van note - harvey
Division of Pennoni

PRINCETON NURSERIES

TREATMENT WORKS APPROVAL ENGINEERING REPORT

Block 102 Lot 5
Block 106 Lot 1
Plainsboro Township
Middlesex County, New Jersey

Prepared For:
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Engineering for a Better Environment

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1. Introduction

This Engineering Report has been prepared to provide the basis for the design of a new sewage pumping station and force main.

Princeton Nurseries is proposing to subdivide portions of Block 102, Lots 5 & 6, and Block 106, Lot 1, located in Plainsboro, Middlesex County, New Jersey, to construct a mixed-use development. The development will proceed in three phases.

Phase I will include the construction of:

- 20 new single-family houses, each with 3 bedrooms,
- 317 new single-family townhouse units, each with 3 bedrooms,
- 68 new single-family townhouse units, each with 2 bedrooms,
- 10 new single-family townhouse units, each with 1 bedroom,
- 31 new single-family townhouse units (Age restricted), each with 3 bedrooms,
- 64 new single-family townhouse units (Age restricted), each with 2 bedrooms,
- 8 new single-family townhouse units (Age restricted), each with 1 bedroom,
- 12 new single-family apartment units, each with 3 bedrooms,
- 170 new single-family apartment units, each with 2 bedrooms,
- 153 new single-family apartment units, each with 1 bedroom,
- A retail development covering 85,645 square feet,
- An office development spanning 80,080 square feet.

Phase II will include:

- A 264-seat restaurant,
- A 125-unit hotel,
- A banquet facility with seating for 500,
- A retail development covering 40,090 square feet.

Future Phase will include:

- 12 new single-family apartment units, each with 3 bedrooms,
- 57 new single-family apartment units, each with 2 bedrooms,
- 28 new single-family apartment units, each with 1 bedroom,
- A retail development covering 68,555 square feet.

Additionally, a sanitary pumping station has been designed to accommodate a portion of the ultimate flows.

The following will be routed to the proposed pump station:

- 20 new single-family houses, each with 3 bedrooms,
- 204 new single-family townhouse units, each with 3 bedrooms,
- 20 new single-family townhouse units, each with 2 bedrooms,
- 6 new single-family townhouse units, each with 1 bedroom,
- A 264-seat restaurant.

The collected sewage will be routed via gravity through an 8" PVC main to a proposed pump station in the northwest corner of the site. Sewage will be pumped through a new 1,044-ft force main of four (4) inch diameter, Pressure Class 350, cement-lined ductile iron piping into a proposed terminal sanitary manhole, ultimately discharging via gravity into an existing sanitary manhole located on-site.

The Pumping Station and force main have been designed to comply with the requirements established under N.J.A.C. 7:14A-23.10. Plans and specifications for construction of the pumping station and force main have been prepared by Van Note-Harvey, division of Pennoni and are attached for reference.

The proposed gravity sewer system is comprised of SDR 35 PVC piping with an "n" value of 0.01, minimum slope of 0.35%, and maximum velocity of 2.69 ft/s, all in accordance with the N.J.D.E.P. capacity requirements. The allowable system flow, when flowing half full, is 1.41 MGD which is larger than the ultimate projected flow of 272,957 gpd.

2. Station Description/Configuration

The sanitary sewer that discharges to the proposed pump station will flow into a pre-cast concrete structure containing a comminutor to grind/screen the trash. Sewage then flows by gravity into the precast concrete wet well with two (2) solids-handling, fixed-speed, submersible sewage pumps capable of discharging the peak flow rate for the project. The pumps will be fitted with discharge bases and guide rail hardware to permit operating personnel to remove each pump from the wet well without entering the below-grade structure. The pumps will be equipped with

explosion-proof motors and mixing valves and will be designed to pass three (3) inch spherical solids.

Individual sewage pump check and isolation valves as well as pressure gauges will be contained in an adjacent, below-grade valve chamber. The chamber piping will incorporate fittings for connection of a temporary bypass pump to the force main in the event of mechanical/electrical equipment failure that would prevent operation of the station pumps.

Pump operation will be automatically controlled by a duplex pump control system capable of automatically starting, stopping and alternating “lead” and “lag” pumps in response to wet well levels. The control system and redundant level sensors will generate alarms in the event of abnormally high or low wet well water levels. Pump malfunction and related operational problems will be additionally monitored by the control system.

A voice-synthesized automatic dialer will be provided to alert operating personnel by telephone should the station malfunction.

An alternate source of electrical power will be provided by an outdoor natural gas fueled and fully automatic emergency power system consisting of an engine driven generator set and automatic transfer switch. The generator set will be sized to power the sewage pumps and all other critical loads for the duration of utility power failures with a maximum 20% starting voltage dip and loads applied in steps as specified.

A potable water service complete with metering and backflow prevention will be provided to a wall hydrant located in a water meter chamber.

The pumping station site area will be protected by board-on-board fence. The station within the fence will be accessed through a gate.

3. Sanitary Flow Calculations

The wastewater flow estimate for the entire proposed site is summarized in Table 1 below. A portion of the flow summarized in Table 1 will flow by gravity directly into the existing manhole located on-site. The existing sanitary sewer main discharges to the public sewer system located in US Route 1.

Table 1 Total Sewer System Wastewater Flow Estimate

Type	Number of Units	Flow Per Unit (gpd/unit)	Flow (gpd)
Phase I			
1-Bedroom Residential Dwelling	163	150	24,450
2-Bedroom Residential Dwelling	238	225	53,550
3-Bedroom Residential Dwelling	349	300	104,700
1-Bedroom Age Restricted Residential Dwelling	8	110	880
2-Bedroom Age Restricted Residential Dwelling	64	170	10,880
3-Bedroom Age Restricted Residential Dwelling	31	225	6,975
Retail	85,645	0.1	8,564.5
Office	80,080	0.1	8,008
Phase II			
Restaurant	264	35	9,240
Hotel	125	75	9,375
Banquet	500	20	10,000
Retail	40,090	0.1	4,009
Future Phase			
1-Bedroom Residential Dwelling (Age Restricted)	28	110	3,080
2-Bedroom Residential Dwelling (Age Restricted)	57	170	9,690
3-Bedroom Residential Dwelling (Age Restricted)	12	225	2,700
Retail	68,555	0.1	6,855.5
Total Average Daily Flow			272,957

Wastewater flowing by gravity into the pumping station is isolated and estimated below in Table 2. The flow estimate totaled in Table 2 serves as the pumping station design flow.

Table 2 Pumping Station Wastewater Flow Estimate

Type	Number of Units	Flow Per Unit (gpd/unit)	Flow (gpd)
1- Bedroom Residential Dwelling	6	150	900
2- Bedroom Residential Dwelling	20	225	4,500
3- Bedroom Residential Dwelling	224	300	67,200
Restaurant	264	35	9,240
Total Average Daily Flow			81,840

The proposed pumping station average daily flow = 81,840 gpd = 56.83 gpm. In accordance with N.J.A.C. 7:14A-23.10, minimum required pump capacity = 56.83 gpm × 2.5 = 142.08 gpm. The station has been designed for minimum 162 gpm and 3.72 ft/s to maintain self-cleaning velocity in the 4" force main.

4. Pump and Wet Well Capacity

Static Head –

Force Main High Point Elevation, Feet = 103.65

All Pumps "Off" Elevation, Feet = 74.50

Static Head, Feet = 29.15

Friction Loss –

Assume Hazen Williams "C" Factor, 120 for new D.I.P. discharge piping and force main. Total Discharge Head Calculations, System Capacity Head Curve and Pump Performance Curve are attached as Appendix A, B and C respectively.

Based upon the system configuration and pump rate, the pumping station will be equipped with two (2) submersible 60 Hz, 3 phase, 230 V, 3 hp Xylem Flygt raw sewage pumps, Model NP 3085SH with 125 mm dia. impeller. Each pump will have a capacity of 162 gpm at 56.8 ft TDH.

The rectangular wet well will be a pre-cast reinforced concrete structure of 5 ft × 5 ft interior dimensions to avoid the obstruction of the pump and comminutor removal. For 1' depth, it provides a volume of 374 gallons or 50 Cu. Ft. The active volume is measured from the "all pumps off" elevation to the "lead pump on" elevation for the pump operation.

Pump operation will be controlled by an Automatic Pump Pilot (APP) controller Model PC3000X as manufactured by Primex. Two (2) redundant back up float switches for low-water-level alarm and high-water-level alarm will be provided. Controls will provide automatic alteration of the lead pump. The primary level sensor will include low water level, all pumps off, lead pump on, lag pump on, and high-water-level. An automatic dialer will report alarm conditions to the designated personnel.

Water Level Elevations:		Source:
High-Water-Level Alarm	= 77.50	APP Controller & Redundant Level Sensor
Lag-Pump On	= 77.00	APP Controller
Lead-Pump On	= 76.50	APP Controller
All Pumps Off	= 74.50	APP Controller
Low-Water-Level Alarm	= 74.00	APP Controller & Redundant Level Sensor

5. Wet Well Detention Time/ On-to-On Cycle Time

The wet well level control system will provide an active storage volume sufficient to prevent excessive pump cycling at the average dry weather rate per N.J.A.C. 7:14A-23.12(a), 4.

Volumes/detention times have been established as follows:

Average Daily Flow, gpd (ULTIMATE)	81,840
Average Daily Flow, gpm (ULTIMATE)	56.83
Wet well cross-sectional area, sq. ft.	25
Active storage depth, ft	1
Active storage volume, gal	374
Detention time, minutes (ULTIMATE)	6.58

Calculate pump "on-to-on" operating cycle at influent flow rate:

Pump Discharge Rate, "D", gpm

Influent Flow Rate, "Q", gpm

Wet Well Active Storage Volume "V", gallons

The shortest "on-to-on" cycle time, minutes:

$$= \frac{V}{Q} + \frac{V}{D - Q}$$

The times are as follows:

Pump Discharge Rate, gpm	162
Influent Flow Rate, gpm (ULTIMATE)	56.83
Wet well active storage volume, gal	374
Shortest "on-to-on" cycle time (ULTIMATE)	10.14

10.14 minutes minimum on-to-on pump cycle times are sufficient to prevent premature failure of mechanical and electrical equipment.

Level control program will be initially field set as required while flows develop at the site.

Force Main

Force main velocity is calculated as follows:

Nominal force main size, inch	4
Force main pipe inside diameter, inch	4.22
Pipe cross-sectional area, square inch	13.99
Pipe cross-sectional area, square feet	0.097
Pump discharge rate, gpm	162
Pump discharge rate, cfs	0.36
Force main velocity, ft/s	3.72

The velocity in the force main meets N.J.A.C. 7:14A-23.10(g) requirement of 2 ft/s minimum.

Appendix A - Force Main Head Calculations

FORCE MAIN SYSTEM FRICTION LOSS CALCULATIONS :

Pipe Type:	Class 52 DIP
C Factor	120
Nominal Pipe Size (in) :	4
Average O.D. (in):	4.80
Pipe I.D. (in) :	4.22
Pipe Dia. (ft) :	0.35
Pipe Area (sq. ft) :	0.10

					Flow Rate [gpm]													
					25		50		75 (25% Flow)		100 (50% Flow)		125 (75% Flow)		142 (100% Flow)		150 (125% Flow)	
Item No.	Source of Friction Loss	Quantity	k	k total	V	Head Loss	V	Head Loss	V	Head Loss	V	Head Loss	V	Head Loss	V	Head Loss	V	Head Loss
					[fps]	[ft]	[fps]	[ft]	[fps]	[ft]	[fps]	[ft]	[fps]	[ft]	[fps]	[ft]	[fps]	[ft]
1	inlet		0.50	0.00	0.57	0.00	1.15	0.00	1.72	0.00	2.30	0.00	2.87	0.00	3.26	0.00	3.44	0.00
2	outlet	1	1.00	1.00	0.57	0.01	1.15	0.02	1.72	0.05	2.30	0.08	2.87	0.13	3.26	0.16	3.44	0.18
3	90 - elbow	2	0.51	1.02	0.57	0.01	1.15	0.02	1.72	0.05	2.30	0.08	2.87	0.13	3.26	0.17	3.44	0.19
4	45 - elbow	8	0.27	2.16	0.57	0.01	1.15	0.04	1.72	0.10	2.30	0.18	2.87	0.28	3.26	0.36	3.44	0.40
5	22.5 - elbow		0.20	0.00	0.57	0.00	1.15	0.00	1.72	0.00	2.30	0.00	2.87	0.00	3.26	0.00	3.44	0.00
6	tee (thru)	1	0.34	0.34	0.57	0.00	1.15	0.01	1.72	0.02	2.30	0.03	2.87	0.04	3.26	0.06	3.44	0.06
7	tee (branch)		1.02	0.00	0.57	0.00	1.15	0.00	1.72	0.00	2.30	0.00	2.87	0.00	3.26	0.00	3.44	0.00
8	gate valve	3	0.14	0.42	0.57	0.00	1.15	0.01	1.72	0.02	2.30	0.03	2.87	0.05	3.26	0.07	3.44	0.08
9	plug valve		1.00	0.00	0.57	0.00	1.15	0.00	1.72	0.00	2.30	0.00	2.87	0.00	3.26	0.00	3.44	0.00
10	butterfly valve			0.00	0.57	0.00	1.15	0.00	1.72	0.00	2.30	0.00	2.87	0.00	3.26	0.00	3.44	0.00
11	check valve	1	1.70	1.70	0.57	0.01	1.15	0.03	1.72	0.08	2.30	0.14	2.87	0.22	3.26	0.28	3.44	0.31
12	wye fitting	3	0.34	1.02	0.57	0.01	1.15	0.02	1.72	0.05	2.30	0.08	2.87	0.13	3.26	0.17	3.44	0.19
13	reducer	1	0.33	0.33	0.57	0.00	1.15	0.01	1.72	0.02	2.30	0.03	2.87	0.04	3.26	0.05	3.44	0.06
Subtotal						0.04		0.16		0.37		0.65		1.02		1.32		1.47

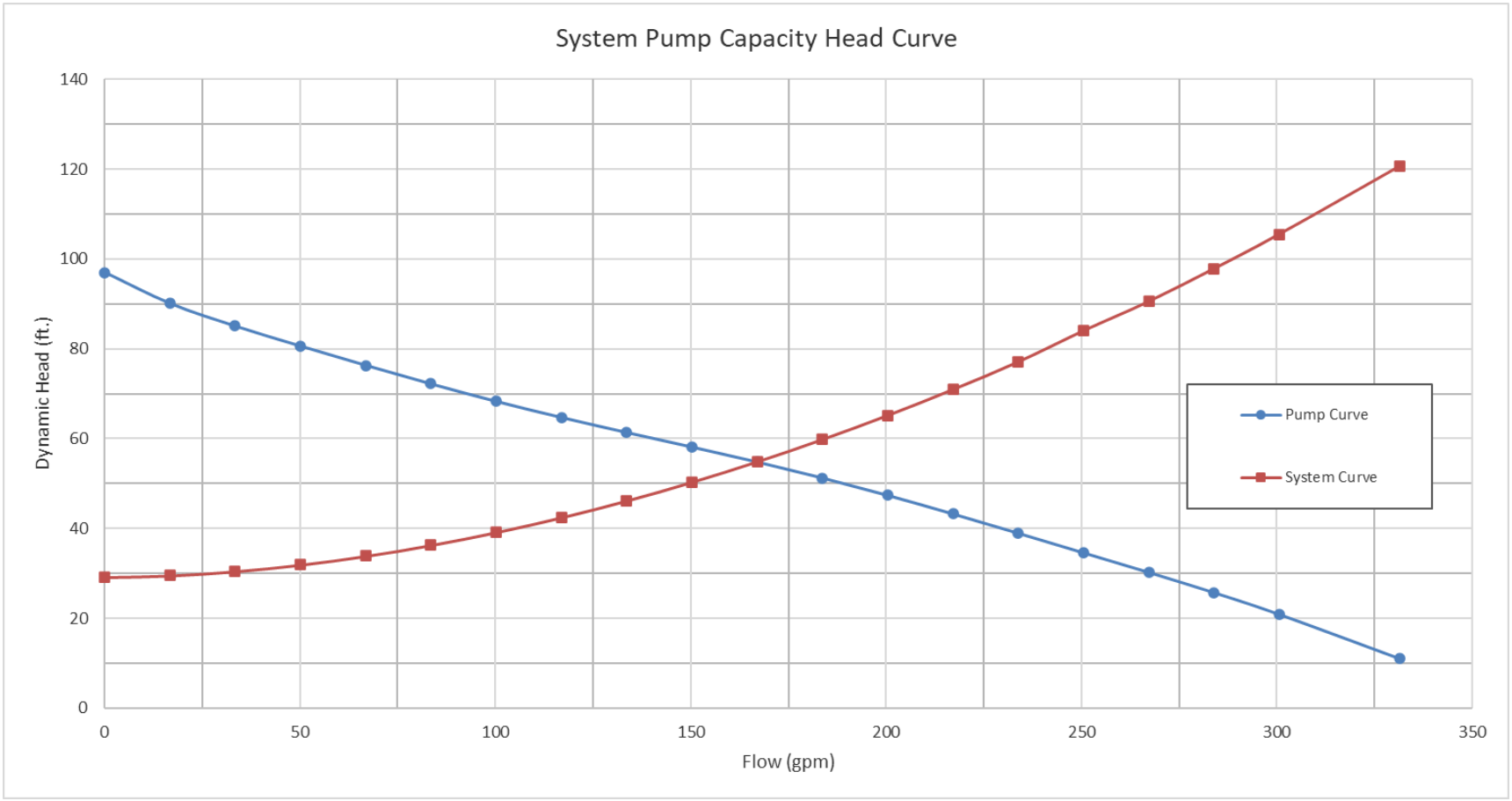
					Flow Rate [gpm]													
					25		50		75		100		125		142		150	
		Force Main Length				Head Loss		Head Loss		Head Loss		Head Loss		Head Loss		Head Loss		Head Loss
		[linear feet]				[ft]		[ft]		[ft]		[ft]		[ft]		[ft]		[ft]
9	Friction Loss Through Pipe	1044				0.24		0.88		1.86		3.18		4.80		6.07		6.72
Total						0.29		1.04		2.23		3.83		5.82		7.39		8.19

[gpm] = gallons per minute [fps] = feet per second [ft] = feet

Calculations of Total Dynamic Head (System Curve)

Flow Rate [gpm]	Friction Loss [ft]	Total Static Head At Min. Wet Well Water Level [ft]	Total Dynamic Head (TDH) At Min. Wet Well Water Level [ft]
0	0	29.15	29.15
25	0.29	29.15	29.44
50	1.04	29.15	30.19
75	2.23	29.15	31.38
100	3.83	29.15	32.98
125	5.82	29.15	34.97
142 (100% Flow)	7.39	29.15	36.54
150	8.19	29.15	37.34

Appendix B – Pump Curve vs System Curve


System Pump Capacity Head Curve
Dynamic Head (ft.)
140
120
100
80
60
40
20
0
0
50
100
150
200
250
300
350
Flow (gpm)
Pump Curve
System Curve

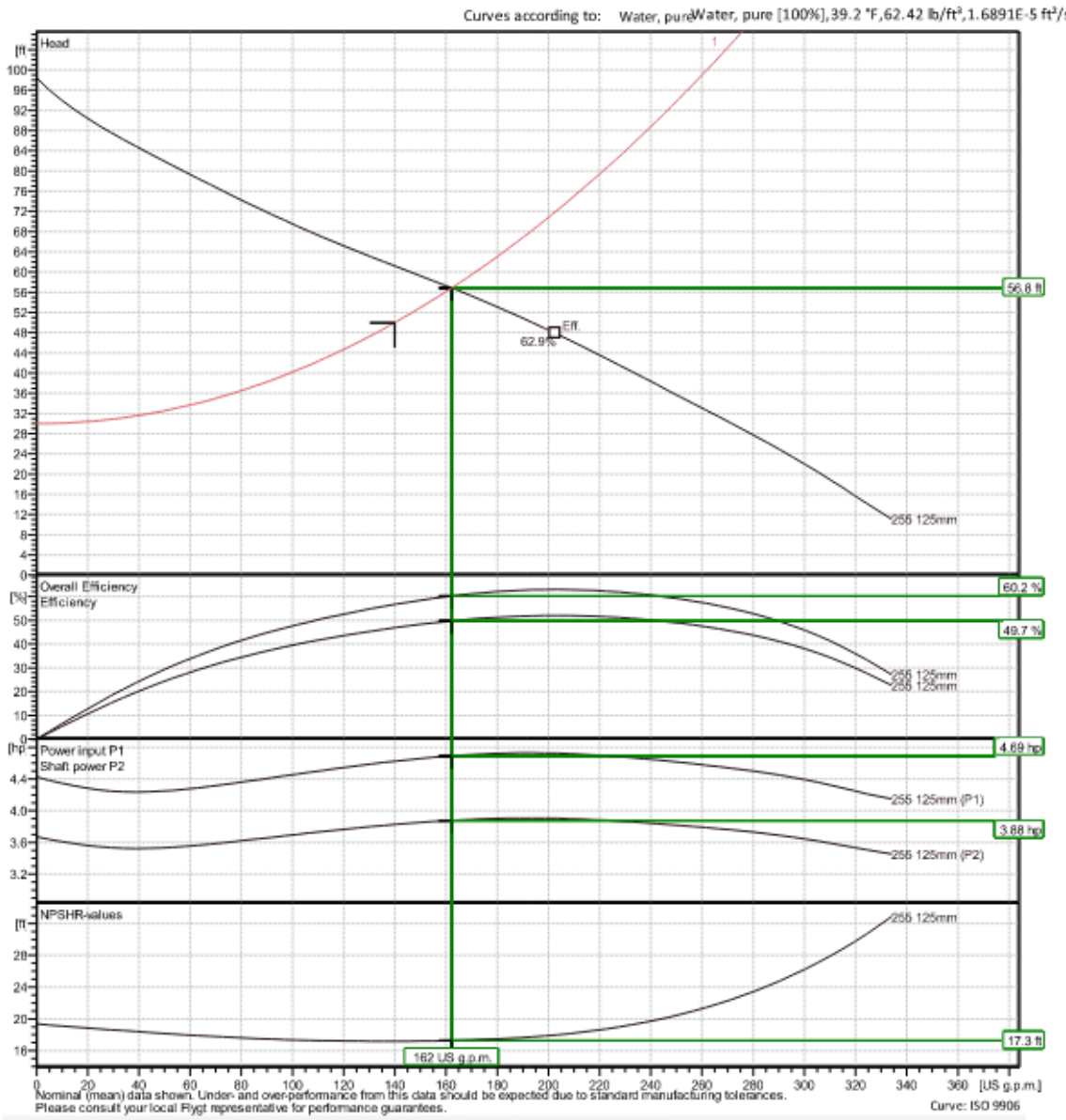
Appendix C - Flygt Pump Model NP 3085SH Performance Curve

NP 3085 SH 3~ Adaptive 255

Performance curve

Duty point

Flow	Head
162 US g.p.m.	56.8 ft



Nominal (mean) data shown. Under- and over-performance from this data should be expected due to standard manufacturing tolerances.
Please consult your local Flygt representative for performance guarantees.

Curve: ISO 9906

Xylect-22226228

Craig Nagler

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