APS Accelerator Porosity Sonde
Epithermal and thermal pulsed neutron solution
The APS* accelerator porosity sonde delivers both epithermal and thermal neutron measurements by using an electronic pulsed neutron generator (PNG) instead of a conventional radioactive chemical source. The combination of the large neutron yield from the PNG and detector shielding incorporated in the tool results in measurements that are relatively insensitive to the borehole environment and formation characteristics, such as lithology and salinity.

Five detectors provide accurate information for conducting porosity evaluation, gas detection, shale evaluation with greater vertical resolution, and borehole correction. APS measurements can be performed in both open and cased holes.

**APPLICATIONS**
- Formation evaluation in open hole and behind casing
- Accurate neutron porosity measurement in environments with thermal neutron absorbers
- Accurate hydrogen index (HI) measurement
- Clay analysis
- Gas detection
- Identification of thin pay zones

**Obtain both epithermal and thermal neutron measurements using a high-energy electronic source for improved measurements and wellsite safety.**

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Five detectors provide accurate information for conducting porosity evaluation, gas detection, shale evaluation with greater vertical resolution, and borehole correction. APS measurements can be performed in both open and cased holes.
The lack of contrast in the gamma ray measurement, shown in the depth track, indicates a shaly sand. Despite this challenging formation, the crossover profiles of both the APS neutron with density (Track 2) and with sonic (Track 1) logs identify all the gas zones in the interval.
THIN BEDS
The greater vertical resolution and lower sensitivity to clay of the APS porosity measurement improves the identification and evaluation of thin beds. Run in combination with Rt Scanner® triaxial induction service or the AIT® array induction imager tool, the APS sonde provides a vertical resolution of approximately 1 ft [0.3 m]. The thermal neutron formation capture cross section (sigma) measurement can be used to focus the vertical resolution of shale evaluation, which is usually obtained from gamma ray measurements.

SHALY SANDS
Because clay has little effect on the APS HI measurement, any gas effect in shaly sands is more visible. The greater visibility reduces the chance of missing a pay zone.

MIXED-LITHOLOGY CARBONATES
The degree of dolomitization in a formation has little influence on the APS carbonate response. As a result, the APS HI measurement in carbonates with unknown or variable dolomitization is representative of true formation porosity.

HIGH-SALINITY FLUIDS
The integration of APS epithermal neutron detection and borehole shielding minimizes the effects of formation and borehole fluids with high salinity. For conventional neutron porosity tools, these effects are much greater and depend on lithology, invasion characteristics, and hydrocarbon saturation.

ROUGH HOLE CONDITIONS
In rugose hole sections, tool standoff can be corrected using the measurements from the APS epithermal array detectors.

DIFFICULT HOLE CONDITIONS
Because the APS sonde does not use a chemical radioactive source, the tool can be deployed in wells with difficult conditions and a greater likelihood of sticking. This eliminates the additional concerns of retrieving the chemical source.
The APS thermal neutron porosity measurement provides continuity for comparison with conventional logs while reducing security and environmental concerns associated with conventional chemical radioactive neutron sources.
The APS thermal neutron porosity agrees well with the measured AmBe porosity over a range of approximately 0 to 30 pu in a Middle East limestone formation. Also note that the APS thermal neutron porosity produces the expected response in the anhydrite beds.

In a shaly sand from South America the APS thermal neutron porosity tracks the measured AmBe porosity for a mixed environment with values spanning a range of approximately 5 pu to 45 pu.

The APS thermal neutron porosity is also available as a high-resolution output. In this example of a North American carbonate containing very low-porosity limestone with some sand and shale, the high-resolution APS thermal neutron porosity agrees well with the conventional AmBe logs.

EQUIVALENT THERMAL NEUTRON POROSITY

A proprietary algorithm computes an equivalent thermal neutron porosity from the APS hydrogen index and sigma measurements. Because the calculation is derived using physics and modeling, it is also free of the biases typically introduced by empirical techniques. The APS equivalent thermal neutron porosity represents the measurement that would be obtained by a traditional thermal neutron tool using an AmBe source.

The APS thermal neutron porosity measurement provides continuity for comparison with conventional logs while reducing security and environmental concerns associated with chemical radioactive neutron sources. In the three log examples shown, the APS thermal neutron porosity (red dash-dot pattern) compares well with the values derived from a conventional AmBe radioactive source–based tool (black curve). Both curves use Schlumberger standard corrections for matrix type, hole size, standoff, mud type and weight, borehole salinity, pressure, and temperature; no correction is made for formation salinity.

In a shaly sand from South America the APS thermal neutron porosity tracks the measured AmBe porosity for a mixed environment with values spanning a range of approximately 5 pu to 45 pu.
### Measurement Specifications

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<th><strong>Output</strong></th>
<th>Hydrogen index, thermal neutron porosity, formation sigma</th>
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| **Logging speed** | Standard: 1,800 ft/h [549 m/h]  
High resolution: 900 ft/h [274 m/h]  
High speed: 3,600 ft/h [1,097 m/h] |
| **Range of measurement** | Porosity: 0 to 60 pu (0 to 60% uncorrected porosity) |
| **Vertical resolution** | 14 in [35.56 cm] |
| **Accuracy** | <7 pu: ±0.5 pu  
7 to 30 pu: ±7%  
30 to 60 pu: ±10%  
Sigma: ±1 cu [±0.1/m] |
| **Depth of investigation** | 7 in [17.78 cm] |
| **Mud type or weight limitations** | None |
| **Combinability** | Combinable with most services  
If combined with ECS* elemental capture spectroscopy sonde, the APS sonde must be run below it |

### Mechanical Specifications

| **Temperature rating** | 350 degF [177 degC] |
| **Pressure rating** | 20,000 psi [138 MPa] |
| **Borehole size—min.** | 4.625 in [11.75 cm] |
| **Borehole size—max.** | 21 in [53.34 cm] |
| **Outside diameter** | 3.625 in [9.21 cm] |
| **Length** | 13 ft [3.96 m] |
| **Weight** | 222 lbm [101 kg] |
| **Tension** | 50,000 lbf [22,410 N] |
| **Compression** | 23,000 lbf [102,310 N] |