display the well bore positioning relating to both in relation to Tvd, Inclination, Line and Azimuth. The proximity plots allow the operator to scroll through the survey file to view the well trend as it is being drilled.

Desk Top Graphs: various embodiments of the systems and methods incorporate Desk Top Graphing allowing all personnel both on and off the location that are monitoring the well to graph out any and all the aspects (6 graphs per set) relating to the drilling of the well to enable all involved to view and make well informed decisions. Various embodiments of the systems and methods allow the operator to graph out for example day, night, 24 hour, overall well, Hha, bit manufacture, bit type (coding), bit type (pdc, tri-cone), motor setting, all Hha’s, motor/bha output, parameters (survey %), parameters (# surveys), time break (# hours), time break (hours %), rotate vs. slide (ROP), meterage vs. percentage, slide, tool face, tool face (unseen) under set at, target number well coordinates that are being calculated against, the book value slide factor, the survey point slide factor and an average slide factor. The proximity plots allow the operator to scroll through the survey file to view the well trend as it is being drilled.

Slide, Rotate Control: various embodiments of the systems and methods incorporate a slide, rotate control enabling the operator to get an actual rate of penetration (ROP) comparison for slides vs. rotates vs. lost tool faces vs. drill times in an exact time logging for all these aspects.

Tvd, Inclination Calculator: various embodiments of the systems and methods incorporate a Tvd, Inclination Calculator enabling the operator to calculate the necessary inclination to rise or drop a given distance over a given distance or to calculate the distance that will be raised or dropped over a given distance at a given inclination.

Interpolation Screen: various embodiments of the systems and methods allow the operator to interpolate and insert a survey with a comment into the active well survey file at any time.

Enter Survey: various embodiments of the systems and methods prompt the operator to enter the actual hole depth then automatically calculates the survey depth based on the Bit to Sensor distance that is entered in the Bha Information Template allowing the operator to cross reference the hole depth as a safe-guard eliminating the human error factor that arises from this calculation being done manually.

Wire-Less Communication Automatic Well File Down Load: in some embodiments, once the location sever establishes communication with the main server the main server automatically down loads the necessary well files.

Automatic Report Emailing: various embodiments of the systems and methods incorporate an automatic report generating system based on time, reporting needed and recipients.

Well Re-Planning Module: various embodiments of the systems and methods incorporate a user friendly well re-planning module enabling the operator to re-plan the well trajectory if and when it is needed.

Well Sidetracking Module: various embodiments of the systems and methods incorporate a user friendly well sidetrack module enabling the operator to plan a sidetrack if and when it is needed.

Automatic Screen Prompts: for various embodiments of the systems and methods, once started the system automatically walks the operator through all the start-up screens enabling the operator to accept or edit the already populated well file if needed.

Other features include an average slide calculator, continual well bore corrections used to calculate drilling instructions based on any deviation from target, non editable predetermined window sizes, factoring in the Kelly bushing height in all depth measurements, a storage medium with a database associating a rank in a hierarchy for each of the plurality of users, one or more outputs connected to the one or more computing units for sending display data produced in the sensory data processing and display module to one or more displays.

These and other aspects of the device and method are set out in the claims, which are incorporated here by reference.

BRIEF DESCRIPTION OF THE FIGURES

Embodiments will now be described with reference to the figures, in which like reference characters denote like elements, by way of example, and in which:

FIG. 1 is a wire-less communication data base system for monitoring a directional drilling operation.

FIG. 1A is a side elevation view of a directional drilling operation.

FIG. 1B is a schematic profile of a server used in the system of FIG. 1.

FIG. 1C is a graph of TVD vs. pipe length illustrating window size plotted at discrete points along a well plan, and with a related graph of plan view line vs. pipe length inset.

FIG. 1D is a graph of azimuth vs. pipe length showing a series of survey date points.

FIG. 2 is a screenshot of a startup screen for the system of FIG. 1.

FIG. 3 is a screenshot of an import well files screen for the system of FIG. 1.

FIG. 4 is a screenshot of a header screen for the system of FIG. 1.
FIG. 5 is a screenshot of a Kelly Bushings Elevation verification screen for the system of FIG. 1.

FIG. 6 is a screenshot of a tie-in screen for the system of FIG. 1.

FIG. 7 is a screenshot of an active code screen for the system of FIG. 1.

FIG. 8 is a screenshot of a predetermined well coordinates and preset window screen for the system of FIG. 1.

FIG. 9 is a screenshot of a Bha information screen for the system of FIG. 1.

FIG. 10 is a screenshot of a program header screen for the system of FIG. 1.

FIG. 11 is a screenshot of a survey file screen for the system of FIG. 1.

FIG. 12 is a screenshot of a data sheets selection screen for the system of FIG. 1.

FIG. 13 is a screenshot of an average slide calculator for the system of FIG. 1.

FIG. 14 is a screenshot of an email screen for the system of FIG. 1.

FIG. 15 is a screenshot of a proximity plots and desk top graphs layover screen for the system of FIG. 1.

FIG. 16 is a screenshot of a proximity plots screen for the system of FIG. 1.

FIG. 17 is a screenshot of a desk top graph command screen for the system of FIG. 1.

FIG. 18 is a screenshot of a desk top graphs screen for the system of FIG. 1.

FIG. 19 is a screenshot of a data sheets layover screen for the system of FIG. 1.

FIG. 20 is a screenshot of a drill down, vertical data template screen for the system of FIG. 1.

FIG. 21 is a screenshot of a build section data template screen for the system of FIG. 1.

FIG. 22 is a screenshot of a lateral section data template screen for the system of FIG. 1.

FIG. 23 is a screenshot of a slide/rotate control screen for the system of FIG. 1.

FIG. 24 is a screenshot of an added comments template screen for the system of FIG. 1.

FIG. 25 is a screenshot of a sub sea, Tvd/Iac calculator screen for the system of FIG. 1.

FIG. 26 is a screenshot of an interpolation screen for the system of FIG. 1.

FIG. 27 is a screenshot of an enter survey screen for the system of FIG. 1.

FIG. 28 is a screenshot of an edit, delete last survey screen for the system of FIG. 1.

FIG. 29 is a screenshot of an edit last slide screen for the system of FIG. 1.

FIG. 30 is a screenshot of a generate reports template screen for the system of FIG. 1.

FIG. 31 is a screenshot of a re-plan well step #1, verification screen for the system of FIG. 1.

FIG. 32 is a screenshot of a re-plan well step #2, target and window corridor parameters screen for the system of FIG. 1.

FIG. 33 is a screenshot of a re-plan well step #3, data display layover screen for the system of FIG. 1.

FIG. 34 is a screenshot of a re-plan well step #4, proximity plots screen for the system of FIG. 1.

FIG. 35 is a screenshot of an active well plans lists screen for the system of FIG. 1.

FIG. 36 is a screenshot of a sidetrack planning step #1, verification screen for the system of FIG. 1.

FIG. 37 is a screenshot of a sidetrack planning step #2, depth verification screen for the system of FIG. 1.

FIG. 38 is a screenshot of a sidetrack planning step #3, survey depth interpolation screen for the system of FIG. 1.

FIG. 39 is a screenshot of a sidetrack planning step #4, sidetrack planning module overlay screen for the system of FIG. 1.

FIG. 40 is a screenshot of a sidetrack planning step #5, targets and window corridor parameters screen for the system of FIG. 1.

FIG. 41 is a screenshot of a sidetrack planning step #6, data display layover screen for the system of FIG. 1.

FIG. 42 is a screenshot of a sidetrack planning step #7, proximity plots screen for the system of FIG. 1.

FIG. 43 is a screenshot of an active wells plans list module screen for the system of FIG. 1.

FIG. 44 is a screenshot of a viewable but non-editable data sheet screen for the system of FIG. 1.

FIG. 45 is a screenshot of a time distribution and ROP viewable but non-editable data sheet screen for the system of FIG. 1.

FIG. 46 is a screenshot of a motor/Bha output viewable but non-editable motor/Bha data sheet screen for the system of FIG. 1.

FIG. 47 is a screenshot of a target and window edits viewable but non-editable data sheet screen for the system of FIG. 1.

FIG. 48 is a screenshot of an ahead, behind, left, right viewable but non-editable data sheet screen for the system of FIG. 1.

FIG. 49A-49N are screenshots of a motor sizes, motor setting and hole sizes template screen for the system of FIG. 1.

FIG. 50 is a screenshot of a viewable but non-editable Bha data sheet screen for the system of FIG. 1.

FIG. 51 is a screenshot of a ROP, ICP, TD, lateral leg verification screen for the system of FIG. 1.

FIG. 52 is a screenshot of an extrapolate ahead screen for the system of FIG. 1.

FIG. 53 is a screenshot of a system warning list screen for the system of FIG. 1.

FIG. 54 is a screenshot of a warning data sheet screen for the system of FIG. 1.

DETAILED DESCRIPTION

Immaterial modifications may be made to the embodiments described here without departing from what is covered by the claims.

Directional drilling began in the early 1990s with slanted wells and eventually expanded in the 1970s to full horizontal wells. Wells are drilled directionally and horizontally for several purposes, including a) increasing the exposed section length through the reservoir by drilling through the reservoir at an angle or horizontally, b) drilling into the reservoir where vertical access is difficult or not possible, for example an oilfield under a town, under a lake, or underneath a difficult to drill formation, c) allowing more wellheads to be grouped together on one surface location to allow fewer rig moves, less surface area disturbance, and make it easier and cheaper to complete and produce the wells, d) drilling along the underside of a reservoir constraining faults to allow multiple productive sands to be completed at the highest stratig-
graphic points, and e) drilling from a safe distance a “relief well” to relieve the pressure of a well producing without restraint (a “blowout”).

[0102] Directional drillers are given a preset well path to follow that is predetermined by engineers and geologists before the drilling commences. When the directional driller starts the drilling process, periodic surveys are taken with a downhole instrument to provide survey data, for example inclination and azimuth, of the well bore. These surveys are typically taken at preset intervals allowing the directional driller to make changes or corrections to the angle or direction as needed to maintain the well bore preset trajectory. Drilling into target zones laterally from surface locations requires careful planning, design and supervision and can be time consuming and costly. However, directional drilling is valuable because it can reduce the environmental cost and scarring of the landscape. Because of these and other benefits the percentage of well bores drilled in this manner has increased from under 2% in the early ’90s to over 70% to date.

[0103] Various methods are currently used to monitor and carry out directional drilling operations.

[0104] Mud motors. Mud motors are positive displacement motors (PDM) that offer steering capability and with it directional control. Mud motors are slid into the formation. Slide drilling refers to drilling with a mud motor rotating the bit downhole without rotating the drillstring from the surface. The bottomhole assembly (BHA) is fitted with a bent sub or a bent housing mud motor, or both, for directional drilling. The operation is conceptually simple: point the bent sub and the bit in the desired direction. Without turning the drillstring, the bit is rotated with a mud motor, and drills in the direction it points. When the desired wellbore direction is attained, the tool face is set to zero and the entire drillstring is rotated and drills straight rather than at an angle. By controlling the amount of hole drilled in the sliding versus the rotating mode, the wellbore trajectory can be controlled so that a curve of any inclination and/or azimuth can be obtained. In comparison to rotary steerable motors discussed below, mud motors are cheaper to operate and can achieve more severe doglegs.

[0105] Directional Drillers on Location. This method of directional drilling is the most common and widely used method of directional drilling in the industry. Directional Drillers are dispatched to the location to work on site and are charged with the task of monitoring the well bore progress according to the predetermined well plan trajectory, doing the mathematical calculation to achieve the target and to keep the well bore on track, relaying instructions as to what well bore corrections have to be carried out to the rig driller, assisting the rig driller when needed (steering to make well bore corrections) and supervising that the instructions are carried out effectively and efficiently. The directional drillers on location also are responsible for communicating the well bore progress and any issues that may arise that may jeopardize the well bore integrity to the oil company representatives on location (company man, geologist), to the oil company head office when necessary, and to the directional service company coordinator they may be employed by or subcontracted to.

[0106] Since the inception of directional drilling trained directional drillers on location was and still is the norm to get these directionally and horizontally drilled wells drilled. This approach is and was the logical progression for industry, take experienced drillers off the rig floor with extensive down hole experience (10 years plus), some sort of formal education or mental aptitude and communication skills and then properly train them in the art of directional drilling. This way the oil company and directional service company that was contracted to do the work had directional supervision on location that could carry out the task at hand with relative ease. Seeing that having supervision on location with extensive down hole experience and communication skills are helpful components to getting a directional well drilled properly and on target, this currently is the preferred system that is in place in the industry to directionally and horizontally drill wells.

[0107] Directional drillers use survey programs to monitor operations. Survey programs that are currently in use in the directional industry represent the well bore positioning as per a particular survey point (10 to 16 meters behind the bit positioning or hole depth) in the well bore, and it is up to the directional driller on location to factor in all the well and well bore variables to make the correct decision as to any and all well deviation corrections that are needed to keep the well bore on the predetermined well trajectory in a time efficient manner. Due to this increase in specialized drilling activity it has created a tremendous shortage of qualified manpower in the directional drilling industry.

[0108] Remote Directional Drilling. A directional subcontracting service company dispatches an individual to set up the survey equipment and down hole Bha at the beginning of the job. After ensuring that everything is operating properly the individual leaves location and the well trajectory is controlled by a text messaging relay system set up through the rig rat monitoring system, air card or in some cases a satellite phone syncronized system. The communication is based between the drilling contractor’s driller on tower and a directional driller that is working out of a central command center off location that is monitoring the well.

[0109] Remote Directional Drilling does reduce some up-front costs of drilling the well by reducing a percentage of the man power expenses on location seeing that the directional driller that is monitoring the well trajectory monitors more than one well at a time from a central command center off location. However, the remote directional drilling system hinges on the assumption that the drilling contractor’s driller on location is capable of steering the well with no assistance and in 90% of the situations this assumption has proven to be true. Thus, in some cases remote directional drilling has created added costs and risks to the drilling of directional and horizontal wells. In all cases of remote directional drilling the directional service company lowers its man power rates to the oil company so the oil company can realize a savings. This savings is at the expense of the experience of the directional drillers and the number of wells the directional driller is put in charge of monitoring. The driller does not have the advantage of knowing what is actually going on at location or any way of knowing if the instructions he relayed to the drilling contractor’s driller are actually being carried out as instructed. Also because the well correction calculations are being performed off location the drilling contractor’s driller on the other hand does not have the advantage of interacting with the directional driller and if he has any questions or issues he has to deal with them on his own. The drilling contractor’s driller furthermore, has no idea of how the well is progressing (directional wise).

[0110] Not only does the drilling contractor’s driller lose the advantage of interacting with the directional driller or knowing how the well is progressing, the oil company representative on location also loses this advantage and of course when the oil company representative on location loses com-
munication pertaining to the progress of the well so does the oil company executives he is reporting too. In a lot of instances this missed communication and inexperience has sent the well trajectory off track to such a degree that the drilling operation has had to be halted and directional drillers dispatched to location to get the well back on track. In some of the extreme cases the well had to be cemented back in order to make the necessary well bore corrections. When remote directional drilling is used in a multi-well pad situation and it goes off track it not only puts the well that is being drilled in a critical situation, it puts one if not more of the wells on that same multi-well location in a critical situation or even can cancel out the drilling of some of the other wells on that same multi-well location. When this happens, the expense and cost to the oil company is astronomical.

[0111] Remote Supervised, Location Directional Drilling. This method of directional drilling is a combination of the previous mentioned approaches of directional drillers on location and remote directional drilling. Directional drillers are dispatched to location to supervise the directional aspects of drilling the well and relay the surveys and their planned directional corrections to an off location experienced directional supervisor working out of a central command center.

[0112] The off location remote supervising directional driller acts as a third directional driller for the well and is relied on to give the directional drillers on location a fresh perspective of the drilling of the well. The off location remote supervisor is actually a senior directional driller that is in control of the well and can assist, advise or overrule the directional drillers on location if he feels that the directional drillers on location are losing control of the well or making the wrong well correction decisions. The off location remote supervisor oversees and makes recommendations to the directional drillers on location, to the oil company representatives on location and in some cases to the oil company’s drilling superintendent overseeing the drilling project. The off location supervisor also oversees well planning, Bha and bit changes and in some cases drilling parameters or drilling aspects depending on his experience.

[0113] However, such an approach is costly and has several major pit falls. Not only do the oil companies have to absorb the high cost of the directional drillers on location they also in some instances have the added costs associated with the remote directional drilling supervisor that is off location. This method of directional drilling is offered and sold to the oil companies on the premise that it will act as a safe guard to ensure that the predetermined well bore trajectory is maintained. However, this approach does nothing if the directional drillers are inexperienced. The remote directional drilling supervisor off location has the same issues to contend with as any other remote directional driller—he has no way of actually knowing what is going on, on location and has to rely on the directional drillers on location communication skills to keep him in the loop. Also, if the remote directional driller has never drilled in that particular area he can become a liability to the operation seeing that he actually has control over and can overrule the directional drillers on location.

[0114] Rotary Steerable System. Rotary Steerable Systems employ the use of specialized down hole equipment to replace conventional directional tools such as mud motors. Such systems are generally programmed by the MWD engineer or directional driller who transmits commands, using surface equipment, (typically using either pressure fluctuations in the mud column or variations in the drill string rotation) that the tool understands and gradually steers into the desired direction. In other words, a rotary steerable is a tool designed to drill directionally with continuous rotation from the surface, eliminating the need to slide to make well bore corrections or need of a mud motor. The methods used to direct the well path fall into two broad categories, these being push-the-bit or point-the-bit. Push-the-bit tools use pads on the outside of the tool which press against the well bore thereby causing the bit to press on the opposite side of the well bore causing a direction change. Point-the-bit technologies cause the direction of the bit to change relative to the rest of the tool.

[0115] Continuous rotation of the drill string allows for improved transportation of well bore cuttings to be carried, by the drilling fluids, to surface resulting in better hydraulic performance, better weight transfer for the same reason and reduced drill string torque. Therefore, the well bore can be less aggressive and smoother than those drilled with a mud motor using the fractured drilling method (slide and rotate) that is predominantly utilized by all other directional drilling systems.

[0116] The directional drillers or MWD operators that run the rotary steerable systems have to have down hole knowledge and experience as well as the ability to translate surveys into what well bore corrections have to be done to keep the predetermined well bore trajectory on track. As well they have to have sufficient computer experience and knowledge to be able to program the rotary steerable assembly to do what is needed to make the proper corrections without over or under steered the well bore. Because of the high level of technology that was put in the development of these systems and the high level of oil field experience, computer and down hole knowledge that is required to operate a rotary steerable system the day rate cost of these systems is astronomical compared to the conventional methods that are currently utilized by the oil and gas industry. In comparison to using a mud motor and a fractured steering system to keep the well bore on its predetermined trajectory a rotary steering system can cost upwards of $18K to $30K (or higher) per day in comparison to $8K to $12K per day for a mud motor. Directional Drilling Companies that provide rotary steerable systems sell them on the basis of drilling the same depth well in a shorter time frame, as per days needed to drill the well. However, it takes upwards of 20 minutes or more to program the down hole computer in the system after the operator gets the survey to make the needed corrections and this gets time consuming and costly for the oil company.

[0117] Near Bit Inclination and Gamma sensors. These tools use second inclination and gamma sensors in the bottom end of the Bha that are placed anywhere from ½ meter to 6 meters behind the bit vs. the normal distance of 10 to 16 meters. The near bit inclination and gamma tools are usually composed of two subs, making the inclination and gamma ray image sensors completely independent. The lower transceiver sub houses the sensor packages, batteries, and electronics which process the at bit gamma ray imaging along with inclination before they are transmitted through the drilling fluid and formation to the upper transceiver sub. The upper transceiver sub transfers the at bit measurements through the MWD tool for mud pulse telemetry to the surface. The lower and upper transmission subs act in conjunction as a repeater sub combination that transmit the near bit measurements to the surface.

[0118] Near Bit Inclination and Gamma improves survey inclination accuracy by eliminating the need to estimate the
inclination at the bit by extrapolating the inclination based on the survey results, which could be 10 to 16 meters behind the bit or the hole depth. Both the near bit inclination and gamma at the bit enable the on location directional drillers and geologists to keep better control of the well bore and make any needed well bore trajectory corrections without having to factor in the unseen hole that has already been drilled that is ahead of the standard inclination and gamma sensors.

Near Bit Inclination and Gamma still requires directional drillers to be dispatched to location with down hole knowledge and experience and the ability to translate the surveys into what well bore corrections have to be done to keep the predetermined well bore trajectory on track. Near bit inclination and gamma subs can cost anywhere from an extra S$K to S$K a day and do nothing to speed up the drilling process. This equipment is highly technical and the oil and gas company representatives both on location and in the head offices have to entrust a major percentage of control of their wells to independent directional service companies that may or may not have the right personnel on location. If the directional service company dispatches personnel with poor communication skills the loss of control issue is only magnified exponentially.

Referring to FIGS. 1 and 1A, a directional drilling operation 10 is illustrated. A directional drilling operation involves a drilling rig 12, a drill string 14 made of pipe courses 18 (unless coiled tubing is used) and terminating in a bottom hole assembly (BHA) 15. BHA 15 may include a mud motor 17, a drill bit 16 and one or more survey sensors 20. Survey sensors 20 may be located behind the bit 16 as shown, unless sensors 20 are near bit or on the bit style sensors. Survey sensors 20 provide feedback to a drilling operator on various characteristics of the orientation, of the portion 22 of the drill string 14 that incorporates sensors 20, such as inclination and azimuth measurements. Drawworks 23 may suspend or be driven 24 for rotating the string 14. A directionally drilled well 26 may include a vertical portion 28, a build portion 30, and a lateral portion 33. Other portions of well 26 may be used in well 26 such as spider legs and side tracks as is conventional in the art, and portion 28 may be slanted or curved in some cases.

Wire-Less Communication Data Base System #1: Referring to FIGS. 1 and 1B, a control system 32 for one or more aspects of directional drilling operation 10 is illustrated. System 32 may be a monitoring system of survey sensor data, for example from sensors 20. Survey sensor may be manually, such as by enter survey sensor data commands, or automatically, such as by connection between sensors 20 and system 32, entered into the system 32, and may include one or more characteristics of orientation of portion 22 of drill string 14 including one or more of survey depth, hole depth, inclination, azimuth, and course length (FIG. 27), and slide and rotate data (FIG. 23). In the example system discussed below, the computing unit 34 may also include an analysis and display module 42 for survey sensor data. Module 42 may carry out some or all of the calculations discussed below, outputting results to one or more displays such as tablet 1b-e and 1h discussed below.

The analysis and display module 42 may be configured to compare one or more characteristics of the orientation of portion 22 of drill string 14 with a well plan. A well plan is used to keep the drilling process on track and drill the well along the precise coordinates designated by the oil company. The well plan may include a series of three dimensional points forming a path to the desired ultimate target, with intermediate points being interpolatable to provide a comparison of well progress at any point of drilling progress. By comparing progress of the well drilling with the well plan, a driller and all other interested parties can keep apprised of progress, correct any deviations from the well plan, and replan the well or plan a side track to deal with problems as they arise.

Other modules may be included such as an identification module 48 for identifying the identity of a user of the hierarchy of tablets/laptops as discussed further below. An alert module 46 may be provided for sending alerts as discussed in more detail below. A lock out module 49 may be provided for at least partially locking one or more users from the system as discussed below.

The monitoring system 32 may be a passive system for a mud motor directional drilling operation (FIG. 1A). Thus, the system 32 may not be in direct operational control of drilling equipment such as weight on bit and drilling mud parameters, but instead system 32 may simply provide an interface to process sensor data and output drilling instructions to assist the driller. Drilling instructions include proposed setting for drilling equipment. Passive systems are easy to incorporate into existing drilling operations because most operations already use passive programs like Winsolve™. In addition, passive programs have the advantage of separating drilling from monitoring thus avoiding the costs associated with auto drilling systems, which require connections between drilling equipment and the control system, and which are fraught with operational difficulties.

FIG. 1 depicts a Two (2) Way Wire-Less Data Base System that enables the oil company to monitor, track and control the well bore positioning on or off the location. All terminals may be tough note books or tablets. The upper part of FIG. 1b may refer to the on location components, and the lower part the remote components. In some case system 32 is a backhaul two way data base communication and system. Wire-Less Communication System Location Server #1a: Reference element 1a may include one or more computing units 34, such as a Wire-Less Communication System Location Server that enables the system to run as a stand-alone system on location if needed, and through one or more input/outputs 36, gather data, receive commands and communicate with the tablets/laptops on location, and communicate with a main server 1g off location.

Wire-Less Communication System Company Representative Tablet/Laptop #1b: Reference element 1b depicts the on location company representative’s tablet or laptop which enables the operator to monitor the well bore progress, enter surveys, initiate slides, enter any and all necessary data and take control of the well bore if necessary through an interactive browser, all actions initiated at this work station are coded and recorded in a viewable, but un-editable worksheet.

Wire-Less Communication System Rig Floor Tablet/Laptop #1c: Reference element 1e depicts the on location drilling contractor’s rig floor driller’s tablet or laptop which enables the operator to monitor the well bore progress, enter surveys, initiate slides and enter any and all necessary data through an interactive browser, all actions initiated at this work station are coded and recorded in a viewable, but un-editable worksheet.

Wire-Less Communication System Directional Driller Tablet/Laptop #1d: Reference element 1d depicts the
on location directional driller's tablet or laptop which enables the operator to monitor the wellbore progress, enter surveys, initiate slides, enter any and all necessary data and take control of the wellbore if necessary through an interactive browser, all actions initiated at this workstation are coded and recorded in a viewable, but un-editable worksheet.

[0129] Wire-Less Communication System Geologist Tablet/Laptop #1c: Reference element 1c depicts the on location geologist's tablet or laptop which enables the operator to monitor the wellbore progress, enter surveys, initiate slides, enter any and all necessary data and take control of the wellbore if necessary through an interactive browser. All actions initiated at this workstation are coded and recorded in a viewable, but un-editable worksheet.

[0130] Wire-Less Communication System Location and Main Server Connection #1f: Reference element 1f depicts the Wire-Less Communication System Location and Main Server Connection that enables the oil company representatives on or off location to monitor, track and control the wellbore positioning at all times. Lines if and all other lines and connections implicitly or explicitly discussed in this document may be or include wired lines or connections.

[0131] Wire-Less Communication System Main Server #1g: Reference element 1g depicts the Wire-Less Communication System Main Server that is set up to run the program, populate all necessary fields and parameters, gather data, communicate with the location server and with the off location supervisors monitoring the well, it also gives the off location supervisors the ability interact and take control of the well if required.

[0132] Wire-Less Communication System Personal Electronic Monitoring Devices #1h: Reference element 1h depicts the Wire-Less Communication System Personal Electronic Monitoring Devices enabling the off location supervisors to monitor the wellbore progress and even take control if necessary through an interactive browser downloaded on their personal electronic devices such as iPod, iPads, Blackberries, Laptops, Tablets, Office or Personal Computers, etc. In general, the interface 32 may have a plurality of terminals connected directly or indirectly through a network such as the internet. Terminals may be actual physical terminals or virtual terminals such as a browser in an oil company executive's office. One or more remote terminals may be used, such as terminals 1h, at least one of which may be at a headquarters of an oil company as shown. To increase the amount of control the oil company has over the drilling, the hierarchy of users may comprise an oil and gas company representative at or near the top of the hierarchy of users.

[0133] Server 34 may include a conflict module 38 for determining if a conflict exists between a command received from a first user, such as directional driller 1d, of a hierarchy of users and a previous command from a relatively higher ranked user of the hierarchy of users, such as an individual 1h at a head quarters of an oil company. A conflict is found for example if a user tries to do something that a relatively higher ranked user has prohibited or flagged for supervisory approval. The previous command may thus include a standing order on the system 32, for example a parameter set up during the startup phase of the system 32 before the well is drilled. Server 34 may also include an execution module 40 for executing the command if no conflict exists. The execution module may represent one or more modules, such as analysis and display module 42, that actually implement the user's command if permitted, by for example calculating drilling instructions or processing survey results, and outputting data to a display. The hierarchical model discussed in this document provides the oil companies executives, supervisors and representatives on and off the location with the ability to take total and absolute control over all the well parameters and regulate decisions relating to the directional aspects of the well bore. Such control is possible despite the delegation of the drilling task to individuals who may or may not be under direct operational control by the oil company.

[0134] The individuals depicted in FIG. 1 make up an exemplary hierarchy of users, in hierarchical order as follows from lowest to highest: driller 1d, geologist 1c, company representative 1h, and the individuals of 1b in order from directional coordinator, drilling superintendent, head of geology, and head engineer. Other hierarchies may include other individuals or replace one or more of the mentioned individuals as needed.

[0135] Start Up Screen #2: FIG. 2 depicts a Start Up Screen that enables the company executives, supervisors, representatives, and all service companies involved in the drilling and/or monitoring of the wellbore to log on the view the well's progress. All personnel monitoring the well's progress must log in per well using the Unit Number (#), Well Name and the main server's Job Reference Number (#) to ensure well security and integrity, all log-ins are coded and recorded by the Main Server.

[0136] Start Up Screen, Unit Number #2a: Reference element 2a depicts the Start Up Screen Unit Number (#) that is automatically populated when the location server is started up and the main server automatically downloads the well files, anyone off location that is monitoring the well will need this unit number in order to log into the well.

[0137] Start Up Screen, Oil Company Name #2b: Reference element 2b depicts the Oil Company Name that is automatically populated when the location server is started up and the main server automatically downloads the well files.

[0138] Start Up Screen, Well Name #2c: Reference element 2c depicts the Well Name that is automatically populated when the location server is started up and the main server automatically downloads the well files, anyone off location that is monitoring the well will need the well name in order to log on to the well.

[0139] Start Up Screen, main server's Job Reference Number #2d: Reference element 2d depicts the main server's Job Reference Number (#) that is automatically populated when the location server is started up and the main server automatically downloads the well files, anyone off location that is monitoring the well will need the Job Reference Number in order to log on to the well.

[0140] Start Up Screen, OK Command Button #2e: Reference element 2e depicts the Start Up Screen OK Command Button that the operator activates to move into the next screen after the operator verifies that all the data in the start-up screen is correct.

[0141] Import Well Files Screen #3: FIG. 3 depicts the Import Well Files Screen enables the operator on location to import well files as a safety precaution if communication cannot be established with the Main Server depicted in Reference element 1g.

[0142] Import Well Files Screen, Command Button #3a: Reference element 3a depicts the Import Well Files Command Button that enables the operator on location to download the main server's well file that is emailed to the operator if com-
munication cannot be established with the Main Server depicted in Reference element 1g.

[0143] Import Well Files Screen, Well File Name & Number #3b: Reference element 3b depicts the Import Well Files Well File Name & Number enabling the operator to ensure that the correct well file is being downloaded.

[0144] Import Well Files Screen, Import Command Button #3c: Reference element 3c depicts the import Command Button that the operator activates to have the system automatically download the pre-populated well file.

[0145] Import Well Files Screen, OK Command Button #3d: Reference element 3d depicts Import Well Files OK Command Button which enables the operator to continue moving forward through the program set up screens.

[0146] Header Screen #4: FIG. 4 depicts the Header Screen which enables the operator to enter or edit any pre-populated header data to ensure that the correct well header information is used.

[0147] Header Screen, Well Header Information #4a to 4i: Reference element 4a to 4i depicts the Well Header information that is automatically populated as soon as the well files are downloaded this enables the operator to verify the well header information and/or edits any information that is necessary.

[0148] Header Screen, OK Command Button #4j: Reference element 4j depicts the OK Command Button enabling the operator to continue moving forward through the program set up screens.

[0149] KB Screen #5: FIG. 5 depicts the corrected KB (Kelly Bushings Elevation) verification Screen which automatically enables the operator to enter or edit any pre-populated elevation data to ensure that the correct KB Elevation is used to drill the well.

[0150] KB Screen, Ground Elevation #5a: Reference element 5a depicts the Original Ground Elevation (obtained from the well license) which is automatically populated as soon as the well files are downloaded enabling the operator to verify the ground elevation and/or make any edits if necessary.

[0151] KB Screen, Cut #5b: Reference element 5b depicts the Elevation Cut that was made when the location was built according the oil company’s construction or location builder’s final elevation surveys, if no cut was made the operator leaves this entry space blank.

[0152] KB Screen, Fill #5c: Reference element 5c depicts the Elevation Fill that was used when the location was built according the oil company’s construction or location builder’s final elevation surveys, if no fill was used the operator leaves this entry space blank.

[0153] KB Screen, Corrected Ground Elevation #5d: Reference element 5d depicts the Corrected Ground Elevation based on the original licensed surveyed ground elevation plus or minus any added fill or cut that was made when the location was built, to ensure that human error is minimized and/or eliminated.

[0154] KB Screen Rig KB to Ground #5e: Reference element 5e depicts the correct measured Rig Kelly Bushing (KB) to Ground measurement after it is received from rig contractor.

[0155] KB Screen, Corrected KB Elevation #5f: Reference element 5f depicts the Corrected Kelly Bushings (KB) Elevation to ensure that human error is minimized or eliminated.

[0156] KB Screen, OK Command Button #5g: Reference element 5g depicts the OK Command Button that the operator activates after he verifies, enters or edits the pre-populated KB Elevation information to continue moving forward through the program set up screens.

[0157] Tie-In Screen #6: FIG. 6 depicts the Tie-In Screen that is automatically pre-populated with the survey tie-in data to ensure that the correct well tie-in information is used.

[0158] Tie-In Screen, Information #6a to #6i: Reference elements 6a to 6i depicts the Tie-In Information Screen that is automatically pre-populated enables the operator to enter or edit any pre-populated survey tie-in data to ensure that the correct well tie-in information is used.

[0159] Tie-In Screen, OK Command Button #6j: Reference element 6j depicts the OK Command Button the operator activates to continue moving forward through the program set up screens.

[0160] Active Code Screen #7: FIG. 7 depicts the Active Code Screen that enables the operator to enter and track the personnel on location and create the active password coding that takes control of the well and gives the oil company executives, supervisors and representatives the ability to take absolute control over all the well parameters and/or regulate any decisions relating to the directional aspects of the well bore. Thus, in some cases the identification module 48 is configured to recognize a user by input by the user of a unique identifier such as a 6 digit code, associated with the user. Other codes or identifiers may be used. Change commands, survey entry data, and other input by the user may be stored along with a user identifier such as the active code in a database 50 (FIG. 1b) that cannot be edited by the user from the computing unit interface. Change commands may include commands, from a user of the plurality of users, of a parameter of the computing unit interface, well plan, or drilling instructions. Such commands are discussed throughout this document. Storage of the database may be in a read only format, at least with respect to access of the data through the system 32, to prevent tampering with the log once made and to encourage accountability for decisions.

[0161] The operator that is in control of the well may create and enter their own private acceptance code to take and maintain absolute control of the well parameters and to regulate any decisions relating to any and all directional aspects of the well bore. The preceding acceptance code activated always over-rides any acceptance codes below it, in other words the oil company representative on location or oil company representative monitoring the well from the head office can automatically take control of the well at any given point in the well if their instructions are not being carried out to their expectations. The Active Acceptance Code may have to be coded in (activated) to incorporate any well targeting coordinate changes, well section window coordinate changes, well plan changes, well plan acceptance, well sidetrack planning, well sidetrack acceptance, well section corridor warnings and alarms (window corridor parameters), and to deviate from drilling instructions proposed by the system 32.

[0162] The hierarchy coding system enables the operator with higher authority to over-ride any other acceptance code no matter where they are in the acceptance code order and is the only acceptance code that can authorize or initiate certain changes such as changes to the well bore trajectory when needed. Currently the hierarchy of the oil company executive relies solely on the experience of the on location supervisors they hire or contract to monitor, interpret and communicate any well bore issues to the head office and entrust that the service companies (directional) they sub-contract dis-
patch qualified personnel to drill their wells. Thus, oil companies are at the mercy of the on location personnel to get their wells drilled in an effective and efficient manner, however anyone that is skilled in the industry art knows that most of the on location supervisors the oil companies hires or contracts to supervise their wells do not have the technical experience or knowledge to recognize when a well is going off track until it is too late due to the fact that technology and methodology behind drilling these well bores in the oil and gas industry is continually changing at an alarming rate. The sub-contracting directional service companies cannot keep up with the demand for properly experienced trained personnel due to the great demand for directional personnel in the oil and gas industry, consequently the directional service companies are attempting to fill the void by turning to inexperienced oil field rig personnel. This inexperienced rig personnel is rushed through directional training and is expected to direct and assist the drilling contractor’s driller, however they lack any type of practical rig experience and prove to be no assistance to the rig personnel.

[0163] The proceeding acceptance code activated may always over-ride acceptance codes below it, in other words if the oil company representative on location or oil company executive off location monitoring the well from the head office can automatically take control of the well at any given point in the well if their instructions are not being carried out to their expectations.

[0164] By tracking all change commands, enter survey commands, and other user input the system provides increased accountability for the plurality of users who interact with the system. In some cases the system tracks and records any and all Bha changes, target coordinate edits, section window corridor parameter edits, survey window corridor percentages, section window corridor parameter breaches, personnel changes, active acceptance coding, well bore calculations, slide/rotate initiations, and motor/Bha outputs. Referring to FIG. 9, if the operator makes any Bha changes the system records what changes were made and stores both the original Bha template along with any and all new Bha templates and incorporates any and all changes as part of the survey file as a comment at the recorded depth the Bha was changed. Referring to FIGS. 32 and 40, as soon as the operator activates the Edit/Target Window Command in the Target and Window Template the original target coordinates are recorded in a viewable but non-editable worksheet template. After the operator makes the target coordinate edits the operator is prompted to select why the edits were made and who initiated the edits then the operator is prompted to and must enter the active acceptance code to activate any and all target coordinate edits. As soon as the operator enters the active acceptance code the new target coordinates are recorded in a viewable but non-editable worksheet template and the edits are activated and incorporated in the well programming. After the operator makes the section window corridor parameter edits the operator is prompted to select why the edits were made and who initiated the edits then the operator is prompted to and must enter the active acceptance code to activate any and all section window parameter edits, as soon as the operator enters the active acceptance code the new section window corridor parameters are recorded in a viewable but non-editable worksheet template and the edits are activated and incorporated in the well programming.

[0165] For every new survey that is entered the system may calculate and record and displays on the program header page the meters, feet, degree or percentage the drilled well bore is moving off the pre-determined planned well bore trajectory based on the inclination, Tvd (true vertical depth), azimuth, plan view line, and motor/Bha output. For every new survey that is entered the system may calculate and record and display on the program header page the percentage the drilled well bore is moving off the pre-determined planned well bore trajectory based on the inclination, Tvd (true vertical depth), azimuth, plan view line, and motor/Bha output.

[0166] In some cases, the previous command that may or may not conflict with a user’s subsequent command is to send an alert to one or more superiors in the hierarchy of users in the event of a predetermined type of command from the first user. Thus, for certain or all change commands, an alert may be sent to a supervisor or supervisor or all users. In some cases, approval of the command may be required before further operations take place. In other cases the user may be disallowed from making those type of changes altogether, and the command may be thus blocked. Thus, the precise level of delegation and hands-off or hands-on control may be exerted upon the drilling staff as desired by the oil company.

[0167] Active Code Screen, Operator Name #7a: Reference element 7a depicts the Active Code Screen Operator Name screen that enables the operator on location to enter the names of all the personnel on location in the appropriate category in their order of authority including the oil company drilling superintendent, head geologist and directional coordinator off location that will be monitoring the well’s progress.

[0168] Active Code Screen, Activation Code #7b: Reference element 7b depicts the Active Code Screen, Activation Code that each individual operator enters to have and maintain control of the well parameters and to regulate any decisions relating to the directional aspects of the well bore, the proceeding acceptance code entered will always over-ride any acceptance codes below it. The acceptance code will always over-ride any other acceptance code no matter where they are in the hierarchy of the acceptance code.

[0169] Active Code Screen, Active Command Indicators #7c: Reference element 7c depicts the Active Command Indicators which are non-assessable indicators which indicate which active acceptance code the system is currently recognizing.

[0170] Active Code Screen, OK Command Button #7d: Reference element 7d depicts the OK Command Button that the operator activates to continue moving forward through the program set up screens.

[0171] Predetermined Well Coordinates & Preset Windows #8: FIG. 8 depicts the Predetermined Well Coordinates and Preset Windows on one template for each section of the well bore that is being drilled that are automatically populated as soon as the well txt file is imported into the system making for ease of use for the operator and to ensure that human error can be taken out of the equation.

[0172] Windows may be used to keep the well on track. Thus, in one case the analysis and display module 42 is configured to determine if a breach has occurred as indicated by a deviation, beyond a predetermined window, of a characteristic from a respective expected characteristic from the well plan. The alert module 46 may do one or more of initiate an alert event or send an alert to one or more of the users of the hierarchy of users in the event of a predetermined condition like a window breach. Deviations may be found as follows. A plurality of characteristics of the orientation of the portion of the drill string in the earth is measured, for example directly
by input by a user of a survey result into the system 32, or indirectly by calculation from other directly entered data. Measuring may thus comprise one or more of measuring with a survey sensor or processing, with the one or more computing units, survey sensor data. The portion 22 of the drill string measured may comprise a drill bit for example if calculations are made to extrapolate survey data to the bit. For each measured characteristic, the one or more computing units determine if a breach has occurred as indicated by a deviation, beyond the predetermined window, of the measured characteristic from a respective expected characteristic from a well plan. If one or more breaches are determined an alert may be sent to one or more or all of the users of the system 32.

[0173] In some cases the predetermined condition warranting alert includes breaches across successive iterations of survey data input for a) the same characteristic or b) different characteristics. Thus, if an operator red lines (deviates beyond the predetermined window) inclination for two back to back surveys, the alert is sent. Other events may occur as a result of the predetermined condition being realized, including lock-out of the user from further use of the interface. In other cases the predetermined condition includes completion of a portion of a well, such as completion of the build portion 30 (FIG. 1). In such cases alerts may be sent to communicate the status of the well to all interested parties.

[0174] The predetermined condition may include, at least partially looking out, with the one or more computing units, one or more users from repeating the measuring or determining stages, for example until clearance is received from a supervisor in the hierarchy. Thus, if the system 32 records two successive breaches, the driller may be locked out from entering further survey data and using the system to assist in drilling. Any further drilling will be done blind, so the lock out feature is an effective tool to prevent a well from going too far off course to correct. Such a warning system gives the oil company or anyone involved in drilling the well an early warning or a percentage (%) of progress relating to the predetermined well bore trajectory as the well is being drilled. Safe-Guard Warning System (phase #1): The system 32 red line safe-guard warning system is set up in a two stage process when one predetermined well bore parameter is breached a single warning will be sent to everyone on and off location monitoring the well performance allowing the operator on location to evaluate and correct the issue at hand. Safe-Guard Warning System (phase #2): When related red line warnings are received in two back to back surveys or two related predetermined parameter red lines are received within the same survey the system 32 program may prompt the operator to re-plan and re-evaluate the well trajectory by locking out the operator from entering any new surveys and send out a continuous warning signal to all personnel both on and off location that are monitoring the well performance until all personnel acknowledge that the second red line warning was received.

[0175] As indicated the warning system may also encompass drilling warnings as targets are reached or about to be automatically changed out, as well section targets are being reached, as lower than normal motor/bha outputs calculated prompting the operator to check for formation changes, when any window parameter corridor is getting close to being breached or is breached and what percentage of window parameter corridor that is deviated from.

[0176] The expected characteristics may be derived by the one or more computing units from the well plan based on a length of drill string inserted into the earth. Thus, if 2000 m of drill string has been inserted, the system 32 determines the expected characteristics, such as TVD, inclination, and azimuth, from the well plan expected at 2000 m of inserted pipe. Because the well plan may consist of discrete data points the expected characteristics may need to be interpolated between well plan points. Using such a method and monitoring components like inclination, azimuth, and at least one three dimensional coordinate of portion 22 such as TVD, allows an operator and all users monitoring the drilling to identify problems before such problems result in large physical deviations from the well plan. For example, deviations from a well plan often start with a deviation from the inclination or azimuth, and if uncorrected over several surveys may result in a large TVD deviation. Otherwise, if a user merely monitors the three dimensional position of the portion 22, such as the absolute distance from the well plan path, a user can only detect deviations after the fact, and possibly when it is too late to correct the well without re-planning. Motor output efficiency may also be monitored by windows, as discussed below. The three dimensional coordinates may include the position of the portion of the drill string projected in a horizontal plane, also referred to as the plan line view. Plan line view is often obtained by summing the horizontal plane coordinate changes between surveys. Plan line view is useful for determining if the well is out to the left or right of the well plan projected in the horizontal plane. Each characteristic can be graphed to illustrate deviations (FIG. 16), and deviations may be represented by grading (FIG. 48) further discussed below.

[0177] Predetermined Well Coordinates & Preset Windows, Target Number #8a: Reference element 8a depicts the Target Number of the section coordinates of which the well bore corrections are being calculated and planned against; target wording is only being used as the coordinate section identifier, because it is the norm in the industry.

[0178] Predetermined Well Coordinates & Preset Windows, Predetermined Well Coordinates #8b: Reference element 8b depicts the predetermined well bore coordinates that are supplies and controlled by the oil company and are used a guide for all system calculations; the well bore coordinates are automatically pre-populated for each well bore section that is being drilled.

[0179] Predetermined Well Coordinates & Preset Windows, Preset Window Corridor Parameters #8c: Reference element 8c depicts the Preset Well Bore Window Corridor Parameters controlled by the oil company that are automatically populated as soon as the well bore predetermined coordinates are imported which are based against the original predetermined well bore trajectory that channel and maintain the drilled well bore to the center of its predetermined well coordinates.

[0180] Predetermined Well Coordinates & Preset Windows, Default Window Setting #8d: Reference element 8d depicts the system default window corridor parameter settings that are automatically pre-populated as soon as the predetermined well coordinates are imported.

[0181] Predetermined Well Coordinates & Preset Windows, Reasons for Edits selections which enables the operator to select the reasons for any edits that may have been done to either the well bore coordinates or section corridor window parameters and records all data or parameter edits (original and new) and reasons for the edits in a viewable, but non-editable worksheet. In general, reasons for changes may be
stored with other change commands in database 50, in order to provide an initiating user with the opportunity to explain why a change was made, to increase transparency and accountability.

[0182] Predetermined Well Coordinates & Preset Windows, Edits by Who #8f; Reference element 8f depicts the Who Made or Ordered the edits selection that enables the operator to select who has ordered either the well coordinates or section window corridors parameters to be changed and records who was responsible for the edits in a viewable, but non-editable worksheet.

[0183] Predetermined Well Coordinates & Preset Windows, Comment #8g; Reference element 8g depicts the add a written comment option enabling the operator to add a comment as to why the well coordinates and/or window corridor parameters were edited, the comments are recorded in a viewable, but non-editable worksheet.

[0184] Predetermined Well Coordinates & Preset Windows, Windows Percentage (%) Parameters #8h; In some cases determining a breach as discussed throughout this document may further comprises assigning a grade associated with major, minor, or no deviation, in which a breach corresponds to a major deviation. The grades, such as percentage points shown in the percentage scaling portion of FIG. 48, may be outputted to a display. The computation of the percentage scaling is done by taking the percentage value of the predetermined window taken up by a deviation of a measured characteristic from the respective expected characteristic. The grades may also be represented on the display by colors on a spectrum of colors indicating at least no, minor, or major deviation. Reference element 8h depicts the Windows Percentage (%) Parameters that the system automatically color codes and assigns to the window settings for each section that is being drilled which is automatically depicted in the survey file and plotted against in the proximity plots; the legend reads as Green (zero to minor deviation) is 0% to 25% of the window parameter settings, Yellow (minor to semimajor) is 26% to 95% of the window parameter settings and Red (semi-major to major deviation) is 96% to 100% of the window parameter settings. The use of these percentages is discussed further below in relation to FIG. 48. Such grades provide the user with a visual representation that can be quickly digested and mentally categorized as important or not important. The window percentage parameters may be adjusted in some cases.

[0185] When any of the section window corridor parameters are breached the system records and displays which parameter(s) was breached and at what level on the program header and in the survey file based on a green, yellow or red breach coding this enables the operator to instantly assess the well bore positioning and what corrections need to be done. The color coding is displayed in the survey file by color coding each survey depth a parameter was breached and color codes the parameter that is displayed in the survey file that was breached such as the inclination, Tvd, azimuth, or motor/ Bha output. The program header also displays the well bore positioning and color codes each parameter based on Tvd (above/below, meters or feet), inclination (ahead/behind), plan view line (right/left), azimuth (ahead/behind) and vertical section (ahead/behind); this color coding is also assigned and displayed by the well bore positioning in every one of the parameters listed above as per the percentage (%) of the window percentage (%) parameter the well bore positioning is out or moving out.

[0186] Predetermined Well Coordinates & Preset Windows, Automatic or Manual Window Parameter Build Section Close #8i; The method may be carried out through a build section of the directional drilling operation, and may further comprise repeating the stages. Referring to FIG. 1c, the respective predetermined windows 29 for one or more characteristics, in this case Tvd, are reduced based on progress through the build section 30. Reference element 8i depicts the Preset Well Bore Window Parameters that may incorporate an automatic window corridor close to ensure that the well is continually directed towards the predetermined well bore coordinates. The windows corridor close parameter is an automatic default setting that closes proportional to progress, for example at a ratio of 1:1 percentage progress through the build section: percentage reduction, thus for further example a rate of 50% of the original preset window corridor parameters for every 50% of the Build Section drilled and automatically stops at position 31 at a minimum threshold, for example 0.25 of a meter or 0.82 of a foot. Changes to the reduction rate may have to be activated and accepted through the active acceptance code in order for the operator to override the automatic close window function. If the change is activated and accepted it is recorded in a viewable, but non-editable worksheet. Plan view inset (with the same reference characters as the Tvd graph but with an "x" suffix added) and other characteristics may be set to close in a similar fashion.

[0187] The windows close parameter is the automatic default setting and closes at a rate of 50% of the preset window corridor parameters for every 50% of the Build Section drilled and automatically stops a 0.25 of a meter or 0.82 of a foot. The leave as manual function command has to be activated and accepted through the active acceptance code in order for the operator to override the automatic close window corridor function. If the leave as manual function is activated and accepted it is recorded in a viewable, but un-editable worksheet. The close window corridor automatic function channels the well bore trajectory to the center of the landing well coordinate for the build section. This function does not allow the well bore trajectory to over or under shoot the intended landing coordinates. This function tightens the corridor gradually as the build section is being drill to insure a proper smooth well bore is drilled on target in every instance.

[0188] The calculation is based on the Tvd and plan view line adjusted and derived from the pre-set pre-determined active well bore plan that is being used to drill the well. That is if the build section is 300 meters in length from the kick off point to the landing or casing point and the window parameter corridor is set at 3 meters (2 meters above and one meter below) for every 50% of the build section drilled the window corridor will automatically close at a rate of 50%. In other words at 150 meters of the build section being drilled the window corridor will close to 0.50 of a meter below and 1.0 meter above; then again at 225 meters of the well bore being drilled (that is 50% of 300 meters, then 50% of the remaining 150 meters of the build section which is 75 meters equating 225 meters of the build section drilled) the window parameter corridor will close once again to 0.25 of a meter below and 0.50 of a meter above; the once again at 262.50 meters of the build section drilled the window parameter corridor will close to 0.13 of a meter below and 0.025 of a meter above; then once again at 281.25 meters of the build section the last window corridor will close to 0.07 of a meter below and 0.13 of a meter above to achieve the minimum window corridor of a
total of 0.20 of a meter, then the system will automatically adjust the window corridor to 0.25 of a meter in total (splitting the difference equally).

[0189] As the system is closing the Tvd window corridor it will be duplicating the exact same function for the plan view line. Other characteristics may be closed in addition to or instead of Tvd and plan view line. At 300 meters of build section the plan view window corridor is automatically set at 2 meters right and 2 meters left of the plan view line based on the pre-set pre-determined active well plan. At 150 meters of the build section being drilled the plan view window corridor will close to 1 meter right and 1 meter left; at 225 meters of the build section being drilled the plan view window corridor will close to 0.50 of a meter right and 0.50 of a meter left; then at 262.50 meters drilled in the build section the plan view window corridor will close to 0.25 of a meter right and 0.25 of a meter left; The at 281.25 meters of the build section being drilled the window corridor will close for the last time to 0.125 of a meter right and 0.125 of a meter left for a total close of the window parameter corridor of 0.25 of a meter.

[0190] Predetermined Well Coordinates & Preset Windows, Active Acceptance Code #8: Reference element 8j depicts the active acceptance code the operator has to enter before any changes will be accepted and incorporated; once the active acceptance code is entered the edits along with the name of the operator that activated the active acceptance code will be recorded in a viewable, but non-editable worksheet.

[0191] Predetermined Well Coordinates & Preset Windows, OK Command #8k: Reference element 8k depicts the OK command button which enables the operator to activate the edits after the active acceptance code is entered.

[0192] Predetermined Well Coordinates & Preset Windows, Active Well Plan #8l: Reference element 8l depicts the Active Well Plan Number that is defined as the active well plan that the well trajectory corrections are calculated against and the base for the proximity plots.

[0193] Predetermined Well Coordinates & Preset Windows, View Next Target Command #8m: Reference element 8m depicts the View Next Command which enables the operator to view all the ensuing targets prior to drilling them and edit them if needed.

[0194] Predetermined Well Coordinates & Preset Windows, View Previous Target Command #8n: Reference element 8n depicts the View Previous Target Command which enables the operator to view any previous targets whether they were drilled or not; however the operator will only be allowed to edit undrilled targets, previous targets that have been drilled will be locked out from any edits.

[0195] Predetermined Well Coordinates & Preset Windows, Edit Target/Window Command #8o: Reference element 8o depicts the Edit Target/Window Command that the operator activates enabling the operator to edit any target or section window corridor parameters, as soon as this command is activated the current (old) well parameters are recorded in a viewable, but non-editable worksheet.

[0196] Predetermined Well Coordinates & Preset Windows, Add Target Command #8p: Reference element 8p depicts the Add Target command button which enables the operator to add a new target to the well section that is being drilled.

[0197] Predetermined Well Coordinates & Preset Windows, Close Command #8q: Reference element 8q depicts the Close Command which enables the operator to close out of the target section window screen without doing any edits.

[0198] Bha Information Screen #9: FIG. 9 Depicts the Bha Information Screen which enables the operator on location to enter, add or edit the down hole Bottom Hole Assembly (Bha) information.

[0199] Bha Information #9a to #9f: Reference elements 9a to 9f depict the Bha Information entries which enables the operator on location to enter or edit any and all Bha data that is relevant to the hole that is being drilled.

[0200] Bha Information, Motor Size (mm/inch) #9g: Reference element 9g depicts the Motor Size drop box that automatically jumps the operator into the motor setting template as soon as it is activated.

[0201] Bha Information, Motor Stabilizer #9h: Reference element 9h depicts the Motor Stabilizer command that automatically jumps the operator into the stabilizer motor settings if yes is activated; if no is activated the command will automatically jumps the operator into the non-stabilizer motor settings.

[0202] Bha Information, Motor Setting #9i: Reference element 9i depicts the Motor Setting drop box that automatically jumps the operator into the motor setting template as soon as it is activated.

[0203] Bha Information, Motor Dogleg (deg) #9j: Reference element 9j depicts the Motor Dogleg (deg) which depicts the theoretical expected motor dogleg output for a specific motor setting which is used in the motor output percentage calculation.

[0204] Bha Information, Motor Stabilizer Size #9k: Reference element 9k depicts the Motor Stabilizer Size if a motor stabilizer is used, the operator enters the size of the stabilizer manually and remains here as well bore records.

[0205] Bha Information, Bit to Gamma Sensor #9l: Reference element 9l depicts the Bha Bit to Gamma Sensor measurement from bit to the gamma sensor in the MWD probe.

[0206] Bha Information, Bit to Sensor #9m: Reference element 9m depicts the Bha Bit to Sensor measurement from bit to the survey sensor in the MWD probe and must be entered or the survey calculations will not calculate properly calculated.

[0207] Bha Information, Add Bha Command Button #9n: Reference element 9n depicts the Add Bha Command enabling the operator to make a Bha change when needed; if a Bha is added it is recorded in a viewable, but non-editable worksheet.

[0208] Bha Information, OK Command #9o: Reference element 9o depicts the OK Command enabling the operator to activate the edits, additions or exit the Bha information screen.

[0209] Bha Information, Self-Entry Motor Setting & Expected Dogleg #9p: Reference element 9p depicts the self-entry motor setting and expected dogleg option which is listed at the top of the drop box giving the operator the option to enter his own motor setting and expected dogleg if it is not listed in the system’s motor template.

[0210] Program Header #10: FIG. 10 depicts the Program Header which enables the operator to view the information that is pertinent to the well bore being drilled and fundamentally removes or eliminates the human error factor due to information being stored in hidden work sheets or templates.

[0211] Program Header, Oil Company Information #10a: Reference element 10a depicts the Oil Company Information as depicted in FIG. 4, such as the oil company name, the well name, the surface location, the field being drilled in, the province and country being drilled in, the well license number, the well unique identification number, the directional
company sub-contracted to supervise the directional work (if applicable), and the rig company name and number that is sub-contracted to drill the well.

[0212] Program Header, Bottom Hole Assembly (Bha) Information #10b: Reference element 10b depicts the Bha Information depicted in FIG. 9, encompassing the Bha number (#), the bit type, the hole size, and the motor setting, the expected theoretical dogleg.

[0213] Program Header, Active Well Plan Number (#) #10c: Reference element 10c depicts the Active Well Plan Number (#) which the system imports from the information from the Active Well Plan Screen depicted in FIG. 35 and can only be changed and coded in through the active well plan screen.

[0214] Program Header, Active Well Number (#) #10d: Reference element 10d depicts the Active Well Number which the system imports the information from the active well screen depicted in FIG. 35 and can only be changed and coded in through the active well screen.

[0215] Program Header, Bit to Gamma #10e: Reference element 10e depicts the Bit to Gamma Sensor measurement which the system imports from the Bha Information Screen and is used in all the applicable data sheets, graphs and all print outs that are associated with those data sheets and graphs and can only be edited through the Bha Information Screen depicted in FIG. 9.

[0216] Program Header, Bit to Survey Sensor #10f: Reference element 10f depicts the Bit to Survey Sensor measurement which the system imports from the Bha Information Screen; the Bit to Survey Sensor measurement is used as a base to calculate the Survey Depth which is used as a base to calculate all the survey calculations, the survey program locks out the operator if no Bit to Sensor measurement appears on the program header. This measurement is used in all the applicable data sheets, graphs and all print outs that are associated with those data sheets and graphs and can only be edited through the Bha Information Screen depicted in FIG. 9.

[0217] Program Header, Surface Casing (Csg) Depth #10g: Reference element 10g depicts the surface casing (csg) depth that the operator enters in the program header and is automatically used as the third survey point in a new drill well bore, as per the petroleum board’s regulations.

[0218] Program Header, Conversion Commands #10h: Reference element 10h depicts the Conversion Commands which enables the operator to convert the well bore calculations from metric to imperial measurements and back again if needed.

[0219] Program Header, Vertical Section Direction, North/ South Tie-In and East/West Tie-In #10i: Reference element 10i depicts the Vertical Section Direction, North/South Tie-In and East/West Tie-In which the system imports from the Tie-In Information Set-Up Screen depicted in FIG. 6 and is used in all survey and well plan calculations and in all the applicable data sheets, graphs and in all print outs that are associated with those data sheets and graphs and can only be edited through the Tie-In Information Set-Up Screen, the program locks out the operator from entering surveys if the Vertical Section Direction, the North/South Tie-In and/or the East/West Tie-In is not entered.

[0220] Program Header, Kelly Bushing (KB) Elevation #10j: Reference element 10j depicts the Kelly Bushing (KB) Elevation which the system imports from the KB Information Set-Up Screen depicted in FIG. 5 and is used in all survey and well plan calculations and all the applicable data sheets, graphs and all print outs that are associated with those data sheets and graphs and can only be edited through the KB Set-Up Screen, the program locks out the operator from entering surveys if the KB Elevation is not entered.

[0221] Program Header, Name of the Active Code Operator #10k: Reference element 10k depicts the Name of the Active Code Operator which the system imports from Active Password Code Screen depicted in FIG. 7 and is currently the active code that has control of the well that is being drilled, active codes can only be activated or de-activated through the active code set-up screen.

[0222] Program Header, Well Section Selection Command #10l: Reference element 10l depicts the Well Section Selection Command which enables the operator to select the section of well that is being drilled, this is extremely important because the well section calculations that are associated with each individual section will be activated as each well section command is activated.

[0223] Program Header, Well Section End Depth #10m: Reference element 10m depicts the Well Section End Depth which enables to operator to keep track of the well section end depth as the well bore is being drilled; these end well depths are entered in the KOP, ICP, TD Verification Screen as depicted in FIG. 50.

[0224] Program Header, Command Buttons #10n: Reference element 10n depicts the Program Header Command Buttons enabling the operator to enter any of the listed worksheets or templates to enter or edit any of the data that is contained or related to that particular worksheet or template.

[0225] Program Header, Surveys Command #10o: Reference element 10o depicts the Surveys Command which enables the operator to view the survey file.

[0226] Program Header, Enter Survey Command #10p: Reference element 10p depicts the Enter Survey Command which enables the operator to enter a new survey.

[0227] Program Header, Edit/Delete Last Survey Command #10q: Reference element 10q depicts the Edit/Delete Last Survey Command which enables the operator to edit or delete the last survey, but only the last survey, the system is the only directional system in the oil field that locks out the operator from editing or changing anything but the last survey to ensure survey integrity.

[0228] Program Header, Edit Last Slide/Tally #10r: Reference element 10r depicts the Edit Last Slide/Tally Command which enables the operator to edit the last slide or tally, but only the last slide or tally, the system is the only directional system in the oil field that locks out the operator from editing or changing anything but the last slide or tally to ensure well trajectory integrity.

[0229] Program Header, Slide/Rotate Comparison #10s: Reference element 10s depicts the Slide/Rotate Comparison which gives the operator a Slide ROP vs. the Rotate ROP in a percentage comparison, a minus (−) percentage lets the operator know how much slower the slides are than the rotates, a positive (+) percentage lets the operator know how much faster the slides are than the rotates.

[0230] Program Header, Ahead/Behind Coordinates Comparison #10t: Reference element 10t depicts the Ahead/Behind Coordinates Comparison which gives the operator instant feedback relating to the well bore positioning in comparison to the TVd, Inclination, Plan View Line, Azimuth, and the Vertical Section positioning proposed in the active well plan that is being used to drill the well and the actual well
positioning according to the surveys being entered, a positive (+) number means the well bore is above or ahead of the active well plan and a negative (-) number means the well bore is below or behind the active well plan positioning.

**0231** Program Header, Ahead/Behind Coordinates Comparison Percentage (%) #10u: Reference element 10v depicts the Ahead/Behind Coordinates Comparison Percentage (%) which gives the operator instant feedback relating to the well bore positioning in a percentage form relating to the pre-set window parameters in relation to the TVd, Inclination, Plan View Line, Azimuth, and the Vertical Section positioning that are being used to drill the well against the actual well position according to the surveys being entered, a high percentage indicates that the actual well positioning that is being drilled is moving out of the pre-set window parameters, a low percentage indicates that the actual well positioning that is being drilled is within the pre-set window parameters and is closer to the center line of the pre-set window parameters.

**0232** Program Header, Active Target #10v: Reference element 10v depicts the Active Target enabling the operator to view which target the automatic calculation module is calculating the well against; the active target can only be changed through the Target and Windows module depicted in FIG. 8.

**0233** Program Header, Data Templates Command #10w: Reference element 10v depicts the Data Templates Command enabling the operator to view and scroll through the data templates depicted in FIGS. 20, 21 and 22.

**0234** Program Header, Re-Plan Well Command #10x: Reference element 10x depicts the Re-Plan Well Command enabling the operator to re-plan the well bore on demand at any given point in the well.

**0235** Program Header, Hole Depth #10y: Reference element 10y depicts the Hole Depth which is entered and recorded through the Enter Survey Command depicted in FIG. 27.

**0236** Program Header, Survey Depth #10z: Reference element 10z depicts the Survey Depth which is calculated by subtracting the Bit to Sensor Measurement depicted in Reference element #10f from the hole depth depicted in FIG. 27.

**0237** Program Header, Inclination #10aa: Reference element 10aa depicts the Survey Inclination which is entered and recorded through the Enter Survey Command depicted in FIG. 27.

**0238** Program Header, Azimuth #10bb: Reference element 10bb depicts the Survey Azimuth which is entered and recorded through the Enter Survey Command depicted in FIG. 27.

**0239** Program Header, True Vertical Depth #10cc: Reference element 10cc depicts the Survey True Vertical Depth which is a calculated survey factor; TVD=[(Cos Previous Inclination x Cos Present Inclination x Present Survey CL/2) x 57.2956 x 2] x (Tan of Present Survey DLS/2)] + Previous Survey TVd = Present Survey TVd.

**0240** Program Header, Sub Sea Depth #10dd: Reference element 10dd depicts the Survey Sub Sea which is a calculated survey factor; Subsea Depth is calculated by subtracting the True Vertical Depth from the KB Elevation in the program heater depicted in Reference element 10j.

**0241** Program Header, North/South Coordinate #10ee: Reference element 10ee depicts the Survey North/South which is a calculated survey factor; [(Sin Previous Survey Inclination x Cos Previous Survey Azimuth) + (Sin Present Survey Inclination x Cos Present Survey Azimuth) x (Survey CL/2) x 57.2956 x 2] x (Tan of Survey DLS/2)] + Previous Survey North, -South Coordinate.

**0242** Program Header, East/West Coordinate #10ff: Reference element 10ff depicts the Survey East/West which is a calculated survey factor; [(Sin Previous Survey Inclination x Sin Previous Survey Azimuth) + (Sin Present Survey Inclination x Sin Present Survey Azimuth) x (Survey CL/2) x 57.2956 x 2] x (Tan of Survey DLS/2)] + Previous Survey East, -West Coordinate.

**0243** Program Header, Vertical Section #10gg: Reference element 10gg depicts the Survey Vertical Section which is a calculated survey factor; Vertical Section = ((Cos Directional Difference) x Closest Distance), Step #1: Square Root ((Survey North/-South Coordinate) x (Survey East/-West Coordinate))= Distance, Step #2: Atan ((Survey East, -West Coordinate) x North/South Coordinate)=cut Quadrant (based on well quadrant queried against the North/-South, East/-West coordinates that the well is currently in)=Closest Azimuth, Step #3: Vertical Section Direction=Copulated Azimuth=Directional Difference, Step #4: (Cos Directional Difference x Closest Distance)= Vertical Section.

**0244** Program Header, Course Length #10hh: Reference element 10hh depicts the Survey Course Length which is a calculated survey factor; Course Length (C=Difference Between) Course Length (CL) is calculated by subtracting Survey Hole Depth #1 from Survey Hole Depth #2.

**0245** Program Header, Turn Rate #10ii: Reference element 10ii depicts the Survey Turn Rate which is a calculated survey factor; Turn Rate = Present Azimuth-Present Azimuth/Course Length x 30 (30 if meters, 100 if feet).

**0246** Program Header, Build Rate #10jj: Reference element 10jj depicts the Survey Build Rate which is a calculated survey factor; Build Rate = Present Angle-Present Angle/Course Length x 30 (30 if meters, 100 if feet).

**0247** Program Header, Dogleg Severity (DLS) #10kk: Reference element 10kk depicts the Survey Dogleg Severity which is a calculated survey factor; DLS=[A Cos (Sin Previous Inclination x Sin Present Inclination) x Cos (C=Difference Between Azimuth)]+[(Cos Previous Inclination x Cos Present Inclination) x Course Length x 30.

**0248** Program Header, Tool Face Drill Off #10ll: Reference element 10ll depicts the Survey Tool Face Drill Off which is a calculated survey factor; Tool Face Drill Off= (Build Rate in Course Length/Dogleg Severity in Course Length) x Cos (Toolface Drill Off). If the Dogleg Output is Zero (0) the system will ignore this calculation.

**0249** Program Header, Motor/Bha Output #10mm: Reference element 10mm depicts the Survey Motor/Bha Output which is a calculated survey factor; Motor/Bha Output %=((Course Length/Meters Seen)>0xAchieved Dogleg)/Motor Expected Dogleg)<100.

**0250** Program Header, Comments #10nn: Reference element 10nn depicts the Comments which are manually by the operator and added and are sent to the survey file, survey file print outs and text (.txt) files at a maximum of 50 characters per comment.

**0251** Program Header, Well Plans Command #10oo: Reference element 10oo depicts the Well Plans Command which enables the operator to enter the active well plans module enabling the operator to view the active well plan.

**0252** Program Header, Targets & Windows Command #10pp: Reference element 10pp depicts the Targets & Windows Command which enables the operator to enter the Targets & Windows Screen depicted in FIG. 8 to perform any needed edits or entries.
Program Header, Average Slide Calculator Command #10qq: Reference element 10qq depicts the Average Slide Calculator Command which enables the operator to enter the average slide calculator screen depicted in FIG. 13 enabling the operator to calculate the average slide that will be needed to achieve a planned dogleg based on the motor setting theoretical dogleg output for the motor setting that is being used or that is being planned to be used.

Program Header, Interpolation Survey Command #10rr: Reference element 10rr depicts the Interpolation Survey Command which enables the operator to enter the interpolation survey screen depicted in FIG. 26 enabling the operator to interpolate a survey point in the well and insert it in the survey file if needed.

Program Header, Plots Command #10ss: Reference element 10ss depicts the Plots Command which enables the operator to enter the proximity plots depicted in FIG. 16 to view the well proximity plots at any given point in the well.

Program Header, Graphs Command #10tt: Reference element 10tt depicts the Graphs Command which enables the operator to enter the desktop graphs comparison selection screen depicted in FIG. 17 enabling the operator to select the desktop graphs that the operator wishes to compare.

Program Header, Generate Reports Command #10uu: Reference element 10uu depicts the Generate Reports Command which enables the operator to enter the reports selection screen depicted in FIG. 30 enabling the operator to select the reports that the operator wishes to print.

Program Header, Extrapolation Command #10vv: Reference element 10vv depicts the Extrapolation Command which enables the operator to enter the Extrapolation Ahead Screen depicted in FIG. 52.

Survey File #11: FIG. 11 depicts a specialized color coded survey file that color codes each individual survey point in accordance to the window corridor parameters depicted in FIG. 8 and incorporates the Hole Depth and a Motor/BHA Output Percentage (%) in the survey file data.

Data Sheets Selection #12: FIG. 12 depicts the Data Sheets Selection Screen which enables the operator to enter and view the non-editable selected worksheets.

Data Sheets Selection, Selection Commands 12a: Reference element 12a depicts the data sheets selection commands which enables the operator to select which viewable, but non-editable data sheets he wishes to view.

Data Sheets Selection, OK Command 12b: Reference element 12b depicts the OK command button which enables the operator to enter the selected worksheets when it is activated.

Average Slide Calculator #13: FIG. 13 depicts the average slide calculator which enables and assists the operator to make an informed decision regarding the motor setting that will be the best for the hole that is being drilled. The average slide calculator allows the operator to calculate the average slide that will be needed based on the motor output percentage against the highest dogleg required in the active or pre-determined well plan. This calculation allows the operator to make a well informed decision as to what motor setting will be needed to properly drill the well by eliminating the guess work or inexperience. Highest Dogleg Required (deg) is the highest dogleg that will be needed in the well section currently being drilled. Motor Setting Dogleg (deg) is the theoretical expected dogleg that the selected motor setting can theoretically achieve. Total Motor Output % is calculated by dividing the highest dogleg in the well plan by the theoretical expected dogleg. Average Single Length (m/ft) is the average single pipe length on each individual rig (the rig on location that is being used to drill the well bore). Average Slide Per Single (m/ft) is calculated by multiplying the Total Motor Output % by the Average Single Length. Formula Highest dogleg required/Motor setting theoretical dogleg=Total motor output %/Average single length=Average Slide Needed per Single

The operator first enters the active well plan highest dogleg that is going to be needed to achieve the target coordinates, then the operator enters the motor setting degree that he intends or plans to set the down hole mud motor at and finally enters the average drill pipe length that is on that particular rig. The average slide calculator automatically calculates the average percentage of each single that will have to be slid then converts this calculation into the actual average into meters or feet that will have to be slid on a per single bases. The percentage of the single that needs to be slid also translates into the percentage of the section of the well that will have to be slid. In other words if the average calculator calculates that 80% of each single has to be slid this also translates into the fact that 80% of that well section will need to be slid. The operator in every instance can use these calculations to make an educated and informed decision whether or not the motor setting he intends to use is sufficient to achieve the target coordinates or the setting that he intends to use is over kill.

Average Slide Calculator, Highest Dogleg Required (deg) #13a: Reference element 13a depicts the Highest Dogleg Required (deg), for example taken from the predetermined active well plan, which will be needed to be achieved to properly drill the well section currently being drilled.

Average Slide Calculator, Motor Setting Dogleg (deg) #13b: Reference element 13b depicts the theoretical Motor Setting Dogleg (deg) output, for example manually entered is the theoretical expected dogleg to be achieved with the selected motor setting.

Average Slide Calculator, Total Motor Output Percentage (%) #13c: Reference element 13c depicts the Total Motor Output Percentage (%) that is calculated by dividing the highest dogleg in the well plan by the theoretical expected dogleg and is used to determine the percentage of the single that must be slid to theoretically achieve the highest dogleg required in the well that is being drilled.

Average Slide Calculator, Average Single Length #13d: Reference element 13d depicts the Average Single Length, for example manually entered, in meters or feet (m/ft) on each individual rig that the well bore is being drill with.

Average Slide Calculator, Average Slide Per Single #13e: Reference element 13e depicts the Average Slide Per Single in meters or feet (m/ft) needed to achieve the target coordinates by multiplying the Total Motor Output Percentage (%) depicted in Reference element #13c by the Average Single Length depicted in Reference element #13d and is used to determine the length (m/ft) of the single that must be slid to theoretically achieve the highest dogleg required in the well that is being drilled.

Average Slide Calculator, OK Command #13f: Reference element 13f depicts the OK Command button which executes the calculation as soon as all the necessary information is entered.
[0271] Average Slide Calculator, Exit Command #13g: Reference element 13g depicts the Exit Command Button which enables the operator to exit the average slide calculator screen.

[0272] Email Screen #14: FIG. 14 depicts the Email Screen which is set up on location as an automated email screen which is executed by the location server’s time clock or the number of surveys entered to send emails based on the type of file and to whom the emails are to be sent too.

[0273] Email Screen, Email Time #14a: Reference element 14a depicts the how the operator wishes to have system send out the emails by time schedule by the 24:00 hour clock, by the number of surveys, or on demand.

[0274] Email Screen, Text (txt) Files #14b: Reference element 14b depicts the operator’s selections relating to the type of text (txt) file(s) to be sent to the recipient the system will automatically generate the file and send it to the recipient as outlined by the time schedule depicted in Reference element 14a.

[0275] Email Screen, PDF Files #14c: Reference element 14c depicts the operator’s selections relating to the type of PDF file(s) to be sent to the recipient the system will automatically generate the file and send it to the recipient as outlined by the time schedule depicted in Reference element 14a.

[0276] Email Screen, Recipient(s) #14d: Reference element 14d depicts the operator’s entries for the recipient(s) to whom the selected files (txt or PDF) and the outlined time schedule the recipient will receive the files on the system will automatically send the files to each individual recipient according to the time schedule and file listing that is selected for that particular recipient.

[0277] Email Screen, Email to Main Server #14e: Reference element 14e depicts the operator selections based on the 24:00 hour clock time schedule to have the entire the main server’s file sent to the Main Server for back-up security purposes the system will automatically send the entire file to the main server every two (2) hours as its default setting if no other time is selected.

[0278] Email Screen, OK Command #14f: Reference element 14f depicts the OK Command that the operator activates to accept and active the automatic email selections and exit the email screen.

[0279] Plots & Graphs Layover #15: FIG. 15 depicts how the Proximity Plots and Desk Top Graphs will layover the program header as soon as their perspective command button is activated.

[0280] Proximity Plots #16: FIG. 16 depicts the Proximity Plots that depict exactly how the well bore being drilled in comparison to the predetermined well bore trajectory in accordance to the pre-set window corridor parameters. In some cases various variables or measurements are tracked for plotting. The disclosed system may plot the survey point whether Tvd is above or below, whether vertical section is ahead or behind, whether inclination is ahead or behind, whether plan view line is right or left, whether azimuth is ahead or behind. The system tracks and graphs crew change (day/night), bit type (pdc/tri-cone), tool face orient time, real slide time, real rotate time, lost tool face time, connection time, survey window parameter benches, motor/bha output, bit manufacture, bit coding, motor setting, window parameters survey %, window parameters number of surveys, time break down (slides/rotates) number of hours, time break down (slide/rotates) % of hours, rotate vs. slide vs. lost tool face, average connection time (and there is going to be more added as the program reaches its completion or heads into the next stages).

[0281] Proximity Plots, Plot Header Information #16a: Reference element 16a depicts the Proximity Plots header information including the Oil Company, Well Name, Surface Location, and the Rig Company and Rig Number.

[0282] Proximity Plots, True Vertical vs. True Vertical Window Corridor Plotting #16b: Reference element 16b depicts the True Vertical vs. Vertical Section Plotting depicting the well bore pre-set window corridors for ahead or behind in vertical section on the drill down or for the vertical section of the well and above or below in true vertical depth for the build and lateral sections vs. the vertical section positioning of the actual well bore being drilled in relation to the pre-set pre-determined well plan.

[0283] Proximity Plots, Window Corridor Percentage Tolerances #16c: Reference element 16c depicts the Window Corridor Percentage Tolerances scaling and color coding that is defaulted by the system and cannot be edited or changed.

[0284] Proximity Plots, True Vertical vs. True Vertical Well Bore Positioning #16d: Reference element 16d depicts the well bore positioning in text form and can be scrolled through to give the operator a true representation of the well bore’s trend.

[0285] Proximity Plots, True Vertical vs. Vertical Section Plotting #16e: Reference element 16e depicts the True Vertical Depth Coordinate Scaling.

[0286] Proximity Plots, True Vertical vs. Vertical Section Plotting #16f: Reference element 16f depicts the Vertical Section Coordinate Scaling.

[0287] Proximity Plots, Plan View Plotting #16g: Reference element 16g depicts the Plan View Plotting of the well bore pre-set window corridors for the North/South coordinates vs. the East/West coordinates left or right positioning of the pre-set pre-determined well plan.

[0288] Proximity Plots, Plan View Plotting #16h: Reference element 16h depicts the well bore positioning is in text form and can be scrolled through to give the operator a true representation of the well bore’s trend.

[0289] Proximity Plots, Plan View Plotting #16i: Reference element 16i depicts the North/South Coordinate Scaling.

[0290] Proximity Plots, Plan View Plotting #16j: Reference element 16j depicts the East/West Coordinate Scaling.

[0291] Proximity Plots, Exit Command #16k: Reference element 16k is the Exit Command Button that the operator activates when the operator wishes to exit the proximity plotting.

[0292] Desk Top Graph Command #17: FIG. 17 depicts the Desk Top Graph Command which enables the operator to select the configuration of desk top graphs he wishes to compare.

[0293] Desk Top Graph Command, Shift Selection #17a: Reference element 17a depicts the Desk Top Graph Command Shift Selection which enables the operator to select the time allotment for the desk top graphs the operator wishes to compare.

[0294] Desk Top Graph Command, Bha Configuration Selection #17b: Reference element 17b depicts the Desk Top Graph Command Bha Configuration Selection which enables the operator to select the Bha configuration the operator wishes to compare.

[0295] Desk Top Graph Command, Graph Comparison Selection #17c: Reference element 17c depicts the Desk Top
Graph Command Graph Comparison Selection which enables the operator to select the graph configuration the operator wishes to compare.

[0296] Desk Top Graph Command, OK Command Button #17d: Reference element 17d depicts the Desk Top Graph OK Command Button which enables the operator to activate the desk top comparison graph selections that he wishes to view and compare.

[0297] Desk Top Graphs #18: FIG. 18 depicts the Desk Top Graphs enabling the operator to view and compare the different aspects in graph form that he has selected for comparison.

[0298] Desk Top Graphs, Shift Selection #18c: Reference element 18a depicts the shift selection and or time allotment that the operator selected for comparison.

[0299] Desk Top Graphs, Bha Configuration Selection #18b: Reference element 18b depicts the Bha configuration that the operator selected for comparison.

[0300] Desk Top Graphs, Desk Top Graph Comparison #18c: Reference element 18c depicts the Desk Top Graphs the operator selected for comparison.

[0301] Desk Top Graphs, Exit Command #18d: Reference element 18d depicts the Exit Command Button that the operator activates when the operator wishes to exit the desk top graphs.

[0302] Data Sheet Layover #19: FIG. 19 depicts how the Data Sheets will layover the program header as soon as a new survey is entered, the last survey is edited or the data sheet command is activated.

[0303] FIGS. 20-22 illustrate exemplary drilling instructions such as drilling equipment parameters like mud motor parameters, inclination, azimuth, tool face setting, slide distance, slide start point, rotate distance, and rotate start point, that may be calculated by the system 32 in response to measured characteristics of the well.

[0304] Referring to FIG. 1D, the computing unit 34 determines what parameters are required to guide the portion of the drill string from the orientation 52 to a selected target 53 on a well plan 27. The measuring and determining stages are repeated for a subsequent orientation 54 further along the well. However, the selected target is switched to a subsequent target 55 on the well plan when the portion of the drill string comes within a predetermined positive distance of the selected target 53 as is the case in FIG. 1D. Thus, if a characteristic is cut as is the case with azimuth at point 54, the system 32 guides the well back onto the well plan in a fashion that increases the chance of a tangential intersect point and reduces the effects or risk of overcorrection.

[0305] As the well bore is drilled the calculations are done to hit the dead center of the target 62 coordinates. However, as the operator closes in on a target within a distance such as 10 meter or 32.8 feet the calculations may become skewed because if the well bore is in the window parameter corridor but is a little high or low (right or left) the calculations will still be based on the target dead center that well bore corrections are being calculated against, but because of the close proximity of the well bore target coordinates the well bore correction calculations will be attempting to hit the dead center of the target coordinates that in essence has already been achieved. The system 32 recognizes the target coordinate measured depth and as the well bore that is being drilled and gets within 10 meters or 32.8 feet of the target’s measured depth at which point the system will automatically drop the close proximity target coordinates and automatically start to calculate the well bore corrections against the next target 64 in line in the same section. This function of automatic target change works on a section by section basis. Thus, the system reads every target and drops and move to each target in each individual section that is being drilled the vertical/drill down, build section, or lateral section, the system will not jump from a build section target to a lateral section target until the command is activated telling the system that the lateral section is being drilled.

[0306] Drill Down, Vertical Data Template #20: FIG. 20 depicts the Drill Down, Vertical Data Template that is automatically activated when a new survey is entered as depicted in FIG. 27, when the last entered survey is edited as depicted in FIG. 28 or when the operator activates the Data Template Command Button as depicted in Reference element 10w on the program header when the Drill Down, Vertical Section of the well bore is being drilled.

[0307] Drill Down, Vertical Data Template, Slide Seen #20a: Reference element 20a depicts the Slide Seen at the survey point in meters or feet between the previous survey point and the present survey point.

[0308] Drill Down, Vertical Data Template, Tool Face Drill Off (T/F) #20b: Reference element 20b depicts what position the Tool Face (T/F) Drilled off at or was held at for the present survey point.

[0309] Drill Down, Vertical Data Template, Build or Drop Percentage (%) #20c: Reference element 20c depicts the Build or Drop percentage (%) of the slide seen that is incorporated into the build or drop calculation for that particular survey point.

[0310] Drill Down, Vertical Data Template, Turn Percentage (%) #20d: Reference element 20b depicts the Turn percentage (%) of the slide seen that is incorporated into the turn calculation for that particular survey point.

[0311] Drill Down, Vertical Data Template, Slide Under #20e: Reference element 20e depicts the Slide Under in meters or feet of slide that are still unseen below the survey point.

[0312] Drill Down, Vertical Data Template, Tool Face Set (T/F) #20f: Reference element 20f depicts the Tool Face setting for the unseen slide below the survey point where the tool face was set at or held for the unseen slide.

[0313] Drill Down, Vertical Data Template, Inclination (Inc.) to Center of Target #20g: Reference element 20g depicts the Inclination (Inc.) that is needed to achieve the center of drill down or vertical target and is calculated based on, Atan[(Square Root(Survey North/-South Coordinate)+ (Survey East/-West Coordinate))/(Target Tvd-Survey Tvd)].

[0314] Drill Down, Vertical Data Template, Azimuth (Azl.) to Center of Target #20h: Reference element 20h depicts the Azimuth (Azl.) that is needed to achieve the center of drill down or vertical target and is calculated based on, Atan[(Target East/-West Coordinate–Survey East/-West Coordinate)/ (Target North/-South Coordinate–Survey North/-South Coordinate)].

[0315] Drill Down, Vertical Data Template, Kick Off Point #20i: Reference element 20i depicts the Kick Off Point measurement picked up from the Drill Down, Vertical target section end depth entered in the target coordinate, the kick off point is the measured depth at which the section of the well bore being drilled switches from the drill down vertical section of the well to the start point of the build section of the well bore being drilled.
Drill Down, Vertical Data Template, Book Value Factor #20v: Reference element 20v depicts the Book Value Factor that is calculated against the motor setting theoretical dogleg motor output picked up from the program header divided by the constant of 30 for a metric calculation and a constant of 100 for an imperial calculation.

Drill Down, Vertical Data Template, Book Value Slide #20k: Reference element 20k depicts the Book Value Slide that is calculated by dividing the survey point inclination by the book value factor giving the operator a base calculation option to execute the present slide against.

Drill Down, Vertical Data Template, Average (Avg) Last 2 Factor #20l: Reference element 20l depicts the Average (Avg) Last 2 Factor that is calculated by averaging the last two (2) slide point results per meter or foot slid.

Drill Down, Vertical Data Template, Average (Avg) Last 2 Slide #20m: Reference element 20m depicts the Average (Avg) Last 2 Slide that is calculated by dividing the survey point inclination by the average last two slides factor giving the operator a base calculation option to execute the present slide against.

Drill Down, Vertical Data Template, Required Tool Face Setting #20n: Reference element 20n depicts the Required Tool Face Setting that is needed to achieve the well bore correction and is calculated by adding 180° to any survey point azimuth that is below 180° and by subtracting 180° from any survey point azimuth that is 180° or higher and is displayed in a magnetic tool face positioning in the drill down, vertical section of the well for any inclination that is 5° or lower.

Drill Down, Vertical Data Template, Operator's Option Slide #20o: Reference element 20o depicts the Operator's Option Slide that enables the operator to initiate his own slide based on his own calculations.

Drill Down, Vertical Data Template, Operator's Option Tool Face Setting #20p: Reference element 20p depicts the Operator's Option Tool Face Setting that enables the operator to initiate his own tool face setting for his own slide based on his own calculations.

Drill Down, Vertical Data Template, Slide Start Point #20q: Reference element 20q depicts the Slide Start Point and is picked up from the hole depth in the survey file.

Drill Down, Vertical Data Template, Rotate Ahead Command #20r: Reference element 20r depicts the Rotate Ahead Command that enables the operator to initiate a rotate ahead option and perform no slides.

Drill Down, Vertical Data Template, Rotate Ahead Starting Point #20s: Reference element 20s depicts the Rotate Ahead Starting Point that is picked up from the survey file hole depth.

Drill Down, Vertical Data Template, Comments #20t: Reference element 20t depicts the Comments option that enables the operator to add a comment to the survey file by activating the command button that precedes the comment.

Drill Down, Vertical Data Template, Bit Extrapolation #20u: Reference element 20u depicts the Bit Extrapolation that is automatically calculated based on the survey point results and is extrapolated to account for the bit to sensor measurement and is automatically displayed at the bottom of the data sheet; the bit extrapolation automatically takes into account any slide that is under the present survey point that has not been seen in the survey calculation, if there is no unseen slide under the survey point the bit extrapolation will automatically follow the build and turn trend unless the straight line command is activated.

Drill Down, Vertical Data Template, Straight Line Bit Extrapolation Command #20v: Reference element 20v depicts the Bit Extrapolation Straight Line Command which enables the operator to have the system straight line the bit extrapolation by holding the inclination and azimuth for the bit to sensor measurement even if there is seen or unseen slide under the survey point.

Drill Down, Vertical Data Template, Add Bit Extrapolation to Survey File Command with Comment #20w: Reference element 20w depicts the Add Bit Extrapolation to Survey File with Comment Command which enables the operator to add the bit extrapolation to the survey file with an optional comment. The "OK" command must be activated for the bit extrapolation to be added to the survey file.

Drill Down, Vertical Data Template, Exit Command 20x: Reference element 20x depicts the Exit Command which enables the operator to exit the data sheet if it was entered through the data templates command on the program header to view the data templates.

Build Section Data Template #21: FIG. 21 depicts the Build Section Data Template that is automatically activated when a new survey is entered, the last entered survey is edited or when the operator activates the Data Template Command Button on the program header when the Build Section of the well bore is being drilled.

Build Section Data Template, Slide Seen #21a: Reference element 21a depicts the Slide Seen at the survey point in meters or feet between the previous survey point and the present survey point.

Build Section Data Template, Tool Face Drill Off (T/F) #21b: Reference element 21b depicts what position the Tool Face (T/F) Drilled Off at or was held at for the present survey point.

Build Section Data Template, Build or Drop Percentage (%) #21c: Reference element 21c depicts the Build or Drop percentage (%) of the slide seen that is incorporated into the build or drop calculation for that particular survey point.

Build Section Data Template, Turn Percentage (%) #21d: Reference element 21d depicts the Turn percentage (%) of the slide seen that is incorporated into the turn calculation for that particular survey point.

Build Section Data Template, Total Slide Under #21e: Reference element 21e depicts the Total Slide Under in meters or feet of slide that are still unseen below the survey point.

Build Section Data Template, First Break Down of Slide Under #21f: Reference element 21f depicts the First Break Down of Slide Under in meters or feet of slide that is still unseen below the survey point, the break down is automatically broken down or separated out from the total slide in relation to the survey the slide was done.

Build Section Data Template, First Break Down of Slide Tool Face Setting #21g: Reference element 21g depicts the First Break Down of Slide Tool Face Setting for the unseen slide below the survey point where the tool face was set at or held for the unseen slide.
[0340] Build Section Data Template, Second Break Down of Slide Under #21h: Reference element 21h depicts the Second Break Down of Slide Under in meters or feet of slide that are still unseen below the survey point, the break down is automatically broken down or separated out from the total slide in relation to the survey the slide was done.

[0341] Build Section Data Template, Second Break Down of Slide Tool Face Setting #21i: Reference element 21i depicts the Second Break Down of Slide Tool Face Setting for the unseen slide below the survey point where the tool face was set at or held for the unseen slide.

[0342] Build Section Data Template, Target Number (#) #21j: Reference element 21j depicts the Target Number (#) that the well bore correction calculations are being calculated against.

[0343] Build Section Data Template, Book Value Factor #21k: Reference element 21k depicts the Book Value Factor that is calculated by dividing the active well planned dogleg by the theoretical motor setting dogleg motor output picked up from the program header.

[0344] Build Section Data Template, Book Value Slide #21l: Reference element 21l depicts the Book Value Slide that is calculated by multiplying the book value factor by the rig average single length giving the operator a basic calculation option to execute the present slide against.

[0345] Build Section Data Template, Survey Point Factor #21m: Reference element 21m depicts the Survey Point Slide Factor that is calculated by dividing the survey dogleg result for the survey by the number of meters or feet that where slid to achieve the dogleg results.

[0346] Build Section Data Template, Survey Point Slide #21n: Reference element 21n depicts the Survey Point Slide that is calculated by dividing the active well planned dogleg that is needed to achieve the target that the well bore corrections are being calculated against by the survey point factor.

[0347] Build Section Data Template, Average (Avg) Last 2 Factor #21o: Reference element 21o depicts the Average (Avg) Last 2 Slide Factors that are calculated by averaging the last two (2) slide point results per meter or foot slid.

[0348] Build Section Data Template, Average (Avg) Last 2 Slide #21p: Reference element 21p depicts the Average (Avg) Last 2 Slices that are calculated by dividing the average last 2 slide factors into the active well planned dogleg needed to achieve the target the well bore corrections are being calculated against giving the operator a basic calculation option to execute the present slide against.

[0349] Build Section Data Template, Planned Dogleg #21q: Reference element 21q depicts the planned dogleg that is needed to achieve the target that the well bore corrections are being calculated against.

[0350] Build Section Data Template, Required Tool Face Setting #21r: Reference element 21r depicts the Required Tool Face Setting that is needed to achieve the well bore corrections that are required to achieve the target that the well bore corrections are being calculated against.

[0351] Build Section Data Template, Operator’s Option Slide #21s: Reference element 21s depicts the Operator’s Option Slide that enables the operator to initiate his own slide based on his own calculations.

[0352] Build Section Data Template, Operator’s Option Tool Face Setting #21t: Reference element 21t depicts the Operator’s Option Tool Face Setting that enables the operator to initiate his own tool face setting for his own slide based on his own calculations.

[0353] Build Section Data Template, Slide Start Point Command #21u: Reference element 21u depicts the Slide Start Point Command that enables the operator to have the system automatically pick up the slide start point from the survey file hole depth.

[0354] Build Section Data Template, Rotate Ahead Command #21v: Reference element 21v depicts the Rotate Ahead Command that enables the operator to initiate a rotate ahead option and perform no slides.

[0355] Build Section Data Template, Rotate Ahead Starting Point #21w: Reference element 21w depicts the Rotate Ahead Starting Point that is picked up from the survey file hole depth.

[0356] Build Section Data Template, Slide Start Point #21x: Reference element 21x depicts the Slide Start Point and is picked up from the hole depth in the survey file or can be entered manually by the operator if the slide start point is started at a point other than the hole depth.

[0357] Build Section Data Template, Comments #21y: Reference element 21y depicts the Comments option that enables the operator to add a comment to the survey file by activating the comment button that precedes the comment.

[0358] Build Section Data Template, Bit Extrapolation #21z: Reference element 21z depicts the Bit Extrapolation that is automatically calculated based on the survey point results and is extrapolated to account for the bit to sensor measurement and is automatically displayed at the bottom of the data sheet; the bit extrapolation automatically takes into account any slide that is under the present survey point that has not been in the survey calculation, if there is no unseen slide under the survey point the bit extrapolation will automatically follow the build and turn trend unless the straight line command is activated.

[0359] Build Section Data Template, Straight Line Bit Extrapolation Command #21aa: Reference element 21aa depicts the Bit Extrapolation Straight Line Command which enables the operator to have the system straight line the bit extrapolation by holding the inclination and azimuth for the bit to sensor measurement even if there is seen or unseen slide under the survey point.

[0360] Build Section Data Template, Add Bit Extrapolation to Survey File Command with Comment #21bb: Reference element 21bb depicts the Add Bit Extrapolation to Survey File with Comment Command which enables the operator to add the bit extrapolation to the survey file with an optional comment. The “OK” command in reference element 21bb must be activated for the bit extrapolation to be added to the survey file.

[0361] Build Section Data Template, Exit Command #21cc: Reference element 21cc depicts the Exit Command which enables the operator to exit the data sheet if it was entered through the data templates command on the program header depicted in reference element 10w to view the data templates.

[0362] Build Section Data Template, Start Slide/Rotate Command #21dd: Reference element 21dd depicts the Start Slide/Rotate Command enabling the operator to start the slide or rotate after the operator makes the decision as to what well bore correction action will be taken.

[0363] Lateral Section Data Template #22: FIG. 22 depicts the Lateral Section Data Template that is automatically activated when a new survey is entered as depicted in FIG. 27, the last entered survey is edited as depicted in FIG. 28 or when the operator activates the Data Template Command Button as
depicted in Reference element 10w on the program header when the Lateral Section of the well bore is being drilled. [0364] Lateral Section Data Template, Slide Seen #22a: Reference element 22a depicts the Slide Seen at the survey point in meters or feet between the previous survey point and the present survey point.

[0365] Lateral Section Data Template, Tool Face Drill Off (T/F) #22b: Reference element 22b depicts what position the Tool Face (T/F) Drilled Off at or was held at for the present survey point.

[0366] Lateral Section Data Template, Build or Drop Percentage (%) #22c: Reference element 22c depicts the Build or Drop percentage (%) of the slide seen that is incorporated into the build or drop calculation for that particular survey point.

[0367] Lateral Section Data Template, Turn Percentage (%) #22d: Reference element 22d depicts the Turn percentage (%) of the slide seen that is incorporated into the turn calculation for that particular survey point.

[0368] Lateral Section Data Template, Total Slide Under #22e: Reference element 22e depicts the Total Slide Under in meters or feet of slide that are still unseen below the survey point.

[0369] Lateral Section Data Template, First Break Down of Slide Under #22f: Reference element 22f depicts the First Break Down of Slide Under in meters or feet of slide that is still unseen below the survey point, the break down is automatically broken down or separated out from the total slide in relation to the survey the slide was done.

[0370] Lateral Section Data Template, First Break Down of Slide Tool Face Setting #22g: Reference element 22g depicts the First Break Down of Slide Tool Face Setting for the unseen slide below the survey point where the tool face was set at or held for the unseen slide.

[0371] Lateral Section Data Template, Second Break Down of Slide Under #22h: Reference element 22h depicts the Second Break Down of Slide Under in meters or feet of slide that are still unseen below the survey point, the break down is automatically broken down or separated out from the total slide in relation to the survey the slide was done.

[0372] Lateral Section Data Template, Second Break Down of Slide Tool Face Setting #22i: Reference element 22i depicts the Second Break Down of Slide Tool Face Setting for the unseen slide below the survey point where the tool face was set at or held for the unseen slide.

[0373] Lateral Section Data Template, Target Number (#) #22j: Reference element 22j depicts the Target Number (#) that the well bore correction calculations are being calculated against.

[0374] Lateral Section Data Template, Center of Sub Sea (SS) Corridor #22k: Reference element 22k depicts the Center of the Sub Sea (SS) Corridor that is currently set and controlled by the lateral window corridor parameters.

[0375] Lateral Section Data Template, Book Value Factor #22l: Reference element 22l depicts the Book Value Factor that is calculated by dividing the active well planned dogleg by the theoretical motor setting dogleg motor output picked up from the program header.

[0376] Lateral Section Data Template, Book Value Slide #22m: Reference element 22m depicts the Book Value Slide that is calculated by multiplying the book value factor by the rig average single length giving the operator a base calculation option to execute the present slide against.

[0377] Lateral Section Data Template, Survey Point Factor #22n: Reference element 22n depicts the Survey Point Slide Factor that is calculated by dividing the survey dogleg result for the survey by the number of meters or feet where slide to achieve the dogleg results.

[0378] Lateral Section Data Template, Survey Point Slide #22o: Reference element 22o depicts the Survey Point Slide that is calculated by dividing the active well planned dogleg that is needed to achieve the target that the well bore corrections are being calculated against by the survey point factor.

[0379] Lateral Section Data Template, Average (Avg) Last 2 Factor #22p: Reference element 22p depicts the Average (Avg) Last 2 Slide Factors that are calculated by averaging the last two (2) slide point results per meter or foot slide.

[0380] Lateral Section Data Template, Average (Avg) Last 2 Slides #22q: Reference element 22q depicts the Average (Avg) Last 2 Slides that are calculated by dividing the average last 2 slide factors into the active well planned dogleg needed to achieve the target the well bore corrections are being calculated against giving the operator a base calculation option to execute the present slide against.

[0381] Lateral Section Data Template, Planned Dogleg #22r: Reference element 22r depicts the planned dogleg that is needed to achieve the target that the well bore corrections are being calculated against.

[0382] Lateral Section Data Template, Required Tool Face Setting #22s: Reference element 22s depicts the Required Tool Face Setting that is needed to achieve the well bore corrections that are required to achieve the target that the well bore corrections are being calculated against.

[0383] Lateral Section Data Template, Operator’s Option Slide #22t: Reference element 22t depicts the Operator’s Option Slide that enables the operator to initiate his own slide based on his own calculations.

[0384] Lateral Section Data Template, Operator’s Option Tool Face Setting #22u: Reference element 22u depicts the Operator’s Option Tool Face Setting that enables the operator to initiate his own tool face setting for his own slide based on his own calculations.

[0385] Lateral Section Data Template, Slide Start Point Command #22v: Reference element 22v depicts the Slide Start Point Command that enables the system to automatically pick up the slide start point from the survey file hole depth.

[0386] Lateral Section Data Template, Rotate Ahead Command #22w: Reference element 22w depicts the Rotate Ahead Command that enables the operator to initiate a rotate ahead option and perform no slides.

[0387] Lateral Section Data Template, Rotate Ahead Starting Point #22x: Reference element 22x depicts the Rotate Ahead Starting Point that is picked up from the survey file hole depth.

[0388] Lateral Section Data Template, Slide Start Point #22y: Reference element 22y depicts the Slide Start Point and is picked up from the hole depth in the survey file or can be entered manually by the operator if the slide start point is started at a point other than the hole depth.

[0389] Lateral Section Data Template, Comments #22z: Reference element 22z depicts the Comments option that enables the operator to add a comment to the survey file by activating the command button that precedes the comment.

[0390] Lateral Section Data Template, Bit Extrapolation #22aa: Reference element 22aa depicts the Bit Extrapolation that is automatically calculated based on the survey point results and is extrapolated to account for the bit to sensor measurement and is automatically displayed at the bottom of
the data sheet; the bit extrapolation automatically takes into account any slide that is under the present survey point that has not been seen in the survey calculation, if there is no unseen slide under the survey point the bit extrapolation will automatically follow the build and turn trend unless the straight line command is activated.

[0391] Lateral Section Data Template, Straight Line Bit Extrapolation Command #22bb: Reference element 22bb depicts the Bit Extrapolation Straight Line Command which enables the operator to have the system straight line the bit extrapolation by holding the inclination and azimuth for the bit to sensor measurement even if there is seen or unseen slide under the survey point.

[0392] Lateral Section Data Template, Add Bit Extrapolation to Survey File Command with Comment #22cc: Reference element 22cc depicts the Add Bit Extrapolation to Survey File with Comment Command which enables the operator to add the bit extrapolation to the survey file with an optional comment. The “OK” command in reference element 22aa must be activated for the bit extrapolation to be added to the survey file.

[0393] Lateral Section Data Template, Exit Command #22dd: Reference element 22dd depicts the Exit Command which enables the operator to exit the data sheet if it was entered through the data templates command on the program header depicted in reference element 10v to view the data templates.

[0394] Lateral Section Data Template, Start Slide/Rotate Command #22ee: Reference element 22ee depicts the Start Slide/Rotate Command enabling the operator to start the slide or rotate after the operator makes the decision as to what well bore correction action will be taken.

[0395] Lateral Section Data Template, Tvd/Inc Calculator Command #22ff: Reference element 22ff depicts the Tvd/Inc Calculator Command that enables the operator to enter the True Vertical Depth (Tvd), Inclination (Inc) Calculator that is depicted in FIG. 25.

[0396] Slide, Rotate Control #23: In some cases the methods may include measuring the elapsed time of an event, such as drilling time, forming part of the directional drilling operation. The system 32 may output from the one or more computing units to a display the elapsed time or a measurement made using the elapsed time. Such a method makes it possible to calculate ROP in a passive survey monitoring system. Other events such as one or more of slide time, rotate time, tool face orientation time, and connection time may be measured. Such a system provides a real-time system for tracking rate of penetration (ROP) for slides, rotates, lost tool faces, actual single drill time, or average connection time (aspects that are extremely important to directional drilling). After the data sheets automatically calculate what action has to be performed to either keep the well bore on track or the necessary well bore corrections the slide/rotate control automatically is activated and as the operator activates each command Orient, Slide, Rotate, Lost Tool Face or End Single the system automatically times and times out and records each individual operation in a viewable but non-editable worksheet. Because the system allows the operator to do this the operator can use this information to make decisions on bit selection vs. formations being drilled through. The operator can also use this information to adjust the drilling parameters as per weight on bit, pump flow, differential pump pressure, or rotary speed to enable the operator to keep the well bore trajectory on track.

[0397] FIG. 23 depicts the Slide, Rotate Control that automatically appears as soon as the Start Slide/Rotate Command is activated in Reference element 20 in the Drill Down, Vertical Data Template, or Reference element 21ld in the Build Section Data Template, or Reference element 22ee in the Lateral Section Data Template.

[0398] Slide, Rotate Control, Orient Command #23a: Reference element 23a depicts the Orient Command, when a slide or well bore correction is to be done the operator activates the orient command when he is working the drill string to orient or set the tool face orientation as per the well bore correction calculation; as soon as the orient command is activated the system automatically locks in the start time and begins to record the time that the operator spends orienting or setting the tool face.

[0399] Slide, Rotate Control, Slide Command #23b: Reference element 23b depicts the Slide Command, as soon as the operator has the tool face oriented or set for the well bore correction that is to be done he activates the slide command; as soon as the operator activates the slide command the system times out the orient command and records the end time for the orient time and records the start time for the slide command for the well bore correction.

[0400] Slide, Rotate Control, Lost Tool Face Command #23c: Reference element 23c depicts the Lost Tool Face Command, while the operator is performing the calculated well bore correction via sliding or steering the well bore and if the operator cannot properly control the tool face setting and is unable to maintain the calculated tool face setting he activates the lost tool face command for every time that the tool face setting is corrupted which automatically times out and records the slide command and times in and records the lost tool face command activation, as soon as the operator has the tool face re-set he re-activates the slide command and the system automatically times out and records the lost tool face command and re-activates and records the new slide command. The operator performs this series of activations until he gets control of the tool face orientation or setting by changing drilling parameters such as tool face, weight on bit, downhole pump pressure, down hole differential pressure etc. If this continually happens for every well bore correction the operator has to look at the possibility getting the drilling contractor’s driller help or instruction, however if the drilling contractor’s driller is skilled in the art he will have to look at possibly changing out some aspect of the bottom hole assembly configuration such as the bit or bit motor configuration etc.

[0401] Slide, Rotate Control, Rotate Command #23d: Reference element 23d depicts the Rotate Command, the operator activates this command either when he has completed the slide or well bore correction and still has meters or feet remaining on the drill pipe single length or when no well bore correction is needed and the operator intends to rotate the entire drill pipe single length. As soon as the operator activates the rotate command the system times out the and records the end time for the previous whatever function command was activated if any and activates and records the start time for the rotate command.

[0402] Slide, Rotate Control, End Single Command #23e: Reference element 23e depicts the End Single Command, the operator activates the end single command when the full drill pipe single length is completed, once the end single command is activated the system will time out and record whatever
command is currently activated and automatically start timing and recording the connection time.

[0403] Slide, Rotate Control, Meters or Feet Needed for Well Bore Correction #23f: Reference element 23f depicts the calculated meters or feet needed to do the well bore correction which is picked up from the Drill Down, Vertical Data Template depicted in FIG. 20, or the Build Section Data Template depicted in FIG. 21 or the Lateral Section Data Template depicted in FIG. 22.

[0404] Slide, Rotate Control, Tool Face Setting Needed for Well Bore Correction #23g: Reference element 23g depicts the calculated Tool Face Setting needed to do the well bore correction which is picked up from the Drill Down, Vertical Data Template depicted in FIG. 20, or the Build Section Data Template depicted in FIG. 21 or the Lateral Section Data Template depicted in FIG. 22.

[0405] Slide, Rotate Control, Slide Start Point Needed for Well Bore Correction #23h: Reference element 23h depicts the Slide Start Point for the calculated meters or feet needed to do the well bore correction which is picked up from the Drill Down, Vertical Data Template depicted in FIG. 20, or the Build Section Data Template depicted in FIG. 21 or the Lateral Section Data Template depicted in FIG. 22.

[0406] Slide, Rotate Control, Slide End Point Needed for Well Bore Correction #23i: Reference element 23i depicts the Slide End Point for the calculated meters or feet need to do the well bore correction which is calculated by taking the slide start point for the well bore correction depicted in reference element 23f and adding the calculated meters or feet needed to do the well bore correction depicted in reference element 23f.

[0407] Slide, Rotate Control, Rotate Single #23j: Reference element 23j depicts the Rotate Single prompt that is picked up when the operator activates the Rotate Ahead Command in the Drill Down, Vertical Data Template depicted in reference element 20r, or the Build Section Data Template depicted in reference element 21r or the Lateral Section Data Template depicted in reference element 22w.

[0408] Added Comments #24: FIG. 24 depicts the Added Comments Template that automatically appears when the operator activates the Added Comment Command in the Drill Down, Vertical Data Template depicted in reference element 20r, or the Build Section Data Template depicted in reference element 21r or the Lateral Section Data Template depicted in reference element 22w which enables the operator to add a written comment up to a maximum of 50 characters to the survey file.

[0409] Added Comments, OK Command #24a: Reference element 24a depicts the OK Command that is activated after the operator writes out the comment that he wishes to have added to the survey file.

[0410] Added Comments, Cancel Command #24b: Reference element 24b depicts the Cancel Command if the operator has entered the added comment template by mistake or if the operator decides to not enter an added comment to the survey file.

[0411] Sub Sea, Tvd/Inc Calculator #25: FIG. 25 depicts the Sub Sea, Tvd/Inc Calculator, enabling the operator to calculate the needed inclination at the bit extrapolation to get the needed rise or drop in Tvd or Sub Sea at a given inclination over a set distance. The second part of the Tvd/Inc Calculator enables the operator to calculate how much Tvd or Sub Sea will be lost or gained at a given inclination over a set distance. The operator enters the Sub Sea, Tvd/Inc Calculator through the command depicted in Reference element 22f in the Lateral Data Template Command. The Tvd calculator tells a user what angle to hold to get where the user wants to go to, and is a simpler version of extrapolate ahead.

[0412] a. Inclination needed at the bit to change Sub Sea or Tvd. Rise the operator enters the meters/feet wanted or needed to rise as a negative (-) number, the program should do this automatically. (Rise as Negative (-) Number/Distance) Acos. Drop the operator enters the meters/feet wanted or needed to drop as a positive (+) number. (Drop as Positive (+) Number/Distance) Acos. Distance the operator enters the meters/feet the rise or drop will be done in. Inclination the inclination is automatically calculated that will be need at the bit extrapolation based on the rise or drop and the distance entered.

[0413] b. Sub Sea or Tvd Change at a Given Inclination. Extrapolated Bit Inclination (Inc.) the operator enters the extrapolated bit inclination. Distance the operator enters the distance (m/ft) that is intended to drill at that given inclination. Rise the rise is automatically calculated based on the inclination and distance entered. The operator is locked out of this cell. (Cos Inclination) Distance, The rise will calculate out as a negative (-) number. Drop the drop is automatically calculated based on the inclination and distance entered. The operator is locked out of this cell. (Cos Inclination) Distance, The drop will calculate as a positive (+) number.

[0414] When the operator activates the Tvd/Inc. Calculator Command and enters the necessary data either in part a or b this will enable him to make a well informed decision as to what will be needed to move the well bore to achieve the necessary well bore corrections. If the operator has to move the well bore up or down as per meters or feet in the lateral section the operator uses part (a) of the Tvd/Inc Calculator, if the operator has to calculate how much the well bore will drop or rise at a given angle over a set distance he uses part (b) of the Tvd/Inc. Calculator.

[0415] When and operator uses part (a) of the Tvd/Inc. Calculator he will know what angle he will need to achieve and maintain, at the bit, to move the well bore up or down a given number of meters or feet over a given distance. If the calculated angle is too high or too low the operator can either adjust the given distance the well bore has to be moved up or down in or the overall distance that the movement will be adjusted in. This calculation enables the operator to make an informed decision which enables him to better control the well bore trajectory as not to jeopardize the well bore integrity.

[0416] When the operator uses part (b) of the Tvd/Inc. Calculator he will know that the well bore will drop or rise at a given angle over a given distance. If the calculated drop or rise is to aggressive or to gradual the operator can either adjust the angle or the overall distance in which the adjustment is being made in. This calculation enables the operator to make an informed decision which enables him to better control the well bore trajectory as not to jeopardize the well bore integrity.

[0417] Sub Sea, Tvd/Inc Calculator, Rise #25a: Reference element 25a describes the Rise in Sub Sea or Tvd that the operator enters in meters or feet that is wanted or needed to rise; the rise is entered as a negative (-) number automatically by the system; (Rise Negative (-)/Distance) Acos.

[0418] Sub Sea, Tvd/Inc Calculator, Drop #25b: Reference element 25b depicts the Drop in Sub Sea or Tvd that the
operator enters in meters or feet that is wanted or needed to drop as a positive (+) number: (Drop Positive (+)/Distance) Aces.

[0419] Sub Sea, Tvd/Inc Calculator, Distance #25c: Reference element #25c depicts the Distance that the operator wishes to have the rise or drop in meters or feet done in.

[0420] Sub Sea, Tvd/Inc Calculator, Inclination (Inc.) #25f: Reference element #25f depicts the Inclination (Inc.) that is needed at the bit that is automatically calculated by the system based on the rise or drop and the distance entered by the operator in meters or feet entered.

[0421] Sub Sea, Tvd/Inc Calculator, Given Inclination (Inc.) #25e: Reference element #25e depicts the Extrapolated Bit Inclination (Inc) the operator enters.

[0422] Sub Sea, Tvd/Inc Calculator, Distance #25f: Reference element #25f depicts the Distance that the operator wishes to hold the given inclination for.

[0423] Sub Sea, Tvd/Inc Calculator, Rise #25g: Reference element #25g depicts the rise that is automatically calculated by the system based on the inclination and distance the operator enters; (Cos Inclination) x Distance.

[0424] Sub Sea, Tvd/Inc Calculator, Drop #25h: Reference element #25h depicts the drop that is automatically calculated by the system based on the inclination and distance the operator enters; (Cos Inclination) x Distance.

[0425] Sub Sea, Tvd/Inc Calculator, OK Command #25i: Reference element #25i depicts the OK Command which enables the operator to execute the calculations needed as soon as the operator enters all the necessary data.

[0426] Sub Sea, Tvd/Inc Calculator, Exit Command #25j: Reference element #25j depicts the Exit Command that the operator activates to exit the Sub Sea, Tvd/Inc Calculation Template.

[0427] Interpolation Screen #26: FIG. 26 depicts the Interpolation Screen which enables the operator to interpolate and insert a survey in the file at any point in the well; the operator enters the interpolation screen through the Interpolate Survey Command depicted in reference element #10r in the Program Header.

[0428] Interpolation Screen, Interpolation Depth #26a: Reference element #26a depicts the Interpolation Depth that the operator wishes to have interpolated; the operator manually enters the interpolation depth.

[0429] Interpolation Screen, Interpolated Inclination #26b: Reference element #26b depicts the Interpolated Inclination.

[0430] Interpolation Screen, Interpolated Azimuth #26c: Reference element #26c depicts the Interpolated Azimuth.

[0431] Interpolation Screen, Interpolated True Vertical Depth #26d: Reference element #26d depicts the Interpolated True Vertical Depth.

[0432] Interpolation Screen, Interpolated Sub Sea Depth #26e: Reference element #26e depicts the Interpolated Sub Sea Depth.

[0433] Interpolation Screen, Interpolated North-South Coordinate #26f: Reference element #26f depicts the Interpolated North-South Coordinate.

[0434] Interpolation Screen, Interpolated East-West Coordinate #26g: Reference element #26g depicts the Interpolated East-West Coordinate.

[0435] Interpolation Screen, Interpolated Vertical Section #26h: Reference element #26h depicts the Interpolated Vertical Section.
when the operator activates the OK Command the data entered here will automatically be entered in the appropriate entries in the survey file and work sheets.

[0451] Edit, Delete Last Survey Screen #28: In some cases the system 32 will only execute user-initiated edit commands of the plurality of characteristics measured in the preceding iteration of the measuring stage. Thus, once a user has satisfied him or herself that survey data is entered properly enough to warrant further drilling, the system 32 prevents editing of that survey data.

[0452] FIG. 28 depicts the Edit, Delete Last Survey Screen, when the operator activates the Edit, Delete Last Survey Command depicted in Reference element 10r in the program header the Edit, Delete Last Survey Screen appears over lapping the survey screen enabling the operator to edit or delete only the last survey that was entered, all other surveys previous to the last survey are locked out.

[0453] Edit, Delete Last Survey, Hole Depth #28a: Reference element 28a depicts the Edit, Delete Last Survey Hole Depth that enables the operator to edit the hole depth for the last survey entered.

[0454] Edit, Delete Last Survey, Survey Depth #28b: Reference element 28b depicts the Edit, Delete Last Survey, Survey Depth that the system automatically calculates by subtracting the Bit to Sensor Measurement depicted in Reference element 10r in the program header from the hole depth that is entered in Reference element 28a:

[0455] Edit, Delete Last Survey, Inclination #28c: Reference element 28c depicts the Edit, Delete Last Survey Inclination that enables the operator to edit the inclination for the last survey entered.

[0456] Edit, Delete Last Survey, Azimuth #28d: Reference element 28d depicts the Edit, Delete Last Survey Azimuth that enables the operator to edit the azimuth for the last survey entered.

[0457] Edit, Delete Last Survey Course Length Calculation #28e: Reference element 28e depicts the Course Length Calculation that the system automatically calculates by subtracting the current survey hole depth from the previous survey hole depth.

[0458] Edit, Delete Last Survey OK Command #28f: Reference element 28f depicts the Edit, Delete Last Survey OK Command when the operator activates the OK Command the data entered here will automatically be entered and recorded in the appropriate entries in the survey file and work sheets.

[0459] Edit, Delete Last Survey, Delete Last Survey Command #28g: Reference element 28g depicts the Delete Last Survey Command which enables operator to delete the last survey entered and only the last survey the system locks out all other surveys above the last survey that was entered.

[0460] Edit Last Slide/Tally Screen #29: FIG. 29 depicts the Edit Last Slide Screen, when the operator activates the Edit, Delete Last Survey Command depicted in Reference element 10r in the program header the Edit Last Slide Screen appears over lapping the survey screen enabling the operator to only edit the last slide that was entered, all other slides previous to the last slide are locked out and cannot be edited.

[0461] Edit Last Slide/Tally, Previous Slide Start Point #29a: Reference element 29a depicts the Edit Last Slide/Tally Previous Slide Starting Point which displays the previous slide’s starting point which enables the operator to use it as a reference point for the slide or tally edit.

[0462] Edit Last Slide/Tally, Meters/Feet (m/ft) Slide #29b: Reference element 29b depicts the Edit Last Slide/Tally Meters or Feet (m/ft) Slide which displays the previous slide’s number of meters or feet that were slid and entered in the previous slide which enables the operator to use it as a reference point for the slide or tally edit.

[0463] Edit Last Slide/Tally, Tool Face Setting #29c: Reference element 29c depicts the Edit Last Slide/Tally Tool Face Setting which displays the previous slide’s tool face setting that was entered in the previous slide which enables the operator to use as a reference point for the slide or tally edit.

[0464] Edit Last Slide/Tally, Edited Slide Start Point #29d: Reference element 29d depicts the Edit Last Slide/Tally Edited Slide Starting Point which displays the new edited slide’s starting point.

[0465] Edit Last Slide/Tally, Edited Meters/Feet (m/ft) Slide #29e: Reference element 29e depicts the Edit Last Slide/Tally Edited Meters or Feet (m/ft) Slide which displays the new edited slide’s number of meters or feet that were slid.

[0466] Edit Last Slide/Tally, Edited Tool Face Setting #29f: Reference element 29f depicts the Edit Last Slide/Tally Edited Tool Face Setting which displays the new edited slide’s tool face setting.

[0467] Edit Last Slide/Tally, OK Command #29g: Reference element 29g depicts the Edit Last Slide/Tally OK Command when the operator activates the OK Command the data entered here will automatically be entered and recorded in the appropriate work sheets.

[0468] Generate Reports #30: FIG. 30 depicts the Generate Reports template that enables the operator to print any well reports selected in a PDF format; the generate reports template is accessed when the operator activates the Generate Reports Command Button depicted in Reference element 10ue in the program header.

[0469] Generate Reports, Drilled Wells #30a: FIG. 30a depicts the Drilled Wells list of the wells that have been drilled, the operator selects the well that he wishes to generate the reports for by activating the command button directly across from the well that he wants to generate the reports for.

[0470] Generate Reports, Well Plans #30b: Reference element 30b depicts the Well Plans list of the well plans, the operator selects the well plan that he wishes to generate the reports for by activating the command button directly across from the well plan that he wants to generate the reports for.

[0471] Generate Reports, Slide Tracks #30c: Reference element 30c depicts the Slide Tracks list of the well side tracks, the operator selects the slide track that he wishes to generate the reports for by activating the command button directly across from the side track that he wants to generate the reports for.

[0472] Generate Reports, Reports List #30d: Reference element 30d depicts the Reports List of the well reports, the operator selects the reports that he wishes to generate by activating the command button directly across from the reports that he wants to have generated.

[0473] Generate Reports, OK Command #30e: Reference element 30e depicts the Generate Reports OK Command when the operator activates the OK Command the system will automatically generate the selected reports for the selected drilled wells, well plans or side tracks.

[0474] Re-Plan Well, Step #1 Verification Screen #31: FIG. 31 depicts Step #1 of the well planning module, a well Re-Plan Well Verification Screen will automatically appear as soon as the operator activates the re-plan well command depicted in Reference element 10x in the program header.
enabling the operator to verify if the well is to re-planned. The systems and methods disclosed here may include self well bore re-planning and sidetracking modules. When a factor is breached due to any window parameter corridor breaches or if any target formation parameter changes are made in the field the operator activates the re-plan well command on the program header and the system will automatically move into the automated well planning module. The automated well planning module prompts and walks the operator through the well planning module step by step to insure that human error is taken out of the equation. The well planning module will verify and lock in the current well bore positioning as the tie-in point (well planning starting point) then the planning module will verify and lock in either the current target parameters or the new target parameters that are selected or edited by the operator. Then the well planning module will automatically execute the well plan and interpolate all survey points between the two selected points. The last step the operator will be prompted through is the well plan verification, acceptance and activation of the new well plan through the active acceptance operator coding.

Reference element 31a depicts the Depth Verification for the beginning point for the beginning of the well re-plan.

Reference element 31b: Reference element 31b depicts the Depth Acceptance Command, if the operator agrees to the depth starting point for the well re-plan the operator activates the “YES” acceptance command.

Reference element 31c: Reference element 31c depicts the Depth Rejection Command, if the operator disagrees to the depth starting point for the well re-plan the operator activates the “NO” command and changes the starting point depth the system will then automatically consider the well plan as a sidetrack and automatically move into the sidetrack module step #1 Sidetrack Verification depicted in FIG. 36.

Re-Plan Well Module #2, Targets & Windows #32: FIG. 32 depicts Step #2 the Re-Plan Well Module the Targets and Window Corridor Parameters.

Re-Plan Well Module #2, Edit Target/Window Command #32a: Reference element 32a depicts the Edit Target/Window Command which enables the operator to initiate the target and or the window corridor parameter editing if necessary.

Reference element 32b: Reference element 32b depicts the Edit Target Parameter selection that enables the operator to edit any or all of the target parameters if necessary.

Re-Plan Well Module #2, Edit Window Corridor Parameters #32c: Reference element 32c: Reference element 32c depicts the Edit Window Corridor Parameters section that enables the operator to edit any or all of the window corridor parameters if necessary. A change predetermined window command may be used to edit windows sizes, and may include modifying the values in 32c as needed. FIG. 47 illustrates a log created of all change window size commands, in order to hold the user changing the window size accountable and track window changes. The windows are what determine whether or not a deviation from the well plan warranting intervention or alert generation has occurred, so monitoring window changes helps an oil company control the drilling of its well.

Re-Plan Well Step #2, Re-Set Window Corridor Parameters Command #32d: Reference element 32d depicts the Re-Set Window Corridor Parameters Command which enables the operator to set all the window corridor parameters to the section default parameters if necessary.

Reference element 32e: Reference element 32e depicts the Reasons for Edits selections which enables the operator to select the reasons for any edits that may have been done to either the well bore coordinates or section corridor window parameters and records all data (original and new) and reasons for the edits in a viewable, but non-editable worksheet.

Reference element 32f: Reference element 32f depicts the Who Made or Ordered the edits selection that enables the operator to select who has ordered either the well coordinates or section window corridors parameters to be changed and records who was responsible for the edits in a viewable, but non-editable worksheet.

Reference element 32g: Reference element 32g depicts the add a written comment option enabling the operator to add a comment as to why the coordinates and/or window corridor parameters were edited, the comments are recorded in a viewable, but non-editable worksheet.

Reference element 32h: Reference element 32h depicts the Accept Command enabling the operator to accept the re-configured well coordinates and/or window corridor parameters and have them interpolated and displayed for the operator’s acceptance or rejection.

Reference element 32i: Reference element 32i depicts the Add Target Command that enables the operator to add a completely new target to the targets and windows module as a blank template with the default section window corridor parameters incorporated.

Data Display Layover Screen #33: FIG. 33 depicts the Data Display Layover Screen for the re-planned well.

Reference element 33a: Reference element 33a depicts the Data Display enabling the operator to verify the re-planned well data to ensure that the target coordinates were correctly planned.

Reference element 33b: Reference element 33b depicts the Check New Plot Command which automatically appears on the program header enabling the operator to access the Re-Plan Well Proximity Plots depicted in FIG. 34 to visually verify that the re-planned well, well coordinates and window corridor parameters were correctly planned.

Reference element 33c: Reference element 33c depicts the Re-Plan Well Proximity Plots module which automatically appears when the operator activates the check new plot command depicted in Reference element 33c; the re-plan well proximity plots are similar to the proximity plots depicted in FIG. 8 with three additional commands depicted in Reference element 34c.

Reference element 34a: Reference element 34a depicts the Re-Plan Well Proximity Plots, Plot Against Command which enables the operator to select which wells he would like to have the re-planned well plotted against for comparison purposes.

Reference element 34b: Reference element 34b depicts the Re-Plan Well Proximity Plots Accept Command which enables the operator to accept the re-planned well as depicted in the re-plan well proximity plots.
0494] Re-Plan Well Step #4, Proximity Plots, Exit Command

0495] Active Well Plans Lists #35: FIG. 35 depicts the Active Well Plans Lists module that enables the operator to verify and activate the correct drilled well and well plan.

0496] Active Well Plans, Drilled Wells List #35a: Reference element 35a depicts the Drill Confirmed List which enables the operator to verify that the system has automatically activated the correct well that is currently being drilled.

0497] Active Well Plans, Well Plan List #35b: Reference element 35b depicts the Active Well Plans List which enables the operator to verify that the system has automatically activated the correct well plan that the system will be calculating the well bore corrections against.

0498] Active Well Plans, Sidetracks List #35c: Reference element 35c depicts the Sidetracks List; however seeing that the well plan was not planned for a sidetrack the system will automatically lock out the side tracks selection list.

0499] Active Well Plans, Acceptance Code #35d: Reference element 35d depicts the Acceptance Code that has to be entered in order for the system to accept and activate the new well plan, the system will not enable the operator to activate the new well plan without entering the active acceptance code.

0500] Active Well Plans, OK Command #35e: Reference element 35e depicts the Active Well Plans OK Command, when the operator activates the OK Command the system will automatically make the new well plan active and record all changes in a viewable, but non-editable worksheet and automatically move back into the surveys module depicted in Reference element 10c in the program header enabling the operator to continue drilling the well bore.

0501] Sidetrack Planning Step #1, Verification Screen #36: FIG. 36 depicts Step #1 of Sidetrack Planning Module which appears automatically if the operator disagrees to the starting point depth for the well re-plan as depicted in FIG. 31 and activates the “NO” command as depicted in Reference element 31c. The sidetrack and replan modules disclosed here allow a user to quickly and efficiently replan the well and get approval from supervisors to go ahead. In some cases supervisors can monitor the replanning stage in real time. The sidetrack module works on the same principles as the planning module; however the difference between the planning and sidetrack module is where and how the well plan and sidetrack plan is executed. A straight well plan is executed from the bottom hole location of the existing well bore where sufficient well bore corrections can still be made to achieve the existing or edited well target parameters. A sidetrack well plan is executed when any well bore corrections no matter how drastic will not be sufficient enough to achieve the necessary well bore corrections to hit the well bore target parameters or the well bore target parameter edits or when some degree of the drill string and or the bottom hole assembly is twisted off and has to be abandoned down hole and has to be maneuvered or drilled around. When a well bore is sidetracked the existing well bore bottom hole is abandoned (comes what is known as a ghost hole) and in some cases filled in with a cement plug to close it off. The new well bore has to be moved away from the old abandoned well bore and in order to do this a new tie-in point (starting point) has to be identified up hole. After the new tie-in point is identified a well plan is drawn up to correct the well bore trajectory enabling the target parameters to be achieved or enabling the operator to move the well bore around the down hole problems or issues.

0502] In some cases the replan and sidetrack embodiments allow the operator to adjust the well bore trajectory for an issue that a formation may create ahead, for example 50 to 100 meters (feet) down the well bore, prior to drilling in that formation. Quick and efficient replan and sidetracking is beneficial when the operator knows that the formation(s) that are coming up in 50 to 100 meters either do not build as high or low that the well plan was averaged on, and the operator needs to adjust the well bore trajectory quickly.

0503] Sidetrack Planning Step #1, Sidetrack Verification YES Command #36a: Reference element 36a depicts Step #1 of the Sidetrack Planning Module, Sidetrack Verification YES Command, if the operator selects a depth other that the well bore hole depth depicted in Reference element 31a and wishes to start a well re-plan at some other depth this is considered a sidetrack and activates the “YES” Command depicted in Reference element 36a to continue moving forward in the sidetrack planning module.

0504] Sidetrack Planning Step #1, Sidetrack Verification NO Command #36b: Reference element 36b depicts Step #1 of the Sidetrack Planning Module, Sidetrack Verification NO Command, if the operator entered this module by mistake or is unsure if he wishes to sidetrack the well bore then the operator activates the NO Command as depicted in Reference element 36b to return to the well re-planning module as depicted in FIG. 31.

0505] Sidetrack Planning Step #2, #37: FIG. 37 depicts Step #2 of the Sidetrack Planning Module, Depth Verification.

0506] Sidetrack Planning Step #2, Depth Verification #37a: Reference element 37a depicts the Sidetrack Planning Step #2, Depth Verification entry that the operator enters the intended depth for the beginning point of the sidetrack.

0507] Sidetrack Planning Step #2, Depth Verification YES Command #37b: Reference element 37b depicts the Sidetrack Planning Step #2, Depth Verification YES Command, if the sidetrack starting point depth depicted in Reference element 37a coincides exactly with a depth that currently exists in the well file the operator activates the YES Command to continue moving forward through the sidetrack module.

0508] Sidetrack Planning Step #2, Depth Verification NO Command #37c: Reference element 37c depicts the Sidetrack Planning Step #2, Depth Verification NO Command, if the sidetrack starting point depth depicted in Reference element 37a does not coincide exactly with a depth that currently exists in the well file the operator activates the NO Command and the system will automatically move into Step #3 in the Sidetrack Module, Interpolation Screen as depicted in FIG. 38.

0509] Sidetrack Planning Step #3, Survey Interpolation Screen #38: FIG. 38 depicts the Sidetrack Planning Step #3 the Survey Depth Interpolation Screen.

0510] Sidetrack Planning Step #3, Sidetrack Interpolation Depth #38a: Reference element 38a depicts the Sidetrack Interpolation Depth automatically picked up by the system from the depth entered by the operator depicted in Reference element 37a.

0511] Sidetrack Planning Step #3, Sidetrack Interpolation Calculated Factors #38b to #38e: Reference elements 38b to 38e depicted in the Sidetrack Interpolation Calculated Fac-
tors, reference elements 38b to 38i are automatically calculated by the system as the coordinate interpolation factors for the hole depth that is depicted in Reference element 38a.

[0512] Sidetrack Planning Step #3, Sidetrack Interpolation Comment #38k: Reference element 38k depicts the Sidetrack Interpolation Comment entry which enables the operator to add a comment, for example “sidetrack starting point”, up to 50 characters long that the operator wishes to have added to the new survey file.

[0513] Sidetrack Planning Step #3, Sidetrack Interpolation Insert Command #38l: Reference element 38l depicts the Sidetrack Interpolation Insert Command which enables the operator to insert the interpolated depth depicted in Reference element 38a and the interpolated coordinate factors depicted in Reference elements 38b to 38i as the sidetrack tie-in point.

[0514] Sidetrack Planning Step #3, Sidetrack Interpolation Exit Command #38u: Reference element 38u depicts the Sidetrack Interpolation Exit Command which enables the operator to return to the sidetrack depth entry screen depicted in Reference element 37a to change the sidetrack depth if needed.

[0515] Sidetrack Planning Step #4, Sidetrack Planning Module Layover Screen #39: FIG. 39 depicts the Sidetrack Planning Module Layover Screen which automatically appears when the operator activates the Insert Command depicted in Reference element 38u.

[0516] Sidetrack Planning Step #4, Interpolated Sidetrack Tie-In Point #39a: Reference element 39a depicts the Interpolated Sidetrack Tie-In Point that is automatically transferred from the Sidetrack Interpolation Screen depicted in FIG. 38 as soon as the operator activates the Interpolation Insert Command depicted in Reference element 38u; the operator is locked out from the interpolated tie-in point and no edits can be done to it in this screen.

[0517] Sidetrack Planning Step #4, Distance Selection #39b: Reference element 39b depicts the Distance Selection which enables the operator to select the meters or feet he intends to slide or steer within the first added distance to the sidetrack.

[0518] Sidetrack Planning Step #4, Tool Face Setting #39c: Reference element 39c depicts the Tool Face Setting which enables the operator to select the tool face setting he wishes to hold the tool face at for the distance of the slide selected in Reference element 39b.

[0519] Sidetrack Planning Step #4, Motor Setting Selection #39d: Reference element 39d depicts the Motor Setting Selection which enables the operator to select the motor setting that will be used for the sidetrack; as soon as the operator selects the motor setting for the sidetrack the system will automatically populate the Dogleg entry in the motor selection section.

[0520] Sidetrack Planning Step #4, Add Depth Command #39e: Reference element 39e depicts the Add Depth Command which enables the operator to add the selections that were made in Reference elements depicted in 39b, 39c and 39d to the Sidetrack Data Display depicted in Reference element 39f; the operator continues to repeat Step #1, Step #2 and Step #3 depicted in Reference elements 39b, 39c and 39d until the desired well bore separation is achieved.

[0521] Sidetrack Planning Step #4, Get a Target Command #39f: Reference element 39f depicts the Get or Select a Target Command which enables the operator to select a target from the Targets Template depicted in FIG. 40 after the desired well bore separation is achieved.

[0522] Sidetrack Planning Step #4, Delete Last Entry Command #39g: Reference element 39g depicts the Delete Last Entry Command which enables the operator to delete the last entry if the operator recognizes that the proper well bore separation was not achieved.

[0523] Sidetrack Planning Step #4, Well Comparison Drop Box #39h: Reference element 39h depicts the Well Comparison Drop Box which enables the operator to select a well other than the automatically system defaulted well to compare the sidetrack against, the system will automatically compare the sidetrack against the original well bore.

[0524] Sidetrack Planning Step #4, Tvd/SS Separation Comparison #39i: Reference element 39i depicts the True Vertical Depth (Tvd) and/or Sub Sea (SS) Separation giving the operator the ability to make an informed decision as to whether or not the proper well bore separation is achieved in relation to True Vertical Depth (Tvd) and/or Sub Sea (SS) well bore separation.

[0525] Sidetrack Planning Step #4, Plan View Line Separation Comparison #39j: Reference element 39j depicts the Plan View Line Separation giving the operator the ability to make an informed decision as to whether or not the proper well bore separation is achieved in relation to the Plan View Line well bore separation.

[0526] Sidetrack Planning Step #4, Sidetrack Data Display #39k: Reference element 39k depicts the Sidetrack Data Display which enables the operator to view the sidetrack planning data as the sidetrack is being planned out.

[0527] Sidetrack Planning Step #4, OK Command #39l: Reference element 39l depicts the Sidetrack OK Command which enables the operator to move to the next sidetrack module after the sidetrack planning is complete.

[0528] Sidetrack Planning Step #5, Targets #40: FIG. 40 depicts Step #5 the Sidetrack Planning Module the Targets and Window Corridor Parameters.

[0529] Sidetrack Planning Step #5, Edit Target/Window Command #40a: Reference element 40a depicts the Edit Target/Window Command which enables the operator to initiate the target and or the window corridor parameter editing if necessary.

[0530] Sidetrack Planning Step #5, Edit Target Parameters #40b: Reference element 40b depicts the Edit Target Parameters selection that enables the operator to edit any or all of the target parameters if necessary.

[0531] Sidetrack Planning Step #5, Edit Window Corridor Parameters #40c: Reference element 40c depicts the Edit Window Corridor Parameters section that enables the operator to edit any or all of the window corridor parameters if necessary.

[0532] Sidetrack Planning Step #5, Re-Set Window Corridor Parameters Command #40d: Reference element 40d depicts the Re-Set Window Corridor Parameters Command which enables the operator to re-set all the window corridor parameters to the section default parameters if necessary.

[0533] Sidetrack Planning Step #5, Reasons for Edits #40e: Reference element 40e depicts the Reasons for Edits selections which enables the operator to select the reasons for any edits that may have been done to either the well bore coordinates or section corridor window parameters and records all data (original and new) and reasons for the edits in a viewable, but non-editable worksheet.

[0534] Sidetrack Planning Step #5, Edits by Who #40f: Reference element 40f depicts the Who Made or Ordered the edits selection that enables the operator to select who has
ordered either the well coordinates or section window corri-
dors parameters to be changed and records who was respon-
sible for the edits in a viewable, but non-editable worksheet.

[0535] Sidetrack Planning Step #5, Accept Command
#40i: Reference element 40i depicts the Add Target Com-
mand that enables the operator to add a completely new target
to the targets and windows module as a blank template with
the default selection window corridor parameters incorporated.

[0536] Sidetrack Planning Step #6, Data Display Layover
Screen #41: FIG. 41 depicts the Data Display Layover Screen
for the sidetrack planning module.

[0537] Sidetrack Planning Step #5, Add Target Command
#40i: Reference element 41a depicts the Add Target Com-
mand that enables the operator to add a completely new target
to the targets and windows module as a blank template with
the default selection window corridor parameters incorporated.

[0538] Sidetrack Planning Step #6, Check New Plot Com-
mand #41b: Reference element 41b depicts the Check New
Plot Command automatically appears on the program header
enabling the operator to access the Sidetrack Well Proximity
Plots depicted in FIG. 42 to visually verify that the sidetrack
planning and well coordinates and window corridor param-
eters were correctly planned.

[0539] Sidetrack Planning Step #7, Proximity Plots #42:
FIG. 42 depicts the Sidetrack Planning Proximity Plots mod-
ule which automatically appears when the operator activates
the check new plot command depicted in Reference element
41b; the sidetrack planning proximity plots are similar to the
proximity plots depicted in FIG. 8 with three additional com-
mands depicted in Reference element 42a.

[0540] Sidetrack Planning Step #7, Proximity Plots, Plot
Against Command #42a: Reference element 42a depicts the
Sidetrack Planning Proximity Plots, Plot Against Command
which enables the operator to select which wells he would
like to have the sidetrack plotted against for comparison pur-
poses.

[0541] Sidetrack Planning Step #7, Proximity Plots, Accept
Command #42b: Reference element 42b depicts the Sidetrack
Planning Proximity Plots Accept Command which enables
the operator to accept the sidetrack plan as depicted in
the sidetrack proximity plots.

[0542] Sidetrack Planning Step #7, Proximity Plots, Exit
Command #42c: Reference element 42c depicts the Sidetrack
Planning Proximity Plots Exit Command which enables
the operator to reject the sidetrack plan and automatically return
to Step #4 the Sidetrack Planning Module as depicted in FIG.
39 to re-begin the sidetrack planning process.

[0543] Active Well Plans List #43: FIG. 43 depicts the
Active Well Plans List Module that enables the operator to
verify and activate the correct drilled well and sidetrack plan.

[0544] Active Well Plans, Drilled Wells List #43a: Refer-
ence element 43a depicts the Drilled Wells List which enables
the operator to verify that the system has automatically acti-
vated the correct well that is currently being drilled.

[0545] Active Well Plans, Well Plans List #43b: Reference
element 43b depicts the Active Well Plans List; however see-
ning that the well plan was planned for a sidetrack the
system will automatically lock out the well plans selection
list.

[0546] Active Well Plans, Sidetrack Plans #43c: Reference
element 43c depicts the Sidetrack List which enables the
operator to verify that the system has automatically activated
the correct sidetrack plan that the system will calculate the
well bore corrections against.

[0547] Active Well Plans, Sidetrack Tie-In Depth #43d:
Reference element 43d depicts the Sidetrack Tie-In Depth
which enables the operator to cross check for the last time that
the correct sidetrack tie-in depth was used to tie-in the sidet-
track planning module.

[0548] Active Well Plans, Acceptance Code #43e: Refer-
ence element 43e depicts the Acceptance Code that has to be
entered in order for the system to accept and activate the new
sidetrack plan, the system will not enable the operator to
activate the new sidetrack plan without entering the active
acceptance code.

[0549] Active Well Plans, OK Command #43f: Reference
element 43f depicts the OK Command, when the operator
activates the OK Command the system will automatically
make the sidetrack plan active and record all changes in a
viewable, but non-editable worksheet and automatically
move back into the surveys module depicted in Reference
element 10b in the program header enabling the operator to
continue drilling the well bore.

[0550] Slide Data Sheet #44: FIG. 44 depicts the Viewable
but Non-Editable Data Sheet which acts as a data gathering
and quick reference template and expands automatically as
data is recorded.

[0551] Slide Data Sheet, Bha Number (ii) #44a: Reference
element 44a depicts the Bha Number (ii) which is recorded
from the program header entry depicted in Reference element
10b in the program header.

[0552] Slide Data Sheet, Survey Course Length #44b: Refer-
ence element 44b depicts the Survey Course Length which
is recorded from the program survey file depicted in Reference
element 10b in the program header.

[0553] Slide Data Sheet, Survey Hole Depth #44c: Refer-
ence element 44c depicts the Survey Hole Depth which is
recorded from the program survey file depicted in Reference
element 10b in the program header.

[0554] Slide Data Sheet, Sensor Bit to Sensor Measure-
ment #44d: Reference element 44d depicts the Survey Bit to
Sensor Measurement which is recorded from the program
header depicted in Reference element 10b in the program header.

[0555] Slide Data Sheet, Survey Depth #44e: Reference
element 44e depicts the Survey Depth which is recorded from
the program survey file depicted in Reference element 10b in
the program header.

[0556] Slide Data Sheet, Survey Inclination #44f: Refer-
ence element 44f depicts the Survey Inclination which is
recorded from the program survey file depicted in Reference
element 10aa in the program header.

[0557] Slide Data Sheet, Survey Azimuth #44g: Reference
element 44g depicts the Survey Azimuth which is recorded
from the program survey file depicted in Reference element
10bb in the program header.
[0560] Slide Data Sheet, Achieved Survey Dogleg #44h: Reference element 44h depicts the Achieved Survey Dogleg which is recorded from the program survey file depicted in Reference element 106k in the program header.

[0561] Slide Data Sheet, Slide Seen #44i: Reference element 44i depicts the Slide Seen which is calculated by subtracting the meters or feet of slide that is being seen between the previous and present survey points.

[0562] Slide Data Sheet, Planned Tool Face #44j: Reference element 44j depicts the Planned Tool Face which is recorded from the active well plan data.

[0563] Slide Data Sheet, Drilled Off Tool Face #44k: Reference element 44k depicts the Drilled Off Tool Face which is recorded from the survey file depicted in Reference element 101i in the program header.

[0564] Slide Data Sheet, Build Percentage (%) #44l: Reference element 44l depicts the Build Percentage (%) which is calculated by dividing the drilled off tool face by 90 then multiplying the answer by 100 for tool face drill offs 90 and above; for tool face drill offs below 90, 90 must be subtracted from the tool face drill off then divided by 90 and multiplied by 100.

[0565] Slide Data Sheet, Turn Percentage (%) #44m: Reference element 44m depicts the Turn Percentage (%) which is calculated by subtracting 100% from the Build Percentage depicted in Reference element 44l.

[0566] Slide Data Sheet, Slide Under #44n: Reference element 44n depicts the Slide Under or not seen in the current survey point which is calculated by subtracting the meters or feet that is below present survey point.

[0567] Slide Data Sheet, Tool Face Set #44o: Reference element 44o depicts the Tool Face Setting which the operator held the tool face setting at for the slide that is under which is picked up from the Drill Down Vertical, Build and Lateral Data Templates depicted in Reference elements 20n, 21r and 22s.

[0568] Slide Data Sheet, Rotate #44p: Reference element 44p depicts the Rotated meters or feet between the previous and present survey points and is calculated by subtracting the slide meters or feet depicted in Reference element 44i from the Course Length depicted in Reference element 44b.

[0569] Slide Data Sheet, Slide Factor #44q: Reference element 44q depicts the Slide Factor which is calculated by dividing the survey dogleg achieved depicted in Reference element 44b by the number of meters or feet seen depicted in Reference element 44i and is used to calculate the next slide needed by dividing this factor into the planned dogleg depicted in Reference element 46i.

[0570] Slide Data Sheet, Slid Running Total #44r: Reference element 44r depicts the Slid Running Total and is continually accumulated as slides are added to the slide seen depicted in Reference element 44i.

[0571] Slide Data Sheet, Rotated Running Total #44s: Reference element 44s depicts the Rotated Running Total and is continually accumulated as rotates are added as depicted in Reference element 44p.

[0572] Slide Data Sheet, Percentage (%) Slid Running Total #44t: Reference element 44t depicts the Percentage (%) Slid Running Total and is calculated by dividing the accumulated meters or feet slid in Reference element 44r by the accumulated course length depicted in Reference element 44b.

[0573] Slide Data Sheet, Percentage (%) Rotated Running Total #44u: Reference element 44u depicts the Percentage (%) Rotated Running Total and is calculated by dividing the accumulated meters or feet rotated depicted in Reference element 44p by the accumulated course length depicted in Reference element 44b.

[0574] Time Distribution & ROP #45: FIG. 45 depicts the Time Distribution and ROP Viewable but Non-Editable Data Sheet which acts as a data gathering and quick reference template and expands automatically as data is recorded.

[0575] Time Distribution & ROP: Bha Number (#) #45a: Reference element 45a depicts the Bha Number (#) which is recorded from the program header entry depicted in Reference element 100b in the program header.

[0576] Time Distribution & ROP, Metres or Feet Slid #45b: Reference element 45b depicts the Metres or Feet Slid initiated by the operator depicted in the Drill Down Vertical, Build and Lateral Data Templates depicted in Reference elements 20k, 20m, 21l, 21n, 21p, 22m, 22o, and 22q.

[0577] Time Distribution & ROP, Metres or Feet Rotated #45c: Reference element 45c depicts the Metres or Feet Rotated in the Course Length which is calculated by subtracting the meters or feet slid depicted in reference element 45b from the survey course length depicted in the survey file depicted in Reference element 100b in the program header.

[0578] Time Distribution & ROP, Slide Start Point #45d: Reference element 45d depicts the Slide Start Point initiated by the operator depicted in the Drill Down Vertical, Build, and Lateral Data Templates depicted in Reference elements 20g, 21s, and 22v.

[0579] Time Distribution & ROP, Slide End Point #45e: Reference element 45e depicts the Slide End Point which is calculated by adding the meters or feet slid depicted in Reference element 45b to the slide start point depicted in Reference element 45d.

[0580] Time Distribution & ROP, Orient Tool Face Start Time #45f: Reference element 45f depicts the Orient Tool Face Start Time which is recorded when the operator activates the Orient Command depicted in Reference element 23a in the Slide, Rotate Control.

[0581] Time Distribution & ROP, Orient Tool Face End Time #45g: Reference element 45g depicts the Orient Tool Face End Time which is recorded when the operator activates the Slide Command depicted in Reference element 23b in the Slide, Rotate Control.

[0582] Time Distribution & ROP, Orient Tool Face Total Time #45h: Reference element 45h depicts the Orient Tool Face Total Time which is automatically calculated by subtracting the start orient time depicted in Reference element 45f from the orient end time depicted in Reference element 45g.

[0583] Time Distribution & ROP, Slide Start Time #45i: Reference element 45i depicts the Slide Start Time which is recorded when the operator activates the Slide Command depicted in Reference element 23b in the Slide, Rotate Control.

[0584] Time Distribution & ROP, Slide End Time #45j: Reference element 45j depicts the Slide End Time which is recorded when the operator activates either the Rotate Command depicted in Reference element 23a, or the Lost Tool Face Command depicted in Reference element 23c, or the End Single Command depicted in Reference element 23e in the Slide, Rotate Control.

[0585] Time Distribution & ROP, Slide Total Time #45k: Reference element 45k depicts the Slide Total Time which is automatically calculated by subtracting the slide start time
depicted in Reference element 45\text{i} from the slide end time depicted in Reference element 45\text{j}.

[0586] Time Distribution & ROP, Lost Tool Face Start Time #45\text{l}: Reference element 45\text{i} depicts the Lost Tool Face Start Time which is recorded when the operator activates the Lost Tool Face Command depicted in Reference element 23\text{c} in the Slide, Rotate Control.

[0587] Time Distribution & ROP, Lost Tool Face End Time #45m: Reference element 45\text{m} depicts the Lost Tool Face End Time which is recorded when the operator activates either the Rotate Command depicted in Reference element 23\text{d}, or the Slide Command depicted in Reference element 23\text{b}, or the End Single Command depicted in Reference element 23\text{c} in the Slide, Rotate Control.

[0588] Time Distribution & ROP, Lost Tool Face Total Time #45n: Reference element 45\text{n} depicts the Lost Tool Face Total Time which is automatically calculated by subtracting the lost tool face start time depicted in Reference element 45\text{i} from the lost tool face end time depicted in Reference element 45\text{m}.

[0589] Time Distribution & ROP, Lost Tool Face Number of Times #45o: Reference element 45\text{o} depicts the Lost Tool Face Number of Times which is automatically recorded every time the Lost Tool Face Command is activated depicted in Reference element 23\text{c}.

[0590] Time Distribution & ROP, Rotate Start Time #45p: Reference element 45\text{p} depicts the Rotate Start Time which is recorded when the operator activates the Rotate Command depicted in Reference element 23\text{d} in the Slide, Rotate Control.

[0591] Time Distribution & ROP, Rotate End Time #45q: Reference element 45\text{q} depicts the Rotate End Time which is recorded when the operator activates either the Orient Command depicted in Reference element 23\text{a}, or the Slide Command depicted in Reference element 23\text{b}, or the End Single Command depicted in Reference element 23\text{c} in the Slide, Rotate Control.

[0592] Time Distribution & ROP, Rotate Total Time #45r: Reference element 45\text{r} depicts the Rotate Total Time which is automatically calculated by subtracting the rotate start time depicted in Reference element 45\text{p} from the rotate end time depicted in Reference element 45\text{q}.

[0593] Time Distribution & ROP, End Single Time #45s: Reference element 45\text{s} depicts the End Single Time which is recorded when the operator activates the End Single Command depicted in Reference element 23\text{c} in the Slide, Rotate Control.

[0594] Time Distribution & ROP, Single Total Time #45t: Reference element 45\text{t} depicts the Single Total Time which is automatically calculated by subtracting the end single time depicted in Reference element 45\text{s} from the single start time either recorded when the operator activates the End Single Command which is depicted in Reference element 23\text{a}, or the Slide Command depicted in Reference element 23\text{b}, or the rotate single command depicted in Reference element 23\text{d} in the Slide, Rotate Control.

[0595] Time Distribution & ROP, Average Connection Start Time #45u: Reference element 45\text{u} depicts the Average Connection Start Time which is automatically recorded when the operator activates the End Single Command which is depicted in Reference element 23\text{c} in the Slide, Rotate Control.

[0596] Time Distribution & ROP, Average Connection End Time #45v: Reference element 45\text{v} depicts the Average Connection End Time which is automatically recorded when the operator activates either the orient command depicted in Reference element 23\text{a}, or the slide command depicted in Reference element 23\text{b}, or the rotate single command depicted in Reference element 23\text{d} in the Slide, Rotate Control.

[0597] Time Distribution & ROP, Average Connection Total Time #45w: Reference element 45\text{w} depicts the Average Connection Total Time which is automatically calculated by subtracting the average connection start time depicted in Reference element 45\text{u} from the average connection end time depicted in Reference element 45\text{v}.

[0598] Time Distribution & ROP, Slide ROP #45x: Reference element 45\text{x} depicts the Slide ROP that is calculated by dividing the meters or feet slid depicted in Reference element 45\text{b} by the total slide time depicted in reference element 45\text{b}.

[0599] Time Distribution & ROP, Rotate ROP #45y: Reference element 45\text{y} depicts the Rotate ROP that is calculated by dividing the meters or feet rotated depicted in Reference element 45\text{e} by the total rotate time depicted in reference element 45\text{r}.

[0600] Time Distribution & ROP, Slide vs. Rotate Comparison Percentage (%) #45z: Reference element 45\text{z} depicts the Slide vs. Rotate Comparison Percentage (%) which is calculated by dividing the Slide ROP depicted in Reference element 45\text{x} by the Rotate ROP depicted in reference element 45\text{y} and displayed on the program header depicted in Reference element 10\text{z}.

[0601] Time Distribution & ROP, System Date #45a: Reference element 45\text{a} depicts the System Date which is automatically recorded at 00:00 hours (24 clock) every day the system is operating.

[0602] Time Distribution & ROP, Who Initiated #45b: Reference element 45\text{b} depicts the Who Initiated any and all of the recorded data in the Time Distribution, ROP Viewable, but Non Editable Data Sheet by means of coded and assigned work stations.

[0603] Motor/Bha Output #46: FIG. 46 depicts the Motor/Bha Output Viewable but Non-Editable Motor/Bha Data Sheet which acts as a data gathering and quick reference template and expands automatically as data is recorded.

[0604] In some cases the motor output efficiency may also be monitored by windows. Thus, throughout a build section 30 of the directional drilling operation, the plurality of characteristics measured may include one or more of an achieved dog leg or build rate of mud motor 17. Computing units 34 may then determine if a breach has occurred as indicated by a deviation, beyond a predetermined window, of one or both of the achieved dog leg or build rate from a respective expected dog leg or build rate of the mud motor. Motor output efficiency or percentage is a useful characteristic to monitor because it is often the first indication of a problem that could eventually lead to a sizable absolute distance deviation from the well bore plan path. The Motor/Bha Output percentage (%) is used to identify if the down hole assembly is achieving above or below the motor settings theoretical dogleg output. If the motor/bha output percentage is lower than 100% this means that the formation or the manner in which the slides are being carried out is not enabling the motor or Bha to achieve its theoretical potential and will put the well bore in jeopardy if nothing is changed. The bottom hole assembly may even have to be pulled out of the hole to change out the type of bit of dial up the motor (increase the motor angle setting). If the motor/bha output is higher than 100% of the theoretical motor or Bha output this means the operator can cut back on the
meters or feet that are being slid to achieve the well bore corrections that are needed as to not over steer the well. The motor/bha output percentage is actually the first warning signal that something is not going to plan and major problems will follow if things continue as they are. After motor output efficiency, inclination, azimuth, TVD and then line rank in order from most sensitive to least sensitive indicators of problems with the drilling.

Motor/Bha Output, Bha Number (®) #46a: Reference element 46a depicts the Bha Number (®) which is recorded from the program header entry depicted in Reference element 10b in the program header, Bha ®.

Motor/Bha Output, Motor Setting #46b: Reference element 46b depicts the Motor Setting which is recorded from the program header entry depicted in Reference element 10b in the program header, Motor Setting.

Motor/Bha Output, Theoretical Motor Dogleg #46c: Reference element 46c depicts the Theoretical Motor Dogleg which is recorded from the program header entry depicted in Reference element 10b in the program header, Motor Dogleg.

Motor/Bha Output, Survey Hole Depth #46d: Reference element 46d depicts the Survey Hole Depth which is recorded from the program survey file depicted in Reference element 10b in the program header.

Motor/Bha Output, Survey Depth #46e: Reference element 46e depicts the Survey Depth which is recorded from the program survey file depicted in Reference element 10b in the program header.

Motor/Bha Output, Survey Inclination #46f: Reference element 46f depicts the Survey Inclination which is recorded from the program survey file depicted in Reference element 100ao in the program header.

Motor/Bha Output, Survey Azimuth #46g: Reference element 46g depicts the Survey Azimuth which is recorded from the program survey file depicted in Reference element 100bb in the program header.

Motor/Bha Output, Achieved Survey Dogleg #46h: Reference element 46h depicts the Achieved Survey Dogleg which is recorded from the program survey file depicted in Reference element 10k6a in the program header.

Motor/Bha Output, Planned Dogleg #46i: Reference element 46i depicts the Planned Dogleg that is recorded from the active well plan depicted in Reference element 10oo in the program header.

Motor/Bha Output, Slide Seen #46j: Reference element 46j depicts the Slide Seen which is calculated by quar- rying the meters or feet of slide that is being seen between the previous and present survey points.

Motor/Bha Output, Survey Course Length #46k: Reference element 46k depicts the Survey Course Length which is recorded from the program survey file depicted in Reference element 10kbb in the program header.

Motor/Bha Output, Motor Output Percentage (%) #46l: Reference element 46l depicts the Motor Output Percentage (%) which is calculated as follows: Motor/Bha Output %=((Course Length/Meters Seen)÷Achieved Dogleg)/Motor Expected Dogleg)×100. Thus, by dividing the course length depicted in Reference element 46k by the meters seen (slid) depicted in Reference element 46l multiplied by the achieved dogleg depicted in Reference element 46l divided by the theoretical motor dogleg depicted in Reference element 46c multiplied by 100, then displayed on the program header survey file depicted in Reference element 10mm:

Target and Window Edits #47: FIG. 47 depicts the Target and Window Edits Viewable but Non-Editable Data Sheet which acts as a data gathering and quick reference template and expands automatically as data is recorded.

Target and Window Edits, Bha Number (®) #47a: Reference element 47a depicts the Bha Number (®) which is recorded from the program header entry depicted in Reference element 10b in the program header.

Target and Window Edits, Survey Hole Depth #47b: Reference element 47b depicts the Survey Hole Depth which is recorded from the program survey file depicted in Reference element 10b in the program header.

Target and Window Edits, Survey Depth #47c: Reference element 47c depicts the Survey Depth which is recorded from the program survey file depicted in Reference element 10c in the program header.

Target and Window Edits, Survey Inclination #47d: Reference element 47d depicts the Survey Inclination which is recorded from the program survey file depicted in Reference element 10ao in the program header.

Target and Window Edits, Survey Azimuth #47e: Reference element 47e depicts the Survey Azimuth which is recorded from the program survey file depicted in Reference element 10bb in the program header.

Target and Window Edits, True Vertical Depth (Tvd) #47f: Reference element 47f depicts the Survey True Vertical Depth (Tvd) which is recorded from the program survey file depicted in Reference element 100c in the program header.

Target and Window Edits, Active Target Number (®) #47g: Reference element 47g depicts the Active Target which is recorded from the program header depicted in Reference element 10v in the program header.

Target and Window Edits, Active Target Acceptance #47h: Reference element 47h depicts the Active Target Acceptance, if other than the program default target is activated then an acceptance name will appear next to the target number depicting who activated and accepted the target.

Target and Window Edits, Original Target Number (®) #47i: Reference element 47i depicts the original target number that is being edited and is recorded from the target screen depicted in Reference element 8bo as soon as the edit target command is activated depicted in Reference element 8o.

Target and Window Edits, Edited Target Number (®) #47j: Reference element 47j depicts the renumbered edits after they are completed and the active acceptance code is entered.

Target and Window Edits, Original Target Depth #47k: Reference element 47k depicts the Original Target Depth depicted in Reference element 8bst that is being edited and is recorded from the target screen as soon as the edit target/window command depicted in Reference element 8o is activated.

Target and Window Edits, Edited Target Depth #47l: Reference element 47l depicts the Edited Target Depth after the edits are completed and are accepted when the active acceptance code is entered depicted in Reference element 8j.

Target and Window Edits, Original Target Inclination #47m: Reference element 47m depicts the Original Target Inclination depicted in Reference element 8bs that is being edited and is recorded from the target screen as soon as the edit target/window command depicted in Reference element 8o is activated.
Target and Window Edits, Edited Target Inclination #47n: Reference element 47n depicts the Edited Target Inclination after the edits are completed and are accepted when the active acceptance code is entered depicted in Reference element 8i.

Target and Window Edits, Original Target Azimuth #47o: Reference element 47o depicts the Original Target Azimuth depicted in Reference element 8i that is being edited and is recorded from the target screen as soon as the edit target/window command depicted in Reference element 8o is activated.

Target and Window Edits, Edited Target Azimuth after the edits are completed and are accepted when the active acceptance code is entered depicted in Reference element 8j.

Target and Window Edits, Original Target True Vertical Depth (Tvd) #47q: Reference element 47q depicts the Original Target True Vertical Depth (Tvd) depicted in Reference element 8b that is being edited and is recorded from the target screen as soon as the edit target/window command depicted in Reference element 8o is activated.

Target and Window Edits, Edited True Vertical Depth (Tvd) #47r: Reference element 47r depicts the Edited Target True Vertical Depth (Tvd) after the edits are completed and are accepted when the active acceptance code is entered depicted in Reference element 8j.

Target and Window Edits, Reasons for Edits #47s: Reference element 47s depicts the Reasons for Edits and is recorded from the target screen as soon as the reason for edits commands depicted in Reference element 8s are activated in the target screen.

Target and Window Edits, Edits by Who #47t: Reference element 47t depicts the Edits by Who and is recorded from the target screen as soon as the edits by who commands depicted in Reference element 8t are activated in the target screen.

Target and Window Edits, Added Comments #47u: Reference element 47u depicts the Added Comments that are entered in the comments section up to 50 characters depicted in Reference element 8g relating to who or why the edits to the selected target were made.

Target and Window Edits, Acceptance Code #47v: Reference element 47v depicts the name that corresponds to the Acceptance Code that is entered to accept the new target parameter edits.

Target and Window Edits, Section #47w: Reference element 47w depicts the Section of the well that the parameters were changed from automatic to manual closing of the window corridor parameters when the command is activated in Reference element 8i.

Target and Window Edits, Automatic Close Window Corridor Parameters #47x: Reference element 47x depicts the hole depth that the Automatic Close Window Corridor Parameter command was activated depicted in Reference element 8i; the system default is to automatically close the window corridor parameters and 0.00 will automatically be entered and recorded as the hole depth if no command is activated.

Target and Window Edits, Manual Window Corridor Parameters Hole Depth #47y: Reference element 47y depicts the Manual Window Corridor Parameter Hole Depth that the Manual Close Window Corridor Parameter command was activated at depicted in Reference element 8i.

Target and Window Edits, Acceptance Code #47z: Reference element 47z depicts the name that corresponds to the Acceptance Code that is entered to accept the change in the window corridor parameters.

Target and Window Edits, Window Section #47aa: Reference element 47aa depicts the Well Bore Section that is being drilled and is recorded as soon as the command is activated depicted in Reference element 101 in the program header.

Target and Window Edits, Window Section after the Edits are completed and the active acceptance code is entered depicted in Reference element 8i; the new window parameters become the original windows if the section windows are edited for a second or third time, etc.

Target and Window Edits, Vertical Section Parameters #47cc: Reference element 47cc depicts the Vertical Section Parameters before and after any edits are made to the Vertical Section ahead or behind scaling during the Vertical, Drill Down Section of the well bore, the new vertical section parameters become the original windows if the section windows are edited for a second or third time, etc.

Target and Window Edits, Original True Vertical (Tvd) Depth Window Corridor Parameters #47dd: Reference element 47dd depicts the Build Section or Lateral Section Original True Vertical Depth Window Corridor Parameters that are selected to be edited.

Target and Window Edits, Edited True Vertical (Tvd) Depth Window Corridor Parameters #47ee: Reference element 47ee depicts the Build Section or Lateral Section Edited True Vertical Depth Window Corridor Parameters.

Target and Window Edits, Original Inclination Window Corridor Parameters #47ff: Reference element 47ff depicts the Drill Down Vertical, Build Section or Lateral Section Original Inclination Window Corridor Parameters that are selected to be edited.

Target and Window Edits, Edited Inclination Window Corridor Parameters #47gg: Reference element 47gg depicts the Drill Down Vertical, Build Section or Lateral Section Edited Inclination Window Corridor Parameters.

Target and Window Edits, Original Plan View Line Window Corridor Parameters #47hh: Reference element 47hh depicts the Drill Down Vertical, Build Section or Lateral Section Original Plan View Line Window Corridor Parameters that are selected to be edited.

Target and Window Edits, Edited Plan View Line Window Corridor Parameters #47ii: Reference element 47ii depicts the Drill Down Vertical, Build Section or Lateral Section Edited Plan View Line Window Corridor Parameters.

Target and Window Edits, Original Azimuth Window Corridor Parameters #47jj: Reference element 47jj depicts the Build Section or Lateral Section Original Azimuth Window Corridor Parameters that are selected to be edited.

Target and Window Edits, Edited Azimuth Window Corridor Parameters #47kk: Reference element 47kk depicts the Build Section or Lateral Section Edited Azimuth Window Corridor Parameters.

Target and Window Edits, Original Motor Output Percentage (%) Window Corridor Parameters #47ll: Reference element 47ll depicts the Build Section or Lateral Section Original Motor Output Percentage (%) Window Corridor Parameters that is selected to be edited.

Target and Window Edits, Edited Motor Output Percentage (%) Window Corridor Parameters #47mm: Refer-
ence element 47mm depicts the Build Section or Lateral Section Edited Motor Output Percentage (%) Window Corridor Parameters.

[0657] Target and Window Edits, Reasons for Edits #47mm: Reference element 47mm depicts the Reasons for Edits and is recorded from the target screen as soon as the reason for edits commands depicted in Reference element 8e are activated in the target screen.

[0658] Target and Window Edits, Edits by Who #47mm: Reference element 47mm depicts the Edits by Who and is recorded from the target screen as soon as the edits by who commands depicted in Reference element 8f are activated in the target screen.

[0659] Target and Window Edits, Added Comments #47mm: Reference element 47mm depicts the Added Comments that are entered in the comments section up to 50 characters depicted in Reference element 8g relating to who or why the edits to the selected target were made.

[0660] Target and Window Edits, Acceptance Code #47mm: Reference element 47mm depicts the name that corresponds to the Acceptance Code that is entered to accept the new target parameter edits.

[0661] Ahead, Behind, Left, Right #48: FIG. 48 depicts the Ahead, Behind, Left, Right Viewable but Non-Editable Motor/Bha Data Sheet which acts as a data gathering and quick reference template and expands automatically as data is recorded.

[0662] Ahead, Behind, Left, Right, Bha Number (##) #48: Reference element 48a depicts the Bha Number (##) which is recorded from the program header entry depicted in Reference element 10a in the program header.

[0663] Ahead, Behind, Left, Right, Well Bore Section #48b: Reference element 48b depicts the Well Bore Section that is being drilled and is recorded as soon as the command is activated depicted in Reference element 10l in the program header.

[0664] Ahead, Behind, Left, Right, Survey Depth #48c: Reference element 48c depicts the Survey Depth which is recorded from the program survey file depicted in Reference element 10b in the program header.

[0665] Ahead, Behind, Left, Right, Survey Inclination #48d: Reference element 48d depicts the Survey Inclination which is recorded from the program survey file depicted in Reference element 10a in the program header.

[0666] Ahead, Behind, Left, Right, Survey Azimuth #48e: Reference element 48e depicts the Survey Azimuth which is recorded from the program survey file depicted in Reference element 10b in the program header.

[0667] Ahead, Behind, Left, Right, True Vertical Depth (Tvd) #48f: Reference element 48f depicts the Survey True Vertical Depth (Tvd) which is recorded from the program survey file depicted in Reference element 10c in the program header.

[0668] Ahead, Behind, Left, Right, Interpolated Active Well Plan Survey Inclination #48g: Reference element 48g depicts the Interpolated Active Well Plan Survey Inclination that is being compared to the actual survey inclination at a particular given point in the well.

[0669] Ahead, Behind, Left, Right, Interpolated Active Well Plan Survey Azimuth #48h: Reference element 48h depicts the Interpolated Active Well Plan Survey Azimuth compared to the actual survey azimuth at a particular given point in the well.

[0670] Ahead, Behind, Left, Right, Interpolated Active Well Plan Survey True Vertical Depth (Tvd) #48i: Reference element 48i depicts the Interpolated Active Well Plan Survey True Vertical Depth (Tvd) being compared to the actual survey true vertical depth (Tvd) at a particular given point in the well.

[0671] Ahead, Behind, Left, Right, Inclination (Inc.) Ahead, Behind (+/-) #48j: Reference element 48j depicts the difference between the actual survey inclination and the interpolated active well plan inclination, a positive (+) number means ahead and a negative (-) number means behind.

[0672] Ahead, Behind, Left, Right, Azimuth (Azi) Ahead, Behind (+/-) #48k: Reference element 48k depicts the difference between the actual survey azimuth and the interpolated active well plan azimuth, a positive (+) number means ahead and a negative (-) number means behind.

[0673] Ahead, Behind, Left, Right, True Vertical Depth (Tvd) Ahead, Behind (+/-) #48l: Reference element 48l depicts the difference between the actual survey true vertical depth (Tvd) and the interpolated active well plan true vertical depth (Tvd), a positive (+) number means ahead and a negative (-) number means behind.

[0674] Ahead, Behind, Left, Right, Vertical Section Drill Down (m/ft) Ahead, Behind (+/-) #48m: Reference element 48m depicts the difference between the actual survey vertical section and the interpolated active well plan vertical section in meters or feet, a positive (+) number means ahead and a negative (-) number means behind.

[0675] Ahead, Behind, Left, Right, Vertical Section Drill Down (m/ft) Right, Left Plan View Line (+/-) #48n: Reference element 48n depicts the difference between the actual survey vertical section drill down plan view line and the interpolated active well plan vertical section drill down plan view line in meters or feet, a positive (+) number means right and a negative (-) number left.

[0676] Ahead, Behind, Left, Right, Build Section (m/ft) Above, Below (+/-) #48o: Reference element 48o depicts the difference between the actual survey build section true vertical depth (Tvd) and the interpolated active well plan build section true vertical depth (Tvd) in meters or feet, a positive (+) number means above and a negative (-) number means below.

[0677] Ahead, Behind, Left, Right, Build Section (m/ft) Right, Left Plan View Line (+/-) #48p: Reference element 48p depicts the difference between the actual survey build section plan view line and the interpolated active well plan build section plan view line in meters or feet, a positive (+) number means right and a negative (-) number left.

[0678] Ahead, Behind, Left, Right, Lateral Section (m/ft) Above, Below (+/-) #48q: Reference element 48q depicts the difference between the actual survey lateral section true vertical depth (Tvd) and the interpolated active well plan lateral section true vertical depth (Tvd) in meters or feet, a positive (+) number means above and a negative (-) number means below.

[0679] Ahead, Behind, Left, Right, Lateral Section (m/ft) Right, Left Plan View Line (+/-) #48r: Reference element 48r depicts the difference between the actual survey lateral section plan view line and the interpolated active well plan lateral section plan view line in meters or feet, a positive (+) number means right and a negative (-) number left.

[0680] Ahead, Behind, Left, Right, Percentage Scaling Ahead/Right True Vertical Depth (Tvd) #48s: Reference element 48s depicts the Tvd Ahead Percentage Scaling which is
calculated by dividing the actual survey Tvd ahead by the target Tvd ahead and is displayed in the Program Header Column #10u.

[0681] Ahead, Behind, Left, Right, Percentage Scaling Ahead/Right Inclination #48t: Reference element 48r depicts the Inclination Ahead Percentage Scaling which is calculated by dividing the actual survey inclination ahead by the target inclination ahead and is displayed in the Program Header Column #10u.

[0682] Ahead, Behind, Left, Right, Percentage Scaling Ahead/Right Line #48u: Reference element 48a depicts the Line Right Percentage Scaling which is calculated by dividing the actual survey line right by the target line right and is displayed in the Program Header Column #10u.

[0683] Ahead, Behind, Left, Right, Percentage Scaling Ahead/Right Azimuth #48v: Reference element 48v depicts the Azimuth Ahead Percentage Scaling which is calculated by dividing the actual survey azimuth ahead by the target azimuth ahead and is displayed in the Program Header Column #10u.

[0684] Ahead, Behind, Left, Right, Percentage Scaling Ahead/Right Vertical Section (VS) #48w: Reference element 48w depicts the Vertical Section (VS) Ahead Percentage Scaling which is calculated by dividing the actual survey vertical section ahead by the target vertical section ahead and is displayed in the Program Header Column #10u.

[0685] Ahead, Behind, Left, Right, Percentage Scaling Behind/Left True Vertical Depth (Tvd) #48x: Reference element 48x depicts the True Vertical Depth (Tvd) Behind Percentage Scaling which is calculated by dividing the actual survey true vertical depth behind by the target true vertical depth behind and is displayed in the Program Header Column #10u.

[0686] Ahead, Behind, Left, Right, Percentage Scaling Behind/Left Inclination #48y: Reference element 48y depicts the Inclination Behind Percentage Scaling which is calculated by dividing the actual survey inclination behind by the target inclination behind and is displayed in the Program Header Column #10u.

[0687] Ahead, Behind, Left, Right, Percentage Scaling Behind/Left Line #48z: Reference element 48z depicts the Plan View Line Left Percentage Scaling which is calculated by dividing the actual survey plan view line left by the target plan view line left and is displayed in the Program Header Column #10u.

[0688] Ahead, Behind, Left, Right, Percentage Scaling Behind/Left Azimuth #48aa: Reference element 48aa depicts the Azimuth Behind Percentage Scaling which is calculated by dividing the actual survey azimuth behind by the target azimuth behind and is displayed in the Program Header Column #10u.

[0689] Ahead, Behind, Left, Right, Percentage Scaling Behind/Left Vertical Section (VS) #48bb: Reference element 48bb depicts the Vertical Section (VS) Behind Percentage Scaling which is calculated by dividing the actual survey vertical section behind by the target vertical section behind and is displayed in the Program Header Column #10u.

[0690] Ahead, Behind, Left, Right, Actual Survey Point North/-South (N-S) Coordinate #48cc: Reference element 48cc depicts the Actual Survey Point North/-South (N-S) Coordinate and is automatically picked up from the survey file and is used to plot the Proximity Plot North/-South Coordinates as depicted in Reference element 16i.

[0691] Ahead, Behind, Left, Right, Actual Survey Point East/-West (E-W) Coordinate #48dd: Reference element 48dd depicts the Actual Survey Point East/-West (E-W) Coordinate and is automatically picked up from the survey file and is used to plot the Proximity Plot East/-West Coordinates as depicted in Reference element 16i.

[0692] Ahead, Behind, Left, Right, Interpolated Active Well Plan Survey North/-South (N-S) Coordinate #48ee: Reference element 48ee depicts the Interpolated Active Well Plan Survey North/-South Coordinate which enables the operator to view a quick reference for comparison against the actual survey North/-South Coordinates.

[0693] Ahead, Behind, Left, Right, Interpolated Active Well Plan Survey East/-West (E-W) Coordinate #48ff: Reference element 48ff depicts the Interpolated Active Well Plan Survey East/-West Coordinate which enables the operator to view a quick reference for comparison against the actual survey East/-West Coordinates.

[0694] Motor Sizes & Settings #49: FIGS. 49A-49N depict the Motor Sizes, Motor Setting and Hole Sizes Template which is a listing of the most common motor sizes, motor settings and hole sizes that are used in the field and is available to the operator through a drop box menu when the operator is setting up the Bha Information relating to the hole size, motor size, setting, theoretical dogleg, and motor stabilizer depicted in FIG. 9 Bha Information.


[0696] Motor Sizes & Settings, Motor Sizes in Millimeters #49b: Reference element 49b depicts the Motor Sizes in Millimeters encompassing motor sizes including 73 mm, 79 mm, 86 mm, 89 mm, 95 mm, 121 mm, 127 mm, 159 mm, 165 mm, 171 mm, 197 mm, 203 mm, 244 mm, and 286 mm.

[0697] Motor Sizes & Settings, Motor Bend Setting #49c: Reference element 49c depicts the Motor Bend Setting that is available for each motor size that is listed in Reference elements 49a and 49b.

[0698] Motor Sizes & Settings, Hole Size in Inches #49d: Reference element 49d depicts the Hole Size that can be drilled in inches based on the motor size for each individual motor size that is listed in Reference elements 49a and 49b.

[0699] Motor Sizes & Settings, Hole Size in Millimeters #49e: Reference element 49e depicts the Hole Size that can be drilled in millimeters based on the motor size for each individual motor size that is listed in Reference elements 49a and 49b.

[0700] Motor Sizes & Settings, Theoretical Dogleg Slick Motor #49f: Reference element 49f depicts the Theoretical Dogleg for Slick or Non-Stabilized Motor in accordance to the hole size in inches or millimeters that is being drilled.

[0701] Motor Sizes & Settings, Theoretical Dogleg Single Stabilizer Motor #49g: Reference element 49g depicts the Theoretical Dogleg for a Motor with a single stabilizer in accordance to the hole size in inches or millimeters that is being drilled.

[0702] Motor Sizes & Settings, Theoretical Dogleg Two Stabilizer Motor #49h: Reference element 49h depicts the Theoretical Dogleg for a Motor with two stabilizers in accordance to the hole size in inches or millimeters that is being drilled.

[0703] Bha Data Sheet #50: FIG. 50 depicts the Bha Data Sheet a Viewable but Non-Editable Bha Data Sheet which
acts as a data gathering and quick reference template and expands automatically as data is recorded.

[0704] Bha Data Sheet, Bha Number (##) #50c: Reference element 50c depicts the Bha Number (##) which is recorded from the program header entry depicted in Reference element 10b in the program header.

[0705] Bha Data Sheet, Bha Depth In #50b: Reference element 50b depicts the Bha Depth In which records the depth the Bha was run in the hole as depicted in Reference element 9a.

[0706] Bha Data Sheet, Bha Depth Out #50c: Reference element 50c depicts the Bha Depth Out which is picked up from the Bha Depth In as soon as the operator enters a new Bha Depth In for the next Bha in session.

[0707] Bha Data Sheet, Hole Size #50d: Reference element 50d depicts the Hole Size of the well bore being drilled as depicted in Reference element 9f.

[0708] Bha Data Sheet, Bha Date In #50e: Reference element 50e depicts the Bha Data in which is automatically recorded based on the system date as soon as the operator enters the Bha in the Bha Information as depicted in FIG. 9.

[0709] Bha Data Sheet, Bha Data Out #50f: Reference element 50f depicts the Bha Date Out which is picked up from the Bha Date In as soon as the system enters a new Bha Date In for the next Bha in session.

[0710] Bha Data Sheet, Bit Manufacture #50g: Reference element 50g depicts the Bit Manufacture as depicted in Reference element 9e.

[0711] Bha Data Sheet, Bit Type (PDC, Tri-Cone) #50h: Reference element 50h depicts the Bit Type (PDC, Tri-Cone) as depicted in Reference element 9d.

[0712] Bha Data Sheet, Bit Type (Bit Code) #50i: Reference element 50i depicts the Bit Type (Bit Code) as depicted in Reference element 9c.

[0713] Bha Data Sheet, Motor Size #50j: Reference element 50j depicts the Motor Size as depicted in Reference element 9g.

[0714] Bha Data Sheet, Motor Setting #50k: Reference element 50k depicts the Motor Setting as depicted in Reference element 9i.

[0715] Bha Data Sheet, Motor Dogleg #50l: Reference element 50l depicts the Motor Dogleg as depicted in Reference element 9j.

[0716] Bha Data Sheet, Motor Stabilizer Run #50m: Reference element 50m depicts if a Motor Stabilizer is run as depicted in Reference element 9b.

[0717] Bha Data Sheet, Motor Stabilizer Size #50n: Reference element 50n depicts the Motor Stabilizer Size as depicted in Reference element 9k.

[0718] Bha Data Sheet, Bit to Sensor #50o: Reference element 50o depicts the Bit to Sensor Measurement as depicted in Reference element 9n.

[0719] Bha Data Sheet, Bit to Gasma #50p: Reference element 50p depicts the Bit to Gasma Measurement as depicted in Reference element 9l.

[0720] KOP, ICP, TD, Lateral Leg (##) #51: FIG. 51 depicts the KOP, ICP, TD, Lateral Leg (##) Verification Screen that automatically appears in session after the Tie-In Screen FIG. 6 as soon as the system is activated and is automatically going through the start up well verification screens.

[0721] KOP, ICP, TD, Lateral Leg (##), Well Kick Off Point (KOP) #51a: Reference element 51a depicts the Well Kick Off Point (KOP) which enables the operator to verify, enter or edit the well kick off point to ensure that the correct well kick off point is being used to drill the well bore.

[0722] KOP, ICP, TD, Lateral Leg (##), Well Intermediate Casing Point (ICP) #51b: Reference element 51b depicts the Well Intermediate Casing Point (ICP) which enables the operator to verify, enter or edit the well intermediate casing point to ensure that the correct well intermediate casing point is being used to drill the well bore.

[0723] KOP, ICP, TD, Lateral Leg (##), Well Total Depth (TD) #51c: Reference element 51c depicts the Well Total Depth (TD) which enables the operator to verify, enter or edit the well total depth to ensure that the correct well total depth is being used to drill the well bore.

[0724] KOP, ICP, TD, Lateral Leg (##), Lateral Leg Number (##) #51d: Reference element 51d depicts the Lateral Leg Number (##) that is being drilled enabling the operator to verify, enter or edit the well lateral leg number (##) to ensure that the correct well lateral leg number is being used to drill the well bore.

[0725] KOP, ICP, TD, Lateral Leg (##), OK Command #51e: Reference element 51e depicts the OK Command which enables the operator to move to the next start up verification screen as soon as it is activated.

[0726] Extrapolate Ahead #52: FIG. 52 depicts the Extrapolate Ahead Screen enabling the operator to extrapolate ahead to estimate what actions will need to keep the well bore on the pre-determined well bore trajectory.

[0727] Extrapolate Ahead, Hole Depth #52a: Reference element 52a depicts the Well Bore Bottom Hole Depth as a starting point for the extrapolation; as soon as the operator activates the Extrapolate Ahead Command depicted in Reference element 10w the extrapolation screen automatically picks up the bottom hole depth from the survey file.

[0728] Extrapolate Ahead, Added (m/ft) #52b: Reference element 52b depicts the Added (m/ft) meters or feet which enables the operator to manually enter a measurement to the hole depth for the extrapolation.

[0729] Extrapolate Ahead, Total Extrapolated Depth #52c: Reference element 52c depicts the Total Extrapolated Depth that the extrapolation will be done for; the total extrapolated depth is calculated by adding the added measurement the operator entered in Reference element 52a to the bottom hole depth depicted in Reference element 52a.

[0730] Extrapolate Ahead, Inclination #52d: Reference element 52d depicts the Well Bore Bottom Hole Depth Inclination that is acts as a starting point for the extrapolation; as soon as the operator activates the Extrapolate Ahead Command depicted in Reference element 10w the extrapolation screen automatically picks up the bottom hole depth inclination form the survey file.

[0731] Extrapolate Ahead, Azimuth #52e: Reference element 52e depicts the Well Bore Bottom Hole Depth Azimuth that is acts as a starting point for the extrapolation; as soon as the operator activates the Extrapolate Ahead Command depicted in Reference element 10w the extrapolation screen automatically picks up the bottom hole depth true vertical depth form the survey file.

[0732] Extrapolate Ahead, True Vertical Depth #52f: Reference element 52f depicts the Well Bore Bottom Hole Depth True Vertical Depth that is acts as a starting point for the extrapolation; as soon as the operator activates the Extrapolate Ahead Command depicted in Reference element 10w the extrapolation screen automatically picks up the bottom hole depth true vertical depth form the survey file.
Extrapolate Ahead, Sub Sea Depth #52g: Reference element 52g depicts the Well Bore Bottom Hole Depth Sub Sea Depth that is acts as a starting point for the extrapolation; as soon as the operator activates the Extrapolate Ahead Command depicted in Reference element 10v, the extrapolation screen automatically picks up the bottom hole depth sub sea depth form the survey file.

Extrapolate Ahead, North/-South Coordinate #52h: Reference element 52h depicts the Well Bore Bottom Hole Depth North/-South Coordinate that is acts as a starting point for the extrapolation; as soon as the operator activates the Extrapolate Ahead Command depicted in Reference element 10v, the extrapolation screen automatically picks up the bottom hole depth north/-south coordinate form the survey file.

Extrapolate Ahead, East/-West Coordinate #52i: Reference element 52i depicts the Well Bore Bottom Hole Depth East/-West Coordinate that is acts as a starting point for the extrapolation; as soon as the operator activates the Extrapolate Ahead Command depicted in Reference element 10v, the extrapolation screen automatically picks up the bottom hole depth east/-west coordinate form the survey file.

Extrapolate Ahead, Vertical Section #52j: Reference element 52j depicts the Well Bore Bottom Hole Depth Vertical Section that is acts as a starting point for the extrapolation; as soon as the operator activates the Extrapolate Ahead Command depicted in Reference element 10v, the extrapolation screen automatically picks up the bottom hole depth vertical section form the survey file.

Extrapolate Ahead, Dogleg Severity #52k: Reference element 52k depicts the Well Bore Bottom Hole Depth Dogleg Severity that is acts as a starting point for the extrapolation; as soon as the operator activates the Extrapolate Ahead Command depicted in Reference element 10v, the extrapolation screen automatically picks up the bottom hole depth dogleg severity form the survey file.

Extrapolate Ahead, Tool Face Drill Off #52l: Reference element 52l depicts the Well Bore Bottom Hole Depth Tool Face Drill Off that is acts as a starting point for the extrapolation; as soon as the operator activates the Extrapolate Ahead Command depicted in Reference element 10v, the extrapolation screen automatically picks up the bottom hole depth tool face drill off form the survey file.

Extrapolate Ahead, Added (m/ft.): Auto Change Cursor Arrows #52m: Reference element 52m depicts the Added (m/ft.) Auto Change Cursor Arrows which enables the operator to cursor the added meters or feet up or down in 1 meter or 3 feet intervals automatically; as the operator cursor the added depth up or down the extrapolation module automatically re-calculate all the associated calculations relating to the depth extrapolation changes.

Extrapolate Ahead, Inclination Auto Change Cursor Arrows #52n: Reference element 52n depicts the Inclination Auto Change Cursor Arrows which enables the operator to cursor the inclination in 0.10 degree intervals automatically; as the operator cursor the inclination up or down the extrapolation module automatically re-calculate all the associated calculations relating to the inclination extrapolation changes.

Extrapolate Ahead, Azimuth Auto Change Cursor Arrows #52o: Reference element 52o depicts the Azimuth Auto Change Cursor Arrows which enables the operator to cursor the azimuth in 0.10 degree intervals automatically; as the operator cursor the azimuth up or down the extrapolation module automatically re-calculate all the associated calculations relating to the azimuth extrapolation changes.

Extrapolate Ahead, Added Comment #52p: Reference element 52p depicts the Added Comment Option which enables the operator to add a comment up to 50 characters to the survey file along with the extrapolation.

Extrapolate Ahead, Interpolate Command #52q: Reference element 52q depicts the Interpolate Command which enables the operator to have the extrapolation automatically interpolated in 10 meter or 30 feet intervals and inserted into the survey file.

Extrapolate Ahead, Exit Command #52r: Reference element 52r depicts the Exit Command that the operator activates to exit the extrapolation screen without inserting the extrapolated survey into the survey file.

System Warning List #53: FIG. 53 depicts the System Warning List that is triggered by various situations and pop up as a screen layover to warn the operator of an issue or situation that has arisen.

System Warning List, KOP Warning #53a: Reference element 53a depicts the KOP Warning that is based on the Well Kick Off Point (KOP) that is depicted in Reference element 51a and pops up as a screen layover as soon as the well hole depth that is entered in the survey file is 20 meters or 65.5 feet above or under the 20 meter or 65.5 feet system allowance.

System Warning List, KOP Warning OK Command #53b: Reference element 53b depicts the KOP Warning OK Command that the operator activates to acknowledge that the warning was received.

System Warning List, ICP Warning #53c: Reference element 53c depicts the ICP Warning that is based on the Well Intermediate Casing Point (ICP) that is depicted in Reference element 51b and pops up as a screen layover as soon as the well hole depth that is entered in the survey file is 20 meters or 65.5 feet above or under the 20 meter or 65.5 feet system allowance.

System Warning List, ICP Warning OK Command #53d: Reference element 53d depicts the ICP Warning OK Command that the operator activates to acknowledge that the warning was received.

System Warning List, TD Warning #53e: Reference element 53e depicts the TD Warning that is based on the Well Total Depth (TD) that is depicted in Reference element 51c and pops up as a screen layover as soon as the well hole depth that is entered in the survey file is 20 meters or 65.5 feet above or under the 20 meter or 65.5 feet system allowance.

System Warning List, TD Warning OK Command #53f: Reference element 53f depicts the TD Warning OK Command that the operator activates to acknowledge that the warning was received.

System Warning List, Measured Depth Surpassed KOP #55g: Reference element 55g depicts the KOP Surpassed Warning that pops up as a screen layover as soon as the well hole depth that is entered in the survey file has surpassed the Kick Off Point (KOP) that is depicted in Reference element 51a.

System Warning List, KOP Surpassed Warning OK Command #55h: Reference element 55h depicts the Surpassed KOP Warning OK Command that the operator activates to acknowledge that the warning was received.

System Warning List, Measured Depth Surpassed ICP #55i: Reference element 55i depicts the ICP Surpassed Warning that pops up as a screen layover as soon as the well
hole depth that is entered in the survey file has surpassed the Intermediate Casing Point (ICP) that is depicted in Reference element 51h. [0755] System Warning List, ICP Surpassed Warning OK Command #53: Reference element 53j depicts the Surpassed ICP Warning OK Command that the operator activates to acknowledge that the warning was received. [0756] System Warning List, Measured Depth Surpassed TD #53k: Reference element 53k depicts the TD Surpassed Warning that pops up as a screen layover as soon as the well hole depth that is entered in the survey file has surpassed the Well Total Depth (TD) that is depicted in Reference element 51c. [0757] System Warning List, TD Surpassed Warning OK Command #53l: Reference element 53l depicts the Surpassed TD Warning OK Command that the operator activates to acknowledge that the warning was received. [0758] System Warning List, Target Change Warning #53m: Reference element 53m depicts the Target Change Warning that pops up as a screen layover as soon as the well hole depth that is entered in the survey file is 10 meters or 32.8 feet above or under the 10 meter or 32.8 feet system allowance that is depicted in Reference element 8c, Target Section End Depth. [0759] System Warning List, Target Change Warning OK Command #53n: Reference element 53n depicts the Target Change Warning OK Command that the operator activates to acknowledge that the warning was received. [0760] System Warnings List, Low Motor Output #53o: Reference element 53o depicts the Low Motor Output Warning that pops up as a screen layover as soon as the motor output enters the red coding as depicted in Reference element 10mn in the Program Header. [0761] System Warnings List, Low Motor Output Warning OK Command #53p: Reference element 53p depicts the Low Motor Output Warning OK Command that the operator activates to acknowledge that the warning was received. [0762] System Warnings List, Two Red Survey Warning #53q: Reference element 53q depicts the Two Red Survey Warning that pops up as a screen layover as soon as two survey factors in session has entered the red window corridor parameter as set in the Section Windows as depicted in Reference element 8c and detailed in Reference element 8h. [0763] System Warnings List, Two Red Survey Warning OK Command #53r: Reference element 53r depicts the Two Red Survey Warning OK Command that the operator activates to acknowledge that the warning was received. [0764] Systems Warning List, All Extrapolations Will Be Deleted Warning #53s: Reference element 53s depicts that all Extrapolations Will be Deleted Warning that pops up as a screen layover as soon as the operator activates the Enter Survey Command as depicted in Reference element 10p in the Program Header if any extrapolations are listed in the survey file when a new survey is being entered. [0765] Systems Warning List, All Extrapolation Will Be Deleted Warning OK Command #53t: Reference element 53t depicts the All Extrapolations Will be Deleted Warning OK Command that the operator activates to acknowledge that the warning was received. [0766] Systems Warning List, Motor Setting Cannot Achieve Well Plan #53u: Reference element 53u depicts the Motor Setting Cannot Achieve Well Plan Warning that pops up as a screen layover which is calculated against the active well plan and the Motor Dogleg entered in the Bha Information depicted in Reference element 9j. [0767] Systems Warnings List, Motor Setting Cannot Achieve Well Plan OK Command #53v: Reference element 53v depicts the Motor Setting Cannot Achieve Well Plan OK Command that the operator activates to acknowledge that the warning was received. [0768] Systems Warning List, Depth Entered is the Same as the Previous Depth Entered #53w: Reference element 53w depicts the Depth Entered is the Same as the Previous Depth Entered that pops up as a screen overlay if the operator inadvertently enters same survey or well plan depth. [0769] Systems Warning List, Depth Entered is the Same as the Previous Depth Entered OK Command #53x: Reference element 53x depicts the Depth Entered is the Same as the Previous Depth Entered Command that the operator activates to acknowledge that the warning was received. [0770] Warning Data Sheet #54: Reference element 54 depicts the Warning Data Sheet that records all warnings and acknowledgements in a viewable, but non-editable worksheet and can only be viewed when the operator activates Data Sheets Command in the Program Header as depicted in Reference element 10n. [0771] Warning Data Sheet, Hole Depth #54a: Reference element 54a depicts the Hole Depth and records it automatically when the warning was received. [0772] Warning Data Sheet, Warnings Received and Acknowledgements #54b to 54l: Reference elements 54b to 54l depict the Warnings Received and Acknowledgements that were received and the laptop or tablet that acknowledged each individual warning. [0773] In some cases more than one computing unit may contain a module or may be used to carry out the methods and systems disclosed here. All modules need not be on the same computing unit. Each module includes a memory, such as at least a portion of a computer readable medium, storing instructions, for example scripted or compiled program code, for carrying out the function of the module. Instructions may be stored in bits. Each set of instructions may include logic patterns. Each computing unit has a central processing unit, associated circuitry and memory, and may be loaded on one or more circuit boards. A power source may be provided, as may a power input connected to the computing unit. The computing unit may be a general purpose computer. The computing unit may be connected directly or indirectly to one or more displays showing data for example using pixels arranged on a screen. A module may include other hardware, such as one or more computers, connections, and displays, required to operate the function of the module. Connections may be wired or wireless through a network such as the internet, LAN, or other suitable network. Storage of data could be done on a computer readable medium in the form of memory, RAM, hard drive space, flash drive space, or other suitable medium storage. Although many examples above disclose the existence of certain items or steps as absolutes, it should be understood that such items are not absolute in other examples. In some cases high ranking users have negative control only, namely the ability to stop the drilling. The screenshots provided in the Figures are of an exemplary system and other systems may incorporate some, all, none, or other screens as desired. Reference to an oil company includes an oil, gas, or oil and gas company. Although mud motor use is discussed, some embodiments may be used with other drilling operations such as rotary steerable operations.
Survey depth generally means length of pipe inserted in the well. Read only refers to the fact that the data cannot be edited by a user through the system itself.

[0774] In the claims, the word "comprising" is used in its inclusive sense and does not exclude other elements being present. The indefinite articles "a" and "an" before a claim feature do not exclude more than one of the feature being present. Each one of the individual features described here may be used in one or more embodiments and is not, by virtue of being described here, to be construed as essential to all embodiments as defined by the claims.

1. A control system for one or more aspects of a directional drilling operation, the control system comprising:
   one or more inputs configured to receive commands; and
   one or more computing units connected to the one or more inputs and having a) a conflict module for determining if a conflict exists between a command received from a first user of a hierarchy of users and a previous command from a relatively higher ranked user of the hierarchy of users, and b) an execution module for executing the command if no conflict exists.

2. The control system of claim 1 in which the control system is a monitoring system for survey sensor data obtained from one or more sensors monitoring progress of the directional drilling operation, and in which the one or more computing units comprise an analysis and display module for survey sensor data.

3. The control system of claim 2 in which the survey sensor data comprises one or more of survey depth, hole depth, inclination, azimuth, course length, and slide and rotate data.

4. The control system of claim 2 in which the monitoring system is a passive system for a mud motor directional drilling operation.

5. The control system of claim 2 in which the command is an enter survey sensor data command.

6. The control system of claim 2 in which the analysis and display module is configured to compare one or more characteristics of the orientation of a portion of a drill string in the earth, obtained from the survey sensor data, with a predetermined well plan.

7. The control system of claim 6 in which the one or more computing units further comprise a well planning module for the directional drilling operation, in which the command is a re-plan well plan command.

8. The control system of claim 7 in which the change well plan command is a sidetrack well plan command.

9. The control system of claim 6 in which the analysis and display module is configured to output drilling instructions.

10. The control system of claim 9 in which the command is a deviate from drilling instructions command.

11. The control system of claim 9 in which the drilling instructions comprise proposed settings for drilling equipment.

12. The control system of claim 6 in which the analysis and display module is configured to determine if a breach has occurred as indicated by a deviation, beyond a predetermined window, of a characteristic from a respective expected characteristic from the predetermined well plan.

13. The control system of claim 12 in which the command is a change predetermined window corridor parameter command.

14. The control system of claim 11 in which the one or more computing units further comprise an alert module for sending an alert to one or more of the users of the hierarchy of users in the event of a predetermined condition.

15. The control system of claim 14 in which the predetermined condition includes determining a breach in a characteristic across successive iterations of survey data input.

16. The control system of claim 14 in which the predetermined condition includes completion of a portion of a well.

17. The control system of claim 14 in which the alert module is configured to send the alert to all users of the hierarchy of users.

18. The control system of claim 2 in which the previous command is to send an alert to one or more superiors in the hierarchy of users in the event of a predetermined type of command from the first user.

19. The control system of claim 2 in which the previous command is to wait for superior approval in the event of a predetermined type of command from the first user, in which the conflict module is configured to find a conflict if the predetermined type of command is entered by the first user.

20. The control system of claim 19 in which the predetermined type of command is a change command.

21. The control system of claim 18 in which the one or more computing units has an alert module for sending the alert.

22. The control system of claim 21 in which the predetermined type of command is a change command.

23. The control system of claim 1 further comprising a storage medium containing a command database, in which the one or more computing units are configured to store the command database along with an identifier of the respective user initiating the command.

24. The control system of claim 23 in which the command database is stored in a read-only format.

25. The control system of claim 23 in which the one or more computing units are configured to store each command in the command database along with a reason for the change command.

26. The control system of claim 1 further comprising an identification module for confirming the identity of a user of the hierarchy of users.

27. The control system of claim 26 in which the identification module is configured to recognize a user by input by the user of a unique identifier associated with the user.

28. The control system of claim 1 further comprising a plurality of user terminals, including one or more remote terminals connected to the control system through a network.

29. The control system of claim 28 in which one or more remote terminals are located at a headquarters of an oil and gas company.

30. The control system of claim 1 in which the hierarchy of users comprises an oil and gas company representative at or near the top of the hierarchy of users.

31. A method of monitoring the progress of a directional drilling operation, the method comprising:
   measuring a plurality of characteristics of the orientation of a portion of a drill string in the earth;
   for each measured characteristic, determining, with one or more computing units, if a breach has occurred as indicated by a deviation, beyond a predetermined window, of the measured characteristic from a respective expected characteristic from a predetermined well plan; and
   initiating an alert event, using the one or more computing units, if one or more breaches are determined.
32. The method of claim 31 being a method of passively monitoring the progress of a mud motor directional drilling operation.

33. The method of claim 31 in which the expected characteristics are derived by the one or more computing units from the predetermined well plan based on a length of drill string inserted into the earth.

34. The method of claim 31 in which measuring comprises one or more of measuring with a survey sensor or processing, with the one or more computing units, survey sensor data.

35. The method of claim 31 in which the portion of the drill string comprises a drill bit.

36. The method of claim 31 in which initiating further comprises sending an alert to one or more of a plurality of users of the one or more computing units.

37. The method of claim 31 in which the plurality of characteristics include inclination, azimuth, and at least one three dimensional coordinate of the portion of the drill string.

38. The method of claim 37 in which the three dimensional coordinate is true vertical depth.

39. The method of claim 37 in which the plurality of characteristics include the three dimensional position of the portion of the drill string.

40. The method of claim 37 in which the plurality of characteristics include absolute distance from a predetermined well plan path.

41. The method of claim 37 in which the plurality of characteristics include hole depth and survey depth.

42. The method of claim 37 carried out through a build section of the directional drilling operation, in which the plurality of characteristics include one or more of an achieved dog leg or build rate of a mud motor connected to a drill bit on the drill string, and further comprising:

determining, with the one or more computing units, if a breach has occurred as indicated by a deviation, beyond a predetermined window, of one or both of the achieved dog leg or build rate from a respective expected dog leg or build rate of the mud motor.

43. The method of claim 37 in which the three dimensional coordinates include the position of the portion of the drill string projected in a horizontal plane.

44. The method of claim 31 carried out through a build section of the directional drilling operation, the method further comprising repeating the stages, in which the respective predetermined window for one or more characteristics is reduced based on progress through the build section.

45. The method of claim 44 in which the one or more characteristics for which the respective predetermined window is reduced is true vertical depth.

46. The method of claim 44 in which the one or more characteristics for which the respective predetermined window is reduced is the position of the portion of the drill string projected in a horizontal plane.

47. The method of claim 44 in which the respective predetermined window is reduced in proportion to progress through the build section.

48. The method of claim 47 in which the respective predetermined window is reduced at a ratio of 1:1 percentage progress through the build section: percentage reduction.

49. The method of claim 44 in which the respective predetermined window is not reduced below a minimum threshold.

50. The method of claim 31 in which:

determining further comprises assigning a grade associated with major, minor, or no deviation, in which a breach corresponds to a major deviation; and

the method further comprises outputting the grades to a display.

51. The method of claim 30 in which the grades are represented on the display by the percentage value of the predetermined window taken up by a deviation of a measured characteristic from the respective expected characteristic.

52. The method of claim 30 in which the grades are represented on the display by colors on a spectrum of colors indicating at least no, minor, or major deviation.

53. The method of claim 31 further comprising:

repeating the measuring and determining stages with the one or more computing units; and

in the event of a predetermined condition, at least partially locking out, with the one or more computing units, one or more users from repeating the measuring or determining stages.

54. The method of claim 53 in which the one or more users are locked out at the measuring stage from entering survey sensor data into the one or more computing units.

55. The method of claim 53 in which the predetermined condition includes determination of a breach in two successive cycles of measuring followed by determining.

56. The method of claim 55 in which the breach found in two successive cycles is a breach of the same characteristic.

57. The method of claim 53 further comprising unlocking the one or more users on receipt by the one or more computing units of a permission signal initiated by a supervisory user.

58. A method of monitoring the progress of a directional drilling operation through a build portion, the method comprising:

measuring, with the one or more computing units, a motor output efficiency by comparing an achieved dog leg or build rate of a mud motor connected to a drill bit in the earth with a respective expected dog leg or build rate of the mud motor; and

initiating an alert event, using the one or more computing units, if the motor output efficiency is outside of a predetermined range.

59. The method of claim 58 being a method of passively monitoring the progress of a mud motor directional drilling operation.

60. The method of claim 58 in which initiating further comprises initiating if the motor output efficiency falls outside of the predetermined range.

61. A method of monitoring the progress of a directional drilling operation, the method comprising:

measuring the orientation of a portion of a drill string in the earth;

determining, with one or more computing units, one or more drilling equipment parameters required to guide the portion of the drill string from the orientation to a selected target on a predetermined well plan; and

repeating the measuring and determining stages, in which the selected target is switched to a subsequent target on the well plan when the portion of the drill string comes within a predetermined positive distance of the selected target.

62. The method of claim 61 being a method of passively monitoring the progress of a mud motor directional drilling operation.
63. The method of claim 61 in which drilling equipment parameters include one or more of inclination, azimuth, tool face setting, slide distance, slide start point, rotate distance, and rotate start point.

64. The method of claim 61 in which the directional drilling operation is a mud motor directional drilling operation, and the drilling equipment parameters comprise mud motor parameters.

65. The method of claim 61 in which the predetermined positive distance is 10 meters or 32.8 feet.

66. A method of logging decisions made during a directional drilling operation, the method comprising:
   providing a plurality of users with access to a computing unit interface for monitoring the progress of a directional drilling operation against a predetermined well plan and displaying drilling instructions;
   receiving at the computing unit interface a change command, from a user of the plurality of users, of a parameter of the computing unit interface, well plan, or drilling instructions; and
   storing the change command along with a user identifier in a database that cannot be edited by the user from the computing unit interface.

67. The method of claim 66 in which the computing unit interface is for passively monitoring and controlling the progress of a mud motor directional drilling operation.

68. The method of claim 66 in which the change command is to a parameter that is a target on the predetermined well plan.

69. The method of claim 66 in which the computing unit interface is configured to determine if a breach has occurred as indicated by a deviation, beyond a predetermined window, of a characteristic, of the orientation of a portion of a drill string, from a respective expected characteristic from the predetermined well plan, in which the change command is to the size of the predetermined window.

70. The method of claim 66 in which the change command is a command to sidetrack or re-plan the well plan.

71. The method of claim 66 in which storing further comprises storing a reason for the change command.

72. The method of claim 66 in which each of the plurality of users has access to the computing unit interface using a unique code.

73. A method of monitoring the progress of a directional drilling operation, the method comprising:
   measuring a plurality of characteristics of the orientation of a portion of a drill string in the earth; and
   outputting, with one or more computing units, at least some of the plurality of characteristics to a display in a read only format.

74. The method of claim 73 being a method of passively monitoring the progress of a mud motor directional drilling operation.

75. The method of claim 73 further comprising:
   repeating the measuring stage; and
   executing user-initiated edit commands of only the plurality of characteristics measured in the preceding iteration of the measuring stage.

76. A method comprising:
   inputting sensor data into one or more computing units, the sensor data obtained from one or more survey sensors monitoring the progress of a directional drilling operation;
   measuring with the one or more computing units the elapsed time of an event forming part of the directional drilling operation; and
   outputting from the one or more computing units to a display the elapsed time or a measurement made using the elapsed time.

77. The method of claim 76 being a method of passively monitoring the progress of a mud motor directional drilling operation.

78. The method of claim 76 in which the event is drilling time, and the measurement outputted is rate of penetration.

79. The method of claim 76 in which the event is one or more of slide time, rotate time, tool face orientation time, and connection time.

80. The method of claim 76 in which inputting is done by manual entry by one or more users through a computing unit interface.

81. The control system of claim 1 in which each computing unit has a central processing unit and associated circuitry and memory.