Rig Instrumentation System and Load Pins

OCEAN DRILLING PROGRAM
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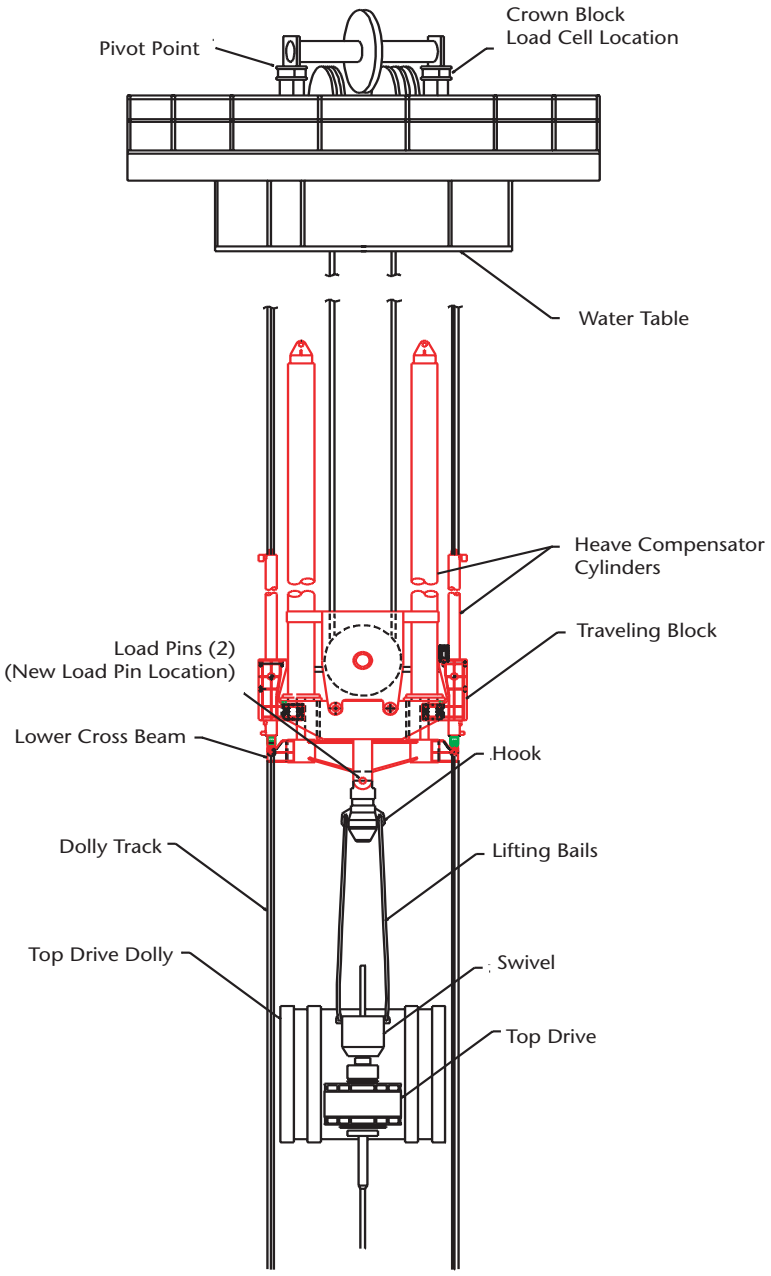
Scientific Application

Rig Instrumentation System

The Rig Instrumentation System (RIS) on the R/V *JOIDES Resolution* (JR) is a state-of-the-art data acquisition system that can analyze data. The ability of the RIS to present real-time data and drilling parameters in digital and graphical formats provides a powerful tool for the Driller, Core Techs, and ODL/ODP drilling supervisors and enhances interpretation of trends to improve decision making and core recovery. The data export feature allows scientists to merge and correlate drilling data with the physical properties of recovered core. This comparison allows for enhanced assessment of poor core recovery intervals. The data recording and post-processing features of the RIS provide information to analyze bit and downhole tool operation and bottom-hole assembly (BHA) performance; however, the raw data require manipulation and refinement.

Instrumented Load Pins

The RIS records and displays the hook load. Hook load is measured by a hydraulic "load cell" located in the crown that "weighs" the total load hanging in the derrick, which includes the weight of the drill wireline, heave compensator, traveling block, and drill string weight supported by the hook. The inertial effects of ship's motion (heave, roll, and pitch) and the stroke of the Active Heave Compensator (AHC) impart a false load into this measurement, which manifests itself as "noise" or erratic needle swings on the driller's weight indicator. To provide a more stable hook load measurement, two instrumented "load pins" (0-500,000 lb each) were installed at the hook's upper support point on the AHC's lower crossbeam, where it is virtually uncoupled from the dynamic reaction forces of the ship's heave and AHC stroke.



Schematic of the upper derrick showing location of the load cell and load pins in relation to the crown block, heave compensator cylinders, and traveling block.

Tool Operations

All RIS sensor data and analog/digital signals are routed directly to the Databox (data acquisition electronics) located in the subsea shop. The Databox converts the signal and outputs it to the Master Computer, which is located in the computer server room. The Master Computer has six communication ports available for additional devices, of which two are used for receiving data from the AHC controller and the coring wireline depth recorder. Two others are used for two-way communication where the RIS both sends and receives data. When measurement/logging-while-drilling (M/LWD) tools are run, the downhole data from the tools are sent to the RIS and certain sets of RIS data are sent to the M/LWD data acquisition system. When continuous tracer injection is required for microbiology sampling, the RIS controls the tracer pump, which automatically adjusts the injection rate to maintain constant tracer concentration with varying mud pump rates.

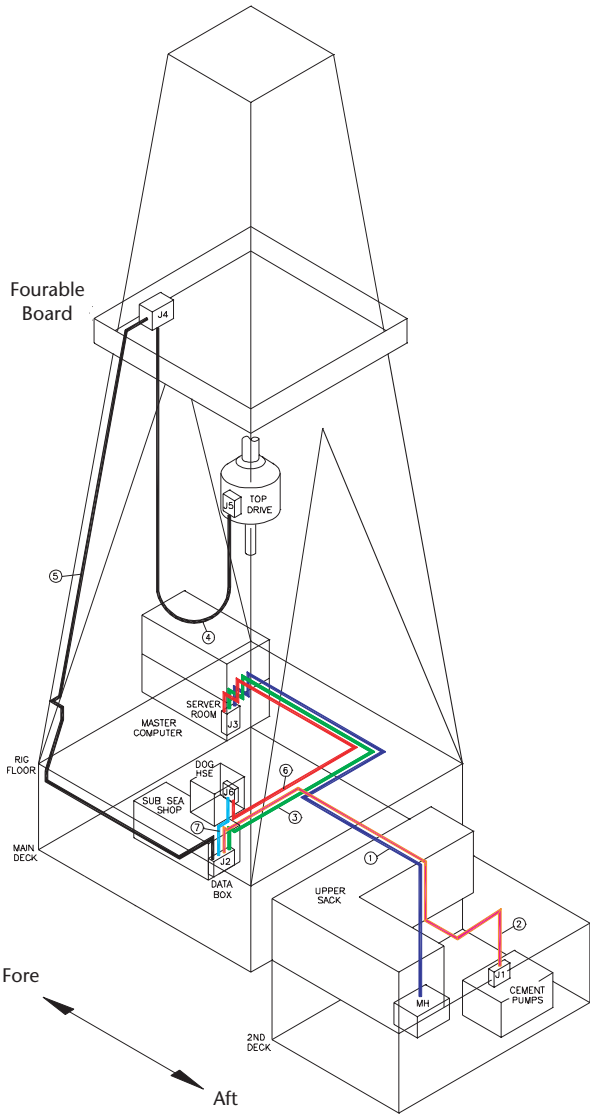
A fiber-optic cable runs between the Master Computer and the rig floor display located in the Driller's workstation. The infrared touch screen on the rig floor display allows the Driller's finger to move the mouse cursor to operate the RIS software, which runs in a Microsoft Windows environment. The Master Computer is linked to the ODP ship's network and broadcasts in real time to remote RIS workstations in the ODP and ODL operations offices and Core Tech shop. The remote workstations are available to these personnel for data analyses and report creation. Each user has independent control over how the data are displayed.

Design Features

1) Data Analysis

Drilling data analysis is initially based on a review of drilling parameters and interpretation of the RIS log graphical display, where historical curves are reviewed for trends and to identify abrupt events.

Benefit: A data set can be studied in both time and depth domains to help understand the contribution of the individual drilling parameter. Curves can be overlaid and tracks can be rearranged to correlate sets of parameters. A zoom-in and zoom-out feature aids in the analysis. A more detailed analysis can be performed by exporting the data in ASCII format, which can be imported into other graphics and analysis programs (e.g., EXCEL and LabView). The science party can acquire exported and corrected ASCII files from the operations office for their data analysis.



Schematic of the RIS cable routing. The cable colors indicate gage and type of cable.

2) Data Variables

One hundred variables (V1-V100) are available in the TruVu software program. Primary data variables already assigned and used by ODP are listed in the Primary Data Variables section. Variables are assigned (e.g., standpipe pressure) and set up (e.g., units) in the TruVu software. There are three types of data: collected from sensors, collected from other devices (e.g., MWD) via communication links, or calculated to one or more variables by math functions in the software. Up to 45 variables can be displayed on the data table screen. Each variable can be set independently with its own filter, refresh rate, and display resolution. Each variable may be saved at its instantaneous, maximum, minimum, or average value over the save period.

Benefit: Allows user to save data in a form compatible with future analysis.

3) Plotting

Hard copy plots of the data can be used for analyzing drilling performance. There are several available "canned" plot formats, but the user can also create custom formats. Up to six traces can be overlaid on each track; however, the number of tracks is limited to what can be viewed within the available space. The output scales of each variable are user defined as well as the range of depth or time. The graphs may be printed to any printer or plotter.

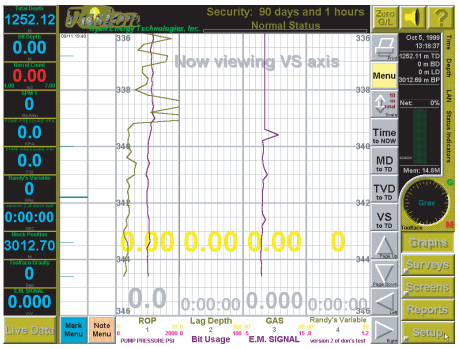
Benefit: Allows user to print hard copies (after reviewing electronic file) for additional analysis of trends.

4) Data Management

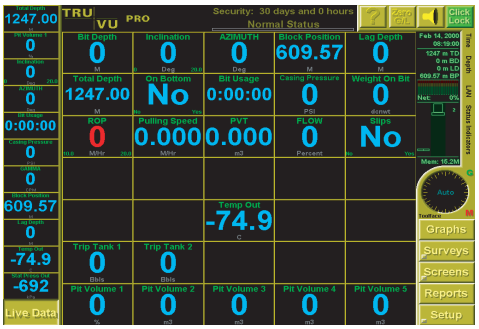
The ODP Marine Electronics Technicians support the operating software and maintain the hardware. The operating software requires a person with significant experience to effectively take advantage of its features.

Data for all ODP holes created during the leg are archived on three sets of CD-ROMs at the end of each leg. One CD set stays on the ship and two are sent to ODP in College Station. Scientists may access RIS data via exported ASCII files, which are requested through the ODP operations office. The RIS database will eventually be moved into the Janus database or moved to a linked database; however, the distribution of raw RIS data presents a data integrity problem. The quality of the raw data must be verified before distribution and manually corrected for sensor calibration changes.

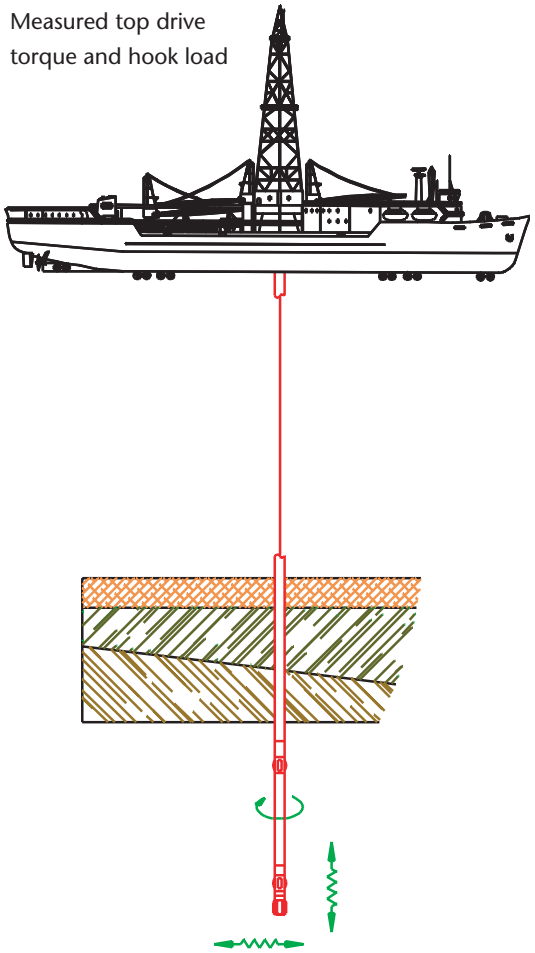
Benefit: Allows wide distribution of custom data sets for further analysis.



Graphical Data Display



Live Data Table Display



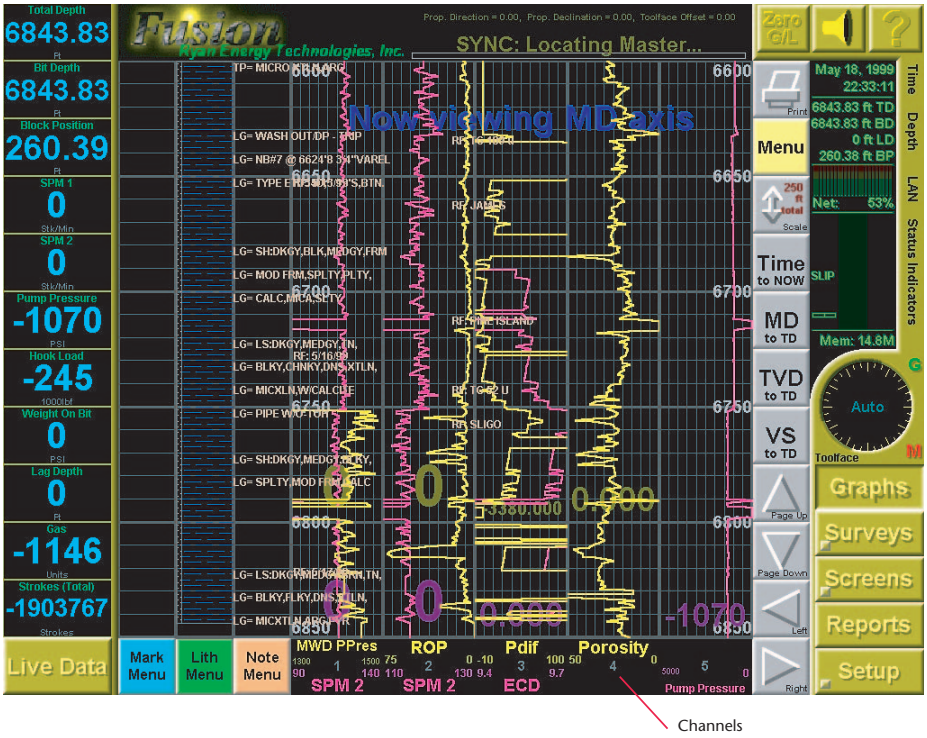
Sensed WOB and TOB

MWD Real-Time Transmission

The two diagrams on the left illustrate the two live data displays: graphical (top) or data table (bottom). The data table is the default screen. To move to the graphical display, one clicks on the green "Graphs" button on the right hand side of the screen. The diagram on the right illustrates Real-Time transmission when using a measurement-while-drilling (MWD) tool. Top drive torque and hook load are measured in the derrick during all drilling/coring. The MWD sensor measures WOB and Torque on Bit (TOB) at the bit and transmits the data to the RIS via a sensor sub.

Primary Data Variables

- Data collected from sensors: traveling block position, top drive torque and revolutions per minute (RPM), standpipe pressure, mud pump rate (strokes) and pressure, cement pump rate (strokes) and pressure, coring wireline tension and depth, hook load (crown and two load pins on traveling block), pipe length (joint counts), and pipe makeup torque.



Screen capture of the RIS live data graphical view, showing the five channels. Each channel can display two traces each for 10 traces total. The eight traces (two traces are not being utilized) displayed in this example are MWD pore pressure, ROP, pressure drop across the bit (Pdif), porosity, strokes per minute (SPM2) on two traces, equivalent circulating density (ECD) or mud weight, and pump pressure.

- Data collected from other devices via RS-422 communication links:

  ship heave and velocity, ship roll and pitch, AHC position/hook load/pressure/ velocity/heave deviation, Schlumberger measurement-while-drilling (MWD) surface measurements and data, and tracer pump status.
- Calculated values: depth, rate of penetration (ROP), and weight on bit (WOB).

Typical Operating Range

- Operating Range: Records all operations 24/7.
- Sampling Rate: All 100 variables are sampled every 0.5 s, and both time- and depth-based data are saved during a job.
- Data Save Rates: All 100 variables are set for 60 s for the time-based database and for every 1.0 m for the depth-based data. Other rates are available but not used.
- Selected Save Rates: A subset of variables are saved at 1 s using a "capture" device.
- Format: The data is saved in ASCII.
- Live-Data Displays: All 100 variables can be displayed on a strip-chart type log (graphical) or data table display:
- The graphical display can monitor five channels with two traces per channel at one time. A scrolling feature allows viewing of up to 20 channels maximum in five-channel increments.
- Time- or depth-based graphs can be viewed as:

  Time-based display from 1 to 50 hr of log,

  Depth-based display from 10 to 250 m of log.
- Up to 45 variables can be monitored at one time in the data table display.
- The user can set the range and scale for each variable.

Limitations

Depth and ROP Measurement

On a riserless vessel, there is no fixed reference to the seafloor (such as a riser) to directly measure drill pipe advancement (i.e., depth and ROP). The RIS constantly collects block position, compensator position, and heave data, however, the current method of obtaining an absolute depth measurement on the *JR* relies on manually tracking the motion of the traveling blocks, which are referenced from the drill floor. The ability to output a dependable calculated bit depth is limited because the:

1. heave compensator stroke effectively disconnects the traveling blocks from the drill pipe advancement,
2. heave measurement's null position is continually being recalculated, and
3. compensator null position varies depending upon the driller.

Raw Data Quality

The quality of the raw data must be verified prior to distribution and manually corrected for sensor calibration changes.