

Hunterston A Site ENGINEERING DESIGN CALCULATION SHEET			SHEET 1 OF 4 SHEETS
TITLE: Check of Discharge to Sea line flow with new pipework extension direct to sea.			DATE: 27/11/23
CALCULATED BY: NAME: [REDACTED] SIGNATURE: [REDACTED] DATE: 4/12/23	CHECKED BY: NAME: [REDACTED] SIGNATURE: [REDACTED] DATE: 7/12/23	APPROVED BY DESIGN AUTHORITY: NAME: [REDACTED] SIGNATURE: [REDACTED] DATE: 12/12/23	CALC. REF: HNA/2912/ED/CS 1556
PURPOSE OF CALCULATION:			
To determine the impact on ADT pump flow and pressure of extending the discharge to sea line from the 'Guinness pot' directly out to sea using new pipes.			
BASIS OF CALCULATION:			
This calculation is based on the original approved version HNA/2912/ED/CS/576, which estimated the flows between 15 and 17 m3/hr. The actual average flow rate on completion of current discharge is nearer 17 m3 per hour. This calculation demonstrates that the impact of the extension is minimal on the current flow range.			
REFERENCES:			
1. Drawing HAD.HDO.2912.000006 (attached) 2. Crane – Flow of fluids –(Reference) 3. Dimensional drawings of extension pipework as supplied by EDF HNB (attached) 4. Pump curve for ADT DTS pumps (attached) 5. Data sheet for PE pipes (attached)			
PURPOSE OF CHECK:			
To ensure that all formulae and assumptions made are valid. In addition, to ensure that the excel spreadsheet format is valid.			
Checklist:			
Is the basis of the calculation clear?	Yes		
Is the basis of the calculation correct?	Yes		
Are all the reference documents available?	Yes		
Are all the reference documents valid?	Yes		
Is the arithmetic correct?	Yes		
Is the calculation technically correct?	Yes		
Are the results valid?	Yes		
Are the conclusions valid?	Yes		
Are alternative calculations required?	No		
* Delete where appropriate			

NOTES:

- 1) Calculations should either be printed or completed in ink. If calculation is completed in pencil then checking and signing must be done in ink on a photocopy to give a true/unchangeable record.
- 2) Systems Engineering and Safety Case Manager have delegated authority for the approval of calculations. If not available then seek advice from Engineering Manager.

ENGINEERING DESIGN CALCULATION SHEET

Title: Check of Discharge to Sea line flow with new pipework extension direct to sea.

Date: 27/In Nov 2023

Calculation Ref: [Redacted]

Calc By: [Redacted]

Checked By: [Redacted]

Approved By: [Redacted]

Calculation Ref: [Redacted]

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Checked By: [Redacted]

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Approved By: [Redacted]

Pump Discharge Friction Losses Calculation

	SIS line	1	2	3	4
Flowrate	17.16	17.16	17.16	17.16	17.16
Density	1000	1000	1000	1000	1000
Viscosity	1.14	1.14	1.14	1.14	1.14
Absolute Roughness	0.046	0.003	0.003	0.003	0.003
Gravitational Constant	9.81	9.81	9.81	9.81	9.81
Vapour Pressure	0.017	0.017	0.017	0.017	0.017
Line Section	1	2	3	4	
Pipe Diameters	52.5	101.2	80	140.6	
Relative Roughness	0.000876	0.000030	0.000038	0.000021	
Velocity	2.20	0.59	0.95	0.31	
Reynolds Number (Re)	1.0E+05	5.3E+04	6.7E+04	3.8E+04	
Friction Factor (f)	0.0246428	0.0149772	0.0142554	0.0194	
Length (m)	120	830.2	122.87	426	58.76
90° bend	10	7.39	0.00	0	2.33
T - Thru	2	0.99	0.00	0	0.00
T - Branch	3	4.44	0.00	0.00	0.00
Ball Valve	7	0.52	0.00	0.00	0.00
Gate Valve	0	0.00	0.00	1	0.11
Check Valve (Swing)	3	3.70	0.00	1	0.71
Reducer - to (mm)			0.48		
Expander - to	101.2	7.38			
Expander - from			100		
Pipe Inlet	0	0	0		0
Pipe Outlet	0	0	0		0
Other					
Total K	80.73	123.35	2.21	1.96	61.11
Head Loss (m)	19.97	2.21	0.09	0.29	0.29
Total Head Loss	22.56 m				
Pressure Loss	2.21 bar				
Other	1.00 bar				
Outlet Static Head (m)	0.00	Globe valve V37 on common Pump outlet			
Required Pump Discharge Pressure	3.21 barg	Since high tide mark remains below the pump level, there is no additional losses to compute.			

Crane/Chemical Engineering Vol 1

From Crane A-24

HUNTERSTON 'A' DECOMMISSIONING SITE ENGINEERING DESIGN CALCULATION SHEET			Sheet 3 of 4
Title: Check of Discharge to Sea line flow with new pipework extension direct to sea.			
Date: 27/11/23			
Calculation Ref	Calc By	Checked By	Approved By
H00/2912/ED/LS/1556	[REDACTED]	[REDACTED]	[REDACTED]
Pump Suction Friction Losses Calculation			
Flowrate	17.16	m3/hr	
Density	1000	kg/m3	
Viscosity	1.14	cP	
Absolute Roughness	0.046	mm	(Ref 3)
Gravitational Constant	9.81	kg/ms ²	
Line Section	1		
Pipe Diameters	77.9 mm	(Ref 6)	
Relative Roughness	0.000591 (e/d)		
Velocity	1.00 m/s		
Reynolds Number (Re)	6.8E+04		
Friction Factor (f)	0.02	From Crane A-24	
	No off	Total k	
Length (m)	6.316	1.62	
90° bend	5	3.00	
T - Thru	1	0.40	
T - Branch	0	0.00	
Ball Valve	2	0.12	
Gate Valve	0	0.00	
Check Valve (Swing)		0.00	
Expander - to	52.5	0.30	
Pipe Inlet	1	0.78	
Pipe Outlet	0	0.00	
Other			
Total K		6.22	
Head Loss (m)		0.32 m	
Total Head Loss	0.32 m		
Pressure Loss	0.03 bar		
Inlet Static Head	0.5 m	Minimum working level - Low Level Switch	
Inlet Pressure	0.0179139 barg		

Title: Check of Discharge to Sea line flow with new pipework extension direct to sea.

Date: 27/11/23

Calculation Ref HUN/2912/EN/CS/1556	Calc By	Checked By	Approved By
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Pump Calculation Results

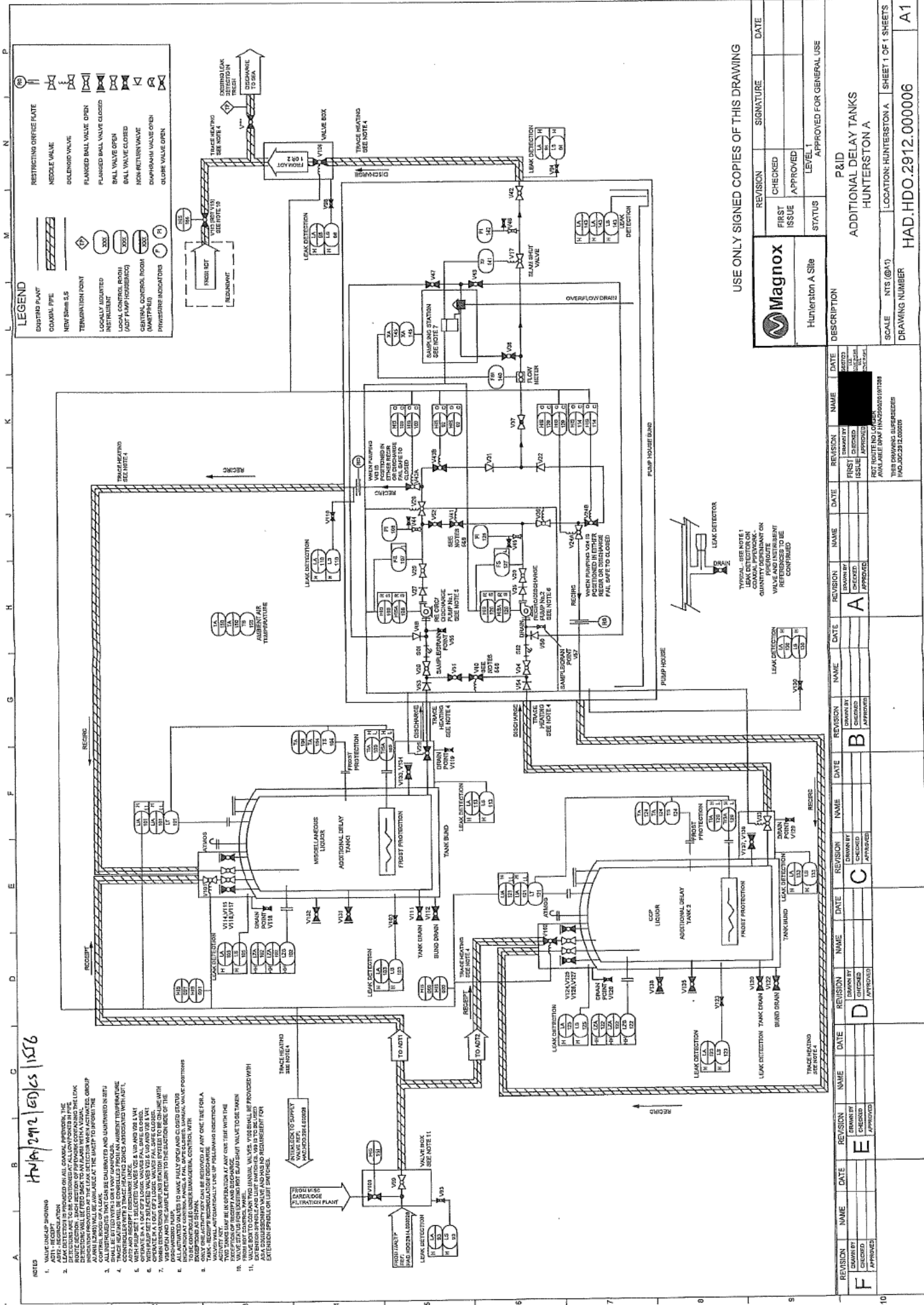
Discharge Pressure	3.21 Barg
Suction Pressure	0.02 barg
Differential Pressure	3.19 bar
NPSH Available	1.01 bar
NPSH Available	10.34 m

Conclusion

Pump flow will remain between 15 and 17.1 m3/hr

HN/2012/ED/CS/1516

- NOTES**
1. VALVE UNLAP SHOWING
 2. AD11 - RECEIPT
 3. LEAK DETECTION IS PROVIDED ON ALL GENERAL PIPEWORK, THE DETECTOR UNIT TO BE POSITIONED AT ALL LOW POINTS AND ALL LEAK DETECTOR UNITS TO BE FED BACK TO ANY PUMP WITH A VISUAL ALARM (ALARM) SHALL BE AVAILABLE AT THE UNIT TO INFORM THE OPERATOR.
 4. CONTROL ROOMS OF ALL VALVES SHALL BE CALIBRATED AND UNLAPPED IN SITU SHALL BE SET TO V131 ON ALL VALVES.
 5. OPERATE IN A 100% OF LOGIC, VALVES SHALL BE CLOSED ON FAILURE OF LOGIC, VALVES SHALL BE CLOSED ON FAILURE OF THE MAIN AND THE AVAILABLE RETURN TO THE ISOLATION SIDE OF THE PRESSURIZED MAIN.
 6. INSTRUMENTATION ADDRESS PANEL & PAL SHUT-CLOSERS, MANUAL VALVE POSITIONER AND VALVE POSITIONER SHALL BE AVAILABLE FOR ALL INSTRUMENTATION.
 7. ONLY ONE INSTRUMENTATION UNIT CAN BE REMOVED AT ANY ONE TIME OR A VALVE SHALL AUTOMATICALLY OPEN UP FOLLOWING ISOLATION OF TWO TANKS MAY BE IN OPERATION AT ANY ONE TIME WITH THE EXCEPTION OF RECEIPT AND SEND PUMP WHICH VALVE TO BE TAKEN FROM HOT SOURCE PUMP.
 8. INSTRUMENTATION ADDRESS PANEL & PAL SHUT-CLOSERS, MANUAL VALVE POSITIONER SHALL BE AVAILABLE FOR ALL INSTRUMENTATION.
 9. AS A CONDITION OF THE CONTRACT THE INSTRUMENTATION SHALL BE PROVIDED WITH A 10% OVERHEAD FOR THE INSTRUMENTATION.



USE ONLY SIGNED COPIES OF THIS DRAWING

	REVISION	SIGNATURE	DATE
	CHECKED		
	APPROVED		
FIRST ISSUE		LEVEL	
STATUS		APPROVED FOR GENERAL USE	

P&ID DESCRIPTION
 ADDITIONAL DELAY TANKS
 HUNTERSTON A
 LOCATION: HUNTERSTON A SHEET 1 OF 1 SHEETS
 SCALE: NTS (0/1)
 DRAWING NUMBER: HAD.HDO.2912.000006
 A1

REVISION	DATE	REVISION	DATE	REVISION	DATE	REVISION	DATE	REVISION	DATE	REVISION	DATE	REVISION	DATE	REVISION	DATE	REVISION	DATE	REVISION	DATE	REVISION	DATE	REVISION	DATE	
F																								
D																								
C																								
B																								
A																								

TYPICAL - SEE NOTE 1
 QUANTITY DEPENDANT ON
 GENERAL PROVISIONS
 VALVE AND INSTRUMENT
 REFERENCES TO BE
 CONFIRMED

NOT ROUTE NO. LOGIC
 AVAILABLE FROM INSTRUMENTS
 (MAGJ0329120006)

THIS DRAWING SUPERSEDES
 (MAGJ0329120006)

ADT PUMPS



**Pricing Sheet /
Scope of supply**

Customer: Magnox North Ltd
 Cust / Proj Ref: E-mail Enquiry
 Item Number: 1
 Service: ADT Pumps 1,2,3,4

Contact: [REDACTED]
 Address: Flowserve Pumps Ltd, Suite 3/2, SP3,
 Skypark, 14 Elliot Place, Glasgow,
 G3 8EP
 Phone: 0141-223-9630

Pump / Stg: 50-32CPXM160 / 1
 Curve Number: E591/0007/1
 FPD Reference: 0829-80239
 Date: Nov 12, 2008

Qty	Description	Average Unit Price	Extended Price
4	50-32CPXM160 FPD - DI Safe Area Motor Supplied by FPD 35 mm Seal Fluid is not flammable Permissible Pump/Motor Combinations Levelling support not supplied Metallic components individually earthed by the User during the installation Alloy Surcharge Ductile Iron Casing GGG40 Klingersil C8200 Gasket Duplex Stainless Steel Impeller PTFE 'O' Ring Ductile Iron GGG40 Seal Housing 316 Stainless Steel Shaft No Casing Gauge Connections Plugged Casing Drain Wetted Thread Static Impeller Balancing to ESS 37 Semi Open Impeller Integral Shaft/Impeller Back Vane Hydraulic Balancing Seal Splash Guard PN20 (ASA150 RF) Flange Drilling With standard surface 16 Bar Casing AES CSSN SIC/SIC/A External Close Clearance Throttle Standard (no connections) Cylindrical Housing Carbon Steel Muff Coupling Hydro test to 1.5*Max Design Pressure Unwitnessed test Test to Grade 2 requirements Test to ISO 9906 Grade 2	UK £ 2223	UK £ 8892

** - additional pricing to follow Feature quantities match pump quantity unless otherwise noted. 1 of 2
 Prices may be subject to exchange rate fluctuations. Proposal is valid for 30 days.

Customer: Magnox North Ltd
 Cust / Proj Ref: E-mail Enquiry
 Item Number: 1
 Service: ADT Pumps 1,2,3,4

Pump / Stg: 50-32CPXM160 / 1
 Curve Number: E591/0007/1
 FPD Reference: 0829-80239
 Date: Nov 12, 2008

Unwitnessed Performance Tests Noise test to ESS 120 Pump - Alkyd ESS 106 Packing - UK delivery Shipment times are current estimates in working weeks ex-works, subject to confirmation at time of order. Two Copies of Instruction Book Material Certification to 2.2 on Casing, Impeller and Shaft In English Driver Standard TEFV motor FPD Choice of make & type [4.00 kW 3000 RPM 112M]		
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Total: UK £ 2223

UK £ 8892

Options

1) Shop Inspection

UK £ +360 each

+ Refer Wks

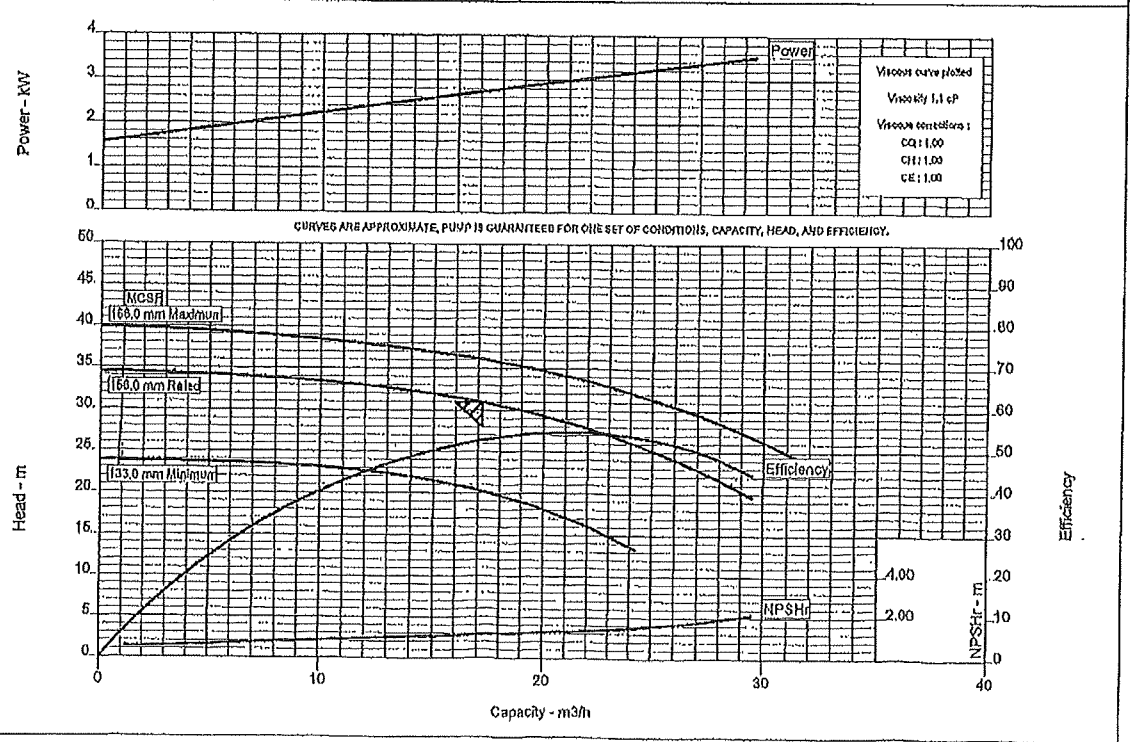
Comments

1) Shipment (after receipt of order) is 8 working weeks.

Customer	: Magnox North Ltd	Pump / Stages	: 50-32CPXM160 / 1
Customer reference	: E-mail Enquiry	Based on curve no.	: E591/0007/1
Item number	: 1	Vendor reference	: 0829-80239
Service	: ADT Pumps 1,2,3,4	Date	: November 12, 2008

Operating Conditions		Materials / Specification	
Capacity	: 17.2 m3/h	Material column code	: DI
Water Capacity (CQ=1.00)	: 17.2 m3/h	Pump specification	: ISO 5199
Normal capacity	: -	Other Requirements	
Total Developed Head	: 30.96 m	Hydraulic selection : No specification	
Water head (CH=1.00)	: 30.96 m	Construction : No specification	
NPSH available (NPSHa)	: 10.3 m	Test tolerance : ISO 9906 Level 2	
NPSHa less NPSH margin	: -	Driver Sizing : Max Power(MCSF to EOC)with SF	
Maximum suction pressure	: 0.0 kPa.g	Seal configuration : Single Seal	
Liquid			
Liquid type	: Other		
Temperature / SG	: 50 °C / 1.000		
Solid Size - Actual / Limit	: - / 8.00 mm		
Viscosity / Vapor pressure	: 1.1 cP / -		

Performance			
Hydraulic power	: 1.45 kW	Impeller diameter	
Pump speed	: 2900 rpm	Rated	: 166.0 mm
Efficiency (CE=1.00)	: 52.8 %	Maximum	: 166.0 mm
		Minimum	: 133.0 mm
NPSH required (NPSHr)	: 1.2 m	Suction specific speed	: 9230 US units
Rated power	: 2.75 kW	Minimum continuous flow	: 1.0 m3/h
Maximum power	: 3.53 kW	Maximum head @ rated dia	: 34.5 m
Driver power	: 4.00 kW / 5.36 hp	Flow at BEP	: 21.4 m3/h
Casing working pressure	: 337.5 kPa.g	Flow as % of BEP	: 80.5 %
(based on shut off @ cut dia)		Efficiency at normal flow	: -
Maximum allowable	: 1600.0 kPa.g	Impeller dia ratio (rated/max)	: 94.0 %
Hydrostatic test pressure	: 2400.0 kPa.g	Head rise to shut off	: 11.3 %
Est. rated seal chamb. press.	: 189.48 kPa.g	Total head ratio (rated/max)	: 85.7 %



9588 SC/EA/212/AMH

Customer : Magnox North Ltd
 Item number : 1
 Service : ADT Pumps 1,2,3,4
 Vendor reference : 0829-80239
 Date : November 12, 2008

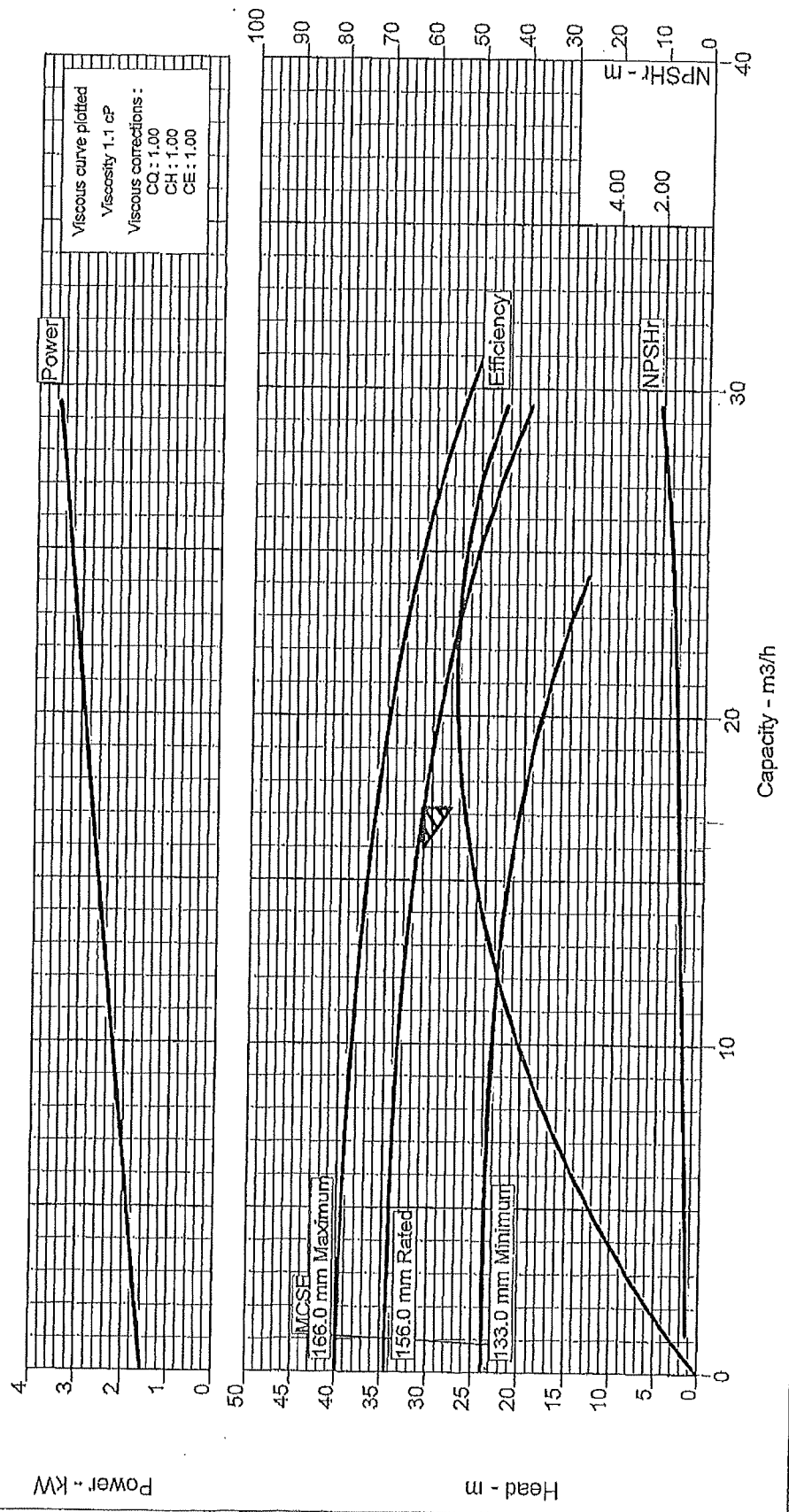
FLOWSERVE Pump Division

Pump size & type : 50-32CPXM160
 Based on curve no. : E591/00071
 Number of stages : 1

Capacity : 17.2 m³/h
 Head : 30.96 m

Specific gravity : 1.000
 Pump speed : 2900 rpm

CURVES ARE APPROXIMATE. PUMP IS GUARANTEED FOR ONE SET OF CONDITIONS, CAPACITY, HEAD, AND EFFICIENCY.



Customer	: Magnox North Ltd	Pump / Stages	: 50-32CPXM180 / 1
Customer reference	: E-mail Enquiry	Based on curve no.	: E591/0007/1
Item number	: 1	Vendor reference	: 0829-80239
Service	: ADT Pumps 1,2,3,4	Date	: November 12, 2008

Construction					Driver Information	
Nozzles	Size	Rating	Face	Pos'n	Manufacturer	: FPD Choice of make a
Suction	50 mm	PN20	RF	End	Power	: 4.00 kW / 5.36 hp
Discharge	32 mm	PN20	RF	Top	Service factor (req'st / act)	: 1.00 / 0.00

Casing mounting : Foot
 Casing split : Radial
 Impeller type : Semi Open
 Bearing Type (Rad/Thr) : - / -
 Bearing lubrication : Grease
 Rotation (view from cplg) : CW per Hyd. Institute

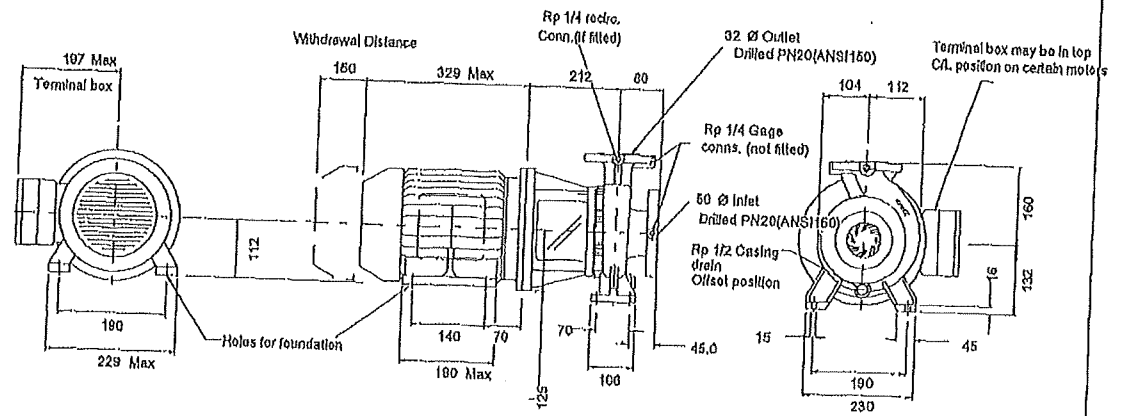
Speed : 3000 rpm
 Orientation / Mounting : Horizontal / Foot and flange
 Driver Type : IEC
 Frame-size / material : 112M / FPD Choice
 Enclosure : TEFV IP54
 Hazardous area class : -
 Explosion 'T' rating : -
 Volts / Phase / Hz : 415 / 3 / 50
 Amps-full load/locked rotor : 6.91 / -
 Motor starting : Direct on line (DOL)
 Insulation : C/F
 Temperature rise : 80 °C
 Motor mounted by : FPD-Newark

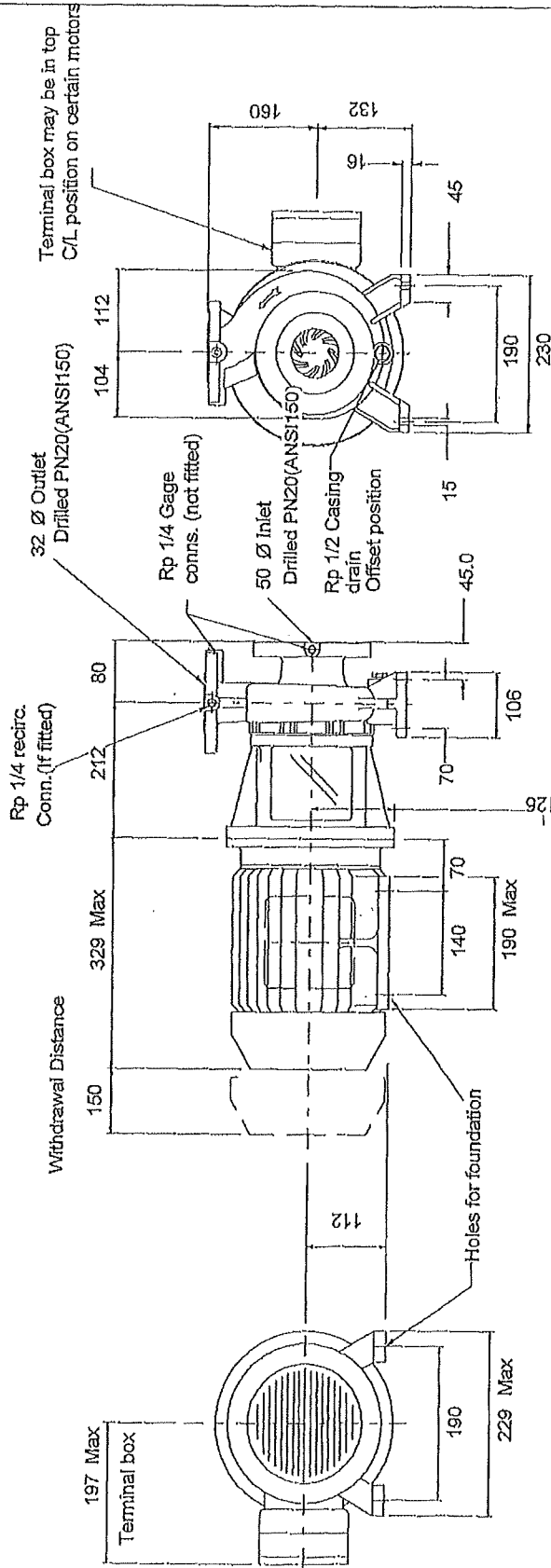
Materials
 Casing : Ductile Iron
 Impeller : Duplex St.St.
 Seal chamber : Ductile Iron
 Shaft : 316 Stainless Steel
 Sleeve : Not Available

Baseplate, Coupling and Guard
 Baseplate type : Not Supplied
 Baseplate material : -
 Baseplate size : -
 Coupling manufacturer : FPD
 Coupling size : -
 Coupling / Shaft guard : -
 Shaft / seal guard : Stainless Steel

Seal, Gland and Piping
 Arrangement : Cartridge
 Size : 35 mm
 Manufacturer / Type : - / -
 Material code (Man'/API) : - / -
 Internal neck bushing : -
 Gland material : -
 Flush : -
 Vent : -
 Drain : None
 Auxiliary sealing device : Throttle Bush
 Seal flush plan : -
 Seal flush material : -
 Aux seal flush plan : -
 Aux seal flush material : -

Weights (Approx.)
 Bareshaft pump(net) : 34.0 kg
 Baseplate(net) : -
 Driver(net) : 42.0 kg
 Shipping gross weight/vol. : 98.8 kg / 0.16 m3





All dimensions are in millimeters unless otherwise specified		Not To Scale		Certified Drawing available with order	
Customer	: Magnox North Ltd	Pump size & type	: 50-32CPXM160	Drawing number	: B777/001A/P0997
Item number	: 1	Pump speed / Stages	: 2900 rpm / 1	Date	: November 12, 2008
Service	: ADT Pumps 1,2,3,4	Flow / Head	: 17.2 m3/h / 30.96 m	Certified by / Date:	
Customer PO #	:	Driver power / Frame	: 4.00 kW / 5.36 hp / 112M	Seal type	: -
Vendor reference	: 0629-80239 Rev. A	Volts / Phase / Hz	: 415 / 3 / 50	Seal flush plan	: -

1.8 Specific machine performance

For performance parameters see section 1.5, *Duty conditions*. Where performance data has been supplied separately to the purchaser these should be obtained and related with these User Instructions if required.

1.9 Noise level

Attention must be given to the exposure of personnel to the noise, and local legislation will define when guidance to personnel on noise limitation is required, and when noise exposure reduction is mandatory. This is typically 80 to 85 dBA.

The usual approach is to control the exposure time to the noise or to enclose the machine to reduce emitted sound. You may have already specified a limiting noise level when the equipment was ordered, however if no noise requirements were defined, then attention is drawn to the following table to give an indication of equipment noise level so that you can take the appropriate action in your plant.

Pump noise level is dependent on a number of operational factors, flow rate, pipework design and acoustic characteristics of the building, and so the

values given are subject to a 3 dBA tolerance and cannot be guaranteed.

*LATEX
DTM*

Similarly the motor noise assumed in the "pump and motor" noise is that typically expected from standard and high efficiency motors when on load directly driving the pump. Note that a motor driven by an inverter may show an increased noise at some speeds.

If a pump unit only has been purchased for fitting with your own driver then the "pump only" noise levels in the table should be combined with the level for the driver obtained from the supplier. Consult Flowserve or a noise specialist if assistance is required in combining the values.

It is recommended that where exposure approaches the prescribed limit, then site noise measurements should be made.

The values are in sound pressure level L_{pA} at 1 m (3.3 ft) from the machine, for "free field conditions over a reflecting plane".

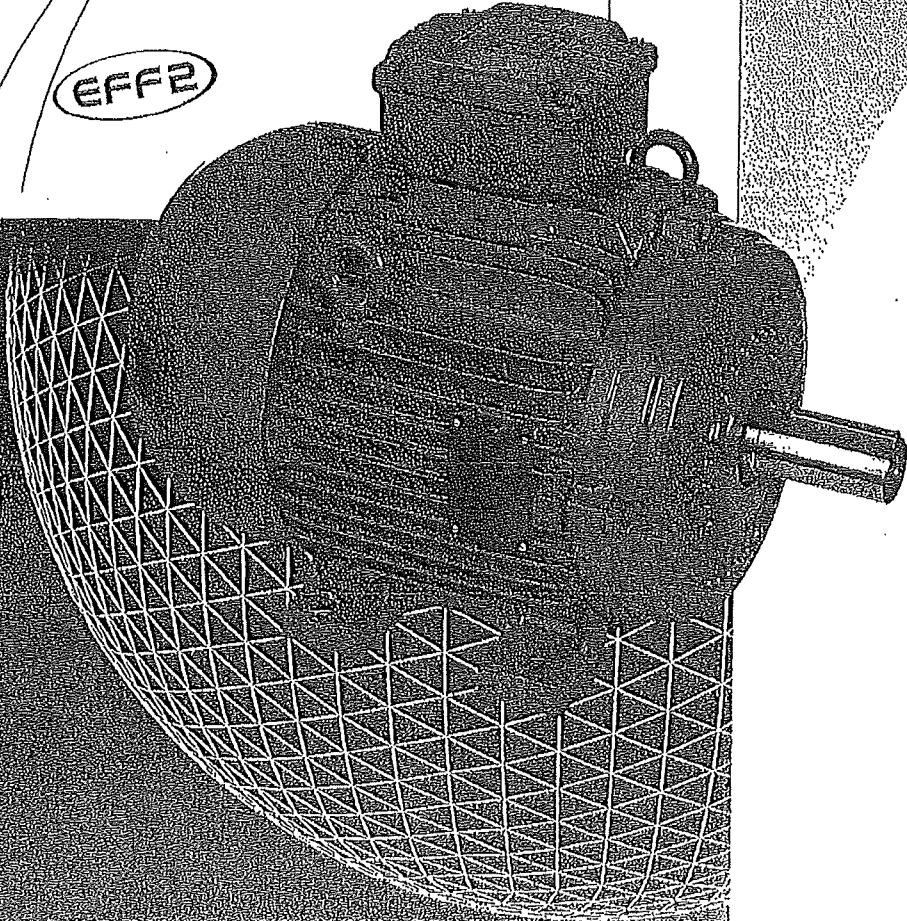
For estimating sound power level L_{WA} (re 1pW) then add 14 dBA to the sound pressure value.

Motor size and speed kW (hp)	Typical sound pressure level L_{pA} at 1 m reference 20 μ Pa, dBA							
	3 550 r/min		2 900 r/min		1 750 r/min		1 450 r/min	
	Pump only	Pump and motor	Pump only	Pump and motor	Pump only	Pump and motor	Pump only	Pump and motor
<0.65 (<0.75)	72	72	64	66	62	64	62	64
0.75 (1)	72	72	64	66	62	64	62	64
1.1 (1.5)	74	74	66	67	64	64	62	63
1.5 (2)	74	74	66	71	64	64	62	63
2.2 (3)	75	76	68	72	65	66	63	64
3 (4)	75	76	70	73	65	66	63	64
4 (5)	75	76	71	73	65	66	63	64
5.5 (7.5)	76	77	72	75	66	67	64	65
7.5 (10)	76	77	72	75	66	67	64	65
11 (15)	80	81	76	78	66	67	64	66
15 (20)	80	81	76	78	70	71	68	69
18.5 (25)	81	81	77	78	71	71	69	71
22 (30)	81	81	77	78	71	71	69	71
30 (40)	83	83	79	81	73	73	71	73
37 (50)	83	83	79	81	73	73	71	73
45 (60)	86	86	82	84	76	76	74	76
55 (75)	86	86	82	84	76	76	74	76
75 (100)	87	87	83	85	77	77	75	77
90 (120)	87	88	83	85	77	78	76	78
110 (150)	89	90	85	87	79	80	77	80
150 (200)	89	90	85	87	79	80	77	80
200 (270)	Ø	Ø	Ø	Ø	86	87	83	86
300 (400)					87	90	85	86

Ø The noise level of machines in this range will most likely be of values which require noise exposure control, but typical values are inappropriate. Note: for 1 180 and 960 r/min reduce 1 450 r/min values by 2 dBA. For 880 and 720 r/min reduce 1 450 r/min values by 3 dBA.

Multivoltage Cast Iron Frame Motors

EFF2

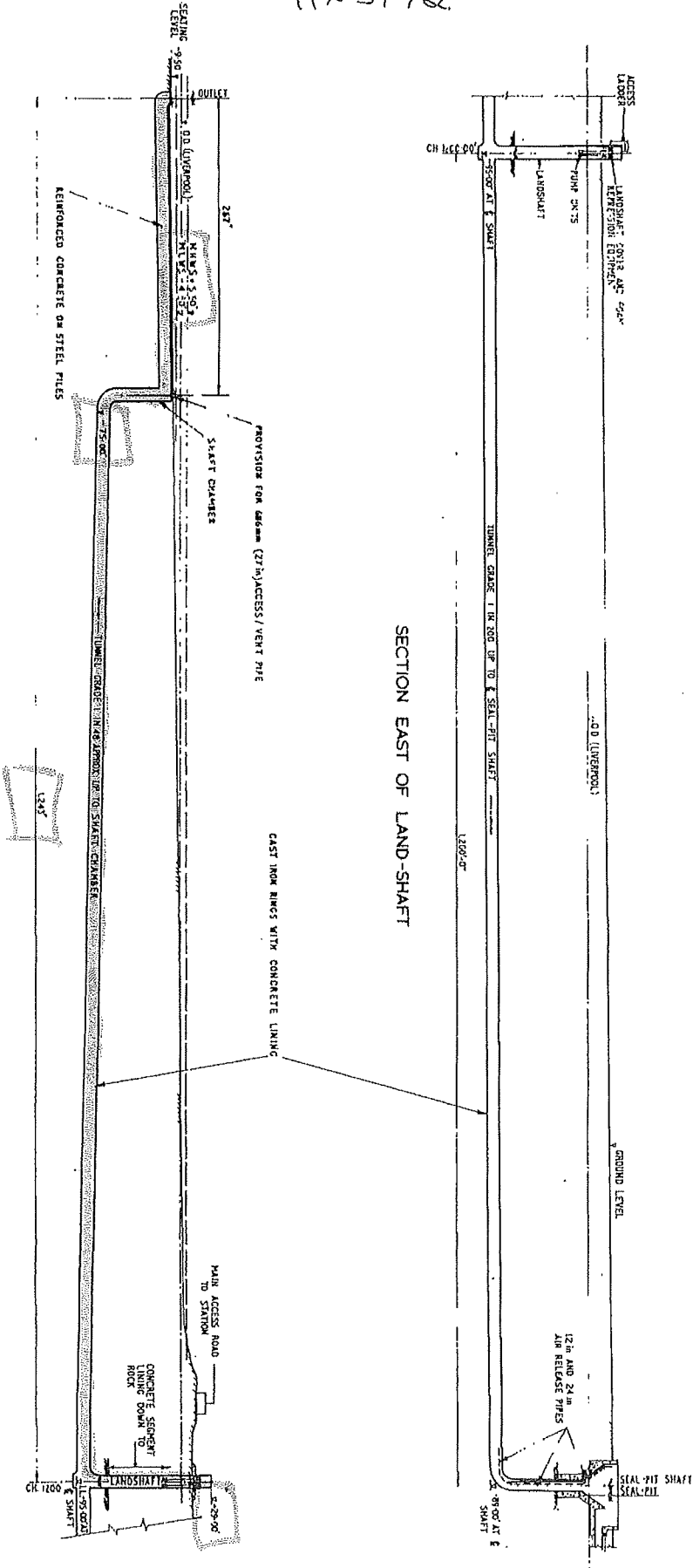


- 2 or 4 phase multivoltage, IP56, TEFC
- 400V frames (80 up to 465 MW)
- 600V or 1200V to 380 kW
- 400V cage rotor / Aluminium die cast
- 400V and 600V cast iron
- Standard steel nameplate AISI 316
- Duct iron
- Glass fibre insulation (AT - 80K)
- 60 and 90 duty class
- Ambient temperature: 40°C, 1000 m a.s.l.
- Dimensions according to IEC 72
- Performance characteristics according to JEC 34
- Degree of protection from frame 225S/M and above
- Motor lead and cable entries in terminal box
- Thermistors (1 phase) fitted in frame
- 100M and above
- Suitable for heavy duty applications
- IEC 60034 - Standard efficiency - IAU-5007
- Mechanical data on pages 36 and 37

- Options Available:**
- Degree of protection IP56, IP65 or IP66
 - Bearing seals
 - Lip seal
 - Oil seal
 - Taconite labyrinth seal and W3 seal for frames 90S and above
 - Thermal protection:
 - Thermistors: frame 132M and below
 - Thermostats
 - RTD-PT 100
 - Space heaters
 - Design H
 - Class "H" Insulation
 - Roller bearings for frame 160M and above
- More options available, on request

- Typical Applications:**
- Pumps
 - Fans
 - Crushers
 - Conveyors
 - Machine tools
 - Milling machines
 - Centrifugal machines
 - Presses
 - Elevators
 - Looms
 - Grinders
 - Woodworking
 - Cooling
 - Packaging equipment
 - Other Severe Duty applications

Hx 5172



SECTION EAST OF LAND-SHAFT

(C24) 16/4
A2
September 1979

Fig 4/3 LONGITUDINAL SECTION OF CIRCULATING WATER OUTLET TUNNEL

HWA/2912/ED/CS/1556



Polyethylene Pipe Dimensions

PE100 SIZE	SDR26		SDR21		SDR17		SDR13.6		SDR11		SDR9		SDR7.4		PE100
	PN 6.3	PN 8	PN 10	PN 12.5	PN 16	PN 20	PN 25	PN 25	PN 25	PN 25	PN 25	PN 25	PN 25	PN 25	
	MIN WALL	MEAN I.D.	MIN WALL	MEAN I.D.	MIN WALL	MEAN I.D.	MIN WALL	MEAN I.D.	MIN WALL	MEAN I.D.	MIN WALL	MEAN I.D.	MIN WALL	MEAN I.D.	SIZE
20	1.6	16.7	1.6	16.7	1.6	16.7	1.6	16.7	1.9	16.1	2.3	15.2	2.8	14.2	20
25	1.6	21.7	1.6	21.7	1.6	21.1	1.9	21.1	2.3	20.2	2.8	19.2	3.5	17.7	25
32	1.6	28.7	1.6	28.7	1.9	28.1	2.4	27.0	2.9	26.0	3.6	24.5	4.4	22.8	32
40	1.6	36.7	1.9	36.1	2.4	35.0	3.0	33.8	3.7	32.3	4.5	30.6	5.5	28.5	40
50	2.0	45.9	2.4	45.0	3.0	43.8	3.7	42.3	4.6	40.4	5.6	38.3	6.9	35.6	50
63	2.4	58.0	3.0	56.8	3.8	55.1	4.7	53.2	5.8	50.9	7.1	48.1	8.6	45.1	63
75	2.9	69.1	3.6	67.6	4.5	65.7	5.5	63.6	6.8	60.9	8.4	57.5	10.3	53.6	75
90	3.5	82.8	4.3	81.1	5.4	78.8	6.6	76.3	8.2	72.9	10.1	68.6	12.3	64.5	90
110	4.3	101.2	5.3	99.1	6.6	96.4	8.1	93.2	10.0	89.3	12.3	84.4	15.1	78.6	110
125	4.8	115.3	6.0	112.8	7.4	109.8	9.2	106.0	11.4	101.4	14.0	96.0	17.1	89.5	125
140	5.4	129.1	6.7	126.4	8.3	123.0	10.3	118.8	12.7	113.8	15.7	107.5	19.2	100.2	140
160	6.2	147.5	7.7	144.4	9.5	140.6	11.8	135.8	14.6	129.9	17.9	123.0	21.9	114.7	160
180	6.9	166.2	8.6	162.6	10.7	158.2	13.3	152.7	16.4	146.2	20.1	138.4	24.6	129.1	180
200	7.7	184.5	9.6	180.5	11.9	175.7	14.7	169.8	18.2	162.4	22.4	153.6	27.3	143.4	200
225	8.6	207.7	10.8	203.1	13.4	197.6	16.6	190.9	20.5	182.7	25.1	173.0	30.8	161.3	225
250	9.6	230.7	11.9	225.9	14.8	219.8	18.4	212.2	22.7	203.2	27.9	192.3	34.2	179.2	250
280	10.7	258.6	13.4	252.9	16.6	246.2	20.6	237.8	25.4	227.7	31.3	215.3	38.3	200.7	280
315	12.1	290.7	15.0	284.7	18.7	276.9	23.2	267.4	28.6	256.1	35.2	242.2	43.0	226.1	315
355	13.6	327.8	16.9	320.9	21.1	312.0	26.1	301.5	32.2	288.7	39.6	273.2	48.5	254.6	355
400	15.3	369.3	19.1	361.3	23.7	351.7	29.4	339.7	36.3	325.2	44.7	307.6	54.6	287.0	400
450	17.2	415.5	21.5	406.5	26.7	395.6	33.1	382.1	40.9	365.8	50.3	346.0	61.5	332.8	450
500	19.1	461.7	23.9	451.7	29.6	439.7	36.8	424.6	45.4	406.5	55.8	384.7	...	...	500
560	21.4	517.2	26.7	506.1	33.2	492.4	41.2	475.6	50.8	455.5	...	...	...	...	560
630	24.1	581.8	30.0	569.5	37.2	554.1	46.3	535.2	57.2	512.3	...	...	...	...	630
710	27.2	655.6	33.9	641.6	42.1	624.3	52.2	603.1	...	...	...	...	...	...	710
800	30.6	738.8	38.1	723.0	47.4	703.2	58.8	680.0	800
900	34.4	829.5	42.9	813.8	53.5	791.6	900
1000	38.2	923.0	47.7	904.2	59.3	879.8	1000

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Calculation (Appendix 1) HNA-2912-ED-CS-1556

A calculation check is required to determine if the existing pumps in the Additional Delay Tanks on the HNA site, used for discharging the contents to sea, are suitable for a proposed modification to the pipeline.

Currently HNA discharge the active liquor into a land shaft within the EDF site. The liquor from HNA is then propelled from the bottom of the land shaft out into the Firth of Clyde by continuous high-volume pumps from the EDF Main Cooling, and Reactor Cooling water systems.

Now that the cooling requirements are no longer required to the same capacity, the high-volume pumps are being switched off and therefore there would be insufficient water available to discharge the liquor from the HNA site out into the Firth of Clyde. To ensure that the liquor from the HNA site reaches at the final discharge point, an extension to the existing pipeline, at the culvert, will be installed by EDF.

This calculation is a modification of the original, when installing the delay tanks at HNA, that was verified by measuring the time taken to discharge the tank contents into the land shaft, and comparing the calculated volume flow figure with that on the pump curve. This revised calculation is presented in excel spreadsheet format and split into four discharge sections and a suction section, with the existing pipework covering the first three and the suction sections, and the extension is given in section 4. Section 1 consists of a small part of the discharge pipework that is made from 2" stainless steel. Section 2, which is most of the discharge line is 4" ABS. Section 3 is some small fittings at the discharge point into the culvert, and Section 4 is the extension pipework which is 6" polyethylene. The nominal 3" stainless steel suction line losses are given on a separate sheet.

The calculation is made using the original flow rate which results in the pressure drop being above the pump operating curve. When computing the flow rate of 15 m³/hr the operating point is on or slightly below the curve. The centrifugal pumps are fixed speed and can only operate on this curve.

Methodology:

- Calculate head loss in each of the four sections of the system based on the frictional losses using the Crane 'two friction factor' method. Note: frictional losses are calculated based on water flowing through the specific pipe material used in each section of the system and includes losses due to fittings (eg. 90o bends, Non-return valves, reducer)
- Determine required pressure on discharge and suction sides of the pump
- Calculate Net Positive Suction Head (NPSH) for the system
- Use pump curve to determine if appropriate flowrate can be achieved based on system properties calculated above

Each of the formula used in the spreadsheet has been checked and verified.

The conclusion is that fitting the new extension pipework will have little impact on flow rate, by dropping it from averaging 17m³/hr to around 15 m³/hr.

The assumptions on this calculation is that the future installed pipes follow the profile of the tunnel from the land shaft to the final discharge point and that there will be no further losses in the pipes due to any additional devices put on the end of the new pipe at the discharge point.

