

**AQWEST PLANT CHLORINATION:  
EFFICIENCY – SAFETY – ENVIRONMENTAL  
PROTECTION:  
AN OPERATIONAL SUCCESS**



*Paper Presented by :*

**Jeff Nock**

*Author:*

**Jeff Nock, Supervisor,**

Aqwest – Bunbury Water Board



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# **AQWEST PLANT CHLORINATION : EFFICIENCY – SAFETY – ENVIRONMENTAL PROTECTION :AN OPERATIONAL SUCCESS**

**Jeff Nock**, *Supervisor*, Aqwest – Bunbury Water Board (WA)

## **ABSTRACT**

This paper is concerned with an approach adopted by Aqwest in regards to the process of chlorination at each of its six (6) water treatment plants. The paper draws from historical data maintained prior to the implementation of the new strategy, and data acquired over two, five year contract periods during which particular attention was paid and records maintained in terms of several critical elements. These elements included OH&S, staff training, and environmental issues, optimising treatment plant operations, produced water costs, water quality deviations, gas release incidents and emergency response.

Linkages are identified between a sole operator concept and that of utilising a cooperative principle including chlorine gas and equipment service providers. We see that the outcomes achieved demonstrate the degree to which optimisation of chlorination systems in a whole of life plan can provide significant benefits to all parties concerned. At the same time the key issue of quality and costs to the consumer can be predicted for the long term and associated costs forecasted accurately for terms in excess of five years.

Finally, the conclusion is that the overall chlorination process can be moulded to suit many applications with the same level of predictable benefits and the same or greater level of reduction in perceived hazard.

## **1.0 Introduction**

### ***Aqwest (Bunbury Water Board)***

Bunbury Water Board was formed in 1906 as a division of Bunbury City Council. In 1996, the Water Board formed its own corporate image and Board of Management with the responsibility for all aspects related to the provision of water services within Bunbury and some surrounding regions which became known as AQWEST Bunbury Water Board.

Bunbury is a vibrant expanding City located on the west coast, approximately 160 km's south of Perth in Western Australia and has a current population of over 35000 and growth rate averaging 2.5% per year



**Figure 1:** Major WA Population Centres



**Figure 2:** Aqwest Region

Overview of current infrastructure operated and maintained by Aqwest is as follows:

- (12) Production Bores
- (6) Water Treatment Plants
- (4) Reservoirs
- (7) Booster Stations
- (330 ) km's of water mains
- (14000) connected services

### **Production Capacity**

The current peak daily demand for water is approximately 36ML day with average daily demand at approximately 19ML day.

All water within the region is sourced from bores. The water generally contains levels of iron and manganese which are beyond the allowable levels within the Australian Drinking Water Guidelines 2004. As such all produced water is filtered and disinfected prior to storage. Iron & Manganese coated media process in simple terms is the process involving perchlorination prior to filtration such that a coating of manganese dioxide is maintained on the filter media. Chlorine control is essential in ensuring good water quality and preventing dirty water complaints.



**Figure 3:** *Aqwest Region and Systems*

## 2.0 HISTORY OF CHLORINATION IN THE REGION

In 1987 and in accordance with Government directives, it was decided to implement disinfection for all water supplied within the region. The alternatives at the time were carefully considered with the resultant outcome that chlorine gas would be utilised.

The decision to use gas chlorine as a disinfectant provided additional benefits in the water treatment process. This allowed Aqwest to initiate the coated media process to more effectively remove manganese.

In conjunction with chlorination, the implementation of Dyna sand filters was effected.

### 2.1 Initial Chlorination Implementation

At the outset, the staff of Aqwest Bunbury Water Board had no previous experience with chlorine gas. As such it was necessary to commence the implementation based on the experience of others and supplier support. As the installations of each of the treatment facilities progressed, a variety of chlorination equipment was used determined at the time by cost or perceived features.

Whilst the water treatment processes improved to a significant degree, it became evident over time that an unacceptable level of resource was required to maintain the chlorination systems in a safe and operable condition.

Additionally, the impact of unreliable chlorination caused additional concerns –

- Population growth and subsequent encroachment of residential areas adjacent to the treatment plants may result in potentially greater public risk from gas releases
- Chlorination failure resulted in mandatory plant shutdowns and subsequently the necessity to pump water outside the planned off-peak electricity tariff periods.
- An overall review of the chlorination systems and processes were required.

### **3.0 CHLORINATION OPERATIONS REVIEW**

In 1994, Bunbury Water Board (Aqwest) committed to a review of the chlorination processes in order to identify the key issues affecting the provision of services.

#### **3.1 Strategic Considerations**

Discussions were held between the Management of Aqwest and Orica with view to forming a partnership incorporating the supply of chlorine and chlorination equipment. The key driver was the risk perceived by Aqwest relating to the operations and maintenance of chlorination systems. It was considered as non core business for Aqwest considering the lack of staff long term experience with chlorination systems.

The discussions were conducted in an informal atmosphere where a variety of options were raised without commitment from either party. It was clearly understood at the outset that any proposal that was developed would have to be referred to the market place to achieve an open tendering process.

The scope of the review required analysis of the chlorination systems and related process issues, identification of items requiring attention in order of priority and development of a scope outlining remedial action required.

#### **3.2 Review Criteria**

The following key issues were identified within the review as elements of particular concern that impacted to a significant degree on the ability of Aqwest to deliver quality cost effective services to the community or potentially cause risk to staff or residents.

- Regular gas leak incidents
- Limited emergency support
- Equipment reliability
- Non-uniformity of equipment
- Lack of adequate local support (technical or spares)
- Quality problems with gas and injection equipment
- No supplier based system engineering or process support
- Instability of prices for equipment and chemicals
- Staff skill levels and lack of confidence in the system.

#### **3.3 Review Outcome**

After evaluation it was decided to source a second party service provider with whom Aqwest could form a partnering arrangement. It is intended that this partner provide all services required by Aqwest, including chemicals and equipment.

The arrangement to be negotiated for a fixed term with all costs to be incorporated thereby with the intent that there would be a direct relationship between cost of service and water produced. Apart from the contract value, the key elements were to be **technology, expertise and ability to deliver**.

### 3.4 Aqwest Requirements

- Fixed price term contract for the supply of chlorine gas
- Assured continuity of chemical supply with inbuilt logistical management
- Standardised chlorination equipment with documented history and references
- Standard operational system philosophy for each plant
- Regular service integration
- Local engineering & service support by reputed company
- Assurance of local availability for equipment and spare parts
- Integration of training programs for Aqwest staff on a regular basis
- Initial and ongoing design support to negate hazards and assist with plant improvements

### 4.0 SELECTING AND APPOINTING THE SERVICE PROVIDER

At the outset, Aqwest produced a document outlining the operational requirements, contract responsibilities and scope of works required to complete the implementation. This document was released to suitable tenderers and assessed on the following basis:

1. History in the region
2. Relationship with equipment supply & service company
3. Local chlorine storage and evidence of logistics management
4. History of proposed products (Quality and ability to deliver)
5. Service support references
6. Company stability
7. Value of offer
8. Ability with support services including credentials for training and emergency response.
9. Design capability
10. A demonstrated focus on entering into a cooperative partnering arrangement with an understanding of the positive outcome intended for all parties.

In 1995 after the tender review and interview process, Aqwest appointed **Orica Chemicals** as the provider of chlorine and associated services. This appointment incorporated the third party nomination of **Hydramet Pty Ltd** as the provider of Wallace & Tiernan chlorination equipment and services including equipment installation, service, engineering support, training and emergency response. The contract provided for an initial period of (5) years during which time Aqwest would pay a fixed rate per kg for chlorine gas. Integral with this cost and based on previously calculated annual gas consumption was the provision of new equipment for all sites, installation of this equipment and all services as required within that period.

## 4.1 Initial Program

Commencing in June of 1995, the installation of new chlorination equipment was carried out at all of the treatment plants. This included replacement of peripheral equipment including control valves, associated electrics, boost pumps, pipe work and other minor items as may have subsequently interfered with system operation over the following 5 years.

The system design and equipment selection for all plants included prime consideration at all stages for safety, risk reduction, uniformity of equipment across the sites and potential for future integration of additional control or monitoring features.

Safety shutdown systems were fitted to all chlorine containers at all sites. This feature ensures that in the event of a gas leak the chlorine is isolated at the source

The supply of new equipment included the provision of spare complete components to allow immediate change out if required. This included chlorine regulators and complete shutdown systems

As part the initial implementation, comprehensive chlorine awareness and operator training was provided to all Aqwest operations staff. Procedures as related to operation of the system, chlorine drum changing and incident response were upgraded to reflect current procedures and relevant regulations. Operators were continually involved at all stages of the installation and participated in all phases of systems commissioning.

## 5.0 REVIEW

The benefits of the integrated supply and support contract became immediately evident after commissioning. These can be summarised as follows:

- Chlorine leak incidents reduced immediately from 1-2 per week to nil in 2005.
- Operators' maintenance involvement reduced from 6-10 hours per week to nil in 2005.
- Operations staff used gained time to improve plant efficiency and monitoring
- All routine maintenance was carried out in accordance with Aqwest requirements
- Optimisation of chlorine use was achieved resulting in cost reductions in real terms
- Treatment plant shutdown due to chlorination failure did not occur
- Operators gained confidence in the chlorination system and all associated duties including drum changing and system operation
- Better equipment allowed more precise measuring of chlorine injected into the filters.
- Training of staff every 12 months in safe handling of chlorine.

The equipment integration also included for treatment plant enhancements to improve the efficiency of the filtration plant and flexibility in operation The primary change in this respect was the allocation of (1) chlorine injector for each individual filter and the ability to allow individual control of gas flow to each unit. This design modification alone allowed a considerably higher standard of control and water quality and the flexibility to remove individual filters from service if required without plant overall interruption.



**Figure 4:** *Chlorine Injection Network*

## 5.1 The Chlorine Gas Option

The experience gained through the implementation of the chlorination systems demonstrates that chlorine gas can be applied with significant benefits over other forms of disinfection and can be used safely in residential areas providing that the available technologies are integrated along with the support of specialist companies with a focus on chlorine supply and application. Operations staff that in the past possibly feared involvement with the gas systems today are comfortable with the systems, work with a thorough understanding and appreciate the benefits of the technology. Since the introduction of these chlorination practices, Aqwest have had no biological water quality deviations outside the water quality guidelines.

At the end of the first 5 year contract, the benefits were considered to be highly visible. Based on this a further 5 year contract was negotiated. This included the upgrade of all chlorination equipment again, thus ensuring that the systems included any new technology and features as may be required for future treatment plant enhancements.

## 6.0 THE FUTURE

The chlorination systems at all treatment plants are operating efficiently, accurately and without leak incidents.



With a projected population growth of approximately 2.5% and the subsequent encroachment of residential areas within the previously designated buffer zones around the water treatment plants, an ongoing focus and attention is required to the safety issues in respect of the chlorination plants.

Aqwest has paid particular attention to investigation and implementation of features which will enhance safety. In the past 12 months this has resulted in the installation of carbon filled chlorine gas absorption columns to all the safety relief systems on gas regulators at all sites. Since the installation of these, there has been no verifiable chlorine leak alarm from within the system. This feature has not only reduced the potential for chlorine impact on the public but further reflects the concern that Aqwest displays for environmental issues within its area of operations.

The stability of these systems due to the cooperative contract arrangement has allowed Aqwest to focus on other issues directly affecting plant operations and look to the future in planning other improvements.

The next stage of development will include the integration of full remote monitoring and control to all aspects of the water treatment plants. This will allow the collection of live data including chlorine residuals, chlorine container weight and chlorine concentration in the event of a release. Consideration of this implementation would not have been practical if there had not been a resolution to the uncertainties associated with the chlorination systems.

To the credit of all those concerned the outcome was based on the best technical and management solution. This was designed to utilise the best equipment, expertise and risk management capacities of the various parties involved.

The long term performance of the negotiated contracts would suggest that the strategic outcomes were successfully achieved.

## **7.0 ACKNOWLEDGEMENTS**

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