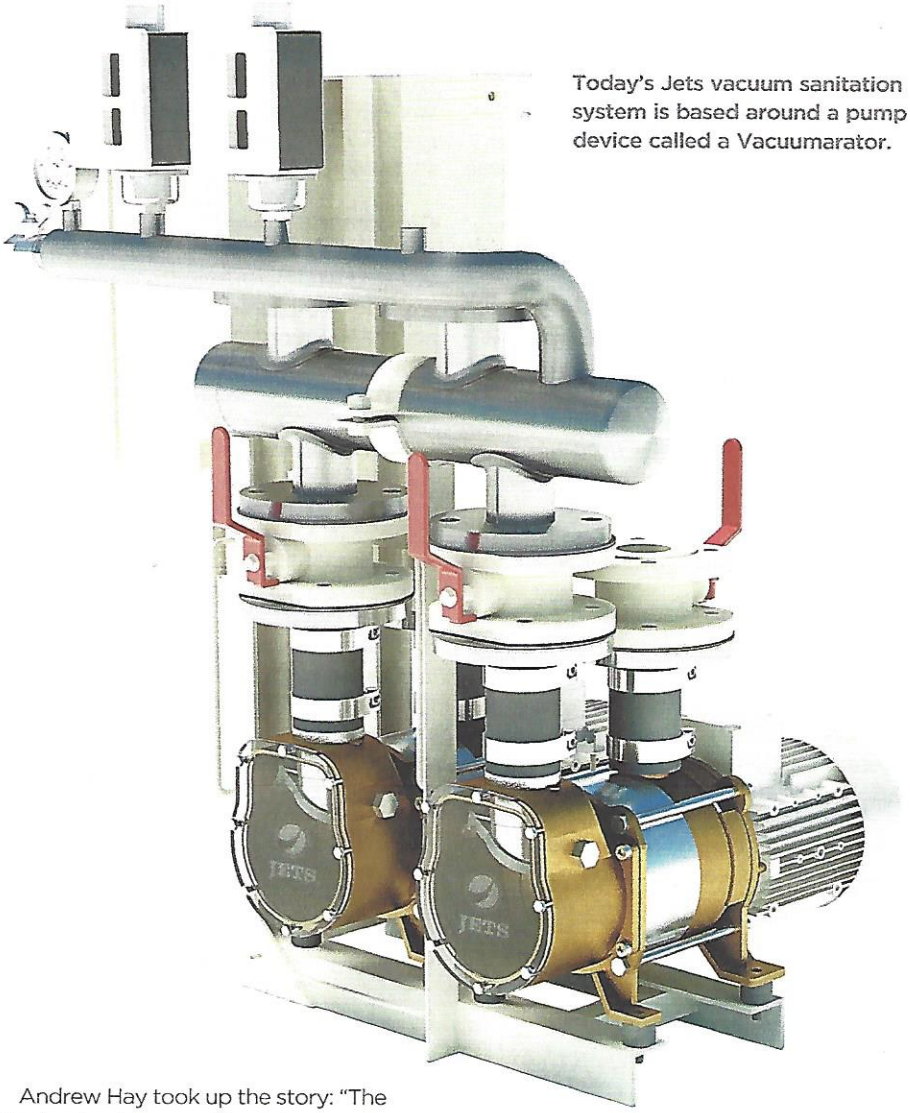
Substantial water savings with fewer blockages

The exclusive UK and Eire distributor for 'Land & Transport' applications for a Norwegian-developed vacuum drainage technology that reportedly consumes one-sixth to one-eighth the volume of water during flushing of 'traditional' gravity toilets, better draws in and 'vents away' pathogens and odours, offers easier, less disruptive installation, and is 'low maintenance, and less prone to blockage', is stepping up its targeting of UK hospitals following a successful first UK healthcare installation at Truro's Royal Cornwall Hospital. *HEJ* editor, Jonathan Baillie, met up with MD, Andrew Hay, and Sales/Marketing director, Nicky Brown, at Otter Vacuum Systems' Downton headquarters near Salisbury, to find out more.

Andrew Hay began by explaining that he first came across vacuum sanitation technology some 13 years ago, when he was running a fleet of mobile toilets, principally for use at outdoor events. He explained: "Recognising that I had a good idea for a foldable portable toilet cubicle which could be transported by trailer to site, and then carried by one man to the required location, I investigated the vacuum toilet technologies then available. I knew that vacuum toilets used considerably less water than gravity toilets, and would thus better suit use in remote locations, such as in the middle of a field. After an exhaustive trawl, I concluded that the vacuum sanitation technology from Norwegian sanitary systems specialist, Jets, would best suit the range of compact mobile toilets that I had designed and developed, and which I then hired out, and subsequently also sold, to the 'top-end' events market."

Lack of a UK distributor

While he still sells the 'Flexiloo' cubicles and urinals worldwide via a separate company (Flexiloo is effectively now a Jets customer), Andrew Hay explained that in 2006, not long after he first encountered the Norwegian company's technology, he discovered Jets had no UK/Eire distributor for its vacuum sanitation technology in 'Land & Transport' applications. Seeing the considerable UK commercial potential for its use in both mobile and land-based sanitation applications, he and his business associate, Nicky Brown (who he had met not long before), thus travelled to Norway, and met with Jet's management team at the company's global headquarters in Hareid on the country's west coast. The pair returned to the UK shortly after, having convinced the Norwegians that Otter Vacuum Systems should take on this UK distributorship, which it has held ever since.



Today's Jets vacuum sanitation system is based around a pump device called a Vacuumarator.

Andrew Hay took up the story: "The Flexiloo business continues to prosper, as do sales of Jets vacuum sanitation systems to a variety of markets. One area where, however, until recently, we had perhaps put insufficient focus, has been selling the technology into the buildings market." One recent high profile project which highlighted the technology's suitability for buildings saw Otter Vacuum Systems supply over 600 toilets, urinals, and grey water collection tanks, to Bloomberg's new European headquarters in London, which opened last October, and is claimed to be one of the world's 'greenest' buildings built to date; it has already been given a BREEAM 'Outstanding' award, with a 98.5 per cent

rating for low water consumption. "In fact," Andrew Hay said, "the Bloomberg installation is almost certainly the UK's biggest vacuum sanitation project yet. Within the static buildings arena," he continued, "we believe there is huge potential for the Jets technology in healthcare facilities, and we plan to strongly target both NHS and private healthcare providers over coming months."

NHS infection control focus

Andrew Hay and Nicky Brown explained that the Jets vacuum sanitation technology harnesses principles first exploited in the late 19th century in vacuum sewerage systems by Dutch engineer, Charles Liernur. Today's distinctly 21st-century Jets system is based around a pump device called a Vacuumarator, which in toilet applications creates the vacuum needed to flush the appliance using very little water, macerates the sewage, and transports it along the pipes to a point where gravity takes over and discharges it into the drain. In the case of waste from, say, a chemotherapy unit, the slurry can be transported to a purpose-designed storage tank until the radioactivity level is sufficiently low for discharge to drain.

Significantly reduced water consumption

Jets says all this is accomplished using 'up to 90 per cent' less water than a 'traditional' gravity toilet. With such low water use, the volume of sewage – which the Vacuumarator expels as a fine slurry – is also cut 'by up to 90 per cent'. This not only lessens the load on pipes and treatment facilities, but – a key selling point for healthcare facilities – also makes blockages, and the ensuing disruption while a ward is decanted to rectify the problems, 'much less likely'. Indeed, the first UK healthcare facility to be supplied with a Jets vacuum sanitation system by Otter Vacuum Systems, Truro's Royal Cornwall Hospital, had a vacuum toilet system installed last autumn to serve its Lowen Ward – part of the Trelawney Wing, which cares for teenagers and young adults with cancer – after repeated problems involving blockage and sewage back-up with the ward's gravity drainage system.

Andrew Hay explained: "Many of the patients on the Lowen Ward are immunosuppressed, making a clean, hygienic care environment paramount. The problems with the existing gravity drainage system had directly affected the ward's operation and the efficiency of the services provided. The system required constant monitoring and jetting, placing a considerable additional burden on the Maintenance team."

To address the issue, it was proposed to install a Jets vacuum drainage system to operate independently of the gravity system. With a complete shutdown of the ward to undertake the work not viable, the project was run in phases, with 'sub-areas' shut down for the construction works.

The Otter Vacuum Systems headquarters in Downton, near Salisbury.

Construction team's co-operation

Andrew Hay said: "The project team included GPJ Consulting Engineers, working as project designer/project administrator on behalf of the Royal Cornwall Hospitals NHS Trust, and the main contractor, TClarke, working closely with us at Otter Vacuum Systems. The team worked really well together from the outset, and the project was completed on time, on budget, with minimal disruption." Key elements included the temporary relocation of some ward services; installation of a vacuum station to accommodate the vacuum plant, control panel, and pressurisation set/break tank; installation of vacuum drainage pipework (for black and grey water); redirection of drainage from existing inlets below ground; installation of vacuum toilets and grey water receiver tanks; drainage connection to the foul sewer; commissioning, and Maintenance staff familiarisation and training.

Training at Otter Vacuum HQ

Jim Tinsdeall, the Royal Cornwall Hospitals NHS Trust's head of Estate Operations, said: "Prior to construction starting, TClarke was trained at Otter Vacuum's headquarters, which paid dividends during the work in terms of us meeting tight project deadlines. Otter Vacuum Systems and GPJ Consulting Engineers visited the site throughout the design, construction, and commissioning phases to ensure a successful project outcome. Following the installation, Otter Vacuum Systems introduced our Estates Maintenance team to the system via a familiarisation session held on the ward, which combined a presentation and practical training.

"Following installation, a planned maintenance regime was introduced, and reactive maintenance has since been massively reduced. There has been just a single critical fault since the installation – involving a blocked pump, which, thanks to the post-installation training, was rectified with little disruption."

A considered decision

He added: "The decision to fit vacuum drainage in a hospital was not taken lightly. We went and looked at installations in numerous locations, including train stations, hotels, and other public venues. The key priority for us was to eliminate the problem of toilets backing up due to blockages caused by a poor installation of traditional drains, and the ongoing problem we all suffer from in hospitals of inappropriate materials, such as 'super wipes', being introduced into the drainage system. After tendering the project we visited Otter Vacuum Systems' headquarters armed with several packs of the wipes, to test the system's ability to deal with them, along with paper towels. The system passed with flying colours, coping with fistful after fistful.

Delighted with the project's success

"Since its installation we have only had one problem of a pump being blocked – caused by a full-size bin liner being flushed through the system. The blocked pump was cleared without having to open the drainage systems in patient areas. The area we fitted the vacuum drainage system to houses immunocompromised patients. We are delighted with the success of the project, and will be looking to fit the vacuum sanitation technology into high-risk areas as and when built or refurbished. Installation-wise, the drainage

system can be contained within a single floor during refurbishment, as the pipeworks run in the ceiling void of the floor you are refurbishing, rather than needing to access the floor below."

Andrew Hay added: "While the Royal Cornwall project was our first UK installation of a Jets vacuum drainage system, we believe the technology's numerous benefits will be rapidly recognised by UK healthcare estates and facilities management and infection control personnel once they get familiar with it. Not only does a Jets vacuum toilet take just one litre to flush, compared with ('typically') 6-8 litres with a gravity toilet, but the system can also significantly improve the patient/staff experience and benefit infection control, with odours and pathogens 'sucked' into the toilet by the vacuum, rather than being aerosolised."

Plans for scientific trials

Recognising, however, that it will take scientific evidence to convince infection and prevention control and estates and facilities personnel of the system's effectiveness, and particularly its efficacy in containing/preventing the spread of pathogenic aerosols, Otter Vacuum Systems plans soon to conduct a trial to verify the system's performance in these areas, using a specially assembled test rig at its Downton base. For this it intends harnessing the expertise of Professor Sohail Khan, Professor of Sustainable Infrastructure at Loughborough University's School of Architecture, Building and Civil Engineering.

Andrew Hay said: "While we are keen to secure scientific trial data that verifies the Jets system's ability to contain pathogens in toilet and washroom environments, we will also be highlighting how it can substantially reduce water consumption." Jets' own data, contrasting the water used by a vacuum toilet and a 'conventional' gravity toilet, based on 6 flushes per day per person, by 5,000 individuals over a full 365 days, in fact indicates an annual saving of 54,750,000 litres (based on an average-sized 6-litre cistern).

The Jets 610 is a floor-mounted stainless steel toilet for demanding applications.

Engineering and maintenance benefits

Alongside its hygiene and water-saving benefits, Andrew Hay highlighted some of the Jets technology's practical benefits – from an engineering, construction, and maintenance perspective. He said: "For example, the Vacuumarator pump – which creates the vacuum, macerates the sewage, and discharges the waste in a single pass – is, to our knowledge, the market's most compact, efficient, and reliable vacuum generator for sanitary systems; it is highly efficient at transporting any combination of black and grey water under vacuum." My interviewee's view was that the first vacuum pump, invented and manufactured by Jets in 1982, was 'revolutionary' even then; since then Jets has continuously developed and refined the technology, and expanded the range of available pump capacities. Andrew Hay elaborated: "Thus if supplying, say, a large acute hospital with a sizeable network of vacuum toilets and grey water collection tanks, there is really no limit to the number of appliances that can be served. Several Vacuumarator pumps can also be assembled in larger modules for higher performance, improved capacity, and added redundancy.

Space savings

"In addition," he explained, "the Jets system's use of 50 mm, rather than the more usual, 110 mm pipework, enables space savings of up to 80 per cent, as the smaller diameter pipework means pipes can be run through ceiling and wall voids, and, equally, that any openings are considerably smaller." Jets explains that pipes can also be routed at, or around, ducts and other 'obstacles', while vacuum pipework can be installed 'at a later stage than traditional gravity piping'. "The plumbing is also more flexible," said Andrew Hay, "since you no longer need depend on gravity for the toilets to work, which means the vacuum system can transport waste vertically."

The Jets technology – with the dimensions and capacity of the Vacuumarator adaptable to the user's requirements – is designed for use with the wide range of toilets and urinals produced in a variety of 'styles', – in both sanitary porcelain and stainless steel – by the Norwegian firm. All can now be supplied by Otter Vacuum Systems to UK healthcare facilities. Jets vacuum drainage systems are also designed to be easily expandable, a process the company says entails considerably less disruption for healthcare engineers or outside contractors than, for example, extending a large acute hospital's traditional gravity-fed system.

A little 'history'

Having considered some of the Jets vacuum drainage technology's main selling points, Andrew Hay and Nicky Brown moved to explain how they came to market the technology, before giving me a more in-depth look at the system's 'workings', and some of the key practical considerations for installation. Andrew Hay explained: "I first came across vacuum sanitation technology while running a mobile toilet hire fleet. I subsequently designed, developed, and had manufactured locally, a one-man portable toilet cubicle to go onto the hire fleet. When we launched the 'Flexiloo' in 2005 – it harnessed Jets technology, as I needed a compact, yet efficient vacuum system – sales went through the roof. I had in fact bought vacuum equipment

directly from Jets just before launching my system, since in those days the company had no UK distributor for Land & Transport. This was around the time I met Nicky, who was working in aviation support, selling and maintaining aircraft spares to high profile customers in the Middle East. She and I now run Otter Vacuum Systems together."

Put onto hire fleet

He continued: "I knew I needed to offer the Flexiloo system to my customers, so I put it onto my hire fleet. However, I never originally intended selling it as we now do. Indeed sales of the Flexiloo – principally to top-end events companies and mobile toilet operators – are still a major revenue earner today. We have, though, been a little slow to get into the 'Buildings' market with the Jets technology, as we are doing now. Alongside having supplied our first Jets vacuum drainage system to the Royal Cornwall Hospital last year, we were delighted to be able to provide 600 toilets, urinals, and grey water interfaces, for the UK's largest vacuum installation yet, at Bloomberg's new European headquarters in London, which opened last October. The Jets equipment supplied to UK customers is generally installed by mechanical and electrical contractors, such as TClarke, whose staff we can train. Jets technology – which we believe is field-leading – has played a major part in Otter Vacuum Systems' success."

How the system works

Andrew Hay went on to explain how the Jets vacuum drainage technology works. Drawing on a comprehensive Otter Vacuum Systems CPD presentation, he explained that the system sees differential atmospheric pressure, rather than the gravity of a 'traditional' WC, used to 'draw in' and then transport waste from toilets, and grey water from sinks and showers, along pipework to the company's Vacuumarator device, which, in a large acute hospital, would typically be installed within a basement plant room '(a compact footprint affords considerable siting flexibility'). He said: "The common definition of atmospheric pressure is the pressure at sea level – expressed in various ways, but most commonly as 1 atmosphere, approximately 1 bar, or 1,000 millibars. Vacuum is any air pressure below atmospheric pressure, and, for simplicity, the vacuum level in a sanitary system is normally expressed as a percentage. With Jets' technology, the pressure difference is created by the Vacuumarator, which creates the vacuum, and macerates and discharges the waste positively, all in one action. Pressure switches which control the stop and start of the vacuum generator maintain a constant vacuum of 35-55% within the pipes. When the toilet is flushed, the contents are transported along the pipes via the pressure difference; transport continues as long as the toilet valve is open, usually a period of about one and a half seconds."

Jets Pearl is an award-winning, wall-mounted vacuum toilet. It can be supplied with a vacuum or electronically-operated mechanism.

Gravity always present

During the discharge period, the waste is carried 5-15 metres, depending on vacuum level, pipe dimensions, and the number of bends etc. With gravity always present, when the transport stops, the waste flows by gravity to the nearest 'low point.' Andrew Hay said: "The pipes should thus be installed with a water lock or transport pocket at this point; at the next discharging of the toilet or other outlets connected to the same side of the transport pocket, the pocket's contents will be moved further along the pipes. In longer pipe runs, there will be simultaneous lines of transport from several pockets until the waste reaches the discharge plant or Vacuumarator."

Here he reiterated some of the practical, 'in use', and environmental advantages of a Jets vacuum drainage system for building designers, contactors, and engineers: "Installing a vacuum sanitation system can be an extremely effective way to achieve very high sustainability levels under a BREEAM or LEED assessment. With the small diameter pipework, and the system operating independently of gravity, pipes can rise vertically, and utilise ceiling voids and wall cavities. Designers are no longer limited to positioning toilets adjacent to vertical stacks, a significant advantage, particularly in heritage buildings, where wall and floor penetrations need to be minimised."

Pathogens 'sucked' into a sealed system

We had already discussed the hygiene / infection prevention benefits of a Jets system, but Andrew Hay was keen to revisit these. He said: "Unlike a gravity toilet, where significant atomisation into the surrounding atmosphere occurs on flushing, when someone flushes a vacuum toilet up to 60 litres of air is sucked in, ensuring that pathogens and odours are taken into a sealed system. The low volume of waste produced simplifies the process, while with the entire system under vacuum, any compromise in the pipework will result in air leaking in, rather than waste leaking out. Vacuum toilets draw air and bacteria into the system with every flush, and – as we believe our planned trials with Loughborough University will show – practically no aerosols are released into the room."

Andrew Hay and Nicky Brown were keen to stress, however, that for a vacuum drainage system to be effective, it must be correctly designed. Alongside the requirement for an interface valve between the atmospheric pressure outside, and the vacuum within the pipework, since the water supply connects directly – without a cistern or other air break – it must be Fluid Category 5, as defined in the Water Regulations.

Grey water collection

The Jets vacuum drainage system also allows collection of grey water from basins and showers via special interface tanks, one of which my hosts showed me, mounted below a washbasin in the Otter Vacuum Systems showroom. Once the water reaches a preset level, a valve opens, and the resulting vacuum then 'flushes' the water into the pipework.

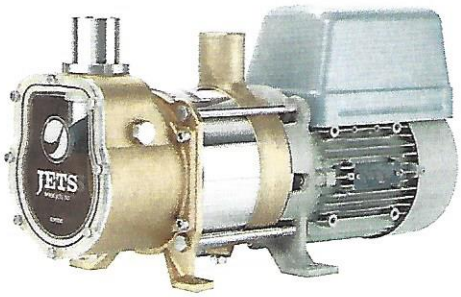
Jets manufactures, and Otter Vacuum Systems can thus supply to UK healthcare customers, an extensive range of both wall and floor-mounted ceramic toilets, urinals, and 'Asian-style' toilets and bidets; stainless steel models are also available. Pipes made of a stainless steel, PVC, ABS, HDPE, and polypropylene, are all compatible, while, depending on the type selected, jointing methods including push-fit, heat fusion, and solvent welding.

Pipework design 'essentials'

While Jets and Otter Vacuum Systems cite numerous advantages for the former's vacuum drainage systems, they stress that, to derive the maximum benefits, 'it is imperative that the associated pipework is designed correctly'.

Key requirements include:

- The location of the vacuum generator, 'as a general rule', should always be at the lowest part of the vacuum system. For building applications, a 100% redundancy in vacuum generation should be allowed. Pipework dimensions vary, but 50 mm pipework is common, and 75 mm pipes may need to be used in installations involving large numbers of toilets or high levels of grey water. Rising pipes from individual toilets should be DN50, and for grey water interfaces, DN32. Each rising pipe can only serve one interface. An optimally constructed piping system is designed to contain as little water as possible during normal operation. This is aided by making horizontal pipes as short, and with as few bends, as possible.
- While pipework can rise vertically from toilets to carry waste at high level, gravity is always present, and thus all horizontal pipes should have a minimum fall of 1:200.
- If possible, toilets should discharge downwards.
- Bends should always be created with a large radius, or two 45° degree bends. The only place that a 90° bend is allowed is directly connected to the toilet or grey water interface.
- Connecting branches must always be made at a maximum angle of 45° in the direction of transport. T pipes, even swept, must never be used.
- Branch pipes, when connected to horizontal pipes, must be from above.
- To avoid any risk of backflow, rising pipes should always be vertical, and should be connected to the upper side of the horizontal, with a goose neck at an angle of 45° to the direction of flow.
- The diameter of a rising pipe must not be increased in the rising part.
- Connection of horizontal branches to downward collecting pipes must always be carried out with a downward 45° connection, and never directly opposite each other. In larger systems, Jets recommends shut-off valves for each branch.
- As with all sanitary systems, scaling will occur. The system will thus need de-scaling, either as part of a normal cleaning programme, or automatically, using dosing pumps.



The Jets 15MB Vacuumarator pump is a 'powerful and versatile' model available in two variants – one for low and medium intensity, and the other for high intensity use.

- Completed installations can be tested under pressure, 'only before any interfaces have been fitted'.
- The pipework should be tested under vacuum, either before the interfaces have been fitted – where the acceptable leakage is from 60% to 50% vacuum over one hour, or after, when the comparable figure is from 55% to 40% vacuum over 20 minutes.

Wider deployment?

Given the range of benefits that Jets and Otter Vacuum Systems cite for the vacuum sanitation technology, I asked Andrew Hay why he thought there had not been greater take-up in healthcare to date. He said: "That's a difficult question. In some hospitals I guess there is still a degree of conservatism, in that gravity toilets have been used for many years and are very well-established, despite their substantial water consumption, the need for regular maintenance, and propensity for blockages. We are conscious that some potential users may worry about blockages in, say, the Vacuumarator apparatus, but we know, from our own tests, that the system's design makes frequent blockages extremely unlikely, coupled to which the Jets vacuum technology's reliability has been proven over more than 40 years."

I wondered how the system costs compared with traditional gravity sanitation equipment. Andrew Hay said: "Generally a vacuum drainage system will cost more. However, the Jets technology offers very considerable savings in water consumption, lower installation costs, and less disruptive fitting, especially during 'refurb' work, plus low maintenance. Add to this the more flexible pipework configuration, and less penetration of walls and ceilings, and while the initial capital costs may be higher, these will be easily recouped medium to longer term.

"While we have only – in the past few months – looked really seriously at targeting the Jets technology at the UK healthcare sector, we are very excited at the commercial potential there." hej