AVS Electronic Circulating Valve

Technical Summary

Intelligent Drilling Tools introduce the Annular Velocity Splitflow or AVS electronic circulating valve with split flow and full bypass positions. AVS is an electronic multi-position circulating valve.

The AVS tools are not activated by drop balls or darts or any other type of mechanism delivered from surface through the drill pipe. The tools are electronic and intelligent, meaning they have onboard sensors with logic and can respond to surface commands sent by "Downlinking" a coded signal to the tool via a pattern of pumps on/off and/or specific RPMs according to a function map. The AVS tools read the signals and shift to the particular position requested.

The AVS has 3 positions:

1. Through Bore - all the drilling fluid flow goes directly through the tool, BHA and Bit.
2. Split Flow - This is an open position that can be nozzled to allow a certain amount of the flow to be diverted into the Annulus, bypassing the BHA. This can be engineered using IDT's SplitFlow software to allow the minimum flow requirement to power MWD / RSS / Motor / Bit hydraulics etc., and the remainder out to the annulus. This maximises Annular Velocity for a given surface pressure increasing Hole Cleaning ability.
3. Full Bypass - This position opens up the Total Flow Area (TFA) further thus allowing maximum flow rate to the annulus for the highest Annular Velocity at the lowest surface pressure. Additionally if Lost Circulation Material (LCM) is pumped, the tool can pass 150ppb coarse LCM. A ball valve closes off the bore to ensure that the Drilling tools and Bit do not become blocked by the LCM material.

Features	Benefits
• No drop balls, Darts or RFID tags	• Can be run in any inclination well
• Command via surface Downlink	• Can be activated in Horizontal wells
• Simple and Rapid commands	• Can be run anywhere in the BHA
• Throughbore at all times	• Can be run below an MWD
• Battery powered. Low power draw	• Splitflow maximises Annular Velocity
• In excess of 100 cycles	• Up to 200ppb LCM through Bypass
• Splitflow position with Variable	• LCM will not enter BHA in Bypass
• Bypass position with BHA shutoff	• Cleans hole while drilling in Splitflow
• 4in^2 TFA in full Bypass position	• No waiting for Balls and Darts to drop

AVS Applications

The AVS has multiple applications including:

Maximise hole cleaning while drilling
Pumping LCM
stabilisers preventing pack offs
Run behind Reamer
Subsea Riser / BOP Jetting
Hole cleaning with Tapered String

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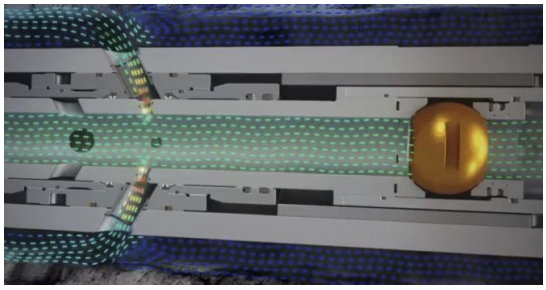
Technical Specification

AVS Tool OD (in)	7	8
Hole Size (in)	8.5	12.25
Tool ID, min (in)	2	2.36
Tool Length (ft)	14.5	17
Tool Weight (tonne)	0.71	1.05
Total Flow Area (in^2):		
Pre-Activation TFA (Through Bore)	3.14	4.37
Split Flow TFA (To Annulus), min/max*	0.20/0.44	0.20/0.44
Full Bypass TFA (To Annulus)	4.00	4.00
Number of Ports	4	4
Number of Cycles	>100***	>100***
Maximum Flow Rate (gpm)	>900	>1400
Minimum Activation Flow Rate (Water) (gpm)**	<100	<100
Maximum Differential Pressure (psi)	5000	5000
Pre-Activation Pressure Drop Across Tool (Water) (psi)	34@500gpm	45@1000gpm
Maximum Tensile Load (lbs)	690,000	900,000
Maximum Torsional Load (ft-lbs)	61,000	88,000
Make up Torque (ft-lbs)	38,000	52,000
Tool Joint End Connections (Box x Pin)	NC50	6 5/8 API REG
Temperature Rating (°C) max.	150	150

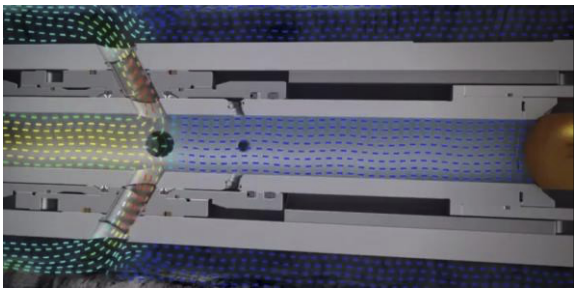
* Nozzle TFA can be selected to fit Splitflow Profile

** Depends on Bit TFA/hydraulics

*** Depends on bottom hole temperature but batteries can last for over 6 weeks once switched on.



Splitflow Position



Bypass Position

AVS Electronic Circulating Valve

Datasheets

INTELLIGENT DRILLING TOOLS

7" AVS Performance Data Sheet

Material: AISI 4330V
Yield Strength: 150 ksi

TOOL BODY

	Nominal 100% RBW	96% RBW
OD (in):	7.060	7.000
Wall Thickness (in:)	0.880	0.850
ID (in):	5.300	5.300
Critical Buckling Force (lbf):	235727	224258
Tensile Strength (lbf):	1022793	968807
Torsional Strength (ft.lbf):	164175	154711

Note: Buckling Force Calculated based on uniform OD and wall thickness.

AVS ASSEMBLY

		Weight (lbf):	1404
Fluid Displacement (gal):	23.69	Length (ft):	14.5
Fluid Capacity (gal):	5.79	Drift Size (in):	1.938
		Differential Pressure Capacity (psi):	5000
		Hydrostatic Pressure Capacity (psi):	15000

INSPECTION INTERVALS

Standard Operating Conditions:	2200 krev
Severe Operating Conditions:	1350 krev

Notes: Standard operating conditions assume maximum 3 deg/100ft DLS and no significant impact or shock loading.
Severe conditions upto a maximum 10 deg/100ft DLS or if jarring / high vibration events occur.

UPPER EXTERNAL CONNECTION: NC50

Tool Connection OD (in):	7.000
Example Mating Component Connection ID (in):	2.813
Example Mating Component Material Yield (ksi):	110
Maximum MUT (ft.lbf):	31519
Tension at Connection Yield (Max MUT) (lbf):	983121
Minimum MUT (ft.lbf):	28911
Tension at Connection Yield (Min MUT) (lbf):	1140885
Connection Torsional Strength (ft.lbf):	52531
Connection Tensile Strength (lbf):	1140885

Notes: Mating connection information provided is intended as a guide, user must ensure adjoining components are suitable
MUT values are based on a dope friction factor of 1.0

LOWER EXTERNAL CONNECTION: NC50

Example Mating Component Connection OD (in):	6.750
Tool Connection ID (in):	2.813
Example Mating Component Material Yield (ksi):	110
Maximum MUT (ft.lbf):	31130
Tension at Connection Yield (Max MUT) (lbf):	868867
Minimum MUT (ft.lbf):	26106
Tension at Connection Yield (Min MUT) (lbf):	1140885
Connection Torsional Strength (ft.lbf):	51883
Connection Tensile Strength (lbf):	1140885

Notes: Mating connection information provided is intended as a guide, user must ensure adjoining components are suitable
MUT values are based on a dope friction factor of 1.0

INTELLIGENT DRILLING TOOLS

8.25" AVS Performance Data Sheet

Material: AISI 4145H
Yield Strength: 100 ksi

TOOL BODY

	Nominal 100% RBW	96% RBW
OD (in):	8.250	8.160
Wall Thickness (in:)	1.125	1.080
ID (in):	6.000	6.000
Critical Buckling Force (lbf):	239136	228672
Tensile Strength (lbf):	1033223	990370
Torsional Strength (ft.lbf):	200190	191604

Note: Buckling Force Calculated based on uniform OD and wall thickness.

AVS ASSEMBLY

		Weight (lbf):	2237
Fluid Displacement (gal):	40.56	Length (ft):	17
Fluid Capacity (gal):	6.64	Drift Size (in):	2.244
		Differential Pressure Capacity (psi):	5000
		Hydrostatic Pressure Capacity (psi):	15000

INSPECTION INTERVALS

Standard Operating Conditions:	2200 krev
Severe Operating Conditions:	1350 krev

Notes: Standard operating conditions assume maximum 3 deg/100ft DLS and no significant impact or shock loading.
Severe conditions upto a maximum 10 deg/100ft DLS or if jarring / high vibration events occur.

UPPER EXTERNAL CONNECTION: 6 5/8 REG

Tool Connection OD (in):	8.250
Example Mating Component Connection ID (in):	2.81
Example Mating Component Material Yield (ksi):	100
Maximum MUT (ft.lbf):	52225
Tension at Connection Yield (Max MUT) (lbf):	1399648
Minimum MUT (ft.lbf):	35445
Tension at Connection Yield (Min MUT) (lbf):	1650950
Connection Torsional Strength (ft.lbf):	87041
Connection Tensile Strength (lbf):	1650950

Notes: Mating connection information provided is intended as a guide, user must ensure adjoining components are suitable
MUT values are based on a dope friction factor of 1.0

LOWER EXTERNAL CONNECTION: 6 5/8 REG

Example Mating Component Connection OD (in):	7.625
Tool Connection ID (in):	2.81
Example Mating Component Material Yield (ksi):	100
Maximum MUT (ft.lbf):	51090
Tension at Connection Yield (Max MUT) (lbf):	1189198
Minimum MUT (ft.lbf):	30389
Tension at Connection Yield (Min MUT) (lbf):	1650950
Connection Torsional Strength (ft.lbf):	85150
Connection Tensile Strength (lbf):	1650950

Notes: Mating connection information provided is intended as a guide, user must ensure adjoining components are suitable
MUT values are based on a dope friction factor of 1.0

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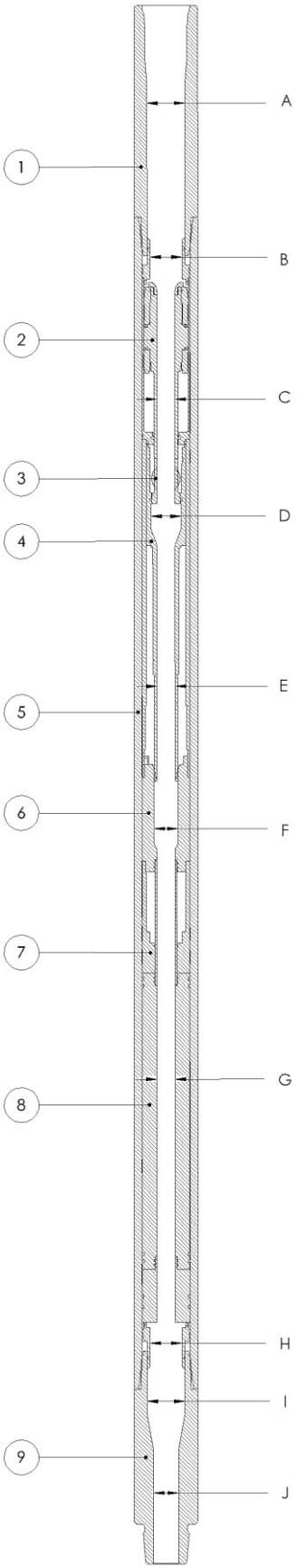
Fishing Diagram (7in)

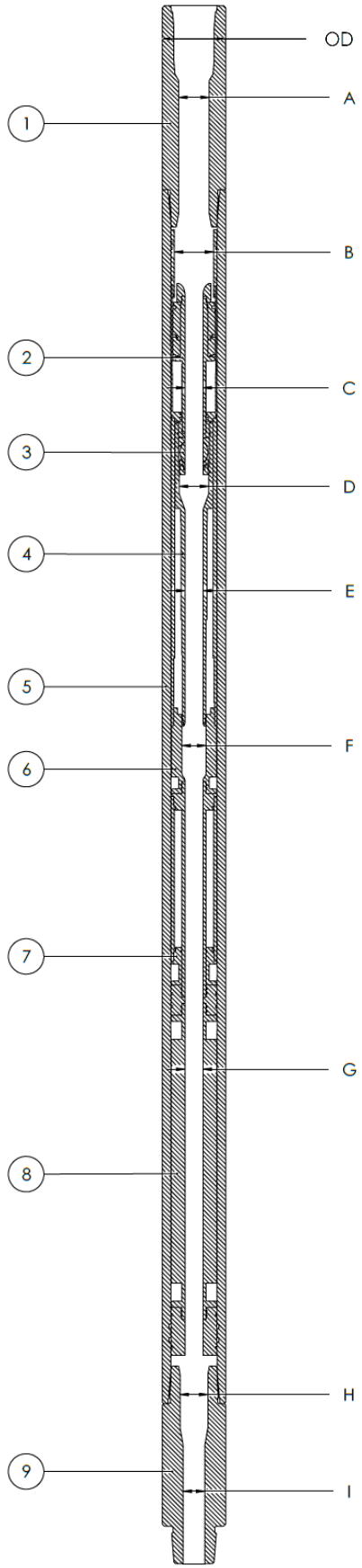


Component	Description
1	Upper Connector
2	Upper Piston
3	Ball Valve
4	Lower Piston
5	Tool Body
6	Motor Housing
7	Compensator Housing
8	Electronics Housing
9	Lower Connector

Location	Bore (in)
A	4.2
B	3.54
C	2.0
D	3.32
E	2.0
F	2.67
G	2.0
H	3.54
I	4.2
J	2.81

AVS Electronic Circulating Valve

Fishing Diagram (8.25in)



Component	Description
1	Upper Connector
2	Upper Piston
3	Ball Valve
4	Lower Piston
5	Tool Body
6	Motor Housing
7	Compensator Housing
8	Electronics Housing
9	Lower Connector

Location	Diameter (in)
OD	8.25
A	4.0
B	5.12
C	2.36
D	3.82
E	2.36
F	3.12
G	2.36
H	3.63
I	2.81