

Rate of Penetration Traces

The Pason EDR has three different Rate of Penetration traces:

- **On-Bottom Rate of Penetration (ROP)** is a time-based calculation. For rig and office customers, this means you are viewing real-time ROP.
- **Overall Rate of Penetration (OROP)** calculates a simple average rate of penetration over a customizable time window of up to 1440 minutes (24 hours). While our ROP and EDR Instantaneous ROP traces only include time spent on bottom; the OROP calculation includes time spent on and off bottom. OROP is useful when you want to measure overall rig performance, rather than just on-bottom performance. For instructions on customizing the time window, see [Setting the OROP Averaging Window](#) on page 5.
- **EDR Instantaneous ROP** displays rate of penetration based on a fixed, 30-second averaging window. This trace doesn't affect any other calculated traces—it's intended for post-well analysis and troubleshooting.

ROP Calculation Method

On the technical side, you need to know two key things: how the EDR calculates on-bottom ROP, and how the user-set ROP averaging window affects the calculation.

The EDR calculates ROP by using a sliding window averaging technique. "Window" simply refers to a period of time. The sliding window averaging technique means that as new depth data is added to the averaging window, older data is removed before the values in the window are averaged. The EDR uses the averaging windows to calculate ROP five times per second, which it then displays once per second.

For more technical detail, look at the example below. It shows some of the key actions in the process, using a four-second averaging window length.

Time (Seconds)	Raw Depth Sensor Data	Averaged Depth Sensor Data	ROP (m/h)
-2.2	1	0.6	32.40
-2.0	1	0.7	32.94
-1.8	1	0.7	33.48
-1.6	0	0.7	34.02
-1.4	1	0.7	34.56
-1.2	0	0.6	34.56
-1.0	1	0.7	35.10
-0.8	1	0.7	35.64
-0.6	0	0.6	35.64
-0.4	1	0.7	36.18
-0.2	1	0.7	36.72
0.0	0	0.6	36.18

- 1 The system divides the window into smaller chunks. In this case, the four-second window is divided into two, two-second chunks. The raw depth sensor data shown here are depth ticks. Note that the entries are recorded every 0.2 seconds (five times per second).
- 2 The system calculates the average in the two-second window: $6 \div 10 \text{ readings} = 0.6$. To understand the “sliding” part of the process, imagine the red box moving up one row. In that case, the calculation becomes $7 \div 10 \text{ readings}$, or 0.7, as you can see recorded in the row above the 0.6.
- 3 The averaged depth sensor data is recorded using the same two-second chunk.
- 4 Last, the system uses a series of calculations to account for sensor calibration and to calculate the rate of penetration, based on the ROP units selected by the rig user.

ROP Averaging Window

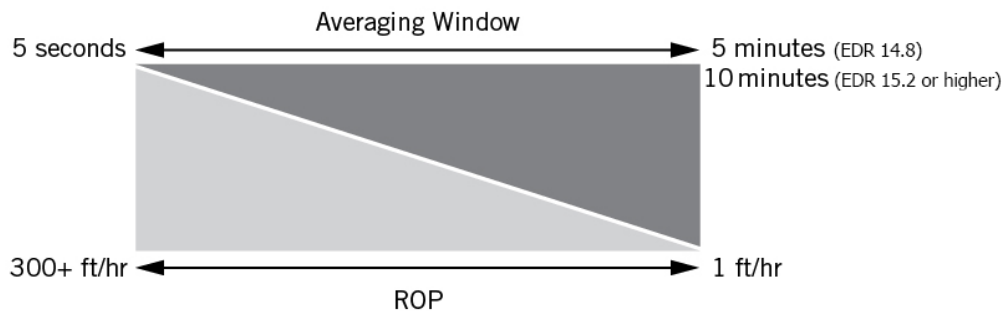
A default *Automatic* ROP averaging setting produces an optimal ROP value by continually monitoring and revising the averaging interval based on your drilling speed. Pason recommends using the default *Automatic* setting. The *Automatic* setting directly affects the trace called *ROP* (which is used in MSE calculations); it doesn't affect either the *EDR Instantaneous ROP* trace or AutoDriller ROP calculations.

Expert users can change the ROP averaging window length. The length of the averaging window controls how responsive the calculated ROP is to changes in drilling speed. The table below shows how the EDR calculates and displays ROP according the average window you choose.

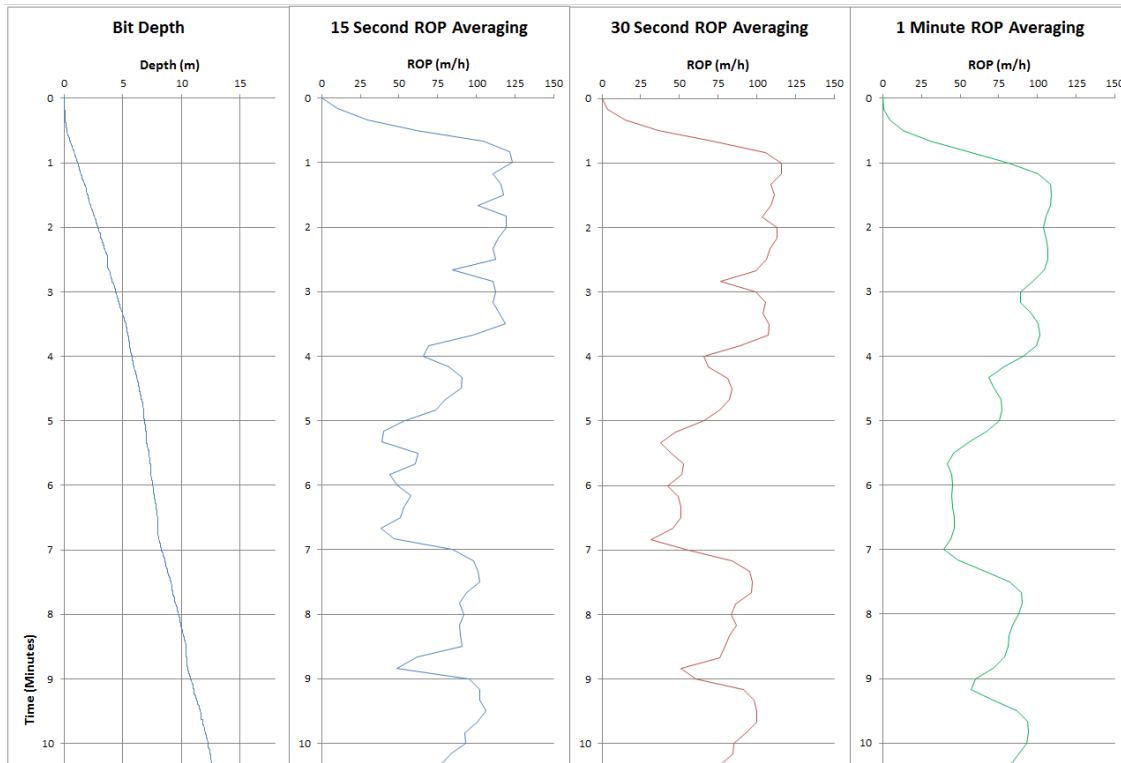
Averaging Window Setting	Time Interval (seconds)	Total ROP Calculations Performed	How the EDR Displays the ROP
5 Seconds	5	25	Once per second, using 25 calculations from the last 5 seconds
15 Seconds	15	75	Once per second, using 75 calculations from the last 15 seconds
30 Seconds	30	150	Once per second, using 150 calculations from the last 30 seconds
1 Minute	60	300	Once per second, using 300 calculations from the last 1 minute
2 Minutes	120	600	Once per second, using 600 calculations from the last 2 minutes
5 Minutes	300	1500	Once per second, using 1500 calculations from the last 5 minutes
10 Minutes	600	3000	Once per second, using 3000 calculations from the last 10 minutes. The 10-minute interval is available in EDR version 15.2 or higher.

Using a short averaging window length results in a rapidly updating ROP value that most closely represents the true instantaneous ROP. A short window length also results in a very detailed, choppy curve. On the other hand, using a longer window results in smoother ROP curves. The length you choose depends on your preference, and on drilling conditions. Follow these general guidelines:

- During fast drilling (high ROP), select a shorter averaging window for a smoother trace.
- During slow drilling (low ROP), select a longer averaging window for a smoother trace.



As you can see below, shorter averaging windows provide quicker responses to changes in ROP and longer windows provide smoother curves.



Setting the ROP Averaging Window

The EDR has a default ROP averaging setting of *Automatic*, which Pason recommends. However, you can change it to any of these intervals: 5 seconds, 15 seconds, 30 seconds, 1 minute, 2 minutes, 5 minutes, or 10 minutes.

To change the length of the ROP averaging window, follow these steps on the DHC or on a Rig Display in driller mode:

1. Select **Menu > Setup > Calibrate**.
2. Enter the calibration password (**255.3158**) and select **OK**.
3. Select **ROP**. The ROP Averaging Interval Setup screen opens.
4. Select the **Change** button to toggle to a new ROP averaging interval. *Automatic* is included as one of the choices.
5. Select **Exit** to save the calibrations and return to the Calibration Menu.

The EDR applies your selection.

Note:

Pason recommends using the default *Automatic* interval setting. If you choose to set the interval yourself, as a general guideline, use a short averaging window when drilling fast and use a long averaging window when drilling slow.

Setting the OROP Averaging Window

OROP doesn't use a sliding averaging window technique. It's a simple average based on whatever length of time you enter. To configure the time window for OROP, on the DHC or on a Rig Display in driller mode, follow these steps:

1. Select the trace box you want to display OROP.
2. Select OROP from the trace list.
3. Click on the **Time Window mins** box and enter the number of *minutes* you want the EDR to use to calculate the OROP average.
4. When finished, click **OK**.

