Triple Combination Tool String

Description
The Triple Combination tool string (Triple Combo) consists of a series of logging tools combined to provide a broad suite of *in situ* physical property measurements in an uncased borehole. The term “Triple Combo” is derived from the three principle measurements collected by the tool string: density, porosity and resistivity. Specifically, the Triple Combo is designed to measure formation density, porosity, deep/intermediate/shallow resistivity, natural gamma radiation, hole size, and fluid temperature, all in a single logging pass.

Applications

Hostile Environment Natural Gamma Sonde
- Clay typing
- Mineralogy identification
- Ash layer detection

Accelerator Porosity Sonde
- Formation porosity
- Lithologic determination

Hostile Environment Litho-Density Tool
- Porosity estimation
- Seismic impedance calculation
- Lithologic boundary definition and textural changes

Dual Induction Tool
- Porosity estimation
- Density and velocity reconstruction
- Lithologic boundary definition and textural changes

Temperature / Pressure / Acceleration Tool
- Geothermics
- Hydrogeology

Deployment Notes
In ODP, the Triple Combo is always the first tool string run into the open borehole to ascertain the condition of the hole. The modular nature of the Triple Combo affords great flexibility with regard to tool substitutions and additions/deletions. For example, third party tools such as the Lamont-Doherty Earth Observatory’s High Resolution Gamma and TAP tools have been run in-line with the Triple Combo.

Tool String Specifications

<table>
<thead>
<tr>
<th>Length:</th>
<th>28.99 meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter:</td>
<td>3.75 inches</td>
</tr>
<tr>
<td>Primary Measurements:</td>
<td>Spectral gamma (Uranium, Potassium and Thorium), Formation density, Formation porosity, Resistivity (Shallow, Medium and Deep depths of investigation), Fluid temperature</td>
</tr>
</tbody>
</table>

Schematic illustration of the Triple Combo tool string and its primary components.
**Triple Combo Tool Specifications**

<table>
<thead>
<tr>
<th>Tool</th>
<th>Measurement</th>
<th>Maximum Temperature</th>
<th>Maximum Pressure</th>
<th>Sample Interval</th>
<th>Vertical Resolution</th>
<th>Logging Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>HNGS</td>
<td>Spectral Gamma</td>
<td>260° C</td>
<td>25,000 psi</td>
<td>6 in.</td>
<td>1.66 ft</td>
<td>1600 ft/hr</td>
</tr>
<tr>
<td>APS</td>
<td>Porosity</td>
<td>176° C</td>
<td>20,000 psi</td>
<td>6 in.</td>
<td>12 - 14 in.</td>
<td>1600 ft/hr</td>
</tr>
<tr>
<td>HLDT</td>
<td>Density</td>
<td>260° C</td>
<td>25,000 psi</td>
<td>6 in.</td>
<td>1.25 ft</td>
<td>1600 ft/hr</td>
</tr>
<tr>
<td>DIT</td>
<td>Resistivity</td>
<td>175° C</td>
<td>20,000 psi</td>
<td>6 in.</td>
<td>2.5 - 8 ft</td>
<td>10,000 ft/hr</td>
</tr>
<tr>
<td>TAP</td>
<td>Temperature/Acceleration/Pressure</td>
<td>105° C</td>
<td>10,000 psi</td>
<td>1 sec.</td>
<td>Conditional</td>
<td>Conditional</td>
</tr>
</tbody>
</table>

Cal = caliper  
HCGR = Gamma ray total cts  
U = Percent Uranium  
K = Percent Potassium  
Th = Percent Thorium  
SFLU = Shallow resistivity  
IDVR = Deep resistivity  
IMVR = Medium resistivity  
RHOM = Formation density  
PEFL = Photoelectric effect  
DRH = Bulk density correction  
APLC = Formation porosity  
SIGF = Capture cross section  

Color coded by tool