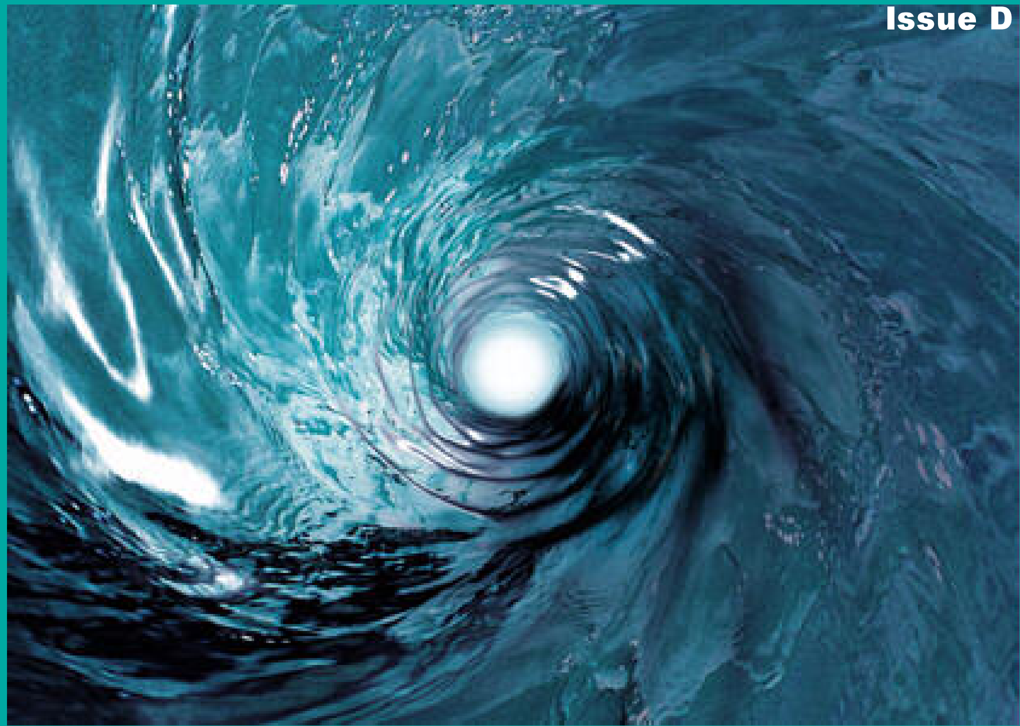
Issue D



PRODUCT CATALOGUE

JETS™
JETS VACUUM AS

Content | Introduction | Vacuumarator | Toilets | Urinal | Grey water equipment
Additional equipment | Vacuum piping | Vacuum Unit | Standards | Representatives

Content

JETS Vacuum AS

Jets Vacuum AS designs and manufactures Vacuum toilet and sanitation systems.

A Jets system is available for any type or size of ship or boat - from the largest cruise liner to the smallest pleasure boat.

Jets has since the start in 1986 been the leading innovator in Vacuum Sanitation Technology, regularly introducing new and advantageous solutions for the marine industry.

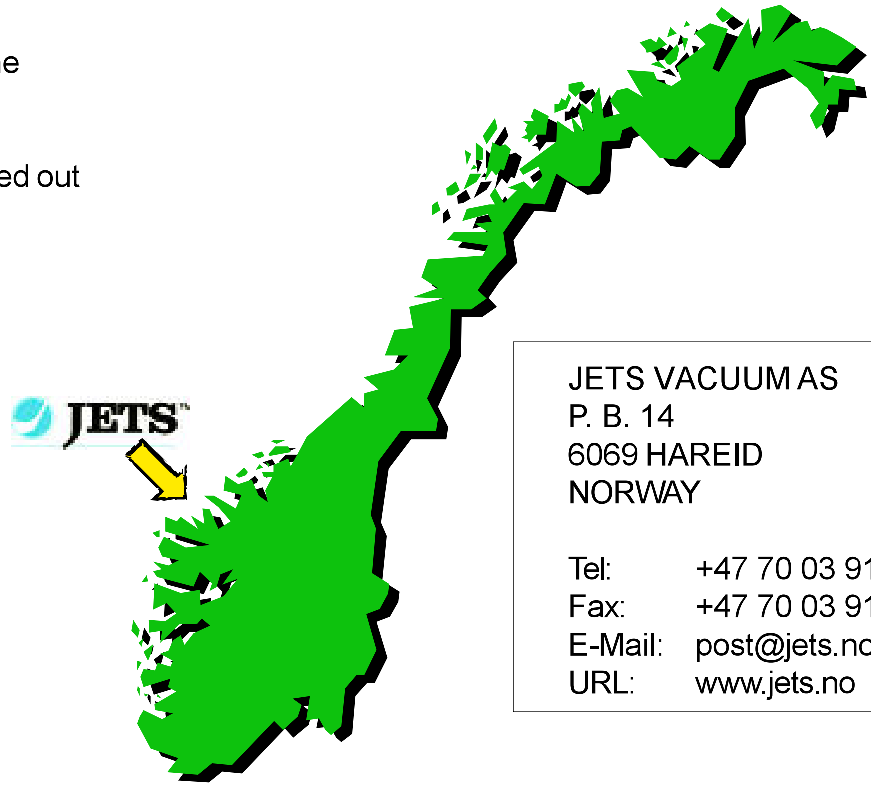
Jets Vacuum AS is located at Hareid, close to Aalesund on the Western Coast of Norway.
Jets Vacuum has branch offices in Korea and Germany.
In addition marketing, sale and technical assistance are carried out via a world wide network of well qualified representatives.

With more than 2000 system in operation – world wide, Jets systems come with a solid and rapid growing international reputation.

The Jets system makes installation of sanitation systems onboard ships extremely simple and cost efficient. It just cannot be made easier.

Main focus on reliability and low life cycle cost, simple, uncomplicated equipment is the basis in Jets design philosophy.

WE MAKE BUILDING AND OPERATION OF SHIPS EASIER.



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Atmospheric pressure:
Air pressure at sea level

Vacuum:
Any air pressure below atmospheric pressure

Grey water:
Water from showers, wash basins and laundry

Black water:
Water and effluents from toilets

Vacuum generator:
Equipment which generates and maintain vacuum

Vacuumarator:
A Jets pump which generates vacuum, macerates sewage and transfers this in one and same operation.

Vacuum unit:
A unit consisting of one or more vacuum generators or Vacuumarators with control equipment.

Vacuum system:
A complete system consisting of vacuum unit, vacuum toilets and in some cases also interface units for grey water and urinals.

EFD valve:
Electronic flushing and discharge valve. The mechanism operating the flushing and discharge of toilets.

ED valve:
Electronic discharge valve. The mechanism operating the discharge of the content in a grey water interface unit or a urinal tank.

FD valve:
Flush and discharge valve. Used together with the VPC controller for operation of toilets.

VPC controller:
Vacuum powered cam controller. Mechanism for pneumatic operation of the FD valve.

Sealing liquid ring:
Liquid ring seal between the rotor and the rotor chamber when a Vacuumarator is in operation.

Sealing liquid:
Liquid needed in order to maintain a Vacuumarator's liquid ring seal (normally black water)

Grey water interface unit:
Tank (normally 8 or 16 ltr) fitted with an ED valve and a float switch for activating the ED valve and discharge of the tank. Unit to be used to interface grey water by gravity with the Vacuum system.

Collecting tank:
Tank for colleting of black and in some cases also grey water from a Vacuum system.

Holding tank:
Tank for holding (storage) of black and in some cases also grey water.

Vacuum breaker:
Devise to prevent back flow (siphon effect) with contaminated water going from a toilet and into the fresh water supply system.

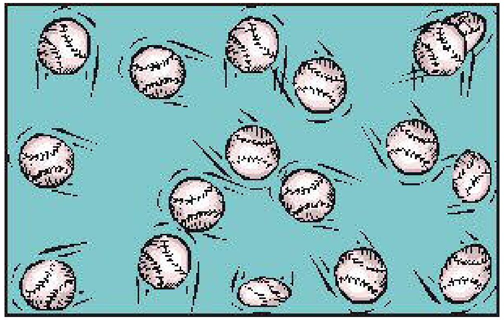
Sewage Treatment plant:
Plant for treatment of black water and in some cases also grey water before overboard discharge.

Vacuum theory

We consider the air to be homogeneous

Talking about atmospheric air, we actually talk about a mixture of several gases and steam. In the following we consider air to be a homogeneous mass. We assume that air consists of particles equal in size, weight and behaviour. We ignore the fact that air normally contains steam.

Particles in movement



At sea level 1m³ air has the weight of approximately 1,2 kg. This air consists of a great amount of particles that are in constant movement. To illustrate this one can imagine a great amount of small balls buzzing around in a limited space, resulting many collisions between the particles and the environment. The environment may be the walls in a tank, a piping system or a liquid surface. This is of great importance for the pump technique.

Atmospheric pressure

All these collisions acts as a constant pressure on the environment. This pressure we call the

Atmospheric pressure

It acts in all directions and is equal to the weight of the air mass in a given area.

Absolute pressure

The pressure decreases proportionally with the altitude as the air gets thinner. In the empty space some hundred kilometres above sea level the pressure has decreased to zero. The amount of particles and the collisions are then so rare, that a pressure cannot be measured.
We have to emphasize that a completely empty space does not exist, and it can also not be practically created. The pressure existing in the imagined empty space is at the absolute zero point. Going down through the atmosphere a rising pressure can be measured. These levels of pressure are called *absolute pressures*.

Measuring units

The pressure measured at sea level is called one atmosphere; 1 atm. Several measuring units have been used to define this pressure.

1 atm equals:

1 kp/cm² = the weight of a 760 mm quicksilver pillar = 760 Torr = the weight of a 10,33 m water pillar

The normal atmospheric pressure is internationally fixed at 1013 mbar. Pressure is to be measured in mbar or N/m². N/m² is seldom used as a measuring unit today. For simplicity pressures in a vacuum sanitary system are normally measured in % vacuum.

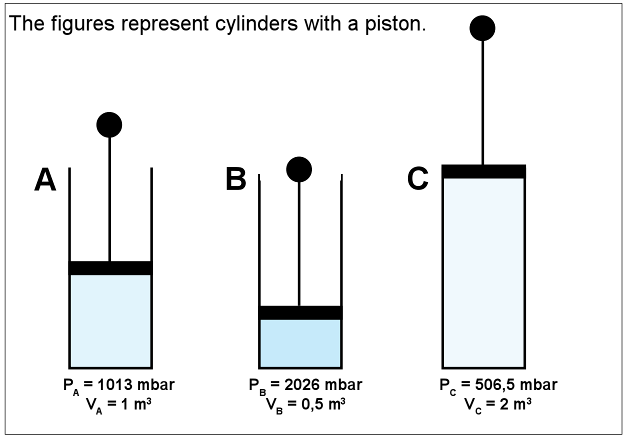
Vacuum area

The pressure area from the absolute zero point to the atmospheric pressure is called the vacuum area or the underpressure area. We have to emphasize that there is no such thing as a negative pressure. Underpressure or vacuum is therefore pressure level, which are beneath the atmospheric pressure.

Boyle-Mariotte's law

If the temperature is kept constant for a defined amount of gas, the pressure and the volume will be inversely proportional.

This can be illustrated in the following way:



Cylinder A contains 1m³ air at atmosphere pressure (1013 mbar).

The air pressure is called: P = 1013 mbar
The volume is called: V = 1m³

In cylinder B the piston has been pushed so far down that the volume in the cylinder has become 0,5m³.
This means that the air particles have been compressed, so that the particle density is twice as big as in fig. A. We assume that the temperature has not been changed from A to B.

The air pressure in B will be: P = 2026 mbar
The volume will be: V = 0,5 m³

In cylinder C, we have pulled the piston further out, so that the volume in the cylinder now is 2 m³. Because we have the same amount of air in the cylinder, this means that the particle density is only 50% compared to fig. A. Therefore also the pressure is halved. We still assume that the temperature has not been changed.

The air pressure in C will be: P = 506,5 mbar
The volume will be: V = 2 m³

When we multiply pressure and volume in these three cases, we will get the following:

$P_A \times V_A = 1013 \times 1 = 1013$
$P_B \times V_B = 2026 \times 0{,}5 = 1013$
$P_C \times V_C = 506{,}5 \times 2 = 1013$

We can see that pressure multiplied with volume is equal in all three cases. This means that if you change the condition of a closed mass of air, the multiplication of pressure and air will be kept constant.
This is called Boyle-Mariotte's law.
In fig. C, when we pulled the piston, we created an "empty space" (a low pressure area) between the piston and the air beneath it. Because of the internal pressure in the air mass, this space was immediately filled with air particles. After a short time, the dispersion became uniform in the whole cylinder. The pressure became equal in the whole cylinder.

Boyle-Mariotte's law gives us the following equation:

$$P \times V = K$$

P = pressure, V = volume, K = constant value

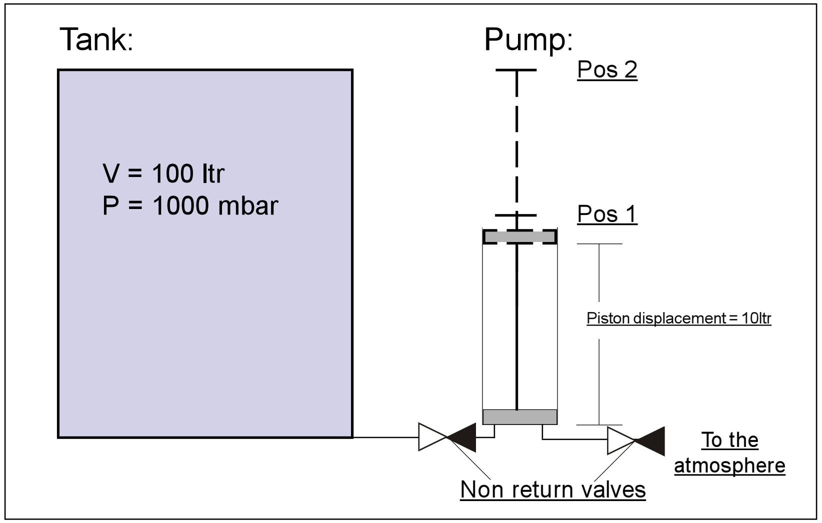
Vacuum theory

It is the pressure within the mass of air that pushes the air particles into the empty space beneath the piston.

Within a locked up mass of air, the pressure is equal.

This capability of "pushing" is the basis for all pump technique.
The capability applies to air- and liquid pumps. All the time there must be a certain pressure on the inlet or the suction side of a pump.

The principle of a vacuum pump



The figure indicates a closed tank that contains 100 litres of air at 1000 mbar pressure.
A thin pipeline connects the tank with the inlet side of a hand pump. The pressure side of the hand pump opens to the atmosphere. Non-return valves are placed in the pipeline on each side of the pump. The pump has a 10 litres piston displacement. We now ignore the volume in the pipeline.

When the piston is in position 1, the total volume is:
V_1 = 100ltr.
When the piston is in position 2, the total volume is:
$V_2 = V_1$+10ltr. = 110ltr.

The starting point for the pump operation is:

P x V = 1000 x 100 = 100000

When the piston has been pulled to position 2, the pressure in the tank will push air particles over to the pump, until the pressure is the same in both tank and pump. The new pressure level, after the first piston stroke, is called P1.
This means that when the piston is pulled to the top (position 2), the total volume in the system is 110 ltr.

According to Boyle Mariotte's law P x V = constant

This gives us the following:

P_1 x 110 = 100000

By solving the equation, we find that
P_1 = 909 mbar.

Thereafter, when the piston is pushed to the bottom (position 1), we will get the following result:

Volume in the system = V = 100 ltr.
Pressure, P_1 = 909 mbar

By the next piston stroke we will get:

$909 \times 100 = P_2 \times 110$

By solving the equation, we find that
$P_2 = 826$ mbar.

Continuing this process, we will find the following:
P_3 = 750 MBAR **P_4 = 681 MBAR** **P_5 = 619 MBAR**
P_6 = 562 MBAR **P_7 = 513 MBAR** **P_8 = 464 MBAR**
P_9 = 424 MBAR **P_{10} = 385 MBAR**

Concluding that the pressure drop per piston stroke is getting less and less.

The pressure will never reach zero.

To illustrate the function, the figure showed a simple piston pump. With some exceptions, the principle is the same for all pump types:

The working element in the pump (e.g piston or rotor) creates an empty space which will be filled because of the pressure in the suction pipeline.

Thereafter, the connection between the suction pipeline and the rotor/piston will be closed, and the air is pushed out through the pump's discharge pipe.

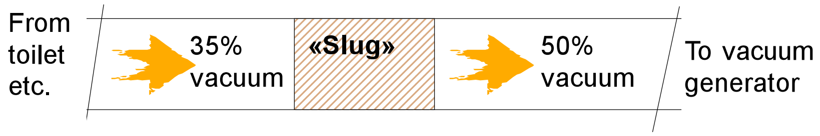
If the pump's working element only consists of mechanical parts, the capacity per stroke or rotation will be the same all over the pressure area in which it operates.

Comparison table between new and old vacuum measurement units:

mbar	N/m^2	atm	% vacuum	mH_20
1013	101300	1,0	0	10,33
1000	100000	0,98	1,3	10,20
900	90000	0,88	11,1	9,17
600	60000	0,59	40,8	6,11
300	30000	0,29	70,4	3,05
100	10000	0,10	90	1,02
0	0	0	100	0

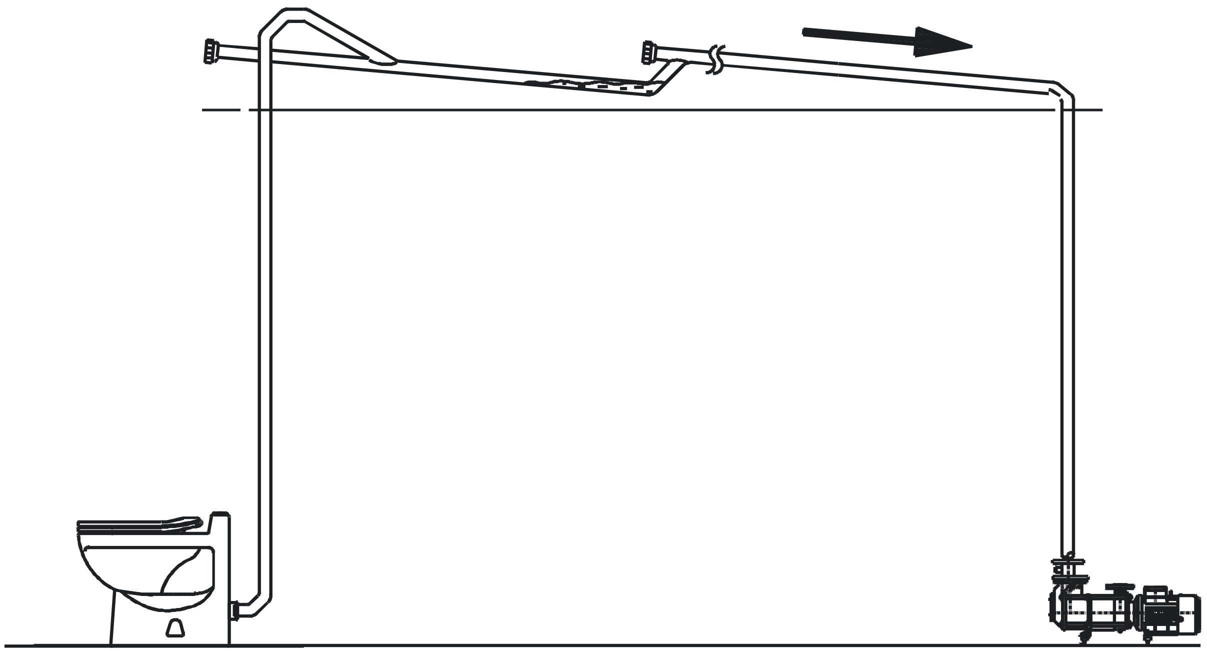
What is a vacuum toilet system?

The basic principle behind a vacuum toilet system is to use differences in air pressure to transport sewage from toilets and urinals and eventually also grey water from sinks and showers. In a modern vacuum system the vacuum is generated directly on the piping, keeping the total system at a constant vacuum, normally between 35 and 50 % vacuum.



When a toilet is flushed approximately 60 litres of air is “sucked” into the piping together with approximately 1 litre of water. The water and sewage create a “slug” and the transport proceeds in such “slugs” as a result of the difference in air pressure in front of and behind the slug.

During the transport in the piping system the “slug” is effected by gravity and will after a time flatten out. Because of this it is necessary to have low point in the piping in order to re- form “slugs” and thus re-establish the pressure difference needed for further transport.



Vacuum toilet system
Advantages

During the last 10 years vacuum toilet systems have become common on all types of ships.
Designers and builders of passenger ships and special vessels have for many years used vacuum systems as a standard. In recent years however, the trend goes in direction of vacuum systems on all types and sizes of ships. The majority of South Korean Shipyards are now using vacuum toilet systems as a standard. The main reason for this is of course the fact that the vacuum system is the most cost effective solution.
Due to:

- High level of installation flexibility
- Total independence of gravity
- Small pipe diameter
- Simple installation
- Low water consumption

First generation

Vacuum tank - Vacuum pump

The Swede Joel Liljendahl developed the first Vacuum toilet system in the 1950's. The idea of Liljendahl was to use vacuum toilets in buildings to reduce water consumption in order to be able to utilize waste products for soil improvement.
Vacuum is created on a vacuum tank by conventional vacuum pumps
Vacuum tank system has good vacuum generating capacities, but also some drawbacks.
Liljendahl sold his concept to Electrolux, who saw a great potential in the ship market. Gradually the Electrolux system became quite common on passenger ships and larger ferries.

Second generation

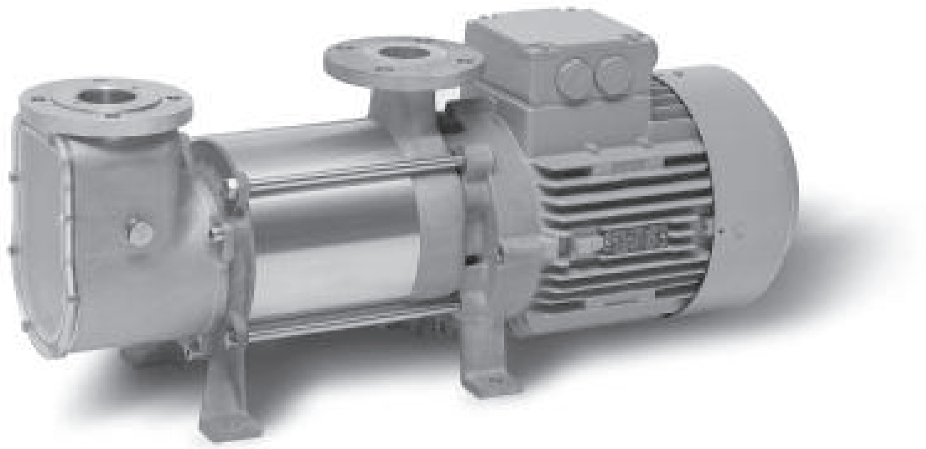
Atmospheric tank og Ejector

In 1975 a Finnish company introduced a new technology for operating a vacuum toilet system. The new solution was to make use of an atmospheric collecting tank and to pump black water through an ejector to create vacuum. This new solution was patented. (The patent has now expired.) This system was simpler and more economical than Electrolux' vacuum tank/vacuum pump system. In 1985 the Finnish company took over Electrolux' vacuum toilet system and got monopoly in the market.

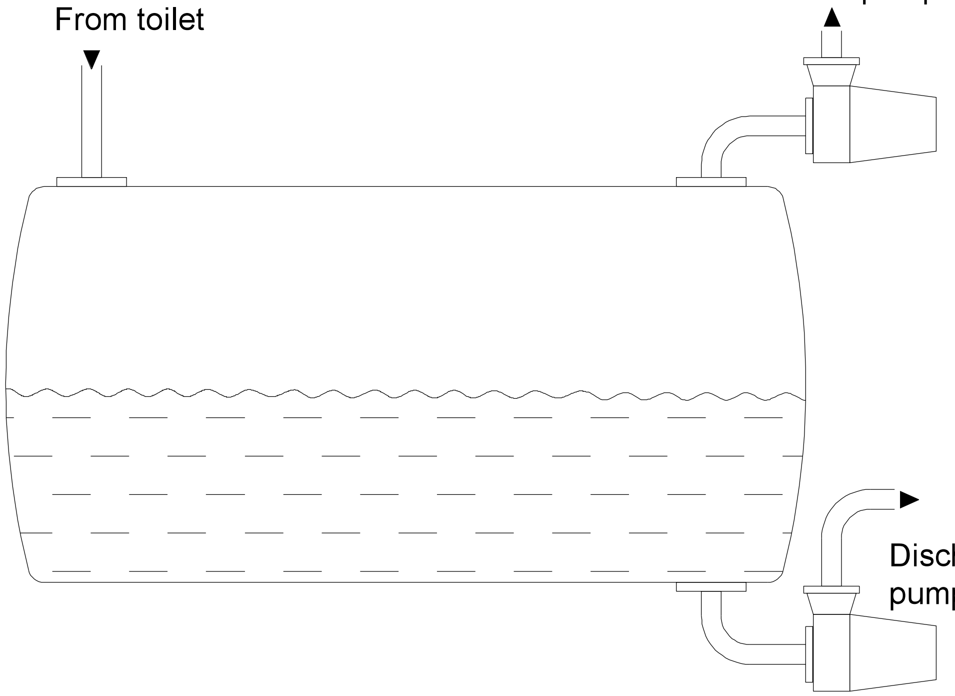
Third generation

Jets Vacuumarator

Olav Hofseth was working with vacuum toilet systems at Bergens Rørhandel in Ulsteinvik. Based on his experience as a chief engineer in overseas trade he saw possibilities for technical improvements. Olav Hofseth established Jets Systemer A/S together with Edvard and John Gjerde in 1986. Jets Vacuumarator, which is a screw pump with a built-in macerator, was developed. The Vacuumarator, which is the heart in the Jets system, is the simplest and most efficient solution for operating a vacuum toilet system. The solution is internationally patented.



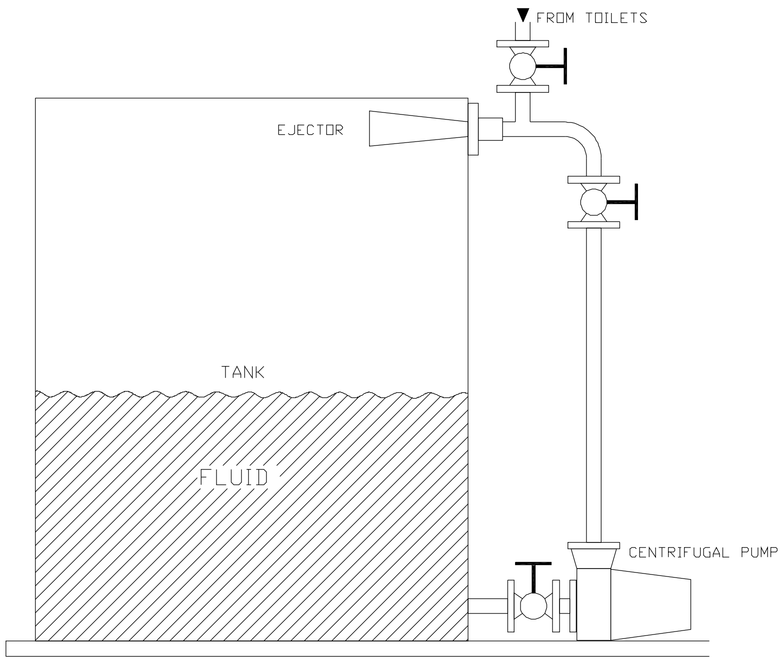
The vacuum tank system



The vacuum tank system is a well-known principle and has for more than 100 years been used in a long range of industrial applications. This solution was introduced for use in Vacuum sewage applications early in the 60's.
A tank is put under vacuum by use of a vacuum pump. Effluents are collected in this tank, which is constantly kept under vacuum.

The system has a great efficiency, but it has also some drawbacks:

a. A vacuum tank is needed.
b. For large systems the tank will be large and bulky due to the special shape that is needed.
c. The system is difficult to install in ships, a lot of free space is required.
d. The system is expensive and complicated.



Use of an ejector to create vacuum is an old and well known principle. An ejector is a nozzle and vacuum is created by pumping liquid via this nozzle. The speed of the liquid creates a vacuum. In order to operate the ejector, a centrifugal pump and a pipe between the pump and the ejector, are needed. A considerable volume of liquid is at all times needed in the tank just in order to generate vacuum.

Vacuum is created in the pipeline by pumping liquid from the tank - via the ejector and back into the tank. There is no vacuum created in the tank. Therefore the pressure in the tank will be atmospheric.

Ejector systems havein general low power to efficiency rate and they also have some other drawbacks.

a. Large circulation of liquid, especially at low liquid level in the tank may result in foaming. A cure against foaming is use of anti foaming agents, which can be quite expensive.

b. The collecting tank may overheat due to large circulation of the liquid.

c. A considerable volume of liquid is at all times needed in the tank just in order to generate vacuum.

d. Ejectors can only handle very small amounts of grey water.

In a Jets system transport is provided by differential air pressure (Vacuum) and thus the requirement for gravity is totally eliminated. The advantages of the Jets system compared with conventional systems are as follows:

A Vacuumarator can pump the sewage directly to a sewage treatment plant, a collecting tank of any type or, in some cases, directly overboard.
Jets Vacuumarators are available in different sizes and capacities.

- Piping independent upon gravity
- Vertical lift capability
- Water consumption of 1,2 ltr. pr. flush
- Small diameter piping
- High degree of installation flexibility.

The heart of a Jets system is the patented Jets Vacuumarator which is the most efficient vacuum generator.

The Vacuumarator is a liquid ring screw pump with an integrated macerator. Vacuum is generated directly on the pipeline - the sewage is macerated and pumped further in the same operation.

A Vacuum unit will consist of one or more Jets Vacuumarators which keep the mains under vacuum. Start and stop of the Vacuumarator are controlled by a pressure switch normally set for operation between 35 - 50 % Vacuum.

Toilets are connected to the pipes via special valves. Jets toilets are available in a range of different models and mechanisms. The connection to piping is only open during the flushing and discharge cycle.

When a toilet is operated, sewage waste water and air are sucked into the vacuum mains and transported to the Vacuumarator. The integrated macerator finely pulps the sewage while pumping it to a Sewage Treatment Plant or a collecting tank.

The engineering excellence of a Jets toilet system now also available for smaller ships and boats.

Jets Solo is a unique Vacuum on Demand system including all the advantages of a Jets system from cruise and passenger ships - but in a scaled-down version for easy and simplified installation.

The heart of the system is the Jets Vacuumarator. This is a vacuum screw pump with an integrated macerator. The Vacuumarator is available for single phase 230V or 24V DC.

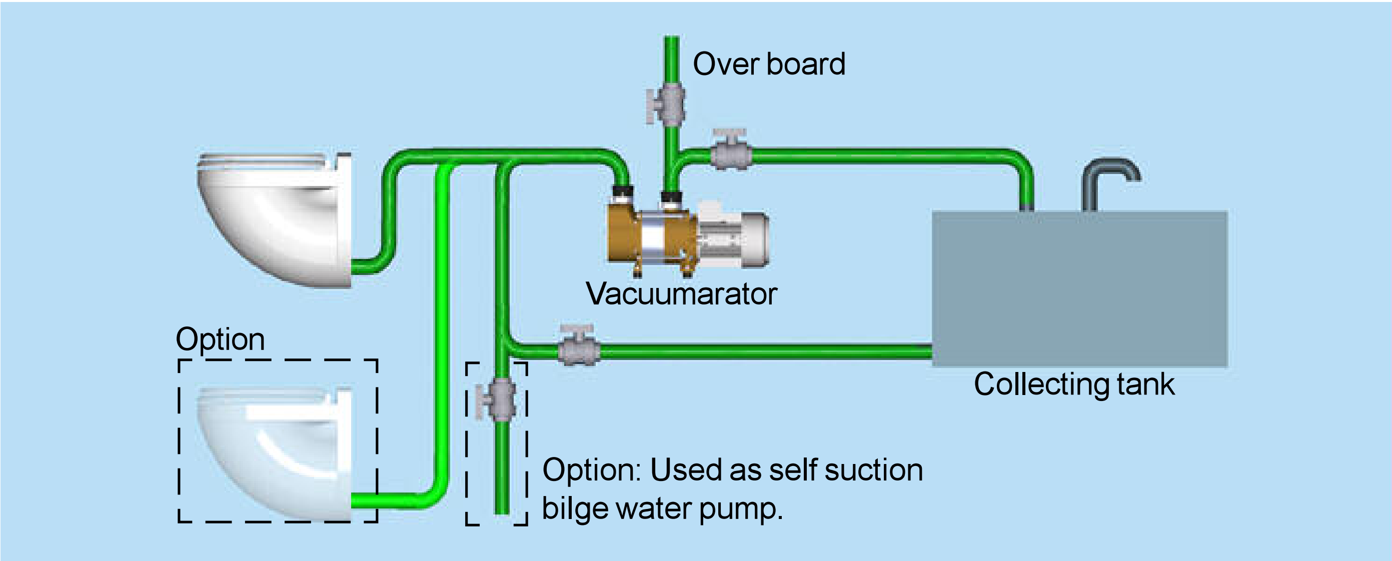
Toilets are connected to the Vacuumarator via 40 mm pipe (flexible hose may also be used) and the discharge is either to a collecting tank or overboard.

The Vacuumarator will start working only when a toilet is activated. Reaching a pre-set vacuum level the toilet valve will open and discharge. The effluents are transported via the Vacuumarator – either to a collecting tank or overboard. The Vacuumarator macerates all the effluents.

Toilets are available for both bulkhead and deck installation.
The system is delivered as an installation kit with easy plug in connections.
The Jets Solo system can be used for up to 3 toilets.

Optional applications for the Vacuumarator:

- Discharge pump for collecting tank.
- Emergency bilge water pump (highly efficient).



The Jets System - Advantages

Jets Vacuumarator principle is a new and recent technical approach to vacuum sanitation systems.
Vacuum is generated directly in the pipeline.
Jets Vacuumarators are the only in-line vacuum generators available.

The Vacuumarator System has several advantages:

Safe and highly efficient vacuum production
Compared to an ejector a Vacuumarator is approximately 40% more efficient. This allows a larger safety margin and a better operation of the system.

No tank needed in order to generate vacuum
The Vacuumarator creates vacuum directly in the pipeline, macerates the sewage and pumps it to either a sewage treatment plant or a collecting tank. There is no need for a great circulation of fluid in order to generate vacuum.

Macerator incorporated in the Vacuumarator
The sewage is finely ground before it is pumped to a treatment plant (or a collecting tank), which is a great advantage if a further cleaning process is considered.

No foaming

In-line installation

Direct interface with all types of sewage treatment plants

More than 95% utilisation of collecting tank capacity
When using a holding tank, the volume of this can be fully utilised. The holding tank can at any times be completely emptied.

Highly flexible solutions with simple installation
The vacuum unit can be located almost anywhere in the ship, independent of the location of the sewage treatment plant or the collecting tank. Connection to the Vacuumarator is only pipe in, pipe out - it simply cannot be made easier.

Very compact and low weight vacuum units
Jets has the smallest and lightest systems available in the market.

Simple and highly reliable toilet operating mechanism
Jets toilets are known for their reliability. The new mechanism is the simplest and most reliable on the market. The whole mechanism (applies only for wall mounted toilets) can easily be changed from the back of the toilet.

Easy maintenance and low spare parts cost
High product specification combined with simple and robust solutions gives the products a superior reliability with a minimum use of spare parts.

Low life cycle cost
The Vacuumarator is simple and has a high grade of tolerance between rotating parts.
High material quality (AISI 316 and bronze) gives long life products.

Latest technology available
Since the establishment in 1986, Jets Vacuum AS has been a leader of the technological development. Products and systems are continuously simplified and improved. Today, Jets is the market leader in vacuum sanitation technology.

Reliable supplier
Jets Vacuum enjoys a solid reputation as a specialist in the field of Vacuum sanitation.

Different types of ships

General

The Jets Vacuumarator is often described as the heart of the Jets Vacuum system.
Jets Vacuumarators are a range of unique Vacuum generators in various sizes suitable for any type of ship.

A Vacuumarator is a liquid ring screw pump with an integrated macerator.
Vacuum is generated directly in the pipeline, black water is macerated inside the Vacuumarator and pumped to either a treatment plant or a collecting tank – all in one operation.

Vacuumarators are highly efficient, compact and utterly reliable and they allow a very flexible installation.

The datasheets in this chapter provide technical details as well as information about capacity.
Based upon details about the number of users, number of toilets (public and private), power supply and preferably also type of ship, Jets will be happy to recommend the best suited Vacuum generation unit.

Content chapter 2; Vacuumarators:

A Jets Vacuumarator is a liquid ring screw pump with an integrated macerator.

A macerator for macerating sewage is incorporated in the Vacuumarator. The macerator consists of one rotating knife fixed to the shaft and one stationary knife fixed to the suction chamber.

The principle of operation is a twin start helical rotor running in a cylindrical tube, which together with two end plates forms the pump body.

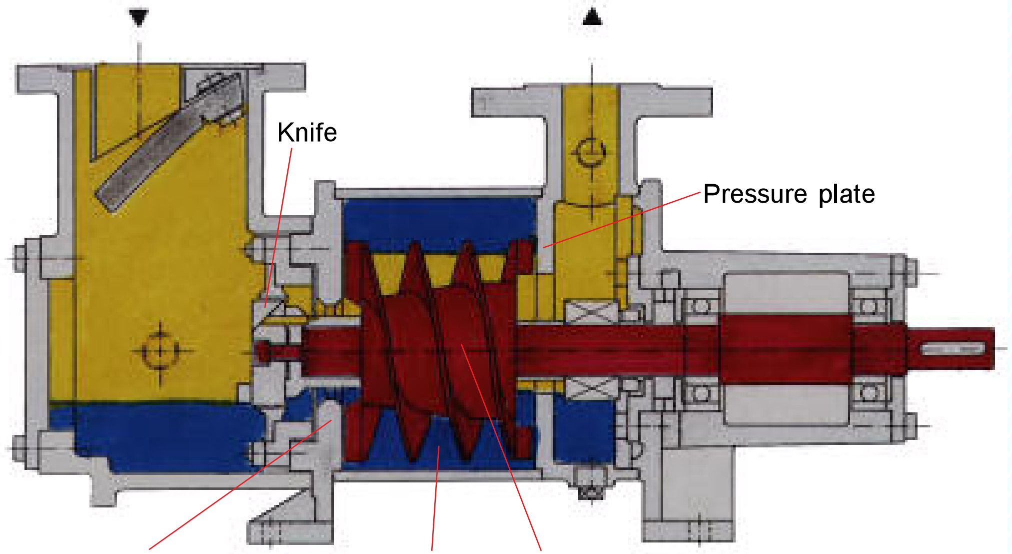
When the Vacuumarator is filled with liquid and started, a liquid ring is created around the rotor. The depth of the liquid ring is governed by the size of the opening in the end plate on the pressure side. This opening is arranged so that the created liquid ring will be touching the rotor hub on one side and the rotor tips on the other. This arrangement creates a serie of progressive crescent shaped cavities travelling from suction to pressure side. Air, sewage and water is pulled into those cavities and transported through the vacuumarator.

The sewage is macerated by the integrated macerator before it enters the pump body.

A Vacuumarator can pump any combination of liquid and air.

Jets Vacuumarator

- CREATES VACUUM
- MACERATES SEWAGE
- PUMPS SEWAGE



Vacuumarator JETS 15MB-D

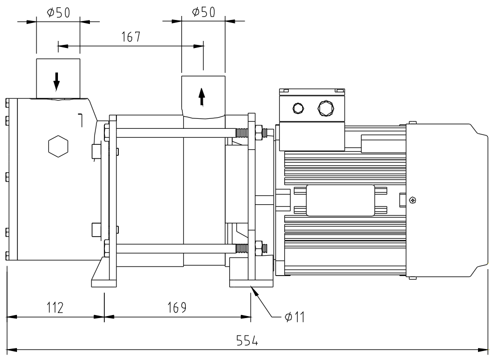
The patented Jets Vacuumarator
- creates vacuum
- macerates sewage
- pumps sewage

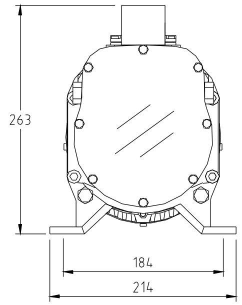
Designed for direct connection to any kind of sewage treatment plant.
Outlet can also be connected to gravity piping or holding tank.

Technical Data

Capacity:	$15 m^3/hr$
Flushing capacity:	150 flushes/hr
Outside dimensions:	214 x 554 x 342 mm. (WxLxH)
Electric motor:	MEZ 7AA 90L-02
Pump casing material:	Bronze RG5
Rotor housing material:	Stainless steel AISI 316
Pump rotor material:	Stainless steel AISI 316
Pump knives material:	Stainless steel AISI 420
Pump shaft material:	Stainless steel AISI 316
Connection, inlet:	Ø 50
Connection, outlet:	Ø 50
Total weight:	37,6 kg
Part no.:	029151100 - AC Voltage

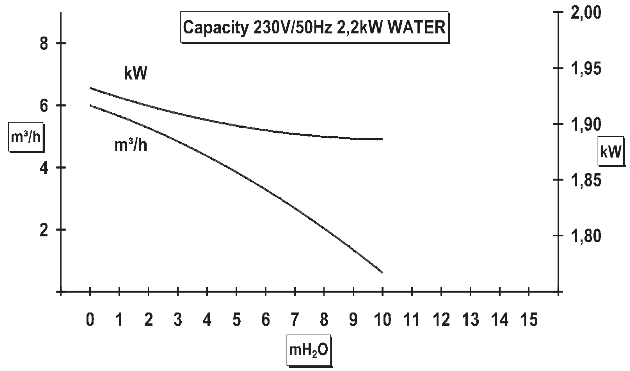
Vacuumarator JETS 15MB-D

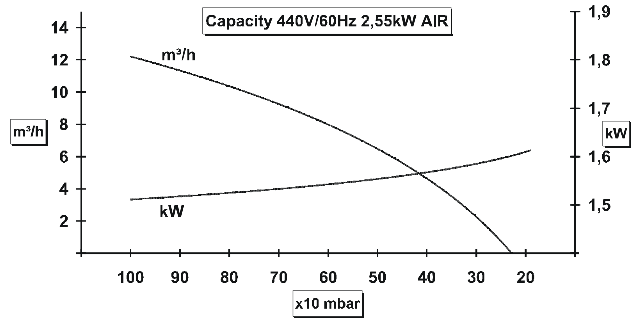


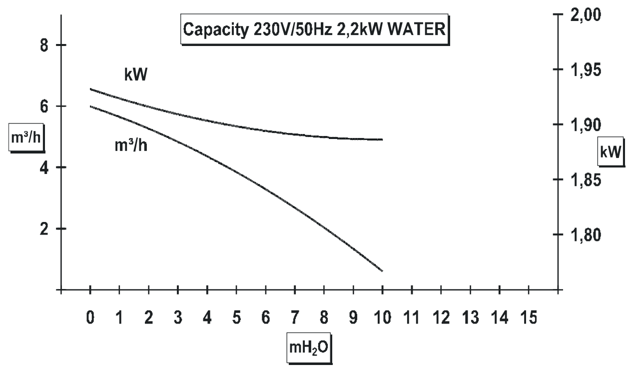


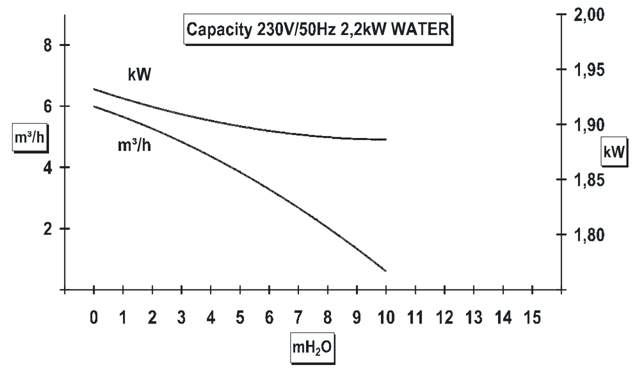
Operating data

	50Hz	60Hz
Speed (nom.)	2.880 Rpm	3.480 Rpm
Power connections (nom.)	220V/380V	440V/255V
Power consumption (nom.)	2,2kW	2,55kW
Current consumption (220V)	8,3A	
Current consumption (380V)	4,8A	
Current consumption (255V)		8,2A
Current consumptiom (440V)		4,75A
Power factor (nom.)	0,85	0,86









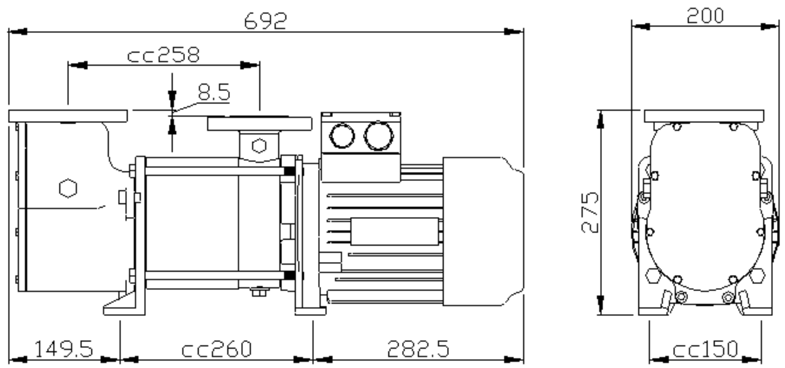
Vacuumarator JETS 25MBA

The patented Jets Vacuumarator
- creates vacuum
- macerates sewage
- pumps sewage

Designed for direct connection to any kind of sewage treatment plant.
Outlet can also be connected to gravity piping or holding tank.

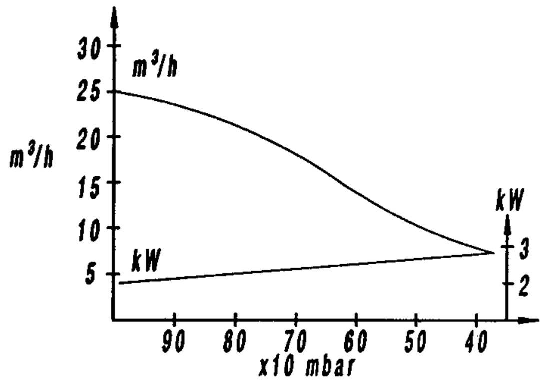
Technical Data

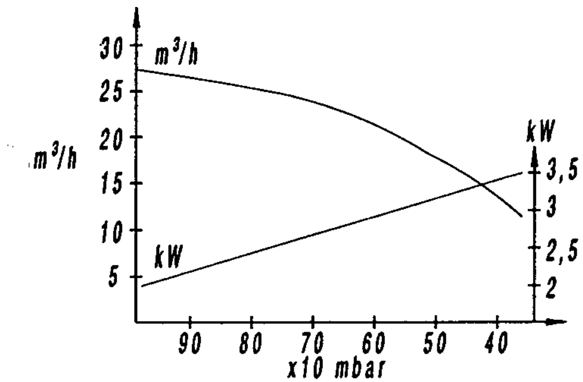
Capacity:	26m^3/hr
Flushing capacity at 50 Hz: .	190 flushes/hr
Flushing capacity a 60 Hz: ..	240 flushes/hr
Outside dimentions:	200 x 692 x 275 (WxLxH)
Electric motor:	MEZ 7BA 100L02
Rotor housing material:	Stainless steel AISI 316
Pump rotor material:	Stainless steel AISI 316
Pump knives material:	Stainless steel AISI 420
Pump shaft material:	Stainless steel AISI 316
Connection, inlet:	DN 50, PN 10
Connection outlet:	DN 32, PN 10
Connection, liquid seal:	1/2" BSP, inside threads
Sealing liquid demand:	4 litres/minute
Total weight:	66 kg
Part number:	023280000

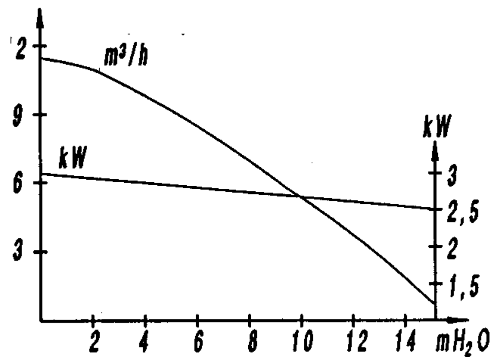


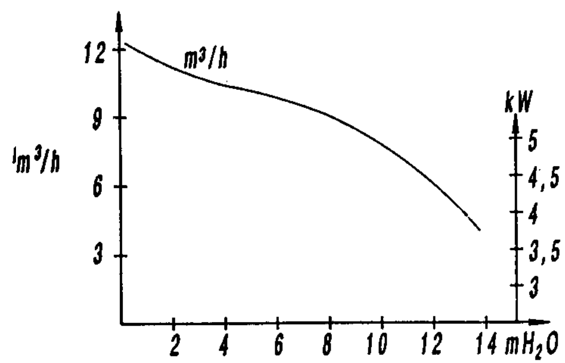
Operating Data

	50Hz	60Hz
Speed (nom.)	2.880 Rpm	3.456 Rpm
Power connections (nom.)	3 x 220 V/3 x 380 V	3 x 254 V/3 x 440 V
Power consumption (nom.)	3,0 kW	3,45 kW
Current consumption (220 V)	11,5 A	
Current consumption (380 V)	6,6 A	
Current consumption (254 V)		11,0 A
Current consumption (440 V)		6,4 A
Power factor (nom.)	0,73	0,73

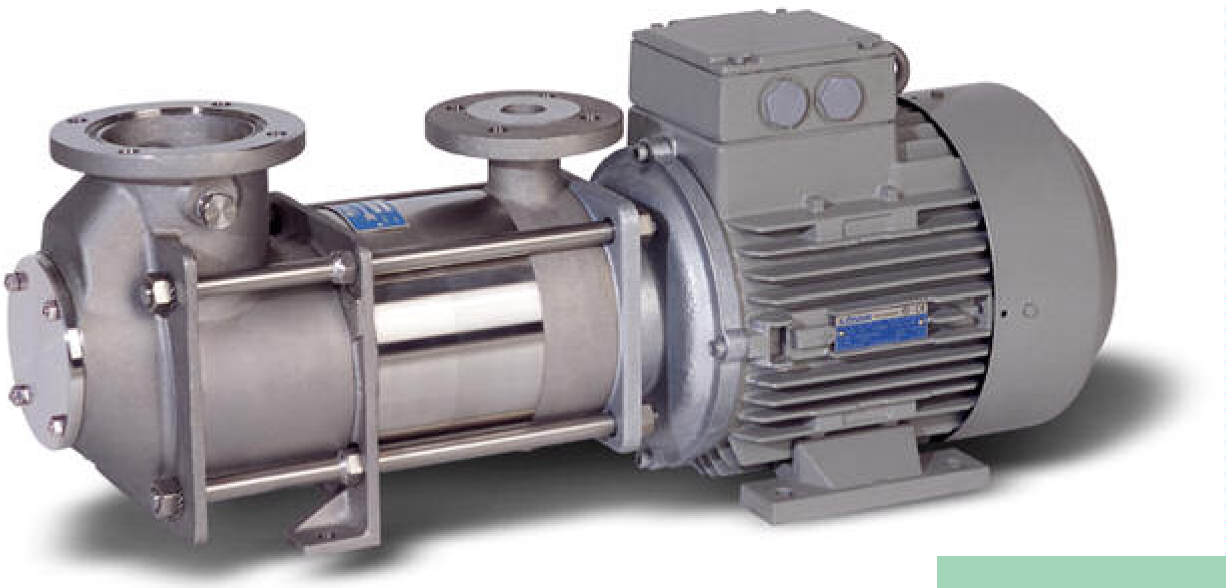








Vacuumarator JETS 25MB-D



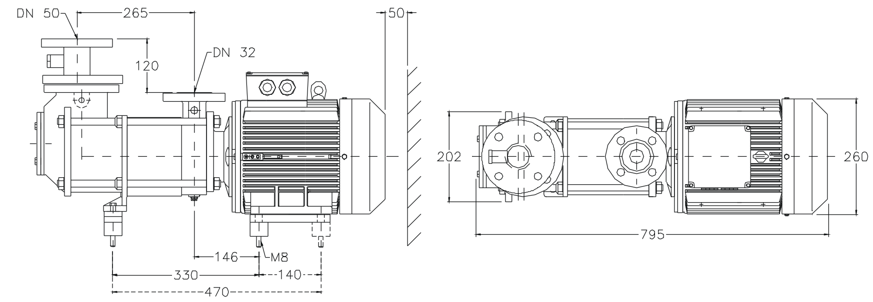
The patented Jets Vacuumarator
- creates vacuum
- macerates sewage
- pumps sewage

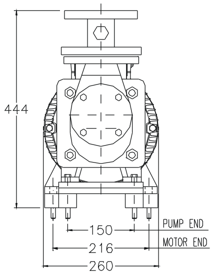
Designed for direct connection to any kind of sewage treatment plant.
Outlet can also be connected to gravity piping or holding tank.

Technical Data

Capacity:	$26m^3/hr$
Flushing capacity at 50 Hz:	190 flushes/hr
Flushing capacity a 60 Hz:	240 flushes/hr
Outside dimentions:	260 x 795 x 444 (WxLxH)
Electric motor:	MEZ 7BA 132 SO 2K
Rotor housing material:	Stainless steel AISI 316
Pump rotor material:	Stainless steel AISI 316
Pump knives material:	Stainless steel AISI 420
Pump shaft material:	Stainless steel AISI 316
Connection inlet	DN 50, PN 10
Connection outlet:	DN 32, PN 10
Connection, liquid seal:	1/2” BSP, inside threads
Sealing liquid demand:	4 litres/minute
Total weight:	102 kg
Part number:	024250000

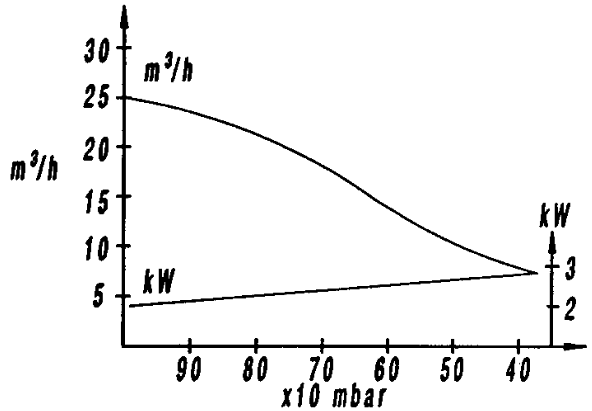
Vacuumarator JETS 25MB-D

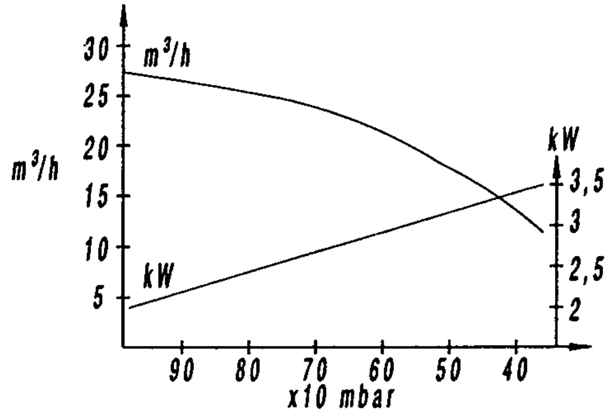


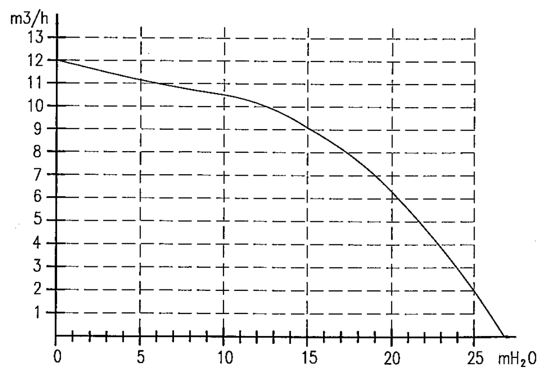


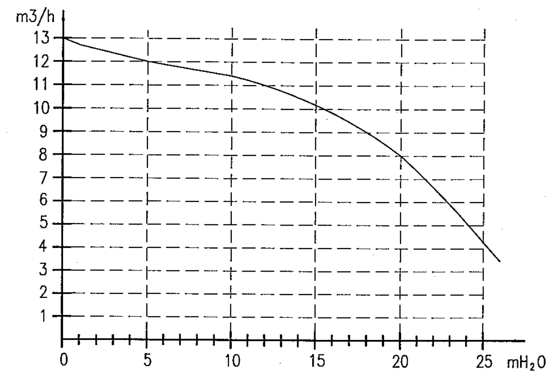
Operating Data

	50 Hz	60 Hz
Speed (nom.)	2980 Rpm	3510 Rpm
Power connections (nom.)	400 V alt. 230 V 3-phase	440 V 3-phase
Power consumption (nom.)	5,5 kW	6,75 kW
Current consumption (nom.)	10,8 A alt. 18,7 A at 230 V	12 A
Power factor (nom.)	0,86	0,84

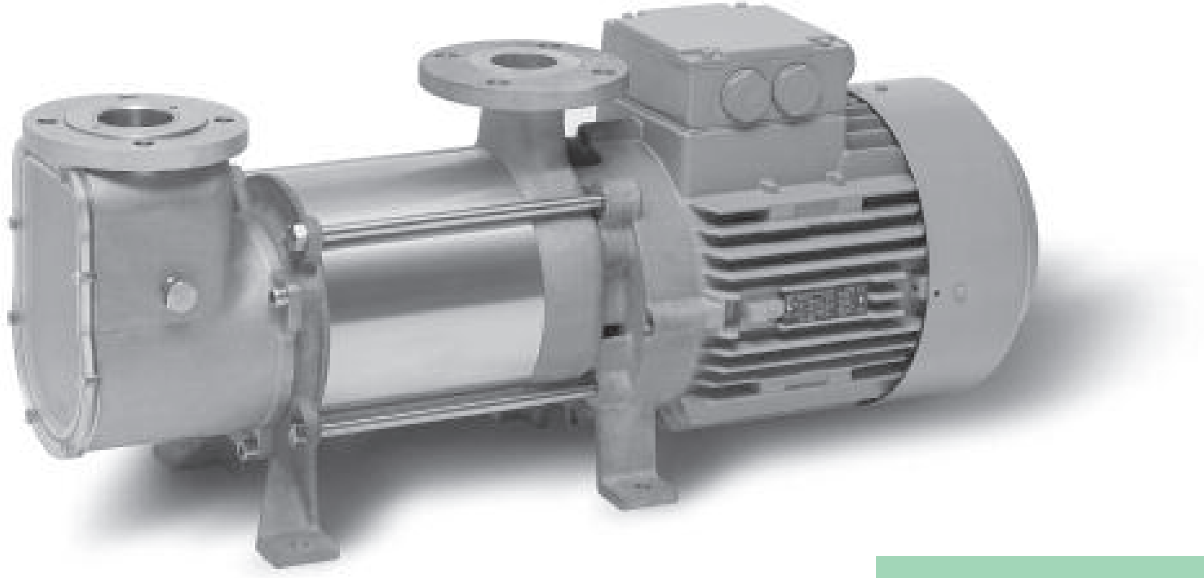








Vacuumarator JETS 65MBA

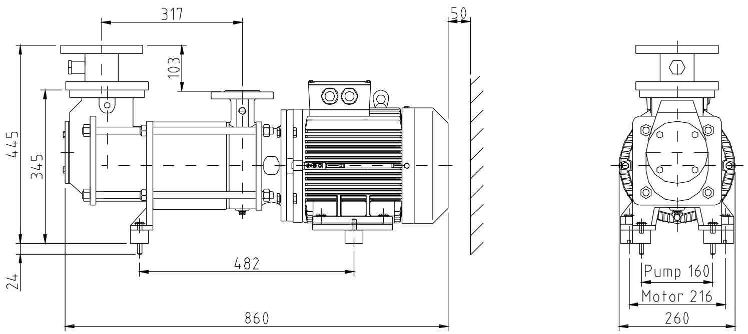


The patented Jets Vacuumarator
- creates vacuum
- macerates sewage
- pumps sewage

Designed for direct connection to any kind of sewage treatment plant.
Outlet can also be connected to gravity piping or holding tank.

Technical Data

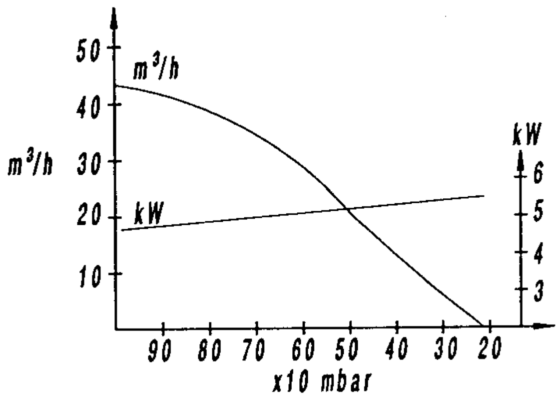
Capacity:	60m³/hr
Flushing capacity at 50 Hz:	520 flushes/hr
Flushing capacity at 60 Hz:	600 flushes/hr
Outside dimentions:	263 x 818 x 336 (W x L x H)
Electric motor:	MEZ 7BA 132 SO 2K
Rotor housing material:	Stainless steel AISI 316
Pump rotor material:	Stainless steel AISI 316
Pump knives material:	Stainless steel AISI 420
Pump shaft material:	Stainless steel AISI 316
Connection, inlet	DN 65, PN 10
Connection, outlet:	DN 32, PN 10
Connection, liquid seal:	1/2” BSP, inside threads
Total weight:	97 kg
Part number, Vacuumarator	02A100101
Part number, el. motor	See Data Sheet No. 3123



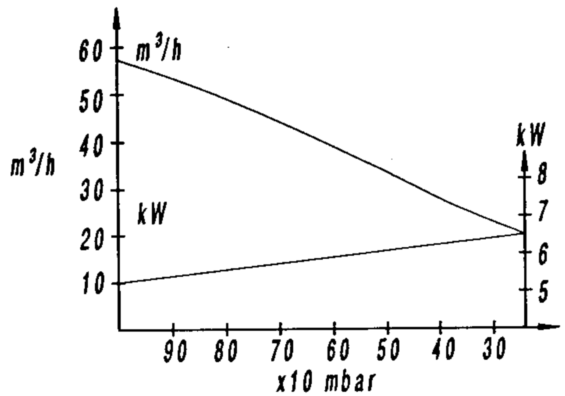
Operating Data

	50Hz	60Hz
Speed (nom.)	2.980 r.p.m	3.510 r.p.m.
Power connections (nom.)	400 V alt. 230 V - 3 phase	400 V alt. 230 V - 3 phase
Power consumption (nom.)	5,5 kW	6,75 kW
Current consumption (nom.)	10,5 A alt. 18,7 A at 230 V	12 A
Power factor (nom.)	0,86	0,84

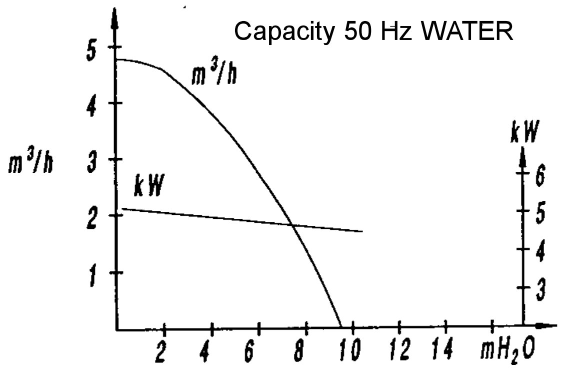
Capacity 50 Hz AIR



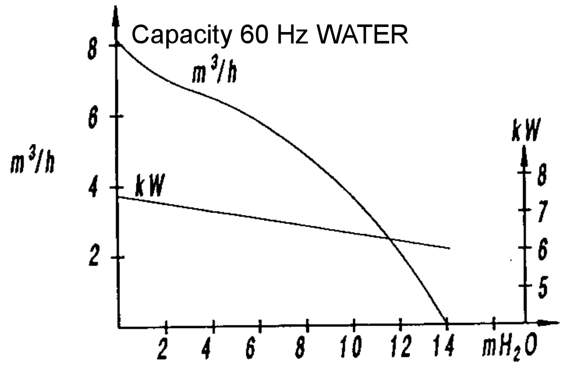
Capacity 60 Hz AIR



Capacity 50 Hz WATER



Capacity 60 Hz WATER



General

Jets offers a range of wall as well as floor mounted toilets in high quality vitreous china. Models in stainless steel are also available.

Toilet operating mechanisms are available in 3 different types and this chapter provides information about the various operating principles as well as data sheets for the various models available.

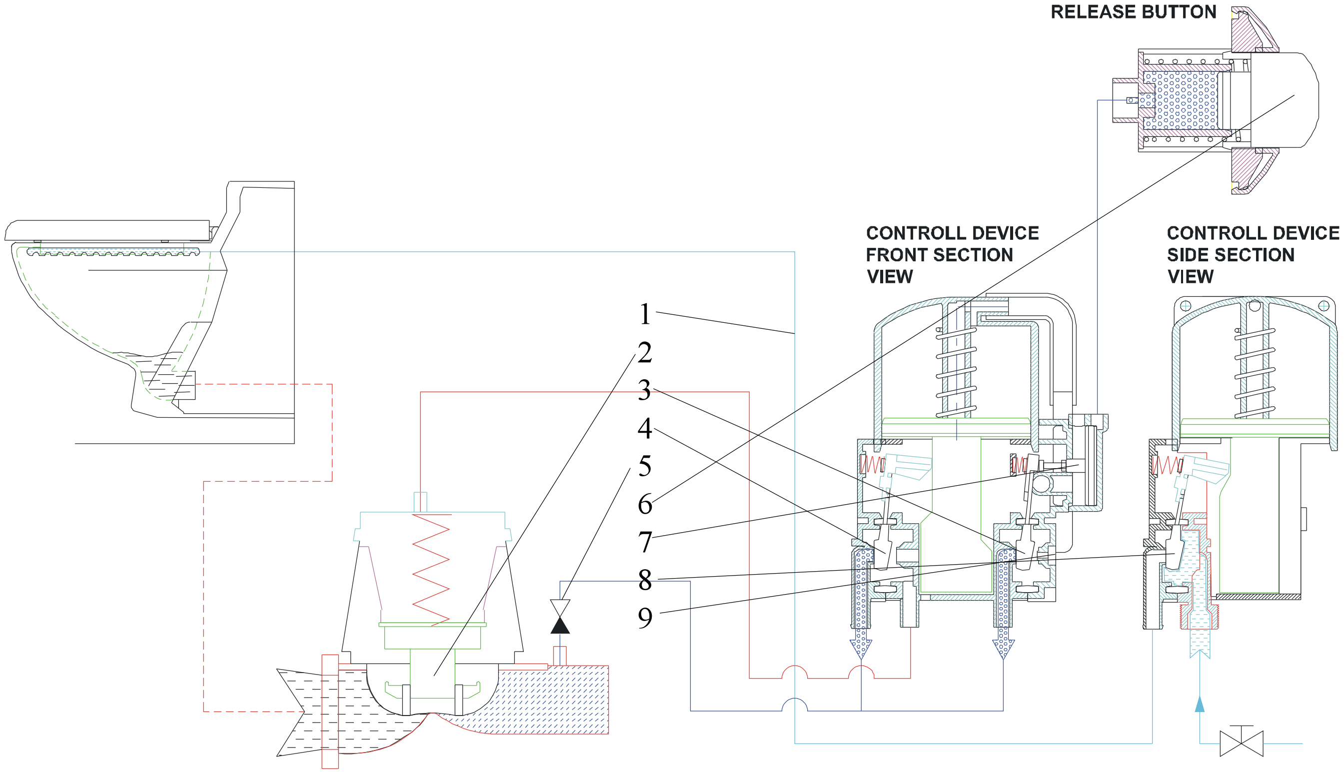
Common for all Jets toilets is the simplicity and reliability of the operating mechanisms.

Content chapter 3; Toilets

Mode of operation Jets FD Valve VPC

Mode of operation Jets FD valve VPC with cam controller and air release button

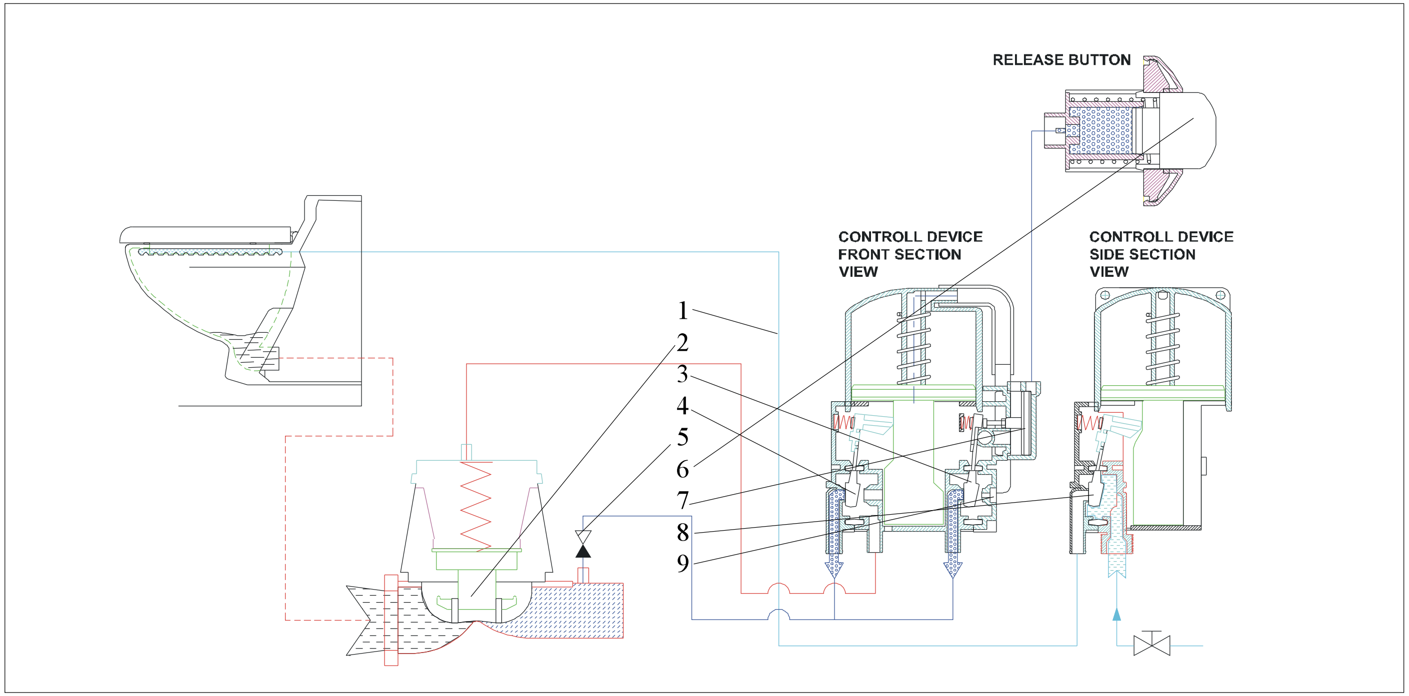
1. Flushing ring hose	*6. Release button*
2. FD valve	*7. Starting piston, cam controller*
3. Starting valve, cam controller	*8. Water valve*
4. Control valve FD Valve	*9. Air orifice, main cylinder*
5. NR-valve	



Mode of operation Jets FD Valve VPC

Normal position:

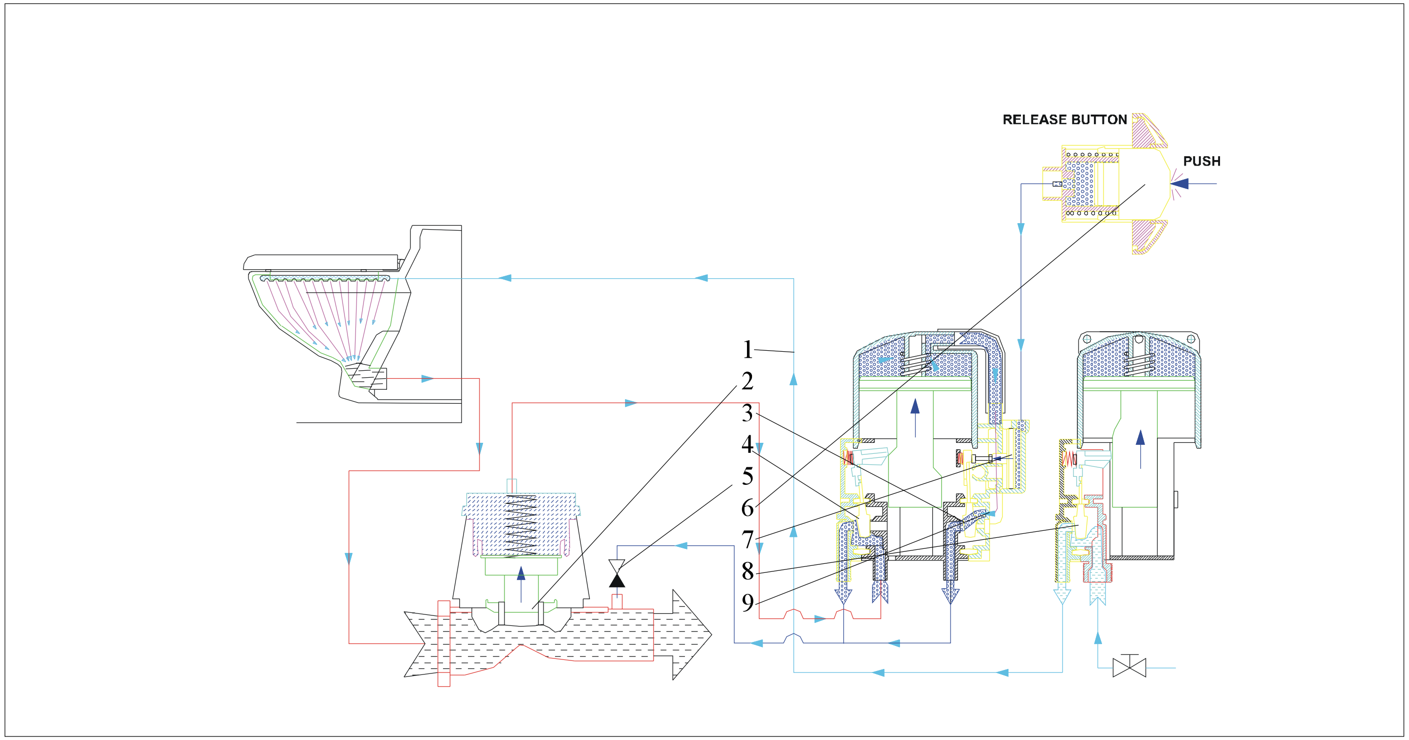
The *FD Valve (2)* is in closed position with water in the toilet and vaccum in the pipe system. There is vaccum in the hoses leading to the *starting valve, cam controller (3)* and the *control valve. (4).*
The *water valve (8)* is in closed position.



Mode of operation Jets FD Valve VPC

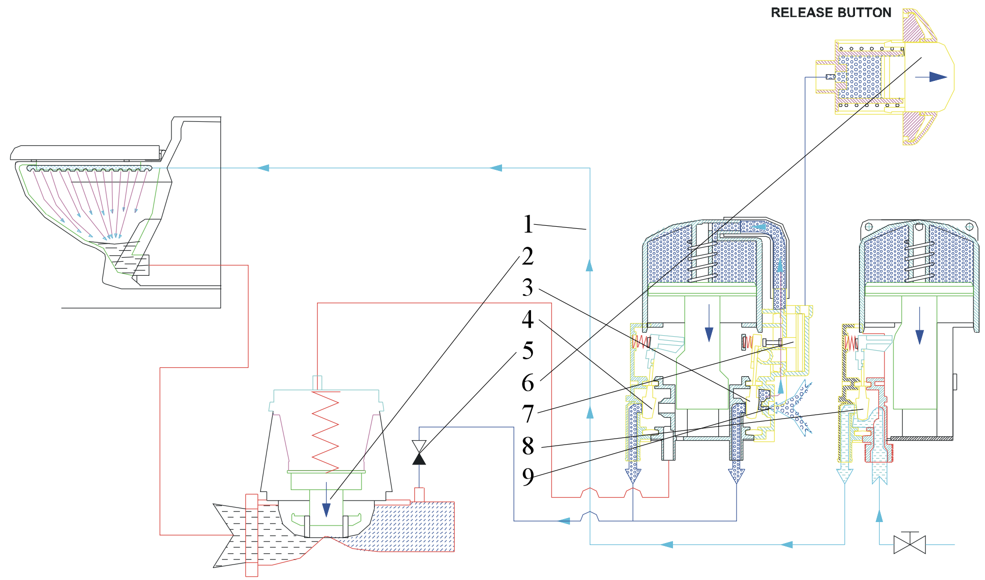
Emptying sequence:

When the *release button (6)* is activated, the air inside this is compressed. The pressure then occuring will be transferred via a hose to the *piston (7)* in the starting cylinder, cam controller .
The piston will be pressed in, leading to the opening of the *starting valve, cam controller (3)*.
This opens for vacuum above the main piston in the cam controller. The piston will be pulled from resting position in lower position to full open.
When the main piston moves upwards, the cam of *the water valve (8)* will open the valve, and water is flushed into the toilet through the *flushing ring hose (1)*.
During the same movement of the piston, *the control valve, FD valve (4)* will open and vacuum will be added above the lifting diaphragm.. This leads to compression of the spring, the *FD valve (2)* will open, and the emptying of the toilet will begin.



Final sequence:

The air pressure inside the *release button (6)* disappears. This is brought about either by letting go of the *release button (6)*, or by air being drained through an orifice in the piston.
The *starting piston, cam controller (7)* will return to resting position due to spring pressure and the *starting valve, cam controller (3)* will be closed. On the cam controller piston's way towards lower position (after approximately 2 seconds) the *control valve, FD valve (4)* will close for the vacuum and open for air to the *FD valve (2).* The membrane guide will be pressed down by the spring pressure and close for the vacuum, simultaneously by opening for air above the lifting diaphragm in the *FD valve (2).* The emptying of the toilet is finished.
Just before the main piston in the cam steering reaches its lower position (after approximately 5 seconds), the *water valve (8)* will close and the water supply to the toilet is shut off.



Mode of operation

Jets EFD-valve consists of the following main components:
A : 3-way solenoid valve air/vacuum
B : Solenoid valve flushing water
Freshwater only
C : Non return valve
D : Lifting yoke
E : Toilet bowl
F : Electronic control
G : Diaphragm chamber
H : Shut-off diaphragm
I : Spring helical

Figure 1 Deactivated

The solenoid valves are closed and shut-off diaphragm (H) is in closed position.

Figure 2 Flushing and discharge

The flushing release button activates the electronic control (F) which opens the solenoid valves. Solenoid valve (B) opens for the water to flush the toilet bowl (E). Solenoid valve (A) opens for the air in the diaphragm chamber (G) and evacuates it into the vacuum pipe. The vacuum in the diaphragm chamber lifts the shut-off diaphragm (H) and the content in the toilet bowl is effectively discharged into the vacuum pipeline.

After two seconds the solenoid valve (A) closes off the vacuum to the pipeline and opens to the atmosphere. The air enters into the diaphragm chamber (G) and the pressure equalizes. The spring helical (I) brings the shut-off diaphragm back to closed position.

Figure 3 Flushing

Solenoid valve (B) continues to flush water into the bowl for 3 more seconds.

After the solenoid valve is closed the EFD-valve is ready for a new flushing

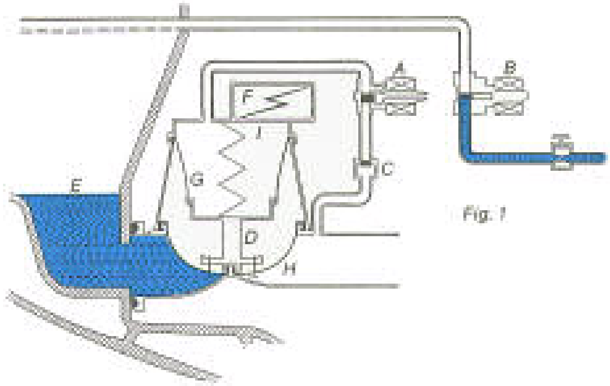


Fig. 1

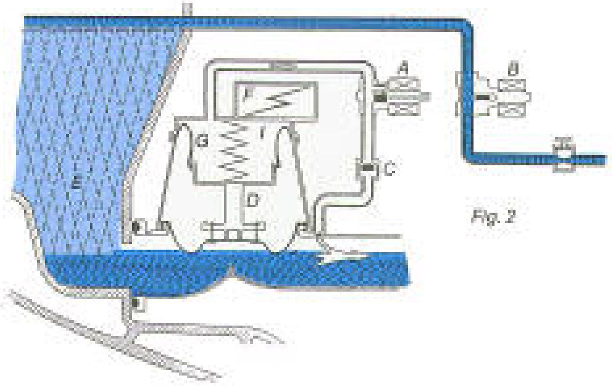


Fig. 2

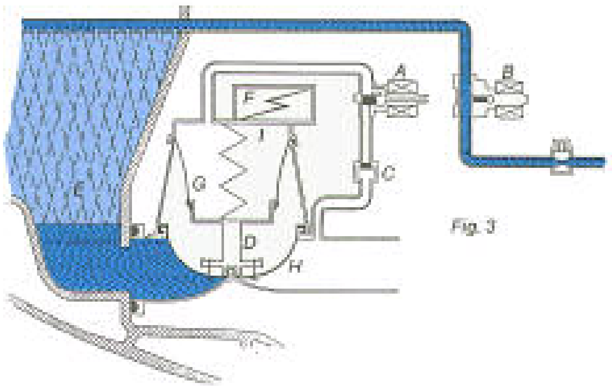


Fig. 3

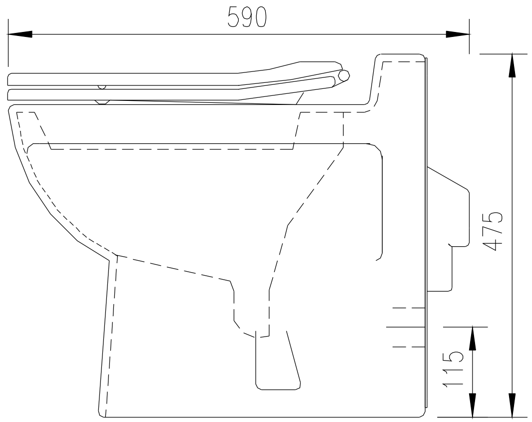
Toilet Jets 50 FD-VPC

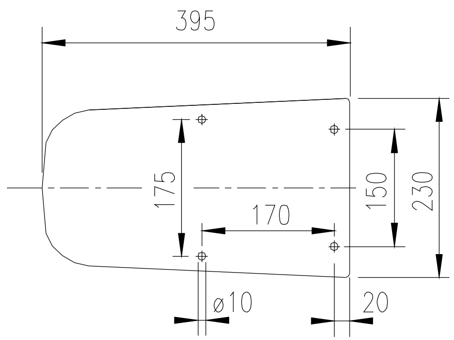
JETS 50 is a floor model
Vacuum toilet in a modern design.
The toilet is equipped with the JETS FD-valve-VPC controller, pneumatic operated, featuring low water consumption, reliable flushing and discharge.

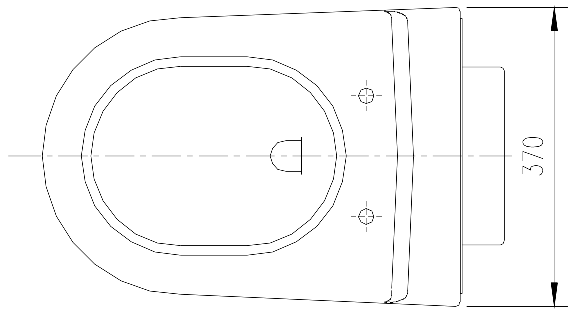
Technical Data

Outside dimensions:	370 x 590 x 475 (W x L x H)
Bowl material:	Vitreous china
Bowl weight net:	17,6 kg
Total weight:	22,2 kg
Water connection:	BSP 1/2” male ball valve
Discharge outlet:	Outside diameter Ø 50mm
Seat & Cover:	Flora
Part no.:	063604900

Toilet Jets 50 FD-VPC







Operating data

Flushing time: .... Adjustable (5 seconds)
Discharge time: .... Adjustable (2 seconds)
Water pressure: .... 2-7 bar
Operating vacuum: .... 500-700 mbar
Water consumption .... Adjustable 1,2 litres)
Air consumption: .... Adjustable (Appr. 60 litres at 500 mbar)

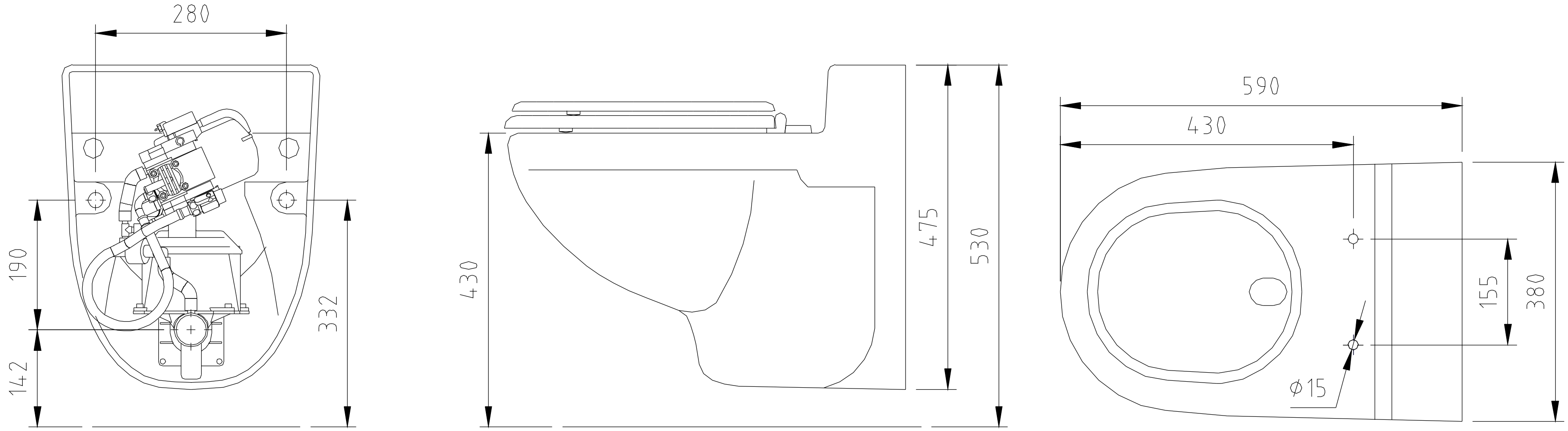
Toilet Jets 64 FD-VPC

JETS 64 is a wall model vacuum toilet in a modern design. The toilet is equipped with the JETS FD-Valve- VPC controller, pneumatic operated, featuring low water consumption, reliable flushing and discharge.

Technical Data

Outside dimensions:	380 x 590 x 475 (W x L x H)
Bowl material:	Vitreous china
Bowl weight net:	18,2 kg
Total weight:	22,6 kg
Water connection:	BSP 1/2" male ball valve
Discharge outlet:	Outside diameter Ø 50mm
Seat & cover:	Bemis
Part no.:	064100030

Toilet Jets 64 FD-VPC



Operating data

Flushing time: .... Adjustable (5 seconds)
Discharge time: .... Adjustable (2 seconds)
Water pressure: .... 2-7 bar
Operating vacuum: .... 500-700 mbar
Water consumption ...... Adjustable 1,2 litres)
Air consumption: .... Adjustable (Appr. 60 litres at 500 mbar)

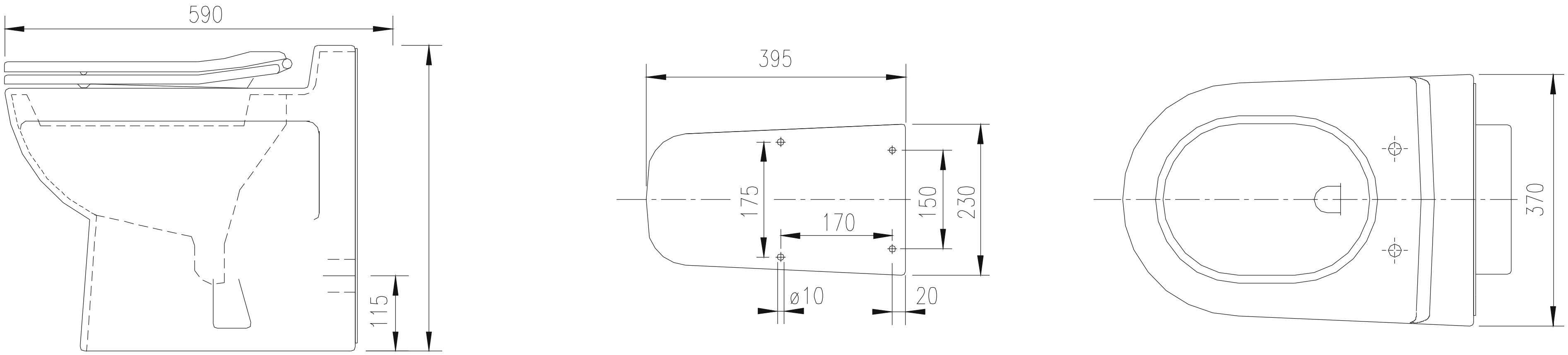
Toilet Jets 50 EFD

JETS 50 is a floor model
Vacuum toilet in a modern design.
The toilet is equipped with the JETS EFD, featuring low water consumption, reliable flushing and discharge.

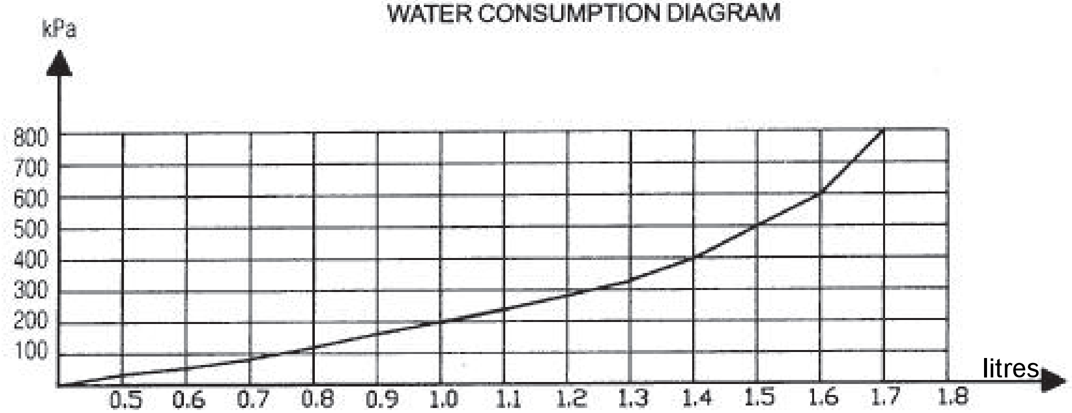
Technical Data

Outside dimensions:	380 x 535 x 465 (W x L x H)
Bowl material:	Vitreous china
Bowl weight net:	16,6 kg
Total weight:	22,3 kg
Power connection:	Flexible rubber cable and plug
Water connection:	BSP 1/2” male ball valve
Discharge outlet:	Outside diameter Ø 50mm
Part no. (230V):	063604300
Part no. (115V):	063604400
Part no. (24V):	063604800
Part no. (36V):	063608500

Toilet Jets 50 EFD



WATER CONSUMPTION DIAGRAM



Operating data

Power supply:............. 230V alt 115V 50/60Hz
Power supply............. 24 VDC
Power supply............. 36 VDC
Power consumption: .. 36 W during flushing and discharge
Flushing time: .... 5 seconds
Discharge time: .... Adjustable (2 seconds)
Water pressure: .... 100 - 800 kPa
Water consumption: ... According to diagram
Operating vacuum: ..... 500-700 mbar
Air consumption: .... Appr. 60 litres at 101 kPa

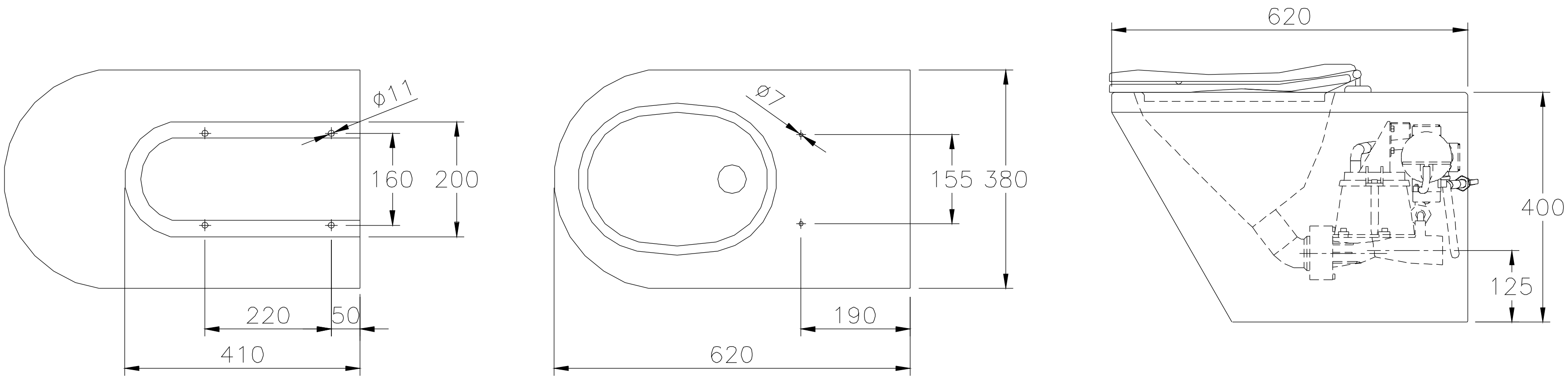
Toilet Jets 60 FD-VPC

JETS 60 is a floor model
Vacuum toilet in a stainless steel design.
JETS 60 is equipped with the Jets FD valve - VPC controller,
featuring low water consumption, reliable flushing and discharge.

Technical Data

Outside dimentions:	380 x 620 x 400 mm (W x L x H)
Bowl material:.........................	Stainless steel
Seat and cover:	Viking 94
Bowl weight net:	14,0 kg
Total weight:	19,0 kg
Water connection:	BSP ½" male ball valve
Discharge outlet:	Outside diameter Ø 50 mm
Part no.:	065605000

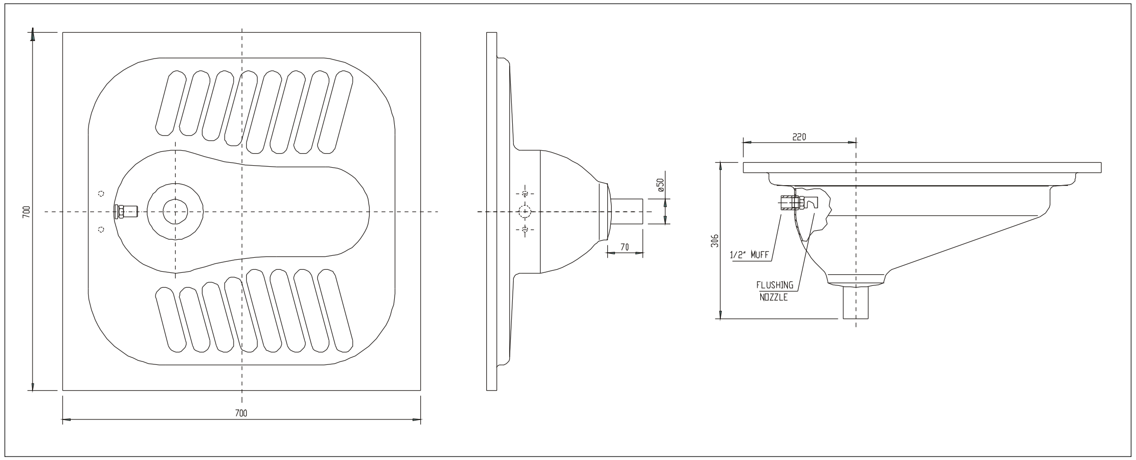
Toilet Jets 60 FD-VPC



Operating data

Flushing time: .... Adjustable (5 seconds)
Discharge time: .... Adjustable (2 seconds)
Water pressure: .... 2-7 bar
Operating vacuum: .... 500-700 mbar
Water consumption .... Adjustable 1,2 litres)
Air consumption: .... Adjustable (Appr. 60 litres at 500 mbar)

Squat pan is also called Asian type toilet and is installed when this type of toilet is required.
Jets squat pan allows for an easy installation and the used of the same toilet operating mechanism used in the other Jets toilets.



General

Jets offers two different solutions for interfacing urinals with a Vacuum system.
One solution is to connect the urinal to a valve mechanism as used in toilets . Operation is via a wall releaser and the flushing water is controlled by the valve mechanism.

The other solution is to use an interface unit identical with one of the grey water units.

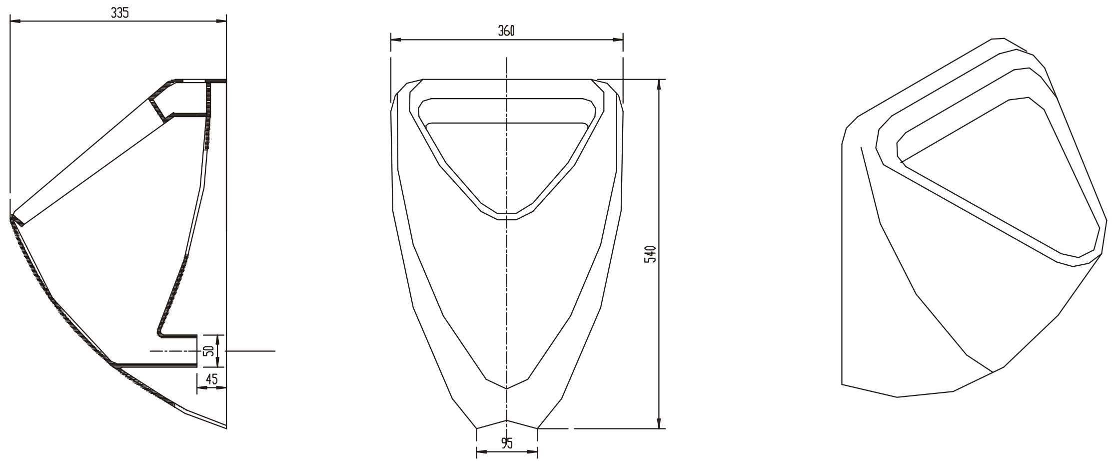
Flushing can in this case either be by conventional urinal flushers or via an automatic flushing device.

The solution to be used depends upon installation and number of urinals in the same location.
In both solutions conventional urinals can be used.

Jets urinals are available in vitreous china as well as in stainless steel.

Content chapter 4; Urinal

Dimensions



Jets 70 and 75 Urinals are designed for integration into Jets Vacuum sanitation systems. The urinal is connected by down pipes to a gravity/vacuum interface tank. This tank is equipped with a Jets EFD-valve that discharge the content into the vacuum sewerage system and controls the flushing of the urinals.
Urinals can also be connected to a Jets ED-valve (without flushing control).

Flushing:
Single-urinal systems will be delivered with manual activation. (Push-button on the wall.)
Multi-urinals will be delivered with a photo-electric activation system.

Other arrangements can also be delivered.

Technical Data

Dimensions: .... 360 x 540 x 335 mm (W x H x D)
Weight: .... 11,2 kg
Material: .... White vitreous china
Part no. Jets 70: .... 070702100 (Water inlet behind, through the wall)
Part no. Jets 75: .... 070702300 (Water inlet above)
Fixing set included
Part no.inlet garniture: 070700200

General

Water from washbasins, showers and washing machines (called grey water) is, on most ships, transported by gravity. In some installations however it can be difficult to arrange a proper gravitation. Interface with the Vacuum system can in such cases be a good solution.

Grey water must be introduced into the Vacuum system via a grey water interface unit. This unit consists of a tank (normally 16 ltr) connected via a valve to the Vacuum system.
Opening of the valve is activated by a level switch located inside the tank.

The grey water interface unit is an atmospheric tank which must be ventilated. Ventilation can either be arranged via a small diameter piping to the ventilation system or via a combined ventilation and non return valve fitted on the tank.

A 16 ltr. grey water interface unit can cater for all grey water from up to 4 cabins. For Washing machines a dedicated interface unit is recommended.

Large volumes of grey water in a Vacuum sanitation system can create problems. A correct piping installation will be of the utmost importance in order to avoid back flow and lack of transport. It is recommended to contact Jets for systems with large Volumes of grey water.

Content chapter 5; Grey water equipment

A grey water interface unit consists of a 16 ltr. Tank fitted with a level switch and an ED Interface valve. Grey water is lead to the tank by gravity and interfaced with the Vacuum system via the ED valve.
The valve is activated by the water level inside the tank. Opening time for air inlet after emptying is adjustable.

Technical Data

Tank:	AISI 304
Outside dimensions, total:	474 x 200 x 459 (l x w x h)
ED valve:	ABS housing with rubber diaphragms
Total weight:	11 kg
Power connection:	230 /115/ 24 Volt Flexible rubber cable and plug
Power consumption:	19 W during discharge
Enclosure:	IP 44
Discharge connection:	Pipe 50 mm outside discharge
Operating Vacuum:	500 - 700 mbar
Ventilation:	Either by pipe or by 2 way air admission valve

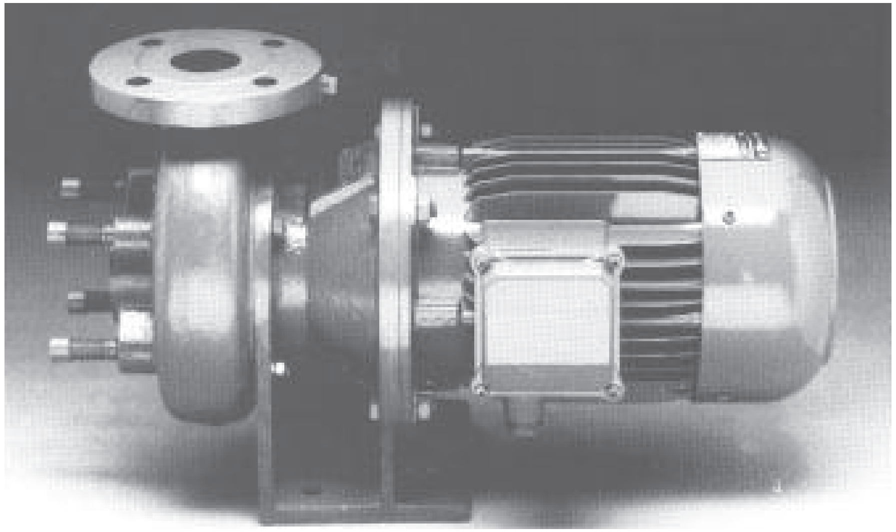
General

There is often a requirement for equipment in addition to the Vacuum toilets system.
Such equipment can be black water discharge pumps an level switches for collecting tanks.

Included here are additional equipment that we use as our standard. Alternatives for special requirements are available.

Content chapter 6; Additional equipment

Discharge Pump

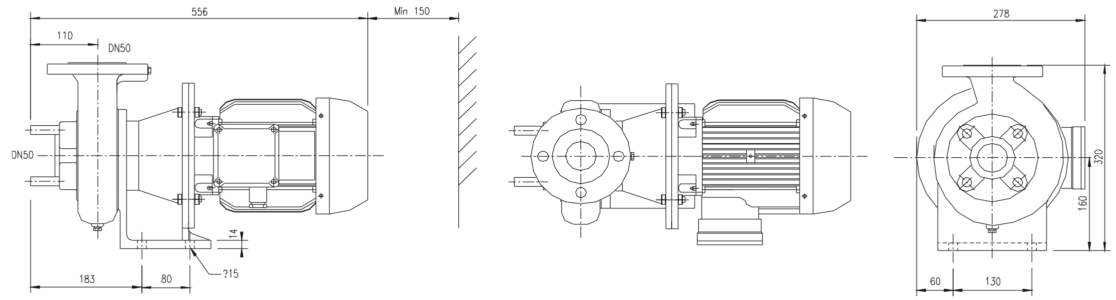


The Discharge Pump is a small, system-integrated, non-clogging centrifugal pump designed for discharging sewage from holding tanks or sewage treatment plants.

Technical data

Capacity: .... According to diagram
Outside dimensions: .... 278 x 516 x 320 (W x L x H)
Pump: .... Herborner 4/HK 50-F
Electric motor: .... AEG AM 100 LS 2
Pump housing material: .... Cast iron
Pump impellar material: .... Cast iron
Pump shaft material: .... Stainless steel 1.4571
Connection, inlet: .... DN 50, PN 10
Connection outlet: .... DN 50, PN 10
Total weight: .... 49 kg

Part number discharge pump complete with electrical motor:
Pump with Ø130 mm impeller: 028214100
Pump with Ø120 mm impeller: 028214200
Pump with Ø110 mm impeller:
230 V: 028214310
Pump with Ø110 mm impeller;
380 - 440 V 3-phase, 50-60 Hz: ... 028214300

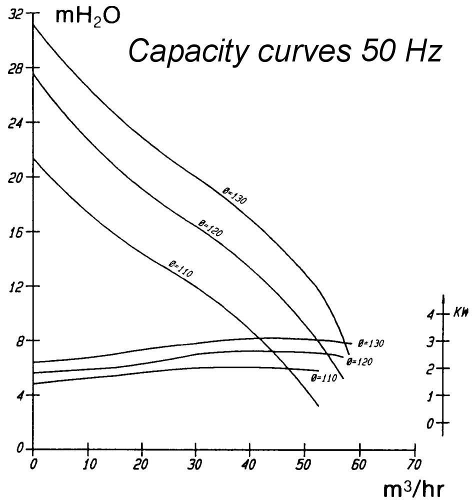


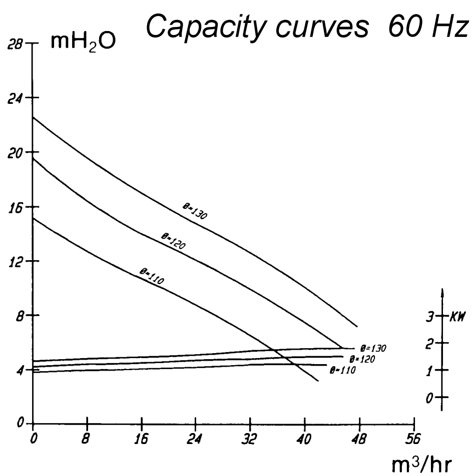
Operating Data

	50 Hz	60 Hz
Speed (nom.)	2.830 Rpm	3.420 Rpm
Power connection (nom.)	380 V - 3 phase	440 V - 3 phase
Power consumption (nom.)	2,9 kW	3,4 kW
Current consumption (nom.)	6,2 A	6,0 A

Technical data, motor

Type:	AEG AM LS20
Mounting:	B5
Frame size:	IEC 100
Enclosure:	IP 54
Insulation class:	B
Ambient temperature:	45° C DnV
Power factor (nom.)	0,87
Connection 380 V/440 V:	Delta





General

Correct installed piping is of vital importance for a Vacuum system. Results of incorrect piping can be back flow and blockages.

A system with pipes from toilets and interface units in downward direction is always recommended. However as lift is also possible the focus of this chapter will mainly be on the special precautions required for such installations.

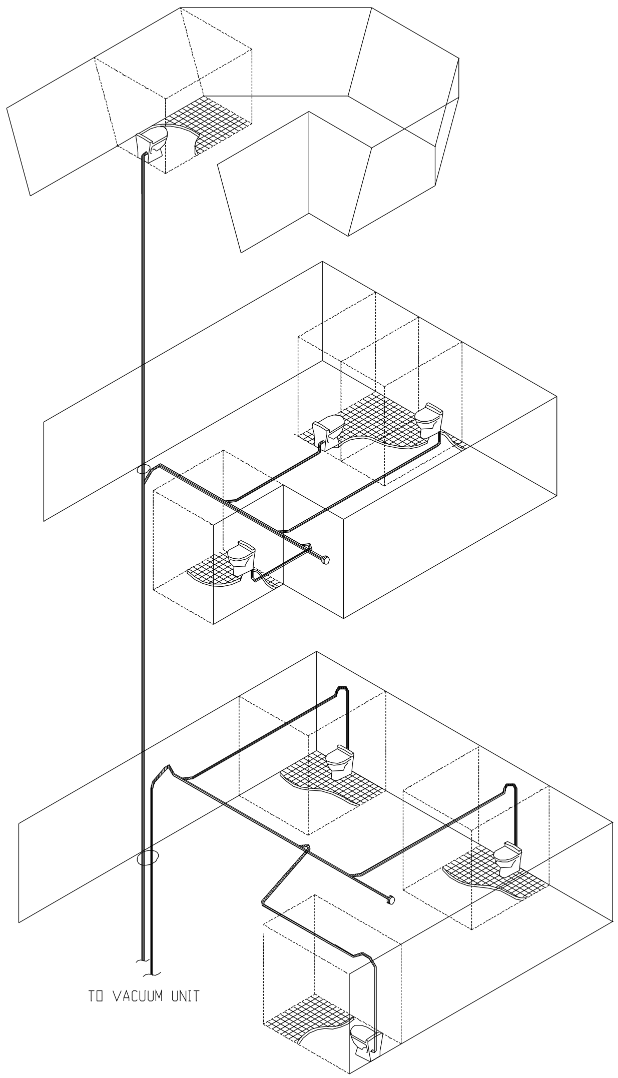
This chapter gives a set of guidelines for piping also including recommendations for pipe diameters.

Jets equipment combined with a well executed piping will ensure trouble free operation of the Vacuum system.

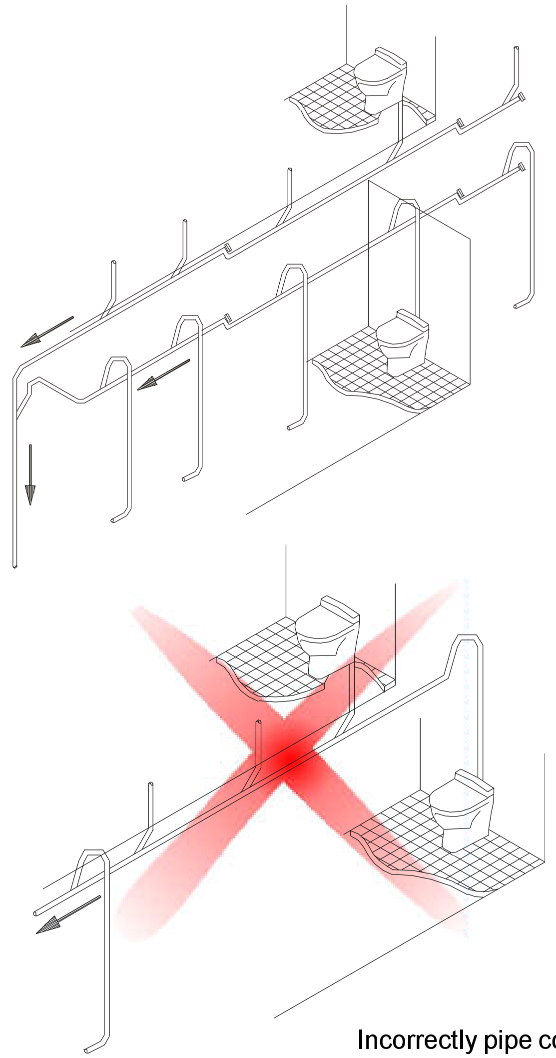
Jets will be happy to provide with expert assistance and comments to your piping diagrams and layouts.

Content Vacuum piping

Vacuum sewage system layout

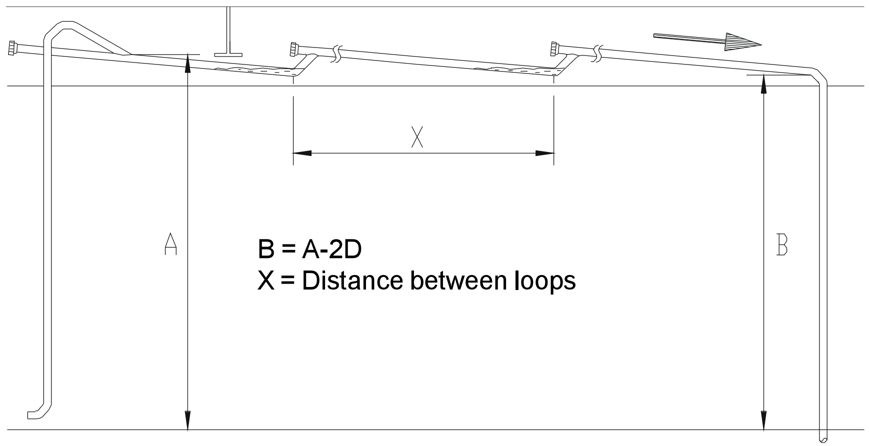


Pipe connections for two decks



Horizontal pipes

In horizontal pipelines onboard a vessel, there is always a possibility for backflow due to trim or list of vessel. Loops and traps to be installed to prevent such problems.



Loops to be arranged depending on

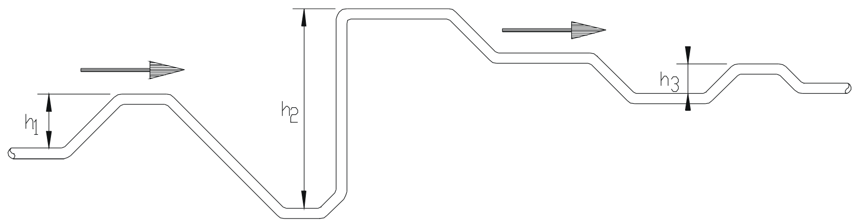
- Length of pipeline
- Trim
- List (If transverse pipeline exceeds 7m)

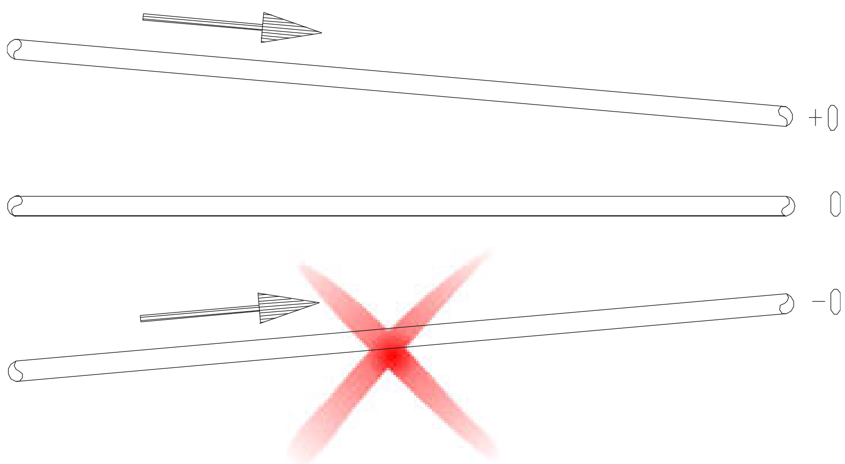
Recommended distance for

- Small fishing vessel: X = 5m
- Factory vessel: X = 10m
- Large vessel (cruise): X = 15m

Total height of rising pipes must not exceed 4 m. (Descending parts can not be subtracted.)

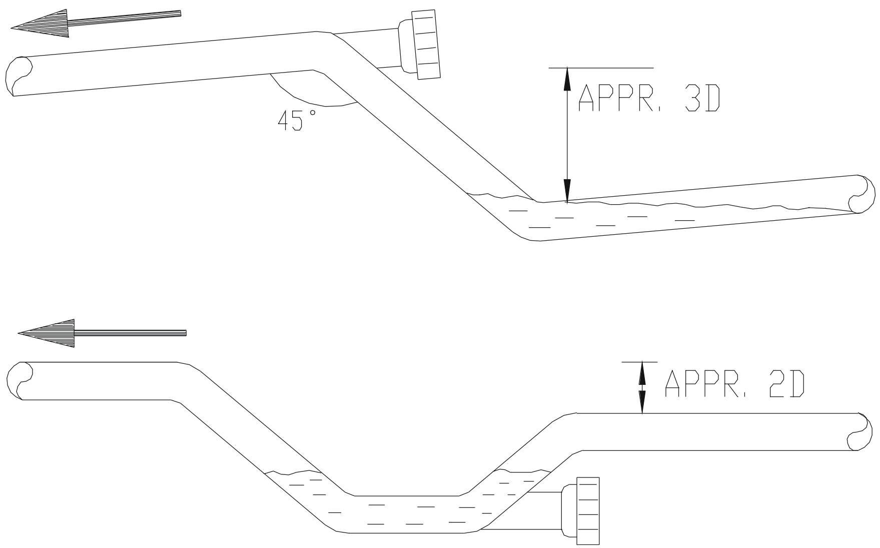
$h_1 + h_2 + h_3 + h_n < 4m$





Horizontal pipes to be installed horizontally or downwards in the direction of flow.
Never upwards!

Traps and loops

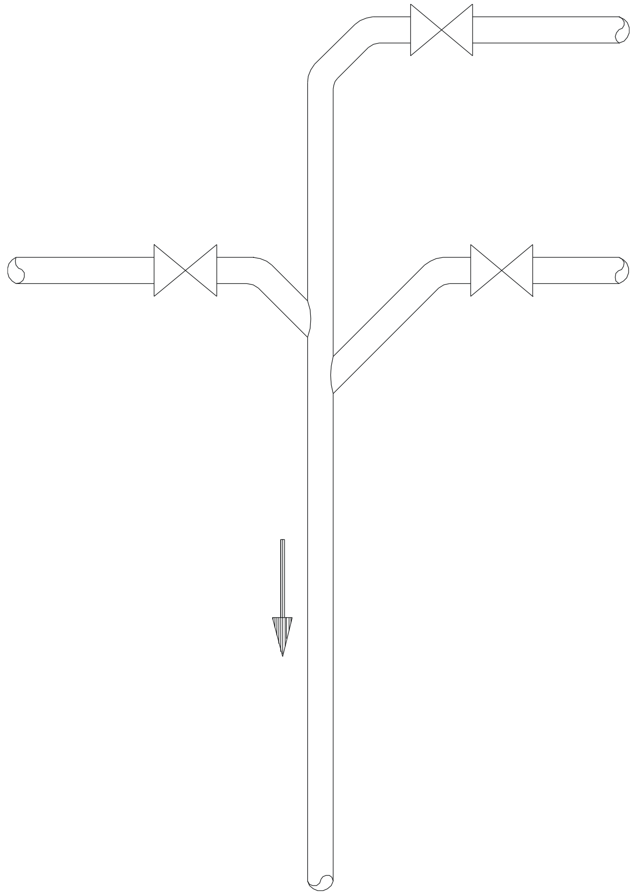


Important to remember:
- Trim of ship
- Total lenght of pipe branch
- Slooping

Valves

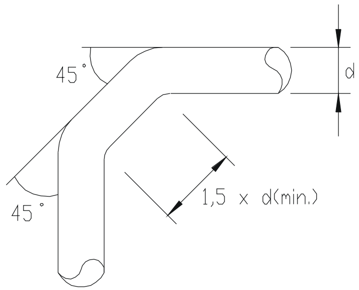
For servicing Your pipelines.
We recommend to have valves for each branch.

All valves need access!

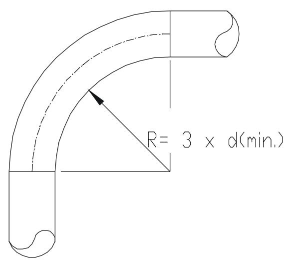


Bends

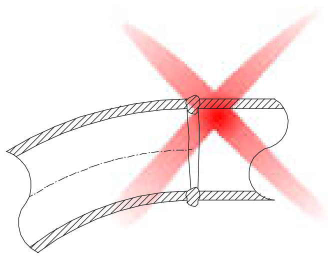
Bends to be made with a large radius of curvature.



For plastic pipes, minimum radius to be 2 x D, or a 90° bend made of two 45° bend pieces.

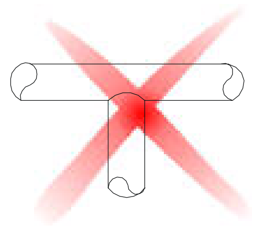


For steel pipes, minimum bend radius to be 3 x D

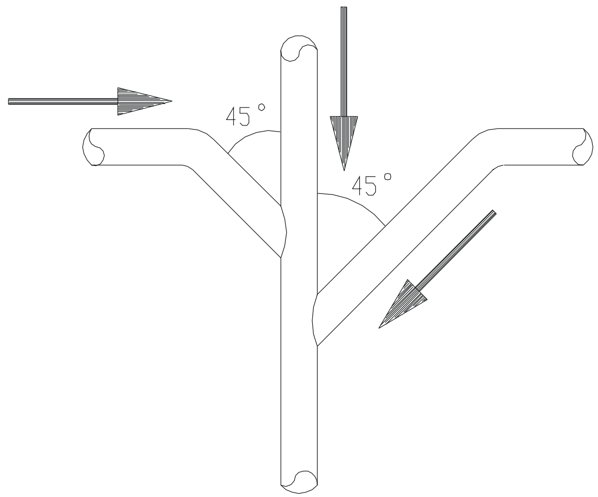


Inside of pipes and fittings to be smooth and without obstructions to avoid clogging.

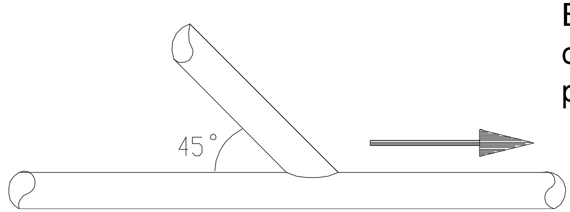
Branches



T-branches not to be used.

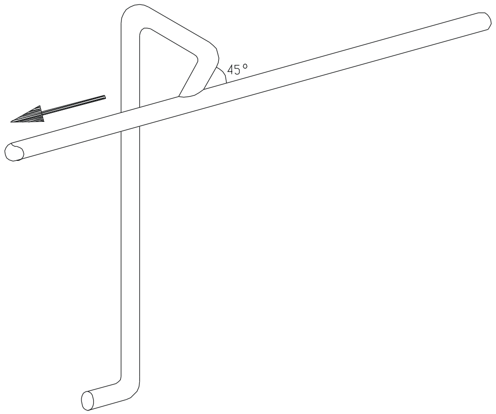


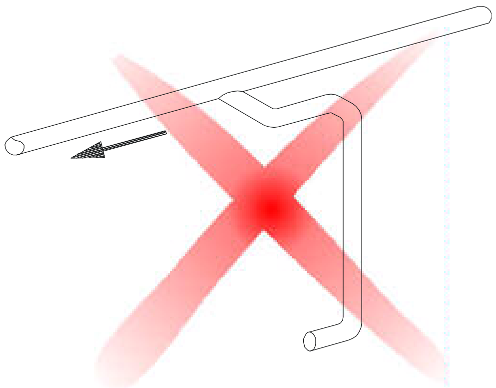
Branch pipes to be connected to main pipes with an angle of 45° between the directions of flow.



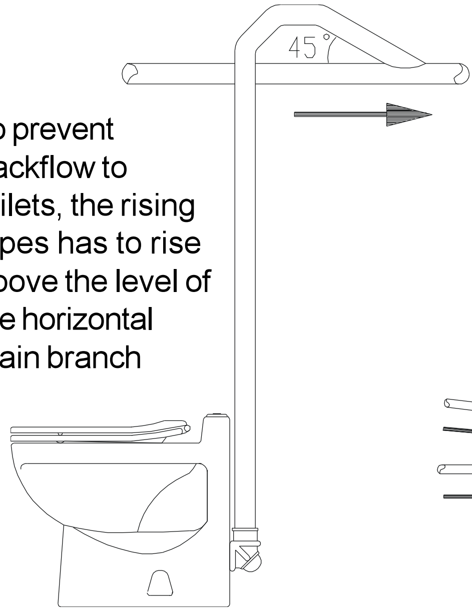
Branch pipes to be connected to main pipe from above.

Connecting to vacuum main branch

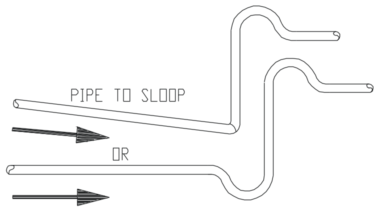




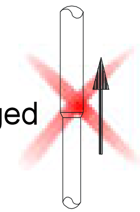
Rising pipes

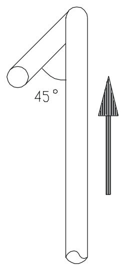


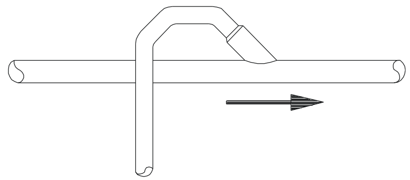
To prevent backflow to toilets, the rising pipes has to rise above the level of the horizontal main branch



The diameter of rising pipe must not be enlarged in the rising part.

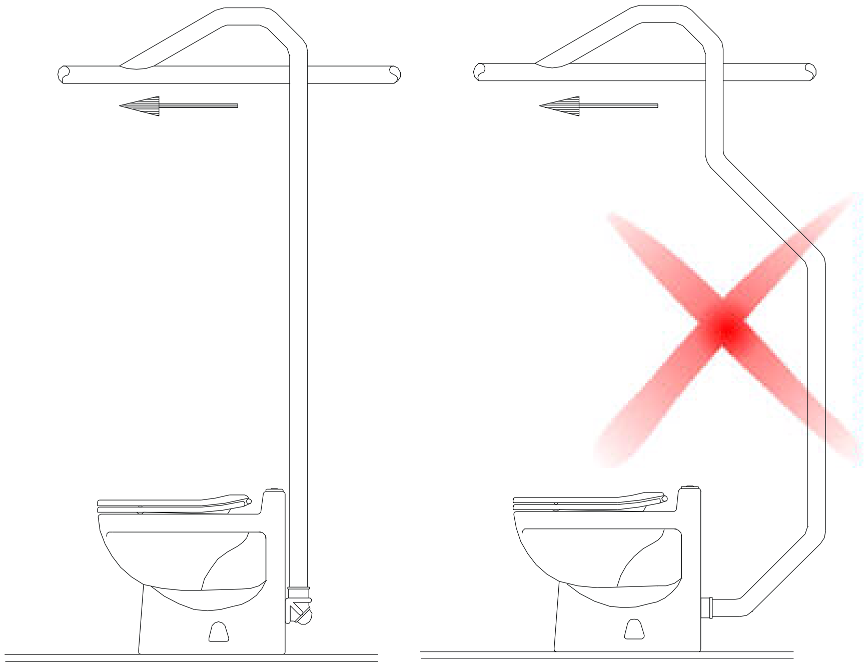




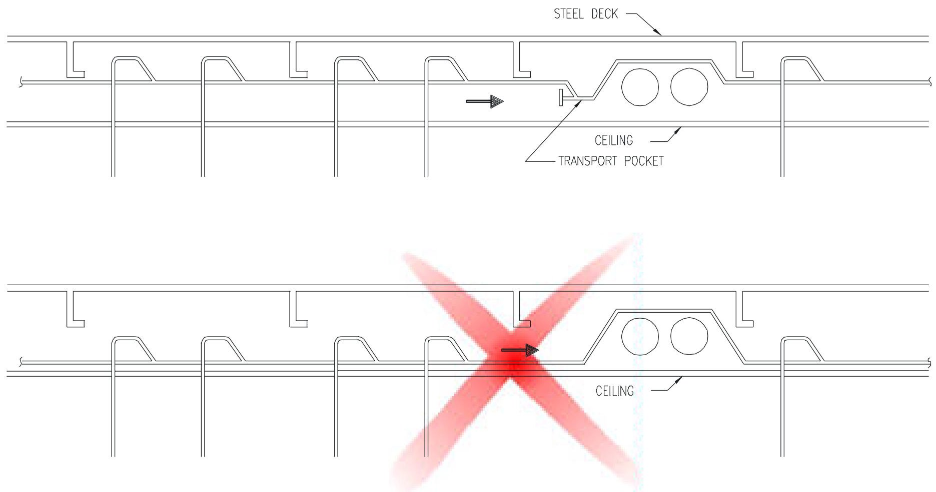


Vertcal pipes

Vertical pipe connections are to be straight running

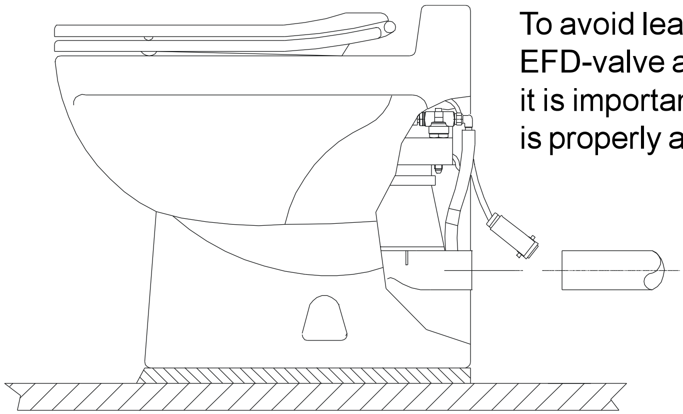


Rising pipes - connection to pipe branch

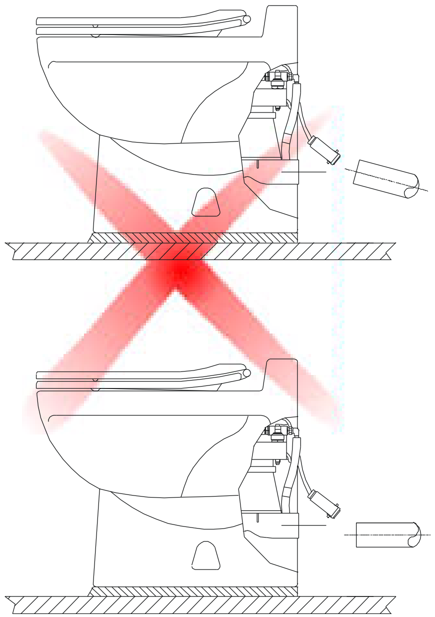


Never connect toilets to low points!

Alignment of pipe to EFD-valve

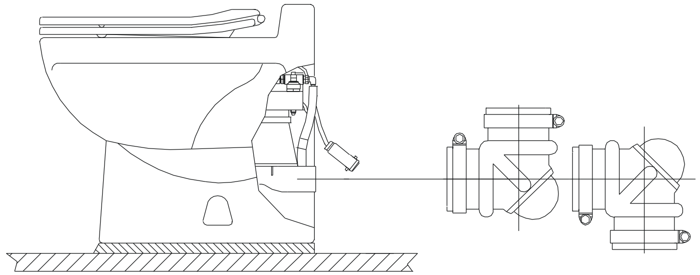


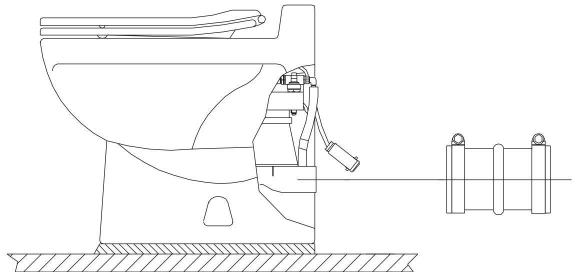
To avoid leakage between EFD-valve and toilet bowl, it is important that the pipe is properly aligned.



If the force of bending is too high because of dis-alignment, leakage between the EFD-valve and the bowl will occur.

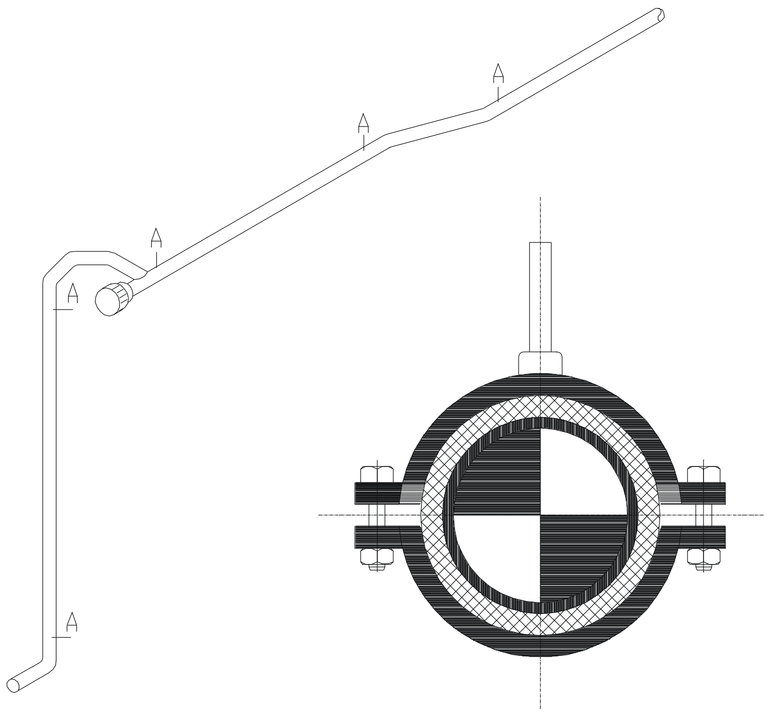
Connection to EFD-/FD-valve





Socket and elbows to be secured by hose clamp.

Vertical pipes

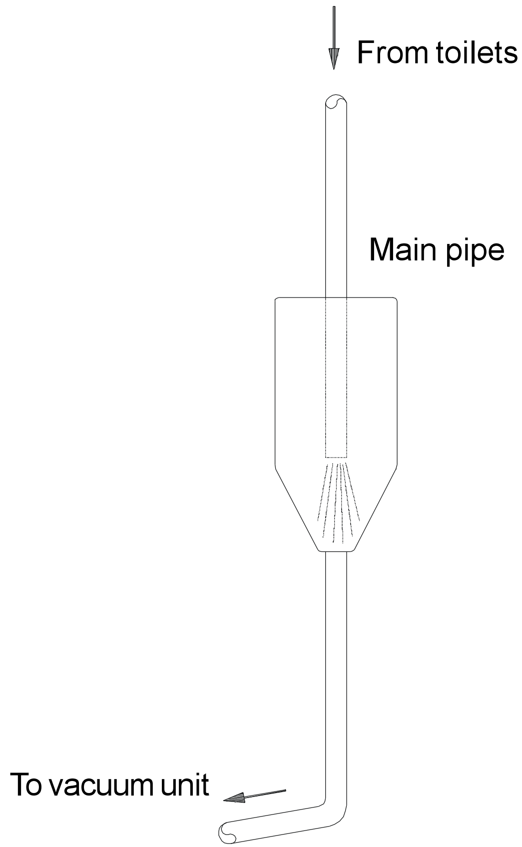


Pipes must be secured by clamps at:

Change of direction
Vertical piping
After connection of toilet or other equipment
Every 1,5 m or (every 2nd. frame) for plastic pipes.
Every 2,0 m for DN 40 steel pipe
Every 2,3 m for DN 50 steel pipe
Every 2,7 m for DN 65 steel pipe
See also pipe manufactures recommendation.

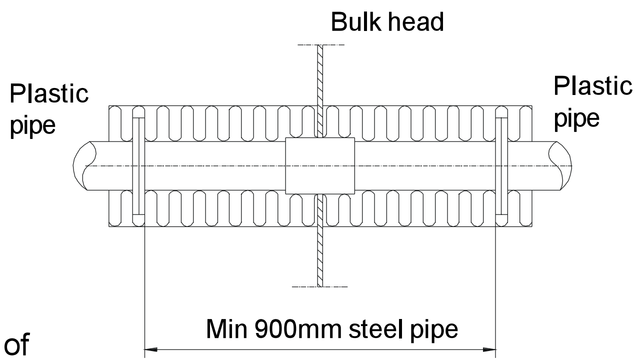
Vacuum accumulating tank

For small vacuum systems (up to appr. 10 toilets), a vacuum accumulating tank is to be considered. An accumulating tank is recommended if total pipe volume is less than 160 l (equal to appr. 85 m pipe length). The tank must be installed vertically and preferably integrated in the main vacuum pipe.

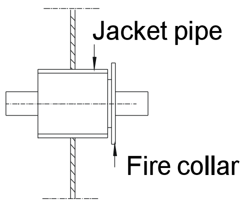


Fire proof penetrations

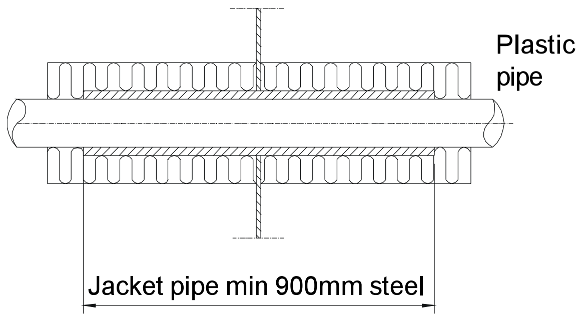
Plastic pipes through fire proof bulkheads and decks



Insulation to be incombustible and of same class as the actual bulkhead or deck. Minimum 450 mm on each side of uninsulated steel bulkhead or deck

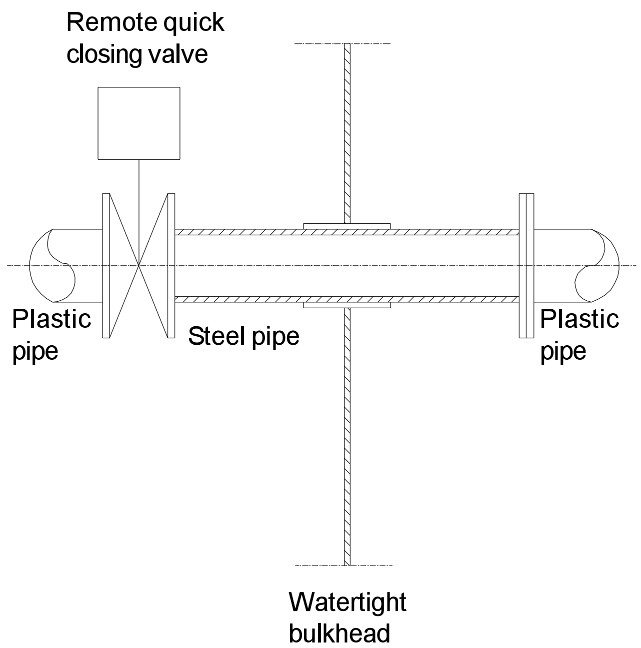


This information is only for adv-ise. Rules given by the national authority and classification societies to be followed.



Watertight penetration

Plastic pipes through watertight bulkheads and decks.



This information is only for advise. Rules given by the national authority and classification societies to be followed.

Test Procedure

A.
Check the tightness by a vacuum test without any components - toilets, scuppers, grey water tanks, vacuumarators etc. - connected. All pipe ends to be blinded.

B.
Check the tightness by a vacuum test with all installed components -toilets, scuppers, grey water tanks, vacuumarators etc. - and all piping lines connected.

Measuring:

A.
Vacuum leakage without any components - toilets, scuppers, grey water tanks, vacuumarators etc. - connected. All pipe ends to be blinded.

Result:
0,6 bar vacuum to _____ bar vacuum during one hour.

Maximum vacuum leakage:
0,6 bar vacuum to 0,5 bar vacuum during one hour.

B.
Vacuum leakage with all installed components - toilets, scuppers, grey water tanks, vacuumarators - and all piping lines connected.
Result:
0,5 bar vacuum to _____ bar vacuum during one hour.

Maximum vacuum leakage:
0,5 bar vacuum to 0,35 bar vacuum with 3 pump starts during one hour.

Descaling of Vacuum sewage pipelines

After some time of use, the sewage pipelines will be filled with urine slag and descaling is necessary.

Before descaling, please observe the following:
Most toilet valves are not constructed for «reversed pressure». So to avoid leakage during the descaling process, the toilets must be disconnected and the pipes plugged.

How to descale the pipeline:
1. Fill up the pipeline with a liquide mixture of phosphoric acid (70-90%) and water. 10% acid and 90% water.
2. Arrange circulation of the mixture if possible. Keep the circulation running for 24 hours.
3. Flush out with water.
4. If there still are remains of urine slag use the same procedure (1-3) with a mixture of 10% of Tetra pyro-Potassium Phosphate.

Pipe tables

Pipe table 1:

Material	PEH	PVC	Steel	SS
Use:	Accomodation up to 75 mm (DN65).	Accomodation up to 75 mm (DN65).	In engine rooms or other heat producing areas. Sizes above DN65/80 to be used *)	In accomodation and engine room.
Minimum pressure rating:	PN10	PN10	PN10	PN10
Connecting method:	Mirror welding. Electric welding sleeve.	Glue	Flange connect. Welding connect. Certified pipe fittings.	Glue

PEH = Polyethylene, High Density
PVC = Polyvinylchlorine, e.g. DIN 86013
SS = Stainless Steel, AISI 304

Notes:
· Plastic pipes do not resist temperatures above 60°C under vacuum conditions.
· Steel pipes to be galvanized.
· Vapors released by PVC solvents are harmful when inhaled.
· Fire protection regulations to be observed.
· Rules of National Authorities and classification Societies to be followed.

Pipe tables

Pipe table 2:

Number of vacuum toilets	Minimum pipe size				
	Connection DN	PEH d x s (mm)	PVC d x s (mm)	Steel d x s (mm)	SS d x s (mm)
3	40	50 x 4,6	50 x 2,4	48,3 x 2,6	50 x 1,0
25	50	63 x 5,8	63 x 3,0	60,3 x 2,9	63 x 1,0
150	65	75 x 6,9	75 x 3,6	76,1 x 2,9 **)	75 x 1,0

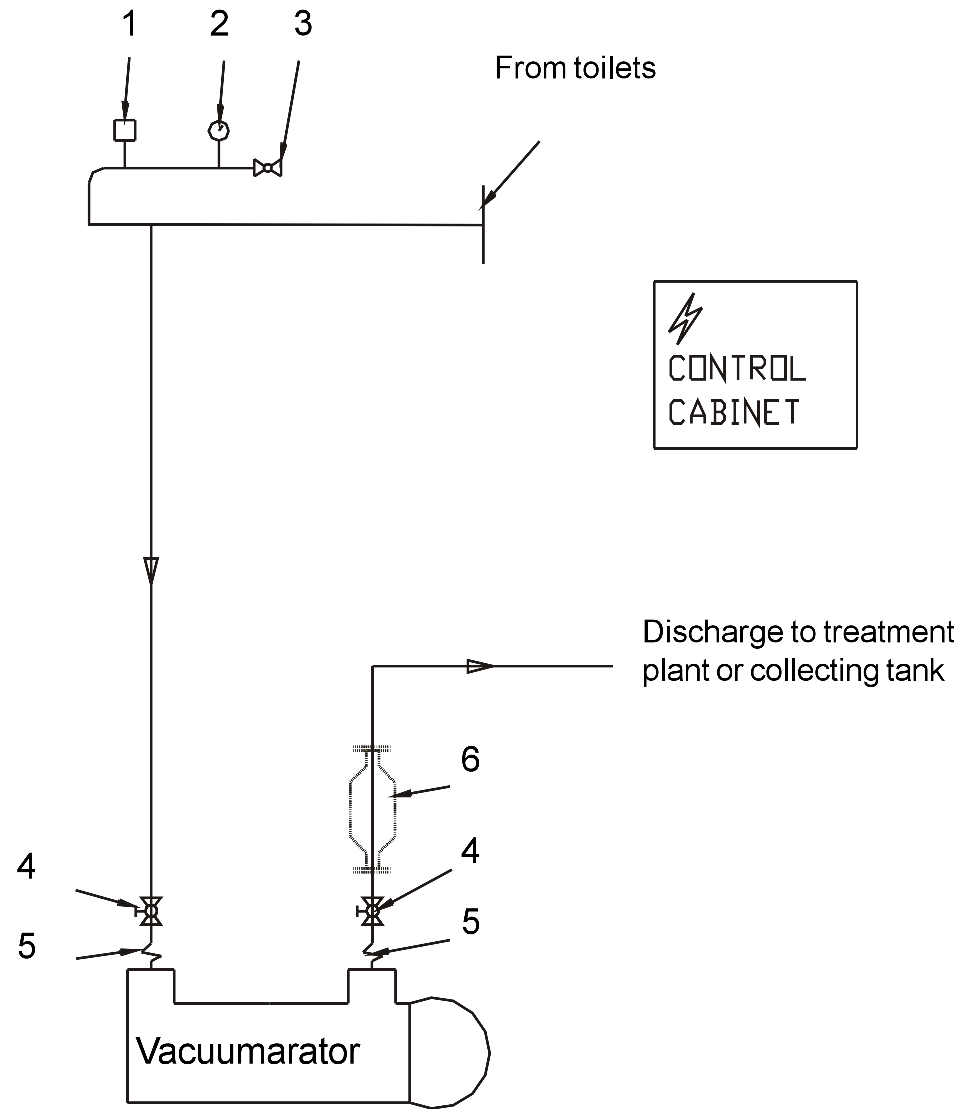
d = Outside diameter   s= wall thickness
*) Supplier to be contacted.
**) Steel pipes for more than 100 toilets, supplier to be contacted.

Typical installation of a Vacuum Unit

A Vacuum unit consists normally of one or more Jets Vacuumarators with valves, pressure switches and control cabinet.

Vacuum units are usually supplied as separate components for yard/client to install.
However the various Vacuum units can also be supplied prefabricated on skid including internal piping and wiring. Jets will be happy to provide you with further details on such units.

The typical configuration is in principle identical for all Jets Vacuum units.
Specific piping diagrams are available for all units and such should be used for installation purposes.
Enclosed diagram is for guidance only.



1. Pressure switch for automatic start/stop
2. Vacuum gauge
3. Ball valve for adjusting/cleaning
4. Shut off valves - ball type
5. Compensators
6. Pot for sealing liquid (only applicable for Jets 25MBA)

A few countries have national standards for Vacuum sewage systems.
These standards are guidelines for design, capacity and installation .

Norwegian Standard 6073, German DIN 0086281 and Danish Værftsstandard 34000 are examples of national standards also including parameters for capacity calculations.
Jets guidelines for piping are basically based upon above standards.

Classification societies have no regulations or formal approvals for Vacuum systems and as such there is no certificate requirements for a Vacuum system.

A Jets system is in principle a transport system for black water and is as such not covered by IMO, US Coast guard, or DOT/ MSA regulations. These regulations however applies for all overboard discharge.

US coast guard certificates Marine Sanitation Devices which either treats black water to prepare it for overboard discharge or stores black water.
Connecting to a collecting tank the Jets system complies with USCG regulation and no formal certification or labelling is required.

USCG concludes that the Jets system is acceptable for use on vessels operating in US waters, provided that either a USCG certified treatment plant or a collecting tank is used.

UK Department of Transport raises no objection to the use of Jets Vacuum sewage system on UK registered ships provided that some layout and installation requirements are followed.

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