#PromisingProjects

World-class oncology hospital: boasts clever HVAC solution

By: Ilana Koegelenberg – assistant editor; with input by Duif Boshoff of Bingelela Consulting Professionals

The ground-breaking Richardsbay Medical Institute oncology hospital has an HVAC system that is truly something different, employing various unique designs to optimise energy-usage

The Richardsbay Oncology Hospital is equipped with a unique TrueBeam Full Field Photon Energy Accelerator for cancer radiation... a very first for South Africa – and Africa. The HVAC system had to be equally sophisticated to ensure the patients that fly in from around the world for this highly specialised treatment, were comfortable – and safe.

Client brief

The client specified the design of an HVAC system that conforms to all the latest SANS 10400 National Building Requirements and more, to make it an energy-efficient system.

System description

The oncology hospital's HVAC design is quite unique in a few aspects, including the fact that it is a two-pipe chilled water system with no AC hot water in the building. The winter heating is done by increasing the fresh-air-supply temperature when heating is needed. This means that there is mostly cooling in the hospital, with the only heating being in the plant room on the fresh-air units.


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1. *The ground-breaking Richardsbay Medical Institute oncology hospital.*
2. *60kW four-pipe energy raiser air-cooled chiller connected to emergency power.*
3. *HDPE pipes need more supports in comparison with black steel pipes but the need for rust prevention is eliminated.*
4. *The AC supply nozzles to the high level entrance lobby protect the hospital against hot air ingress.*


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In summer, fresh-air is supplied to the hospital at about 23°C to 24°C, but as soon as the temperatures start dropping in winter (which isn't often in Richards Bay), the fresh-air supply temperature is increased to about 28°C, using the fan coil units. Thanks to the reverse chiller, this can easily be done without wasting energy. The four-pipe chiller not only gives cold water, but also hot water on the condensing side (for free). Re-cooling is done, not re-heating. This means that fresh air is blown into the building at an increased temperature and then the cooling-only cassettes control the temperature, bringing it down. It's basically the exact opposite of a variable air volume (VAV) re-heat system.

The Bingelela Consulting team who took on this project, design a lot of clean rooms so they were familiar with the building requirements for a facility such as this, applying a lot of the same logic in their design.

The team made sure no expense was spared on the plant room, the back-bone of the system to ensure it complied with all SANS 10400 requirements. To achieve a balance in the system, simpler hideaway cassettes were installed.

All fresh air supply to the building is equipped with crossflow heat recovery with chilled water and hot water coils for fresh-air temperature and relative humidity control. There is a two-pipe chilled water system on the building and a four pipe on the plant room.

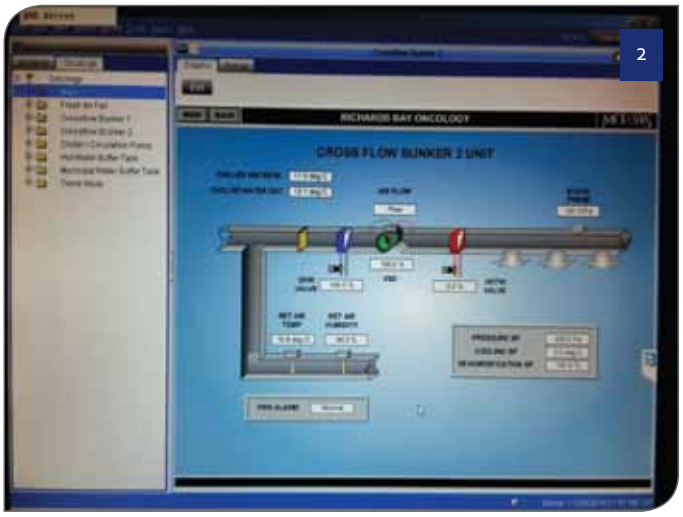
All pipe work is HDPE, no black steel pipes were used to prevent rust, which is quite a common problem in Richards Bay.

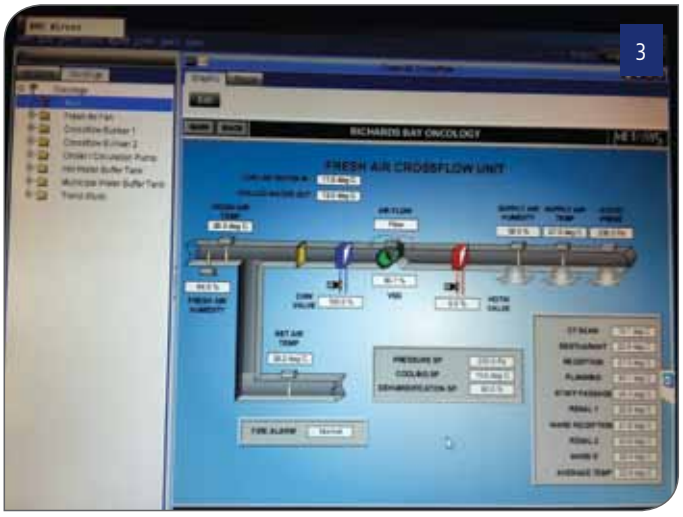
The air handling units (AHU) to the bunkers are 100% fresh air but heat recovery takes place by means of a crossflow box at Bunker 1 and run around a coil at Bunker 2. Crossflow was a must as there is ozone in the air, coming from the radiation machine, which needs to be exhausted to the outside. An energy-wheel wasn't an option here as it has a certain percentage leakage.

The chilled water, potable hot water, and potable cold water all run in a four-pipe ring main on each floor on a common cable tray. Two pipes are used for chilled water, one for hot water, and one for potable water. The entire piping system was designed by the Bingelela team and no specialised wet service engineers were needed.

There are no geysers installed at the oncology hospital; the hot water is provided by an open hot water tank. A continuous-flow heating system, using the heat

1. *Varian TrueBeam 3D imaging radiation unit.*
2. *BMS Radiation bunker temperature monitoring.*
3. *BMS fresh-air supply control with 10 zone temperature monitoring.*





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recovery water from one of the chillers is used for this hot water. The chiller water flows into an unpressurised, insulated, square tank with a lid on it (there is a separate square tank for the chilled water). If too much water is pumped into the tank, it spills over. All pipes come in from the top of the tank. In the hot water tank, the hot water supply from the reverse chiller is kept hot at 55°C (by means of the insulation). For the cold water that goes into the building, the water is split in the tank, going through a thin, medical-grade stainless steel coil. When it comes out on the other side, there is both hot and cold water. Because the hot water doesn't stand in a geyser or a tank, there is no risk of Legionnaires disease. There is a small pump on the hot water line to keep it going, always drawing the water around the ring slowly, ensuring instant hot water whenever a tap is opened.

Main fresh-air AHU with crossflow heat recovery and supply air duct to kitchen makeup air.

The chilled water backup is done in an insulated open tank similar to that of the hot water but with no stainless steel coils, just high level and low level pipes (6°C drawn from the bottom and 12°C returned to the top)

The hospital is conditioned by means of chilled water cassettes and hide-away units with pre-conditioned fresh-air supplied to all areas at about two air changes per hour (ACH) all around. This fresh air system runs from emergency power which

Varian TrueBeam 3D imaging radiation unit.

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means that cooled fresh air supply is maintained during load shedding.

A full building management system (BMS) controls the winter/summer conditions of the facility.

The fresh-air makeup for the kitchens (in front of the kitchen hoods) and the rest of the building, come from the fresh-air AHU with crossflow heat recovery from air gathered from toilets, stores, corridors, etc. Because it's a crossflow box and not an energy-wheel, it is possible to use the air from toilets as it will remove all smells. Then air from outside is also pushed through the crossflow box, going through a cooling and heating coil to be the perfect temperature. A large portion of this goes to the kitchen, pumping fresh, cool air into the kitchen as soon as the extract canopies are activated.

The centralised fresh-air system with supply air and return air is also all ducted to one point for energy recovery.

Challenges

The biggest challenge was successfully controlling the hospital with a two-pipe chilled water system, using expensive fresh-air AHUs but low-cost fan coil units (cooling only) throughout the hospital.

The open buffer tanks and stainless steel hot water coil was a challenge and especially to get the pump suction and supply heads working without using pressurised buffer tanks. This was but Phase 1 of the project with Phase 2 currently underway and Phase 3 scheduled for later in the year.

1. *Main 180kW air-cooled chiller (left) with the open top chilled water buffer plus potable hot water tank on the right.*
2. *Bunker 2's run around coils for fresh air AHU with HDPE pipes exposed for clarity.*

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List of professionals			
Owner		Schoonies Twee	Freddy Schoonhoven
Developer		Schoonies Twee	Freddy Schoonhoven
Architect / Designer		4D Architects	Fanus Nel
Project manager		4D Architects	Fanus Nel
Consulting engineer	Electrical	Motla Consulting	Danie van Wyk
	Mechanical	Bingelela Consulting	Duif Boshoff
	Wet services	Bingelela Consulting	Duif Boshoff
	Civil	Hokmah	Ian Loretz
Contractors	Main building	Jawet Construction	Johan Nel
	HVAC & R	Exland	Schalk Exley
	Electrical	Khulu Projects	Robin Vermaak
Product suppliers	HDPE Pipes	NRB Piping	
	Pumps	KSB Pumps	
	Chillers	Airco	
	BMS	Johnson Control	
	Buffer tanks	Orange/Afripex	

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TrueBeam technology

In addition to highly qualified oncologists and radiotherapists, the Richardsbay oncology department boasts the first Varian TrueBeam linear accelerator in Africa, making its approach to cancer treatment of a global standard.

The Varian TrueBeam integrates 3D imaging for extremely precise radiotherapy delivery. TrueBeam synchronises radiation dosage, real-time tumour tracking and imaging with millimetre precision. It delivers 3D-conformal radiotherapy, Intensity-Modulated Radiation Therapy (IMRT) and RapidArc radiotherapy. TrueBeam has an On-Board Imager (OBI) controlled by two robotic arms that rotate around the patient to create a 3D image to confirm the location of the tumour. TrueBeam then provides a precisely sculpted 3D radiation dose as it rotates 360° around the patient. The system continuously monitors the movement of the tumour as the patient breathes ('respiratory gating') and only delivers radiation when the tumour is in exactly the right place. This allows for a higher, more effective dosage amount without additional risk of side effects, including damage to normal, surrounding tissues.

The high precision and power possible with TrueBeam helps evolve radiotherapy and expand patient treatment options. RACA