API 682 Seal Qualification Test Certificate

Seal Tested:	CAPI Type A Dual	
Nominal Sizes Tested:	50mm (2”), 100mm (4”)	
Seal Materials Tested:	Premium Grade Blister Resistant Carbon Graphite Reaction Bonded Silicon Carbide	
API Seal Type:	Type A	
API Seal Configuration(s):	2CW-CS 2CW-CW 3CW-FB	
API Seal Category:	2, 3	
API Flush Plan(s):	11 & 52/53	
Test Fluid:	Flashing Hydrocarbon (Propane)	Non-Flashing Hydrocarbon
Base Pressure:	17 barg (250 psig)	7 barg (100 psig)
Base Temperature:	30°C (90°F)	20°C (70°F)
Speed:	3600 rpm	3600 rpm

This is to certify that the above seals have been tested in accordance with API 682 requirements.

Stephen Shaw CEng FIMechE CMIOSH BEng (Hons) MBA
Group Engineering Director

AESSEAL®
ENVIRONMENTAL TECHNOLOGY

Mechanical Seal Qualification Test Form

2CW-CS, 2NC-CS, 3NC-FF, 3NC-BB, 3NC-FB

Test Ref: T2/2/PT00801_4 Revision: 06/23

Manufacturer: AESSEAL plc Seal Type / Model: CAPI Type A Dual (FHS-CS)

Arrangement: 2CW-CS ☑ 2NC-CS ☐ 3NC-FF ☐ 3NC-BB ☐ 3NC-FB ☐

Materials of Construction: Primary Seal Faces: Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide; Secondary Seal Faces*: Antimony Carbon FH71Z5/SC2 Reaction Bonded Silicon Carbide

Secondary Seals: Fluoroelastomer; Metal Hardware: 316 SS

Seal Size: 50mm; Shaft Speed: 3600rpm

Pumped Fluid (Table I.2): Nonhydrocarbon (water, caustic acid) ☐ Nonflashing Hydrocarbon ☐ Flashing Hydrocarbon ☑

Shaft Runout (Figure 19): <0.1mm; Sleeve Runout (Figure 19):; Chamber Concentricity (Figure 12): <0.1mm; Seal Chamber Face Runout (Figure 14):

Test Fluid: Propane; Base-point Temperature °C (°F): 30 / (86); Base-point Pressure MPa (bar) (psi): 1.7 / (17) / (247)

Relative Density (SG):; Vapor Pressure:; Solids: None; Particle Size: N/A *Dual Seals

Test Procedure: ☑ I.3.13 (for 2CW-CS, 2NC-CS Arrangements)

☐ I.3.15 (for 3NC-FF, 3NC-BB, 2NC-FB)

Data Point Ref.	Date	Time	Inner Seal		Buffer/Barrier			Speed r/min	Seal Leakage			
			Pressure	Temp.	Medium	Pressure	Temp.		Inner	Outer		
			barg (psig)	°C (°F)		barg (psig)	°C (°F)		ml/m^3 (vol. ppm)	ml/m^3 (vol. ppm)	cm^3/h	L/h (normalized)
I.6;1	28-03-2006	15:36	19.93 (246)	30.34 (87)	N/A	N/A	N/A	3600	4	N/A	N/A	
I.6;1	28-03-2006	09:18	16.98 (246)	30.11 (86)	N/A	N/A	N/A	3600	0	N/A	N/A	
I.6;2	28-03-2006	09:20	16.81 (244)	29.91 (86)	N/A	N/A	N/A	0	10	N/A	N/A	
I.6;2	28-03-2006	13:20	16.92 (246)	30.2 (86)	N/A	N/A	N/A	0	6	N/A	N/A	
I.6;3	28-03-2006	13:25	10.21 (148)	30.04 (86)	N/A	N/A	N/A	Cyclic	3	N/A	N/A	
I.6;3	28-03-2006	14:41	10.16 (147)	30.14 (86	N/A	N/A	N/A	Cyclic	4	N/A	N/A	
I.7;a1	28-03-2006	17:10	17.05 (247)	29.98 (86)	Propane	0.7 (10)	<40 (<104)	3600	N/A*	3.5	N/A	
I.7;a2	01-04-2006	21:00	16.94 (246)	30.8 (86)	Propane	0.7 (10)	<40 (<104)	3600	N/A*	3	N/A	
I.7;b0 to b5	03-04-2006	08:44	17.14 (249)	8.7 (48)	Nitrogen	1.7 (25)	<40 (<104)	0	N/A*	N/A	N/A	
I.7;c1	03-04-2006	11:30	17.13 (248)	27.8 (82)	Diesel	2.8 (41)	<40 (<104)	3600	N/A*	N/A	4.1	
I.7;c2	07-04-2006	15:20	17.14 (249)	30.09 (86)	Diesel	2.8 (41)	<40 (<104)	3600	N/A*	N/A	1.87	
I.7;d1	10-04-2006	09:10	16.99 (246)	4.2 (40)	Diesel	16.8 (244)	<40 (<104)	0	N/A*	N/A	0	
I.7;d2	10-04-2006	13:30	17.11 (248)	7.3 (45)	Diesel	17 (247)	<40 (<104)	0	N/A*	N/A	0	

Outer Seal Face Wear: Stationary Face: 0 Rotating Face: 0.82% mm (in.) / % wear

Inner Seal Face Wear: Stationary Face: 0 Rotating Face: 0 mm (in.) / % wear (I.3.15 only)

This is to certify that the seal noted above has been tested in accordance with the API 682 requirements.

Authorised By:
Stephen Shaw
Group Engineering Director

Notes:
1. Conducted to latest version of API 682 at time of test; 3rd edition.
2. API 682 specifies pass rate for liquid leakage as <5.6 g/h which equates to 134.4 g/day or 1000ppm for gas and vapour.
3. API 682 specifies pass rate for containment seal faces is <1% available seal face wear.
4. *Data previously collected for inner seal faces at same conditions in test points 1 to 3.

AESSEAL® ENVIRONMENTAL TECHNOLOGY

Mechanical Seal Qualification Test Form

1CW, 2CW-CW, 3CW-FB, 3CW-FF, 3CW-BB

Test Ref: T2/3/PT00801_14 Revision: 06/23

Manufacturer:	AESSEAL plc			Seal Type / Model:	CAPI Type A Dual
Seal Type:	A ☑	B ☐	C ☐	ES ☐	☐
Materials of Construction: Primary Seal Faces:	Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide			Secondary Seal Faces:	Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide
Secondary Seals:	Fluoroelastomer			Metal Hardware:	316 SS
Seal Size: 50mm	Seal Code: 2CW-CW	Piping Plan: 52		Shaft Speed:	3600rpm
Pumped Fluid (Table I.2):	Nonhydrocarbon (water, caustic acid) ☐		Nonflashing Hydrocarbon ☐		Flashing Hydrocarbon ☑
Shaft Runout (Figure 19): <0.1mm	Sleeve Runout (Figure 19):		Chamber Concentricity (Figure 12): <0.1mm		Seal Chamber Face Runout (Figure 14):
Test Fluid: Propane	Base-point Temperature °C (°F): 30 / (86)		Base-point Pressure MPa (bar) (psi): 1.7 / (17) / (247)		
Relative Density (SG):	Vapor Pressure:		Solids: None	Particle Size: N/A	*Dual Seals

DYNAMIC TEST 100 h minimum			Pressure barg (psig)	Process Temp. °C (°F)	Flush Temp. IN °C (°F)	Flush Temp. OUT °C (°F)	Flush Flow Rate m^3/h (U.S. gal/min)	Seal Chamber Temp. °C (°F)	Barrier Fluid Pressure barg (psig)	Barrier Fluid Temp. IN °C (°F)	Barrier Fluid Temp. OUT °C (°F)	Power Consumption kW (hp)	Hydrocarbon Leakage g/day (ppm)	Nonhydrocarbon Leakage cm^3/min	Circulating Device m^3/h (U.S. gal/min)
Date	Time														
	Start	Stop													
14-08-2006	14:49		17.22 (250)	29.65 (85)	N/A	N/A	N/A	29.65 (85)	6.81 (99)	10.7 (51)	47.89 (118)	0.8 (1)	0	N/A	0.15 (0.66)
18-08-2006		16:49	16.96 (246)	29.42 (85)	N/A	N/A	N/A	29.42 (85)	7.79 (113)	11.3 (52)	48.93 (120)	0.8 (1)	0	N/A	0.15 (0.66)
STATIC TEST 4 h minimum															
18-08-2006	16:51		16.67 (242)	27.11 (81)	N/A	N/A	N/A	18.38 (65)	7.74 (112)	11.3 (52)	43.9 (111)	0	0	N/A	0
21-08-2006		09:48	16.55 (240)	19.38 (67)	N/A	N/A	N/A	31.16 (88)	7.83 (114)	16.8 (62)	18.05 (64)	0	0	N/A	0
CYCLE TEST 5 cycles minimum															
21-08-2006	10:05		16.73 (243)	31.16 (88)	N/A	N/A	N/A	31.16 (88)	7.64 (111)	9.6 (49)	49.35 (120)	0.8 (1)	0.33 (0.7)	N/A	0.15 (0.66)
21-08-2006			17.2 (249)	29.89 (86)	N/A	N/A	N/A	29.89 (86)	7.58 (110)	10.7 (51)	51.02 (124)	0.8 (1)	0	N/A	0.15 (0.66)
21-08-2006		12:03	16.83 (244)	25.47 (78)	N/A	N/A	N/A	25.47 (78)	7.59 (110)	13.9 (57)	35.56 (96)	0	0	N/A	0

This is to certify that the seal noted above has been tested in accordance with the API 682 requirements.

Authorised By:
Stephen Shaw
Group Engineering Director

Notes:
1. Conducted to latest version of API 682 at time of test; 3rd edition.
2. API 682 specifies pass rate for liquid leakage as <5.6 g/h which equates to 134.4 g/day or 1000ppm for gas and vapour.
3. Average outer seal leakage barrier fluid measured at less than <0.1g/hr
4. kW / HP are calculated theoretical values.
5. Less than 0.03% face wear measured.

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Mechanical Seal Qualification Test Form

1CW, 2CW-CW, 3CW-FB, 3CW-FF, 3CW-BB

Test Ref: T2/4/PT00801_14 Revision: 06/23

Manufacturer:	AESSEAL plc			Seal Type / Model:	CAPI Type A Dual
Seal Type:	A ☑	B ☐	☐ C ☐	ES ☐	☐
Materials of Construction:	Primary Seal Faces:	Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide		Secondary Seal Faces:	Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide
	Secondary Seals:	Fluoroelastomer		Metal Hardware:	316 SS
Seal Size:	50mm	Seal Code: 3CW-FB	Piping Plan: 53	Shaft Speed:	3600rpm
Pumped Fluid (Table I.2):	Nonhydrocarbon (water, caustic acid) ☐		Nonflashing Hydrocarbon ☐		Flashing Hydrocarbon ☑
Shaft Runout (Figure 19):	<0.1mm	Sleeve Runout (Figure 19):		Chamber Concentricity (Figure 12):	<0.1mm
				Seal Chamber Face Runout (Figure 14):	
Test Fluid:	Propane	Base-point Temperature °C (°F):	30 / (86)	Base-point Pressure MPa (bar) (psi):	1.7 / (17) / (247)
Relative Density (SG):		Vapor Pressure:		Solids:	None
				Particle Size:	N/A

*Dual Seals

DYNAMIC TEST 100 h minimum			Pressure barg (psig)	Process Temp. °C (°F)	Flush Temp. IN °C (°F)	Flush Temp. OUT °C (°F)	Flush Flow Rate m^3/h (U.S. gal/min)	Seal Chamber Temp. °C (°F)	Barrier Fluid Pressure barg (psig)	Barrier Fluid Temp. IN °C (°F)	Barrier Fluid Temp. OUT °C (°F)	Power Consumption kW (hp)	Hydrocarbon Leakage g/day (ppm)	Nonhydrocarbon Leakage cm^3/min	Circulating Device m^3/h (U.S. gal/min)
Date	Time Start	Time Stop													
14-08-2006	14:49		17.22 (250)	29.65 (85)	N/A	N/A	N/A	29.65 (85)	17.73 (257)	12.6 (55)	26.9 (80)	1.24 (1.7)	0	N/A	0.15 (0.66)
18-08-2006		16:49	16.96 (246)	29.42 (85)	N/A	N/A	N/A	29.42 (85)	17.83 (259)	15.8 (60)	30 (86)	1.26 (1.7)	0	N/A	0.15 (0.66)
STATIC TEST 4 h minimum															
18-08-2006	16:51		16.67 (242)	27.11 (81)	N/A	N/A	N/A	18.38 (65)	17.85 (259)	16.6 (62)	30.1 (86)	0	0	N/A	0
21-08-2006		09:48	16.55 (240)	19.38 (67)	N/A	N/A	N/A	31.16 (88)	17.78 (258)	16.7 (62)	16.6 (62)	0	0	N/A	0
CYCLE TEST 5 cycles minimum															
21-08-2006	10:05		16.73 (243)	31.16 (88)	N/A	N/A	N/A	31.16 (88)	17.76 (258)	14.6 (58)	27.7 (82)	1.27 (1.7)	0	N/A	0.15 (0.66)
21-08-2006			17.2 (249)	29.89 (86)	N/A	N/A	N/A	29.89 (86)	17.77 (258)	16.3 (61)	30.1 (86)	1.24 (1.7)	0	N/A	0.15 (0.66)
21-08-2006		12:03	16.83 (244)	25.47 (78)	N/A	N/A	N/A	25.47 (78)	17.77 (258)	19.1 (66)	25.8 (78)	0	0	N/A	0

This is to certify that the seal noted above has been tested in accordance with the API 682 requirements.

Authorised By:
Stephen Shaw
Group Engineering Director

Notes:
1. Conducted to latest version of API 682 at time of test; 3rd edition.
2. API 682 specifies pass rate for liquid leakage as <5.6 g/h which equates to 134.4 g/day or 1000ppm for gas and vapour.
3. Average outer seal leakage barrier fluid measured at less than <0.5 g/hr
4. kW / HP are calculated theoretical values.
5. Immeasurable face wear observed.

AESSEAL® ENVIRONMENTAL TECHNOLOGY

Mechanical Seal Qualification Test Form

2CW-CS, 2NC-CS, 3NC-FF, 3NC-BB, 3NC-FB

Test Ref: T2/5/PT00801_18 Revision: 06/23

Manufacturer: AESSEAL plc

Seal Type / Model: CAPI Type A Dual (FHS-NCCS)

Arrangement: 2CW-CS ☑ 2NC-CS ☐ 3NC-FF ☐ 3NC-BB ☐ 3NC-FB ☐

Materials of Construction: Primary Seal Faces: Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide

Secondary Seal Faces*: Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide

Secondary Seals: Fluoroelastomer

Metal Hardware: 316 SS

Seal Size: 50mm

Shaft Speed: 3600rpm

Pumped Fluid (Table I.2): Nonhydrocarbon (water, caustic acid) ☐ Nonflashing Hydrocarbon ☐ Flashing Hydrocarbon ☑

Shaft Runout (Figure 19): <0.1mm

Sleeve Runout (Figure 19):

Chamber Concentricity (Figure 12): <0.1mm

Seal Chamber Face Runout (Figure 14):

Test Fluid: Propane

Base-point Temperature °C (°F): 30 / (86)

Base-point Pressure MPa (bar) (psi): 1.7 / (17) / (247)

Relative Density (SG):

Vapor Pressure:

Solids: None

Particle Size: N/A

*Dual Seals

Test Procedure: ☑ I.3.13 (for 2CW-CS, 2NC-CS Arrangements)

☐ I.3.15 (for 3NC-FF, 3NC-BB, 2NC-FB)

Data Point Ref.	Date	Time	Inner Seal		Buffer/Barrier			Speed r/min	Seal Leakage			
			Pressure	Temp.	Medium	Pressure	Temp.		Inner	Outer		
			barg (psig)	°C (°F)		barg (psig)	°C (°F)		ml/m³ (vol. ppm)	ml/m³ (vol. ppm)	cm³/h	L/h (normalized)
I.6;1	12-05-2007	08:31	16.82 (244)	29.32 (85)	N/A	N/A	N/A	3600	N/A	5	N/A	
I.6;1	16-05-2007	12:27	16.84 (244)	29.98 (86)	N/A	N/A	N/A	3600	N/A	2	N/A	
I.6;2	16-05-2007	12:40	17.02 (247)	29.9 (86)	N/A	N/A	N/A	0	N/A	0	N/A	
I.6;2	16-05-2007	16:54	17.01 (247)	30.21 (86)	N/A	N/A	N/A	0	N/A	0	N/A	
I.6;3	16-05-2007	17:02	16.91 (245)	30.6 (87)	N/A	N/A	N/A	Cyclic	N/A	4	N/A	
I.6;3	16-05-2007	18:03	16.91 (245)	30.77 (87)	N/A	N/A	N/A	Cyclic	N/A	5.25	N/A	
I.6;3	16-05-2007	18:04	16.95 (246)	30.7 (87)	N/A	N/A	N/A	Cyclic	N/A	4.5	N/A	
I.7;a1	16-05-2007	19:07	16.9 (245)	29.99 (86)	Propane	0.7 (10)	<40 (<104)	3600	N/A	16.5	N/A	
I.7;a2	20-05-2007	22:15	16.92 (246)	30.48 (87)	Propane	0.7 (10)	<40 (<104)	3600	N/A	23	N/A	
I.7;b0 to b5	21-05-2007	11:20	16.94 (246)	29.97 (86)	Nitrogen	1.7 (25)	<40 (<104)	0	N/A	Nitrogen press. drop 1.8 psi / 5 mins		
I.7;c1					Diesel	2.8 (41)	<40 (<104)	3600				
I.7;c2					Diesel	2.8 (41)	<40 (<104)	3600				
I.7;d1	21-05-2007	12:02	16.94 (246)	29.96 (86)	Diesel	17 (247)	<40 (<104)	0	N/A	N/A	0	
I.7;d2	21-05-2007	16:02	16.89 (245)	30.06 (87)	Diesel	17 (247)	<40 (<104)	0	N/A	N/A	0	

Outer Seal Face Wear: Stationary Face: 0 Rotating Face: 0.0127 (0.0005) / 0.57% mm (in.) / % wear

Inner Seal Face Wear: Stationary Face: 0 Rotating Face: 0.010 (0.0004) / 1% mm (in.) / % wear (I.3.15 only)

This is to certify that the seal noted above has been tested in accordance with the API 682 requirements.

Authorised By:
Stephen Shaw
Group Engineering Director

Notes:
1. Conducted to latest version of API 682 at time of test; 3rd edition.
2. API 682 specifies pass rate for liquid leakage as <5.6 g/h which equates to 134.4 g/day or 1000ppm for gas and vapour.
3. API 682 specifies pass rate for containment seal faces is <1% available seal face wear.
4. Average outer seal hydrocarbon leakage (point 1 to a2) of 6.7ppm.
5. c1 and c2 ommitted due to inner seal leakage volume innappropriate for non-contacting containment seal operation.

AESSEAL® ENVIRONMENTAL TECHNOLOGY

Mechanical Seal Qualification Test Form

1CW, 2CW-CW, 3CW-FB, 3CW-FF, 3CW-BB

Test Ref: T2/6/PT00801_13 Revision: 06/23

Manufacturer: AESSEAL plc Seal Type / Model: CAPI Type A Dual

Seal Type: A ☑ B ☐ ☐ C ☐ ES ☐ ☐

Materials of Construction: Primary Seal Faces: Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide Secondary Seal Faces: Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide

Secondary Seals: Fluoroelastomer Metal Hardware: 316 SS

Seal Size: 100mm Seal Code: 2CW-CW Piping Plan: 52 Shaft Speed: 3600rpm

Pumped Fluid (Table I.2): Nonhydrocarbon (water, caustic acid) ☐ Nonflashing Hydrocarbon ☐ Flashing Hydrocarbon ☑

Shaft Runout (Figure 19): <0.1mm Sleeve Runout (Figure 19): Chamber Concentricity (Figure 12): <0.1mm Seal Chamber Face Runout (Figure 14):

Test Fluid: Propane Base-point Temperature °C (°F): 30 / (86) Base-point Pressure MPa (bar) (psi): 1.7 / (17) / (247)

Relative Density (SG): Vapor Pressure: Solids: None Particle Size: N/A *Dual Seals

DYNAMIC TEST 100 h minimum			Pressure barg (psig)	Process Temp. °C (°F)	Flush Temp. IN °C (°F)	Flush Temp. OUT °C (°F)	Flush Flow Rate m^3/h (U.S. gal/min)	Seal Chamber Temp. °C (°F)	Barrier Fluid Pressure barg (psig)	Barrier Fluid Temp. IN °C (°F)	Barrier Fluid Temp. OUT °C (°F)	Power Consumption kW (hp)	Hydrocarbon Leakage g/day (ppm)	Nonhydrocarbon Leakage cm^3/min	Circulating Device m^3/h (U.S. gal/min)
Date	Time														
	Start	Stop													
27-07-2006	15:15		17.02 (247)	26.91 (80)	39 (102)	N/A	N/A	26.91 (80)	8.49 (123)	39 (102)	65 (149)	5.28 (7)	0	N/A	0.24 (1.1)
04-08-2006		09:40	16.86 (245)	32.49 (90)	50 (122)	N/A	N/A	32.49 (90)	8.66 (126)	50 (122)	75 (167)	5.24 (7)	<2.1 (6.6)	N/A	0.24 (1.1)
STATIC TEST 4 h minimum															
04-08-2006	09:40		17.01 (247)	27.58 (82)	49 (120)	N/A	N/A	27.58 (82)	8.62 (125)	49 (120)	72 (162)	0	0	N/A	0
04-08-2006		13:40	16.74 (243)	22.16 (72)	20 (68)	N/A	N/A	22.16 (72)	8.47 (123)	20 (68)	21 (70)	0	0	N/A	0
CYCLE TEST 5 cycles minimum															
04-08-2006	13:40		17.3 (251)	27.54 (82)	32 (90)	N/A	N/A	27.54 (82)	8.75 (127)	32 (90)	62 (144)	5.34 (7)	0	N/A	0.24 (1.1)
04-06-2006			17.27 (250)	33.3 (92)	34.1 (93)	N/A	N/A	33.3 (92)	8.6 (125)	34.1 (93)	62 (144)	5.34 (7)	0	N/A	0.24 (1.1)
04-06-2006		15:56	16.74 (243)	27.82 (82)	31.6 (89)	N/A	N/A	27.82 (82)	8.53 (124)	31.6 (89)	44.4 (112)	0	0	N/A	0

This is to certify that the seal noted above has been tested in accordance with the API 682 requirements.

Authorised By:
Stephen Shaw
Group Engineering Director

Notes:
1. Conducted to latest version of API 682 at time of test; 3rd edition.
2. API 682 specifies pass rate for liquid leakage as <5.6 g/h which equates to 134.4 g/day or 1000ppm for gas and vapour.
3. Average outer seal leakage barrier fluid measured at less than <0.1g/hr
4. kW / HP are calculated theoretical values.
5. Immeasurable face wear observed.

AESSEAL® ENVIRONMENTAL TECHNOLOGY

Mechanical Seal Qualification Test Form

1CW, 2CW-CW, 3CW-FB, 3CW-FF, 3CW-BB

Test Ref: T2/8/PT00801_17 Revision: 06/23

Manufacturer: AESSEAL plc Seal Type / Model: CAPI Type A Dual

Seal Type: A ☑ B ☐ ☐ C ☐ ES ☐ ☐

Materials of Construction: Primary Seal Faces: Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide Secondary Seal Faces: Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide

Secondary Seals: Fluoroelastomer Metal Hardware: 316 SS

Seal Size: 100mm Seal Code: 2CW-CW Piping Plan: 52 Shaft Speed: 3600rpm

Pumped Fluid (Table I.2): Nonhydrocarbon (water, caustic acid) ☐ Nonflashing Hydrocarbon ☐ Flashing Hydrocarbon ☑

Shaft Runout (Figure 19): <0.1mm Sleeve Runout (Figure 19): Chamber Concentricity (Figure 12): <0.1mm Seal Chamber Face Runout (Figure 14):

Test Fluid: Propane Base-point Temperature °C (°F): 30 / (86) Base-point Pressure MPa (bar) (psi): 1.7 / (17) / (247)

Relative Density (SG): Vapor Pressure: Solids: None Particle Size: N/A *Dual Seals

DYNAMIC TEST **100 h minimum**			**Pressure** barg (psig)	**Process Temp.** °C (°F)	**Flush Temp. IN** °C (°F)	**Flush Temp. OUT** °C (°F)	**Flush Flow Rate** m^3/h (U.S. gal/min)	**Seal Chamber Temp.** °C (°F)	**Barrier Fluid Pressure** barg (psig)	**Barrier Fluid Temp. IN** °C (°F)	**Barrier Fluid Temp. OUT** °C (°F)	**Power Consumption** kW (hp)	**Hydrocarbon Leakage** g/day (ppm)	**Nonhydrocarbon Leakage** cm^3/min	**Circulating Device** m^3/h (U.S. gal/min)
Date	**Time**														
	Start	**Stop**													
05-10-2006	14:55		16.81 (244)	28.03 (82)	N/A	N/A	N/A	37.21 (99)	1.5 (22)	21 (70)	57 (135)	5.54 (7)	0	N/A	0.24 (1.1)
10-10-2006		14:00	19.96 (289)	28.6 (83)	N/A	N/A	N/A	35.88 (97)	2.5 (36)	22 (72)	58 (136)	5.53 (7)	0	N/A	0.24 (1.1)
STATIC TEST 4 h minimum															
10-10-2006	14:01		16.92 (245)	29.6 (85)	N/A	N/A	N/A	29.86 (86)	2 (29)	22 (72)	57 (135)	0	0	N/A	0
11-10-2006		09:30	16.93 (246)	28.9 (84)	N/A	N/A	N/A	28.33 (83)	1.5 (22)	23 (73)	42 (108)	0	0	N/A	0
CYCLE TEST 5 cycles minimum															
11-10-2006	09:37		16.85 (244)	31.05 (88)	N/A	N/A	N/A	36.81 (37)	1.5 (22)	21.9 (72)	56.4 (134)	5.55 (7)	0	N/A	0.24 (1.1)
11-10-2006			16.84 (244)	31.33 (88)	N/A	N/A	N/A	37.66 (100)	1.5 (22)	23 (73)	57 (135)	5.55 (7)	0	N/A	0.24 (1.1)
11-10-2006		12:28	17.23 (250)	24.65 (76)	N/A	N/A	N/A	26.09 (79)	1.5 (22)	22 (72)	42 (108)	0	0	N/A	0

This is to certify that the seal noted above has been tested in accordance with the API 682 requirements.

Authorised By:
Stephen Shaw
Group Engineering Director

Notes:
1. Conducted to latest version of API 682 at time of test; 3rd edition.
2. API 682 specifies pass rate for liquid leakage as <5.6 g/h which equates to 134.4 g/day or 1000ppm for gas and vapour.
3. kW / HP are calculated theoretical values.
4. Less than 1% face wear (0.0001") measured.
5. No measurable volume or visible leakage recorded.

AESSEAL®
ENVIRONMENTAL TECHNOLOGY

Mechanical Seal Qualification Test Form

2CW-CS, 2NC-CS, 3NC-FF, 3NC-BB, 3NC-FB

Test Ref: T2/9/PT00801_20 Revision: 06/23

Manufacturer: AESSEAL plc Seal Type / Model: CAPI Type A Dual (FHS-NCCS)

Arrangement: 2CW-CS ☑ 2NC-CS ☐ 3NC-FF ☐ 3NC-BB ☐ 3NC-FB ☐

Materials of Construction: Primary Seal Faces: Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide Secondary Seal Faces*: Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide

Secondary Seals: Fluoroelastomer Metal Hardware: 316 SS

Seal Size: 50mm Shaft Speed: 3600rpm

Pumped Fluid (Table I.2): Nonhydrocarbon (water, caustic acid) ☐ Nonflashing Hydrocarbon ☐ Flashing Hydrocarbon ☑

Shaft Runout (Figure 19): <0.1mm Sleeve Runout (Figure 19): Chamber Concentricity (Figure 12): <0.1mm Seal Chamber Face Runout (Figure 14):

Test Fluid: Propane Base-point Temperature °C (°F): 30 / (86) Base-point Pressure MPa (bar) (psi): 1.7 / (17) / (247)

Relative Density (SG): Vapor Pressure: Solids: None Particle Size: N/A *Dual Seals

Test Procedure: ☑ I.3.13 (for 2CW-CS, 2NC-CS Arrangements)

☐ I.3.15 (for 3NC-FF, 3NC-BB, 2NC-FB)

Data Point Ref.	Date	Time	Inner Seal		Buffer/Barrier			Speed r/min	Seal Leakage			
			Pressure	Temp.	Medium	Pressure	Temp.		Inner	Outer		
			barg (psig)	°C (°F)		barg (psig)	°C (°F)		ml/m³ (vol. ppm)	ml/m³ (vol. ppm)	cm³/h	L/h (normalized)
I.6;1	12-10-2007	11:48	16.89 (245)	28.51 (83)	N/A	N/A	N/A	3600	N/A*	0.7	N/A	
I.6;1	16-10-2007	16:02	17.08 (248)	29.95 (86)	N/A	N/A	N/A	3600	N/A*	12.25	N/A	
I.6;2	16-10-2007	16:03	16.5 (239)	27.22 (81)	N/A	N/A	N/A	0	N/A*	0	N/A	
I.6;2	17-10-2007	10:41	16.96 (246)	30.35 (87)	N/A	N/A	N/A	0	N/A*	2.45	N/A	
I.6;3	17-10-2007	10:44	16.89 (245)	30.4 (87)	N/A	N/A	N/A	Cyclic	N/A*	3.85	N/A	
I.6;3	17-10-2007	12:26	17.04 (247)	30.35 (87)	N/A	N/A	N/A	Cyclic	N/A*	7.7	N/A	
I.6;3	17-10-2007	12:31	16.85 (244)	29.16 (85)	N/A	N/A	N/A	Cyclic	N/A*	4.9	N/A	
I.6;3	17-10-2007	12:42	16.96 (246)	30.33 (87)	N/A	N/A	<40 (<104)	Static	N/A*	1.05	N/A	
I.7;a1	17-10-2007	12:47	17.1 (248)	31.05 (88)	Propane	0.7 (10)	<40 (<104)	3600	N/A*	15.75	N/A	
I.7;a2	22-10-2007	09:15	16.73 (243)	30.38 (87)	Propane	0.7 (10)	<40 (<104)	3600	N/A*	46.55	N/A	
I.7;b0 to b5	22-10-2007	09:24	17.21 (250)	28.96 (84)	Nitrogen	1.7 (25)	<40 (<104)	0	N/A*	Nitrogen press. drop 0.3 psi / 5 mins		
I.7;c1					Diesel	2.8 (41)	<40 (<104)	3600				
I.7;c2					Diesel	2.8 (41)	<40 (<104)	3600				
I.7;d1	22-10-2007	10:07	16.8 (244)	30.52 (87)	Diesel	17 (247)	<40 (<104)	0	N/A*	N/A	7	
I.7;d2	22-10-2007	14:07	17.05 (247)	30.42 (87)	Diesel	17 (247)	<40 (<104)	0	N/A*	N/A	7	

Outer Seal Face Wear: Stationary Face: 0 Rotating Face: 0.008 (0.00032) / 0.53% mm (in.) / % wear

Inner Seal Face Wear: Stationary Face: 0 Rotating Face: 0 mm (in.) / % wear (I.3.15 only)

This is to certify that the seal noted above has been tested in accordance with the API 682 requirements.

Authorised By:
Stephen Shaw
Group Engineering Director

Notes:
1. Conducted to latest version of API 682 at time of test; 3rd edition.
2. API 682 specifies pass rate for liquid leakage as <5.6 g/h which equates to 134.4 g/day or 1000ppm for gas and vapour.
3. API 682 specifies pass rate for containment seal faces is <1% available seal face wear.
4. Average outer seal propane leakage (point 1 to a2) of 9.52 ppm.
5. *Inner seal data previously recorded <1.25ppm during test ref T2/7/PT00801_17.

AESSEAL® ENVIRONMENTAL TECHNOLOGY

Mechanical Seal Qualification Test Form

1CW, 2CW-CW, 3CW-FB, 3CW-FF, 3CW-BB

Test Ref: T4/4/PT00API_8 Revision: 06/23

Manufacturer:	AESSEAL plc			Seal Type / Model:	CAPI Type A Dual
Seal Type:	A ☑	B ☐	☐ C ☐	ES ☐	
Materials of Construction:	Primary Seal Faces:	Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide		Secondary Seal Faces*:	Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide
	Secondary Seals:	Fluoroelastomer		Metal Hardware:	316 SS
Seal Size:	50mm	Seal Code: 3CW-FB	Piping Plan: 11 & 53	Shaft Speed:	3600rpm
Pumped Fluid (Table I.2):	Nonhydrocarbon (water, caustic acid) ☐		Nonflashing Hydrocarbon ☑		Flashing Hydrocarbon ☐
Shaft Runout (Figure 19):	0.025mm	Sleeve Runout (Figure 19):		Chamber Concentricity (Figure 12):	0.1mm
				Seal Chamber Face Runout (Figure 14):	<0.1mm
Test Fluid:	Mineral Oil	Base-point Temperature °C (°F):	20 (68)	Base-point Pressure MPa (bar) (psi):	0.7 / (7) / (102)
Relative Density (SG):	0.873	Vapor Pressure:	N/A	Solids:	None
				Particle Size:	N/A

*Dual Seals

DYNAMIC TEST 100 h minimum			Pressure barg (psig)	Process Temp. °C (°F)	Flush Temp. IN °C (°F)	Flush Temp. OUT °C (°F)	Flush Flow Rate m^3/h (U.S. gal/min)	Seal Chamber Temp. °C (°F)	Barrier Fluid Pressure barg (psig)	Barrier Fluid Temp. IN °C (°F)	Barrier Fluid Temp. OUT °C (°F)	Power Consumption kW (hp)	Hydrocarbon Leakage g/day (ppm)	Nonhydrocarbon Leakage cm^3/min	Circulating Device m^3/h (U.S. gal/min)
Date	Time Start	Time Stop													
26-07-2002	15:00		6.85 (99)	19.93 (68)	18.11 (65)	18.6 (65)	0.3 (1.32)	18.17 (65)	7.76 (113)	21.5 (71)	39.5 (103)	0.84 (1.13)	0	N/A	0.15 (0.66)
31-07-2002		10:13	6.89 (100)	20.1 (68)	19.82 (68)	18.44 (65)	0.35 (1.54)	18.85 (66)	7.83 (114)	25.9 (79)	44.1 (111)	0.84 (1.13)	0	N/A	0.18 (0.79)
STATIC TEST 4 h minimum															
31-07-2002	10:13		6.89 (100)	20.07 (68)	19.78 (68)	18.4 (65)	0.35 (1.54)	18.65 (66)	7.82 (113)	25.7 (78)	40.9 (106)	0	0	N/A	0
31-07-2002		14:43	7.04 (102)	19.56 (67)	16.87 (68)	17.29 (63)	0.29 (1.28)	17.62 (64)	8.13 (118)	20.7 (69)	20.8 (69)	0	0	N/A	0
CYCLE TEST 5 cycles minimum															
31-07-2002	14:55		6.87 (100)	19.64 (67)	16.95 (68)	17.9 (64)	0.29 (1.28)	17.63 (64)	7.94 (115)	23.6 (74)	41.6 (107)	0.85 (1.14)	0	N/A	0.18 (0.79)
01-08-2002			7.14 (104)	19.57 (67)	17.69 (64)	18.73 (66)	0.29 (1.28)	18.37 (66)	8.37 (121)	25.8 (78)	44.2 (112)	0.88 (1.18)	0	N/A	0.2 (0.88)
02-08-2002		10:05	7.23 (105)	19.52 (67)	17.54 (64)	17.6 (64)	0.3 (1.32)	17.56 (64)	8.52 (124)	25 (77)	37.2 (99)	0	0	N/A	0

This is to certify that the seal noted above has been tested in accordance with the API 682 requirements.

Authorised By:
Stephen Shaw
Group Engineering Director

Notes:
1. Conducted to latest version of API 682 at time of test; 1st edition.
2. API 682 specifies pass rate for liquid leakage as <5.6 g/h which equates to 134.4 g/day or 1000ppm for gas and vapour.
3. Average outer seal leakage barrier fluid measured at less than <0.2g/hr
3. kW / HP are calculated theoretical values.

AESSEAL®
ENVIRONMENTAL TECHNOLOGY

Mechanical Seal Qualification Test Form

1CW, 2CW-CW, 3CW-FB, 3CW-FF, 3CW-BB

Test Ref: T4/9/PT00813_2 Revision: 06/23

Manufacturer:	AESSEAL plc			Seal Type / Model:	CAPI Type A Dual
Seal Type:	A ☑	B ☐	☐ C ☐	ES ☐	
Materials of Construction:	Primary Seal Faces:	Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide		Secondary Seal Faces*:	Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide
	Secondary Seals:	Fluoroelastomer		Metal Hardware:	316 SS
Seal Size:	100mm	Seal Code: 3CW-FB	Piping Plan: 11 & 53	Shaft Speed:	3600rpm
Pumped Fluid (Table I.2):	Nonhydrocarbon (water, caustic acid) ☐		Nonflashing Hydrocarbon ☑		Flashing Hydrocarbon ☐
Shaft Runout (Figure 19):	<0.1mm	Sleeve Runout (Figure 19):		Chamber Concentricity (Figure 12):	0.127mm
				Seal Chamber Face Runout (Figure 14):	<0.1mm
Test Fluid:	Mineral Oil	Base-point Temperature °C (°F):	20 / (68)	Base-point Pressure MPa (bar) (psi):	0.7 / (7) / (102)
Relative Density (SG):	0.873	Vapor Pressure:	N/A	Solids:	None
				Particle Size:	N/A

*Dual Seals

DYNAMIC TEST 100 h minimum			Pressure barg (psig)	Process Temp. °C (°F)	Flush Temp. IN °C (°F)	Flush Temp. OUT °C (°F)	Flush Flow Rate m^3/h (U.S. gal/min)	Seal Chamber Temp. °C (°F)	Barrier Fluid Pressure barg (psig)	Barrier Fluid Temp. IN °C (°F)	Barrier Fluid Temp. OUT °C (°F)	Power Consumption kW (hp)	Hydrocarbon Leakage g/day	Nonhydrocarbon Leakage cm^3/min	Circulating Device m^3/h (U.S. gal/min)
Date	Time														
	Start	Stop													
08-06-2006	15:47		6.84 (99)	19.80 (68)	21.61 (71)	32.92 (91)	0.23 (1.01)	29.75 (86)	7.67 (111)	41.44 (107)	67.35 (153)	3.30 (4.4)	0	N/A	0.32 (1.4)
13-06-2006		08:30	7.06 (102)	20.29 (69)	26.20 (79)	40.81 (105)	0.24 (1.06)	37.11 (99)	7.85 (114)	54.38 (130)	85.73 (186)	3.35 (4.5)	0	N/A	0.29 (1.3)
STATIC TEST 4 h minimum															
13-06-2006	08:30		7.07 (103)	20.22 (68)	26.14 (79)	40.91 (106)	0.27 (1.19)	37.11 (99)	7.86 (114)	53.11 (128)	84.44 (184)	0	0	N/A	0
13-06-2006		12:30	7.13 (103)	20.03 (68)	21.80 (71)	28.28 (83)	0.31 (1.36)	26.41 (80)	7.80 (113)	28.46 (83)	28.02 (82)	0	0	N/A	0
CYCLE TEST 5 cycles minimum															
13-06-2006	12:45		6.97 (101)	19.01 (66)	23.10 (74)	35.85 (97)	0.23 (1.01)	32.95 (91)	7.86 (114)	52.66 (127)	84.79 (185)	3.38 (4.5)	0	N/A	0.29 (1.3)
14-06-2006			7.16 (104)	21.95 (72)	28.94 (84)	44.16 (112)	0.25 (1.10)	41.34 (106)	7.90 (115)	59.10 (138)	94.69 (202)	3.35 (4.5)	0	N/A	0.29 (1.3)
14-06-2006		13:50	7.08 (103)	19.16 (67)	22.69 (73)	63.07 (146)	0.32 (1.41)	37.62 (100)	7.72 (112)	47.83 (118)	63.07 (146)	0	0	N/A	0

This is to certify that the seal noted above has been tested in accordance with the API 682 requirements.

Authorised By:
Stephen Shaw
Group Engineering Director

Notes:
1. Conducted to latest version of API 682 at time of test; 3rd edition.
2. API 682 specifies pass rate for liquid leakage as <5.6 g/h which equates to 134.4 g/day or 1000ppm for gas and vapour.
3. Average outer seal leakage barrier fluid measured at less than <0.1 g/hr
4. kW / HP are calculated theoretical values.

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ENVIRONMENTAL TECHNOLOGY

Mechanical Seal Qualification Test Form

1CW, 2CW-CW, 3CW-FB, 3CW-FF, 3CW-BB

Test Ref: T4/10/PT00813_3 Revision: 06/23

Manufacturer: AESSEAL plc

Seal Type / Model: CAPI Type A Dual

Seal Type: A ☑ B ☐ ☐ C ☐ ES ☐

Materials of Construction: Primary Seal Faces: Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide

Secondary Seal Faces*: Antimony Carbon FH82A/SC2 Reaction Bonded Silicon Carbide

Secondary Seals: Fluoroelastomer

Metal Hardware: 316 SS

Seal Size: 100mm Seal Code: 2CW-CW Piping Plan: 52

Shaft Speed: 3600rpm

Pumped Fluid (Table I.2): Nonhydrocarbon (water, caustic acid) ☐ Nonflashing Hydrocarbon ☑ Flashing Hydrocarbon ☐

Shaft Runout (Figure 19): <0.1mm

Sleeve Runout (Figure 19):

Chamber Concentricity (Figure 12): 0.127mm

Seal Chamber Face Runout (Figure 14): <0.1mm

Test Fluid: Mineral Oil

Base-point Temperature °C (°F): 20 / (68)

Base-point Pressure MPa (bar) (psi): 0.7 / (7) / (102)

Relative Density (SG): 0.873

Vapor Pressure: N/A

Solids: None

Particle Size: N/A

*Dual Seals

DYNAMIC TEST 100 h minimum			Pressure barg (psig)	Process Temp. °C (°F)	Flush Temp. IN °C (°F)	Flush Temp. OUT °C (°F)	Flush Flow Rate m^3/h (U.S. gal/min)	Seal Chamber Temp. °C (°F)	Barrier Fluid Pressure barg (psig)	Barrier Fluid Temp. IN °C (°F)	Barrier Fluid Temp. OUT °C (°F)	Power Consumption kW (hp)	Hydrocarbon Leakage g/day	Nonhydrocarbon Leakage cm^3/min	Circulating Device m^3/h (U.S. gal/min)
Date	Time Start	Time Stop													
04-07-2008	16:42		7.03 (102)	20.70 (69)	N/A	N/A	N/A	20.70 (69)	3.03 (44)	39.50 (103)	57.52 (136)	3.94 (5.3)	0	N/A	0.39 (1.7)
09-07-2008		09:45	6.98 (101)	20.61 (69)	N/A	N/A	N/A	20.61 (69)	3.03 (44)	44.58 (112)	60.90 (142)	3.94 (5.3)	0	N/A	0.39 (1.7)
STATIC TEST 4 h minimum															
09-07-2008	09:45		7.03 (102)	20.82 (69)	N/A	N/A	N/A	20.82 (69)	3.11 (45)	44.44 (112)	60.90 (142)	0	0	N/A	0
09-07-2008		13:45	6.99 (101)	21.10 (70)	N/A	N/A	N/A	21.10 (70)	3.09 (45)	24.12 (75)	22.70 (73)	0	0	N/A	0
CYCLE TEST 5 cycles minimum															
09-07-2008	13:55		7.06 (102)	20.66 (69)	N/A	N/A	N/A	20.66 (69)	3.02 (44)	36.88 (98)	55.06 (131)	3.94 (5.3)	0	N/A	0.39 (1.7)
10-07-2008			6.96 (101)	19.66 (67)	N/A	N/A	N/A	19.66 (67)	2.98 (43)	46.37 (115)	62.65 (145)	3.94 (5.3)	0	N/A	0.39 (1.7)
10-07-2008		16:22	7.02 (102)	19.60 (67)	N/A	N/A	N/A	19.60 (67)	3.18 (46)	41.84 (107)	46.97 (117)	0	0	N/A	0

This is to certify that the seal noted above has been tested in accordance with the API 682 requirements.

Authorised By:
Stephen Shaw
Group Engineering Director

Notes:
1. Conducted to latest version of API 682 at time of test; 3rd edition.
2. API 682 specifies pass rate for liquid leakage as <5.6 g/h which equates to 134.4 g/day or 1000ppm for gas and vapour.
3. Average outer seal leakage barrier fluid measured at less than <0.5 g/hr
4. kW / HP are calculated theoretical values.
5. Less than 0.33% face wear measured.

AESSEAL® ENVIRONMENTAL TECHNOLOGY