

Rig data feed (WITS)

SharpShooter can read the rig's WITS Level 0 feed so the hole depth, bit depth and the rest of the rig's channels can be seen beside the slide sheet. It reads the feed. The only thing it sends is Pason's keep-alive (see below). The one thing it writes on the job is the slide sheet's slides - where the string slid and how far - from what the feed saw (see Slides entered from the feed below). A survey posted on the feed is offered - or, with **Add each new survey from the feed to the sheet by itself** ticked, goes on by itself when it sits sensibly after the last one - and never changes a survey already there (see Surveys posted on the feed below).

WITS Level 0 is the plain-text feed most rig-floor systems can hand out (Pason, and the other common data systems, under a name such as "WITS out", "WITS serial/TCP out" or "third-party data feed"). Ask the rig's data hand to turn it on for your computer.

Setting up the WITS connection, step by step

The usual rig set-up: the rig's data system (the EDR) sends WITS out of one serial port to the rig computer (computer 1), and computer 1 passes it on down a second cable to a second computer (computer 2) if there is one.

- **The cables.** EDR WITS port -> serial cable -> USB serial adapter on computer 1 (port A). For computer 2: a **null-modem** serial cable (9-pin, female both ends, send and receive crossed) from a second port on computer 1's adapter (port B - a 2- or 4-port USB serial adapter) to computer 2's own USB serial adapter. Most rig outputs need a null-modem cable or adapter between the rig's cable and computer 1's adapter too: a straight cable gives nothing at all. Pason's own ports are RS-422 - a USB adapter goes through Pason's RS-232 converter box.
- **1. At the rig.** Ask the rig's data hand to switch **WITS Level 0 out** on for the serial port your cable is in: 9600, 8 data bits, no parity, 1 stop bit.
- **2. Computer 1 - find the port.** Plug in the adapter. Windows **Device Manager > Ports (COM & LPT)** shows it as a COM port (install the adapter's driver if it shows with a warning).
- **3. Computer 1 - read the feed.** Open the job, then **Rig Data > Rig data feed (WITS)...** Choose **Serial cable from the rig**, leave the port on **Automatic** and **Pason keep-alive** ticked, and press **Start reading**. The state turns green and **Heard on the wire** starts counting. Most channels map themselves; check the **Measurements** tab (hole depth, bit depth, rotary RPM, torque, pressure, flow, toolface). From now on the feed starts by itself when the job opens.
- **4. Computer 1 - pass it on.** On the **Second computer** tab tick **Out of serial port** and leave it on **Automatic**: SharpShooter finds the port computer 2 is on by itself once computer 2 is reading (or pick port B and 9600).
- **5. Computer 2 - read the same feed.** Open the same job - copy it over with **Cross shift over the cable** if computer 2 does not have it - then **Rig Data > Rig data feed (WITS)...**, **Serial cable from the rig**, port **Automatic** (or **Find the cable**), keep-alive ticked, **Start reading**. Computer 2 reads exactly what the EDR sends, and records its own slides and activity from it.
- **6. Check both.** Both states green, the **Value now** column moving on both. Computer 2 gets the feed only while computer 1 is reading; nothing is ever sent to the EDR from computer 2.

If nothing arrives, see **If nothing arrives** under Connect below: the WITS output not switched on for that port, a straight cable where a null-modem one is needed, the wrong COM port, or the speed.

Open it

Rig Data > Rig data feed (WITS)... Open the job first: the mapping is saved with the job.

The window has the feed's state and **Start / Stop reading** at the top (grey stopped, amber searching or connecting, green reading), the connection in one card, and the rest on tabs: **Measurements** (the mapping and the rig's units), **Your channels**, **Everything the rig sends**, **Second computer** and **Settings** (rocking the pipe). Hover over a button for what it does.

It starts by itself: a job whose feed was reading when SharpShooter closed starts reading again the moment the job is opened, with the window closed. Stop reading turns that off until you start it again.

Connect

Three ways, depending on what the rig's system offers:

- **Serial cable from the rig** - a cable from the EDR into a USB serial adapter on this computer. Leave the port on **Automatic** (the standard): SharpShooter listens on every port at each usual speed until one sends WITS, reads that one only, and when the cable is unplugged or nothing arrives for 30 seconds it searches again by itself - no button to press. The port it found last goes first next time. Bluetooth ports and a port passing the feed on are never searched. Pick a COM port and speed (9600 is the usual one) to read that port only.
- **Rig computer over the network** - SharpShooter dials out. Enter the rig data computer's address and the port its WITS output uses.
- **Let the rig connect to this computer** - SharpShooter waits. Enter the port to listen on and give the rig hand this computer's address and that port.

Pason keep-alive (on unless you turn it off): a Pason EDR stops sending WITS unless the device on the other end sends it one packet at least every 30 seconds. SharpShooter sends Pason's own handshake packet - TVD, code 0111, with -9999 for "no value" - when reading starts and every 10 seconds after, on the cable and on the network, and the Automatic search sends it on each port it listens to. It changes nothing on the rig. Turn it off only for a port the rig has set to Send Only.

Press **Start reading**. Readings show the moment they arrive. **Heard on the wire** counts the channels arriving, and each one shows its **Value now**. **Stop reading** always stops straight away.

If nothing arrives:

- On the network, the feed is not switched on at the rig end, the address or port is wrong, or Windows Firewall is blocking the port on this computer.
- On the cable, the status line says so after a minute, with how many keep-alives went out. Pason's settings are 9600, 8 data bits, no parity, 1 stop bit. Most rig serial outputs need a **null-modem** cable or adapter between the rig's cable and the USB adapter; a straight cable gives nothing at all. Pason's own ports are RS-422: a third-party RS-232 device such as a USB adapter goes through Pason's RS-232 converter box. Check the WITS output is switched on for the port the cable is in, and that the COM port chosen is the adapter the cable is plugged into (Device Manager > Ports shows them).
- If the status line counts bytes coming in but no WITS records, the speed is wrong - **Automatic** tries every speed.

Choose a port on the rig's side wherever possible, and do not forward a WITS port on an internet router. The feed carries no password of any kind.

Two computers on one WITS port

The EDR usually has one WITS port. A 4-port USB serial adapter does not split it by itself - each of its ports is separate - so the computer on the EDR passes the feed on. On the Rig data feed window's **Second computer** tab:

- **Out of serial port** - plug the EDR into one port of the adapter as usual, run a **null-modem cable** from another port of the adapter to the second computer's serial port (its own USB serial adapter), and pick that port and speed here. On the second computer choose **Serial cable from the rig**, its own port and the same speed (or press **Find the cable**).
- **Send to a computer on the network** - both computers on the same rig network or Wi-Fi. On the second computer choose **Let the rig connect to this computer**, port 5000, and press **Start reading** - it waits. Here, tick **Send to a computer on the network** and type the second computer's address (and port, 5000 unless you changed it). This computer connects out to it, so nothing on this computer needs a firewall opening; the first time, Windows on the second computer may ask whether SharpShooter may use the network - choose **Allow** (private networks). The feed is never sent to the rig's own computer.

The bytes go on exactly as the EDR sent them, so the second computer reads them as if it were on the EDR - SharpShooter or any other WITS program. Nothing is sent to the rig, and the EDR's own port is never written to. Only this computer keeps the Pason keep-alive going, so the second computer's **Pason keep-alive** can be off. The second computer gets the feed only while this one is reading. A second computer that is slow, unplugged or switched off never holds this one up.

Cross shift over the cable

The null-modem cable between the two computers also carries the job, both ways. Open **Cross shift over the cable** (the three-dot menu, or the button on the **Second computer** tab) on both computers, press **Send this job** on the one with the job and **Get the job** on the other. The whole job copies across - surveys, slides, plan, BHA, offsets, casing, rig activity and settings - and is checked against a fingerprint at the far end; a line lost or garbled on the cable is sent again by itself. The rig feed keeps flowing while it copies (the job's lines go between the records). At 115200 allow about a minute for every 400 KB (at 9600, a minute for every 33 KB); the window says the size and the time to expect. The well database reference data of an imported job stays behind - the other computer keeps its own. The job arrives as a database of its own beside the current one (cross-shift-....db) and SharpShooter offers to open it; nothing runs from what comes over. Both computers need the 27 September 2026 build or later: during a handover the rig computer gives the second computer a turn to answer about every half second, and an older copy at either end cannot take turns - if the other computer does not answer, the window says so, the handover stops and the feed carries on (hand over by Wi-Fi or a USB stick instead). The second computer must be reading the feed **by cable** with the keep-alive on, and it never sends a byte until it has heard SharpShooter on the rig computer.

Just the surveys and slides. When the other computer already has the well, press **Send the surveys and slides only** - a few kilobytes, seconds on the cable. On the other computer open the same well and press **Get**: the surveys (with their BHA and sensor offset), slides, BHAs and INC/AZ ahead rows it does not have are added to it. Nothing there is changed - a survey that reads differently at the same depth, or a slide overlapping one there with other depths, stays as it is there and the window says so, and a survey above that copy's tie-in stays out. Both computers need this build.

Cable speed. Automatic - nothing to set. For a handover both computers go to **115200** baud by themselves, twelve times quicker than 9600, and back to the cable's own speed (9600 unless changed on the **Second computer** tab) when it is done; the rig computer settles it and the cross shift window says which speed it is on. If 115200 does not come through, both go back to 9600 by themselves and the handover carries on there. The rig feed keeps going to the second computer while a job copies.

Without software: a **Y cable** from the EDR port works too - the EDR's transmit (pin 3 on a 9-pin plug) and ground (pin 5) to both computers' receive (pin 2) and ground, with only one computer's transmit (pin 3) wired back to the EDR's receive (pin 2) for the keep-alive. Do not use a plain parallel Y splitter that ties both computers' transmit wires together.

Map the channels

A WITS feed is a list of numbered codes. Which number carries which measurement differs from rig to rig, so the codes have to be lined up with SharpShooter's measurements once per rig.

Press **Work out the mapping** after the values have been arriving for a few seconds. SharpShooter recognises the two depth channels from the depth this well is already at, and picks the rest from the codes actually being heard and the range each measurement has to fall in. Anything it cannot work out is left blank and named.

Check every row against **Value now** before relying on it. A row whose value is outside the believable range for that measurement is marked **Value looks wrong for this measurement** - usually the wrong code, or feet and metres the other way round.

To set or change a row by hand, click its **WITS code** (or select it and press **Set the code for the selected row...**), or type the code in. The list shows the row's usual code first even before the rig sends it - 0723 for **MWD Continuous Inc**, 0724 for **MWD Continuous Azi** - then every code the rig is sending with its name and value now. A row whose code the rig has not sent says **Rig not sending 0723 yet**: add that item to the WITS the rig's recorder sends out. **Remove the code from the selected row** clears one.

Mapped by themselves: the rig sends the MWD's continuous readings only now and then (with the pumps on, as the MWD pulses them up), so they are often not there when the mapping is first worked out. **MWD Continuous Inc** (0723) and **MWD Continuous Azi** (0724) now map by themselves the first time the rig sends them with a believable value, if the row is still empty - saved with the job straight away, with the Rig data feed window open or not. The tool's six raw readings do the same, as a set, when all six usual codes arrive (see Raw survey readings below). A row you clear by hand stays empty until you set a code on it again. A channel of your own on the same code (added under Your own channels) is taken off: the row carries it now, and the slide call reads it.

Press **Save mapping**. The mapping travels with the job, so a job sent to the other hand or to the office arrives mapped. The address, port and direction are remembered on this computer only.

Your own channels

A rig can send items SharpShooter has no row for. Under the mapping, **Your own channels** takes up to 20 of them: press **Add a channel...**, type the four-digit **WITS code** and a **name** (for example 0725 - MWD Continuous Gamma) and, if you like, the unit it comes in. Each one shows its **Value now** live, and the new values are kept with the job with the bit depth at the time - at most one every 5 seconds each - so **Export CSV** gives them back as a spreadsheet later. A code already carried by one of the standard rows is refused (its row shows it). Your own channels are shown and kept only: nothing in the slide call, the activity or the anti-collision reads them.

The measurements SharpShooter maps are: hole depth, bit depth, block height, rate of penetration, hook load, weight on bit, torque, rotary RPM, standpipe pressure, differential pressure, flow in, gamma, inclination, azimuth, gravity toolface and magnetic toolface - and the MWD's **MWD Continuous Inc** and **MWD Continuous Azi** (0723 and 0724 on Pason), an **at-bit inclination** where the assembly has one (see Continuous INC / AZ below), and the tool's six **raw survey readings** (see Raw survey readings below).

Use one of your channels for a measurement: select it and press **Use the selected channel for a measurement...** - pick the measurement (the likely one is picked already: Ax, Accel X or Gx is Raw Gx; Mx, Mag X, Bx or Hx is Raw Bx; your continuous inclination is MWD Continuous Inc) - or press **Tie my channels to measurements by name** to do all of them at once. The measurement then reads that code in place of the one it had, the channel comes off your list, and your name stays on the code in the lists and the EDR traces. Picking one of your channels' codes on a measurement row does the same.

Every item the rig sends

Below your own channels, **Every item the rig sends** lists every WITS item on the wire - nothing to map or type. Each one is named from the standard WITS list (for example 0126 **Tank volume (active)**, 0123 **Pump stroke rate #1**, 0122 **Casing (choke) pressure**, 0140 **Gas (average)**), by the measurement it is mapped to, or by your own channel's name; an item the list does not name shows its WITS record, for example **MWD formation evaluation item 0823**. **Rename the selected item...** (or double-click it) gives it your rig's name and unit; an empty name goes back to the standard one.

While the feed reads, each item's value is kept with the job against the time - when it changes, one every 5 seconds at most, and once a minute when it holds still - whatever the bit is doing. The well, date and time items are left out. The values live in a file of their own beside the database (*name*.db.traces), left out of the 15-minute automatic backups because a month of a busy rig is a few hundred MB. Untick **Keep every item the rig sends** to stop it for this job; what is kept stays. **Show the traces...** opens **Rig Data > EDR traces** (below).

Ask what a long stop was (30 min or more): when the bit has sat still with the rotary stopped for 30 minutes or more, a small window asks what it was - rig repair, cut and slip drilling line, test BOP or any of your company's codes - with an optional note. Save puts it on the activity as a typed line over the feed's Rig service line (change or delete it on the Activity window like any typed line); **Leave as Rig service** keeps the feed's line. One question at a time: stops that end while one is open wait their turn. It is not asked while the BHA is out of the hole, or for a stop a typed line already covers.

EDR traces

Rig Data > EDR traces draws every item kept against the time, like the rig's own EDR: tracks side by side, time running down the page with the newest at the bottom, up to four curves on a track, each with its own scale shown in the heading with its value, and the rig's activity in a coloured strip beside the clock (green rotating, orange sliding, grey connection, blue circulating, purple tripping, brown rig service). Bit and hole depth on the same track share one scale.

- **Hover** for every curve's value at that moment, and the time.
- **Zoom in** and **Zoom out** (or the + and - keys, or **Ctrl + wheel**) halve or double the time shown, from 1 minute to 30 days. Pick a time in **Show**, or type your own there (45 min, 3 h, 2 days) and press Enter. **Drag down the traces** over a stretch and let go: that stretch fills the screen. **Show all** (Home key) puts the whole record on one screen. The clock lines go down to every 5 seconds when zoomed in.
- **Mouse wheel** moves back and forward in time (Up / Down and Page Up / Page Down keys too). **Earlier**, **Later** and **Go to...** move the window; **Live** (End key) follows the newest data - double-click the traces to turn it back on.
- **Click a track's heading** (or right-click a track): add a curve (up to four), take one off, set its scale by hand or let it scale by itself, move or remove the track. **Add a track** adds one; **Standard tracks** puts back hook load and WOB, RPM and torque, standpipe and differential pressure with flow in, hole and bit depth with ROP, pits and gas. The tracks are remembered on this computer.

- **Export (CSV)...** writes the curves shown, a row every 5 seconds to 1 minute. **Save picture...** writes a PNG of the window.
- An **imported EDR file** fills the traces too, on the same items and in the rig's units.
- On the **Office** copy the traces come from the rig through the website (the company's Well data on the portal has to be on), and the window takes the newest every minute while **Live** is on.

Nothing SharpShooter works out reads the traces: they are for looking at and exporting.

■ The rig's units

A WITS feed carries numbers, not units, and each recorder sends its own: Pason sends the rig's display units and converts torque only. Canadian rigs usually send metric, US rigs imperial - and not always the WITS standard (kdaN, kN·m, kPa, L/min metric; klb, kft·lb, psi, gal/min English).

- **SharpShooter works the units out by itself** while the feed is reading. Every ten seconds it compares the live values with this well: the depth on the wire against the well's depth (metres or feet - feet means an imperial rig), the hook load against the weight of a string that long, and standpipe, flow and torque while the rig is pumping and rotating. A row that cannot be right is moved to the unit that fits, saved with the job, and the line above the table says what changed and why; weight on bit follows the hook load and differential follows the standpipe.
- The **Rig units** column shows how each channel is read; **Value now** shows the value as sent and, when the job is displayed in the other system, converted (for example *92.4 kdaN (208 klb)*).
- **Click a row's Rig units** to change it by hand (the list stays open until you pick): load in daN, kdaN, kN, t, klb or lb; torque in kN·m, daN·m, N·m, kft·lb or ft·lb; pressure in kPa, MPa, bar or psi; flow in L/min, m³/min, gal/min or bbl/min. The depths, block height and ROP move together. It is saved with the job straight away.
- The Status column says *looks like kdaN* (or whatever fits) on a row that does not add up.
- The rig units are kept with the job. They are separate from the job's METRIC | IMPERIAL display: a metric job can read a US rig, and switching the display never changes how the rig is read.
- **Torque on a metric rig:** a number in the thousands is read as **ft·lb** - Canadian rigs send torque in ft·lb - not daN·m or N·m. A job that had it as daN·m or N·m is moved to ft·lb once; pick another by hand and it stays.
- **Rotary RPM** shows RPM, gamma API.
- Pason's default codes are suggested too: hook load 0115, weight on bit 0117, torque 0119, flow 0219 (total pump output), azimuth 0715 (corrected).

■ Slides entered from the feed

With the feed reading and **rotary RPM** mapped, the slide sheet records your slides itself: where the string slid, how many metres, and the average toolface the feed saw (45R, 30L, or 123Mag in vertical hole), with the note *From the rig feed*. The row is the **effective slide** - the metres slid times the share of the slide the toolface held - so 12.5 m slid with the toolface held 80% is entered as 10.0 m from where the slide started; the note keeps *slid 12.5 m · T/F held 80% · effective 10.0 m*. With no toolface mapped the whole slide is entered. A slide is a run of one-metre cells where the string was not turning while the bit drilled ahead - at least a metre and at least a minute, so a connection or a survey on bottom is not a slide. The row goes on once the slide is over - when the string rotates on bottom again, or at the connection - not metre by metre while you slide. Map **gravity toolface** (and magnetic for vertical hole) and the rows carry the T/F too; without it they read *T/F?* until you type one.

Slide, a short rotate, slide again is one slide. Rotate for 3.5 m or less between two slides - toolfaces no more than 90 degrees apart - and the sheet has one row: the metres slid in both parts, at the toolface of the two together, from where the slide started, noted *2 slides joined · 2.8 m rotated between*. The rotate is not counted as slid. The first part goes on when the rotate starts and grows to take in the second once it is over; two rows the feed wrote before for one such slide are folded into one. A row you typed or changed is left as it is, and Undo puts the two back. A stretch the feed did not see (it dropped) is not a rotate and still splits.

Every row it writes is yours to edit or delete like any other. Retype a From, To or T/F and the feed never touches that row again; delete it or Undo it and it stays off. A slide you typed by hand always wins over what the feed saw at the same depth. Slides drilled before the feed started watching a well are not added on their own: **Rig feed slides** on the slide sheet's button row lists everything the feed saw between two depths - slid and rotated metres, T/F and how well it was held - and enters the ones that are not on the sheet. The depths are the feed's bit depth: check them against the tally. With the feed off, the sheet works exactly as before.

Auto-enter slides (on the survey sheet's rig feed bar, beside Add to sheet; ticked unless you untick it) turns this on or off for the job. Unticked, the feed still records every slide it sees, and **Rig feed slides** enters them when you choose.

■ Import an EDR file (no live feed)

Rig Data > Import EDR file... reads the rig recorder's export after the fact - for a well drilled without the feed connected, or a stretch where the feed dropped. It reads:

- **Pason** time exports: *YYYY/MM/DD*, *HH:MM:SS*, *Hole Depth*, *Bit Depth*, *Block Height*, *Rate Of Penetration*, *Hook Load*, *Weight on Bit*, *Rotary RPM* or *Top Drive Rotary*, *Top Drive Torque*, *Standpipe Pressure*, *Differential Pressure*, *Total Pump Output*, *Gamma*, *Inclination*, *Azimuth*, toolface and *On Bottom* - with the unit in brackets (meters, feet, kdaN, klbs, kN.m, kft_lbs, kPa, psi, m3_per_min, gal_per_min).
- **RigCLOUD, WellData / RigSense** and other exports (*Date*, *Depth - Bit*, *Bit Position*, *Hookload*, *Top Drive RPM*, *Flow In*, *Pump Pressure*), WITSML mnemonics (DMEA, DBTM, BPOS, ROPA, HKLA, WOBA, TQA, RPMA, SPPA, MFIA) and **LAS** time logs.
- CSV, tab or text files, and **.xlsx** (save an old .xls as .xlsx first).

The window shows each measurement it found, the column it came from and the unit - *from the file* when the file says so, *worked out - check it* when the numbers decided (feet or metres from this well's depth, then loads, pressures, flow and torque from what they read while drilling, as **Check the units** does for the live feed). Change any unit before you press **Import**.

The file is then played through the same rules as the live feed: the rig log by bit depth while on bottom, the **Activity** window (rotating, sliding, connections, trips), rocking the pipe (on 1-second files) and, with rotary RPM in the file, the slides entered on the sheet marked *From the rig feed*. A 10-second export counts ten seconds a row; a gap of more than 30 seconds shows as lost feed. Times the job already has from the live feed are skipped, so importing the same file twice - or one that overlaps the live record - never counts anything twice. Hand-typed slides always win, and nothing is sent to the rig. Times are read as this computer's local time.

■ Surveys posted on the feed

Pason sends the last posted survey on the feed - **0708** sensor depth, **0713** inclination, **0715** azimuth - when the MWD sends its surveys into Pason. Map the three (Survey depth, Survey INC, Survey AZ) and, when a new set settles for a few seconds, the slide sheet shows it in a bar with **Add to sheet** and **Dismiss**; the phone app's Surveys tab shows the same. Add puts on only a new, deeper survey - on the pending tally row already at that depth, or on the sheet's blank row - and never changes a survey or a tally depth already on the sheet. A survey that differs from the one on the sheet at that depth is shown, not applied. Some rigs send a live depth on 0708 instead; that is recognised (the depth keeps moving while the angles stand still) and nothing is offered.

Auto-accept surveys (the tick on the survey sheet's rig feed bar, beside Add to sheet - the bar shows whenever the feed is reading; saved with the job, off until you tick it) puts each new survey on as soon as it lands, when it sits sensibly after the last survey on the sheet: deeper than it and no more than 100 m on, no dogleg over 15°/30 m, not below the bit, and - when the survey check readings (gravity, field, dip) are mapped - not graded bad. Anything else waits in the bar with the reason, for you to Add or Dismiss. The survey sheet has to be open for it to go on (it goes on the moment you open it), it never changes a survey or a tally depth already on the sheet, and **Undo** takes one off.

Raw survey readings (for MSA)

Some MWD systems also send the tool's raw readings for each survey: the three gravity and three field readings. Map them on the rows **Raw Gx (survey), Raw Gy, Raw Gz, Raw Bx, Raw By and Raw Bz (survey)** - the codes differ from rig to rig, so check each **Value now** against the MWD hand's survey printout. The codes offered first are Ax 0733, Ay 0734, Az 0735 (gravity, the accelerometers) and Mx 0736, My 0737, Mz 0738 (field, the magnetometers); when all six arrive they map by themselves, and on another rig a single one of them is never taken on its own. These codes never go to the client portal, mapped or not. Each time a survey is posted on the feed with all six there, SharpShooter keeps its six readings with the survey depth, INC and AZ and the BHA in the hole, in the job's raw readings for **Rig Data > MSA from raw readings** (gravity in g, m/s² or mg and field in nT, μ T or gauss are told apart by size). A second reading at the same BHA and depth is kept out. The readings stay on this computer - they never go to the client portal - and nothing works out an MSA until you press **Work it out**.

Rig activity from the feed

Activity > Rig activity fills itself in from the feed, second by second:

- **on bottom making new hole** - rotating or sliding (drilling when no rotary RPM is mapped). The pumps are not asked: drilling is told from the bit and the blocks. The bit picked up 0.3 m or more, or the string in the slips (the blocks moving while the bit depth holds still), is a **connection**, whatever the rotary does - backing out and spinning in the next stand never reads as a slide. After a connection it is drilling again only once new hole is made. A pump reading that is missing, stuck on or stuck off changes nothing here. New hole is the hole getting deeper - the bit set down a few centimetres in the slips makes none - and a drilling line needs 0.2 m of it; drilling slower than about 0.4 m/h reads as pauses on bottom. When the feed starts, the first reading is where the hole is, not new hole: a bit sitting still reads as off bottom until it drills, and drilling already under way is one line from the first second;
- **within 40 m of bottom** - a connection; circulating when the pumps run on past 20 minutes;
- **more than 40 m off bottom with the pumps off** - a trip, out or in by the way the bit is going; a short stop in the slips between stands is part of the same trip;
- **more than 40 m off bottom with the pumps on** - circulating; **running in with the pumps on and the string turning** - reaming (code 3); **running in with the pumps on and the rotary stopped** - filling pipe, still tripping in;
- **back from a trip in, before drilling resumes** - never a connection: near bottom it stays **tripping in** (pumps off, or on with the rotary stopped), or **reaming / wash to bottom** when the string turns and goes down with the pumps on. Connections count again once new hole is made;
- **after casing is run, before new hole** - the string turning, the pumps on and the bit going down is **drilling cement** (code 2C); its metres are not counted as drilled. A casing line is the one written after Running casing, or any line with the casing code;
- **anywhere, the bit sitting still with the rotary stopped for more than 10 minutes** - a **rig service** (code 7), from the moment it stopped.

The lines are coloured: **rotate blue, slide on magnetic toolface orange, slide on gravity toolface green** (which toolface is the job's crossover at the slide's depth).

Each line shows the **Parameters** it was drilled with (WOB, RPM, torque, differential, flow and ROP averaged over its depths, in the job's units; the toolface held on a slide), the **Formation** the bit was in (from the job's formation tops and the surveys), and the **BHA**. Lines under half a minute are left out of the list; their time still counts. Click a line to change it. **Save**, beside the day picker, writes the activity down and sends it to the office when the well is linked and you are signed in; saving or deleting a line sends it too. The codes are the full standard list (IADC 1-34, with 2S sliding, 6I tripping in and 20A connection).

Pumps on under Auto is learned from this rig: once the feed has seen the rig pump, the pumps count as on from 30% of the flow in (or, with no flow mapped, the standpipe pressure) it pumps at - never under the pumps-on settings - so a trickle reads as off. The pumps decide only circulating, tripping, reaming, filling pipe, drilling cement and the cement steps - never drilling or sliding. **Sliding or rotating** is the slide signs' answer: the rotary RPM, a backwards turn, the torque against the rotating torque, a steady toolface, and - when the rig sends one - the rig's own slide seen / effective slide figure. That last one can be switched off on the Settings tab (Slide signs), because how the rig works its figure out is not known to SharpShooter. The Thresholds window shows what it learned. A line that says drilling but made less than 0.2 m of new hole reads as a connection or a pause.

Thresholds... on the Activity window shows every number the activity is worked out with - near bottom, longest connection, rig service, trip movement, pumps on, BHA depth, out of the hole, safety meeting, pause at surface, casing on bottom, cementing. **Auto** (ticked) uses SharpShooter's own numbers; untick it to change them. They are used from the next reading on and kept on this computer.

BHA laid down and picked up

The directional driller is usually away handling tools while the BHA comes out and the next one goes in, so the feed writes both by itself and asks only once the new BHA is in:

- On a well drilled past 100 m (330 ft), when the feed sees the bit coming up and it goes under 100 m, the trip is followed.
- When the bit is out of the hole (within 10 m of surface), **6L • Lay down BHA** goes on the activity - from when the bit came under 100 m to when it reached surface, with the BHA that was in the hole.
- When the bit starts back in, **6P • Pick up BHA** goes on from there, brought up to date until the bit is back past 100 m.
- Then SharpShooter asks **what went in the hole** (the question stays open until you answer):
- **New BHA picked up** - pick the BHA; it goes beside the pick-up and becomes the one in the hole.
- **Running casing** - the pick-up becomes **12 • Run casing and cement**, running until the next BHA goes in. The BHA column stays blank. Then the feed carries on by itself:
- **Circulate on bottom** - the casing within 20 m of the hole depth with the rig's pumps on for 2 minutes: **5 • Condition mud and circulate**, from when the pumps came on.
- **Cementing** - the rig's pumps off but returns still coming up the flow line for 5 minutes (the cementers pumping): **12 • Cementing**, from when the rig's pumps stopped. Displacing with the rig pumps is still cementing.
- **Nipple up BOP** - the flow line quiet with the rig's pumps off for 5 minutes: **14 • Nipple up BOP**, from when the flow stopped, until the next BHA starts in; then the feed writes the pick-up by itself.
- Map **Flow out (flow line)** (0128 on most rigs - the flow paddle, in percent or as a flow) for the cementing and nipple-up steps; "flow" is judged against what the flow line read while circulating on bottom, so either kind works.
- **Other** - your own code and what it is, the same way as casing.
- **Not a BHA change** - takes the two lines back off.
- **Later** leaves the lines as the feed wrote them.
- **Safety meeting**: on the way out under 100 m, the first time the **block height** stands still for 5 minutes, **26 • Safety meeting or drill** goes on from when the blocks stopped until they move again, and the lay-down starts after it. Not on the way in.
- **When the string gets light** the rig's bit depth often stops tracking. While it is not moving and the blocks are, SharpShooter follows the depth from the block travel instead: coming out, each metre the blocks go up is a metre the string comes up (lowering a component to the catwalk does not count); going in, each metre down is a metre in (hoisting a component does not count). Going in is counted only once the bit is out of the hole and the blocks have stood still for 10 minutes, so the last of the lay-down is not taken for the pick-up. As soon as the rig's bit depth moves again it is used as it is. Map **block height** on the Rig data feed window for this.
- A trip that turns back before the bit is out of the hole writes nothing. Closing SharpShooter part way through is fine: the trip carries on when it opens again.

On the Activity window, **right-click a line** and pick **Insert row after this one...** to put an activity in between: it starts where that line ended, and a typed line after it starts later, when the new one ends (a feed line needs nothing - the typed line takes its place for its own time). The window keeps its buttons on the bottom at any size; drag the bar between the two tables to give either more room, and **How is this worked out?** has the explanation.

BHA laid down... and **BHA picked up...** do the same by hand when there is no feed. They are ordinary typed lines: change or delete them like any other (one deleted by hand is not written again). A company using its own codes gets its own lay-down, pick-up or casing code when one is described that way.

The bottom is the rig's own **hole depth** whenever it is mapped, so a pipe tally filled in ahead never makes the hole look deeper than it is. The **BHA** column shows which BHA was in the hole when the feed wrote each line (the Activity window's status line, and the phone's Activity tab, show the one in the hole now). Lines written before 23 September have no BHA.

Continuous INC / AZ

Map **MWD Continuous Inc** (0723 on Pason) and **MWD Continuous Azi** (0724), and **At-bit inclination** if the assembly has an at-bit sensor. SharpShooter keeps each new reading the MWD sends while the pumps are on - a continuous reading at the sensor (the bit depth less the bit-to-sensor distance), an at-bit reading at the bit - so what the well did between two surveys is not lost: 91° on one survey and 91.1° on the next can hide a build to 93° and the slide that brought it back. The continuous AZ is kept and drawn; the slide call uses the **continuous INC only**, with the last survey's AZ.

- **Gamma** on the Continuous INC window says where its depth comes from: the BHA's gamma to bit (measured), or an assumed depth - the survey sensor's distance - when the BHA has no gamma to bit set. A change in gamma says the rock may have changed, not how hard it is.
- **Continuous INC** beside Real Time AC on the survey sheet draws the readings against depth with the surveys as dots and the slides as bars, lists them, and says what happened since the last survey. While the sensor is passing through the last slide it shows the **live build, turn and dogleg** through it.
- On the survey sheet's **LATEST SURVEY** row, while a slide is being seen by the sensor, SharpShooter shows **SLIDE BEING SEEN • Build +x.xx°/m • Cont INC yy.yy° • Motor z.z°/30m so far** (per ft on a feet job), brought up every 10 seconds; it goes away once a survey is past the slide. The motor output is worked out as the sensor goes into the slide: the INC change so far through the slide, divided by the share of the slide's toolface that builds or drops, over the length seen. When it cannot be worked out yet it says why (no toolface on the slide, a slide set mostly sideways, under 1 m seen, or the INC moving the other way). It is shown only - the slide call holds still through the slide. The **Auto-accept feed surveys** tick on the same row is the same switch as on this window.
- **Gamma**: when gamma is mapped, each new value with the pumps on is kept against the depth of the gamma sensor (the bit depth less the BHA's gamma-to-bit distance) and drawn under the continuous INC in the **Continuous INC / AZ / Gamma** window. It is kept and shown only for now - a later version may use it to spot a hard streak (a lens) beside a slide that did not get through.
- **START • Continuous INC** starts the slide call from the newest continuous INC past the last survey, with the last survey's AZ; **At bit • continuous INC** takes it on to the bit through the slides after it. The at-bit INC is used first when there is one.
- **Survey to survey**: that start is taken when a survey comes in (from the readings up to then) and holds until the next survey, where the call is worked out again. Readings in between are drawn and listed but do not move the call. A restart keeps the same start.
- **MOTOR • Continuous • last slide** reads the motor output off the continuous INC before and after the last slide the sensor has passed - what the slide really did, not survey to survey.
- Readings that fluctuate - that jump away from the readings either side of them - are thrown out (drawn as red crosses, listed as *not used*). When too many do, or the readings do not agree with the surveys within 1° at the same depths, none are used and the slide sheet goes back to **survey to survey**, and says why.

The call holds still through a slide

Once the feed shows a slide under way, the slide call stays as it was when the slide began, and the at-bit status says *Slide under way since 14:32 - the call stays as it was when the slide began and is worked out again once the slide is over.* Everything read during the slide - the slide itself, the continuous and at-bit INC - is kept, and counts as soon as the slide is over: the string rotating on bottom again, a connection (off bottom for more than 2 minutes), a trip, or more than 5 minutes circulating or waiting. A short pick-up to put the toolface back is part of the same slide. Continuous INC is used for what a finished slide did at its own depths and for where the hole is now; the rotating tendency still comes from the surveys.

Corrected (MSA) surveys from a file

Rig Data > Import corrected surveys (MSA)... reads the corrected survey list the MSA provider sends - CSV, tab or semicolon text (decimal commas too), column-aligned text, **.xlsx** or **LAS**. It finds the heading row and picks the **corrected** INC and AZ columns (not the raw ones, and never a column that holds the amount of correction), the depth unit (from the heading, a units row, a line above the table, or whichever unit lines up with the sheet), and the north reference (a *North reference* line, LAS *AZREF*, or the one kind of north the file mentions; with grid and true columns side by side it takes the job's). Every choice can be changed in the window.

Every station is lined up with the sheet (within 0.15 m):

- **the same** - nothing to do;
- **a correction** - the survey at that depth takes the file's INC and AZ; its MD, note and BHA stay. Ticked, unless it moves INC more than 1° or AZ more than 3° - then check it first;
- **deeper than the last survey** - a new survey on the active BHA, taking the pending tally row at that depth;
- **the tie-in, a depth between surveys, no tie-in yet** - shown and never applied.

A file whose azimuths are in a different north reference from the job is refused; a file that does not say needs a tick to confirm it matches. When every azimuth moves by the same amount, the window says so and nothing is ticked - that is a north-reference difference (grid convergence or declination), not an MSA correction. If the file has TVD, the window compares it with ours after the ticked changes. **Apply ticked** goes through the survey sheet's history: **Undo** takes it back, and each station is written down with the file, the time and the old angles.

MSA from the tool's raw readings (our own)

Rig Data > MSA from raw readings... works out a multi-station correction itself, from the MWD tool's raw readings - the three gravity and three field readings (Gx, Gy, Gz, Bx, By, Bz) of every survey in one BHA run.

1. **Import raw readings...** - the provider's raw survey export (CSV, text, Excel or LAS) with an MD column and the six readings; a BHA or run column and the provider's raw INC and AZ help. Gravity in g, m/s² or mg and field in nT, μT or gauss are told apart by size. The readings stay in the job's database on this computer and are never overwritten - a second reading at the same run and depth is kept out.
2. Check the **reference**: total field (nT), dip, gravity, declination and grid convergence - the same reference the MWD provider used. Tick **IFR** when it came from an in-field referencing service.
3. **Work it out.** The tool's axes are checked against the provider's own raw INC and AZ. Then the tool's fixed errors are found: the axial bias (drill-string magnetism) and axial scale always, the two cross-axial biases only when the surveys are spread round the toolface. Surveys taken while the tool moved, and ones far off the rest, are left out and listed with the reason.
4. Read the **verdict**: Good, Check before use, or Refused with the reason. It refuses under 10 surveys, when nearly every survey is in the east-west zone (a lateral within about 25-35° of east or west), when two different answers fit, or when even corrected the readings do not agree with the reference (check for outside iron).
5. **Send to review...** puts the corrected surveys through the same window as a provider's corrected file: nothing changes until you tick and Apply, and Undo takes it back. Surveys in the east-west zone are shown but not ticked.

It is advisory: the MWD provider's corrected survey stays the survey of record unless your company says otherwise. It never runs on its own, never uses the continuous INC / AZ, and never changes the plan, the slide call or the AC tool code.

Notes

- Depths and rates are shown in the job's own units. The mapping stores codes, not units, so re-check the depth rows if the rig changes its output units.
- Values of -999.25, -999 and 999999 are the usual "no data" markers and are treated as no value.
- If the recorder keeps its own slide length (Pason: **Effective Slide / Slide Seen**) and **Average Toolface**, map those channels as well - they are the rig's own numbers and they outweigh everything worked out here, on the live feed and in an EDR file alike.
- Sliding and rotating are told apart by four signs added up: the rotary stopped (under 5 RPM), the rotary turning backwards, surface torque down from the rotating torque the well is drilling with, and an MWD toolface that holds still. No one sign decides, and the pump pressure is not part of it; the feed window shows what each sign says. With only RPM mapped the answer is the same as it always was. Rocking the pipe - a few wraps each way, over and over - reads as sliding too: the RPM keeps coming back to zero (three reversals inside two minutes, each wrap under a minute), so the slide sheet, the log and the Activity window call it a slide marked ***pipe rocked***. The thresholds are on the Rig data feed window - **Rocking the pipe: reversals · within (s) · longest wrap (s) · stopped under (RPM)** - remembered on this computer and applied to the running feed at once; **Standard** puts 3 / 120 / 60 / 5 back. Off-bottom time, tripping and a stalled feed are not recorded.

- The rig's WITSML service is separate: owner copies use **Rig Data > WITSML / MWD surveys** for corrected surveys over WITSML; a corrected list sent as a file goes through **Import corrected surveys (MSA)** above.