

Performance



Hydraulic Propulsion Selection Manual for Engineers

Revision 3 APR. 2003

Sub-Atlantic Limited, Unit 12, Airways Industrial Estate, Pitmedden Road, Dyce, Aberdeen, AB21 0DT Scotland UK

Tel: +44 (0)1224 723623

Fax: +44 (0)1224 723822

Email: sales@sub-atlantic.co.uk

Web: www.sub-atlantic.co.uk

Revision Record

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Propulsion Products

Since their launch in 1998, Sub-Atlantic's 'SA' range of hydraulic thrusters have been selected for approximately 90% of new build cable burial/maintenance vehicles. Working in this highly aggressive environment, they have become renowned for their reliability, efficiency and exceptional performance. The ROV sector is now also recognising the considerable benefits to be gained, having been selected for the majority of 'new design' systems such as Stolt Offshore's, 'SOLO Mk II', Thales Geosolutions's 'G3' or Deep Ocean's 'Installer'.



'SA' Range of Hydraulic Thrusters

We offer a '**Preferred Range**' and a '**Non-Standard Range**' of hydraulic thrusters.

Our '**Preferred Range**' is available in four sizes, SA300-30, SA380-40, SA420-60 & SA500-110, where the first number represents the diameter of the propeller in millimetres and the second, the motor displacement in cubic centimetres. The SA300 and SA380 units are usually used on work ROVs, the SA420 and SA500 for cable ROVs.



Our '**Non-Standard Range**' is available in a number of different options of motor displacement, propeller size, motor manufacturer and mounting style. In certain cases, we can also produce specials to customer's requirements. Details of the SA-300-20cc and SA-380-30cc are shown in this manual.



When selecting hydraulic propulsion thrusters for an underwater vehicle design, many highly important considerations such as efficiency, pressure and flow, weight, size and forward/reverse characteristics must be taken into account. Failure to correctly interpret these or to use inaccurate data will result in a system with inferior performance and incapable of meeting your expectations.

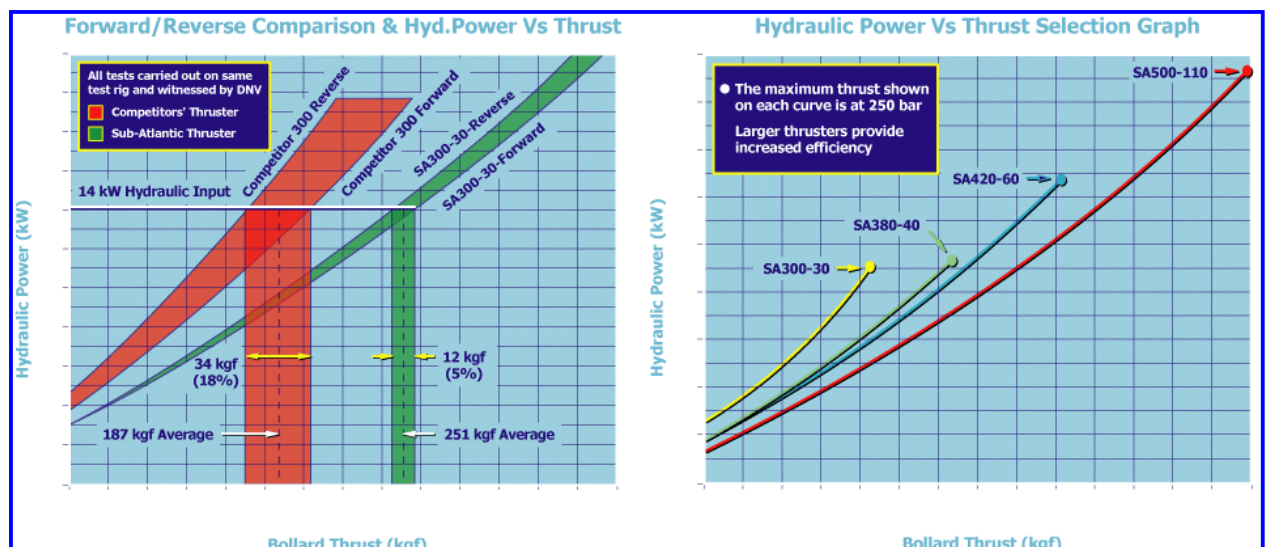
During the development phases of the 'SA' range, Sub-Atlantic evaluated various competitor's thruster products. We found that the actual test results and weights proved to be vastly different from the data claimed in their technical publications.

In fact, some of the data proved to be theoretically impossible to achieve. Sub-Atlantic therefore introduced a policy to ensure that all our own test performance data was witnessed by a reputable third party certification organisation (DNV). It is this commitment and confidence in our product that will give you peace-of-mind. Remember and ask for independently witnessed test data before you purchase your system or better still, test it yourself. If they can't provide it, ask the question "why not"!

Main Features

In addition to peace-of-mind, our hydraulic thrusters will provide you with the following benefits:

- | | |
|---|--|
| Proven Reliability | Originating from the design of the shaft sealing system which utilises hard, non-wearing ceramic and PTFE materials. Secondly, a rugged VOAC bent axis piston motor is used, capable of clocking up tens of thousands of trouble-free hours. We know SA thrusters are reliable because we sell very little spare parts! |
| More Efficient | Our thrusters convert more thrust from the available hydraulic power supply. |
| Superb Forward/Reverse Characteristics | Comparing input power to the output thrust, our forward and reverse thrust curves fall within a 5% band. This is important in a typical vectored configuration, as the overall system performance will only be as good as the average forward/reverse thrust. For the same power input, SA performance far exceeds other thrusters on the market. Check out the comparison graph. |
| Lighter | This means less ROV buoyancy required, less in-water drag leading to more usable thrust which means you will still be working when the increasing current puts the other back on deck. |
| DNV Witnessed Performance | Unlike some others, our thrusters will perform just like we say they will. |
| Retro-Fittable | SA thrusters use common mounting configurations so ROV performance upgrades are easy. |



Preferred Range

The standard Range consists of the following four units: -

Preferred Range						
Model	Propeller Diameter mm	Motor Displacement cc	Bollard Thrust @ 250bar kgf	Weight in Air kg	Weight in Water kg	Mount
SA-300-30	300	28.1	370	18	10	Flange
SA-380-40	385	37.7	460	27	14	Flange
SA-420-60	420	58.2	590	34	17	Flange
SA-500-110	500	110.1	850	59	31	Flange

These are the most common types available and should be selected where possible.

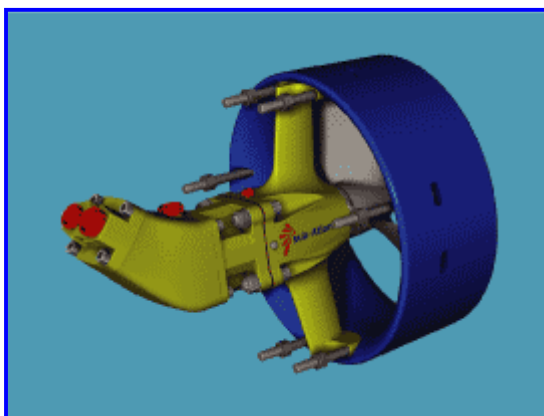
Non-Standard Range

Different Motor/Propeller Combinations

The VOAC motors used all have identical mounting interfaces to the thruster body, no matter the motor displacement. This makes them particularly suitable for interchanging with different propeller sizes to obtain higher running efficiencies. For example, in an application where limited hydraulic power and oil flow is available but maximum thrust is required, an SA-380-40 thruster (which normally uses a 37.7 cc motor) can be simply fitted with a 28.1 cc motor and used instead of an SA300-30. By using the larger propeller, increased efficiency can be achieved without the requirement for more oil flow. Details of these are shown in this manual.

SA-300/1002-(20 or 30)

This is a version of the SA-300 with special mounting configuration to fit Innerspace 1002 brackets. This is a particularly useful option for carrying out a quick retrofit on ROVs with frames with permanently welded thruster brackets such as 'Cobra'. Four to eight mounting studs can be positioned to suit. The motor can be 20 or 30cc displacement depending on the oil flow available.



Non-Standard Range						
Model	Propeller Diameter mm	Motor Displ. cc	Bollard Thrust @ 250bar kgf	Weight In Air kg	Weight in Water kg	Mount
SA-300-20	300	19.0	230	17	9	Flange
SA-380-30	385	28.1	330	26	13	Flange
SA-300-1002-20	300	19.0	230	17	9	Innerspace
SA-300-1002-30	300	28.1	370	18	10	Innerspace

Different Motor Manufacturers

Thrusters are also available with conversion kits which allow different motors to be used, such as Rexroth. Contact and we will advise you of these options.

Special Sizes

In certain cases, we may be able to supply special sizes.

Testing

Sub-Atlantic thrusters are tested at a depth of approx. 2.7 metres below the surface. The general procedure is illustrated on Drawing No. 0438-GA attached. All testing is witnessed by DNV who issue a certified certificate of authenticity.

Installation Drawings

The following General Arrangement drawings are attached: -

Model	Drawing No.
SA-300	0283-GA
SA-380	0313-GA
SA-420	0301-GA
SA-500	0431-GA
SA-300-1002	1412-GA
Thuster Test Rig	0438-GA

Performance Graphs

Comprehensive graphs are attached which allow an engineer to fully quantify performance at bollard condition through to 6 knots advance speed.

SA-300 Thrust versus Hydraulic Power
SA-300-30 cc Thrust versus Pressure & Flow @ 0 Knots
SA-380-30 cc Pressure versus Thrust & Flow @ 0, 1.5, 3.0, 4.5 & 6.0 Knots
SA-380 Thrust versus Hydraulic Power
SA-380-40 cc Thrust versus Pressure & Flow @ 0 Knots
SA-380-40 cc Pressure versus Thrust & Flow @ 0, 1.5, 3.0, 4.5 & 6.0 Knots
SA-420 Thrust versus Hydraulic Power
SA-420-60 cc Thrust versus Pressure & Flow @ 0 Knots
SA-420-60 cc Pressure versus Thrust & Flow @ 0, 1.5, 3.0, 4.5 & 6.0 Knots
SA-500 Thrust versus Hydraulic Power
SA-500-110 cc Thrust versus Pressure & Flow @ 0 Knots
SA-500-110 cc Pressure versus Thrust & Flow @ 0, 1.5, 3.0, 4.5 & 6.0 Knots
SA-300-20 cc (non-standard) Thrust versus Pressure & Flow @ 0 Knots
SA-380-20 cc (non-standard) Pressure versus Thrust & Flow @ 0, 1.5, 3.0, 4.5 & 6.0 Knots
SA-380-30 cc (non-standard) Thrust versus Pressure & Flow @ 0 Knots
SA-380-30 cc (non-standard) Pressure versus Thrust & Flow @ 0, 1.5, 3.0, 4.5 & 6.0 Knots

Other Equipment Available

Servo-Valve Pack

This extremely compact servo valve pack weighs only 32 kg in air, 15 kg in sea water and measures 775 x 198 x 213 mm.

This valve pack is generally used to provide precise control of the propulsion thrusters on underwater vehicles. The pack utilises 77 LPM rated servovalves which provide low pressure drop on most standard ROV applications. The use of this pack in conjunction with Sub-Atlantic's efficient thrusters and hydraulic power units, will produce an unbeatable propulsion solution with regard to reliability, efficiency and cost.



The valves can also be used to control any tool requiring a variable speed or reversible function. The unit can use Star or Moog (Ultra) valves. Unless specified, Sub-Atlantic supply the Star valve as standard as this is half the weight of the Moog. Both types of valve are functionally identical and interchangeable.

Features: -

- **Compact and Lightweight**
- **280 Bar maximum input pressure, 350 LPM maximum input flow rate**
- **Pressure Relief Valve provides pump protection**
- **Integral Soft Start Valve or Pump Remote Control Valve options**
- **'STAR' lightweight Servo Valves rated 77 lpm full flow @ 70 bar pressure drop**
- **Water Ingress Sensors located to suit all mounting orientations.**
- **Temperature Sensor fitted to the return oil galley.**
- **Various Control System Options**
- **Integral Cover Relief Valve**
- **Fully Captive Screw Assemblies. No more lost screws!**
- **Lightweight Plastic Cover shaped to provide easy air bleeding and draining.**
- **Options available**

For full installation details, schematics, drawings, etc, request User Manual Doc. No. 1218-UM

75 & 110 kW Hydraulic Power Units (HPU)

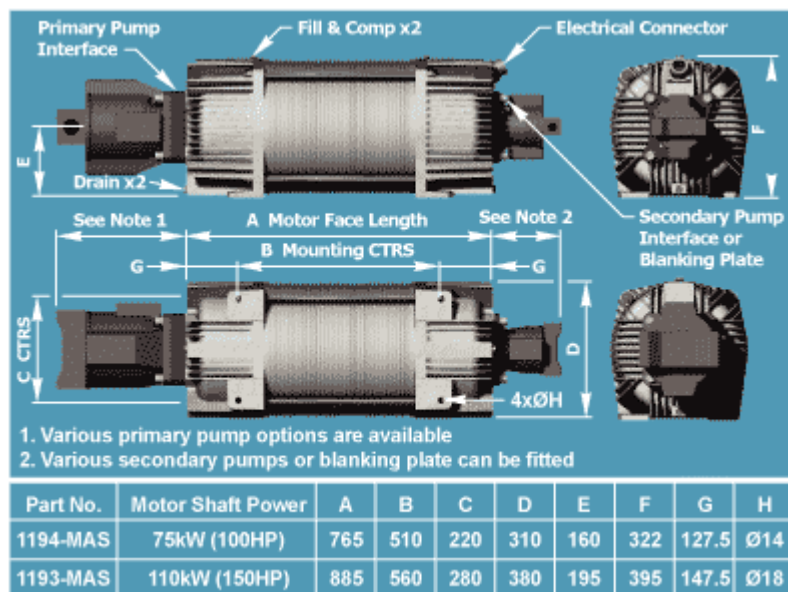
These HPUs are ideal for driving thruster systems and hydraulic tools requiring higher power inputs. The submersible motor unit can also be used to drive other types of rotating machinery such as water pumps for trenching machines. The motor uses a Zeihl-Abegg rotor/stator unit which has for many years been successfully used in the ROV industry. The standard motor is 4 pole, 3000 vac running at 1700 rpm full load speed @ 60Hz. Other voltage and speed options are available on request.

The motor body and end cap design provides for efficient heat

dissipation, which is essential when working in hot climates. Motor winding temperature and water ingress sensors are included for connection to customers control system. The motor is filled with transformer or hydraulic oil which must be positively compensated (compensators are available, see Hydraulic Products Brochure).



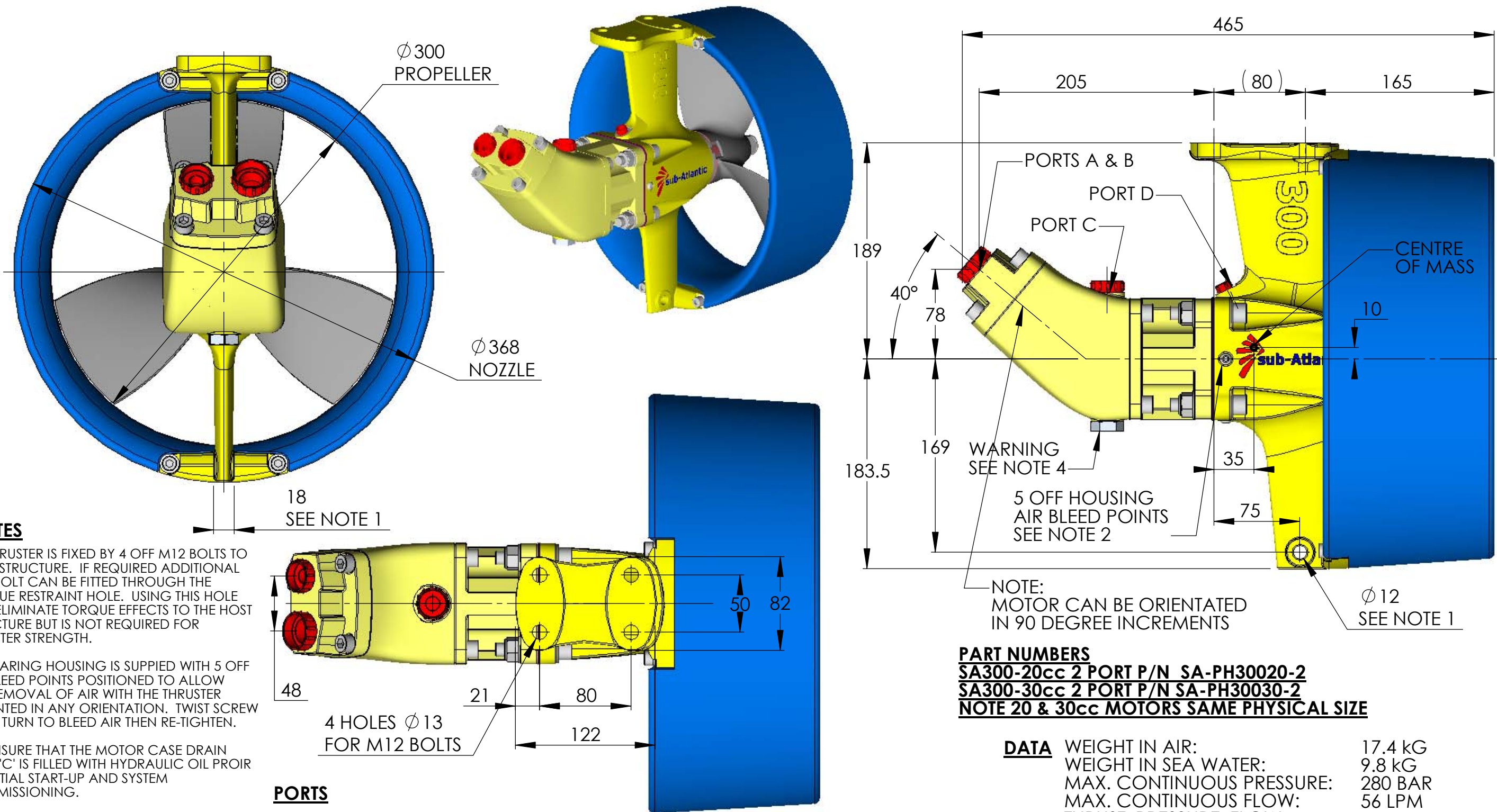
Various hydraulic pumps can be fitted to the motor by means of an Interface Plate. A secondary pump can also be fitted to the opposite end of the motor to provide a separate isolated hydraulic circuit. Compensated pumps are generally used which automatically 'unload' when there is no power demand. Pumps from different manufacturers such as VOAC or Rexroth in various sizes and control options can be supplied fitted and ready to run.



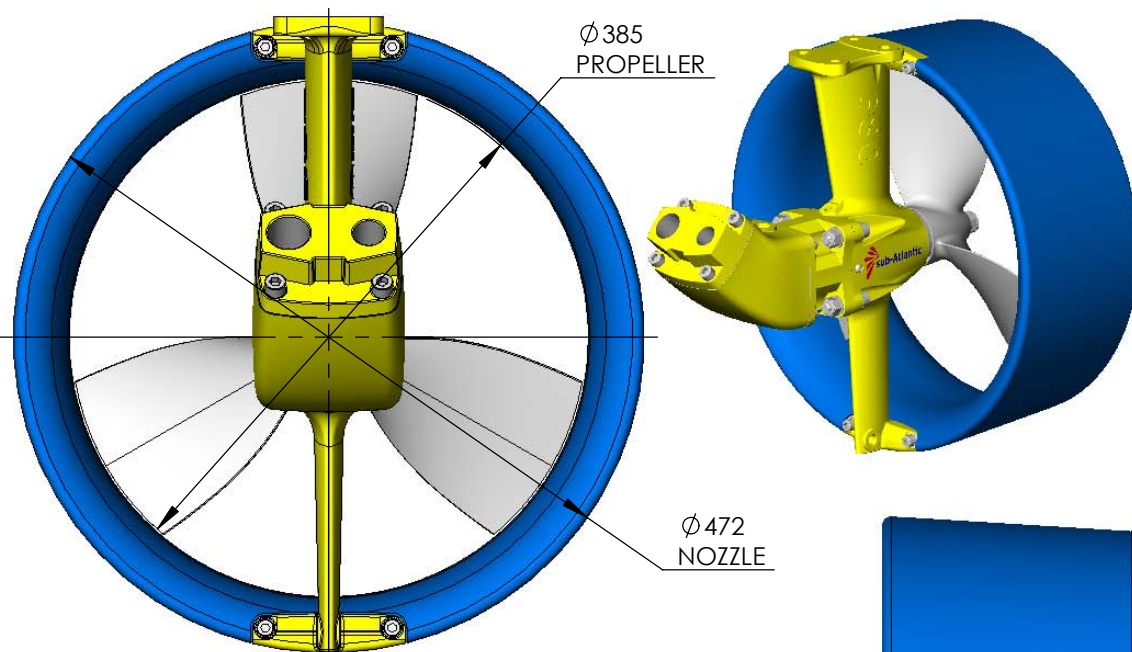
Typical Pump Options Available Sizes (cc)

VOAC PV Range 16, 20, 23, 32, 40, 46, 63, 80, 92, 140, 180, 270

Rexroth A10VSO Range 28, 45, 71, 100, 140



					MATERIAL ALUMINIUM, STAINLESS STEEL & PLASTICS	WT AIR	WT WATER	 Woodburn Road, Blackburn Business Park, Blackburn, Aberdeen. U.K. AB21 0PS Tel: ++44 (0) 1224 798660 Fax: ++44 (0) 1224 798661	PROJECT HYDRAULIC THRUSTERS				
						- kg (E)	- kg (E)		TITLE SA-300 20cc & 30cc - 2 PORT HYDRAULIC THRUSTER GENERAL ARRANGEMENT & INSTALLATION DRAWING	DOC. No.	0283-GA	SHEET 1 of 1	REV 3
						DRAWN	CGM						
					DATE	30/09/98							
3	CMI	07/11/06	PART NUMBERS ADDED		FINISH HARD ANODISING & POWER PAINT COATINGS	CHECK	SSM						
2	EBR	6/09/02	NOTES UPDATED	CMI		APPRV.	CGM						
1	CGM	30/09/98	APPROVED FOR CONSTRUCTION			ENGR.	CGM						
USO, TOLERANCES TO BE						SCALE (USO) ORIG. SIZE							
REV	BY	DATE	DESCRIPTION		APP	1 : 3.5 A3							
RECORD OF REVISIONS													

**NOTES**18
SEE NOTE 1

1. THRUSTER IS FIXED BY 4 OFF M12 BOLTS TO HOST STRUCTURE. IF REQUIRED ADDITIONAL M10 BOLT CAN BE FITTED THROUGH THE TORQUE RESTRAINT HOLE. USING THIS HOLE WILL ELIMINATE TORQUE EFFECTS TO THE HOST STRUCTURE BUT IS NOT REQUIRED FOR THRUSTER STRENGTH.

2. BEARING HOUSING IS SUPPLIED WITH 5 OFF AIR BLEED POINTS POSITIONED TO ALLOW THE REMOVAL OF AIR WITH THE THRUSTER MOUNTED IN ANY ORIENTATION. TWIST SCREW ONE TURN TO BLEED AIR THEN TIGHTEN.

3. ENSURE THAT THE MOTOR CASE DRAIN PORT 'C' IS FILLED WITH HYDRAULIC OIL PRIOR TO INITIAL START-UP AND SYSTEM COMMISSIONING.

PORTS

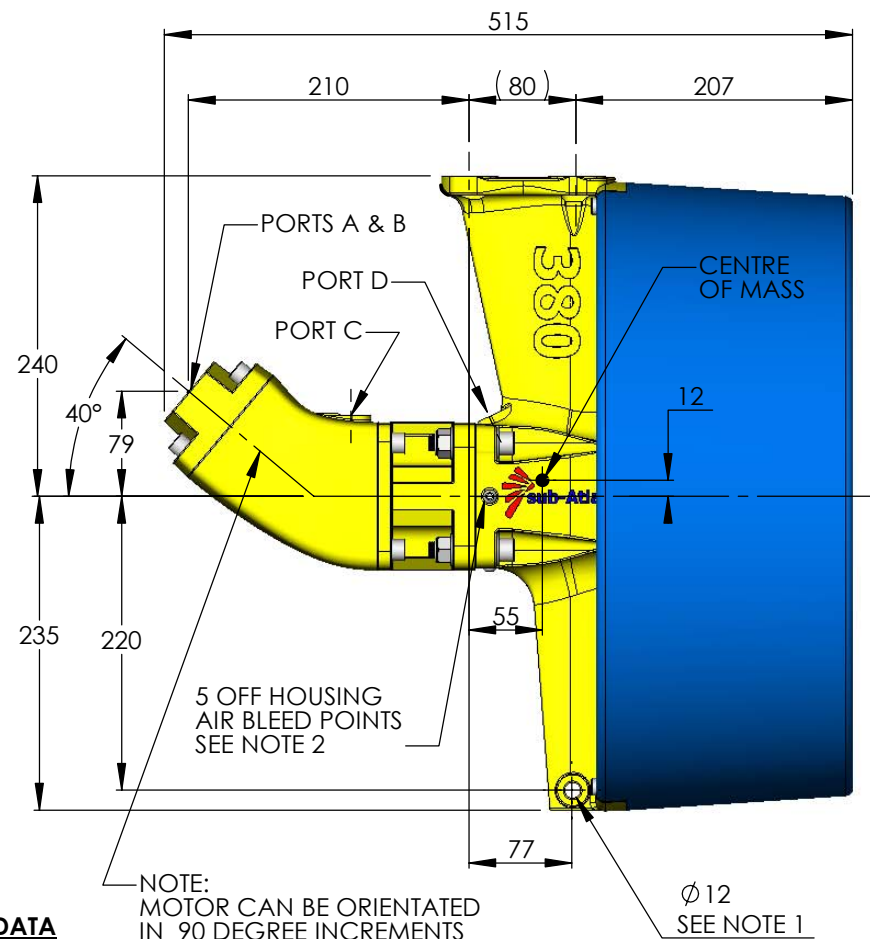
'A' 1" BSPP - HYDRAULIC SUPPLY OR RETURN
'B' 3/4" BSPP - HYDRAULIC SUPPLY OR RETURN
'C' 1/2" BSPP - MOTOR CASE DRAIN
'D' 1/8" BSPP - BEARING HOUSING OIL SUPPLY

REV	BY	DATE	DESCRIPTION	APP
2	SSM	05/09/2002	EXTRA NOTES ADDED	CMI
1	CGM	11/01/99	APPROVED FOR CONSTRUCTION	CMI
RECORD OF REVISIONS				

MATERIAL
ALUMINIUM, STAINLESS
STEEL & PLASTICS

FINISH
HARD ANODISING & POWER
PAINT COATINGS

USO, TOLERANCES TO BE

**DATA**

WEIGHT IN AIR: 27 kg
WEIGHT IN SEA WATER: 14 kg
MAX. CONTINUOUS PRESSURE: 250 BAR (Higher Possible - Consult Tech. Dept.)
MAX. CONTINUOUS FLOW: 70 LPM
THRUST, PRESSURE, FLOW: REFER TO DATA SHEET

OTHER THRUSTERS AVAILABLE: SA-300, SA-420, SA-500, SA-300-1002 INNERSPACE REPLACEMENTS & OTHER SPÉCIALS. ASK FOR DATA SHEETS

WT AIR
- kg (E)

WT WATER
- kg (E)

DRAWN
CGM

DATE
11/01/99

CHECK
MBI

APPRV.
RWR

ENGR.
CGM

sub-Atlantic

Unit 12, Airways Industrial Estate
Pitmedden Road, Dyce,
Aberdeen, U.K. AB21 0DT
Tel: ++44 (0) 1224 723623
Fax: ++44 (0) 1224 723822

SCALE (USO) 1:4
ORIG. SIZE A3

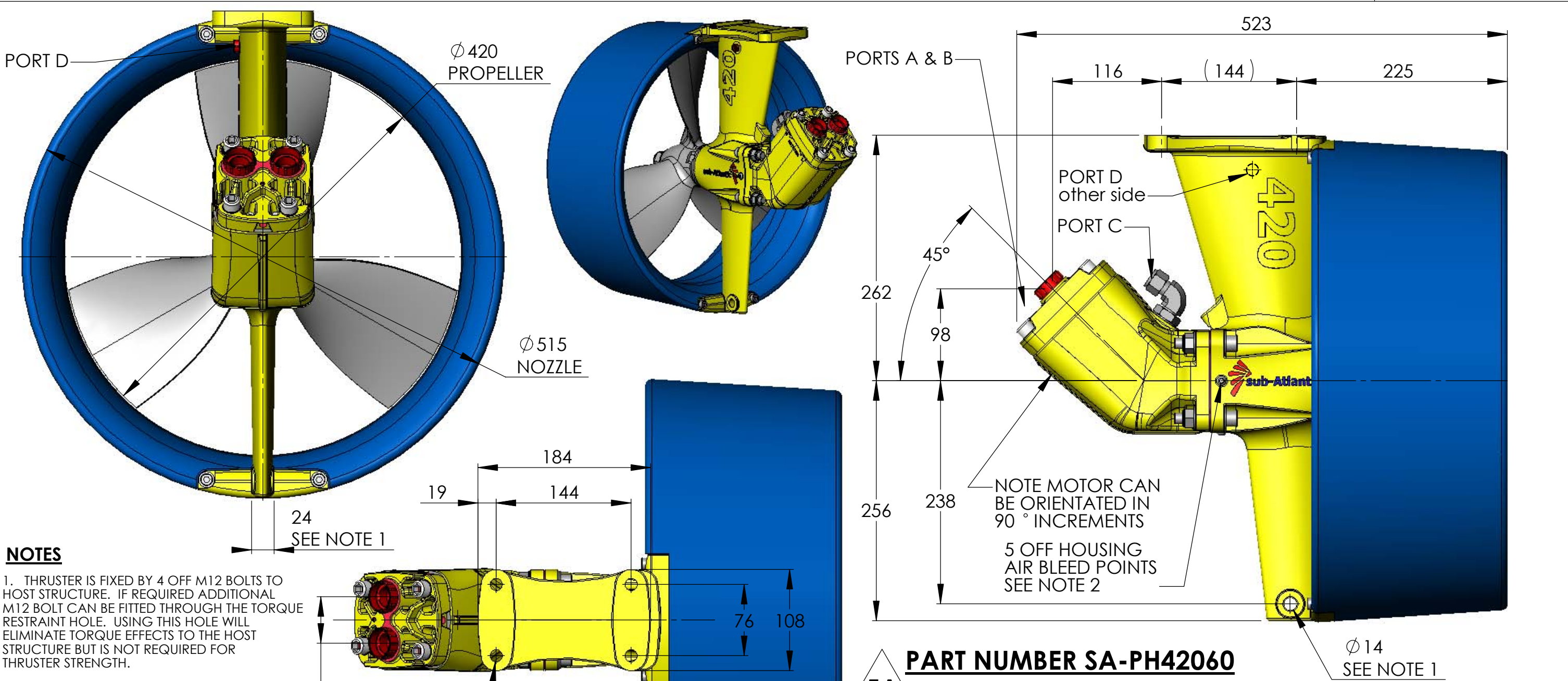
PROJECT HYDRAULIC THRUSTERS

TITLE
**SA-380 HYDRAULIC THRUSTER
GENERAL ARRANGEMENT
& INSTALLATION DRAWING**

DOC. No. 0313-GA

SHEET 1 of 1

REV 2



5A

DATA
WEIGHT IN AIR: 33 kG
WEIGHT IN SEA WATER: 17 kG
MAX. CONTINUOUS PRESSURE: 280 BAR
MAX. CONTINUOUS FLOW: 99 LPM
THRUST, PRESSURE, FLOW: REFER TO DATA SHEET

5A

OTHER SIZES AVAILABLE: SA-300, SA-380 & SA-500, SA-300-1002 INNERSPACE REPLACEMENTS & OTHER SPECIALS ASK FOR DATA SHEETS

RECORD OF REVISIONS				MATERIAL ALUMINIUM, STAINLESS STEEL & PLASTICS FINISH HARD ANODISING & POWER PAINT CAOTINGS USO, TOLERANCES TO BE	WT AIR	WT WATER	 Woodburn Road, Blackburn Business Park, Blackburn, Aberdeen. U.K. AB21 0PS Tel: ++44 (0) 1224 798660 Fax: ++44 (0) 1224 798661	PROJECT HYDRAULIC THRUSTERS					
5A	CMI	06/11/06	ADDITIONAL INFORMATION ADDED		- kg (E)	- kg (E)		TITLE HYDRAULIC THRUSTER - SA420-61 GENERAL ARRANGEMENT & INSTALLATION DRAWING	DOC. No.	0301-GA	SHEET 1 of 1	REV 5A	
5	CMI	19/03/05	BEARING HOUSING COMP PORT RELOCATED		CMI	DRAWN							CGM
4	CMI	10/01/05	MODIFIED WITH NEW MOTOR VERSION		CMI	DATE							30/09/98
3	EBR	6/09/02	INFORMATION UPDATED		CMI	CHECK							MBI
2	CGM	26/01/99	MOUNTING DETAILS ALTERED		CMI	APPRV.							RWR
1	CGM	30/09/98	APPROVED FOR CONSTRUCTION		CMI	ENGR.							CGM
REV	BY	DATE	DESCRIPTION		APP								

THIRD ANGLE PROJECTION



						MATERIAL	WT AIR	WT WATER	 Unit 12, Airways Industrial Estate Pitmedden Road, Dyce, Aberdeen, U.K. AB21 0DT Tel: ++44 (0) 1224 723623 Fax: ++44 (0) 1224 723822	PROJECT	HYDRAULIC THRUSTERS			
						ALUMINIUM, STAINLESS STEEL & PLASTICS	- kg (E)	- kg (E)		TITLE	SA-500 HYDRAULIC THRUSTER GENERAL ARRANGEMENT & INSTALLATION DRAWING			
						FINISH	DRAWN	CGM						
						HARD ANODISING & POWER PAINT COATINGS	DATE	08/10/99						
2	EBR	13/09/02	NOTES UPDATED ECN-029-02				CHECK	MBI						
1	CGM	08/10/99	PRELIMINARY FOR INFORMATION	CM1	USO, TOLERANCES TO BE		APPRV.	RWR						
REV	BY	DATE	DESCRIPTION	APP			ENGR.	CGM	SCALE (USO)	ORIG. SIZE	DOC. No.	0431-GA	SHEET 1 of 1	REV 2
RECORD OF REVISIONS									1 : 5	A3				

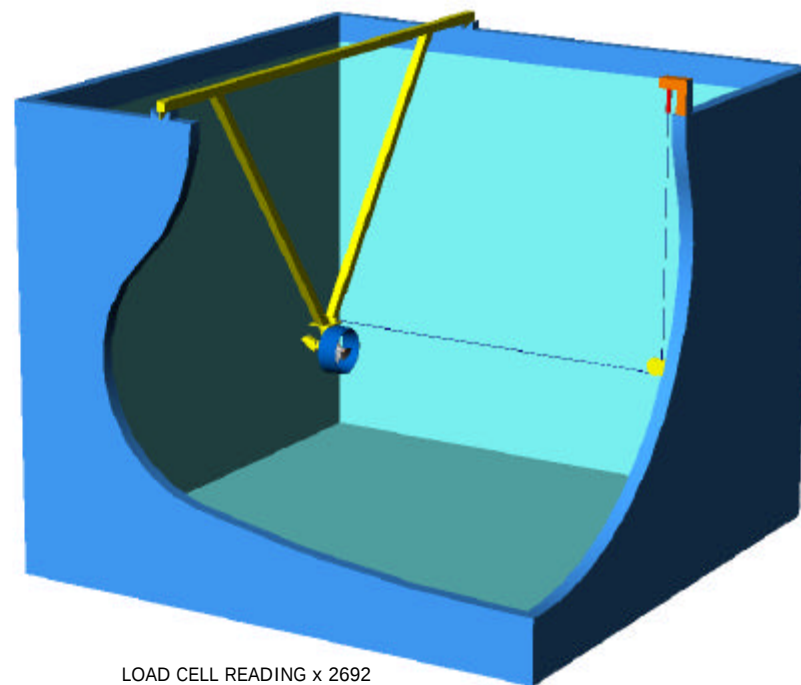
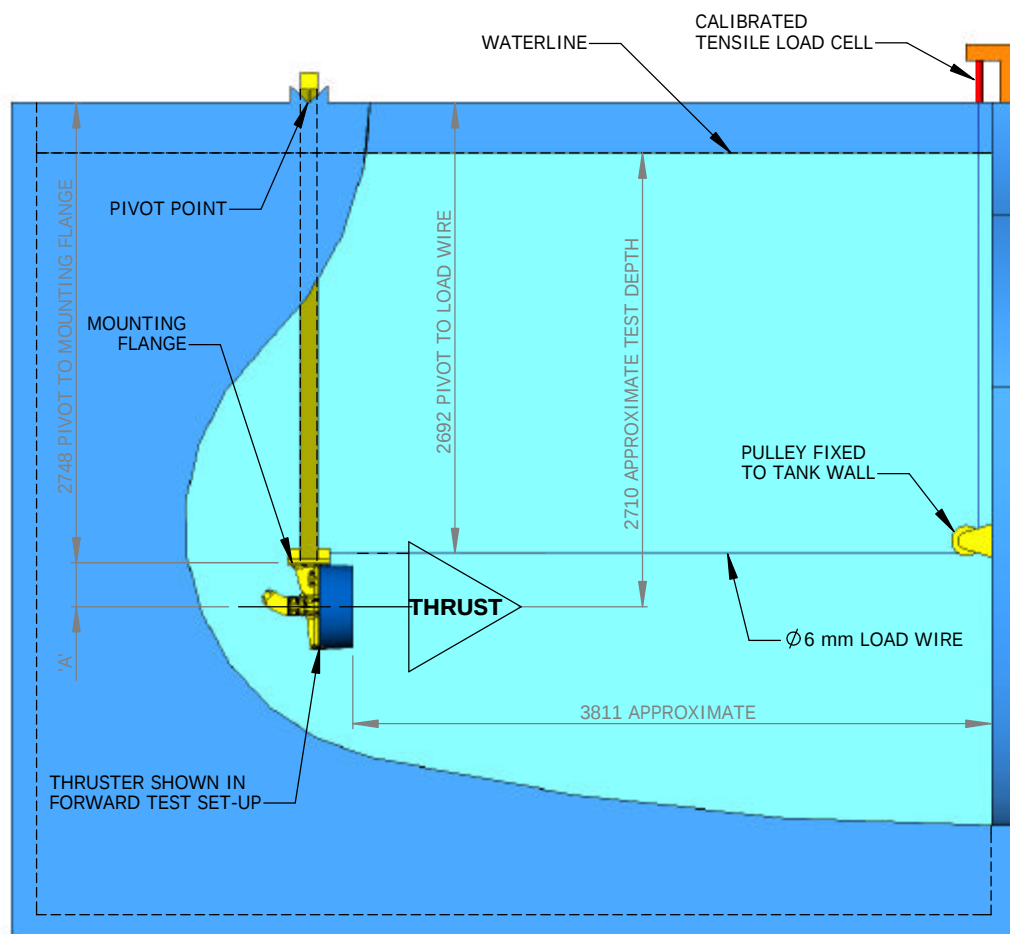


- ## PORTS

STANDARD VERSION



					MATERIAL	WT AIR	WT WATER	 Unit 12, Airways Industrial Estate Pitmedden Road, Dyce. Aberdeen, U.K. AB21 0DT Tel: ++44 (0) 1224 723623 Fax: ++44 (0) 1224 723822 SCALE (USO) 1 : 4 ORIG. SIZE A3	PROJECT HYDRAULIC THRUSTERS			
					ALUMINIUM, STAINLESS STEEL & PLASTICS	- kg (E)	- kg (E)		TITLE SA-300-1002 HYD. THRUSTER GENERAL ARRANGEMENT & INSTALLATION DRAWING			
						DRAWN	CMI					
					FINISH	DATE	22/11/01					
					HARD ANODISING & POWER PAINT COATINGS	CHECK	MBI					
1	EBR	4/09/02	ISSUED FOR CONSTRUCTION	CMI	USO, TOLERANCES TO BE	APPRV.	CMI		DOC. No.	1412-GA	SHEET 1 of 1	REV 1
A	CMI	22/11/01	ISSUED FOR APPROVAL	CMI		ENGR.	CMI					
REV	BY	DATE	DESCRIPTION		APP							
RECORD OF REVISIONS												

IF IN DOUBT - ASK!

$$\text{BOLLARD THRUST} = \frac{\text{LOAD CELL READING} \times 2692}{(2748 + 'A')}$$

PRESSURE IS RECORDED DIRECTLY AT MOTOR INLET AND OUTLET ON CALIBRATED PRESSURE GAUGES. TEST PRESSURE = INLET PRESSURE MINUS OUTLET PRESSURE.

MOTOR INLET FLOW IS RECORDED ON CALIBRATED FLOW METER.

OIL TEMPERATURE IS RECORDED FROM FLOWMETER.

CASE DRAINAGE IS RECORDED AT 200 BAR.

OUTLINE TEST PROCEDURE (FORWARD & REVERSE TESTS)

1. SET FLOW RATE AT 5 LPM, SWITCH OFF FLOW AND ALLOW WATER IN TANK TO SETTLE, SWITCH ON FLOW, RECORD INLET & OUTLET PRESSURES, LOAD CELL & FLOW RATE.
2. SET FLOW RATE AT NEXT INCREMENT (e.g. 7.5 LPM), SWITCH OFF FLOW AND ALLOW WATER TO SETTLE, SWITCH ON FLOW AND TAKE NEXT SET OF READINGS.
3. REPEAT AS ABOVE FOR FLOW INCREMENT STEPS UNTIL THE MAXIMUM MOTOR PRESSURE IS REACHED.
4. REMOVE TEST FRAME, REVERSE THRUSTER ON FRAME, RELAX IN TANK AND CARRY OUT TESTS AS ABOVE TO CHECK REVERSE BOLLARD THRUST.

1	CMI	28/01/99	APPROVED FOR CONSTRUCTION	
REV	BY	DATE	DESCRIPTION	APP
RECORD OF REVISIONS				

MATERIAL -
FINISH -
USO, TOLERANCES TO BE

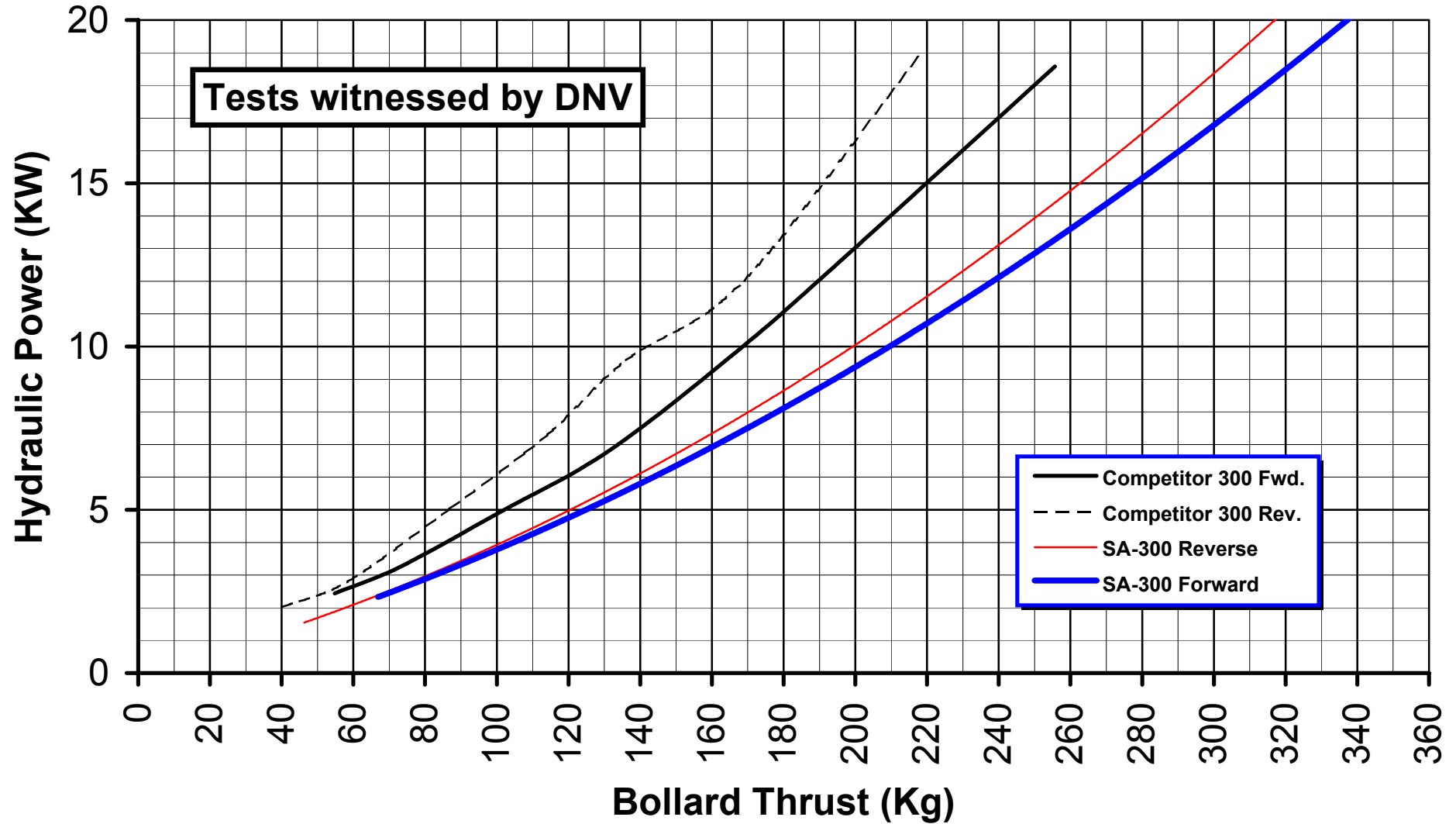
WT AIR	WT WATER
-	kg (E) -
DRAWN	CMI
DATE	28/01/99
CHECK	MBI
APPRV.	RWR
ENGR.	RWR


Unit 12, Airways Industrial Estate Pitmedden Road, Dyce, Aberdeen. U.K. AB21 0DT Tel: ++44 (0) 1224 723623 Fax: ++44 (0) 1224 723822 SCALE (USO) ORIG. SIZE
1 : 30 A3

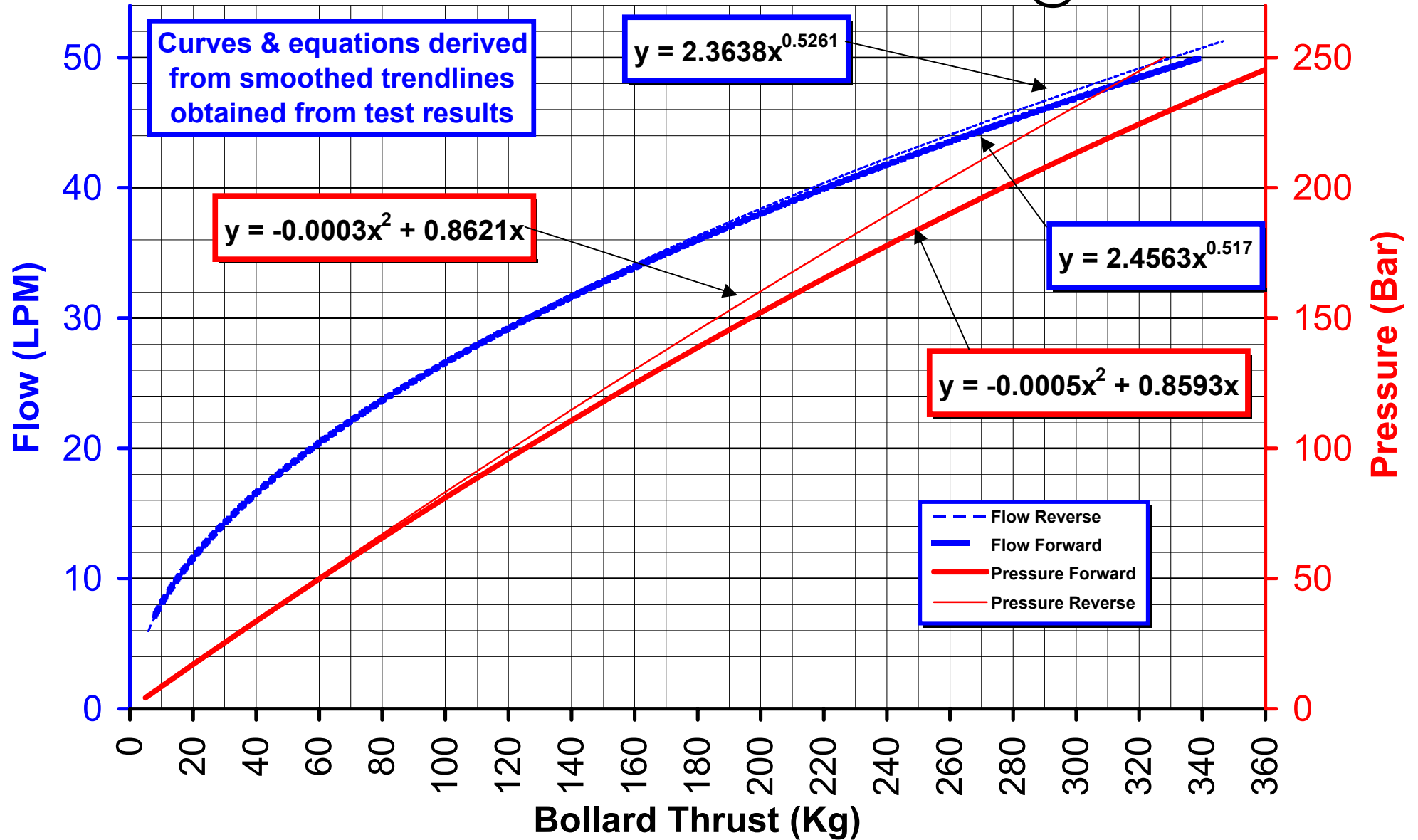
PROJECT	HYDRAULIC THRUSTERS
TITLE	THRUSTER TEST RIG GENERAL ARRANGEMENT Sheet 1 of 1
DOC. No.	0438-GA
REV	1

SA-300 Hydraulic Power Vs Thrust

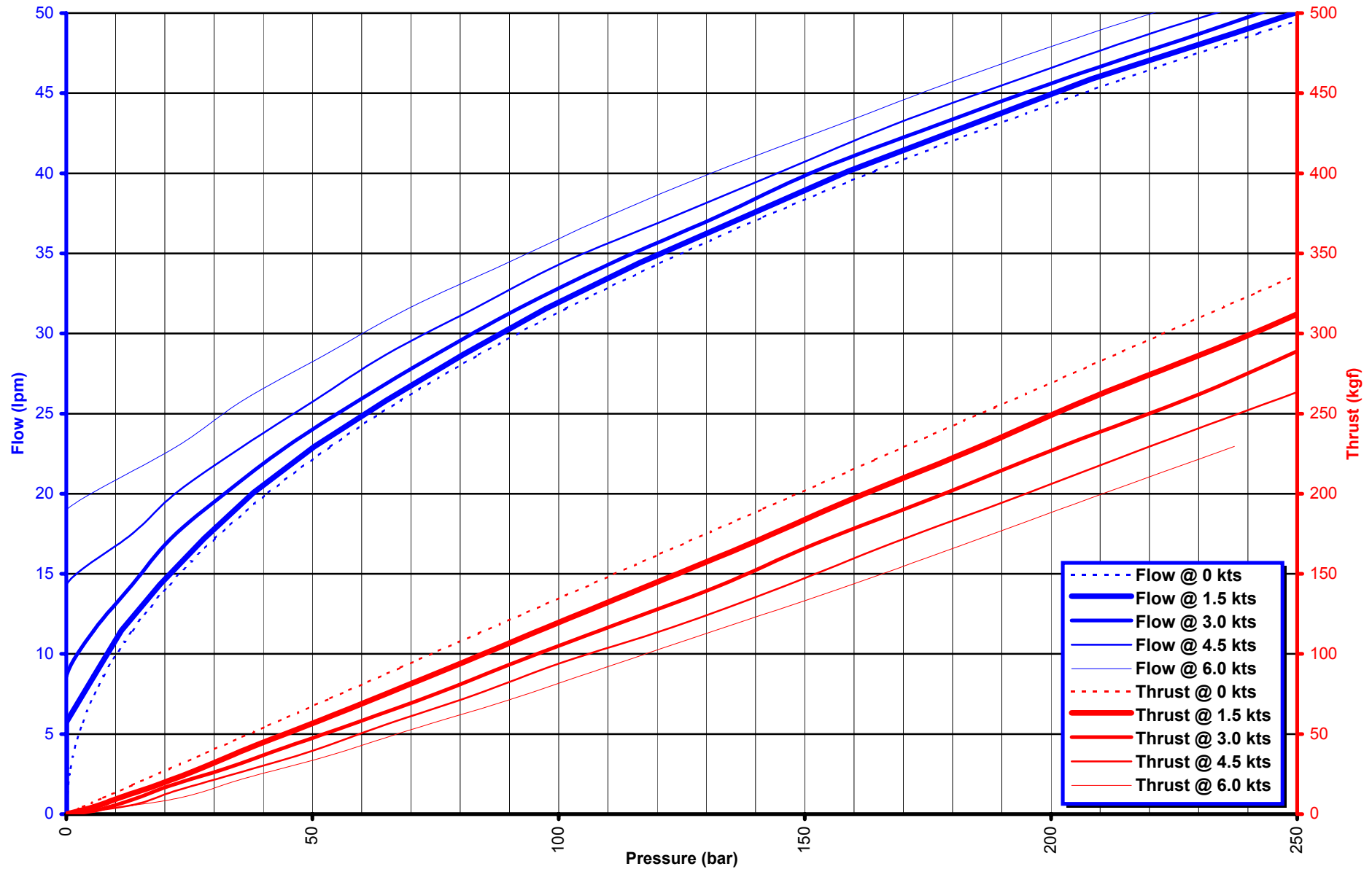
(Competitor comparative also shown)



SA-300-30cc Flow & Pressure V Thrust @ 0 Knots



SA-300-30cc-SF Flow & Thrust V Pressure at Various Advance Speeds

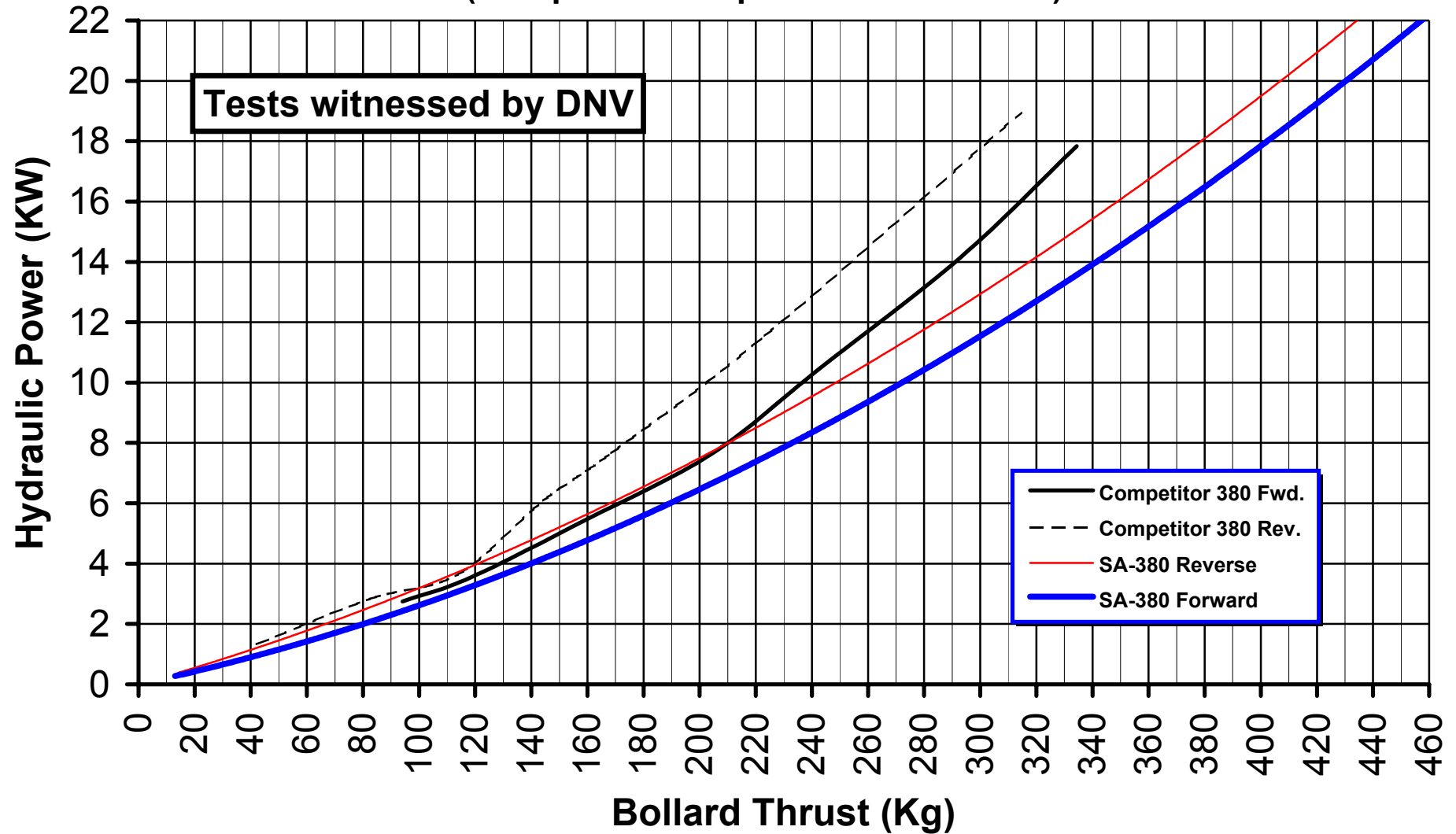


Copies of Certified DNV data sheets available

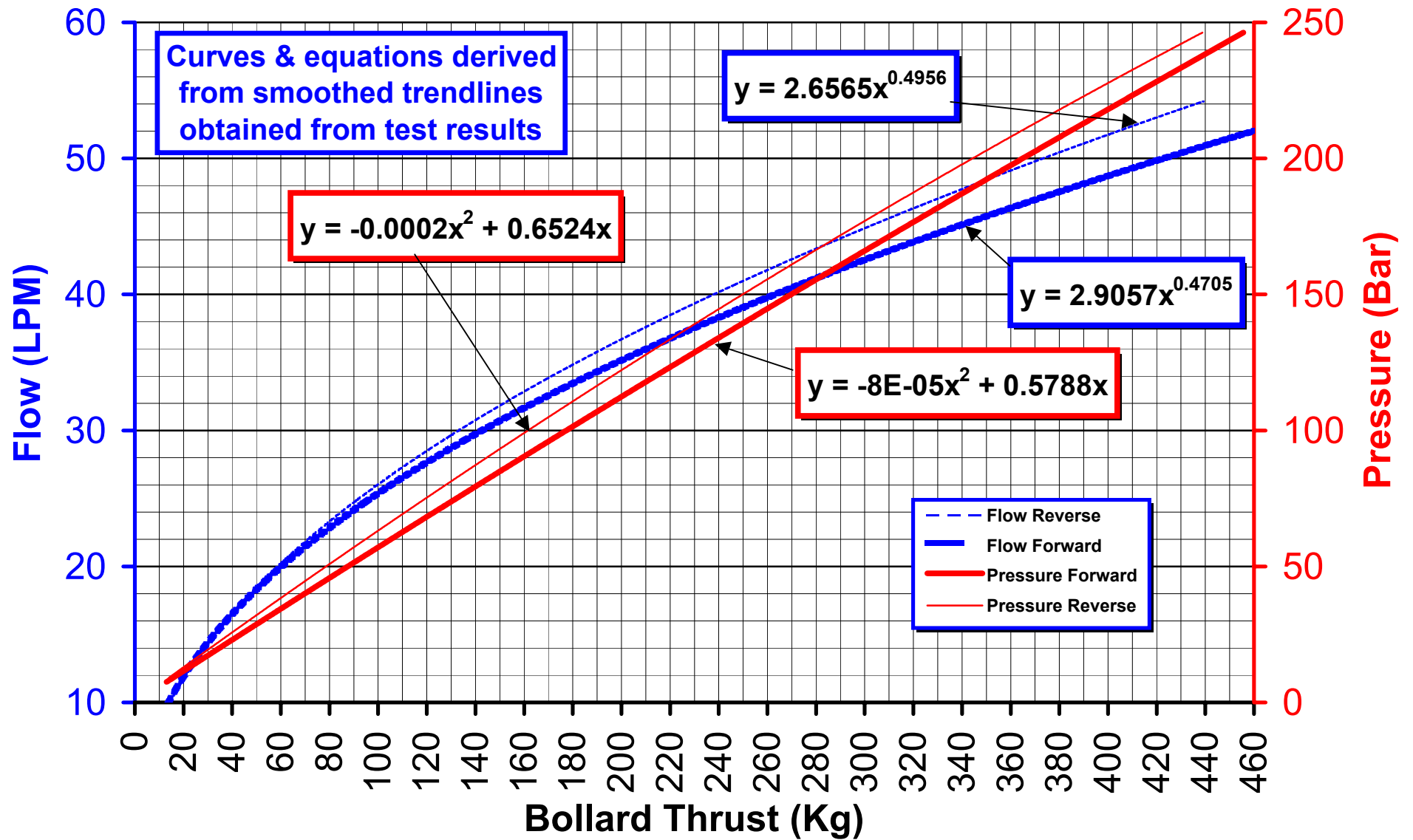
Curves & equations derived from DNV witnessed bollard test results

SA-380 Hydraulic Power Vs Thrust

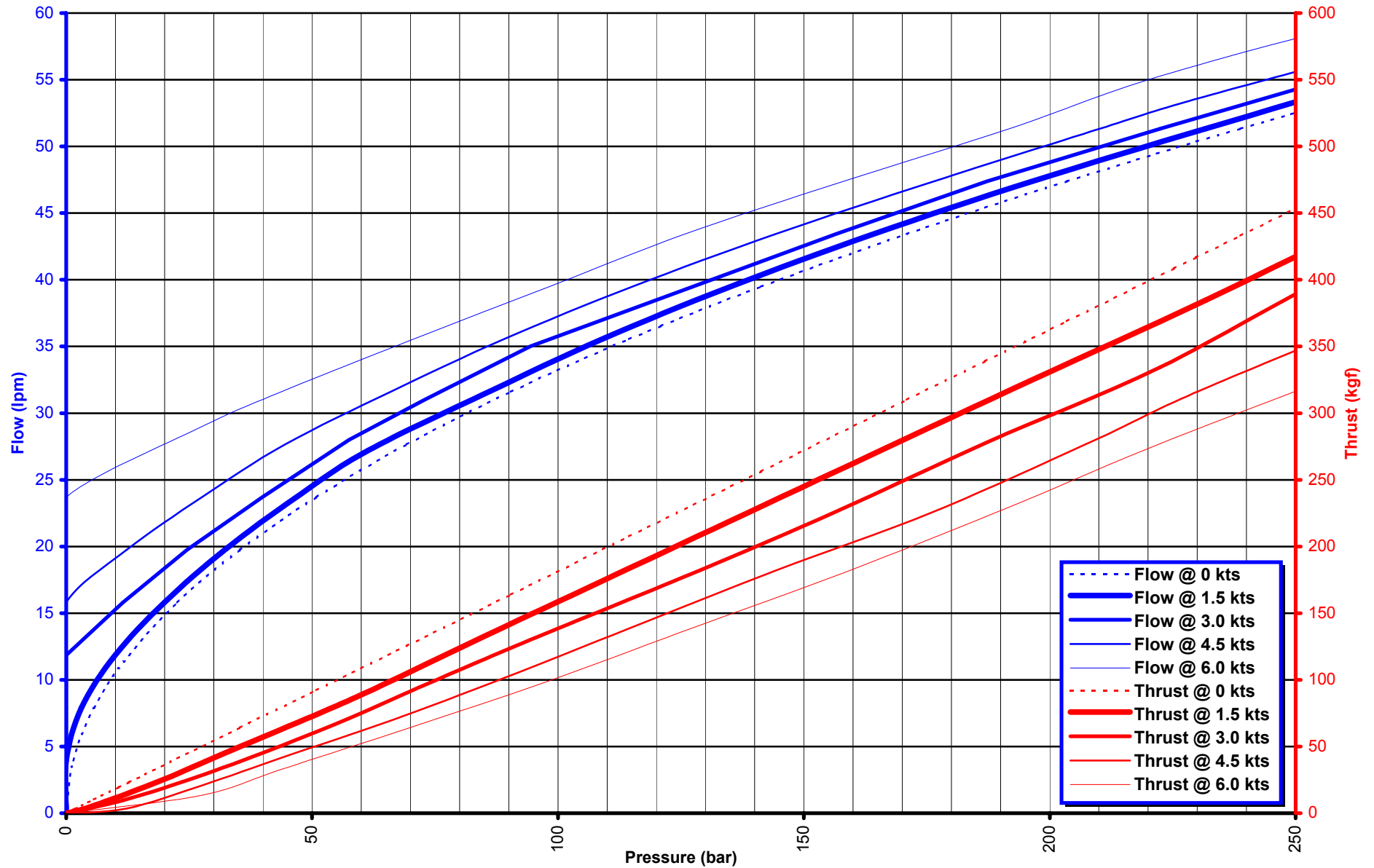
(Competitor comparative also shown)



SA-380-40cc Flow & Pressure V Thrust @ 0 Knots



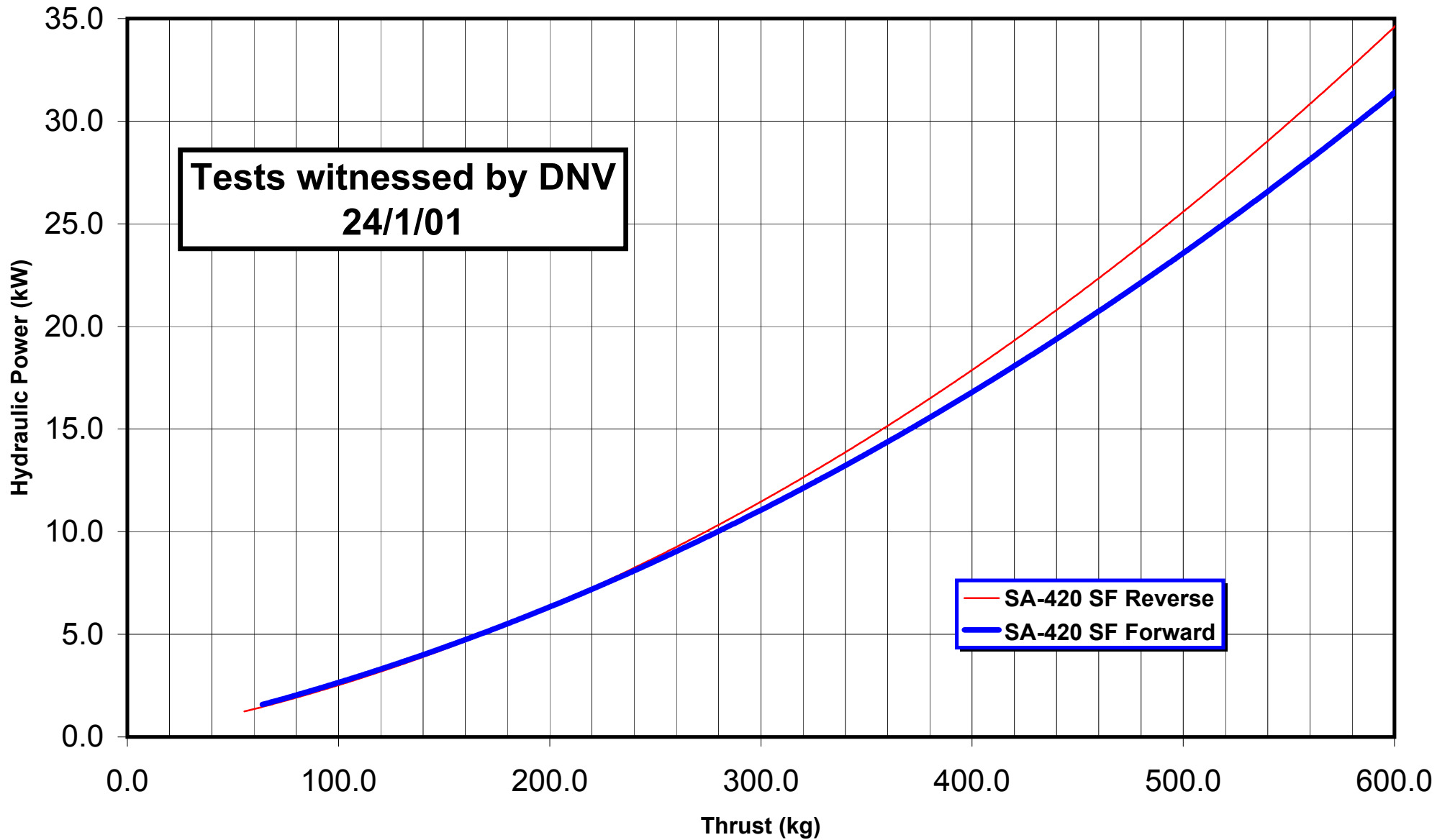
SA-380-40cc-SF Flow & Thrust V Pressure at Various Advance Speeds



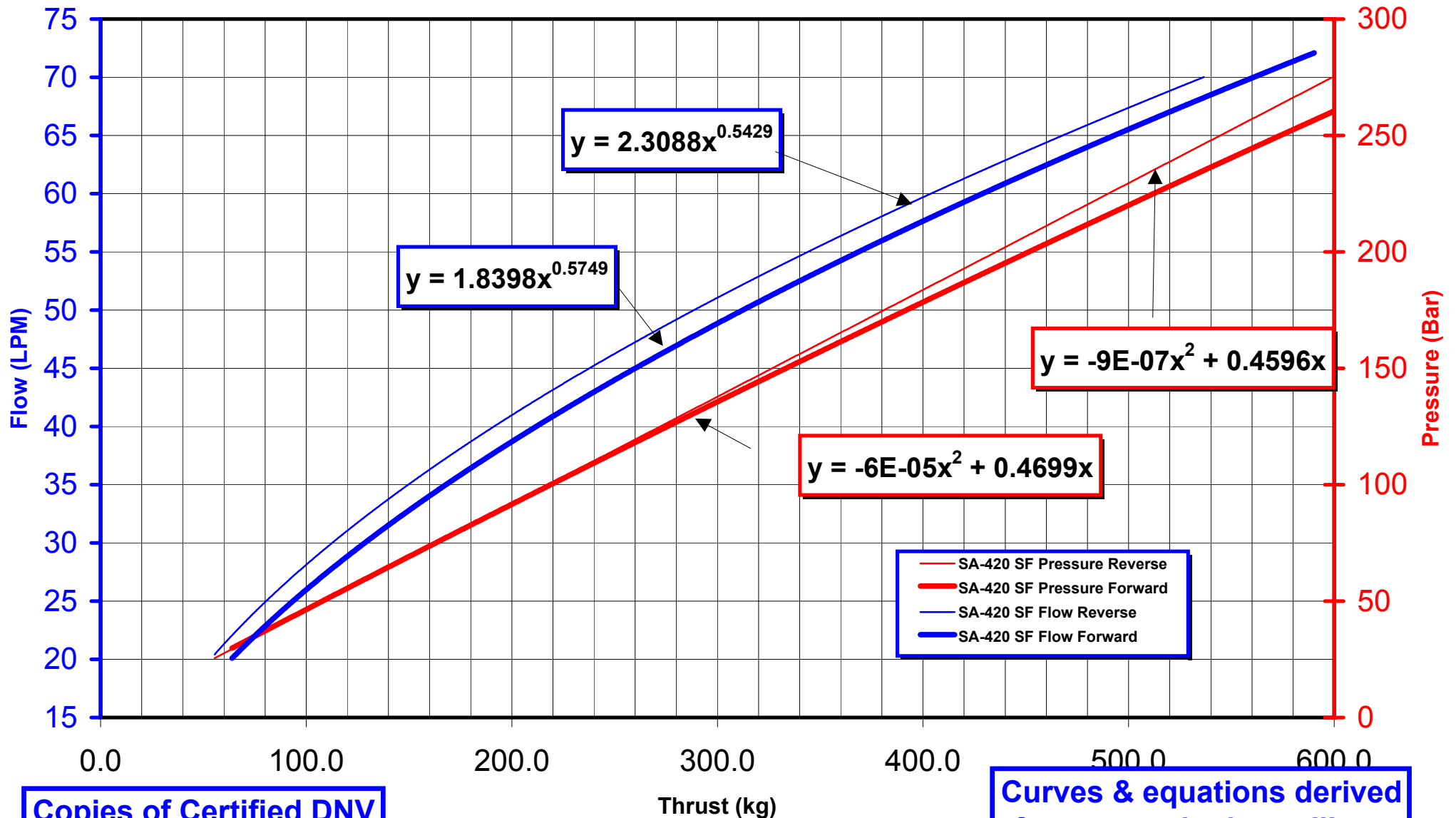
Copies of Certified DNV data sheets available

Curves & equations derived from DNV witnessed bollard test results

SA-420 SF Hydraulic Power Vs Thrust @ 0 knots



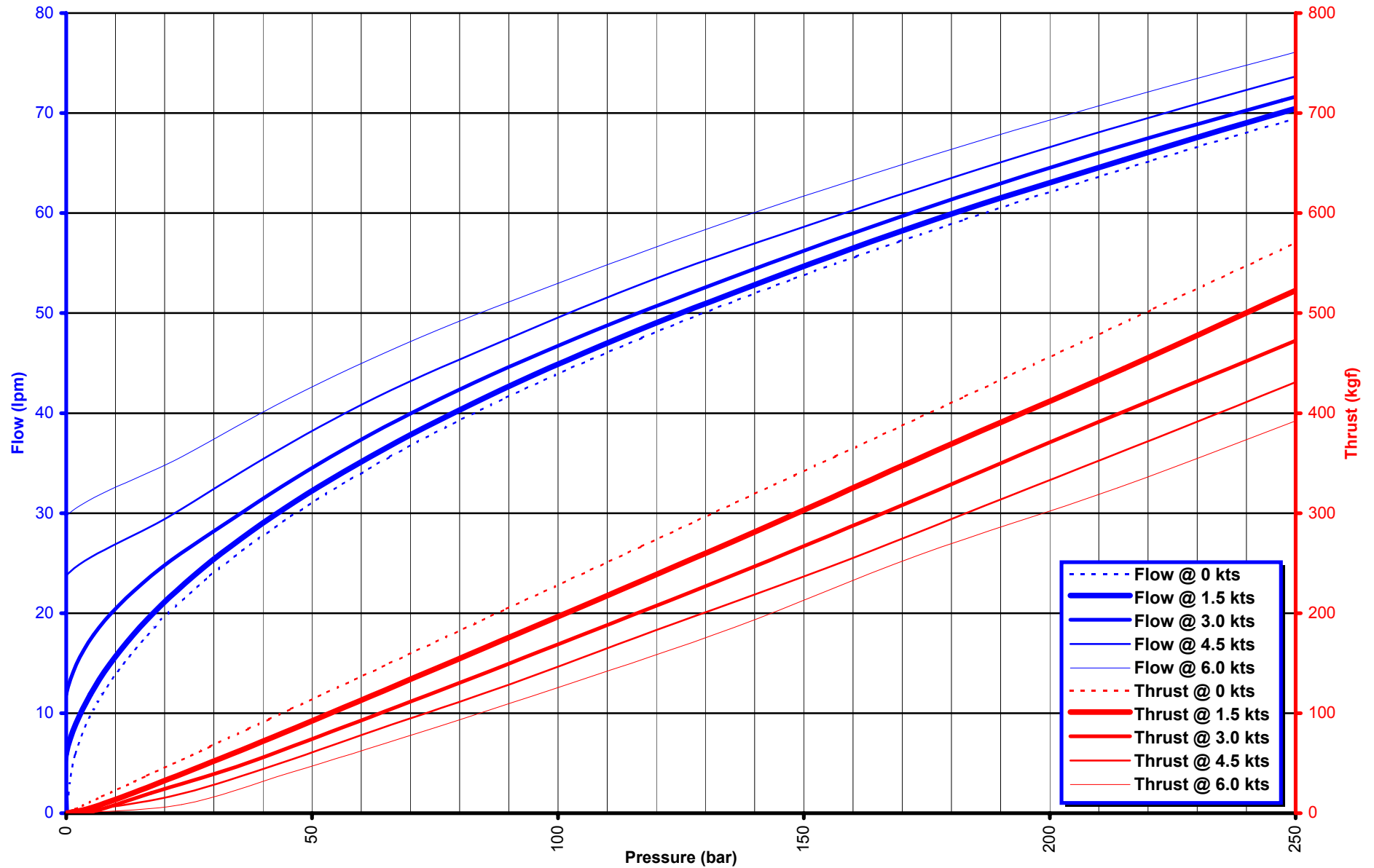
SA-420-60cc Flow & Pressure V Thrust @ 0 knots



Copies of Certified DNV
data sheets available

Curves & equations derived
from smoothed trendlines
obtained from test results

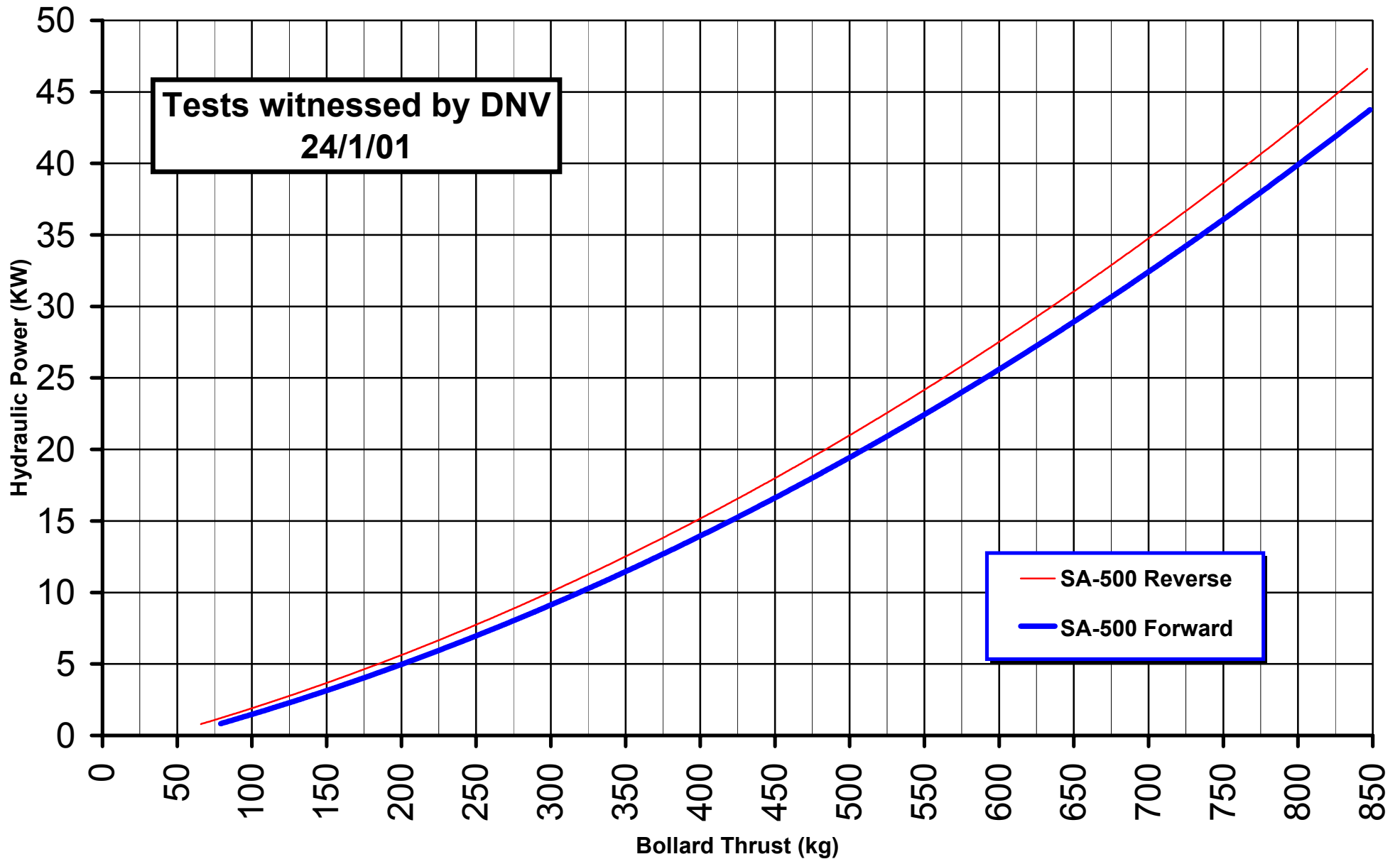
SA-420-60cc-SF Flow & Thrust V Pressure at Various Advance Speeds



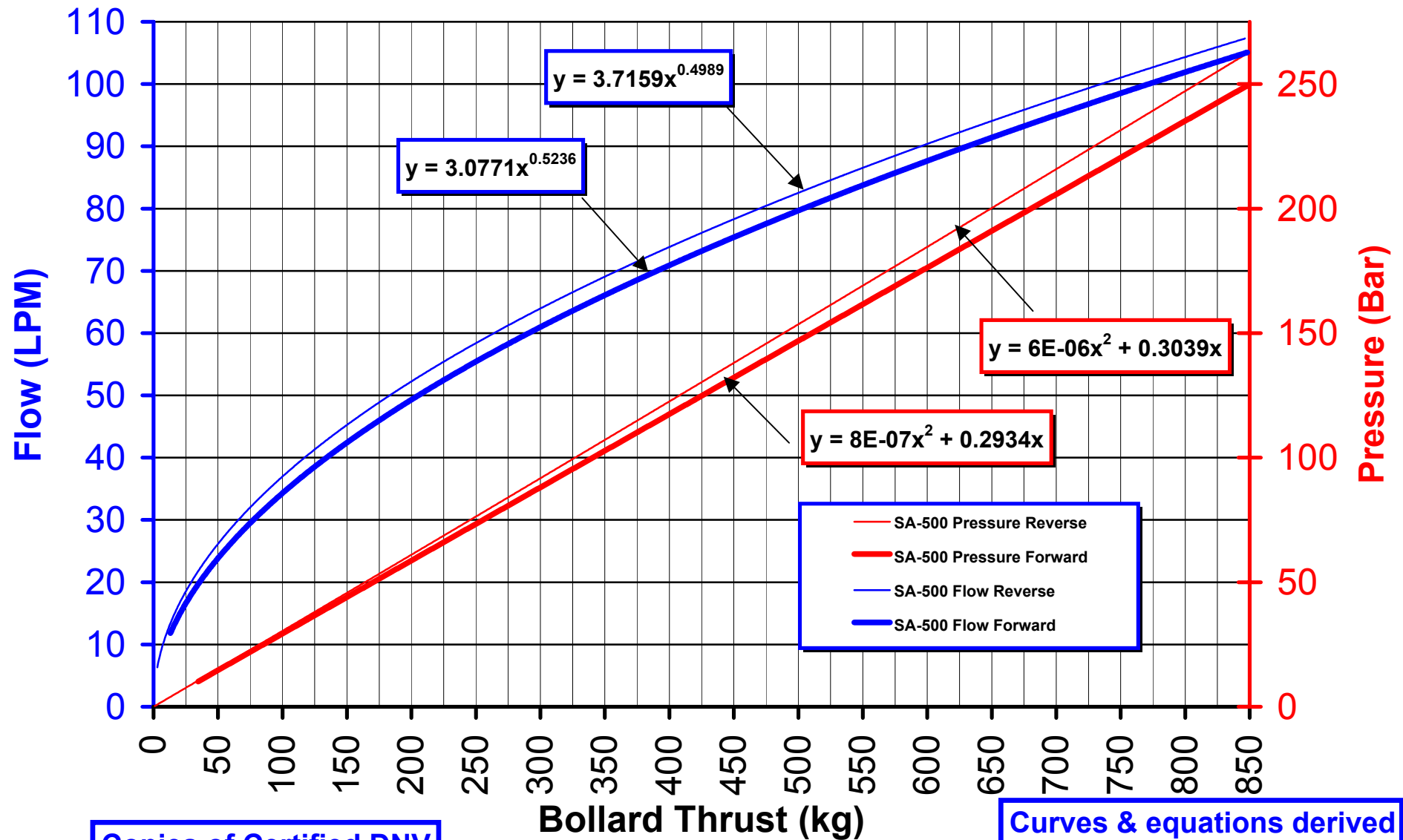
Copies of Certified DNV data sheets available

Curves & equations derived from DNV witnessed bollard test results

SA-500 Hydraulic Power Vs Thrust @ 0 knots



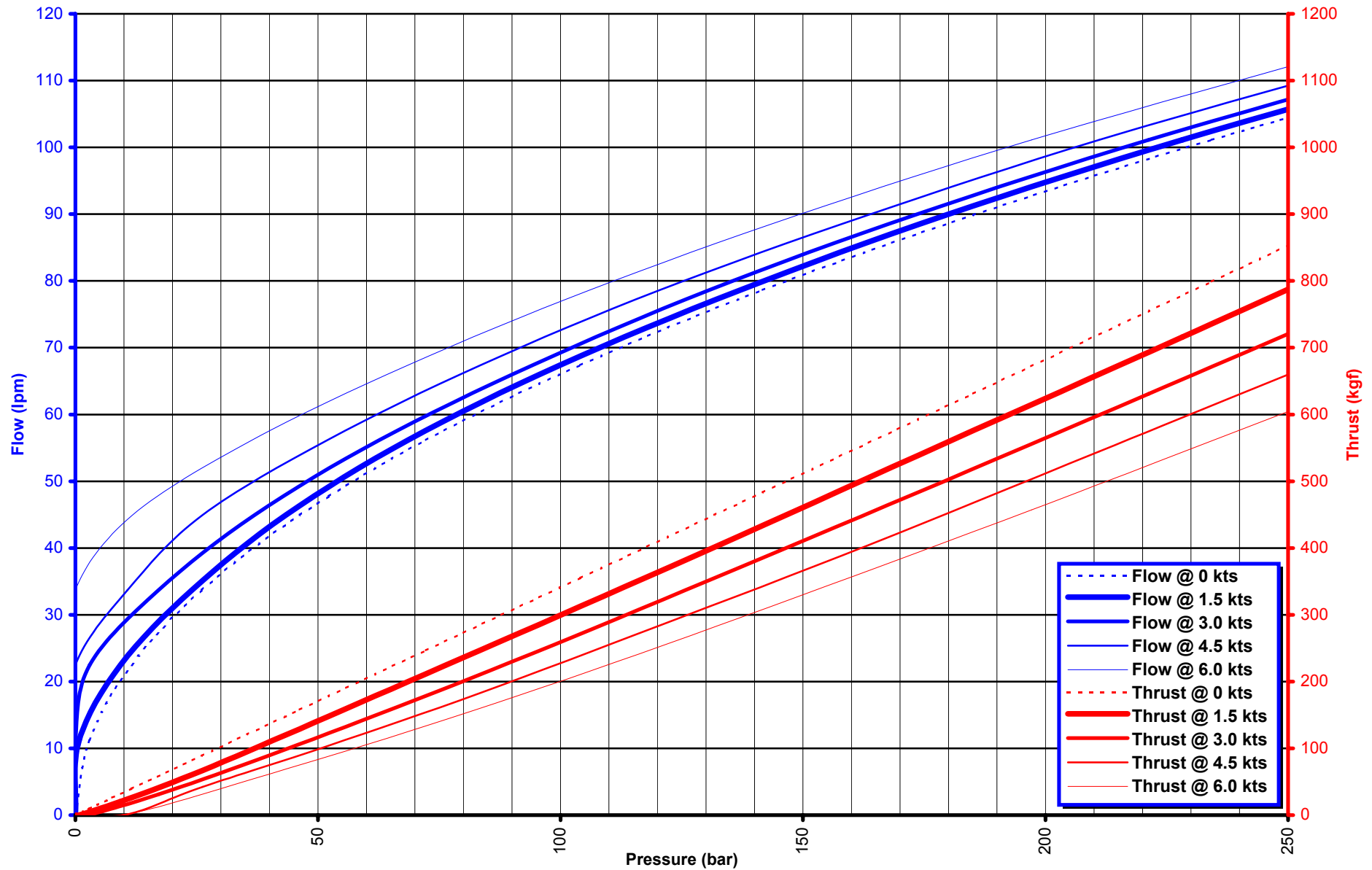
SA-500-110cc Flow & Pressure V Thrust @ 0 knots



Copies of Certified DNV
data sheets available

Curves & equations derived
from smoothed trendlines
obtained from test results

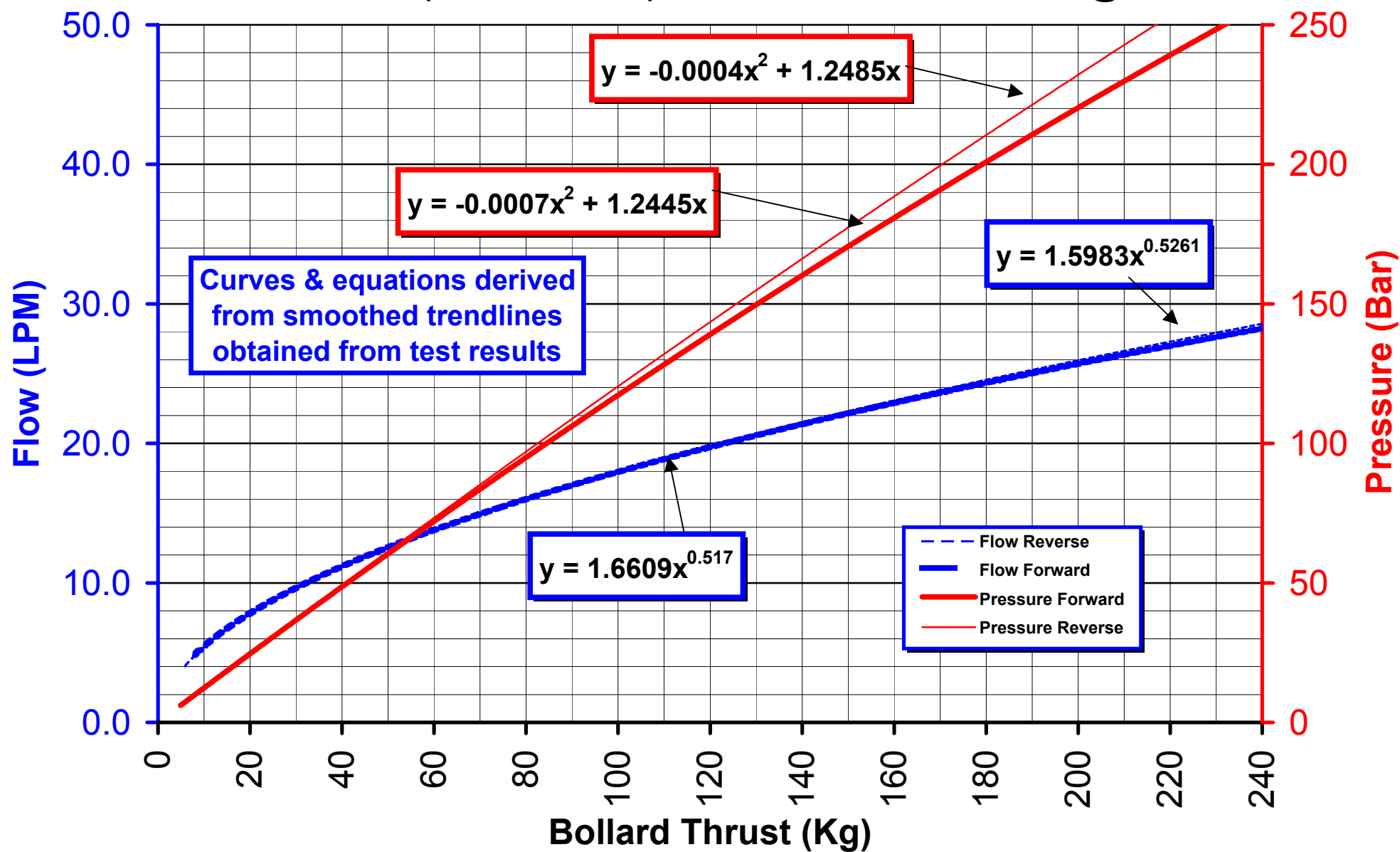
SA-500-110cc-SF Flow & Thrust V Pressure at Various Advance Speeds



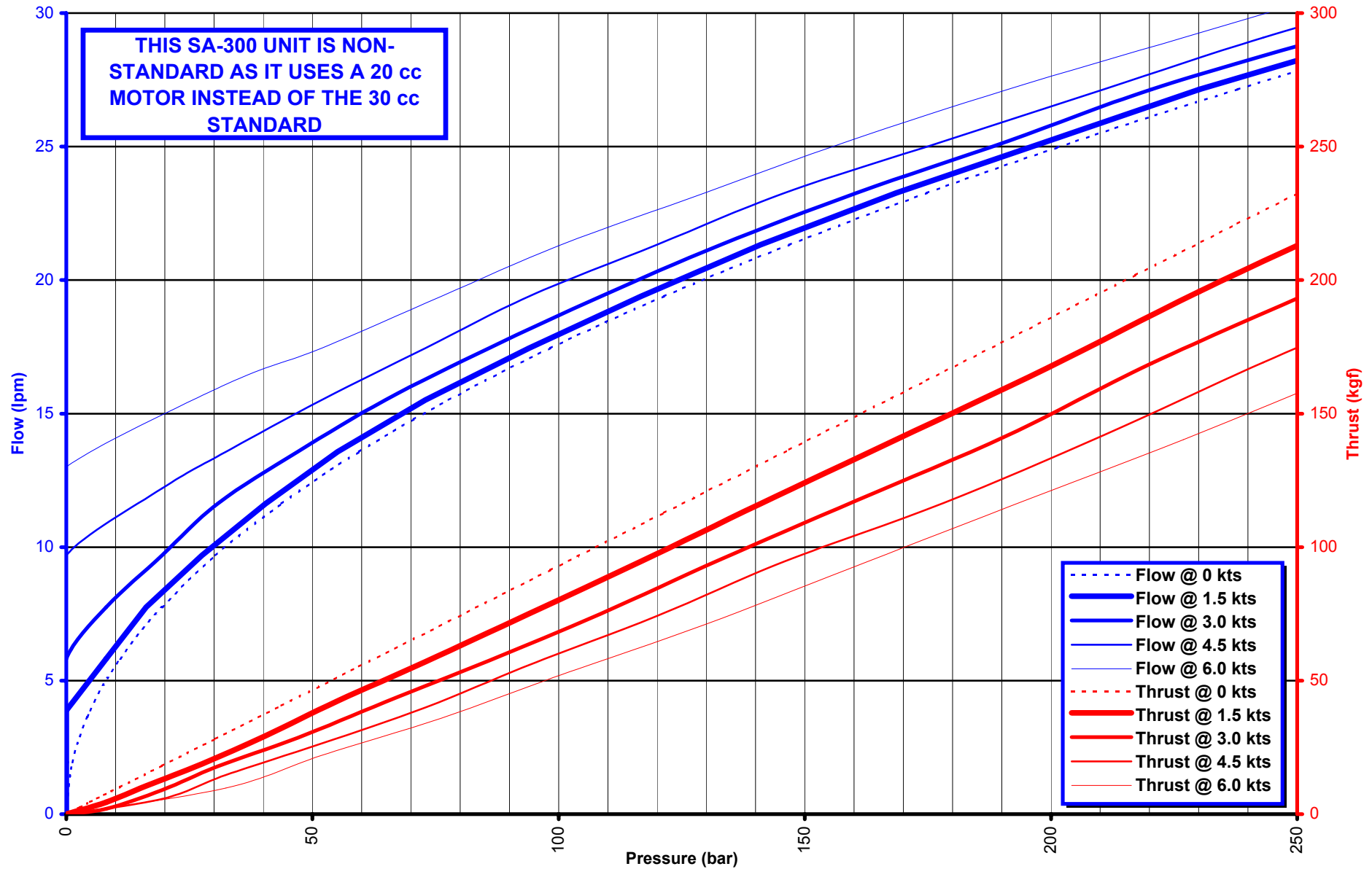
Copies of Certified DNV data sheets available

Curves & equations derived from DNV witnessed bollard test results

SA-300-20cc (non-standard) Flow & Pressure V Thrust @ 0 Knots



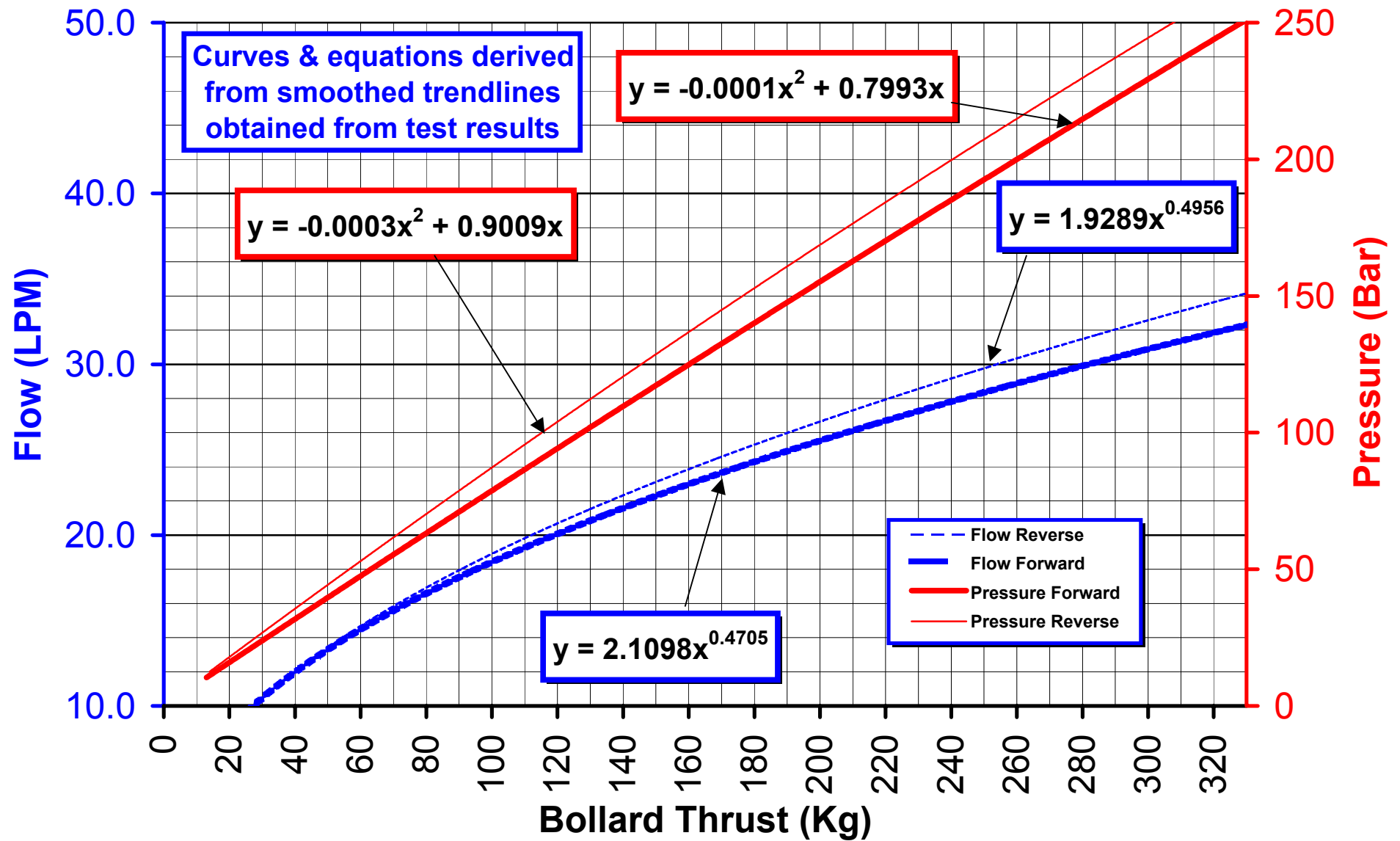
SA-300-20cc-SF (non-standard) Flow & Thrust V Pressure at Various Advance Speeds



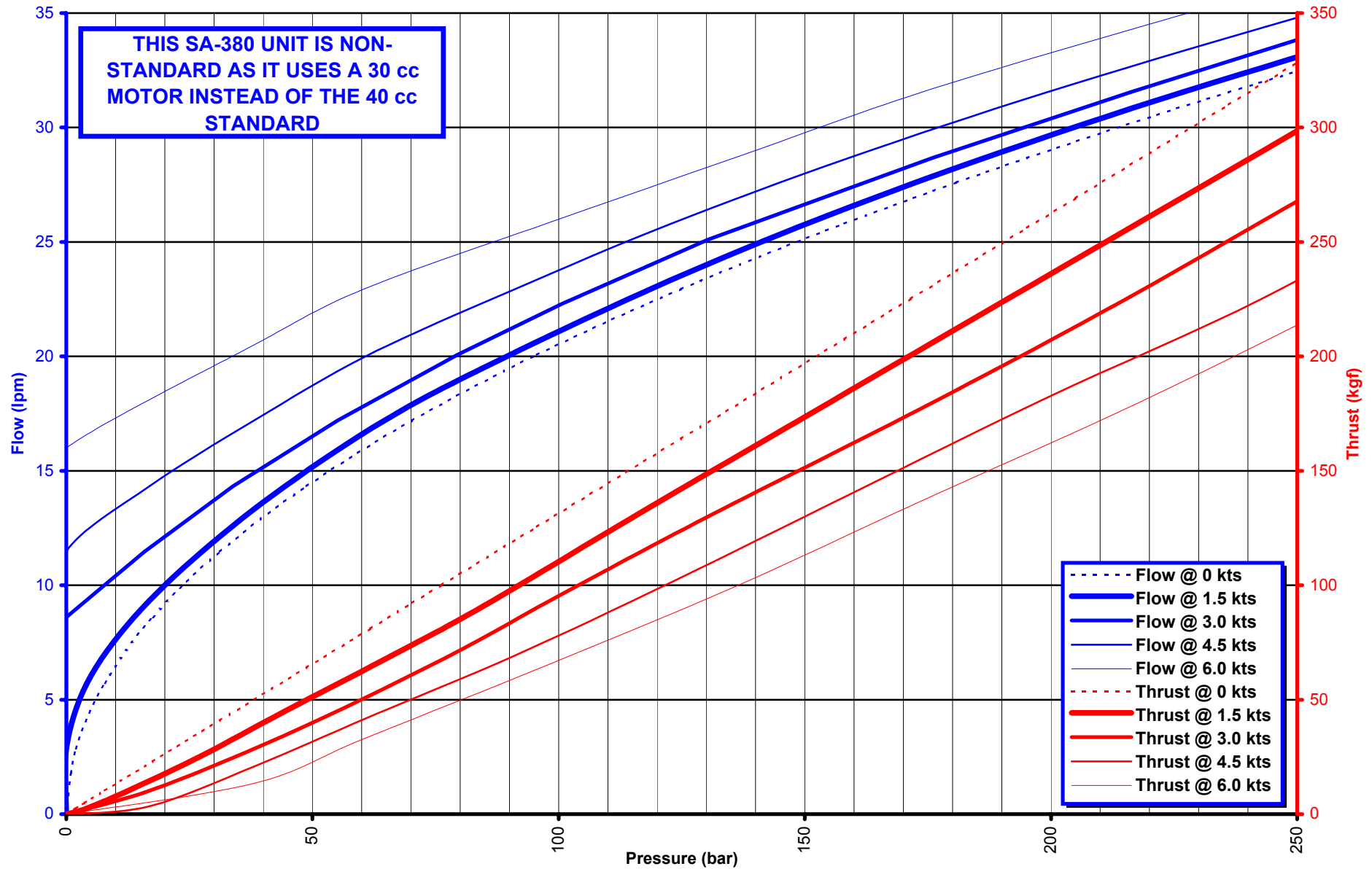
Copies of Certified DNV data sheets available

Curves & equations derived from DNV witnessed bollard test results

SA-380-30cc (non-standard) Flow & Pressure V Thrust @ 0 Knots

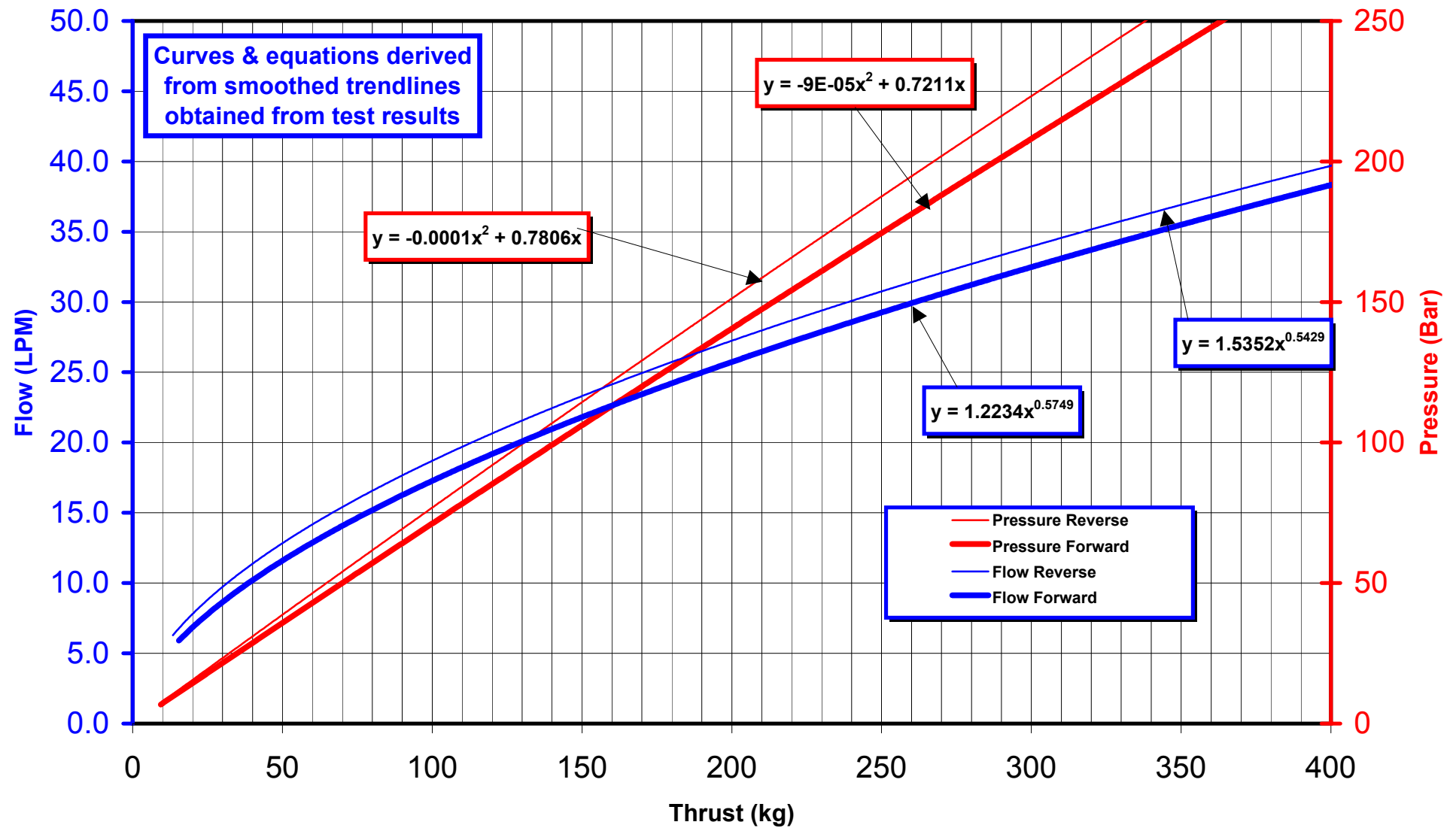


SA-380-30cc-SF (non-standard) Flow & Thrust V Pressure at Various Advance Speeds

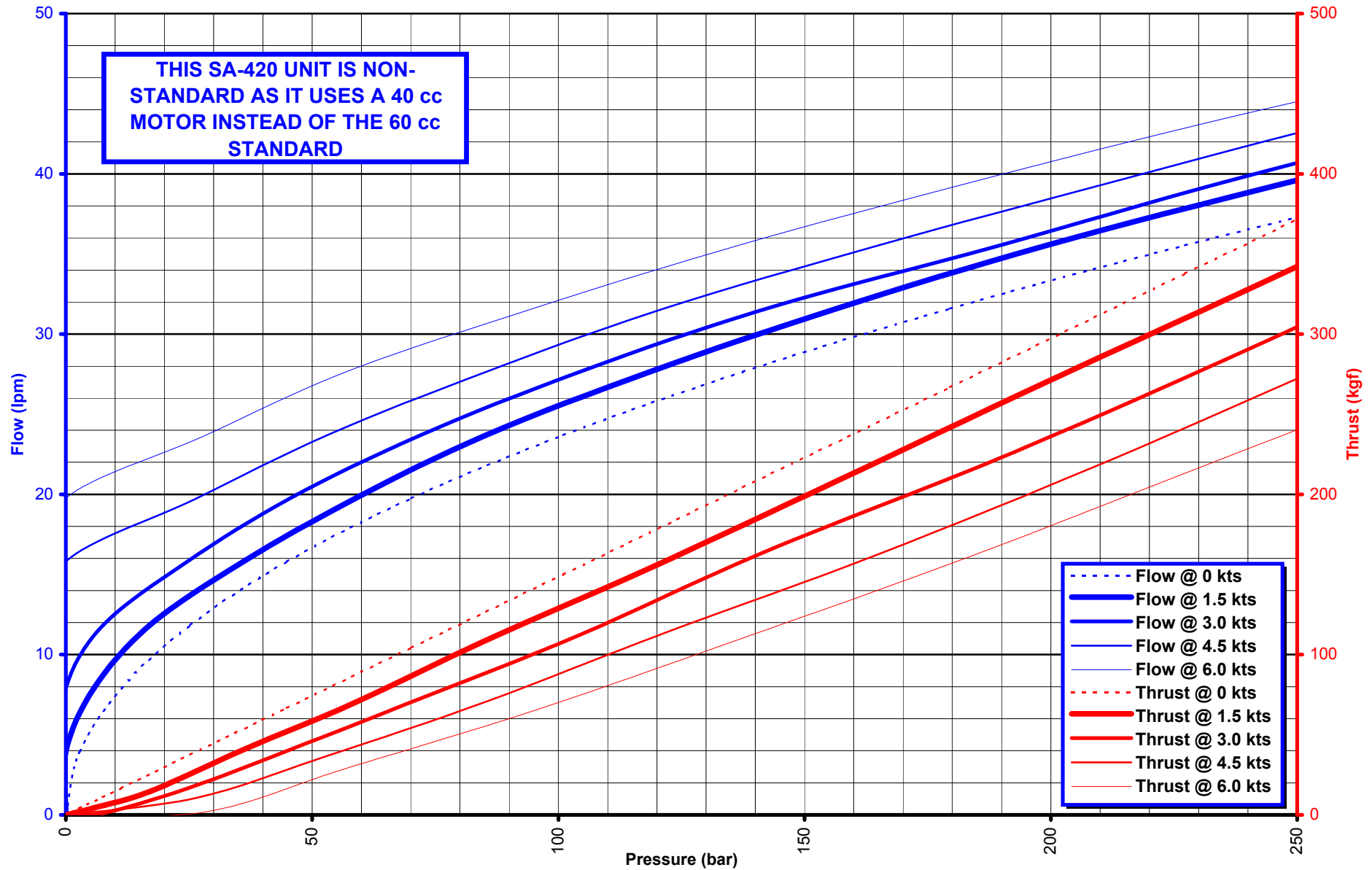


Curves & equations derived from DNV witnessed bollard test results

SA-420-40cc (non-standard) Flow & Pressure V Thrust @ 0 Knots



SA-420-40cc-SF (non-standard) Flow & Thrust V Pressure at Various Advance Speeds



Copies of Certified DNV data sheets available

Curves & equations derived from DNV witnessed bollard test results