DESIGN AND CONSTRUCTION OF AN OZONATION FACILITY AT AN EXISTING WATER TREATMENT PLANT

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ABSTRACT

In June 2007 Bricon was one of three firms selected from an Expressions of Interest process to provide a tender for the design and construction of an ozonation plant to be located alongside Armidale's existing Water Treatment Plant. The tender was issued in August 2007 and closed on the 9th October 2007. The letter of acceptance was issued to Bricon at the end of November 2007. The value of the tender was $3.45 million.

Design work commenced immediately and preliminary design drawings were provided in January 2008. CHAIR (construction related) and HAZOP (operational review) meetings were held and a final design provided for Council's approval in March 2008.

Construction commenced in April 2008 with site clearance and excavation and the new facility was essentially complete in December. Unfortunately problems with equipment from Wedeco, who provided the ozone generators, injectors and destructor, delayed completion of commissioning until February 2009.

During the whole of this process the contractor's local knowledge together with continuing feedback from plant operators and Council's engineers and supervisors led to a number of changes that made the completed facility easier and more pleasant to operate.

1.0 INTRODUCTION

Figure 1: ***Site Plan Showing Location of Proposed Facility***

The technical requirements for the proposed new ozonation plant were based on investigative work, including pilot testing, undertaken by Council's consultants, Hunter Water Australia (HWA).

This specified the location, the hydraulic profile and the operating parameters governing the design, including maximum and minimum flows, ozone dosing requirement, retention periods and ozone residuals both in the water returned to the main plant filters and any discharges to the atmosphere.

Because the new facility would be close to houses located on the periphery of the plant and overlooking the site, noise generated by the facility when complete was of particular concern and to a large extent dictated the orientation of the building, materials used for construction and the treatment of any ventilation and access openings.

It was extremely important not to interfere with the operation of the Water Treatment Plant, the sole source of potable water for the City of Armidale. Close cooperation with plant personnel was essential to ensure that deliveries of chemicals and other necessary supplies were not affected and that any physical connections to the existing plant, for example the outlet from the settled water channel, had to be scheduled for periods when the plant was not producing water. Fortunately, the fall off in demand for water in recent years meant that this requirement caused very little problem.

Because of the tight contract timetable, it was necessary to allow for construction to be undertaken progressively as the detailed design was being finalised. This is one of the distinct advantages of design and construct contracts over other forms of project delivery.

Construction operations involved coordination of both local and regional subcontractors and international suppliers. As ozone is extremely corrosive all pipework and other equipment in contact with the ozonated water needed to be stainless steel or other resistant material.

2.0 DISCUSSION

2.1 Tender Submission

In submitting a tender Bricon possessed a number of advantages that it was hoped would manifest themselves in our bid. We had undertaken a number of projects, similar in both scope and size, in the surrounding region, including water and sewerage treatment plants. Being a local firm we have always had close and good relations with Armidale Dumaresq Council and having worked on previous projects at the Water Treatment Plant had an intimate knowledge of its layout and operating philosophy. Although we had no experience with ozonation equipment we have a close relation with ITT, the Australian arm of Wedeco the ozone equipment manufacturer, and the ability to undertake design of civil, mechanical and electrical work in-house.

Our submission conformed to the many constraints imposed by the tender. These included locating the plant to the south of the existing plant on a sloping site; having water from the settled water channel to west of the sedimentation tanks gravity fed into the ozone contactor, with the ozonated water pumped back to the filter block; the responsibility to ensure that the day-to-day operations of the plant were not interfered with and the requirement to minimise noise both inside the building and at the boundaries of the site.

At the time of tender ozone equipment of the size and scope required was only available in Australia from two firms Wedeco and Ozonia. Wedeco is a German company owned by ITT and Ozonia is based in Switzerland and operates through an Australian agent.

However, just prior to the time when the tender was called Ozonia had changed its Australian distributor and the new agency was unable to provide any meaningful assistance.

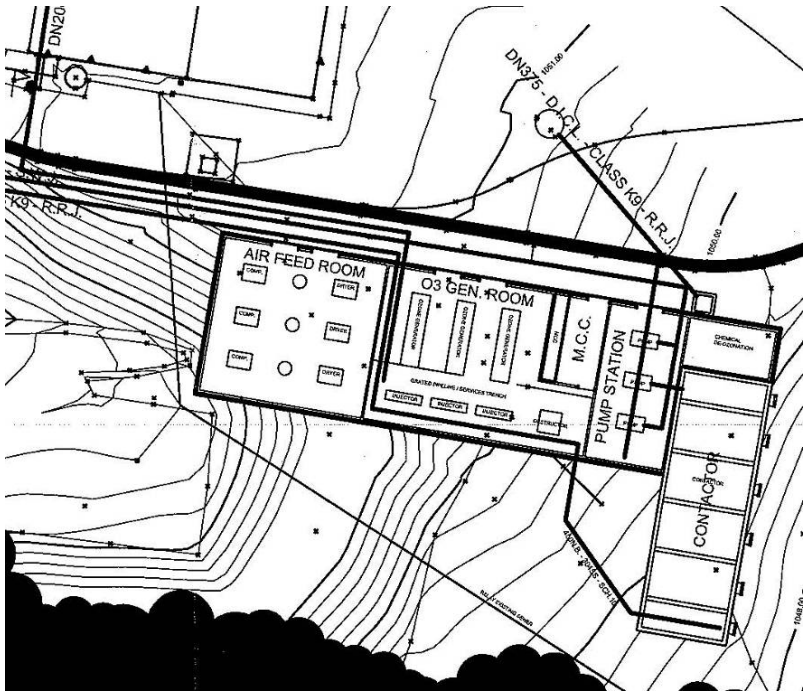

Figure 2: ***Tender Layout***

In preparing the tender we followed a few basic principles. Ease of access is important both in terms of gaining entry to the front of the buildings for the delivery and further down the road, the removal, of electrical and mechanical equipment. Internally sufficient room had to be allowed around key items for ease of maintenance. This means providing buildings that have plenty of available space without making them excessively large. As a follow on from this, it is essential to ensure that equipment is as easy as practically possible to maintain, for instance by minimising bending and stretching and having electrical equipment where possible as a plugged in item rather than being hardwired, so that removal or replacement can be undertaken without having to call in an electrician. To minimise noise the location of ventilation and other openings and their treatment was vital as the plant has an extremely low background noise level. With this in mind we placed all of the doors and the ventilation inlets on the on the north side of the buildings facing the WTP and utilized acoustically baffled inlets. The building ventilation outlets on the roof are surrounded by an acoustic enclosure for the same reason. Given the nature of the site our design attempted to minimise the volume of excavation by locating the plant as far east on the sloping site as possible and placing the ozone contactor, the deepest unit, at the lowest point as shown on the tender layout. This also facilitated noise reduction by effectively "digging–in" the structures and utilising the natural sound attenuation properties of the embankments.

As with any tender it is essential to reduce the number of unknowns. These can impact the price and result in the loss of the tender or later when construction starts lead to conflict between contractor and client. This was part of the reason for reducing excavation as no matter how extensive the site geotechnical investigations are, latent conditions are normally some of the chief sources of additional costs.

As well, we thought it necessary to clarify points in the specification and submitted 33 requests for information during the tender process. Although this might seem to be excessive (I am reliably informed that our competitors submitted no more than half a dozen between them) they were invaluable tool that allowed both sides to come to a better understanding of the precise contents of the final package and any pricing impacts before the contract was awarded.

With this information to hand we were able to submit a very detailed tender that provided Council with a clear idea of what our offer contained, including elevations of the building that showed that they were architecturally compatible with the brick and concrete structures of the existing plant. Drawings with the tender included a site layout, a detailed plant layout, elevations and six process and instrumentation (PID) drawings that illustrated in detail how the plant would operate. The advantage of PID drawings was that they also greatly enhanced our own knowledge of how the plants would operate and allowed us to obtain more accurate budget prices from suppliers.

2.2 Preliminary Design

As soon as our tender was accepted we commenced a close dialogue with Council and their consultants to refine the design and address any unresolved concerns arising from our layout. One of the main points raised was that the length of the settled water pipe between the ozone injection point and the contactor. For most efficient treatment ozonated water should be disbursed into the contactor as soon as possible.

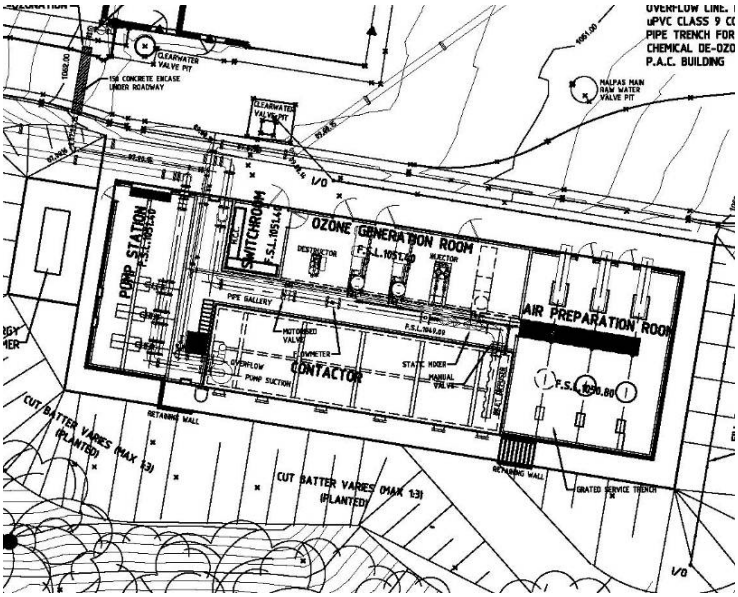

Figure 3: ***Final Layout***

Reviewing our proposal we found that by swapping the pump station and the air feed room, moving the whole complex to the west and constructing the contactor alongside the ozone generation room we could save pipework costs and provide a layout that met the client's demands without incurring significant extra expenditure. However, with this new layout and the fairly tight time schedule imposed by the contract we were forced to make use of precast panels as permanent formwork for the contactor and other areas to allow for concurrent construction by the various trades. The final layout drawings show how the facility has become more compact while retaining functionality.

Output

Once the final plan was arrived at the internal layout of the contactor was refined utilising computational fluid dynamics modelling. The flow through the contactor has to be structured so that it an even, up and over, plug flow is produced that ensures all of the water spends at least 10 minutes in the contactor to allow ozone treatment to work. Our tender allowed for two computer runs to validate the design. ADC then paid for an additional two runs to check improvements suggested by HWA. The picture above shows the output from the final computer run.

2.3 Design Workshop

Based on the new layout the other drawings were revised and circulated to Council engineers, supervisors and operators and the consultants as the basis for discussion at a HAZOP meeting. This meeting used the PID drawings as a template for plant operations that allowed all of those attending to first of all understand how the plant worked and then to make a meaningful contribution to improving various aspects of those operations.

Recommendations that came out of the meeting included: the need for a motorised stoplog located in the settled water channel to prevent drawdown and scouring of the channel when the ozonation plant restarted; a gas analyser in the lower level pipe gallery in the ozone generator room to provide additional warning should an ozone leak occur (ozone is heavier that air); an air flowmeter on the discharge from the ozone destructor to provide an idea of how much air is being discharged to atmosphere and warn against failure; the development of a procedure by ADC for access to the ozonation plant buildings as well as numerous other minor operational and safety improvements. It also provided an opportunity for Council to rationalise on the amount of monitoring instruments thereby saving on both initial costs and the recurring cost for routine maintenance and calibration.

2.4 Detailed Design

Following the HAZOP meeting detailed design drawings were provided. The process of improvement continued and a number of further modifications were included following discussions on site. These discussion included operators who had been unable, for one reason or another, to attend the HAZOP meeting.

These included providing washdown pipework to the south side of the contactor to allow for the cleaning of the contactor. A stainless steel strainer was provided on the cooling water delivery pipework after it was noted by one operator that the backwash tank from where the supply was taken had a history of dirty water from time to time. A level transmitter was also installed in this tank to provide a more accurate record of how much water it contained (previously it only had a high level alarm). For better visual surveillance the installation of windows between the ozone generator room and adjacent rooms was proposed.

2.5 Construction

Just prior to the start of construction ADC added the construction of a new backwash water sump pit and the installation of new backwash pumps into the contract. This work was initially intended to be undertaken as a separate contract, possibly using in-house forces, but ADC realised that there were significant advantages to bundling this work in with the main contract. Similarly, they also added the work needed to upgrade the

electricity supply.
During the construction period regular monthly site meetings were held at the Water Treatment Plant. These were attended by the WTP's lead operator plus any operator on shift at the time (subject to the exigencies of WTP operations). ADC made sure that their operators were available for consultation on site by putting all of them through a construction safety induction course. The Contractor also made it clear that they invited critical comment at any time on the design and the work-in-progress to ensure that as many operational issues that may come up later were identified and addressed early, allowing changes to be included often for no additional cost.

The meetings continued to provide ideas for improvement to the long term durability and ease of operation of the ozonation plant. A concrete floor coating was added to minimise problems with slipping, and the walls and ceiling, originally bare concrete were painted white to increase the lighting levels inside the buildings and enhance the working atmosphere. The outside of the building facing the WTP was also painted to improve the aesthetics of the building. On the functional side a compressed air line was extended from the new air preparation room into the existing WTP and connected into an existing air receiver in the filter gallery. This will let ADC decommission the air compressors in the WTP, saving on running costs and maintenance.

As is normal in this type of retrofit construction the opportunity was taken to make minor low cost improvements to the existing plant, taking advantage of the presence of a contractor on site. New doors were installed to the filter gallery and the chlorine room. The road between the ozonation plant and the chemical block was concreted to enable it to withstand the heavy traffic associated with chemical deliveries. Similarly a failed section of road alongside the PAC dosing facility was concreted after installing pipework to improve drainage. The area outside the front of the chemical block had new asphalt laid to replace the existing cracked and deteriorated asphalt and improve surface drainage.

3.0 CONCLUSION

The successful implementation of the ozonation plant project highlights the importance of involving all participants, the client's engineers, the consultants, the contractor's staff, the treatment plant supervisors and the operators in the design and construction process from the start. In a retrofit project when the contractor is operating on an existing site this will involve both formal processes such as HAZOP meetings and monthly site meetings as well as more informal discussions with operators on a day-to-day basis. Whilst it is important that any suggestions are acted on via standard contractual pathways, the added value of this type of input has contributed greatly to the final product, a modern, high technology, user friendly water treatment facility.