What is a Jets™ vacuum sanitary system?

A vacuum sanitary system uses air instead of precious water to transport human waste. Only a small volume of water is used to clean the bowl.

The basic principle for a modern vacuum sanitary system is the use of an in-line pump to create the vacuum directly in the piping system.

When a vacuum toilet is flushed, the waste in the toilet bowl is drawn into the piping by the very air needed to transport it.

The Jets™ Vacuumarator™ pump then macerates the sewage using an integrated macerator, and automatically pumps it to a sewerage system of choice.

Two basic Jets™ vacuum systems

VOD™ (Vacuum On Demand):
Smaller systems with up to 4 toilets, urinals and/or grey water interface units.

CVS™ (Constant Vacuum System):
Larger systems with an unlimited number of toilets, urinals and/or greywater interface units.

Vacuum is the future of sustainable sanitary systems!
Three vacuum generating principles

**Fifties and sixties solution**
First generation vacuum sanitary systems were large and bulky, including an expensive vacuum tank. They required several pumps to operate satisfactorily. One set of pumps maintained the vacuum in the system’s large tank, while a second set of discharge pumps was used to empty the tank’s contents.

**Seventies and eighties solution**
The ejector system launched in the late seventies was an improvement over the first generation. However, it was still a system of considerable size. As in the first generation systems, several pumps were needed to operate an ejector system. A recirculation tank was also needed for vacuum generation, and this caused other problems such as foaming.

**Millennium solution**
The patented Jets™ Vacuumarator™ pump is the most compact, efficient and reliable vacuum generator for vacuum toilet systems. The Vacuumarator™ pump can pump directly to a sewage treatment plant, a sewage tank, a biogas plant, or the public sewer system.

![Diagram of vacuum system](image)
<table>
<thead>
<tr>
<th>Feature</th>
<th>Traditional gravity toilets</th>
<th>Jets™ VC™</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need for gravity / slope</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Litres of water per flush</td>
<td>6 to 19 litres</td>
<td>1 litre</td>
</tr>
<tr>
<td>Sewage per year per person</td>
<td>13 - 41 m$^3$</td>
<td>2 m$^3$</td>
</tr>
<tr>
<td>Hygiene</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Pipe dimensions</td>
<td>110-150 mm</td>
<td>50-75 mm</td>
</tr>
<tr>
<td>Piping cost</td>
<td>High</td>
<td>Lower</td>
</tr>
<tr>
<td>Initial investment cost</td>
<td>Depends on type of project</td>
<td>Depends on type of project</td>
</tr>
<tr>
<td>Return on investment</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Installation work advantages</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Installation flexibility</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Cost of outdoor infrastructure</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Transport / pumping cost water in</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Transport / pumping cost sewage out</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Sewage treatment cost</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Separation of black and grey water</td>
<td>Not sustainable</td>
<td>Sustainable solutions</td>
</tr>
<tr>
<td>Use of blackwater for biogas</td>
<td>Not sustainable</td>
<td>Sustainable solutions</td>
</tr>
</tbody>
</table>
How much can you save?

You will save 153,300 m$^3$ of fresh water annually

<table>
<thead>
<tr>
<th></th>
<th>Traditional WC</th>
<th>Jets™ VC™</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water required per flush</td>
<td>8 litres</td>
<td>1 litre</td>
</tr>
<tr>
<td>Toilet visits per person - per day - average</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Number of persons</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Operation days per year</td>
<td>365</td>
<td>365</td>
</tr>
<tr>
<td>Total use of water per year</td>
<td>175,000 m$^3$</td>
<td>21,900 m$^3$</td>
</tr>
</tbody>
</table>

Local water price per m$^3$ (€2 per m$^3$) | 306,600 Euro |
Sewage disposal cost per m$^3$ (€1 per m$^3$) | 153,300 Euro |
Total direct savings | 459,900 Euro |

Indirect savings - water used for flushing toilets:
- 80-90% less transportation / pumping cost of fresh water
- 80-90% less transportation / pumping cost of sewage
- 80-90% less sewage for disposal and treatment
A Jets™ vacuum system fits in with any kind of bathroom – a luxurious retreat, the charm of traditional craftsmanship, or an ultra-modern design.

There’s no need to compromise on any detail just because you have chosen an environment-friendly sanitary solution. On the contrary – Jets™ flexibility creates new opportunities for creative bathroom architecture.
A Jets™ System may consist of...

- Alternatives for sewage discharge
- Treatment plant
- Sewage tank
- Public sewer
- Biogas plant
- Rising pipe
- Vacuumator™ pump
- Greywater interface unit
The robust Jets™ solution has proved to be highly practical for numerous applications.

In-line installation of Vacuumarator™ pumps combined with a small footprint and low weight allows unique installation flexibility and considerable weight savings compared with other systems.
The patented Vacuumarator™ pumps are the most compact, efficient and reliable vacuum generators available for vacuum toilet systems.

- Continuous flow with no increase in temperature will enhance any downstream treatment process.
- Single-in, single-out connection allows true in-line installation – no need for extra components.
- Highly efficient vacuum production enables a small motor with low energy consumption.
- The helical screw and liquid seal ensure efficient vacuum production.
- The integrated macerator cuts waste to a fine pulp for optimal transport.

Unique Vacuumarator™ pump
Toilets should have the capacity to handle peak periods when they are used by 67% of users within one hour.

The average person uses a toilet 6 times a day.

One public toilet allows up to 15 visits per hour.

Urinals: Allow up to 60 visits per hour.

According to international standards:

- A Jets™ solution can be configured for any capacity and configuration.
- Compact units with a small footprint are easy to install.

<table>
<thead>
<tr>
<th>Type</th>
<th>No. of flushes per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>10NT</td>
<td>100</td>
</tr>
<tr>
<td>15MB</td>
<td>150</td>
</tr>
<tr>
<td>30MB-D</td>
<td>300</td>
</tr>
<tr>
<td>50MBA</td>
<td>480</td>
</tr>
<tr>
<td>195MBA</td>
<td>1800</td>
</tr>
</tbody>
</table>

Jets™ is a practically limitless system.
limitless system

750NT
7500

Limitless
The Jets™ vacuum toilet – safe and simple construction

- High standard seat and cover
- High quality vitreous china
- Vacuum-operated flush and discharge valve
- Water supply
- 50 mm outlet

Jets™ – reliable solutions – easy to operate and maintain
Vacuumarator™ pump
well-proven technology

Quality materials
All materials are rated for professional sanitation. The metals used are corrosion resistant.

The Vacuumarator™ pump has a proven record for low maintenance.

The integrated macerator is made of high quality materials.

The helical screw principle uses liquid to create the seal, minimizing mechanical wear.

Few moving parts. Robust and reliable.
Jets™ toilets save USD 165,000 every year for this business complex in São Paulo

Complexo JK in São Paulo is a 30-storey office block of 90,000 square metres.

The building was not originally designed for vacuum toilets when construction started.

After the project had been on hold for some time, the new owner saw the advantages of a Jets™ installation.

The system, with 412 toilets, was delivered in December 2007. And further vacuum toilet installations are planned.
Challenges

WATER SUPPLY: Although Brazil has the largest reserve of fresh water on Earth, São Paulo is facing a water crisis due to wastage and contamination.

SEWAGE: The costs of treating sewage have risen in line with water prices.

SEWER CONNECTION: The closest point for the sewer connection was already working at full capacity. The nearest possibility was 200 metres away.

INFRASTRUCTURE: The vast population of the megacity has placed its infrastructure under strain.

BUILDING DESIGN: The building had not originally been designed for vacuum toilets.

Jets™ Solution

WATER SUPPLY: The Jets™ vacuum system reduced water use by up to 90% of what gravity toilets would need. With São Paulo's soaring water prices, that meant a payback period of less than two years and substantial savings every year after that.

SEWAGE: Sewerage costs were also reduced by up to 90%, saving running costs for the building complex every day.

SEWER CONNECTION: The pumping power already available in the Jets™ system made it possible to pump the sewage to the connection point further away. A gravity system would have required an additional pump.

INFRASTRUCTURE: Jets™ solutions create new opportunities for property development in areas with overloaded water and sewerage systems.

BUILDING DESIGN: The small-diameter pipes needed for the Jets™ system made it possible to install vacuum toilets in a later construction phase. The flexible piping will also make it easier to change the layout to suit the different needs of new tenants in the future.

High costs

Lower total costs
In São Paulo, Brazil, water is scarce and expensive. In 2007 this university installed a Jets™ system which paid for itself in 15 months.
Challenges

**WATER SUPPLY:** High bills for water were a burden on the university.

**SEWAGE:** With so many users, the volume of sewage and the associated costs were substantial.

**CLOGGING:** Clogging and vandalism had been a problem with the previous toilets, where a blockage could put a whole group of toilets out of action.

**22,000 STUDENTS:** With traditional gravity toilets - 60,000 toilet flushes per day 420,000 litres of water per day

---

Jets™ Solution

**WATER SUPPLY:** With less than 1 litre per flush, Jets™ toilets reduced water consumption for flushing from 420,000 litres to about 60,000 litres every day.

**SEWAGE:** Volumes were cut by up to 90%, dramatically reducing the load on the sewerage systems and cutting costs accordingly.

**GREATER RELIABILITY:** Students appreciated the new Jets™ toilets, and there were far fewer problems with blocked toilets. If one toilet did get blocked, it was an isolated problem which did not affect the other toilets.

**22,000 STUDENTS:** With Jets™ vacuum toilets - 60,000 toilet flushes per day Only 60,000 litres of water per day

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**Daily water cost**

USD 1800

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**Daily water cost**

USD 320
At Uninove’s Campus “Barra Funda”, one central 195MB Vacuumarator™ unit collects sewage from half of the building (360 toilets). Another 195MB Vacuumarator™ unit is connected with the first to serve the other 360 toilets. The water supply is connected to the reservoir, which collects rainwater.

The vacuum system makes it possible to transport sewage upwards.
**Jets™ breakthrough in Brazil**

“Our first major breakthrough in Brazil - the Uninove university in São Paulo.”

Our second breakthrough in Brazil - the Torre São Paulo office block.

Interview with Marco Cerulli, Tavola engenharia – Jets™ distributor in Brazil

The next installation was at the university of Uninove in São Paulo. The complete project involves 720 toilets in the Barra Funda buildings and 680 on the Santo Amaro campus.

Another major installation was the WTorre office block with 426 toilets. A great advantage of Jets™ systems is the flexibility that they enable in the floor layout.

Today, there is a whole new awareness of the potential of vacuum toilets for saving water in Brazil. And with Brazil’s high charges for water and sewerage, the payback period for the installations completed so far has been about 15 months.

“Green buildings – my niche”

“I had seen traditional vacuum systems for toilets before. As an engineer, I was sceptical. But when I saw the Jets™ solution, I understood straight away that this was a much, much better design. With a small, powerful Vacuumarator™ pump and no need for a vacuum tank, it was easy to use and maintain.

I was looking for an opportunity in technology projects that would enable me to compete with larger players. Green buildings created a niche for me. Jets™ vacuum toilets became an important part of my portfolio.

As a trial, Tavola installed 5 toilets at Incor, the Heart Institute at the University Hospital of São Paulo. During each of the two installation phases, half of the emergency room closed down for the installation. The other half continued functioning normally.

“They all liked how easy the system was to run”

The clients loved the vacuum system. The patients liked the idea of green technology and the hospital was very pleased with how easy the system was to run.

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“Only this?”

If I take people to see the Vacuumarator™ pump, I have to ask the maintenance staff to clean the technical room first, because they hardly ever have to go in there otherwise and it might get a bit dusty. When my guests ask where the whole vacuum installation is, I say: “You’re looking at it.”

“What?” they say, “only this?” They can’t believe it’s so compact.

“With Brazil’s high charges for water and sewerage, the payback period for installations completed so far has been about 15 months.”

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Vacuum sanitary systems can be installed without closing down hospital sections. With small-diameter vacuum pipes, there is much less need for core drilling and the resulting noise and dust. This hospital in France, Les Cadrans Solaires, has 138 vacuum toilets. These were installed during renovation of the building with very little impact on the normal hospital functions. The system has functioned reliably since it started operating in 1993.

At the Belfast City Hospital, renowned for its work in cancer diagnosis, treatment, and research, Jets™ sanitary systems provide a practical and effective solution for storing radioactive sewage until the radioactivity has been reduced to a safe level. The low volume of sewage from vacuum toilets simplifies this process. Greater hygiene with less risk of aerosol contamination from flushing toilets is another important factor.

In a pilot project, five vacuum toilets were installed at Incor, the Heart Institute at the University Hospital of São Paulo, one of the world’s leading cardiology institutions. The installation was completed in two stages. During each stage, half of the emergency room was closed down for the installation – the other half continued functioning normally.
### ISOLATION OF SEWAGE

**Challenges**

- **ISOLATION OF SEWAGE**: Sewage contaminated by radioactive isotopes poses a risk to the environment.
- **HYGIENE**: Hospital-acquired infections are a growing concern.
- **RENOVATIONS**: May disturb patients and make it necessary to close sections of the hospital.

**Jets™ Solution**

- **ISOLATION OF SEWAGE**: Jets™ sanitary solutions make it possible to install a sealed system for isolating radioactive sewage until the radioactivity has been reduced to a safe level. The low volume of sewage from a vacuum sanitary system simplifies this process.
- **HYGIENE**: A Jets™ toilet draws air and pathogens into the vacuum system with every flush. Practically no aerosols are released into the room.
- **RENOVATIONS**: Vacuum sanitary systems with small diameter pipes can be installed in existing facilities with much less downtime and disturbance to patients than gravity systems involve. There is less need for floor and ceiling penetration, with the resulting dust produced by concrete drilling. Sewage can even be pumped upwards for up to 4 meters.

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**Vacuum toilets offer new solutions for sewage isolation and hygiene**

**Hospitals need better sanitary systems**
The Norwegian University of Life Sciences (UMB) – focusing on sustainability – chooses Jets Solutions

Vision: closing the loop

The Norwegian University of Life Sciences and Jets™ both require an innovative sanitation system for collecting and recycling wastewater and organic household wastes in order to reuse water, energy and nutrients.
SEWAGE IS A RESOURCE: Greywater (from sinks, showers and washing machines) and blackwater (from toilets) go to separate outlets. This creates possibilities for water saving and reuse, and production of organic fertilizer and renewable energy (biogas) from blackwater. This is the aim behind the sanitation system at Sørhellinga Building and student apartments at the Norwegian University of Life Sciences (UMB). They are equipped with a Jets™ vacuum toilet system and biological purification of greywater.

RENEWABLE ENERGY: Concentrated black water from vacuum toilets is a resource for renewable energy (biogas).

RECOVERY OF NUTRIENTS: Vacuum toilets make it possible to recover valuable nutrients from blackwater so that it can be used as organic fertilizer in the field of agriculture.

LESS ENERGY AND CO₂ EMISSIONS: A source separating outlet, vacuum toilets, and low-energy greywater purification reduce the energy needed for water pumping and sewage treatment. This also reduces CO₂ emissions.

SØRHELLINGA – AN OPPORTUNITY REALIZED: The university’s Sørhellinga Building, built in 1979, has been modernized with environment-friendly technology including vacuum toilets, a source separating outlet for grey- and blackwater, and a separate water supply for flushing toilets. The biological purification of greywater has been developed by the university and Jets™ through the company Ecomotive™.
When 70,000 fans visit toilets within a few minutes you need enormous water and sewage capacity!

Unless you install a vacuum sanitary system

The Castelão Stadium in Fortaleza, Brazil, holds the record for the world’s largest onshore vacuum sanitary installation. Read more about it on www.jetsgroup.com.
### Challenges

**FIFA RECOMMENDATIONS:** There should be at least 20 toilets for each 1000 women, and 15 toilets and/or urinals for each 1000 men, with a higher ratio in VIP areas. The infrastructure required to achieve this may be difficult to provide.

**WATER CONSUMPTION:** Gravity toilets for stadiums need large volumes of water.

**SEWERAGE:** The volume of sewage from the stadium may overload the existing infrastructure.

**DIFFICULT TERRAIN:** Geological conditions at stadiums can make excavation difficult.

**HYGIENE:** Inadequate, unhygienic and dirty toilets may be a health risk and encourage anti-social behaviour.

### Jets™ Solution

**FIFA RECOMMENDATIONS:** Jets™ vacuum systems can meet the recommended specifications and cope with high flushing rates in short periods, proven for decades on the world’s largest cruise liners. The small footprint of the system, simpler logistics, less need for core drilling and sewerage trenching make it easier to install vacuum toilets. Small-diameter vacuum piping can be routed upward and around obstacles.

**WATER SAVINGS:** Water consumption can be reduced by up to 90% compared with gravity toilets.

**SEWERAGE:** Vacuum toilets reduce sewage volumes by up to 90%, reducing the load on the existing public network.

**DIFFICULT TERRAIN:** Vacuum piping can be laid in shallow trenches in flat, rocky, sandy, or swampy terrain, reducing installation and maintenance costs. The built-in vacuum can also be used to pump sewage to the nearest connection point.

**MORE HYGIENIC:** The powerful vacuum draws the waste along with more than 60 litres of air into the piping with every flush, reducing aerosols and odours. Spectators respect clean and efficient toilet facilities.

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**Costly infrastructure is needed**

**Cost-effective solutions for stadiums**
Jets™ systems add sanitary benefits to food processing plants

The ultimate in hygiene is essential at this Marine Harvest salmon processing plant in Herøy, Norway — one of the largest in the world. Jets™ vacuum toilets make it possible to keep the sanitary systems completely separate from the production area.
Challenges

**FOOD SAFETY:** Consumers and authorities set high standards for food safety. It is vital to pay the utmost attention to hygienic food production. One recall of products or a stop in production because of contaminated food due to poor hygiene can spell disaster for a food producer and its reputation.

**TOILET FLUSHING MAY SPREAD GERMS:** Gravity toilets may spread germs and odours with every flush.

**LACK OF INFRASTRUCTURE:** Processing plants may be some distance from municipal sewer connections.

**FACTORY UPGRADE COSTS:** The need for continuous renewal and upgrades of the production facilities involves high costs.

**DIFFICULT TERRAIN:** The land around processing plants may be rocky or difficult to excavate.

**REGULATIONS FOR FACTORY DESIGN:** Stricter regulations from the authorities may require changes in factory sluices and plumbing installations. This can be difficult to achieve with gravity sanitary systems.

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Jets™ Solution

**EXTREME HYGIENE:** The flexibility of the Jets™ vacuum system makes it easy to keep sewage in a closed system separate from the production area, contributing to the highest standards of cleanliness and hygiene.

**CLEANER FLUSHING:** The powerful vacuum draws the waste along with 60 litres of air into the piping with every flush, reducing aerosols and odours to an absolute minimum.

**PUMP SEWAGE TO NEAREST CONNECTION:** The built-in pumping power in the Jets™ system can be used to pump sewage several hundred metres to the nearest connection point. No extra pump is needed for this process. And with 90% less sewage, the load on the infrastructure is far less.

**SAVE UPGRADE COSTS:** The flexibility and adaptability of the Jets™ vacuum system save costs when production facilities are upgraded. It is easy to position sanitary facilities wherever they fit in best in the building.

**SHALLOW TRENCHES:** Less excavation is needed for vacuum piping.

**REGULATIONS FOR FACTORY DESIGN:** Replacing gravity toilets with vacuum technology during renovations makes it easier to update the factory layout for compliance with new regulations that may be introduced in the future.
“In unspoilt fjords and valleys greentech solutions make sense – smarter ways to build are the bonus!”
“When you look out over the Ørsta fjord and the Sunnmøre Alps, you understand: the environment is at the heart and soul of this hotel. Our guests expect us to take the best possible care of it.

The small-diameter vacuum piping was a great advantage during the renovations. It reduced our installation costs because we did not need to do so much core drilling or to hack up existing floors, and we needed less ceiling height.

What’s more, we did not need to close the hotel during the building period. The vacuum system cuts our water consumption and sewage output by 80-90%, reducing our operating costs. And the sewage – both blackwater and greywater – is a resource with the potential for renewable energy. To survive in this competitive market, we must listen and live up to our customers’ expectations regarding environmental issues. Choosing the greenest possible alternative gives us a competitive edge.”

“Traditional ways are not good enough any longer...

...the time has come for better solutions!”

– says Sigurd Johan Torheim, owner of Hotell Ivar Aasen in Ørsta, Norway
New opportunities in both new buildings and rehabilitation projects

- Bedroom converted to bathroom. Bathroom can be located anywhere - without disturbing the floor below.
- Small pipe dimensions save space in ceilings and walls.
- Room ready for interior fitting of bathroom, kitchen, laundry.
- New opportunities for areas at street level - restaurant, hair salon, dental surgery.
- Make the most of a basement, position sanitary installations anywhere.
Case 1 - Making the most of a basement

**CHALLENGE:** An insurance company needed extra space. To make the most of the basement, the company wanted to install two toilets there. But the basement was below the municipal sewer line.

**JETS™ SOLUTION:** The vacuum system enabled sewage to be pumped up to the municipal sewer. No need for new piping or concrete drilling in the upper floors. Above ground, the staff could carry on working as usual without downtime.

The compact Vacuumator™ pump needed less than a square metre of space, so it was easy to fit into an existing storeroom.

Case 3 - No concrete drilling for the dentist

**CHALLENGE:** The offices for the county dentist were above a supermarket. The dentist needed two toilets in the waiting room as well as a washbasin and mouth-rinse facility in the surgery. Installing a gravity toilet would have involved drilling through the concrete floor slab, not to mention placing a soil pipe over the vegetable counter of the supermarket below.

**JETS™ SOLUTION:** Instead of core drilling, a Jets™ vacuum system was installed. The Vacuumator™ pump was placed in the loft together with the air compressors needed for the dental equipment.

Case 2 - Don’t disturb tenants below

**CHALLENGE:** An apartment owner wanted to install a new bathroom in the building without disturbing the existing tenants who were living below or putting a soil pipe through their ceiling.

**JETS™ SOLUTION:** A Jets™ system was installed, with the vacuum pipe leading up to the ceiling and into the existing soil pipe. The people living below were unaffected.

Case 4 - Defying gravity

**CHALLENGE:** A house situated below the municipal sewer line and close to a protected lake with 250 species of nesting birds.

**JETS™ SOLUTION:** A Jets™ vacuum system was installed with two toilets, a shower and kitchen plumbing in the main house. A self-contained basement unit had a shower, toilet, washbasin and kitchen. A gravity solution would have required a large tank and pump station, and would have been more expensive to install. The sewerage pipe had to be dug beneath the road, so the small dimensions and small sewage volume were a major advantage. The result: a complete sanitary solution, fully compliant with municipal regulations.
Jets™ Sanitary Systems – made to please

- solutions that make sense for a new century

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