

CMC No: 13.5S

DNV GL Job No:  
A0384073

DNV GL UK LTD  
**SURVEILLANCE VISIT REPORT**  
General.



Client: Drilltools Ltd	Client Certification Ref: N/A
Vendor / Location: Drilltools Ltd, Meikle Wattle	Project Number: N/A

SCOPE

Witness Verification testing of Drilltools DT Surface Flapper Safety Valve as per Testing Procedure M-0101-7000H Rev.A in accordance with API Specification 7NRV

DISCIPLINE	Y	N	TASK	Y	N
Mechanical	Y		Visual Survey	Y	
Electrical		N	Document Review		N
Structural		N	Pressure Test	Y	
Other (Specify Below)	N/A		Function Test	Y	
			Load Test		N
			Other (Specify Below)	N/A	

DESCRIPTION

Witness Verification testing of Drilltools DT Surface Flapper Safety Valve S/No DT SFSV -0101 as per Testing Procedure M-0101-7000H Rev.A (As described in API Specification 7NRV)

Equipment used

Data Logger c/w 0- 2000 bar Hydrotechnik Pressure Transducer S/No: Z150141428 Calibrated 31/07/16

Marsh Funnel Viscometer as described in API RP13 B1

Flowmeter, Wafer Type 0- 6000 l/min range. S/No 16205327 Calibrated 25/07/16

Activities Witnessed 27/02/17

Procedure Sections

- 6.a to 6.f** Body Hydrostatic Proof Test: The valve body was pressurised to 250 psi and held for 5 minutes. The pressure was increased to 22,500 psi for and held for 15 minutes. No visible leakage was observed and a steady chart
- 6.g to 6.i** Valve Seat Hydrostatic Test: The valve was pressurised below the flapper to 250 and held for 5 minutes. The pressure was increased to 15,000 psi and held for 15 minutes. No visible leakage was observed and a steady chart was noted.
- 6.j to 6.n** Valve Seat Gas Test: The valve was pressurised to 250 psi for 5 minutes, dropped to 50 psi for 5 minutes then increased to 3,750 psi below the flapper and held for a period of 50 minutes. No visible leakage was observed and a steady chart was noted.

If any person suffers loss or damage which is proved to have been caused by any negligent act or omission of DNV GL UK LTD then DNV GL UK LTD shall pay compensation to such person for his proved direct loss or damage. However, the compensation shall not exceed an amount equal to ten times the fee charged for the service in question, provided that the maximum compensation shall never exceed USD 2 million. In this provision 'DNV GL UK LTD' shall mean the Foundation DNV GL UK LTD as well as all its subsidiaries, directors, officers, employees, agents and any other acting on behalf of DNV GL UK LTD.

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General



**Other activities witnessed while on site.**

Drifting of valve using 2.156" dia x 48 "

The flow media viscosity was measured prior to commencement of flow loop testing. The testing involved the use of a Marsh Funnel Viscometer as described in API RP13 B1. The measured funnel /volume test was recorded at 73 seconds.

The sand content of the flow media was checked using sample flasks and centrifuge in accordance with API MPMS. The sand content was measured at 2.5%


**Activities Witnessed 15/03/17**

**Procedure Sections**

- 6.z to 6.aa** The valve was pressurised below the flapper to 15,000 psi for 15 minutes. No visible leakage was observed and a steady chart was noted.
- 6.bb to 6.cc** Valve Seat Gas Test. The valve was pressurised to 250 psi for 10 minutes, dropped to 50 psi for 10 minutes then increased to 3,750 psi below the flapper and held for a period of 15 minutes. No visible leakage was observed and a steady chart was noted.
- 6.ff to 6.hh** Valve Seat Hydrostatic Test (Secondary). The valve was pressurised to 15,000 psi below the flapper and held for a period 15 minutes. No visible leakage was observed and a steady chart was noted.
- 6.ii** Drifting of valve using 2.156" dia x 48 "

**CONCLUSIONS**

**All activities witnessed and found to be in accordance with Drilltools Ltd Testing Procedure M-0101-7000H Rev A which is based on the requirements for valve qualification testing as specified in API Specification 7NRV**

<p><b>Surveyor: Raymond Hay</b></p> <p>For DNV GL UK LTD</p> <p>This document has been digitally signed and will therefore not have handwritten signatures</p> <p>Raymond Hay Surveyor</p> 	<p><b>Date: 16<sup>th</sup> March 2017</b></p>	<p><b>Place: Drilltools, Meikle Wartle</b></p>
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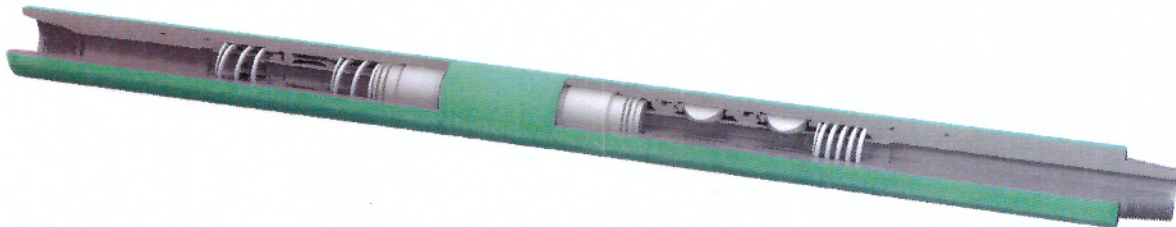
If any person suffers loss or damage which is proved to have been caused by any negligent act or omission of DNV GL UK LTD then DNV GL UK LTD shall pay compensation to such person for his proved direct loss or damage. However, the compensation shall not exceed an amount equal to ten times the fee charged for the service in question, provided that the maximum compensation shall never exceed USD 2 million. In this provision "DNV GL UK LTD" shall mean the Foundation DNV GL UK LTD as well as all its subsidiaries, directors, officers, employees, agents and any other acting on behalf of DNV GL UK LTD.



Testing Protocol			
Test Procedure No.	M-0101-7000H	Revision	A
Tool Assembly Family	0101		
Tool Description	DT Surface Flapper Safety Valve		

Issued By	Jeff Knight
Date	27/02/17
Checked By	Paul Hilliard
Date	27/02/17

Revision	Date	ECN



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## 1. Introduction

Drilltools Ltd has designed and manufactured a surface flapper safety valve for use in oilwell drilling operations. The American Petroleum Institute (API) have developed a specification which defines minimum requirements for valves of this type – API Specification 7NRV. It is Drilltools' intention to qualify the surface flapper safety valve to the applicable sections of this specification and to seek DNV-GL verification of the qualification.

## 2. Testing Location

Testing of the valve will take place at the Drilltools facility in Aberdeen. The full address of the facility is :

Wood Cottage  
Meikle Wartle  
Inverurie  
AB515BH

## 3. Test Facility Description

The test facility to be used consists of several elements.

### 1) Pressure test cell

The pressure test cell consists of a chamber into which the valve can be mounted. This constrains the valve in a secure manner in the event of any catastrophic failure. The test cell itself is located below ground level in a pit which is covered with a steel plate lid. All pressure tests will be conducted within this cell using temporary pumping and pressure monitoring equipment. The pressure test medium will be fresh water for hydro-testing and nitrogen for gas leak testing. The nitrogen will be supplied from 300bar nitrogen gas cylinders.

### 2) Wellbore

The wellbore consists of an 85ft deep vertical bore lined with a 9 5/8" casing. The wellbore is cemented and completely sealed from the surrounding formation. The wellbore can be connected to a circulating system for circulating fresh water at a rate of 300gpm. The wellbore will be used for the cycle testing of the valve using a manual flow manifold to reverse the flow through the valve as required.

### 3) Flowloop

The flowloop consists of two centrifugal pumps with a maximum flowrate of 2400gpm. The pumps are MCM O'Drill mud charge pumps capable of pumping mud slurries. The flowloop is connected to a 128 cuft (22 bbl) mix tank with agitator for making up sand slurry. The viscosifier will be API bentonite and the sand has been sieved through 180 micron and 150 micron screens. The viscosity of the sand slurry will be measured using a standard Marsh funnel and sand content using a centrifuge and API centrifuge tubes. The flowrate will be recorded using an electro-magnetic flowmeter.



## 4. Meters and Measuring Devices

### 1) Pressure

Pressure monitoring and recording will be achieved using an electronic pressure transducer and data logger.

Pressure sensor type: Hydrotechnik

Serial No: Z150141428

Range: 0-2000 bar (0-29,007psi)

Last Calibration: 31-July-2016 By: Vector Supplies Ltd, Aberdeen

### 2) Temperature

Temperature will be measure when required using standard pencil thermometers and an electronic temperature transducer and data logger for permanent monitoring if required.

### 3) Flow rate

Flow rate will be measured using an electromagnetic flowmeter for the sand slurry and an ultrasonic inline meter for well flow.

Flowmeter type: 6" Toshiba LF335 / 620 Electromagnetic Flowmeter

Serial No: 16205327

Range: 0 – 6000 lpm

Last calibration: 25-July-2016

### 4) Gas leak testing

Flowmeter type: 'Peashooter' type gas flowmeter

Range: 0 – 25 lpm

### 5) Drift

Nylon API drift 2.156" OD 42" long.

## 5. Valve Test Protocol

Testing will be performed as set out in the relevant sections of document API Specification 7NRV – Specification for DrillString Non-Return Valves (First Edition July 10 2006 Re-Affirmed December 2012). The testing will be limited to that specified for an NRV as the valve consists of a stand-alone NRV without using NRV subs, landing nipples or equalising heads.

Applicable Sections;

Section 7.1 Testing General

Section 7.2 Verification Testing - testing will be for class 1 and class 2S service with independent 3<sup>rd</sup> party verification of test results by DNV-GL.

Section 7.3 General Requirements for Test Facility – back pressure to control rate will be supplied by a sacrificial valve on the pump discharge line.

Section 7.4 NRV Test Procedure – note 7.4.9 should read Repeat 7.4.2 to 7.4.6.

Section 7.5 NRV Nitrogen Pressure Test (ambient temperature only)

Section 7.6 NRV Hydro Pressure Test (ambient temperature only)

Section 7.7 NRV Cycle Test

Section 7.8 NRV Erosion Test

Data will be recorded electronically where necessary and will be monitored on CCTV.

The valve uses industry standard nitrile and viton seals with no non-standard seal types or materials. As such elastomer testing will not be performed.

## 6. Test Procedure

- a. Verify model and serial number of valve.
- b. Drift the valve with a 2.156" API drift.
- c. Fill valve with water to remove any air.
- d. Apply water pressure from the top of the valve (free flow direction) to perform a low pressure body test for 5 mins at 250-300psi.
- e. Increase the water pressure to 22,500psi (test pressure) for 15 minutes.
- f. Bleed pressure to zero from the bottom of the valve (ensuring entire valve is bled down).
- g. Apply water pressure from the bottom of the valve (flow stop direction) against the valve flappers. Ensure the top of the tool is open with a free leak off path. Apply 250-300psi for 5 minutes. Record leakage (if any).
- h. Increase the pressure below the flappers to 15,000psi (working pressure) for 15 minutes. Wait 3 minutes then record leakage (maximum leak rate 10cm<sup>3</sup>/min).
- i. Bleed the pressure to zero from the bottom of the valve.

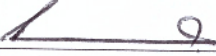


- j. Purge the valve completely to nitrogen.
- k. Increase the nitrogen pressure below the flappers to 250psi. Wait 1 minute then record nitrogen leak rate (max leak rate 140 lpm).
- l. Reduce nitrogen pressure back to 50psi. Wait 1 minute then record nitrogen leak rate (max leak rate 140 lpm ).
- m. Increase the nitrogen pressure below the flappers to 3,750psi. Wait 1 minute then record nitrogen leak rate (max leak rate 140 lpm).
- n. Bleed the nitrogen pressure to zero from the bottom of the valve.
- o. Fill the valve completely with water.
- p. Apply water pressure below the flappers to 15,000psi for 10 minutes. Wait 3 minutes then record leakage (maximum leak rate 10cm<sup>3</sup>/min ).
- q. Bleed the pressure to zero from the bottom of the valve.
- r. Install the valve vertically in the cycle test facility.
- s. Apply water flow in the free flow direction at 200 USgpm for 5 minutes.
- t. Reverse the water flow to cycle the valve to closed for 15 seconds.
- u. Repeat steps x. and y. for a minimum of 100 cycles of the valve.
- v. Install the valve vertically in the erosion test facility.
- w. Apply sand slurry flow in the free flow direction of the valve for a minimum of 200 cumulative hours. The sand slurry consists of water viscosified with bentonite and containing 2% (+/- 0.5%) by volume of sand between 180 microns and 150 microns in size. Check the viscosity and temperature every hour maintaining viscosity between 65 and 75 seconds (Funnel viscosity). Maintain the flowrate above 248 USgpm (938 lpm) which represents a velocity through the tool ID of greater than 20ft/s. On completion re-measure the sand content of the slurry.
- x. Remove the valve from the erosion test facility.
- y. Fill the valve completely with water.
- z. Apply water pressure below the flappers to 15,000psi for 10 minutes. Wait 3 minutes then record leakage (maximum leak rate 10cm<sup>3</sup>/min).
- aa. Bleed the pressure to zero from the bottom of the valve.
- bb. Purge the valve completely to nitrogen.
- cc. Increase the nitrogen pressure below the flappers to 250psi. Wait 1 minute then record nitrogen leak rate (max leak rate 140 lpm). Reduce nitrogen pressure back to 50psi. Wait 1 minute then record nitrogen leak rate (max leak rate 140 lpm ).
- dd. Increase the nitrogen pressure below the flappers to 3,750psi. Record nitrogen leak rate (max leak rate 140 lpm).
- ee. Bleed the nitrogen pressure to zero from the bottom of the valve.

- ff. Fill the valve completely with water.
- gg. Apply water pressure below the flappers to 15,000psi for 10 minutes. Wait 3 minutes then record leakage (maximum leak rate 10cm<sup>3</sup>/min).
- hh. Bleed the pressure to zero from the bottom of the valve.
- ii. Drift the valve with a 2.156" API drift.
- jj. This concludes the test procedure.

## 7. DNVGL Verification

DNVGL will perform a verification of the valve testing as defined in API Specification 7NRV.

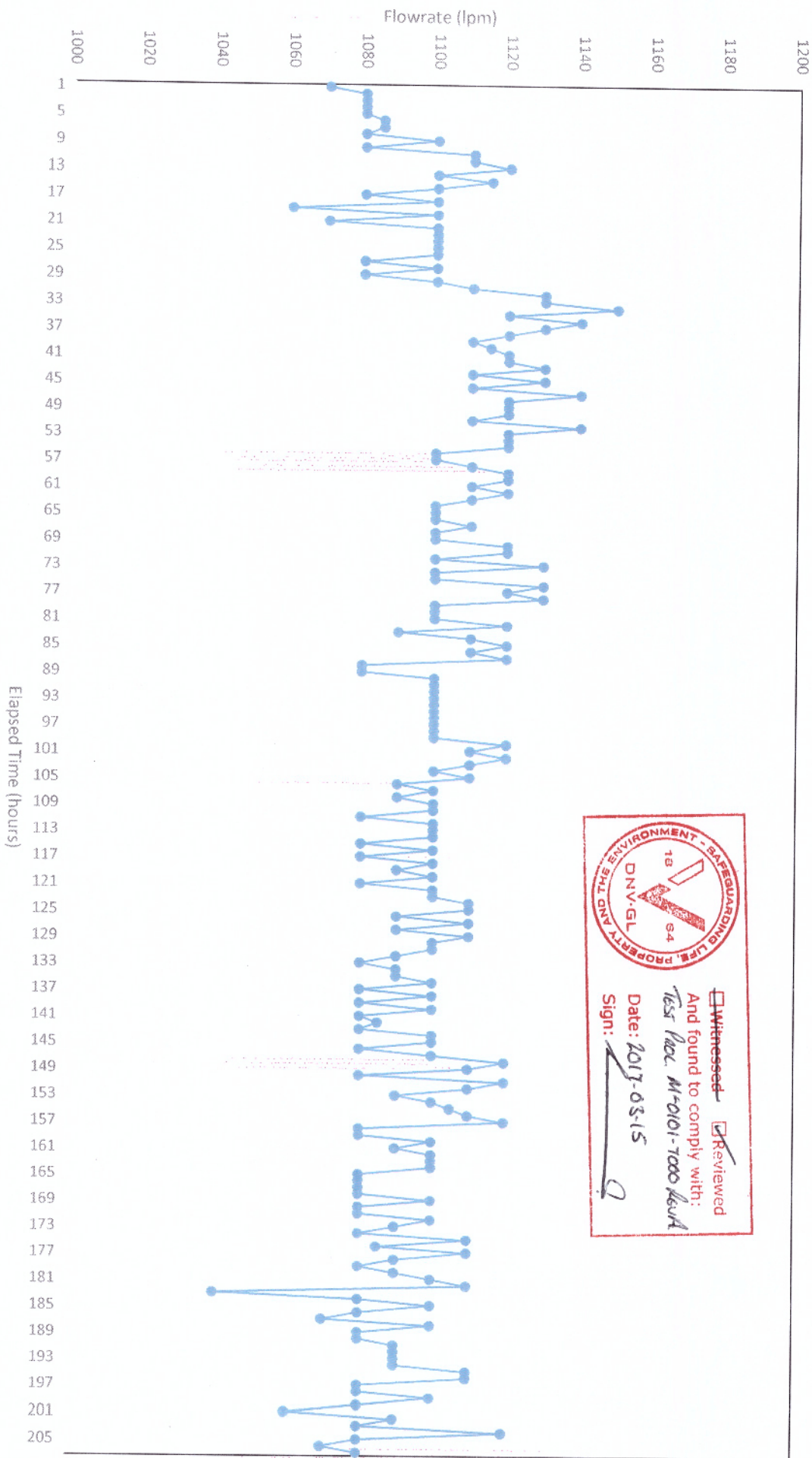
DNV Surveyor	Name	Raymond Hay <i>James Keyward</i>	Date 27/2/2017 15/3/2017
	Signature		
Drilltools Rep	Name	Jeff Knight	Date
	Signature		




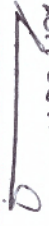


## Sign-off Sheet

DT SFSV 101 (15Kpsi H2S) API Spec7NRV Erosion Test 2-11 Mar 2017 Meikle Wartle  
 Ref Procedure M-0101-7000H  
 Erosion test flow rate versus time



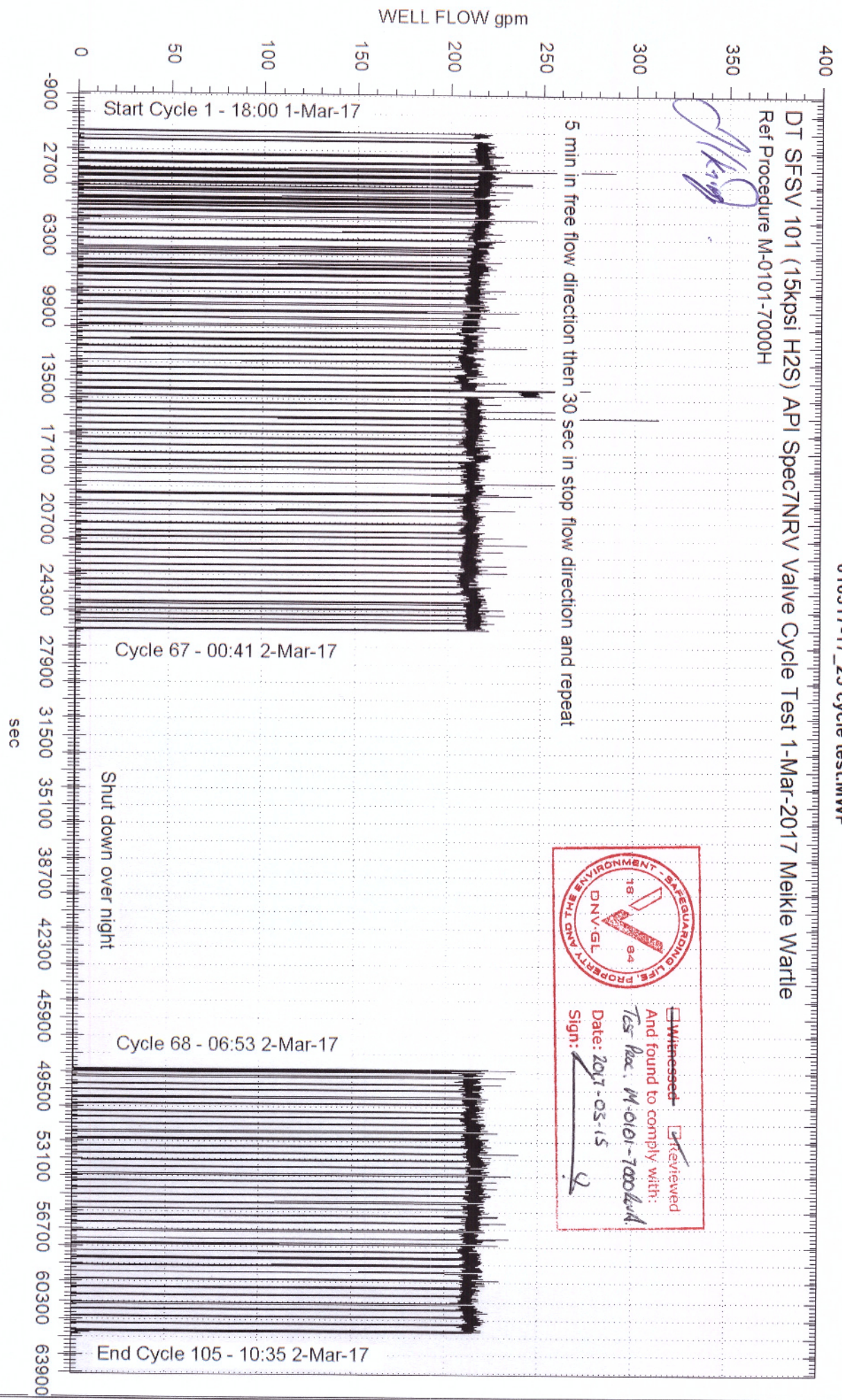
Witnessed     Reviewed  
 And found to comply with:  
 Test Proc. M-0101-7000 Rev A  
 Date: 2017-03-15  
 Sign: 



DT SFSV 101 (15kpsi H2S) API Spec2NRV Valve Cycle Test 1-Mar-2017 Meikle Wartle  
Ref Procedure M-0101-7000H

*[Handwritten Signature]*

5 min in free flow direction then 30 sec in stop flow direction and repeat



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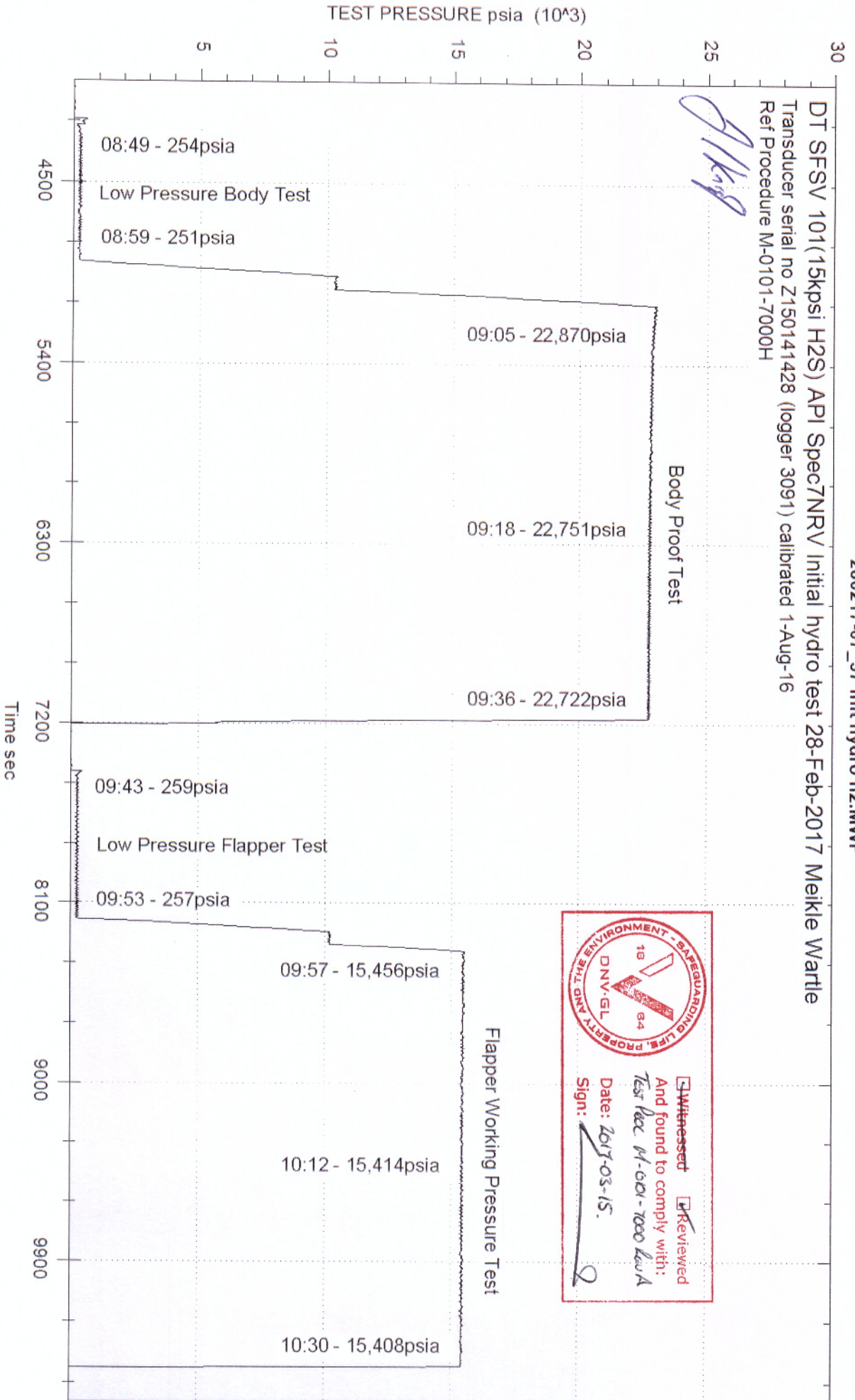
Witnessed  Reviewed  
And found to comply with:  
Test Rec: M-0101-7000H  
Date: 2017-03-15  
Sign: *[Signature]*



DT SFSV 101(15kpsi H2S) API Spec7Nrv Initial hydro test 28-Feb-2017 Melke Wartle

Transducer serial no Z150141428 (logger 3091) calibrated 1-Aug-16  
 Ref Procedure M-0101-7000H

*Alkay*



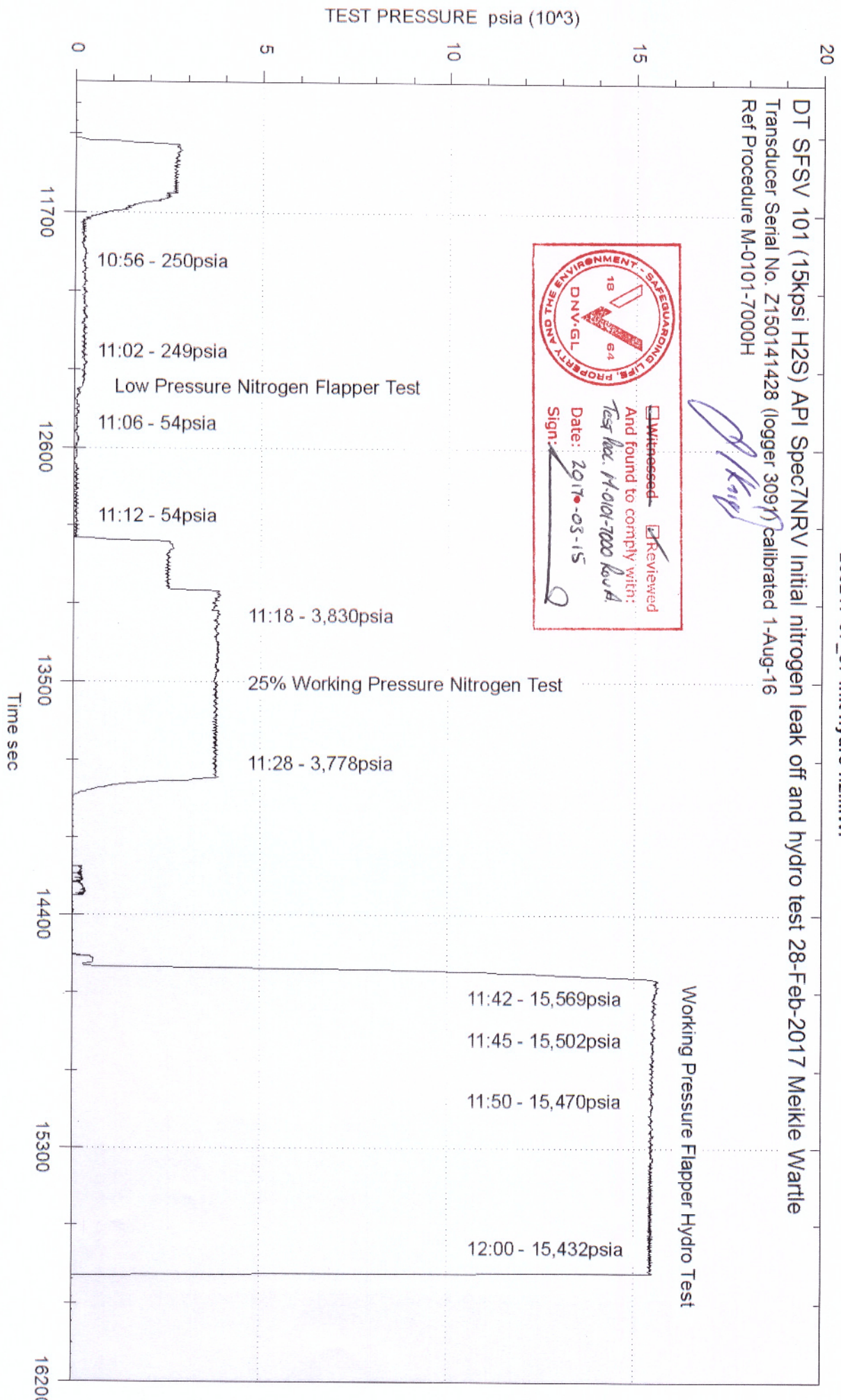
Witnessed  Reviewed  
 And found to comply with:  
 Test Rec M-001-7000 Rev A  
 Date: 2017-03-15.  
 Sign: *[Signature]*



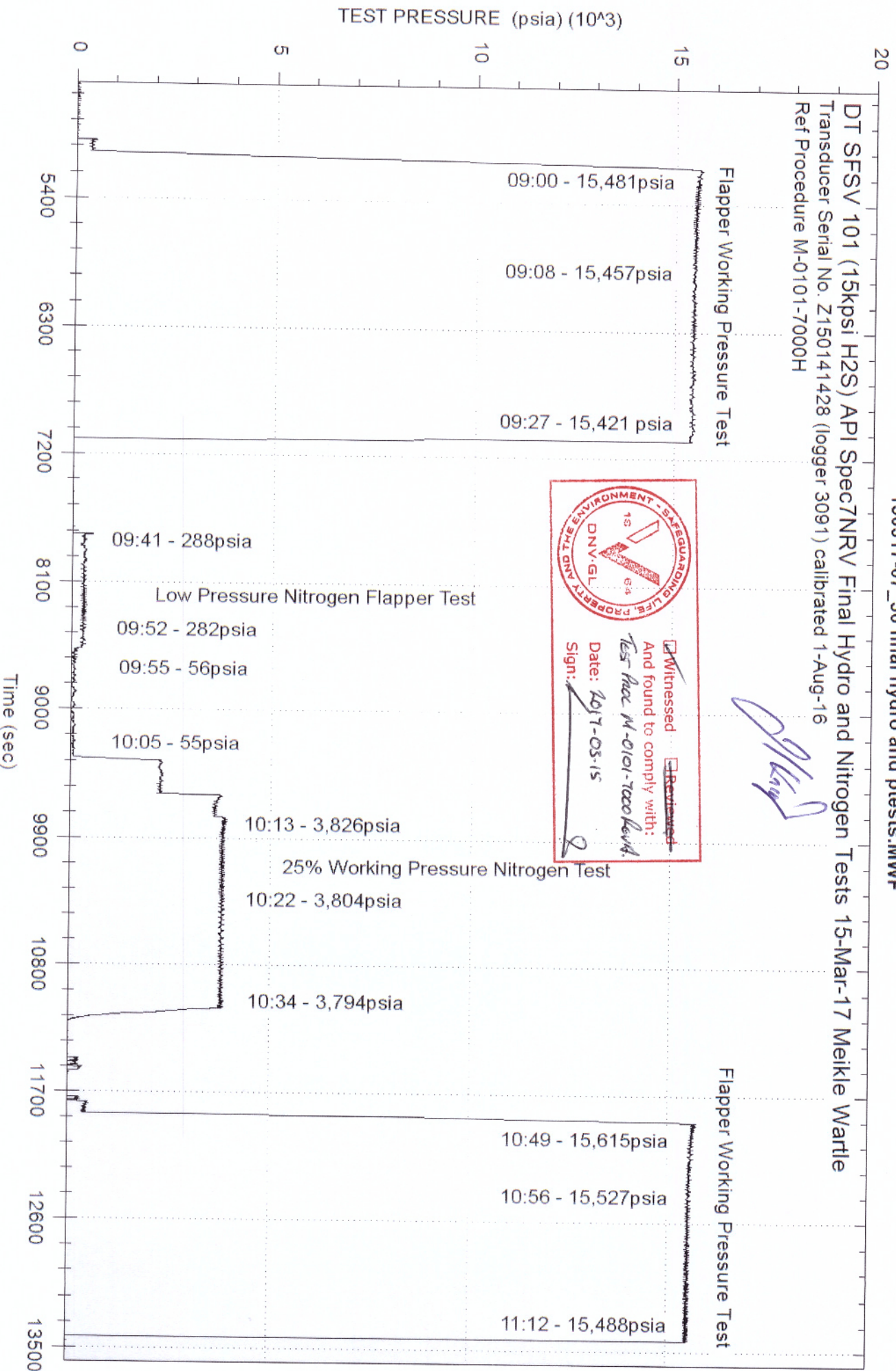
DT SFSV 101 (15kpsi H2S) API SpectNRV Initial nitrogen leak off and hydro test 28-Feb-2017 Meikle Wartle  
Transducer Serial No. Z150141428 (logger 3091) calibrated 1-Aug-16  
Ref Procedure M-0101-7000H

*[Handwritten Signature]*

Witnessed  Reviewed  
And found to comply with:  
Test Spec. M-0101-7000 Rev A  
Date: 2017-03-15  
Sign: *[Signature]*



DT SFSV 101 (15kpsi H2S) API SpectNRV Final Hydro and Nitrogen Tests 15-Mar-17 Meikle Wartle  
 Transducer Serial No. Z150141428 (logger 3091) calibrated 1-Aug-16  
 Ref Procedure M-0101-7000H



**DNV-GL**  
 AND THE ENVIRONMENT - SAFEGUARDING LIFE, PROPERTY AND THE ENVIRONMENT  
 15 64  
 Witnessed  Reviewed  
 And found to comply with:  
 Test Proc M-0101-7000 Rev.4  
 Date: 2017-03-15  
 Sign: *[Signature]*

*[Handwritten Signature]*



<b>Test Location</b>	Aberdeen UK	<b>Manufacturer</b>	Drilltools Ltd
<b>Address</b>	Wood Cottage	Drilltools Representative	Jeff Knight
	Meikle Wartle	Telephone	44 (0)7909685796
	Inverurie		
	Aberdeenshire	DNV Surveyor	Raymond Hay
	AB515BH UK	Qualification Date	28-Feb - 15-Mar 2017

**Valve to be Tested**

Type	NRV	Rated working pressure	15,000psi
Class	Class 1 and Class 25	Nominal size	7"
Model	DT SFSV H2S	Minimum specified ID	2.25"
Serial No.	101	Drift size	2.156"

**Hydro Pressure Test** (digital / chart / video)

Date	28-Feb-2017
Time	08:49 - 08:59
Pressure	254psi low body
Average Test Temperature	10degC
Leak Rate	No recorded leakage
Time	09:18 - 09:36
Pressure	22,751psi high body
Average Test Temperature	10degC
Leak Rate	No recorded leakage
Time	09:43 - 09:53
Pressure	259psi low flapper seat
Average Test Temperature	10degC
Leak Rate	No recorded leakage
Time	10:12 - 10:30
Pressure	15,414psi high flapper seat
Average Test Temperature	10degC
Leak Rate	No recorded leakage

**N2 Pressure Test** (digital / chart / video)

Date	28-Feb-2017
Time	10:56 - 11:28
Pressure low	250psi
Pressure low	54psi
Pressure high	3,830psi
Average Test Temperature	10 degC
Leak Rate	No visible bubble on bubble hose

**Hydro Pressure Test** (digital / chart / video)

Date	28-Feb-2017
Time	11:45 - 12:00
Pressure	15,502 psi
Average Test Temperature	10 degC
Leak Rate	No recorded leakage

**Cycle Test** (digital / video)

Date	1-Mar-2017 - 2-Mar-2017
Time	18:00-00:41, 06:53-10:35
Flow Media	Water
Pressure	20psi
No. Cycles	105

**Flow / Erosion Test** (digital / video)

Start date	2-Mar-2017
Start time	15:30
Flow Media	Water / bentonite
Viscosity (secs) (70 +/- 5)	75 secs @ 14 degC
Sand Content (% v/v) (2 +/- 0.5)	2.50%
Pressure	25psi
Velocity (20ft/s minimum)	23.5 ft/s
Flowrate (938 l/min minimum)	1,105 l/min
Final Sand Content (%v/v)	2.50%
Final viscosity (secs)	73 secs @ 33degC
No. Hours	207

**Hydro Pressure Test** (digital / chart / video)

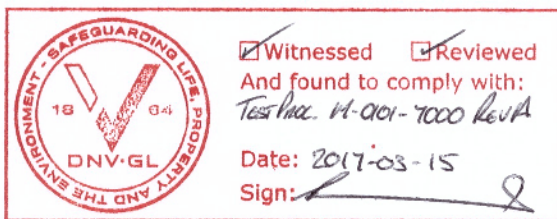
Date	15-Mar-2017
Time	09:00
Pressure	15,421psia
Average Test Temperature	12 degC
Leak Rate	Zero

**N2 Pressure Test** (digital / chart / video)

Date	15-Mar-2017
Time	09:40
Pressure low	282 / 55psia
Pressure high	3,794psia
Average Test Temperature	12 degC
Leak Rate	Zero

**Hydro Pressure Test** (digital / chart / video)

Date	15-Mar-2017
Time	10:49
Pressure	15,488psia
Average Test Temperature	12 degC
Leak Rate	Zero



DNV Surveyor	Name	Raymond Hay + <i>JAMES KEYWASH</i>	Date	
	Signature	<i>[Signature]</i>		15/3/2017
Drilltools Rep	Name	Jeff Knight	Date	
	Signature	<i>[Signature]</i>		15/3/17

CMC No: 13.5S

DNV GL Job No:  
A0384073

**DNV GL UK LTD**  
**SURVEILLANCE VISIT REPORT**  
General.



Client: Drilltools Ltd	Client Certification Ref: N/A
Vendor / Location: Drilltools Ltd, Meikle Wartle	Project Number: N/A

**SCOPE**  
Witness Verification testing of Drilltools DT Surface Flapper Safety Valve as per Testing Procedure M-0101-7000 Rev.A

DISCIPLINE	Y	N	TASK	Y	N
Mechanical	Y		Visual Survey	Y	
Electrical		N	Document Review		N
Structural		N	Pressure Test	Y	
Other (Specify Below)	N/A		Function Test	Y	
			Load Test		N
			Other (Specify Below)	N/A	

**DESCRIPTION**

Witness Verification testing of Drilltools DT Surface Flapper Safety Valve S/No DT SFSV -0101 as per Testing Procedure M-0101-7000H Rev.A (As described in API Specification 7NRV)

Equipment used

Data Logger c/w 0- 2000 bar Hydrotechnik Pressure Transducer S/No: Z150141428 Calibrated 31/07/16


Activities Witnessed 15/03/17

**Procedure Sections**

- 6.z to 6.aa** The valve was pressurised below the flapper to 15,000 psi for 10 minutes. No visible leakage was observed and a steady chart was noted. .
- 6.bb to 6ee** Valve Seat Gas Test. The valve was pressurised to 250 psi for 5minutes, dropped to 50 psi for 5 minutes then increased to 3,750 psi below the flapper and held for a period of 50 minutes. No visible leakage was observed and a steady chart was noted.
- 6.ff to 6.hh** Valve Seat Hydrostatic Test (Secondary). The valve was pressurised to 15,000 psi .below the flapper and held for a period 10 minutes.No visible leakage was observed and a steady chart was noted.
- 6.ii** Drifting of valve using 2.156" dia x 24 "

**CONCLUSIONS**

**All activities witnessed and found to be in accordance with Testing Procedure M-0101-7000 Rev.A**

 <p>For DNV GL This Document has been digitally signed and will therefore not have handwritten signatures. <b>Keyland, James</b> Surveyor</p>	Date:	Place:
	15 <sup>th</sup> March 2017	Drilltools, Meikle Wartle

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