>>> SEAN McGOWAN

How to chill a shark

What happens when Australia's largest marine theme park faces the prospect of a 40°C weekend and the water cooling system for one of its major exhibits requires urgent maintenance? The answer is a frantic, but well coordinated five day project with the ultimate goal of keeping Sea World's sharks and marine life cool and calm, reports Sean McGowan.

The reef lagoon at Sea World's Shark Bay. © 2008 and TM Sea World Property Trust

Shark Bay at Sea World, located on Queensland's Gold Coast, is the world's largest man-made lagoon system for sharks – an area of over one hectare which holds six million litres of water, and an array of shark species and other marine life from local and northern tropical waters.

The two-level exhibit provides spectacular viewing for visitors both above water level and below, through large windows, with the exhibit split into two pools – a tropical reef lagoon that visitors can swim with the sharks in, and a larger lagoon designed to replicate a natural sand-bottomed partial reef, home to the larger shark species.

Opened in 2003 at a cost of $14 million, Shark Bay at Sea World attracts over 1.5 million visitors each year.

Designed to hold a water temperature range of between 21 and 27°C, Shark Bay's custom-designed reverse cycle system had a required combined cooling capacity in the vicinity of 600kW.

But soon after completion, and on the eve of a predicted heatwave, the system was found to be in urgent need of maintenance. Sea World management were forced to find a quick-fire solution, or face the possibility of releasing sharks from the exhibit to avoid heat stress as the lagoon water quickly rose beyond optimum temperatures.

Who ya gonna call?

According to Chris Deaves, engineering coordinator with Warner Village Theme Parks, operators of Sea World, the requirement was simply to find a suitably sized chiller and associated equipment, and have it installed and operating before the expected heatwave forecast for the following weekend.

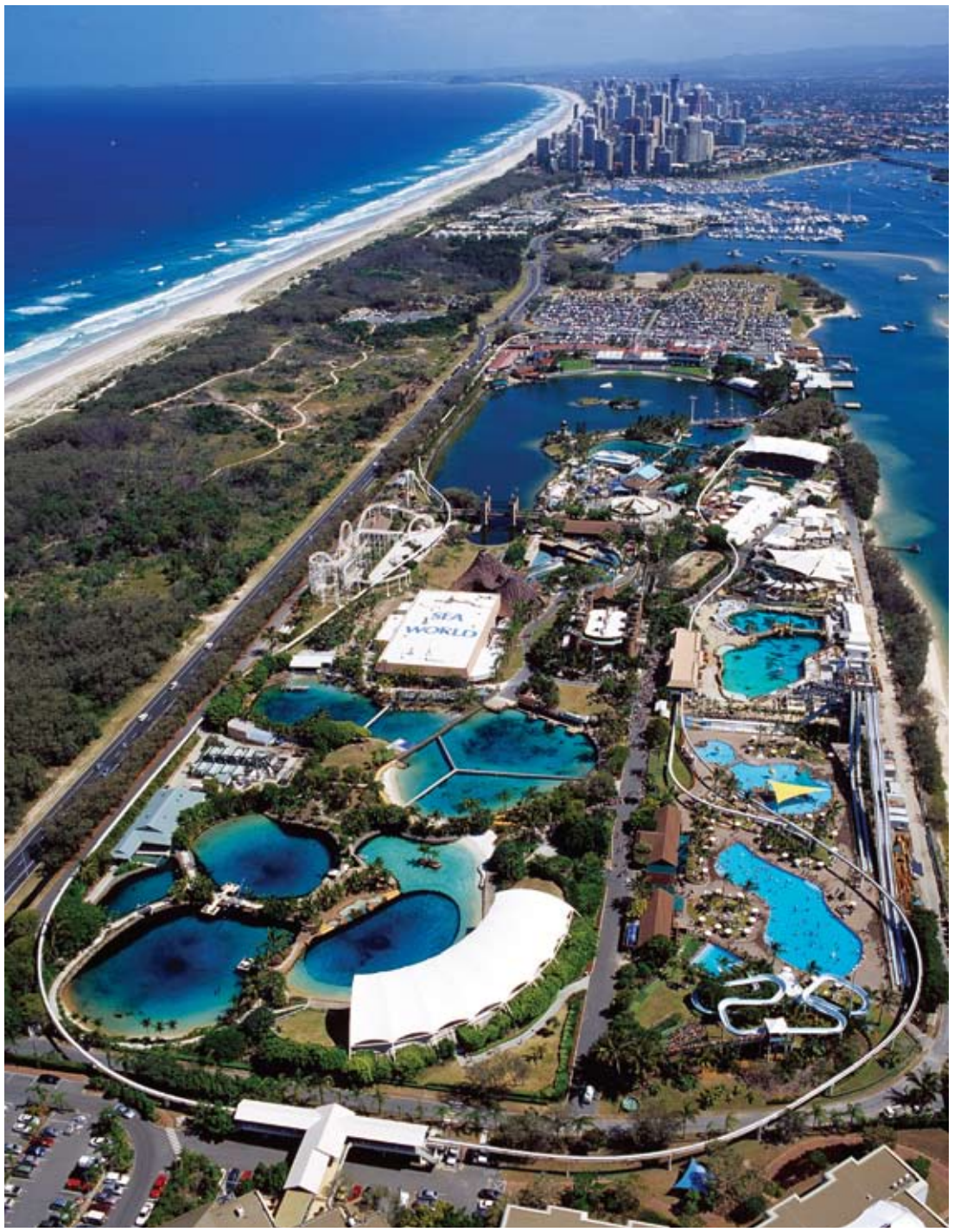
"On a Monday morning in the middle of summer, I received a call from Chris and Adrian Summers from Sea World, asking if we could assist," recalls Mike Palmer, engineering manager with Haden Engineering.

"They had asked their regular mechanical services company who had advised it was beyond their immediate capacity, and had accordingly searched bigger companies to see who could help. I suspect we were the first to say yes!"

Knowing the design capacity of the cooling plant that required urgent maintenance, Palmer set about the onerous task of procuring a chiller within the day.

"At first inspection, it would probably have been possible to procure a rental machine for installation, however, the client preferred to spend their money on something that would also be of future use (for the money that was being committed)."

Thankfully, he had been involved with a project at Princess Alexandra hospital in Brisbane (while working



Sea World: A view from the top. © 2008 and TM Sea World Property Trust

for Palmer Air Conditioning) that had a temporary air cooled chiller installed part way along the ring main to cover load in the precinct which the intended central energy plant was not yet completed to handle.

Armed with the knowledge that Haden had completed the central energy plant, Palmer took the punt that the chiller would no longer be required by the hospital, and set about trying to procure it.

"The advantages were that the chiller was originally installed with its own mechanical services switchboard and controls; its own circulation pump and associated fittings," he says.

Its location in a garden shed on the hospital grounds also meant its removal would be simplified. If the chiller could be acquired, Palmer was certain it could solve a number of other procurement and build issues facing the team with only four days to find a solution.

"After a number of discussions and telephone calls, and with the assistance of Queensland Health staff, the procurement of the chiller was approved from within the department. We really appreciated their assistance."

You can count on Murphy's Law

While a chiller had been located and procured, there remained some uncertainty as to its state. It had not been operational for some time, and it was not known whether refrigerant had been decanted and a nitrogen holding charge inserted or not.

Nevertheless, following demolition of the shed and chiller pipe, electricians, plumbers and transport people were called in to remove and transport the chiller to its new home at Shark Bay on the Wednesday morning, less than 48 hours after the initial call to Palmer, but also within two days of the Friday deadline.

Unfortunately, detailed engineering checks of the unit revealed that it would not have sufficient compressor cooling at the elevated water temperatures, a concern that had been at the back of Palmer's mind from the outset.

"At about 9.30am on the Wednesday, I concluded that we needed a heat exchanger, and to provide a primary/secondary solution. I had made a call to Alfa Laval for the preliminary selections when Chris rang me to advise that we needed a heat exchanger – to which I responded 'I know, now tell me your reason.'"

Deaves had learned that the sharks were intolerant of any significant dissolved copper concentration in the lagoon water, and as the procured chiller had copper tube work in the evaporator, this was a significant risk and concern. The heat exchanger would require a barrier between the copper components of the chiller, and the lagoon water.

"Experience had taught us that titanium was the only material to withstand the effects of warm chlorinated salt water in our environment," adds Deaves, who had also managed to get flow curves for the pumps and knew what pressure drop would occur with the new chiller, so was able to specify a heat exchanger for maximum performance.

Achieving peak performance from the new chiller was a major problem to overcome, considering the below 18°C return water temperature required (at the elevated ambient conditions), whilst the lagoon water was in the vicinity of 29.5°C.

On top of that, consideration also had to be given to its use in seawater, and given the expense the unit would also need to be robust enough to last for future use as well.

"The first indications were that it may take 6 to 10 weeks to repair the main cooling pl ant, and that this temporary plant would be required to operate 24 hours a day, 7 days a week until that plant was back on line. This is a significant period to build up fouling and corrosion in warm seawater," explains Palmer.

"In addition, it was determined that the exchanger may have to remain in service much longer (than anticipated) and long term corrosion resistance was an issue."

The solution was a stainless steel/titanium plate heat exchanger, but getting one built and on site in 24 hours seemed near impossible.

No ifs, buts or maybes

"I've been involved in a number of very fast track design and construct special projects, to the extent that they're almost routine," says Palmer, adding that the challenge is always to relate the urgency to other parties involved.

"Once people understand that this is a genuine need and that they can play a very important part, a sense of excitement and commitment builds and from there people will support each other far more than your average working arrangement."

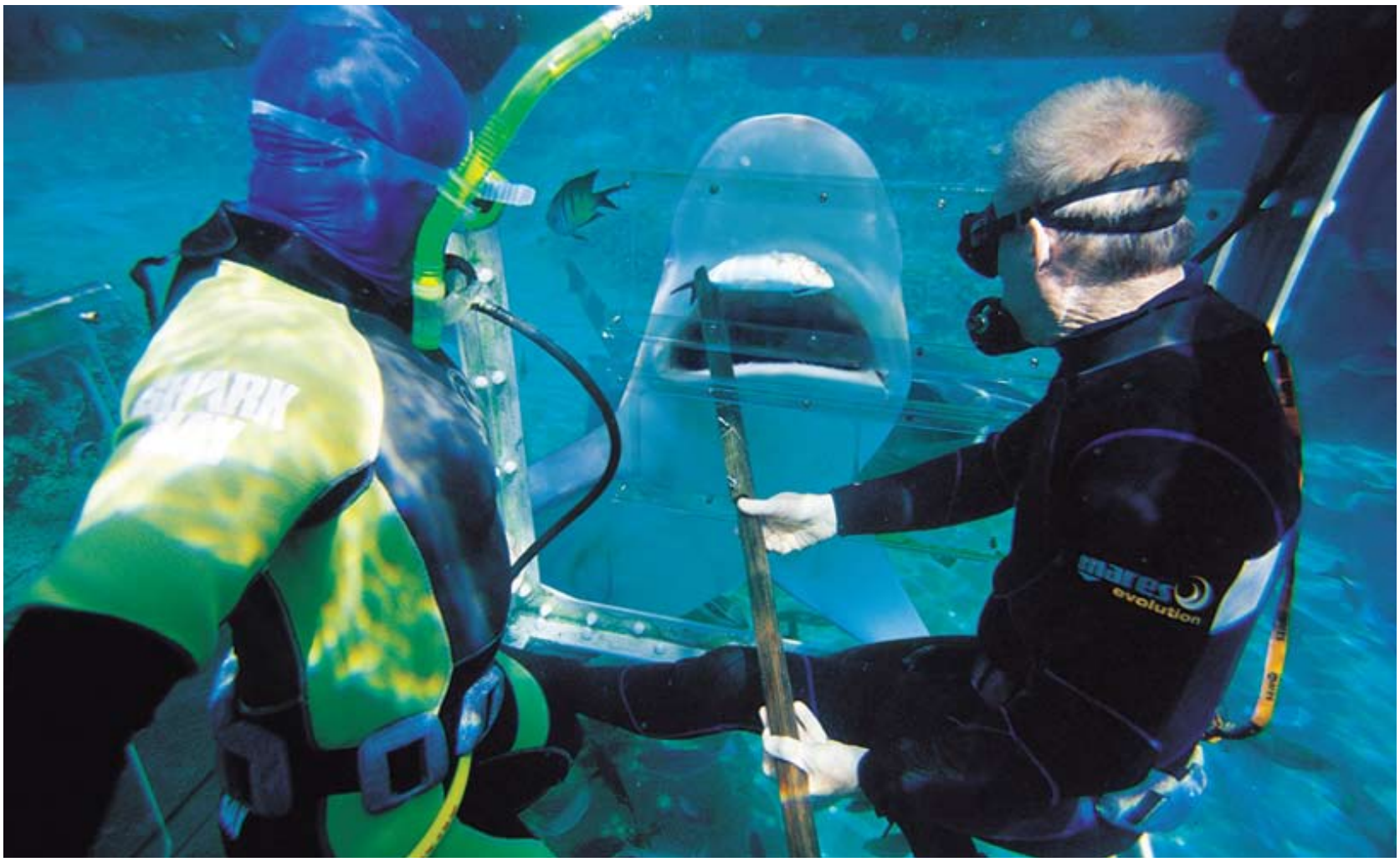
And so it was that Alfa Laval in Sydney, committed to a remarkable project.

Despite a worldwide shortage of titanium materials at the time, Alfa Laval staff quickly acquired the required components and worked through the night building the heat exchanger to spec.

"Due to the late hour of completion of the unit, we were unable to get a carrier until the morning, so our staff drove the unit down to the airport to get it on the first flight from Sydney to Brisbane," says Sandra Rossetto, manager comfort and refrigeration at Alfa Laval.

Later that day, the engineering team at Sea World took delivery of the heat exchanger and set about installing it, along with the chiller and a secondary pump suitable for the flow and pressure parameters calculated.

With the chiller installed, a technician performed all the possible checks including dry runs to ensure it



Getting up close and personal with a resident of Shark Bay. © 2008 and TM Sea World Property Trust

Mike Palmer

would be available for immediate start once charged with refrigerant when water was made available on the evaporator side.

According to Deaves, the chiller was set up with two water loops – a fresh water loop through the heat exchanger and the chiller vessel; and a salt water loop that is pumped through the other side of the heat exchanger back into the lagoon.

The team made a decision to tap into the system down stream of the filters, requiring an asphalt road to be dug up and piping laid under it, going back to the location of the chiller.

"The final 24 hours were labour intensive and the gaffer tape was out in force, but we did have everything on site that we needed. As the chiller hadn't operated for some time, we didn't know if it would start straight up," says Deaves.

It was mid-morning on the Friday; just hours before the heat would start affecting the marine life of the lagoon, that the chiller was switched on for the first time.

After just a few minor hiccups, it began performing, and the lagoon water temperature was soon maintained at 27°C.

The heat is on

Just as forecast, that weekend's temperatures soared into the low 40's on the Gold Coast, with the heatwave continuing well into the following week.

With the primary system running on partial capacity and the temporary system running at full capacity, the Shark Bay lagoon water temperature was maintained at 27°C, with no loss or harm to marine life.

Since then, the temporary system has been installed more permanently, with a further 750 kW of capacity also installed, along with an emergency power supply, such is the importance of the water temperature for this exhibit.

According to Palmer, it is a project that still gets talked about today.

He says the lessons learned were all the general, good practice project management tools of procurement and communication, and clearly defining to all parties what the end game was.

"Communication, communication, communication," asserts Palmer.

"Chris and I would have been on the phone to each other ten times a day. On top of that, almost anything is possible if you respect people for their abilities, give them the power to make decisions and pay a fair price for a product, particularly when you want it yesterday!" ▲