

# **Water Treatment Program Manual**

**7<sup>th</sup> Revision, June 2014**

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## SECTION A - WATER TREATMENT PROGRAM OUTLINE

### 1.0 History of Program

The Government of Alberta has had a Water Treatment Program for as long as it has had buildings and power plants. Initially, the program was informal in the sense that no documented processes or procedures were in place to ensure standardization or consistency of the program application. Over time however, system modifications and advanced technology has brought about change to how the government administers this program.

In 1977 Property Management Division representatives from across the Province met to discuss the need to modify the program, with a profound emphasis on the importance and value of proper maintenance and conditioning of the building systems. It was also determined in what form those modifications should take. Discussions were later held at managerial level meetings in order to obtain department wide input and support for the proposed changes, eventually resulting in the first publication of the Water Treatment Program Manual.

In the early 1980's the government embarked on an initiative to privatize the property management of several owned buildings. The privatization of buildings resulted in contracted staff now being responsible for performing daily water testing and treatment. Recognizing the need to preserve the water treatment program within these facilities, the government engaged the services of a private consultant with extensive knowledge and experience in the field of water treatment and charged them with the responsibility to oversee and ensure ongoing compliance with the program primarily related to the outsourced buildings. The consultant also acted as a resource to in-house operations staff on a request basis.

In May 2008 Property Management elected to recruit a Water Treatment Specialist. This position effectively replaced the services formerly provided by the private consultant and captured the overall responsibility for technical assistance to operators and managers for in-house and outsourced services alike.

In April 2009, the Water Treatment Committee enhanced it's effectiveness through the introduction and formal participation on the committee of representatives from four of the major stakeholders managing our outsourced properties.

To ensure an understanding of the system operations, water testing and treatment, and familiarity with the government program, a training course was developed for the benefit of contractors and government staff involved in water treatment. This training is provided on an annual basis with interim guidance and instruction made available through the Water Treatment Specialist or Water Treatment Co-ordinators as required. In association with this training a manual is available and may **be found using the following link.**

<http://www.infrastructure.alberta.ca/Content/docType306/Production/WTComplete.pdf>

## ***History of Program (cont'd)***

The Government Water Treatment Program Manual was developed in April 1984 emphasizing the use of generic chemical treatment as a standard policy. It has since undergone several revisions in order that the information contained therein remains current, accurate and appropriate for application to the operation and maintenance of water systems in government buildings. Over time, several systems have adopted the use of proprietary treatment as an alternative, primarily as a result of generic treatments no longer being the best option available of producing adequate protection. In addition, technological advances in the development of chemical treatments has proved some proprietary treatments are now preferred and not only provide superior protection but are more stable treatments allowing less frequent testing and addition of treatment product, while not increasing the risk of system deterioration.

The GOA continues to encourage the use of generic treatment where possible. Where proprietary treatment programs are in use or under consideration, it is incumbent upon the operators to fully understand, which product is best suited for the specific application, its properties, harmful effects to personnel (MSDS) and environmental consequences. In all cases where proprietary is used, the treatment must be first authorized by the GOA Water Treatment Specialist and reviewed by the respective Water Treatment Coordinator.

The dates and purpose for the revisions are as follows:

**Revision 1** of the Water Treatment Program Manual was issued in January 1995 in order to accommodate the administrative, personnel and technical changes that occurred since the 1984 edition.

**Revision 2** of the Water Treatment Program Manual was issued in January 1997 in order to include Section I — Environmental Guideline.

**Revision 3** of the Water Treatment Program Manual was issued January 2000 in order to accommodate technical changes that had occurred since the 1997 edition.

**Revision 4** of the Water Treatment Program Manual was issued April 2004 and was updated to reflect technical changes and the addition of the Potable Water System.

**Revision 5** of the Water Treatment Program Manual was issued October 2005 and was updated to reflect a change of department name from Alberta Infrastructure to Alberta Infrastructure and Transportation.

**Revision 6** of the Water Treatment Program Manual was issued March 2010 and was updated to reflect technical updates.

**Revision 7** of Water treatment Program Manual was issued June 2014 and was updated to reflect technical updates.

## 2.0 Purpose of Program

The purpose of the Water Treatment Program is to prevent deterioration of the water systems in Alberta Government buildings that are managed by or on behalf of Alberta Infrastructure. This is a formal standardized Water Treatment Program. It is called the WATER TREATMENT PROGRAM because it deals with the preconditioning of system water, water test procedures, water test reagents, water test apparatus, and scale & corrosion inhibitors. All of these items have to do with the prevention of corrosion, scale formation, and other related forms of deterioration of the water systems.

An important purpose of the Water Treatment Program is to support the department's commitment to demonstrate Environmental Stewardship. As opportunities arise environmentally friendly treatments and best practices will be evaluated and implemented where feasible.

The program emphasizes the mechanical aspects of preventing system deterioration as a significant part of the overall success of any chemical treatment. This includes such activities as eliminating water leakage from the system, eliminating air leakage into the system, dealing with low pressure points in the system, checking circulation in the system, etc.

In fact, the order of events in the program is as follows:

- (a) ensure water systems are mechanically correct in design, operation and maintenance;
- (b) ensure all water that is put into the water system is preconditioned to ensure good quality;
- (c) treat the water system with chemicals as required to prevent system deterioration.

Experience has shown that if items (a) and (b) are knowingly and diligently adhered to, item (c) can be optimized for greater system efficiency. One of the prime sub-objectives of the program is to reduce chemical consumption, thereby increasing cost effectiveness.

**Any changes to existing systems water treatment must have prior written approval from Alberta Infrastructures Water Treatment Specialist**

### 3.0 Program Personnel

The people who will be most involved in the Water Treatment Program are:

#### 3.1 Alberta Infrastructure Managers

The Manager in each area carries the ultimate responsibility for the operation, maintenance and condition of the water systems. The Manager is expected to be familiar with the services and resources available through the Water Treatment Program, their Water Treatment Co-ordinator and the Water Treatment Specialist. It will be their decision as to how these services and resources are used in their respective areas. Each Area Manager must appoint and support a Water Treatment Co-ordinator for his area.

#### 3.2 Property Management Firms - Managers

The Property Managers of the firms responsible for the condition of the water systems in buildings managed on behalf of Alberta Infrastructure. They are required to be familiar with the Water Treatment Program and the Water Treatment Training Manual. They ensure any recommendations of the Water Treatment Specialist are followed and report all water treatment related issues to the respective Alberta Infrastructure Manager. Each Manager must appoint and support a Water Treatment Co-ordinator for his area.

#### 3.3 Building Operators

The Building Operators in the facilities carry out the day-to-day operation and maintenance of the water systems. They are expected to know the kinds of services and advice that are available from their Water Treatment Co-ordinator and the Water Treatment Specialist. They are encouraged to attend any relevant water treatment training seminars to stay current with water treatment practices.

#### 3.4 Water Treatment Co-ordinators

The Water Treatment Co-ordinator is responsible to their respective Manager for the overall success and viability of the program in their area. They are required to be familiar with water treatment basics, have a good understanding of water systems, have access to water testing equipment and be free to occasionally visit facilities throughout their assigned area.

Specifically, the responsibilities of each Water Treatment Co-ordinator will be as follows:

- (a) They are encouraged to attend any relevant water treatment training seminars to stay current with water treatment practices;
- (b) Act as a Technical Resource and support for Building Operators;

## ***Program Personnel (cont'd)***

### ***3.4 Water Treatment Coordinators (cont'd)***

- (c) Perform periodic field visits to check the systems and issue a written report of findings and recommendations to the Manager;
- (d) Act as a liaison with the Water Treatment Specialist.
- (e) Update the inventory of building water systems on a semi-annual basis.

### **3.5 Water Treatment Program Committee**

The committee functions as an ongoing technical resource to management and operational staff, providing training, advice, guidance and support related to water treatment in all government owned buildings. Each Area within Property Managements regionalized organizational structure as well as several of the primary total property management service providers has representation on the committee. All committee members meet formally on a semi-annual basis to report on the status of the systems within their respective areas of responsibility. The members discuss items of interest, treatment, operational problems encountered, solutions, system enhancements and modifications, new technology and general sharing of information related to water treatment. These discussions serve to increase awareness of the Water Treatment Program objectives and increase continuity of the program application and intent. The members operate as a cohesive network of water treatment authorities which together work to ensure effective water treatment programs are employed that provide optimum protection and preservation of the systems and it's components while practicing environmental best practices.

### **3.6 Water Treatment Specialist**

The Water Treatment Specialist is responsible for providing technical support and is retained by Property Management.

The primary role of the Specialist for the Water Treatment Program is to provide the professional expertise required to make the program work, assist in solving unusual problems, provides advice to those involved in the operation and maintenance of the water systems throughout the province. The Specialist will be responsible to the Program Director. The Specialist is the recognized authority on best practices for Water Treatment. Instructions, advice and recommendations from the Specialist shall take precedence over that provided from chemical suppliers, contractors, or manufacturers representatives.



## ***Program Personnel (cont'd)***

### ***3.6 Water Treatment Specialist (cont'd)***

Specifically, the Water Treatment Specialist will:

- (a) Establish and/or approve acceptable field water test procedures to be used in the program;
- (b) Prescribe chemical treatment for applicable mechanical systems;
- (c) Respond to and advise on system problems brought to his attention by the Manager or the Water Treatment Coordinator;
- (d) Develop and distribute information to help keep staff up to date and informed;
- (e) Responsible for coordinating laboratory services and distributing the reports;
- (f) Maintain an overview of the Water Treatment Program and advise the Program Director on problems, modifications or new technologies;
- (g) Available to consult with and advise Project Managers on the systems requirements, the type of cleaning procedures, treatment of new or retrofitted systems;
- (h) Provide advice on the commissioning of new systems as requested;
- (i) Participate in Water Treatment Co-ordinators' Meetings by speaking on relevant interest/problem topics;
- (j) Approve any changes to existing systems water treatment.

### ***3.7 Program Director***

The Program Director is one of the designated Regional Executive Directors of Alberta Infrastructure, Property Management. They will be responsible for the overall coordination and viability of the Water Treatment Program, the involvement and level of activity of the Water Treatment Program Specialist, and will ensure that the list of Water Treatment Co-ordinators is kept current semi-annually and distributed to all concerned. They will also act as Chairperson for the semi-annual Water Treatment Co-ordinators' Meetings.

## **SECTION B — DEFINITIONS OF TERMS RELATED TO WATER TREATMENT**

This Section contains an alphabetical listing of the definitions of the most often used terminology relating to water and water treatment.

For information on chemicals and reagents, refer to Sections D and H respectively.

**Acidity:** the quantitative capacity of an aqueous solution to react with hydroxyl ions (i.e., solutions which have pH levels less than 7.0 are considered to be acidic);

**Acidity, Free Mineral:** the quantitative capacity of an aqueous solution to react with hydroxyl ions to a pH level of 4.3;

**Acidity, Theoretical Free Mineral:** the free mineral acidity that would result from the conversion of the anions of strong acids (e.g., hydrochloric, sulphuric, and nitric) to their respective free acids;

**Algae:** a simple form of aquatic plant life, which multiply by division and requires sunlight for survival;

**Anion:** a negatively charged ion;

**Anion Exchange Resin:** a material which is capable of the reversible exchange of anions (e.g., ion exchange resin in the chloride form for dealkalizers and demineralizers);

**Amines:** Volatile components for the protection of the condensate return system. Neutralizing and filming amines are available. Most commonly used are the neutralizing amines morpholine, diethylaminoethanol (DEAE), and cyclohexamine. These amines neutralize carbonic acid and raise the pH of the condensate return system.

**Alkalinity:** the quantitative capacity of an aqueous solution to react with hydrogen ions (i.e., solutions which have a pH level greater than 7.0 are considered to be alkaline);

**Backwash:** that part of the operating cycle of an ion exchange process in which water is passed through a bed of ion exchange resin in the reverse direction to that of the service run in order to remove the accumulated particulate matter;

**Bacteria:** a single cell organism without a nucleus, usually in the shape of rods, spheres, or spirals, and is sub-divided into aerobic bacteria (i.e., bacteria which require oxygen to survive), and anaerobic bacteria (i.e., bacteria which survive in the absence of oxygen);

**Biocide:** a toxic material such as chlorine which is used to kill living bacteria;

**Bleed-off:** a term applied to the portion of re-circulating water that is drawn from the water system, either continuously or intermittently, in order to lower the dissolved and/or suspended solids concentration in water, and thus diminish the potential for fouling;

## **Definitions (cont'd)**

Blow-down: a term applied to the portion of boiler water that is drawn from the boiler, either continuously or intermittently, in order to lower the dissolved and/or suspended solids concentration in the boiler water, and thus diminish the potential for scale formation;

Breakthrough (also leakage): the first appearance of unexchanged ions in the effluent stream of an ion exchanger (e.g., in a softener, this would be hardness);

Brine: the saturated salt solutions that are used for softener and dealkalizer regenerations;

Buffer: an aqueous solution which resists changes of its pH level when acids or bases are added to it or when it is diluted with water;

Buffer Standard: a buffer solution that is used to calibrate pH meters prior to pH testing;

Carry-over: the entrainment of small droplets of boiler water & associated dissolved solids in the steam leaving the boiler;

Catalyst: a material which increases the reaction rate of a chemical reaction, but which itself is not consumed in the chemical reaction (e.g., cobaltous sulphate);

Cation: a positively charged ion;

Cation Exchange Resin: a material which is capable of the reversible exchange of cations (e.g., ion exchange resin in water softeners and demineralizers);

Caustic: the lay term equivalent of sodium hydroxide;

Caustic Embrittlement: a form of metal failure that occurs in steam boilers at riveted joints and at tube ends, the cracking being predominantly intercrystalline (i.e., a metal failure which occurs in steam boilers at high pressure & high alkalinity concentrations);

Chlorine: a disinfecting oxidising agent which is most widely used in water treatment;

Chlorine, Combined Available: the chlorine residual which exists in water systems as a chemical combination with ammonia or organic matter after the chlorine has been satisfied;

Chlorine Demand: the amount of chlorine consumed by organic matter & bacteria in water systems;

Chlorine, Free Available: the hypochlorous ions ( $\text{OCl}^-$ ), hypochlorous acid ( $\text{HOCl}$ ), or any combination thereof present in water (i.e., the portion of chlorine in water systems that is available for the immediate oxidation -killing- of bacteria & organic matter);

## **Definitions (cont'd)**

Chlorine, Residual: the total amount of free & combined chlorine remaining in water systems after its chlorine demand has been satisfied;

Chlorine, Total: the sum of free & combined chlorine;

Chlorosity: the concentration of the dissolved chloride equivalent in water at 20 °C;

Colorimetric: a name which is given to a chemical test method where the results of the test are determined by the amount or shade of colour that is developed;

Colour Standard: a hermetically sealed glass tube or slide that contains a stable solution which is equivalent in colour to the colour that is developed when an indicator is added to a definite concentration of chemical (i.e., colour standards are generally furnished in a comparator unit with a series of values covering a specific range);

Comparator Unit: a device for holding colour standards and a test sample in adjacent positions so that the colours of each may be easily compared with one another;

Composite Sample: a combination of two or more grab samples collected during a defined time period;

Concentrate: a high strength of the indicated material, usually expressed as per cent;

Concentration: the amount of material dissolved in a unit volume of solution, expressed as mg/l, ppm, or %;

Conductivity: The conductivity of water reflects the amount of the minerals salts and impurities dissolved in it. Conductivity is measured in microsiemens/cm ( $\mu\text{S}/\text{cm}$ ).

Corrosion: the chemical or electrochemical reaction between a metal and its surroundings;

Corrosion Coupon: a pre-weighed metal specimen that is inserted into a liquid stream in order to determine the corrosiveness of the liquid;

Corrosion Products: the material which is produced from corrosion of metal;

Cycle of Concentrations: a ratio of the dissolved solids in boiler water or cooling tower water compared with the dissolved solids in the feedwater to these units;

Dealkalized Water: a process which is used for the reduction of alkalinity in water (e.g., a chloride form anion dealkalizer);

Deionized Water: see Demineralized Water;

Demineralized Water: water which has had most of its salts removed by ion exchange;

## ***Definitions (cont'd)***

**Deposit:** a loose porous material, less dense than scale, which is composed of material such as corrosion by-products, oil, mill scale, weld splatter, or fouling contaminants;

**Dissolved Matter:** that matter, exclusive of gases, which is dispersed in water to give a single homogeneous liquid phase;

**Effluent:** the discharge water from any process or unit (e.g., water emerging from a softener);

**End Point:** the point in a titration procedure where a colour change of the sample takes place;

**Exhaustion:** the state in which the ion exchange resin is no longer capable of useful ion exchange;

**Generic Chemical:** a chemical which is identified with a chemical name and is composed of only one chemical;

**Grains per Gallon:** a unit of measurement in water analysis and water treatment, stated as gpg (e.g., 1 gpg is equivalent to 17.1 ppm);

**Hardness:** the polyvalent cation concentration in water, equal to the sum of the calcium, magnesium, strontium, iron, aluminum, zinc, and manganese ions (i.e., total hardness), but in most applications calcium & magnesium constitute the major portion of these ions;

**Hard Water:** water which has a high calcium and/or magnesium concentration, and which is undesirable in certain applications because of its scale forming characteristics;

**Hydrogen Cycle:** the operation of a cation exchange cycle wherein the removal of specified cations from the influent water is accomplished by exchange with an equivalent amount of hydrogen ions from the ion exchange resin;

**Influent:** the incoming water to a process or unit (e.g., water entering a softener);

**Inhibitor:** a material which is used to prevent or reduce scale formation or corrosion;

**Ion Exchange:** a reversible process by which ions are interchanged between an insoluble material and a liquid with no substantial structural changes in the material;

**Ion Exchange Capacity (volume basis):** the number of milliequivalents of exchangeable ions per millilitre of backwashed and settled bed of ion exchange resin in its standard form (i.e., a measurement of the actual performance of an ion exchange resin to remove dissolved impurities from water);

## **Definitions (cont'd)**

Ion Exchange Capacity (weight basis): the number of milliequivalents of exchangeable ions per dry gram of ion exchange resin in its standard form (i.e., a measurement of the actual performance of an ion exchange resin to remove dissolved impurities from water);

Ion Exchange Resin: an insoluble synthetic or organic material that has the ability to exchange reversibly certain ions in its structure, or attached to its surface as functional groups, with ions in a surrounding media (e.g., softener & demineralizer resin);

Langelier Index: a calculated saturation index for calcium carbonate that is useful in predicting scaling & corrosive tendencies;

Magnetite: the black passivated oxide state of iron;

Microorganism: any microscopic organism, including algae & bacteria;

Mixed Bed: a physical mixture of anion and cation exchange resins;

Monitoring: the regular sampling, measuring, recording, and/or signalling of the characteristics of water or waterborne material;

mpy: a measure of corrosion penetration rate, expressed as mils per year;

Neutralized Conductivity /TDS: Steam boiler samples are neutralized with Galic acid before the determination of conductivity or TDS. This takes away the contribution the alkalinity makes to this parameter and ensures that the true amount of mineral salts and impurities is determined.

Operating Cycle: an ion exchange process consisting of a backwash, regeneration, rinse, and service steps;

Oxygen Demand: the amount of oxygen required, under specified test conditions (i.e., BOD for biochemical oxygen demand and COD for chemical oxygen demand), for the oxidation of waterborne organic and inorganic matter;

Particulate Matter: the non-linear matter, exclusive of gases, which is heterogeneously dispersed in water (e.g., suspended solids cause turbidity);

pH: a measure of the degree of acidity or alkalinity of a solution (i.e., pH levels less than 7.0 are acidic, pH levels greater than 7.0 are alkaline, and a pH level of 7.0 is neutral);

Pitting: localized corrosion of a metal surface which is confined to a point or very small area, and which progresses in depth rather than laterally;

Potable Water: Water that is suitable for human consumption.

## ***Definitions (cont'd)***

**Potable Water System:** A water supply system, which provides water suitable for human consumption. It does not include Municipal Potable Water Systems or other Potable Water Systems, which are Licensed, Operated and Monitored by Alberta Environment.

**PPM:** a unit of measurement in chemical testing which indicates the parts by weight of a substance in relation to one million parts by weight of water, may also be expressed in milligrams/litre (mg/L);

**Precision:** the degree of repeated measurements of the same parameter expressed quantitatively as the standard deviation computed from the results of a series of controlled determinations;

**Priming:** a violent upheaval of water within a steam boiler so that the liquid boiler water is thrown into the steam line;

**Proprietary Chemical:** a chemical which is usually identified with a chemical or supplier name, followed by a number, and is typically a multi blended product (composed of numerous chemicals);

**Regenerant:** the solution which is used to restore activity to an exhausted ion exchange resin (e.g., a brine solution is used as a regenerant for a water softener);

**Regeneration:** that part of the operating cycle of an ion exchange process in which a specified chemical solution is passed through the ion exchange bed to prepare it for a service run (e.g., brine is used to remove calcium & magnesium from a softener resin, and replace them with sodium) **Regeneration Level:** the total weight of regenerant used per unit quantity of ion exchange resin in a single regeneration;

**Reserve Alkalinity:** a measure of the corrosion inhibitor concentration in glycol solutions, and is determined by titrating the sample with standard hydrochloric acid. Reserve alkalinity (100%) is the reserve alkalinity mathematically converted to 100 Vol% glycol.

**Rinse:** that part of the operating cycle of an ion exchange process in which a specified amount of water is passed through a bed of ion exchange resin to remove the residual regenerant solution;

**Ryznar Stability Index:** see Langelier Index;

**Salinity:** the sodium chloride or salt content of natural water supplies or salt water pools;

**Scale:** a hard dense crusty deposit which is formed by the evaporation of a solution directly in place upon a confining surface, and it is usually composed mainly of hardness salts;

**Sequestering Agent:** a material that is used to prevent deposit formation by creating a water soluble compound;

## ***Definitions (cont'd)***

**Service Run:** that part of the operating cycle of an ion exchange process in which water is passed through a bed of ion exchange resin to remove specific ions from the water or to exchange them for an equivalent amount of a specified ion from the ion exchange resin;

**Shelf Life:** the length of time that an analytical reagent can be stored without its chemical composition deteriorating or changing so that the reagent is unacceptable for use;

**Shock Treatment:** the application of extremely high concentrations of chlorine to destroy bacteria & algae in cooling tower and swimming pool systems;

**Sludge:** a "mud-like" residue which is formed from the chemical treatment of hardness salts in water, and is considered to be a normal by-product of water treatment;

**Sodium Cycle:** the operation of a cation exchange unit wherein the removal of specified cations from the influent water is accomplished by exchange with an equivalent amount of sodium ions from the ion exchange resin (e.g., a water softener operates in the sodium cycle);

**Softening:** a process that is used to eliminate or reduce the hardness concentration in water (e.g., ion exchange softeners);

**Surfactant:** a compound that is used to break down the bond between a deposit or film and the metal surface;

**Suspended Solids:** a mixture of non-settling particles within a liquid that can be removed by filtration;

**Thermophilic:** micro-organisms that grow best at temperatures greater than 50 °C;

**Threshold Effect:** the ability of low levels of a chemical to hold large amounts of scale forming minerals in solution, thus preventing scale formation;

**Titration:** a water test method that is used to determine the concentration of a dissolved substance by adding to the test solution, a suitable indicator (e.g., P-Ind 602) and a standard solution until an end-point has been reached;

**Total Dissolved Solids (TDS):** A measure of the amount of mineral salts and impurities dissolved in the water. The TDS is measured in parts per million (ppm) or microsiemens/cm ( $\mu\text{S}/\text{cm}$ ).

**Total Matter:** the sum of the suspended and dissolved solids;

**Turbidity:** a cloudy hazy appearance in water which is caused by finely divided particles that are suspended in water, and expressed as Jackson Turbidity Units (i.e., JTU), Formazan Turbidity Units (i.e., FTU), or Nephelometric Turbidity Units (i.e., NTU);



### ***Definitions (cont'd)***

Volatile: a material which is capable of becoming a vapour (e.g., morpholine);

Water System (for this manual): refers to hot water heating systems, chilled water systems, steam boiler systems, condenser water or cooling tower systems, air washer humidifier systems, glycol heating & cooling systems, domestic hot & cold water systems, and contact steam cooking systems;

Zeolite: a term that is used to describe a type of ion exchange resin, as in sodium zeolite softening.

## SECTION C – WATER SYSTEMS

### 1.0 Domestic Hot Water System

#### 1.1 Description

A typical domestic hot water system as shown in Figure C-1 is a system which provides hot water for washing and general domestic use.

The principal components of a domestic hot water system include a heat source (e.g., converter, fired heater, fired boiler, or electric immersion elements), circulating pump, storage tank, and metered water make-up.

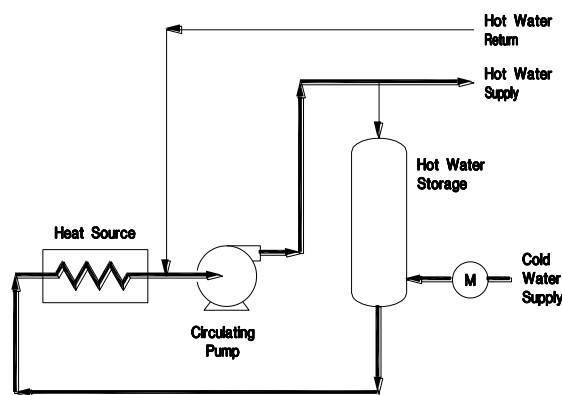


Figure C-1: Schematic Diagram of a Typical Domestic Hot Water System

#### 1.2 Operation and Maintenance

Since the water within these systems either contacts food or is taken internally, there is no chemical treatment of these systems; however, some systems incorporate water softening. Therefore, the corrosive tendencies of oxygenated soft water and the corrosive and scaling tendencies of oxygenated hard water can only be controlled by the following operational and maintenance activities:

- (a) Limit the operating temperature of the circulating water to 60 °C (140 °F);
- (b) Limit the velocity of the circulating water to 1.2 metres/second (4 feet per second);
- (c) Repair leaking fixtures as soon as possible.

## 2.0 Closed Hot Water Heating System

### 2.1 Description

A typical closed hot water heating system as shown in Figure C-2, is a heating system where hot water is circulated to finned elements or fan coil units throughout the building, or through heating coils in an HVAC system to provide space heating.

The principal components of a hot water heating system include a heat source (i.e., converters, fired heaters, or fired boilers), automatic air vents, circulating pumps, expansion tank (atmospheric or pressurised), safety valves, heat exchangers, flow switch, low-water fuel cut-off controller, chemical pot feeder, by-pass filter with flow element, corrosion coupon rack, water make-up meter, backflow preventer, and pressure regulator.

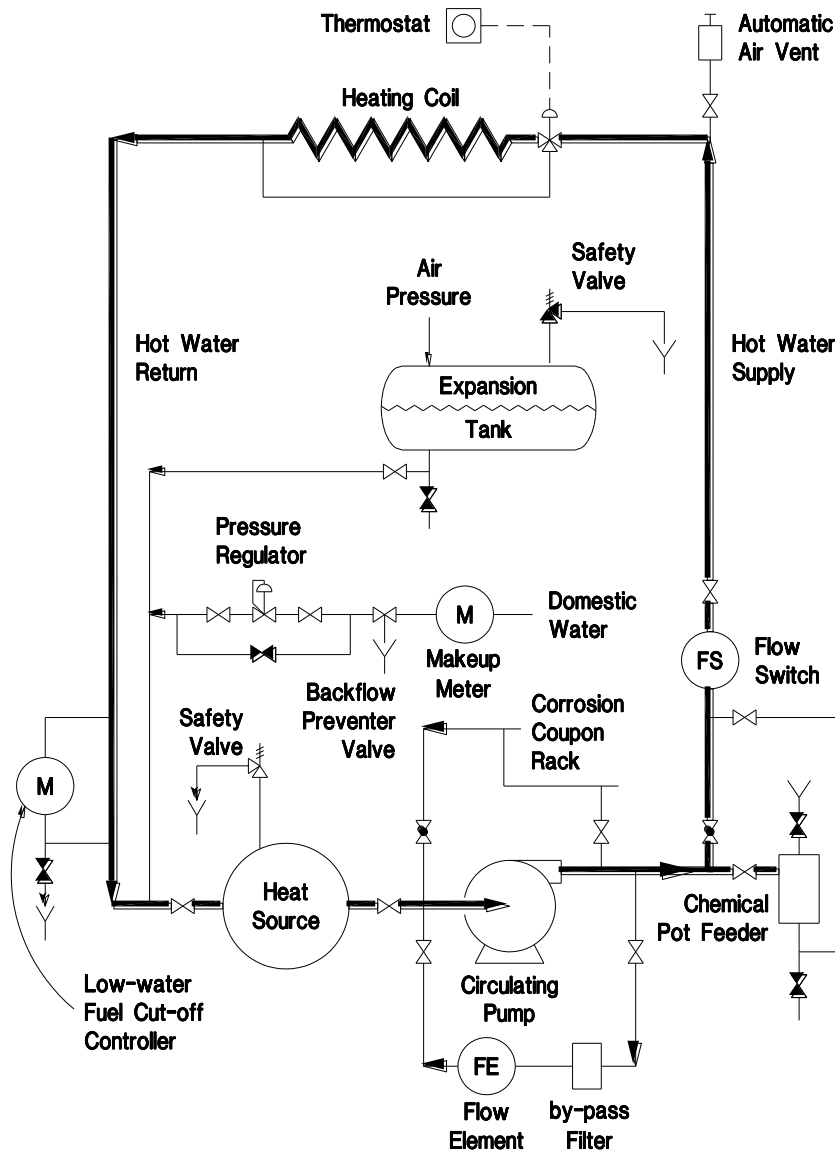


Figure C-2: Schematic Diagram of a Typical Hot Water Heating System

**Closed Hot Water Heating System (cont'd)**

2.2 Operation and Maintenance

These systems are susceptible to scale formation, caused by the precipitation of hardness salts which originate from the fresh water make-up, and corrosion caused by dissolved oxygen, which originates from the fresh water make-up and/or air ingress.

Therefore, once the system is filled with water, every effort should be made to minimize the entrance of additional hardness salts and dissolved oxygen into the system by the following operational type methods:

- a) Limit the amount of make-up water as follows:
  - (i) Install water meter(s) in the water make-up line(s);
  - (ii) Locate and repair system leaks immediately;
  - (iii) Adjust pump packing seals so that there is minimum leakage;
  - (iv) Ensure that pumps with mechanical seals have zero leakage;
  - (v) Do not drain and fill these systems seasonally—if maintenance or inspection is required, only those portions of the system that are affected should be drained;
  - (vi) Ensure that the safety valves have zero leakage;
  - (vii) Minimize the amount of water lost from the system during water sampling, low-water fuel cut-off controller blow down, safety valve testing, corrosion coupon installation/removal & filter cartridge replacement;

- (b) Ensure that there is positive pressure at the top of the system at all times by maintaining a minimum static system pressure according to the following equation by the addition of air to the expansion tank:

Imperial formula:  $P = (H/2.31) + 5$   
Metric formula:  $P = (9.81 \times H) + 34.5$

Where P: system pressure at the circulating pumps with the pumps shut off, psig or kPa;  
H: elevation of the system piping above the circulating pumps, feet or metres;

- (c) Ensure there is a visible water level of half of a sight glass in the expansion tank at all times (if expansion tank does not have a sight glass refer to 2.2b);
- (d) Replace faulty automatic vents as required;

## **Closed Hot Water Heating System (cont'd)**

### 2.2 Operation and Maintenance (cont'd)

- (e) It is essential to maintain corrosion parameters within specified limits when the system is not drained but is shut down for extended periods of time. When this occurs the system pumps must be run weekly to ensure distribution of chemicals throughout the system. The amount of circulation time required depends on the volume of system and size of pumps. Testing frequencies of a shutdown system are the same as if it was in normal operation and the test sample is to be taken after the system has had ample time to circulate.

### 2.3 Water Treatment

When a new system is filled with unsoftened domestic water and heated for the first time, the hardness salts are precipitated evenly in the boiler & system piping, and the dissolved oxygen is consumed by local corrosion, thus leaving only inert nitrogen in the system. In this perfectly closed state, the water in the system will not cause further corrosion or scale formation.

However, since the system cannot be perfectly closed, sulphite can be added as an oxygen scavenger or an Organic based Phosphonate corrosion inhibitor for system metal passivation. System pH levels must be buffered to a range of 8.5-9.5 for optimum corrosion control. (Note: corrosion of copper material can increase at pH levels greater than 9.5; also corrosion of iron material increases at pH levels less than 8.5).

Sodium sulphites along with Organic Phosphonates will react with iron & copper in the system to form black iron magnetite & cupric oxide, respectively. These two materials will offer moderate corrosion protection for the system, but if air and other contaminants are allowed to enter the system, this protection will be sacrificed causing the underlying metal to corrode. Treatment consumption will also increase as a result.

With Sulphite in particular the TDS concentration can increase in the water which causing the water in the system to become erosive. Organic Phosphonates are not typically associated with high TDS.

The addition of a dispersing agent such as sodium hexameta phosphate to the system is not recommended because although it is capable of maintaining hardness salts in solution in its poly phosphate form, the alkalinity & the elevated temperature in the system will convert it either to the phosphoric acid form which will cause corrosion, or to the ortho phosphate form which will precipitate the hardness salts.

Chemical treatment cannot correct the problems associated with continuous hardness & air ingress into the system. Chemical treatment can only provide a certain amount of temporary insurance against the effects of these contaminants should they temporarily gain entrance to the

## ***Closed Hot Water Heating System (cont'd)***

### ***2.3 Water Treatment (cont'd)***

system. Therefore, under normal operation, if the operation & maintenance activities referred to previously are diligently carried out, only very small amounts of chemicals, or maybe none at all, are required in order to maintain their residual concentrations after the initial charge has been added.

If excessive amounts of a pH buffer or sodium sulphite have been added to the system, its pH level can rise above 9.5 pH and the TDS concentration will also gradually increase possibly surpassing its limit of 2000 ppm. Therefore, in order to prevent corrosion of the copper material, due to high pH levels, and erosion of iron material, due to the high TDS concentration, the system water must be partially drained, and replaced with fresh make-up water. Sodium sulphite or Organic Phosphonate treatments must be added such that its concentration is maintained as per control test limits.(Sec 2.4). Also, the source of any air ingress into the system must be located and the appropriate corrective actions taken.

### ***2.4 Control Tests***

In order to minimize scaling and/or corrosion of these systems, the following control tests must be performed, and all water test results must be documented on a dedicated record sheet (see typical record sheet overleaf).

- (a) Document the make-up water meter reading at least once per month—it must be negligible;
- (b) Determine & document the sulphite or Organic Phosphonate concentration of the water in the system at least once per month (including shutdown periods)
  - 1. Sulphite based treatments— must be 50-100 ppm  $\text{SO}_3$  (80–160 ppm  $\text{Na}_2\text{SO}_3$ ); do not blowdown if it is high;  
Note: Determine which value the Sulphite test kit is testing for and follow the limit for that specific test kit ie;  $\text{SO}_3$ =Sulphite and  $\text{NaSO}_3$ =Sodium Sulphite.
  - 2. Organic Phosphonate based Treatments-must be 120-160ppm if testing for trace potassium (K) and 30-60ppm if testing by the Orthophosphate digestion method.  
Note: Determine which value the Organic test kit is testing for and follow the limit for that specific test kit. Or follow the manufacturers recommended control limits for that product.
- (c) Determine & document the pH level of the water in the system at least once per month—it must be 8.5-9.5 pH; add caustic if it is low; blow down if it is high;

## ***Closed Hot Water Heating System (cont'd)***

### ***2.4 Control Tests (cont'd)***

- (d) Determine & document the TDS (or conductivity) level of the water in the system at least once every month—it must be less than 2000 ppm or less than 2500 microsiemens/cm ( $\mu\text{S}/\text{cm}$ ); blowdown if it is high;
- (e) Determine & document the visual appearance of the water in the system at least once per month—it must be clear, colourless and no visible signs of sediment;
- (f) Replace the by-pass filter cartridge when the flow indicator shows a reduced flow and document this activity, follow the manufacturers recommendations in determining the proper flow rates through these devices;
- (g) Install iron & copper corrosion coupons for a 90 day interval once during the operational season. The Water Treatment Specialist may adjust the frequency depending on corrosion rate results. The iron corrosion rate must be less than 0.5 mpy, and the copper corrosion rate must be less than 0.2 mpy. Systems containing aluminum shall also have aluminum coupons installed for a 90 day interval once during the operational season, aluminum corrosion rates must be less than 1.0 mpy.

(h) WATER TREATMENT LOG SHEET

BUILDING NAME & LOCATION: \_\_\_\_\_

BUILDING FILE NO.: \_\_\_\_\_

WATER SYSTEM: HOT WATER HEATING

Date	pH	TDS	Treatment	Meter Reading	Filter Change	Inhibitor Added	Comments

Control Limits

- pH: 8.5-9.5
- TDS: 2500 microsiemens/cm ( $\mu\text{S}/\text{cm}$ ) max. Or 2000 ppm max.
- Sulphite: 50-100 ppm  $\text{SO}_3$  (80–160 ppm  $\text{Na}_2\text{SO}_3$ )



### 3.0 Steam Boiler System

#### 3.1 Description

A typical steam boiler system as shown in Figure C-3, is a system which provides steam for space heating, humidification, indirect contact cooking, and/or sterilising. See item 9.0 of this Section for information on a Contact Steam Cooking System.

The principal components of a steam boiler system include a steam boiler, condensate return tank, condensate pump, deaerator, feedwater pump, steam traps, low water flame cut-off controller, chemical feeder, and make-up water treatment equipment. However, depending on the size of the system and the end use of the steam, other components may include a converter or heating coils, unit heater, steam sparger, jacketed steam cooker, and/or steam steriliser.

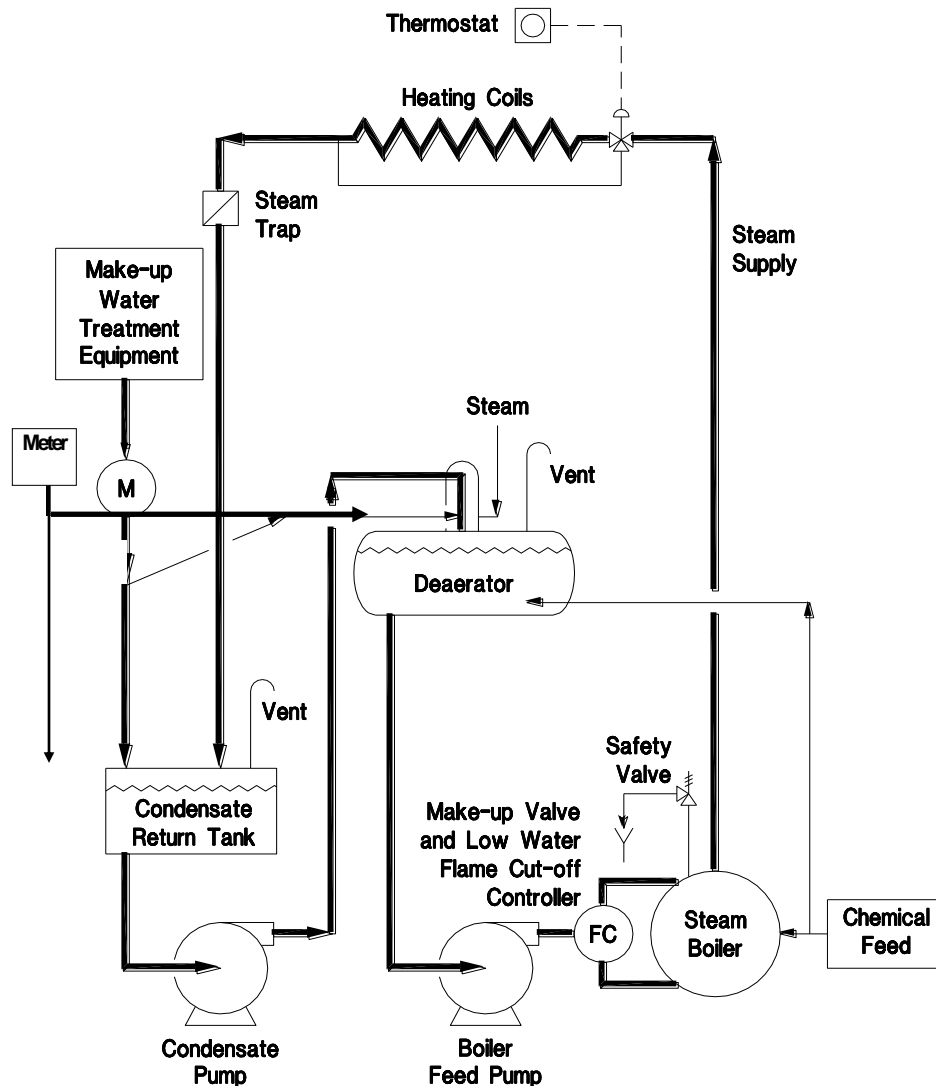


Figure C-3: Schematic Diagram of a Typical Steam Boiler System

## **Steam Boiler System (cont'd)**

### 3.2 Operation and Maintenance

Due to the elevated temperatures and the concentration effect in these systems, they require closer attention to basic operating and maintenance procedures than the closed water systems in order to protect them against contaminants such as dissolved oxygen, dissolved carbon dioxide, and hardness salts.

The specific operating and maintenance procedures are indicated in ASME (American Society of Mechanical Engineers) Boiler & Pressure Vessel Code, Section VI, "Recommended Rules for the Care and Operation of Heating Boilers" and Section VII, "Recommended Rules for Care and Operation of Power Boilers". However, the more general procedures are as follows:

- (a) Limit the amount of make-up water as follows:
  - (i) Install water meter(s) in the water make-up line(s);
  - (ii) Locate and repair system leaks immediately;
  - (iii) Repair faulty steam traps immediately;
  - (iv) Collect all condensate in the condensate return tank;
- (b) Blow down the water gauge glass at least once per week—prove the low water flame cut-off controller at the same time;
- (c) Prove the operation of the bottom blowdown valve by opening and closing it once per week;
- (d) Drain the boiler for inspection as required by the Alberta Boilers Safety Association; See ASME Boiler & Pressure Vessel Code Section VI and Section VII.
- (e) For seasonal shutdown, drain after the boiler and furnace have cooled sufficiently to prevent damage to the boiler and to prevent the baking of internal deposits on the heating surface but while there is sufficient heat still present to dry the interior when ventilated.
- (f) For short term shutdown, flood the boiler up to the steam stop valve with treated water such that the minimum sulphite & hydroxide alkalinity concentrations are 200 ppm  $\text{SO}_3$  & 200 ppm  $\text{CaCO}_3$  (300 ppm  $\text{Na}_2\text{SO}_3$ ) respectively.

## Steam Boiler System (cont'd)

### 3.3 Water Treatment

The following recommendations are made with respect to the water treatment for these systems:

- (a) The make-up water treatment to these systems depends on the size of the system and the end use of the steam. The make up water for all steam systems should be softened. However, it must be softened for systems which have measurable make-up and also dealkalized when the total alkalinity concentration in the make-up is high
- (b) Catalyzed sodium sulphite must be added at a point after mechanical deaeration such that a residual sulphite concentration of 30-60 ppm (50-100 ppm  $\text{Na}_2\text{SO}_3$ ) is maintained in the boiler water; it is not critical if the sulphite concentration is greater than 60 ppm  $\text{SO}_3$  (100 ppm  $\text{Na}_2\text{SO}_3$ ), but it must be greater than 30 ppm  $\text{SO}_3$  (50 ppm  $\text{Na}_2\text{SO}_3$ ). The sulphite solution must not be mixed in the same feeder as phosphate as it will precipitate the cobalt catalyst of the catalyzed sulphite thus rendering it ineffective;
- (c) If the pH of the boiler water is less than 10.5, caustic must be added to the boiler; if the pH of the boiler water is greater than 11.5, the blowdown rate must be increased and the caustic addition must be decreased—the boiler water pH level must be 10.5-11.5 pH;
- (d) If the boiler water total alkalinity concentration is greater than 700 ppm  $\text{CaCO}_3$ , then the blowdown rate must be increased and/or the caustic or tri-sodium phosphate addition must be decreased;
- (e) If the boiler water hydroxide alkalinity concentration is less than 150 ppm  $\text{CaCO}_3$ , caustic or tri-sodium phosphate must be added to the boiler water; alternately, if the boiler water hydroxide alkalinity concentration is greater than 300 ppm  $\text{CaCO}_3$ , the blowdown rate must be increased and the caustic or tri-sodium phosphate addition must be decreased;
- (f) Phosphate, either hexameta or tri-sodium types, must be added such that a residual phosphate concentration of 40-80 ppm  $\text{PO}_4$  is maintained in the boiler water;

**Steam Boiler System (cont'd)**

**3.3 Water Treatment (cont'd)**

- note(i): if the phosphate is added upstream of the boiler feed pumps, hexameta phosphate must be used since tri-sodium phosphate would precipitate hardness salts, thus increasing the wear on pump seals—hexameta phosphate on the other hand keeps hardness in solution until it reaches the boiler, at which point the alkalinity and increased temperature there converts it to tri-sodium phosphate;
  - note (ii): if the phosphate is added directly to the boiler water, either hexameta or tri-sodium phosphate may be used;
  - note (iii): if the phosphate is being consumed more rapidly than tri-sodium phosphate is being added (i.e., hardness inleakage into the system), hexameta phosphate should be used at least temporarily because it has a higher phosphate concentration and thus a higher capacity for hardness than tri-sodium phosphate;
  - note (iv): when hexameta phosphate is used, its conversion to tri-sodium phosphate in the boiler effectively reduces the OH alkalinity concentration and the pH level of the boiler water;
- (g) If the pH level of the condensate return is less than 8.0, a neutralizing amine must be added to the feedwater after the make-up location; if the pH level of the condensate return is greater than 9.5, the amine addition must be decreased—the condensate return pH level must be 8.0-9.5. If problems persist in achieving proper pH levels in the condensate return system, seek the advice of the Water Treatment Specialist. If a portion of the steam is used to control the humidity level within the building, the condensate return pH level must be 8.0-8.5 and the amine concentration in the building air handling system must be in compliance with the amine exposure limits indicated in the Alberta Occupational Health and Safety Code; Chemical Hazards, Biological Hazards and Harmful Substances. If there is no condensate return, amine must not be added);.....
- (h) In conjunction with the above controls and regulation of boiler blowdown, the boiler water neutralised total dissolved solids must be controlled within the limits of 1500-3000 ppm or 2000-4000 microsiemens/cm ( $\mu\text{S}/\text{cm}$ ).

## Steam Boiler System (cont'd)

### 3.4 Control Tests

In order to minimize scaling and/or corrosion of these systems, the following control tests must be performed daily. All water test results must be documented on a dedicated record sheet (see typical record sheet overleaf):

- (a) Log the quantity of water softened/dealkalized between regenerations;
- (b) Log make-up meter reading at each testing interval;
- (c) Perform the following tests and log these test results:
  - (i)... neutralized total dissolved solids must be 1500-3000 ppm 2000-4000 ..... microsiemens/cm ( $\mu\text{S}/\text{cm}$ );
  - (ii).. phosphate ..... must be 40-80 ppm  $\text{PO}_4$ ;
  - (iii) . hydroxide alkalinity ..... must be 150-300 ppm  $\text{CaCO}_3$ ;
  - (iv) . total alkalinity ..... must be less than 700 ppm  $\text{CaCO}_3$ ;
  - (v).. sulphite .. must be 30-60 ppm  $\text{SO}_3$ ; (50 ppm  $\text{Na}_2\text{SO}_3$ )
  - (vi) . pH ..... must be 10.5-11.5.
- (d) Determine and log the pH level of the condensate return—it must be 8.0-9.5 pH for systems that are not used for humidity control and 8.0-8.5 pH for systems that are used for humidity control;
- (e) Determine and log the TDS concentration of the condensate return—it must be less than 40 ppm 50 microsiemens/cm ( $\mu\text{S}/\text{cm}$ );
- (f) Determine and log the total hardness concentration of the condensate return & softener effluent—they both must be less than 2 ppm  $\text{CaCO}_3$ ;
- (g) While performing the above tests, note the general appearance of the water samples—the boiler water samples may be colourless or amber & contain either no sediment or a small amount of sediment. Condensate & softener samples must be clear & colourless with no sediment.

WATER TREATMENT LOG SHEET

BUILDING NAME & LOCATION:

BUILDING FILE NO.:

WATER SYSTEM: STEAM BOILER NO.

Year:	Month:	Day:																				
Boiler Water P Alkalinity		(record)																				
Phosphate Addition																						
Caustic Addition																						
Sulphite Addition																						
Amine Addition																						
Make-up Meter Reading																						
Blow Down Water Gauge Glass (prove low level flame cut-off)																						
Prove Operation of Bottom Blow Down																						
OH Alkalinity (150-300 ppm CaCO <sub>3</sub> )																						
Phosphate (40-80 ppm PO <sub>4</sub> )																						
Boiler Water Sulphite (30-60 ppm SO <sub>3</sub> )																						
Condensate pH (Refer to Page C-11)		(8.0-9.5 / 8.0-8.5)																				
Boiler Water pH		(10.5-11.5)																				
Condensate Hardness		(2 ppm CaCO <sub>3</sub> max)																				
Softener Hardness		(2 ppm CaCO <sub>3</sub> max)																				
Condensate TDS		(50 (µS/cm) max.)																				
Boiler Water M Alkalinity		(700 ppm CaCO <sub>3</sub> max)																				
Boiler Water TDS (3000 ppm or 4000 µS/cm max.)																						

(500–3000 ppm (2000–4000 microsiemens/cm (µS/cm))  
30–60 ppm SO<sub>3</sub> (50 - 100 ppm Na<sub>2</sub>SO<sub>3</sub>)

## 4.0 Closed Chilled Water Cooling System

### 4.1 Description

A typical closed chilled water cooling system, as shown in Figure C-4, is a cooling system where cool water is circulated to fan coil units throughout the building or through cooling coils in an HVAC system to provide space cooling.

The principal components of a chilled water cooling system include a cooling source (e.g., chiller of the absorption, compression or centrifugal type, or a cooling tower in a free cooling system), automatic air vents, circulating pumps, pressurised expansion tank, heat exchangers, low-temperature cut-out switch, flow switch, chemical pot feeder, by-pass filter with flow element, corrosion coupon rack, water make-up meter, backflow preventer valve, and pressure regulator.

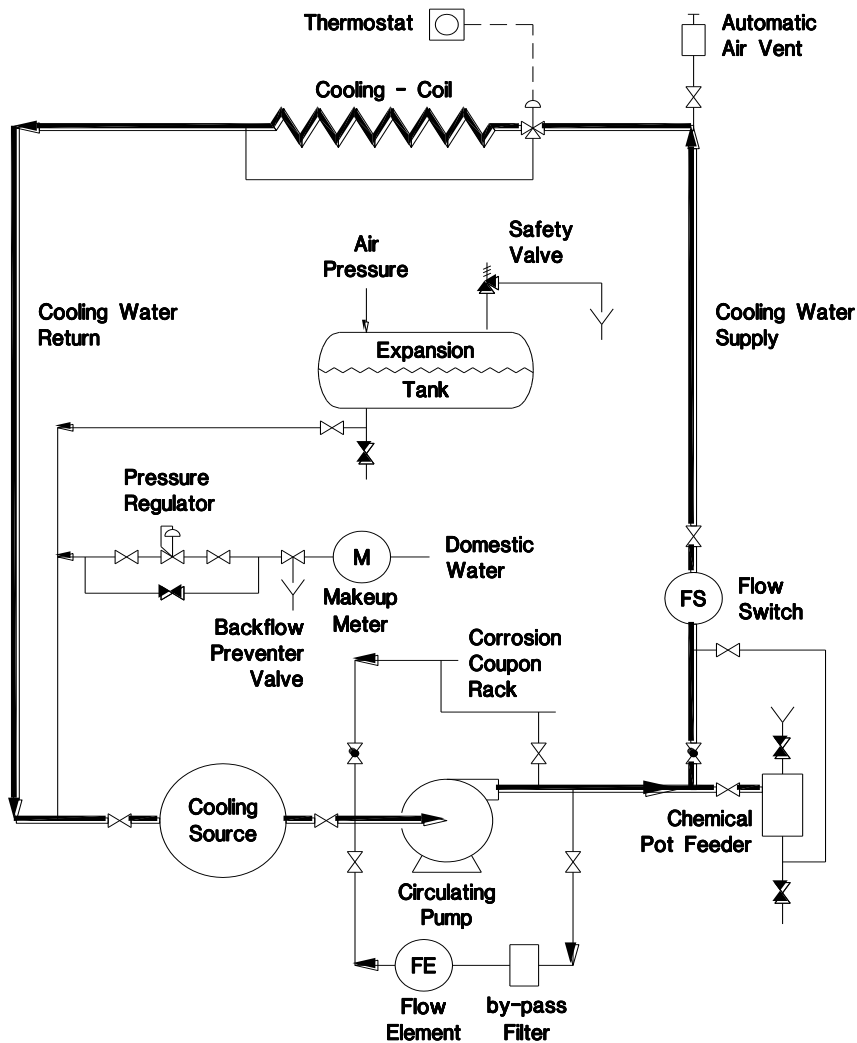


Figure C-4: Schematic Diagram of a Typical Chilled Water Cooling System

## ***Closed Chilled Water Cooling System (cont'd)***

### 4.2 Operation and Maintenance

These systems are susceptible to corrosion caused by dissolved oxygen and bacteria.

Once the system is filled with water, every effort should be made to minimize the entrance of additional dissolved oxygen into the system by the following operational type methods:

- (a) Limit the amount of make-up water as follows:
  - (i) Install water meter(s) in the water make-up line(s);
  - (ii) Locate and repair system leaks immediately;
  - (iii) Adjust pump seals with packing so that there is minimum leakage;
  - (iv) Ensure that pumps with mechanical seals have zero leakage;
  - (v) Do not drain and fill these systems seasonally—if maintenance or inspection is required, only those portions of the system that are affected should be drained;
  - (vi) Ensure that the safety valves have zero leakage;
  - (vii) Minimize the amount of water lost from the system during water sampling, safety valve testing & filter cartridge replacement activities;

- (b) Ensure that there is positive pressure at the top of the system at all times by maintaining a minimum static system pressure according to the following equation by the addition of air to the expansion tank:

Imperial formula:  $P = (H/2.31) + 5$

Metric formula:  $P = (9.81 \times H) + 34.5$

Where P: system pressure at the circulating pumps with the pumps shut off, psig or kPa;

H: elevation of the system piping above the circulating pumps, feet or meters;

- (c) Ensure that there is a water level in the expansion tank at all times;
- (d) Replace faulty automatic vents as required;
- (e) Confirm the operation of the make-up water meter by noting the changes in its reading before & after such activities as water sampling, safety valve testing & filter cartridge replacement;



## ***Closed Chilled Water Cooling System (cont'd)***

### ***4.2 Operation and Maintenance (cont'd)***

- (f) It is essential to maintain corrosion parameters within specified limits when the system is not drained but is shut down for extended periods of time. When this occurs the system pumps must be run weekly to ensure distribution of chemicals throughout the system. The amount of circulation time required depends on the volume of system and size of pumps.

Testing frequencies of a shutdown system are the same as if it were in normal operation and the test sample is to be taken after the system has had ample time to circulate

Should the system become contaminated with bacteria the effects can be minimized by:

- (a) Drain the expansion tank at the beginning & end of the cooling season;
- (b) At the end of the cooling season, drain the cooling coils, and fill or flush them with glycol, Refer to Section 7.3 for concentration limits to ensure adequate freeze protection ;
- (c) At the beginning of the cooling season, drain the glycol from the cooling coils to a container, and thoroughly flush out the cooling coils with water.

### ***4.3 Water Treatment***

When a new system is filled with domestic water for the first time, the dissolved oxygen is consumed by local corrosion, thus leaving only inert nitrogen in the system. In this perfectly closed state, the water in the system will not cause further corrosion.

However, since the system cannot be perfectly closed, sulphite can be added as an oxygen scavenger or an Organic based phosphonate corrosion inhibitor for system metal passivation. System pH levels must be buffered to a range of 8.5-9.5 for optimum corrosion control. (Note: corrosion of copper material can increase at pH levels greater than 9.5; also corrosion of iron material increases at pH levels less than 8.5).

Sodium sulphites along with Organic Phosphonates will react with iron & copper in the system to form black iron magnetite & cupric oxide, respectively. These two materials will offer moderate corrosion protection for the system, but if air and other contaminants are allowed to enter the system, this

## ***Closed Chilled Water Cooling System (cont'd)***

### ***4.3 Water Treatment (cont'd)***

protection will be sacrificed causing the underlying metal to corrode. Treatment consumption will also increase as a result.

With Sulphite in particular the TDS concentration can increase in the water which can cause the water in the system to become erosive. Organic Phosphonates are not typically associated with high TDS.

The addition of a dispersing agent such as sodium hexameta phosphate to the system is not recommended because scale formation is not usually a problem in closed chilled water systems.

Chemical treatment can not correct the problems associated with continuous air ingress into the system. Chemical treatment can only provide a certain amount of temporary insurance against the effects of this contaminant should it temporarily gain entrance to the system. Therefore, under normal operation, if the operations & maintenance activities referred to previously are diligently carried out, only a very small amounts of chemicals, or maybe none at all, are required in order to maintain their residual concentrations after the initial charge has been added.

Based on a generally acceptable maximum make-up water rate of 0.1% of the system capacity per day, the "rule-of-thumb" maximum acceptable sodium sulphite addition rate in grams/month is equivalent to 2% of the system capacity in imperial gallons. That is, if the system capacity is 1,000 imperial gallons, the maximum acceptable sodium sulphite addition rate would be 20 grams/month. If the sulphite consumption is greater than this amount, excessive air is entering the system via, either the make-up water or air ingress.

If excessive amounts of a pH buffer or sodium sulphite have been added to the system, its pH level can rise above 9.5 pH and the TDS concentration will also gradually increase possibly surpassing its limit of 2000 ppm. Therefore, in order to prevent corrosion of the copper material, due to high pH levels, and erosion of iron material, due to the high TDS concentration, the system water must be partially drained, and replaced with fresh make-up water. Sodium sulphite or Organic Phosphonate treatments must be added such that their concentration is maintained as per control test limits.(Sec 2.4). Also, the source of any air ingress into the system must be located and the appropriate corrective actions taken.

## ***Closed Chilled Water Cooling System (cont'd)***

### ***4.3 Water Treatment (cont'd)***

If, as a result of testing using the dip slide method, bacteria are detected in the system, an approved biocide, must be added.

If the chilled cooling water system is part of a direct free cooling system (i.e., mixing of the water in the condenser and chilled water systems to reduce the energy costs related to mechanical chilling), the corrosion rates of the system may be greater than the limits indicated in Section 4.4, in which case, the combined system must be treated with a proprietary scale/corrosion inhibitor.

### **4.4 Control Tests**

In order to minimize corrosion of these systems, the following control tests must be performed, and results must be documented on a dedicated record sheet (see typical record sheet overleaf):

- (a) Document the make-up water meter reading at least once per month—it must be negligible;
- (b) Determine & document the sulphite or Organic Phosphonate concentration of the water in the system at least once per month (including shutdown periods)
  - 3. Sulphite based treatments— must be 50-100 ppm  $\text{SO}_3$  (80–160 ppm  $\text{Na}_2\text{SO}_3$ ); do not blowdown if it is high;  
Note: Determine which value the Sulphite test kit is testing for and follow the limit for that specific test kit ie;  $\text{SO}_3$ =Sulphite and  $\text{NaSO}_3$ =Sodium Sulphite.
  - 4. Organic Phosphonate based Treatments-must be 120-160ppm if testing for trace potassium (K) and 30-60ppm if testing by the Orthophosphate digestion method.  
Note: Determine which value the Organic test kit is testing for and follow the limit for that specific test kit. Or follow the manufacturers recommended control limits for that product.
- (c) Determine & document the pH level of the water in the system at least once per month—it must be 8.5-9.5 pH; add a pH buffer if it is low; blowdown if it is high;

## ***Closed Chilled Water Cooling System (cont'd)***

### 4.4 Control Tests (cont'd)

- (d) Determine & document the TDS (or conductivity) level of the water in the system - once per month—it must be less than 2000 ppm or less than 2500 microsiemens/cm ( $\mu\text{S}/\text{cm}$ ); blowdown if it is high;
- (e) Determine & document the visual appearance of the water in the system at least once per month—it must be clear & colourless;
- (f) Replace the by-pass filter cartridge when the flow indicator shows a reduced flow and document this activity, follow the manufacturers' recommendations in determining the proper flow rates through these devices.
- (g) Install iron & copper corrosion coupons for a 90 day interval once during the operational season. The Water Treatment Specialist may adjust the frequency depending on corrosion rate results. The iron corrosion rate must be less than 0.5 mpy, and the copper corrosion rate must be less than 0.2 mpy. Systems containing aluminum shall also have aluminum coupons installed for a 90 day interval once during the operational season, aluminum corrosion rates must be less than 1.0 mpy.

WATER TREATMENT LOG SHEET

BUILDING NAME & LOCATION:

BUILDING FILE NO.:

WATER SYSTEM: CHILLED WATER

Date	pH	TDS	Treatment	Meter Reading	Filter Change	Inhibitor Added	Comments

Control Limits

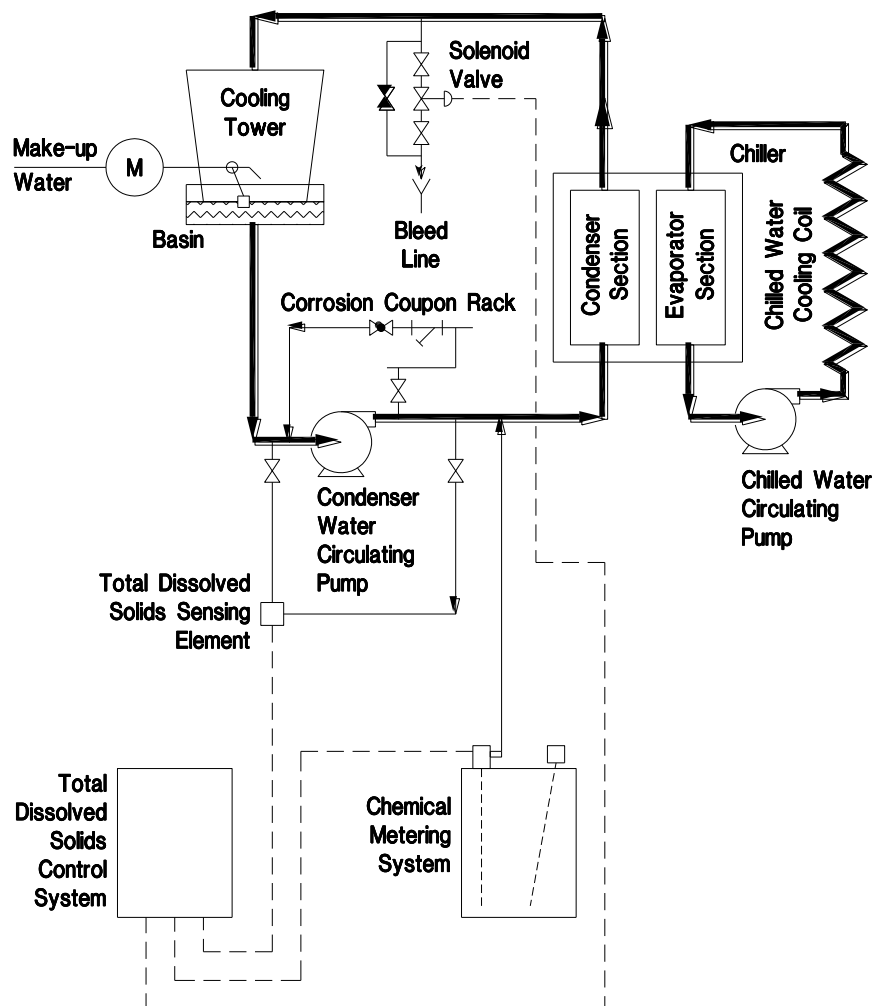
- pH: 8.5-9.5
- TDS: 2500 μS/cm max. or 2000 ppm max.
- Sulphite: 50-100 ppm SO<sub>3</sub> (80-160 ppm Na<sub>2</sub>SO<sub>3</sub>)

## 5.0 Open Cooling Water System

### 5.1 Description

A typical open cooling water system or condenser water system as shown in Figure C-5 is a system which normally provides cooling water for the condenser section of a chiller unit. However, in a “free cooling” system, the condenser water system provides either direct or indirect cooling—via a heat exchanger—to the coils of a chilled water system when the chiller unit is by-passed.

The principal components of these systems include a cooling tower, circulating pump, cooling coils, heat exchanger, continuous bleed-off valve, TDS control system, chemical feed system, corrosion coupon rack, and metered make-up water control.



Note: The corrosion coupon rack must be lower than the water level in the basin of the cooling tower so that the coupon rack is flooded at all times.

Figure C-5: Schematic Diagram of a Typical Open Cooling Water System

## ***Open Cooling Water System (cont'd)***

### **5.2 Operation and Maintenance**

The fresh make-up water to these systems contains hardness salts, dissolved oxygen, and dissolved solids. If these contaminants as well as microbiological contaminants and air-borne debris are not controlled, corrosion, scaling, and fouling will occur within these systems.

Corrosion, scaling, and fouling may be partially controlled by the following operational and maintenance activities:

- (a) Adjust the setting of the TDS controller such that scaling and corrosion are prevented;
- (b) Log the make-up water meter reading at least once per week;
- (c) Provide screens on the slats of the cooling tower if airborne debris are gaining access to the cooling tower;
- (d) Inspect the cooling tower at least once per week to detect scaling, corrosion, or slime growths;
- (e) Inspect the chiller condenser coils and chilled water cooling coils when maintenance is being carried out on these units.

### **5.3 Water Treatment**

Since the water within these systems is continuously aerated and exposed to the atmosphere, the prevention of corrosion due to dissolved oxygen, scale formation due to hardness salts, and fouling due to bacteria cannot be accomplished by operational techniques alone. Therefore, chemical treatment must be used to provide protection against these contaminants.

The following recommendations are made with respect to the water treatment for the majority of these systems:

- (a) Whether the system is treated with proprietary or non-proprietary chemical methods depends on such factors as the make-up water quality, the size of the system, and the operating time of the system.
- (b) If proprietary chemical treatment is preferred, it must be authorized by the Water Treatment Specialist. The concentration as well as the TDS in the system will be recommended by the chemical supplier.

## **Open Cooling Water System (cont'd)**

### **5.3 Water Treatment (cont'd)**

- (c) If the evaluation shows that generic chemical treatment is preferred, the following recommendations are made:
  - (i) The make-up water must consist of fresh domestic water and softened domestic water, blended so that the combined total hardness concentration of 25-50 ppm  $\text{CaCO}_3$  is maintained in the circulating water;
  - (ii) Sodium hexameta phosphate must be added such that a residual poly phosphate concentration of 10-20 ppm  $\text{PO}_4$  is maintained in the circulating water;
- (d) Add a proprietary biocide treatment as required to control microbiological growths—if these growths proliferate beyond normal control, consult with the Water Treatment Specialist. The maximum bacteria population is  $10^3$  colony forming units/ml.

If the chilled cooling water system is part of a direct free cooling system (i.e., mixing of the water in the condenser and chilled water systems to reduce the energy costs related to mechanical chilling), the corrosion rates of the system may be greater than the limits indicated in Section 5.4, in which case, the combined system must be treated with a proprietary scale/corrosion inhibitor.

### **5.4 Control Tests**

In order to minimize scaling, corrosion & fouling of these systems, the following control tests must be performed, and test results must be documented on a dedicated record sheet (see typical record sheet overleaf):

- (a) Log the make-up water meter reading at least once per week;
- (b) Determine and log the TDS concentration of the water in the system 3 times per week;
- (c) Determine and log the pH of the water in the system 3 times per week;
- (d) Determine and log the total hardness of the system, 3 times per week—maintain to a maximum of 600 ppm  $\text{CaCO}_3$ ;
- (e) Determine and log the chemical inhibitor concentration of the water in the system 3 times per week;



## ***Open Cooling Water System (cont'd)***

### ***5.4 Control Tests (cont'd)***

- (f) Determine and log the bacteria concentration of the water in the system at least once per month.
- (g) Prior to installing corrosion coupons ensure system is clean, treated and fully operational;
- (h) Install iron & copper corrosion coupons for a 45 day interval during the operational season. The Water Treatment Specialist may adjust the frequency depending on corrosion rate results. The maximum iron corrosion rate is 2 mpy; the maximum copper corrosion rate is 0.2 mpy.
- (i) Ensure coupons are removed for testing at the end of the cooling season;
- (j) Determine & document the visual appearance of the water in the system at least once per month—it must be clear & colourless.

# WATER TREATMENT LOG SHEET

BUILDING NAME & LOCATION: \_\_\_\_\_

BUILDING FILE NO.: \_\_\_\_\_

WATER SYSTEM: CONDENSER WATER

Date	pH	TDS	Corrosion Inhibitor ppm	Hardness ppm	Bacteria	Inhibitor Added	Biocide Added	Meter Reading

**Control Limits**

- pH: 8.0-9.0
- TDS: as per supplier's recommendation
- Corrosion Inhibitor: as per supplier's recommendation
- Hardness: 600 ppm CaCO<sub>3</sub> max
- Bacteria: 10<sup>3</sup> cfu/ml max.
- Free Chlorine: 0.2-0.8 ppm

## 6.0 Humidification Systems

### 6.1 Re-circulating Air Washer Humidification

#### 6.1.1 Description

A re-circulating air washer humidifier system cleans, humidifies, and cools the air by re-circulating water through spray nozzles from a reservoir within the ductwork of an HVAC system. (A typical schematic diagram of this system is shown in Figure C-6 below)

The principal components of these systems consist of an air washer re-circulating pump, spray nozzles, continuous bleed-off valve, humidistat, cooling/heating coils or media, reservoir, and metered make-up water with controller.

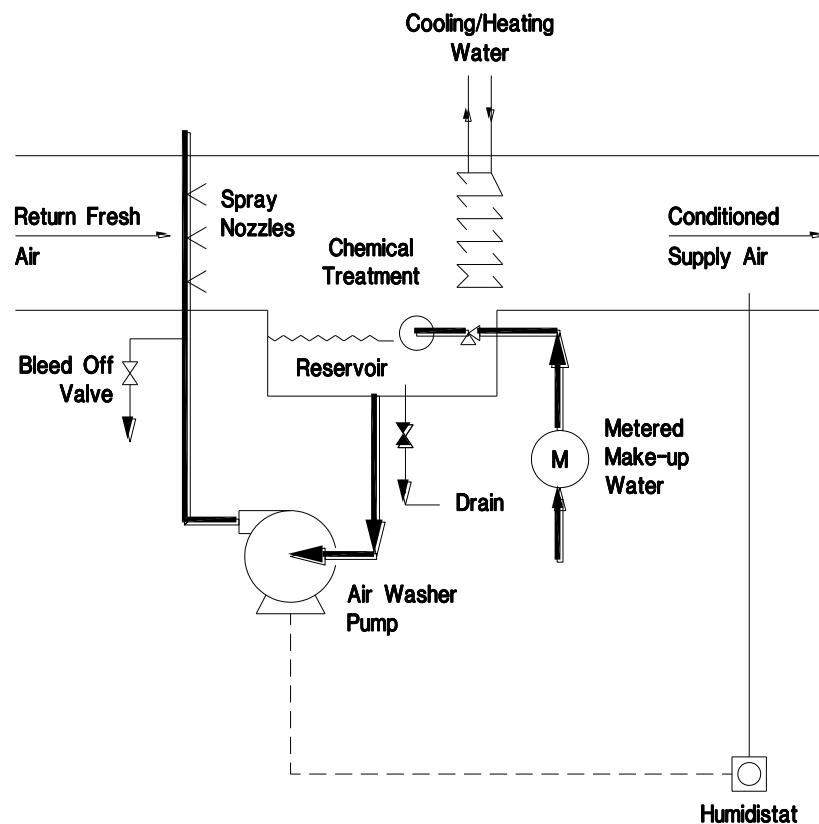


Figure C-6: Schematic Diagram of a Typical Air Washer Humidifier System

## ***Humidification Systems (cont'd)***

### 6.1.2 Operation and Maintenance

The fresh make-up water to these systems contains hardness salts, dissolved oxygen, and dissolved solids. If these contaminants as well as microbiological contaminants and air-borne debris are not controlled, corrosion, scaling, and fouling will occur within these systems.

Corrosion, scaling, and fouling may be partially controlled by the following operational and maintenance activities:

- (a) Adjust the setting of the bleed valve such that scaling and corrosion are prevented;
- (b) Log the make-up water meter reading at least once per week;
- (c) Inspect the nozzles, reservoir & baffle surfaces at least once per week to detect scaling, corrosion, or slime growths;
- (d) Clean the nozzles and ductwork as required.

### 6.1.3 Water Treatment

Since the water within these systems is continuously aerated and exposed to the atmosphere, the prevention of corrosion due to dissolved oxygen, scale formation due to hardness salts, and fouling due to bacteria cannot be accomplished by operational techniques alone. Therefore, chemical treatment must be used to provide protection against these contaminants.

The following recommendations are made with respect to the water treatment for the majority of these systems:

- (a) Whether the system is treated with proprietary or non-proprietary chemical methods depends on such factors as the make-up water quality, the size of the system, and the operating time of the system.
- (b) If proprietary chemical treatment is preferred, it must be authorized by the Water Treatment Specialist. The concentration as well as the TDS in the system will be recommended by the chemical supplier.

## **Humidification Systems (cont'd)**

### **6.1.3 Water Treatment (cont'd)**

- (c) If the evaluation shows that generic chemical treatment is preferred, the following recommendations are made:
  - (i) The make-up water must consist of fresh unsoftened domestic water;
  - (ii) Sodium hexameta phosphate must be added such that a residual polyphosphate concentration of 10-20 ppm PO<sub>4</sub> is maintained in the circulating water;
- (d) Add a proprietary biocide treatment as required to control microbiological growths—if these growths proliferate beyond normal control, consult with the Water Treatment Specialist. The maximum bacteria population is 10<sup>3</sup> colony forming units/ml.

### **6.1.4 Control Tests**

In order to minimize scaling, corrosion & fouling of these systems, the following control tests are recommended, test results must be documented on a dedicated record sheet (see typical record sheet overleaf):

- (a) Log the make-up water meter reading at least once per week;
- (b) Determine and log the TDS concentration of the water in the system, and adjust the continuous bleed-off valve as required 3 times per week—contact the Water Treatment Specialist for control limits;
- (c) Determine and log the pH of the water in the system 3 times per week;
- (d) Determine and log the chemical inhibitor concentration of the water in the system 3 times per week
- (e) Determine and log the bacteria concentration of the water in the system at least once per month—it must be less than 10<sup>3</sup> cfu/ml (i.e., colony forming units/ml);
- (f) Determine & document the visual appearance of the water in the system at least once per month—it must be clear & colourless.

## **Humidification Systems (cont'd)**

### 6.2 Once Through Air Washer System

#### 6.2.1 Description

A once through air washer humidifier system performs the same functions as the re-circulating type. However, in the once through type of air washer humidifier system instead of re-circulating the water through the system, fresh water is evenly distributed at the top of the media and allowed to flow down over the media and out to drain. Since there is no accumulation of water in this type of system, chemical treatment is not required, however periodic testing for bacteria is recommended.

The principal components of these systems consist of spray nozzles, humidistat, cooling/heating coils or media and metered make-up water with a solenoid valve.

#### 6.2.2 Operation and Maintenance

- (a) Monitor Microbiological growth on the media by performing a dip-slide test;
- (b) Log the make-up water meter reading at least once per week;
- (c) Periodically inspect the nozzles, media, baffle surfaces to detect excessive scaling, corrosion, or slime growths;
- (d) Clean the nozzles and ductwork as required.
- (e) Consult Water Treatment Specialist for problematic conditions

### 6.3 Gas-Fired Direct Steam Humidifiers

#### 6.3.1 Description

These humidifiers generate mineral free, odourless and sterile steam at atmospheric pressure inside a fully insulated stainless steel tank and then directly disperse the steam into ducts or air handling units. They are more efficient than electric humidifiers and require low maintenance. Because the surfaces of this humidifier are stainless steel including heat exchanger, tank and water control system it is acceptable for use with all water types. There is no accumulation of water in this type of system because the humidifier will periodically blow-down water from the tank, as adjusted, so no chemical treatment or control tests are required.

## ***Humidification Systems (cont'd)***

### *6.3 Gas-Fired Direct Steam Humidifiers*

#### *6.3.1 Description (cont'd)*

The principal components of these humidifiers consist of tank, heat exchanger, combustion system, water control system, auto blow-down, control panel, steam distributor and humidistat or DDC control.

#### 6.3.2 Operation and Maintenance

Normally these humidifiers operate on cold potable softened water and since the output is pure clean steam, minerals from incoming water are left behind. These minerals will eventually coat the tank walls or settle to the bottom of the tank. To minimize this scale build-up the automatic blow-down must be set according to the local water conditions. Measuring the amount of hardness of the incoming water and referring to the manufacturers guidelines will determine the adjustment needed for the blow-down rate. Contact the Water Treatment Specialist for additional information.

The following recommendations are made with respect to the maintenance required for the majority of these systems:

- (a) Clean tank, exchanger and water controls each season (minimum). The mineral content of the incoming water, unit-running time, output capacity setting and blow-down rate ultimately determine the time between cleanings;
- (b) Log the make-up water meter reading at least once per week;
- (c) Monitor system weekly to ensure efficient operation;
- (d) Clean the steam distributor and ductwork as required.

WATER TREATMENT LOG SHEET

BUILDING NAME & LOCATION:

BUILDING FILE NO.:

WATER SYSTEM: RE-CIRCULATING AIR WASHER HUMIDIFIER

Date	pH	TDS	Corrosion Inhibitor	Hardness	Bacteria	Meter Reading	Inhibitor Added

Control Limits

- pH: record
- TDS: as per supplier's recommendation
- Inhibitor: as per supplier's recommendation
- Hardness: 25-50 ppm CaCO<sub>3</sub> (softened make-up only)
- Bacteria: 10<sup>3</sup> cfu/ml max.



## 7.0 Glycol System

### 7.1 Description

A typical glycol system as shown Figure C-7 (overleaf), is a heating/cooling system in which an ethylene or propylene glycol-water solution is circulated to fan coil units throughout the building or through heating/cooling coils in an HVAC system in order to provide space heating/cooling without the inherent risk of freeze damage.

The heat source may be converters, fired heaters, or fired boilers; the cooling source is a chiller.

The principal components of these systems include a heating/cooling source, automatic air vents, circulating pumps, flow switch, expansion tank, heat exchangers, a pumping system to introduce the glycol/water solution into the system, safety valves, low-water fuel cut-off controller, bypass filter with flow element and corrosion coupon rack (coupon rack and corrosion coupon monitoring is not mandatory on these systems). In order to prevent undetected dilution of the glycol concentration in the system, a water make-up connection is not recommended for these systems; however, if a make-up connection is provided, it must contain a water meter, backflow prevention device & pressure regulator.

Note: Glycol systems for emergency generator diesel engines, which utilise diesel automotive grade glycol in accordance with the supplier recommendations, are not included in this Section.

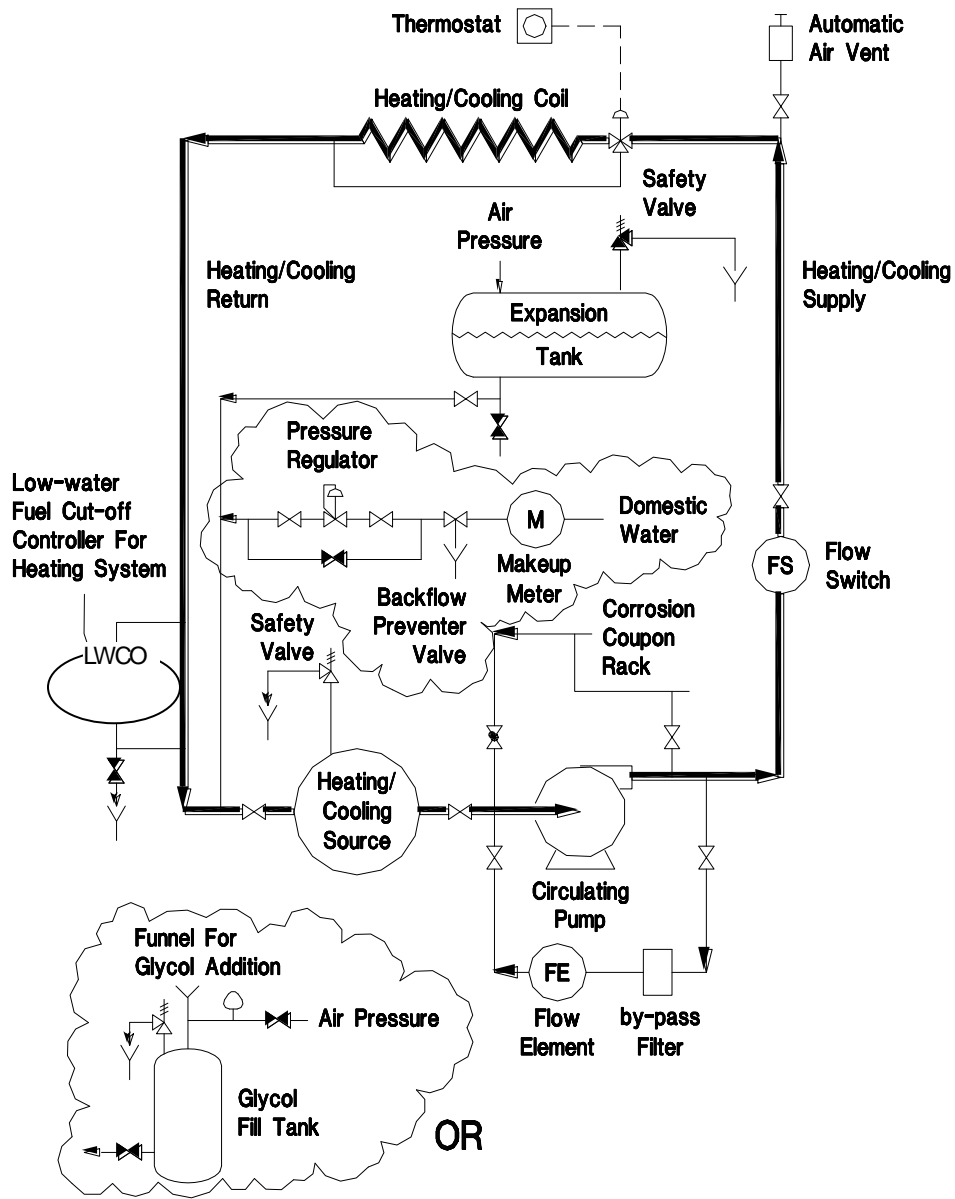


Figure C-7: Schematic Diagram of a Typical Glycol System

## ***Glycol System (cont'd)***

### **7.2 Operation and Maintenance**

Industrial grade glycol is composed of ethylene or propylene glycol, a corrosion inhibitor, and water. Note that automotive grade glycol should not be used in commercial or industrial glycol systems because their corrosion inhibitors have a limited useful life and they contain silicates which can foul or plug the system.

If there is a concern that the glycol may be orally consumed, an industrial grade propylene glycol should be used because of its low oral toxicity, otherwise an industrial grade ethylene glycol is the preferred choice. Note: In order to accurately measure the glycol concentration in the system, ethylene and propylene glycol must not be mixed together in the same system.

Since dissolved oxygen in the system will decompose glycol into an organic acid, particularly at elevated temperatures, thus causing corrosion & fouling, both types of glycol contain a corrosion inhibitor, typically dipotassium hydrogen phosphate.

The water which is used to mix with concentrated glycol must be of the highest possible quality (i.e., softened, demineralized, deionized, boiler condensate); otherwise the hardness and corrosive salts in most domestic water supplies will deplete the corrosion inhibitor concentration in the glycol.

Once the system is filled with the glycol-water solution, every effort must be made to minimise the entrance of additional hardness salts and dissolved oxygen into the system by the operational type methods indicated below.

- (a) A water connection is not recommended; however, if a water connection is provided, limit the amount of make-up water as follows:
  - (i) install a water meter in the water make-up line, and confirm its operation by noting the changes in its reading before & after such activities as water sampling, low-water fuel cut-off controller blowdown, safety valve testing & filter cartridge replacement activities;
  - (ii) locate & repair system leaks immediately;
  - (iii) adjust pump seals with packing so that there is minimum leakage;
  - (iv) ensure that pumps with mechanical seals have zero leakage;
  - (v) do not drain & fill the system seasonally—if maintenance or inspections are required, only those portions of the system that are affected should be drained;

## **Glycol System (cont'd)**

### **7.2 Operation and Maintenance (cont'd)**

- (vi) ensure that safety valves have zero leakage;
  - (vii) minimize loss from the system during glycol sampling, low-water fuel cut-off controller blowdown, safety valve testing & filter cartridge replacement activities;
  - (viii) All glycol discharge shall be captured to be re-used or disposed in accordance with Environmental Guidelines.
- (b) Ensure that there is a positive pressure at the top of the system at all times by maintaining a minimum static system pressure according to the following equation by the addition of air to the expansion tank:

Imperial formula:  $P = (H/2.31) + 5$

Metric formula:  $P = (9.81 \times H) / 34.5$

Where P: pressure at the circulating pumps with the pumps shut off, psig or kPa;

H: elevation of the system piping above the circulating pumps, feet or meters;

- (c) Ensure that there is a glycol-water solution level in the expansion tank at all times;
- (d) Replace faulty automatic vents as required;
- (e) In order to prevent excessive decomposition of the glycol into organic acids, the operating bulk temperature of the glycol-water solution must be limited to 120 °C (250 °F).

### **7.3 Chemical Treatment**

In order to provide freeze protection (i.e., a glycol concentration which is sufficient to prevent the formation of ice crystals and thus remain pumpable at the lowest temperature experienced by the fluid) down to at least -34°C, the acceptable glycol concentration range for cooling systems which are operational year round and for heating systems is 48-87 vol% for ethylene glycol systems and 49 vol% minimum for propylene glycol systems; however, for the economic reasons, the preferred glycol concentration range is 48-52 vol% with a corresponding freeze point range of -34 °C to -40 °C for ethylene glycol systems and 50-54 vol% with a corresponding freeze point range of -34 °C to -40 °C for propylene glycol systems. Other than causing a higher energy consumption, a high glycol concentration is acceptable; therefore, dilution is not required, unless the ethylene glycol concentration is greater than 88 vol%.

## **Glycol System (cont'd)**

### **7.3 Chemical Treatment (cont'd)**

In order to provide burst protection (i.e., a glycol concentration which is high enough to prevent bursting of pipes and other mechanical damage, but not necessarily high enough to keep the fluid pumpable) down to less than -50 °C, the acceptable glycol concentration range for ethylene glycol cooling systems which are operational only during the summer months is 30-85 vol%; however, for economic reasons, the preferred glycol concentration range is 30-35 vol% with a corresponding freeze point range of -16 °C to -19 °C. Similarly, the acceptable propylene glycol concentration range is 35 vol% minimum, but the preferred range is 35-40 vol% with a corresponding freeze point range of -16 °C to -19 °C for burst protection down to less than -40 °C. Other than causing a higher energy consumption, a high glycol concentration is acceptable; therefore, dilution is not required

These lower glycol concentrations are in place only if the glycol system is not exposed to outside temperatures during the winter months.

Since glycol concentrations less than 20 vol% are a nutrient source for bacteria, the glycol concentration must be greater than 20 vol%.

The following equation may be used to calculate the approximate amount of glycol required to increase the glycol concentration in a system:

$$G = V \times (CD-CP)/(100-CP)$$

Where G: volume of present glycol solution to be drained from the system and volume of fresh concentrated glycol to be added to the system, litres  
CD: desired glycol concentration, vol%  
CP: present glycol concentration, vol%  
V: volume of the system, litres

In order to provide adequate corrosion protection of the glycol system, the reserve alkalinity based on a glycol concentration of 100% (i.e., RA 100%), which is an indication of the corrosion inhibitor level, must be maintained at a level of at least 9.0 for all glycol concentrations by corrosion inhibitor additions as required.

If the RA (100%) value is less than 9.0, the following equation may be used to calculate the first estimate for the amount of corrosion inhibitor addition that is required:

$$I = 1.75 \times V/100$$

Where I: volume of inhibitor, litres  
V: volume of the system, litres

## Glycol Systems (cont'd)

### 7.4 Control Tests

In order to minimize fouling and/or corrosion of glycol systems, the following control tests must be performed (note that due to the more sophisticated nature of the chemical tests for glycol systems, the glycol concentration, pH & reserve alkalinity levels for glycol samples should be performed by a commercial laboratory. Testing of glycol samples shall be arranged between the Water Treatment Specialist and the Building Operator:

- (a) Document the make-up water meter reading at least once per month—it must be negligible;
- (b) Determine & document the glycol concentration in the system at least once per year—the following control limits must be maintained:
  - (i) for ethylene glycol cooling systems that are operational year round & for ethylene glycol heating systems, the glycol concentration must be 48-52 vol% with a corresponding freeze temperature of  $-34$  to  $-40$  °C & a burst temperature of less than  $-50$  °C;
  - (ii) for propylene glycol cooling systems that are operational year round & for propylene glycol heating systems, the glycol concentration must be 50-54 vol% with a corresponding freeze temperature of  $-34$  to  $-40$  °C & a burst temperature of less than  $-40$  °C;
  - (iii) for ethylene glycol cooling systems that are operational only during the cooling season, the glycol concentration must be 30-35 vol% with a corresponding freeze temperature of  $-16$  to  $-19$  °C & a burst temperature of less than  $-50$  °C;
  - (iv) for propylene glycol cooling systems that are operational only during the cooling season, the glycol concentration must be 35-40 vol% with a corresponding freeze temperature of  $-16$  to  $-19$  °C & a burst temperature of less than  $-40$  °C;
- (c) Determine & document the pH level in the system at least once per year—it must be greater than 8.5;
- (d) Determine & document the reserve alkalinity level in the system at least once per year—the RA(100%) level must be greater than 9.0;
- (e) Replace the by-pass filter cartridge when the flow indicator shows a reduced flow and document this activity;

## 8.0 Water Softener System

### 8.1 Description

A typical water softener system as shown in Figure C-8 is a system which replaces scale forming constituents in a water supply with a non-scale forming constituent.

The principal components of these systems include a pressure vessel containing sub-fill, cation exchange resin, internal distributors, as well as a brine tank, brine eductor/venturi, and regeneration timer or service water meter.

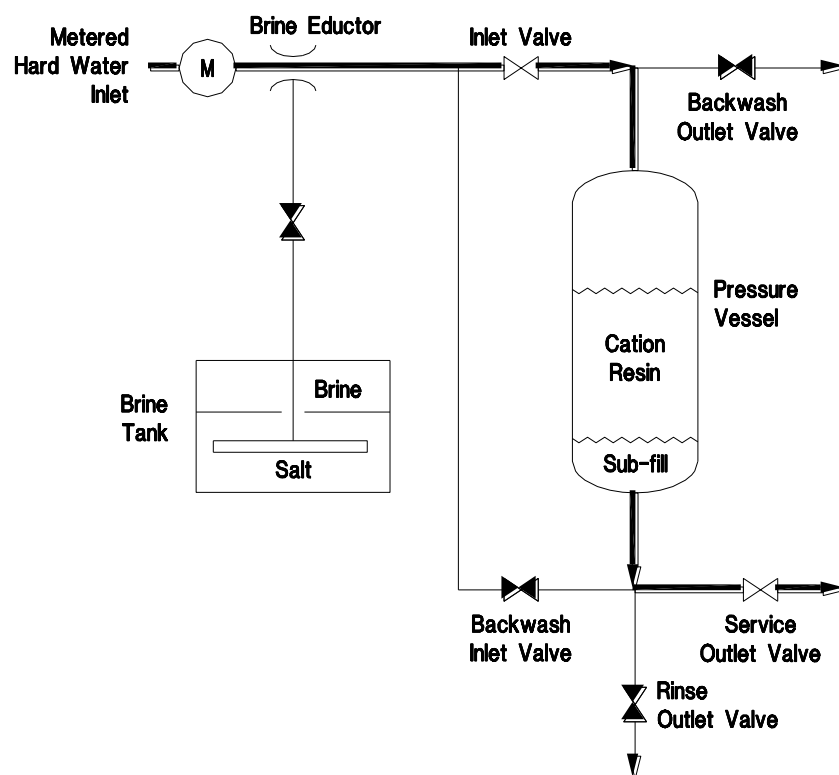


Figure C-8: Schematic Diagram of a Typical Water Softener System

## **Water Softener System (cont'd)**

### 8.2 Operation

A given size of water softener will soften a specific quantity of water with a specific hardness. Initially the water leaving the softener should be tested for hardness at least once per day, and the time should be determined when it should be regenerated. Where a meter is provided, the gallonage can be determined and the time frequency for regeneration can then be set. The salt is relatively inexpensive so the regeneration frequency should not be extended past the hardness break through.

The regeneration cycle consists of the backwash, regeneration or brining, and rinse steps.

During the backwash step, the flow of water is reversed through the vessel in order to remove dirt and cracked resin beads and also to loosen the resin bed.

During the regeneration or brining step, brine at a concentration of 20-25% is drawn from the brine tank; the hardness forming cations attached to the ion exchange resin are replaced by the sodium ions from the brine.

The amount of salt added for brine strength will determine how many litres of water can be softened. Generally 5-15 lbs/ft<sup>3</sup> (80-240 kg/m<sup>3</sup>) add metric) is common practice. However 15 lbs/ft<sup>3</sup> of resin is not salt efficient or economical in order to increase softening capacity

During the rinse step, excess brine is washed out of the vessel until the hardness in the effluent rinse is reduced to less than approximately - 2ppm as CaCO<sub>3</sub>.

While in the service cycle, hard water is passed through the resin bed. Hardness forming cations in the influent water are replaced by an equivalent amount of sodium ions from the resin. There are no other changes in the water quality.



## **Water Softener System (cont'd)**

### 8.3 Maintenance

In order to maintain optimum performance of the softener, the following maintenance activities are recommended to be performed by experienced or qualified personnel.

- (a) Obtain a sample of the resin and have it analyzed as required—see Section E for sampling procedures;
- (b) While collecting the resin sample, measure the bed height and compare the actual height with the design height—if resin has been lost, check the service outlet collector screens for a break and the backwash valve setting for excess backwash flow rates;
- (c) Clean or replace resin as determined by its analysis;
- (d) Maintain timer or water meter in good working order;
- (e) Flush out the brine lines periodically.

## 9.0 Contact Steam Cooking System

### 9.1 Description

A typical contact steam cooking system as shown in Figure C-9 is the only acceptable system which provides steam for direct contact cooking of cafeteria type food.

The principal components of these systems include a culinary steam generator and a culinary steam cooker. However, if the culinary steam generator is a gas fired unit, an exhaust fan should also be provided in order to exhaust the products of combustion.

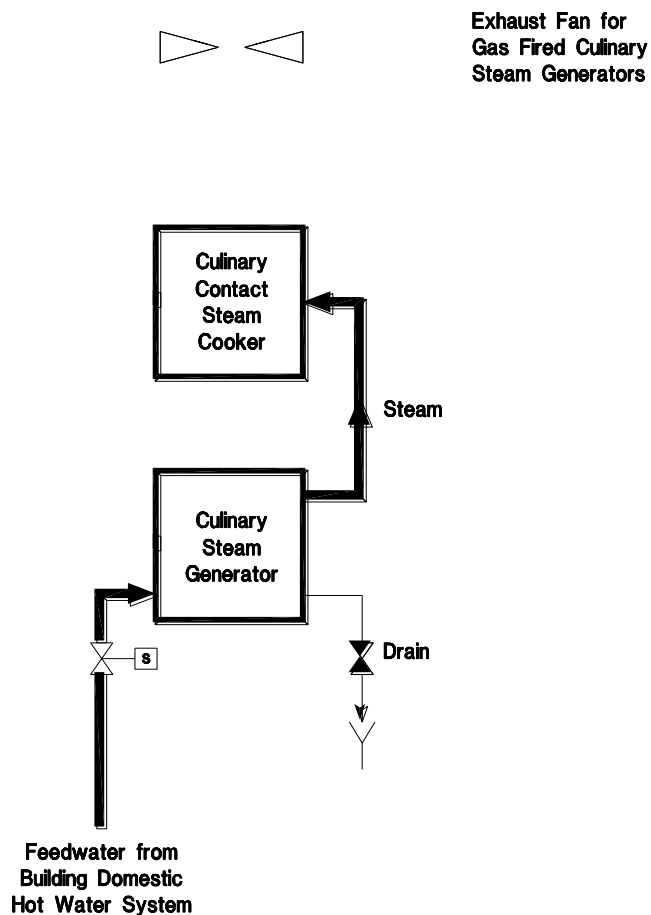


Figure C-9: Schematic Diagram of a Typical Contact Steam Cooking System

## Contact Steam Cooking System (cont'd)

### 9.2 Operation and Maintenance

Since the steam produced by these systems comes into direct contact with food, there can be no chemical treatment of the water and steam in these systems, and the feedwater to these systems must be unsoftened domestic water. Therefore, the corrosive and scaling tendencies of oxygenated water can only be minimised by the following operational and maintenance activities:

- (a) Ensure that the feedwater to the culinary steam generator is unsoftened domestic water from the building domestic hot water system;
- (b) Drain and re-fill the culinary steam generator with fresh hot water at the end of each cooking period (note: this activity can be performed automatically every time the unit is shut off by connecting the drain and fill solenoid valves to the on/off switch or it can be performed manually);
- (c) In those cases where daily draining of the culinary steam generator does not alleviate scaling sufficiently, the cleaning procedure indicated overleaf shall be used.

#### Cleaning Procedure for Culinary Steam Generator

In order to maintain optimum performance of the steam generator, the following cleaning procedures are recommended to be performed by experienced or qualified personnel.

- (a) Required equipment and material includes a plastic mixing tank, a plastic circulating pump, plastic supply & return lines, safety eye goggles, pH paper, metric scale, sulfamic acid, soda ash, and an approved inhibitor;
- (b) Disconnect the feed and drain lines of the culinary generator, and connect these to the circulating pump discharge line and the return line to the mixing tank;
- (c) Prepare the acid solution by adding sufficient sulfamic acid to warm water in the mixing tank such that a pH of 4-5 is obtained, then add 0.2 grams of inhibitor for every 100 grams of acid added;
- (d) Circulate this solution through the culinary generator until the foaming action stops, then drain the spent acid from the culinary generator and the mixing tank into a holding tank;
- (e) Prepare a neutralising solution by adding 5 grams of soda ash for each litre of warm water in the mixing tank, circulate it through the culinary generator for at least one hour, and then drain the culinary

## **Contact Steam Cooking System (cont'd)**

### Cleaning Procedure for Culinary Steam Generator (cont'd)

generator and the mixing tank into the holding tank for disposal to the sanitary sewer system;

- (f) Flush out the culinary generator using warm water until the pH of the rinse water is the same as the domestic water;
- (g) Reconnect the feed and drain lines of the culinary generator and return it to service.

## 10.0 Potable Water System

### 10.1 Introduction

For the purpose of this Section a Potable Water System is a system, which provides potable water for general domestic use. It does not include Municipal Potable Water Systems or other Potable Water Systems, which are Licensed, Operated and Monitored by Alberta Environment.

If the water source is a cistern or reservoir, the fill water must be originally drawn from a water source that is Approved and Licensed by Alberta Environment. Furthermore, the tanker truck that is used to transport the water must be Licensed by Alberta Environment.

If the water source is a creek, river, lake, or if the water source is a well under the influence of a creek, river or lake, Approval and Licensing must be obtained from Alberta Environment. Therefore, this Section does not pertain to these systems.

Although water from a dugout or lagoon may be used for general service water (i.e., washing floors, flushing toilets, etc.) this water source must NOT be directly or indirectly connected to a Potable Water System.

A water system that has been tested and proven to contain water that is unfit for human consumption shall have the appropriate official international signage (i.e., faucet, water drop and drinking glass with a red encircled line through it) affixed to the wall in clear view above all faucets and outlets in the water system until such time that this same water is properly treated, tested and approved for human consumption.

### 10.2 Definitions

**Communal Water Supply:** A communal water supply is one that serves more than one building, lot, or similar place, and where there is a need to safeguard the public health. A communal water supply differs from a public water supply in that it involves distribution of the water to at least 2 different places, whether public or private. Examples include, but not limited to: water co-operatives, trailer parks, campgrounds, ski hills, etc.

**Distribution System:** A water distribution system means a system of pipes, valves, fittings, storage reservoirs and appurtenances that is shared by a communal development to convey potable water to two or more service connections.

**Esherichia Coli (E.coli):** The finding of E.coli in water indicates the presence of material of fecal origin and thus a potentially dangerous situation, the nature of which should be determined by immediate investigation.

## **Potable Water System (cont'd)**

### **10.2 Definitions (cont'd)**

**Groundwater:** The water that systems pump and treat from aquifers (natural reservoirs below the earth's surface).

**Groundwater Under Influence of Surface Water (GWI):** Any water beneath the surface of the ground with (i) significant occurrence of insects or other macro-organisms, algae, organic debris, or disease causing bacteria, or (ii) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions. Alberta Environment shall investigate and make judgement to if a source is considered as "under influence".

**Privately Owned Development:** Means a recreational development, school, Mobile Home Park, restaurant, motel, community hall, work camp, holiday park, campsite, picnic site, information centre, or other similar development, including such a development owned or operated by the Government.

**Public Water Supply:** A public water supply is one that services a single building, lot, or similar place, and where there is a need to safeguard the public health. Examples include, but are not limited to: food establishments, bed & breakfast facilities, gas stations, information centres, golf club houses, etc.

**Source Water:** Water in its natural state, prior to any treatment for drinking.

**Surface Water:** The water that systems pump and treat from sources open to the atmosphere, such as rivers, lakes, and reservoirs.

**Total Coliforms (TC):** Total coliforms are a group of closely related bacteria that are, with a few exceptions, not harmful to humans. The absence of TC in the distribution system minimizes the likelihood that fecal pathogens are present. TC is used to determine the vulnerability of a system to fecal contamination.

**Wellhead Protection Area:** The area surrounding a drinking water well or well field which is protected to prevent contamination of the well(s).

## **Potable Water System (cont'd)**

### 10.3 Description

For the purpose of this Section a typical Potable Water System as shown in Figure C-10 (overleaf), is a system which provides potable water for general domestic use.

The principal components of a potable water system include a water source (i.e., well, cistern, reservoir) supply pump, pressure tank and pressure switch. It may also include a water conditioner (i.e. filter, softener, iron filter, reverse osmosis unit, ultra-violet sterilizer unit) and/or chlorine injection equipment (i.e. mixing tank, mixer, metering pump).

The minimum treatment for surface water source is filtration followed by disinfection. No water should enter a communal distribution system unless it has been disinfected with a residual disinfectant.

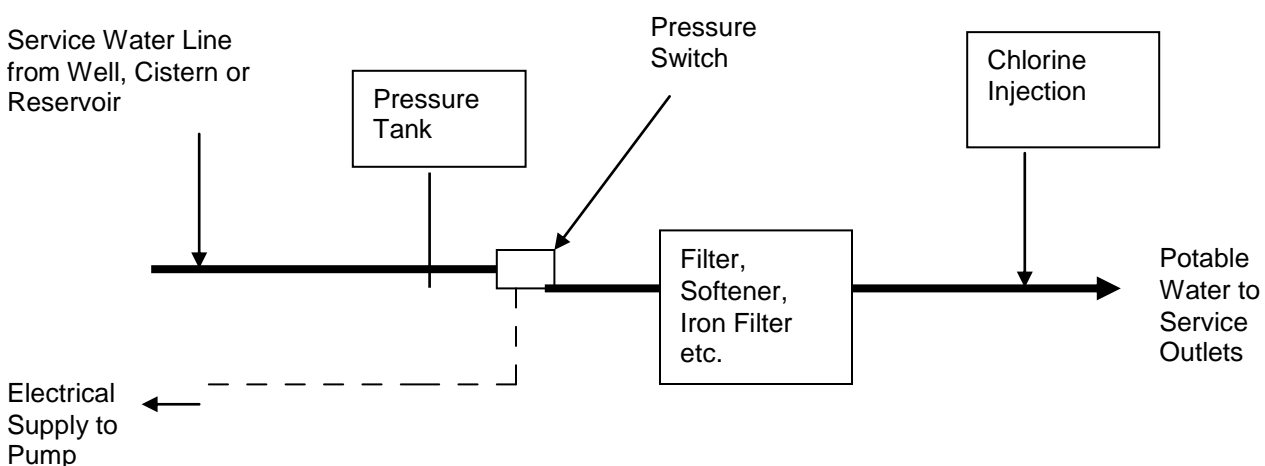
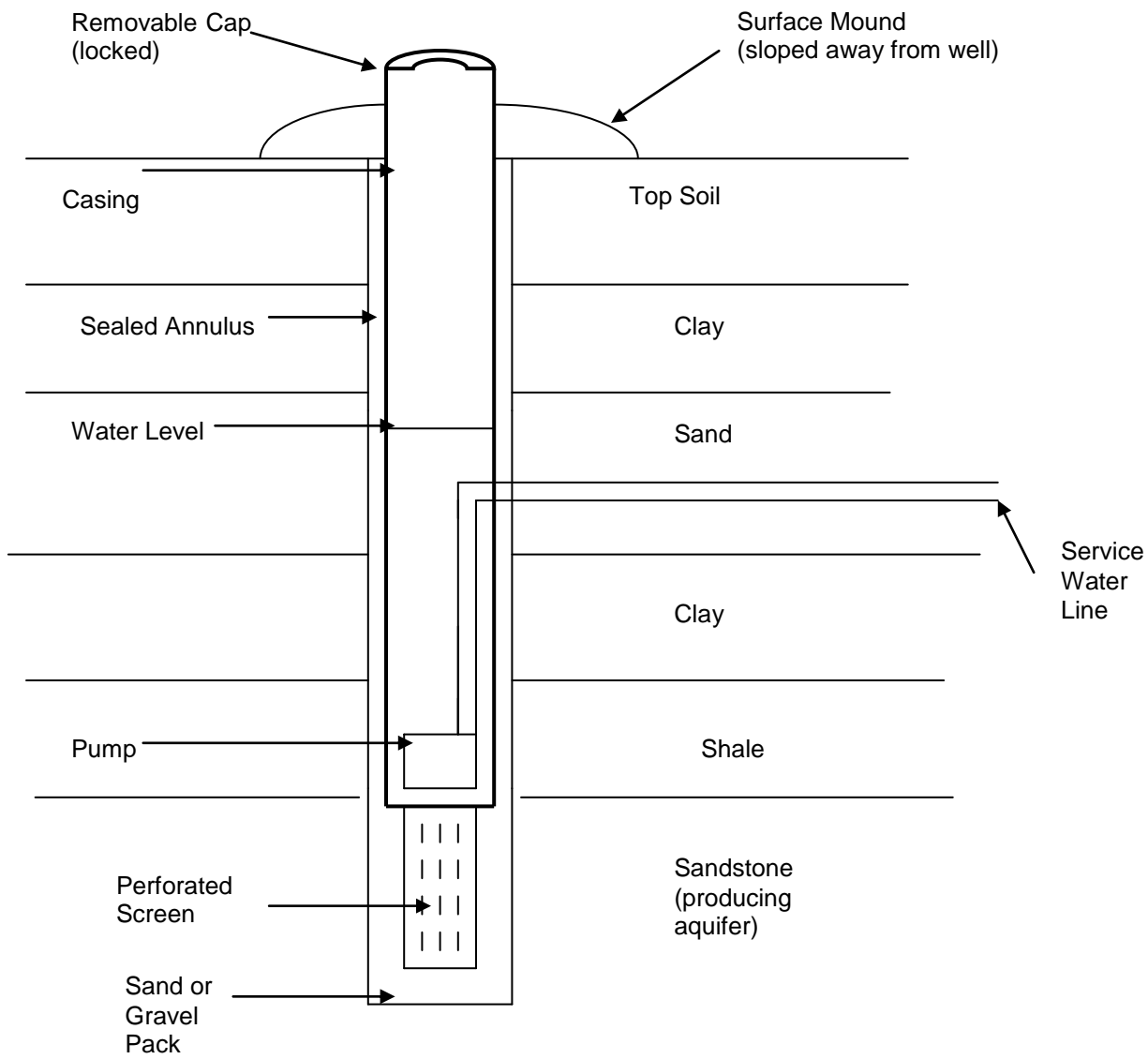


Figure C-10: Schematic Diagrams of a Typical Water Well and Distribution System



## **Potable Water Systems (cont'd)**

### 10.4 Water Quality Standards

A standard bacteriological analysis determines the total coliform and faecal coliform bacteria concentrations in the water sample. The total coliform and faecal coliform bacteria are indicator organisms for the potential presence of pathogenic (i.e., disease causing) bacteria. The presence of *Escherichia coli* (i.e., *E coli*), one species of the faecal coliform group, is a definite indicator of faeces (i.e., animal & human waste). Other species of the faecal coliform group (i.e., *Klebsiella pneumoniae*, *Enterobacter cloacae*) are not restricted to faeces but occur naturally on vegetation and in soils. The maximum acceptable concentration for coliform bacteria—both total and faecal—must be less than that indicated in the latest editions of the following standards:

- (a) Guidelines for Canadian Drinking Water Quality (Health Canada), and
- (b) Alberta Environment Standard (<http://environment.alberta.ca/>).

Note that a standard bacteriological analysis does NOT determine the non-pathogenic (i.e., non-disease causing) bacteria such as iron bacteria or sulphate reducing bacteria, nor does it determine viruses or protozoa (e.g., *Giardia*).

Similarly, a routine (e.g., pH, turbidity, TDS, nitrate/nitrite, etc.) and possibly a non-routine (e.g., pesticides, etc.) potable water chemical analysis must be performed on water samples, and the maximum acceptable concentrations for each of these parameters must be less than that indicated in the latest editions of the following standards:

- (a) Guidelines for Canadian Drinking Water Quality (Health Canada), and
- (b) Standard and Guidelines for Municipal Water Works, Wastewater and Storm Drainage Systems (Alberta Environment) <http://environment.alberta.ca/>

### 10.5 Water Treatment

The need for water treatment of the system (e.g., chlorination, filtration) is specified by Alberta Environment (<http://environment.alberta.ca/>).

## **Potable Water System (cont'd)**

### **10.5 Water Treatment (cont'd)**

Depending on the source of the water, treatment may be required to ensure the water is microbiologically safe and palatable. Groundwater usually does not contain harmful micro-organisms, but depending on the aquifer and well system, can be contaminated through surface infiltration, surface water contamination (groundwater under influence), and abandoned wells. Surface water has a greater potential of being contaminated by disease causing bacteria. As a result, proper disinfection is needed for all surface water supplies. The ideal system is a multi-barrier approach to treating surface water consisting of watershed protection, filtration and disinfection.

The minimum treatment for groundwater source is disinfection.

The minimum concentration of free chlorine and chloramines that must be maintained in the distribution system is 0.2 mg/L for groundwater and 0.5 mg/L for groundwater under the influence of surface water.

### **10.6 Control Tests**

In order to minimize the health risks associated with these systems, the following control tests must be performed, and all test results must be documented on a dedicated record sheet (see typical record sheet overleaf):

- (a) If chlorination is specified, determine & document the free chlorine residual or combined chlorine residual concentration of the water in the system at least once per week (note: this frequency may change at the discretion of the local Public Health Inspector) - it must be 0.1-0.5 mg/l Cl<sub>2</sub>; reduce the chlorine concentration in the chemical mixing tank if it is high; increase the chlorine concentration in the chemical mixing tank if it is low (note: laundry bleach is not recommended for this application).
- (b) Obtain a sample bottle, sampling procedure, and sample requisition form for bacteriological analysis either from the Provincial Laboratories in Edmonton or Calgary, or from your local Provincial Health office, and submit a water sample of the system for bacteriological analysis to any one of these locations quarterly. (Note: this frequency may change at the discretion of the local Public Health Inspector) - If the results are unsatisfactory, you will be contacted by Alberta Public Health, and Alberta Environment will specify & verify the appropriate corrective actions, as soon as the results are known.

## **Potable Water System (cont'd)**

### 10.6 Control Tests (cont'd)

- (c) Obtain a sample bottle, sampling procedure, and sample requisition form for potable water routine chemical analysis either from the Provincial Laboratories in Edmonton or Calgary, or from your local Provincial Health office, and submit a water sample of the system for potable water routine chemical analysis to any one of these locations once per year for cistern and reservoir systems, and once every two years for well water systems. (Note: this frequency may change at the discretion of the local Public Health Inspector) - If the results are unsatisfactory, you will be contacted by Alberta Public Health, and Alberta Environment will specify & verify the appropriate corrective actions, as soon as the results are known.

For detailed information on microbial indicators, sampling protocol, interpretation of results, site investigation, communication and action protocol, refer to "Environmental Public Health Field Manual for Private, Public and Communal Drinking Water Systems in Alberta" Web link:

<http://www.health.alberta.ca/documents/Drinking-Water-Systems-2004.pdf>

or

[Environmental Public Health Field Manual for Private, Public and Communal Drinking Water Systems in Alberta](#)

Additional information can be found at the following web link:

<http://environment.alberta.ca/>

WATER TREATMENT LOG SHEET

BUILDING NAME & LOCATION:

BUILDING FILE NO.:

WATER SYSTEM: POTABLE WATER

Date	Time	Bacterio-logical Analysis	Routine Chemical Analysis	Chlorine Concentration (mg/l Cl)	Comments

## SECTION D — ION EXCHANGE RESIN

### 1.0 Types of Ion Exchange Resin

There are two types of exchange resin currently being used within Government of Alberta buildings.

Generally Cation Resins are used for water softening and Anion Resins are for Dealkalyzing.

#### a) Resin Principals

The Cation exchange resin has a positive charge and is normally associated with the softening process. This resin is also known as Sodium Zeolite and is typically the strong acid type. The resin is made of tiny polystyrene beads which have positively charged sodium ions loosely attached. These Sodium Ions will be readily given up for more desirable positive Ions such as Calcium and Magnesium. This exchange will continue until all possible sodium Ions have gone. At this point the resin beads are exhausted and need a new charge of sodium Ions. This is accomplished by reversing the softening reaction. A calcium chloride brine solution (salt) is introduced to the exhausted resin to remove the Calcium and Magnesium and restore the Sodium Ion on the resin bead once again. This is called the regeneration cycle and repeats continuously as needed.

The Anion exchange resin has a negative charge and is normally associated with the dealkalization process. Dealkalyzers are similar to softeners and are also regenerated with salt. The anion resin is charged with chloride ions on the resin beads instead of sodium, these are typically the strong base type. Their principal purpose is to replace bicarbonate ions from the make up water with chloride ions.

The anion resin does not remove silica from the water.

When removal of carbon dioxide is necessary, a small amount of sodium hydroxide (caustic) solution is added to the salt brine solution tank for regeneration. This will convert the CO<sub>2</sub> (Carbon Dioxide) gas into bicarbonate alkalinity which can then be exchanged by the anion resins chloride ion.

#### b) Other Resin types

These resin types are:

- Strong Acid Hydrogen Cation
- Weak Acid Hydrogen Cation
- Weak Base Anion
- Strong Base Anion

Due to the scope of this manual, all the resin types above and their applications are not discussed.

## ***Ion Exchange Resin (cont'd)***

### **2.0 Sampling of Ion Exchange Resin for Analysis**

Poor performance from an ion exchange unit is most often due to mechanical failures (i.e., reduced/increased water pressure during the backwash, regeneration, or rinse cycles, faulty water meters, faulty water analysers, regenerant pump failure, regenerant ejector failure, faulty valve operation, faulty underdrains, etc.) which if not corrected will eventually lead to the breakdown of the ion exchange resin.

For this reason, as well as the fact that there is natural attrition of the resin, a sample of resin is required for analysis in order to determine the extent of damages and corrective actions.

It is very important to ensure that, as far as possible, the sample of resin acquired for analysis is representative of the total bed from which it was taken.

Samples taken from or near the bed surface are usually not suitable for examination as the small particle material present will invalidate the test results.

The suggested procedure for sampling ion exchange resin is indicated overleaf.

#### **Procedure for Sampling of Ion Exchange Resin**

- (a) Operate the unit to its normal exhaustion end-point, then backwash, regenerate, and rinse in the normal manner;
- (b) Depressurise the unit, remove the upper man-way cover, and while draining, observe and record the appearance of the top inlet distributor and regenerant distributor (i.e., are they level, are they loose, are openings filled with resin, etc.);
- (c) Drain the unit to a level below the bed surface—Note: a hot process unit must be cooled before draining in order to prevent dehydration;
- (d) Observe and record the appearance of the bed surface (i.e., clean, dirty, level, hilly, mounded in centre, cracks, slopes to side, pulled away from shell, etc.);
- (e) Measure and record the bed depth;
- (f) If the bed surface is not normal, probe the bed with a metal rod to the supporting bed in a number of spots in order to see if the supporting bed is level, and record observations;

## ***Ion Exchange Resin (cont'd)***

### ***2.0 Sampling of Ion Exchange Resin for Analysis (cont'd)***

- (g) Obtain a core sample from the resin bed as follows:
- (i) add water to the unit until the surface of the bed is submerged;
  - (ii) thrust a thin walled 1" copper, stainless steel, or rigid plastic tube down into the resin bed to the supporting bed;
  - (iii) cap or plug the top end of the tube;
  - (iv) drain the unit;
  - (v) slowly withdraw the tube;
  - (vi) transfer the resin sample to a plastic bottle by adding water to the top of the tube while it is held over the mouth of the bottle;
  - (vii) repeat steps (i) through (vi) until approximately 1 litre of resin is collected;
  - (viii) add water from an operating unit to the sample bottle until the resin sample is submerged;
  - (ix) identify the resin sample by marking the name of the building and the unit it was collected from on the outside of the sample bottle;
  - (x) complete the attached data sheets;
  - (xi) pack the resin sample (Note: in cold weather, insulate the sample in order to prevent it from freezing) with the data sheets overleaf and mail the package to the supplier.

***Ion Exchange Resin (cont'd)***

**Ion Exchange Resin Sample Data Sheet**

A. Origin of Sample

Building Name:

\_\_\_\_\_

Address:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Contact Person:

\_\_\_\_\_

B. Sample Collection

Date of Sample Collection: \_\_\_\_\_

Sampling Procedure: Core Sample; \_\_\_\_\_ Surface Sample; \_\_\_\_\_

C. Ion Exchanger Specifications

Duty (i.e., softener, dealkalizer, etc): \_\_\_\_\_

Diameter, in: \_\_\_\_\_

Freeboard, in: \_\_\_\_\_

Depth of Resin, in: \_\_\_\_\_

Volume of Resin, ft<sup>3</sup>: \_\_\_\_\_

Manufacturer of Resin: \_\_\_\_\_

Resin Name: \_\_\_\_\_

Normal Service Flow, USGPM: \_\_\_\_\_

Maximum Service Flow, USGPM: \_\_\_\_\_

Service Run, USG: \_\_\_\_\_

Age of Resin, years: \_\_\_\_\_



***Ion Exchange Resin (cont'd)***

***Ion Exchange Resin Sample Data Sheet (cont'd)***

D. Influent Water Quality

Source/origin:		_____
Temperature,	°F:	_____
Total Hardness,	ppm CaCO <sub>3</sub> :	_____
Sodium,	ppm CaCO <sub>3</sub> :	_____
Iron,	ppm Fe:	_____
Alkalinity,	ppm CaCO <sub>3</sub> :	_____
Chloride,	ppm CaCO <sub>3</sub> :	_____
Sulphate,	ppm CaCO <sub>3</sub> :	_____
pH:		_____
Conductivity,	microsiemens/cm:	_____

E. Regeneration

Regenerant Name:		_____
Regenerant Concentration,	%:	_____
Amount of Regenerant,	lb/cycle:	_____
	lb/ft <sup>3</sup> resin:	_____
Backwash Flow Rate,	USGPM:	_____
Backwash Duration,	minutes:	_____
Regenerant Flow Rate,	USGPM:	_____
Regenerant Duration,	minutes:	_____
Rinse Flow Rate,	USGPM:	_____
Rinse Duration,	minutes:	_____

## ***Ion Exchange Resin (cont'd)***

### **3.0 Cleaning of Fouled Ion Exchange Resin**

If the resin analysis shows that the resin is fouled, consideration should be given to cleaning it, rather than discarding it and purchasing new resin. However, as there are various foulants for the different resin types as well as the fact that very corrosive chemicals are used in the procedures, this decision should not be made without discussions with the Consultant.

In order to appreciate the complexity and commitment one has to make when cleaning ion exchange resin, the following procedures are included below & overleaf:

- (a) Preventative Maintenance Cleaning of Sodium Form Cation Resins;
- (b) In-situ Cleaning of Sodium Form Cation Resin;
- (c) In-situ Cleaning of Cation/Anion Resin;
- (d) In-situ Cleaning of Anion Resin.

#### **Preventative Maintenance Cleaning of Sodium Form Cation Resins**

- A. Chemicals and Materials
  - (i) Sodium hydrosulphite, 2-4 oz. per cubic foot of resin;
  - (ii) Rubber gloves;
  - (iii) Ventilation.

- B. Procedure

As a means of preventing a resin bed from becoming badly fouled with iron, a preventative maintenance program consisting of the addition of 2-4 oz. of sodium hydrosulphite per cubic foot of resin directly to the brine tank for every regeneration may be implemented.

Note that this procedure should only be used for sodium form cation resins.

## ***Ion Exchange Resin (cont'd)***

### ***3.0 Cleaning of Fouled Ion Exchange Resin (cont'd)***

#### **In-situ Cleaning of Sodium Form Cation Resin**

- A. Chemicals and Materials
  - (i) Sodium hydrosulphite, 1.25 lbs per cubic foot of resin;
  - (ii) Fresh water supply nearby for rinsing down spills;
  - (iii) Protective clothing while handling sodium hydrosulphite;
  - (iv) Ventilation.
  
- B. Procedure
  - (i) Thoroughly backwash the resin;
  - (ii) Regenerate the resin with brine in the normal manner;
  - (iii) Slow rinse the resin to only a slightly salty taste in samples collected at the effluent;
  - (iv) Isolate the unit from the process by closing the isolating valves and breaking the main outlet line;
  - (v) Depressurize the unit and remove the upper man-way cover;
  - (vi) Lower the water level in the unit until the amount of water above the resin bed is equal to  $\frac{1}{2}$  of the volume of the resin bed;
  - (vii) Prepare a concentrated sodium hydrosulphite/water solution by adding the amount of sodium hydrosulphite to yield a 4% solution when mixed with water above the resin bed in step (vi)—since these solutions lose their effectiveness quite rapidly, they should be utilized immediately after mixing and only the amount needed for a specific treatment should be prepared at one time;
  - (viii) Mix the concentrated sodium sulphite/water solution with the water above the resin bed in step (vi);
  - (ix) Drain from the bottom of the unit until the hydrosulphite solution level is just above the resin bed level;
  - (x) Mix the hydrosulphite solution and resin so that the cleaning solution is evenly mixed throughout the resin bed—do not agitate with air as this will oxidise the hydrosulphite and render it ineffective;
  - (xi) Allow the cleaning solution to contact the resin for 4-12 hours;
  - (xii) Replace the upper man-way cover;
  - (xiii) Drain, downflow rinse the unit, and backwash for 30 minutes to remove the loosened foreign material;
  - (xiv) Regenerate the resin using twice the normal amount of regenerant and return the unit to service after the effluent pH level is normal.

## ***Ion Exchange Resin (cont'd)***

### ***3.0 Cleaning of Fouled Ion Exchange Resin (cont'd)***

#### **In-situ Cleaning of Cation/Anion Resin**

##### **A. Chemicals and Material**

- (i) For each 100 ft<sup>3</sup> of resin, 375 USG of 10% inhibited hydrochloric acid—uninhibited hydrochloric acid should be used for cleaning anion resin;
- (ii) For neutralising each 100 USG of 10% HCl, 127 lbs of soda ash, 89 lbs of hydrated lime, or 96 lbs of caustic are required;
- (iii) Fresh water supply for rinsing down acid spills;
- (iv) Protective clothing while handling acid.

##### **B. Procedure**

- (i) Thoroughly backwash the resin;
- (ii) Regenerate the resin in the normal manner (Note: anion resin must be rinsed with 10% brine before the acid is introduced);
- (iii) Isolate the unit from the process by closing the isolating valves and breaking the main outlet line;
- (iv) Depressurize the unit and remove the upper man-way cover;
- (v) Lower the water level in the unit to approximately 3" above the resin bed;
- (vi) Add the 10% acid, the volume of which should be equal to ½ of the volume of the resin bed, slowly through the man-way and onto the top of the resin bed;
- (vii) Open the bottom drain valve to lower the acid level in the unit to a point approximately 3" above the top of the resin bed;
- (viii) If oil-free air is available, air lance the acid soaked resin bed for approximately 30 minutes—if oil-free air is not available, allow the resin to soak in the acid for 1-2 hours;
- (ix) Drain the acid from the unit, allowing the spent acid which should be amber in colour to pass through the neutralising material before entering the drains system;
- (x) Replace the man-way cover;
- (xi) Rinse the unit downflow with water until samples collected at the outlet of the unit are water white in colour—for cation resin, the pH level of the unit effluent will be low due to hydrogen form from the acid;
- (xii) Repeat step (ii) of the procedure;
- (xiii) Check the pH level of the effluent rinse water—if necessary, repeat the regeneration until the effluent pH level is within normal limits;
- (xiv) Reconnect the outlet line and return the unit to service.

## ***Ion Exchange Resin (cont'd)***

### ***3.0 Cleaning of Fouled Ion Exchange Resin (cont'd)***

#### **In-situ Cleaning of Anion Resin**

##### **A. Chemicals and Materials**

- (i) Decationized water or softened water, heated;
- (ii) Fine grade sodium chloride, about 14-42 lbs per ft<sup>3</sup> of resin—exact amount depends on the number of squeezes required;
- (iii) Glass sample bottles.

##### **B. Procedure**

- (i) Thoroughly backwash the resin;
- (ii) Isolate the unit from the process by closing the isolating valves and breaking the main outlet line;
- (iii) Depressurize the unit and remove the upper man-way cover;
- (iv) Lower the water level in the unit to 1-2' above the resin bed;
- (v) Regenerate with caustic at the set points shown for the first caustic regeneration in Table E-1 overleaf;
- (vi) Slow rinse the resin at the set-points shown for the first caustic regeneration in Table E-1 overleaf;
- (vii) Regenerate with warm salt at the set-points shown for the salt regeneration in Table E-1 overleaf;
- (viii) Slow rinse the resin at the set points shown for the salt regeneration in Table E-1 overleaf—collect effluent samples every 5 minutes until the most intense colour is observed—retain and set aside the sample having the maximum colour intensity and discard the rest;
- (ix) Regenerate with caustic and then rinse at the set-points shown for subsequent caustic regenerations in Table E-1 overleaf;
- (x) Repeat steps (vii), (viii), and (ix) until the maximum colour eluted during the brining is a small fraction of the colour observed after the first treatment—approximately 2-6 squeezes are required to purge out most of the organics;
- (xi) Replace the upper man-way cover;
- (xii) Repeat step (i);
- (xiii) Regenerate the resin with twice the normal amount of salt if the unit is a chloride form dealkalizer or organic trap;
- (xiv) Regenerate the resin with twice the normal amount of caustic if the unit is a hydroxyl form strong base anion unit;
- (xv) Check the pH level of the effluent rinse water—if necessary, repeat the regeneration until the effluent pH level is within normal limits;
- (xvi) Reconnect the outlet line and return the unit to service.

## Ion Exchange Resin (cont'd)

Table E-1: Set-Points for Brine Squeeze Procedure

Parameter	Units	First Caustic Regeneration	Salt Regeneration	Subsequent Caustic Regenerations
Quantity of Regenerant	Lb/ft <sup>3</sup> of resin	2.0	7.0	2.0
Regenerant Strength	%	3.5	15	5.0
Quantity of Regenerant	Lb/ft <sup>3</sup> of resin	57	46.6	40
Volume of Regenerant	USG/ft <sup>3</sup> of resin	6.9	5.2	4.8
Flow Rate of Regenerant	USG/ft <sup>3</sup> of resin	0.35	0.2	0.24
Time for Regeneration	Minutes	20	25	20
Regenerant Temperature	°F	Ambient	130-140	Ambient
Rinse Water Temperature	°F	90-140	90-140	90-140
Flow Rate of Rinse Water	USG/ft <sup>3</sup> of resin	0.2	0.5	0.2
Time for Rinsing	Minutes	10	15	10

### 4.0 Ordering New Ion Exchange Resin

Once it is determined that the existing resin should be replaced or its volume increased, the correct resin must be selected. In order to be able to monitor the performance of the resin, each ion exchange unit should contain resin from only one manufacturer. If you are adding resin, refer to the original product specifications for ordering the correct product.

Ion exchange resin cannot be purchased directly from the manufacturer. Contact a local supplier for detailed product information, supply, and service.

The following table lists resin types from the major resin manufacturers most commonly used in water treatment applications. A diverse range of resins is available for specific applications and conditions. For selecting the appropriate resin contact the supplier or the water treatment consultant.

#### Resin Types from Major Resin Manufacturers

Ion Exchange Unit	Rohm & Haas	Sybron
Softener, sodium cycle	Amberlite IR 120 Na	Lewatit S1467
Cation Exchanger, hydrogen	Amberlite IR 120 Na	Lewatit S1467
Anion Exchanger, hydroxyl	Amberlite IRA 402 Cl	Lewatit Mono Plus
Dealkalizer, chloride cycle	Amberlite IRA 410 Cl	Ionac C 249
Mixed Bed Exchanger Cation Resins Anion Resins	Amberjet 1200 H Amberjet 4200 Cl	Ionac NM-60
Condensate Polisher, sodium	Amberlite 252 Na	Lewatit MonoPlus

## ***Ion Exchange Resin (cont'd)***

### **5.0 Storage of Ion Exchange Resins**

In order to ensure that ion exchange resin, new or used, does not deteriorate during storage or extended periods of plant shut down, it is advisable to observe the following precautions.

#### **5.1 Storage**

Ion exchange resin is moist when packed and shipped from the manufacturer and it is important to ensure that it is not allowed to subsequently dry out as a proportion will almost certainly crack or break when re-wetted.

The resin containers are water tight when the product leaves the factory and it is important to ensure that the resin remains sealed in the containers if it is being stored before use.

Avoid storing resin where it will be subjected to extremes in temperature (e.g., in direct sunlight, or in a boiler room, or outside in sub-zero temperatures where the resin may freeze).

#### **5.2 Plant Shutdown**

When ion exchange units are shut down for an extended period (e.g., for a month or more), it is advisable that they be left filled with water for cation units and with alkaline brine solution (i.e., 2% NaOH-10% NaCl) for anion units.

The units should be checked from time to time during the shutdown to ensure that the beds have not inadvertently been drained, which could result in the resin drying out. When resins have dried out, they should be re-wetted with brine soaking steps starting with a 15% NaCl solution and decreasing the brine concentration by 5% with each subsequent soaking step.

Cation and ion resins operating in a demineralizer will require regeneration with several times the design regenerant quantity following a brine/water dehydration in order to achieve acceptable product water quality. However, cation resin used for base exchange softening and anion resin used in the chloride form for dealkalizing will both finish in a regenerated condition after brine rehydration and they can be put straight into service after backwashing.

## ***Ion Exchange Resin (cont'd)***

### **6.0 Conditioning of New Ion Exchange Resin Before Use**

Sodium form softener and condensate polisher resin, as well as chloride form dealkalizer resins, may be used directly without regeneration. However, they should be thoroughly backwashed and rinsed prior to service.

All other resins should be thoroughly backwashed and regenerated using at least twice the design amount of regenerant at the design concentration prior to service.



## SECTION E —CHEMICALS, SUPPLIES AND MISCELLANEOUS PROGRAMS

### 1.0 General

The Government Water Treatment Program Manual was developed emphasizing the use of generic chemical treatment as a standard policy. Over time, several systems have adopted the use of proprietary treatment as an alternative, primarily as a result of generic treatments no longer being the best option available of producing adequate protection.

In addition, technological advances in the development of chemical treatments has proved some proprietary treatments are now preferred and not only provide superior protection but are more stable treatments allowing less frequent testing and addition of treatment product, while not increasing the risk of system deterioration.

The GOA continues to encourage the use of generic treatment where possible. Where proprietary treatment programs are in use or under consideration, it is incumbent upon the operators to fully understand, which product is best suited for the specific application; its properties, harmful effects to personnel (MSDS) and environmental consequences. In all cases where proprietary is used, the treatment must be first authorized by the GOA Water Treatment Specialist and reviewed by the respective Water Treatment Coordinator. Refer to Appendix A at the end of section E for “Guidelines For Completion Of Application To Use Alternate Chemical Treatment”.

### 2.0 Sample Verification and Testing

The purpose of the **Sample Verification and Testing** is:

- (a) to provide a verification function in terms of checking test accuracy, test procedures, reagent quality, etc.;
- (b) to ensure consistency in water test procedures;
- (c) to provide early detection of water treatment problems; and
- (d) to identify problems and remedial actions for systems.

It is not mandatory for the field sites to submit samples to their Co-ordinators. These samples should be submitted for testing only if there are any problems. It is expected that each Co-ordinator will visit his assigned sites at least twice each year—preferably before each Water Treatment Co-ordinators’ Meeting—to review test procedures as well as assess the condition of mechanical equipment and water treatment systems. Sample verification tests, if required, could be carried out during these site visits. If there is a problem in maintaining the control limits, the Water Treatment Co-ordinator should get in touch with the Water Treatment Specialist for advice.

## **Chemicals, Supplies and Miscellaneous Programs (cont'd)**

### *Sample Verification and Testing (cont'd)*

As indicated above, there is no set schedule for the verification testing of samples. The timing and frequency of these tests are left to the discretion of the Water Treatment Co-ordinator.

### **3.0 Corrosion Monitoring Program**

The Corrosion Monitoring Program is intended to provide early detection of system condition, particularly in regards to the corrosion rates for the piping and equipment. This early detection allows the Co-ordinator to work with the Water Treatment Specialist, Manager and the Building Operator to prevent severe deterioration of equipment and piping systems. Corrosion Coupons are issued through the Specialist. In order to ensure proper monitoring, consistency, testing and recording of results, all coupons must be obtained from the Specialist.

#### **3.1 Corrosion Coupon Installation and Removal Procedure**

Corrosion coupon testing is an accepted method for monitoring the corrosion inhibitor performance of a water management program. By exposing a pre-measured metal coupon to controlled representative system condition, corrosion rates can be qualified and compared to acceptable standards. Actual corrosion rates expressed in "mils per year" (thousands of an inch) will vary depending on the system being treated and the metal of the coupon. In many cases, the systems actual operating conditions will present greater corrosive tendencies. This must all be taken into account when determining the actual corrosion rate of a coupon.

The following should be considered when installing and removing corrosion coupons.

1. When installing or removing coupons, do not touch coupon surfaces with bare hands, use care to protect the surfaces from any abrasion. Abrasion will affect the weight of the coupon and adversely affect the corrosion rate.
2. Do not remove any deposits from the coupons. Any deposit or film will be cleaned by the laboratory prior to measurement.
3. To install, attach the coupon to the end of the holder with the Stainless Steel or Nylon bolt, nut and washer.

## ***Chemicals, Supplies and Miscellaneous Programs (cont'd)***

### *Corrosion Coupon Installation and Removal Procedure (cont'd)*

4. Apply Teflon tape to the piping plug threads, install and tighten so that the machined or scored line on the end of the coupon holder (plug) runs perpendicular with the plane of the coupon rack piping. This will ensure proper flow across the coupon.
5. Ensure that the mild steel coupon is up stream of the copper coupon. Refer to schematic for coupon placement.
6. Retain the original envelope for each coupon. Record the installation date on the envelope and secure on or near the installed coupon.
7. At the end of the sample period (90 days), remove the coupon carefully, let it air dry and place in the original envelope. The 90 day installation period is recommended as this provides a closer approximation to normal long-term system conditions.
8. Record the removal date on the envelope, along with name and address of plant, type of system and any other relevant information. Installation and removal dates are critical, as this is a crucial link in the calculation of the corrosion rate.
9. Conditions such as excessive flow, inadequate flow or periodic shutdown, may significantly affect observed rates of corrosion. Ensure that flow is consistent during the sample period and is not exceeding the permissible range of (5-8 GPM, 1-2 meters per second). The use of a set flow restricting device in the coupon rack must be installed after the coupons. This will ensure proper flow rates at all times.
10. Water Treatment Coordinators shall ensure that corrosion coupon racks, holders, and attachments are installed in the appropriate manner. See following "Corrosion Coupon Rack Installation" Schematic.

# Chemicals, Supplies and Miscellaneous Programs (cont'd)

## Corrosion Coupon Installation and Removal Procedure (cont'd)

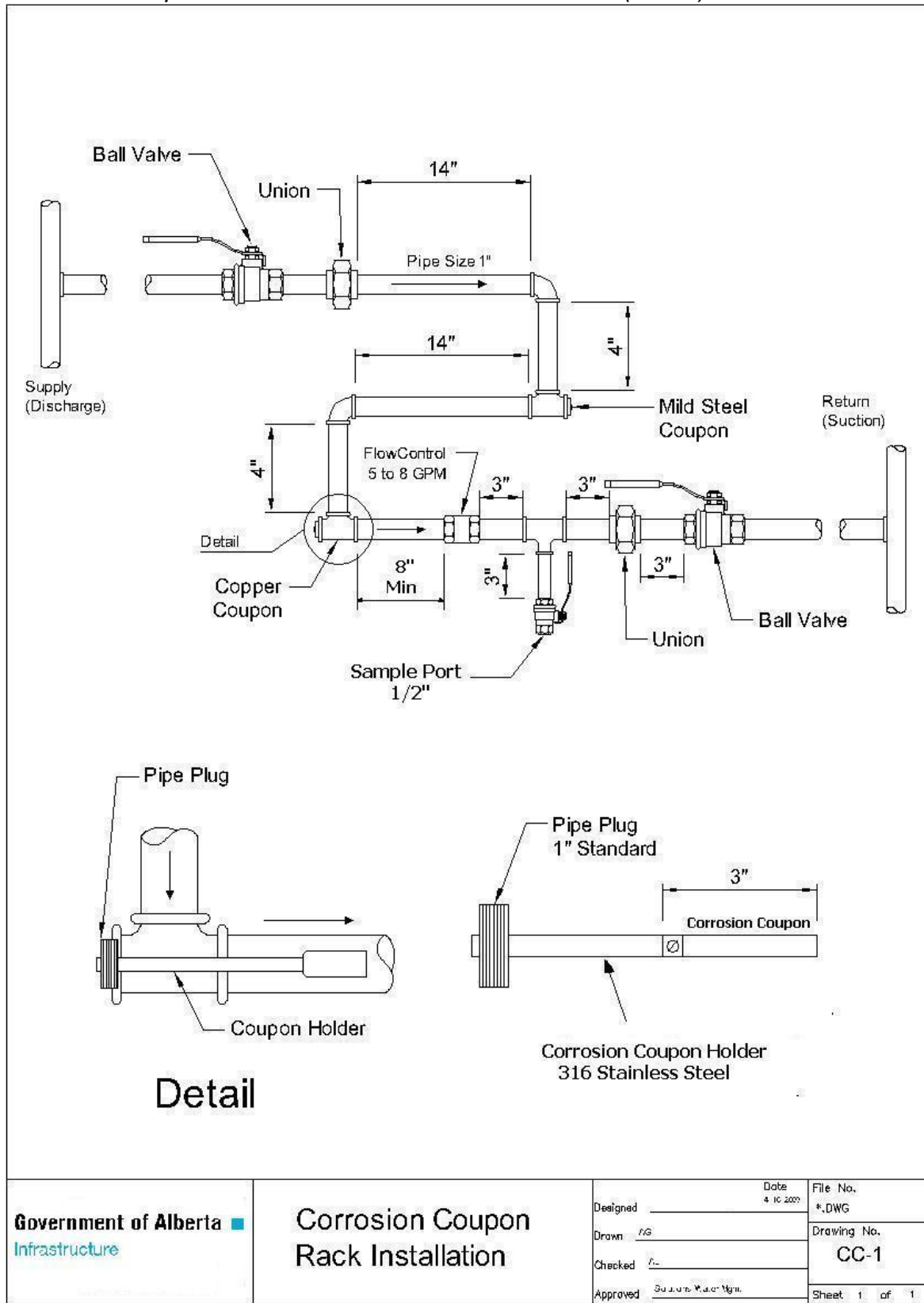


Figure E-1: Corrosion Coupon Rack Installation Schematic  
 Drawing Courtesy of Solutions Water Management Ltd.

**Chemicals, Supplies and Miscellaneous Programs (cont'd)**

*Corrosion Coupon Installation and Removal Procedure (cont'd)*

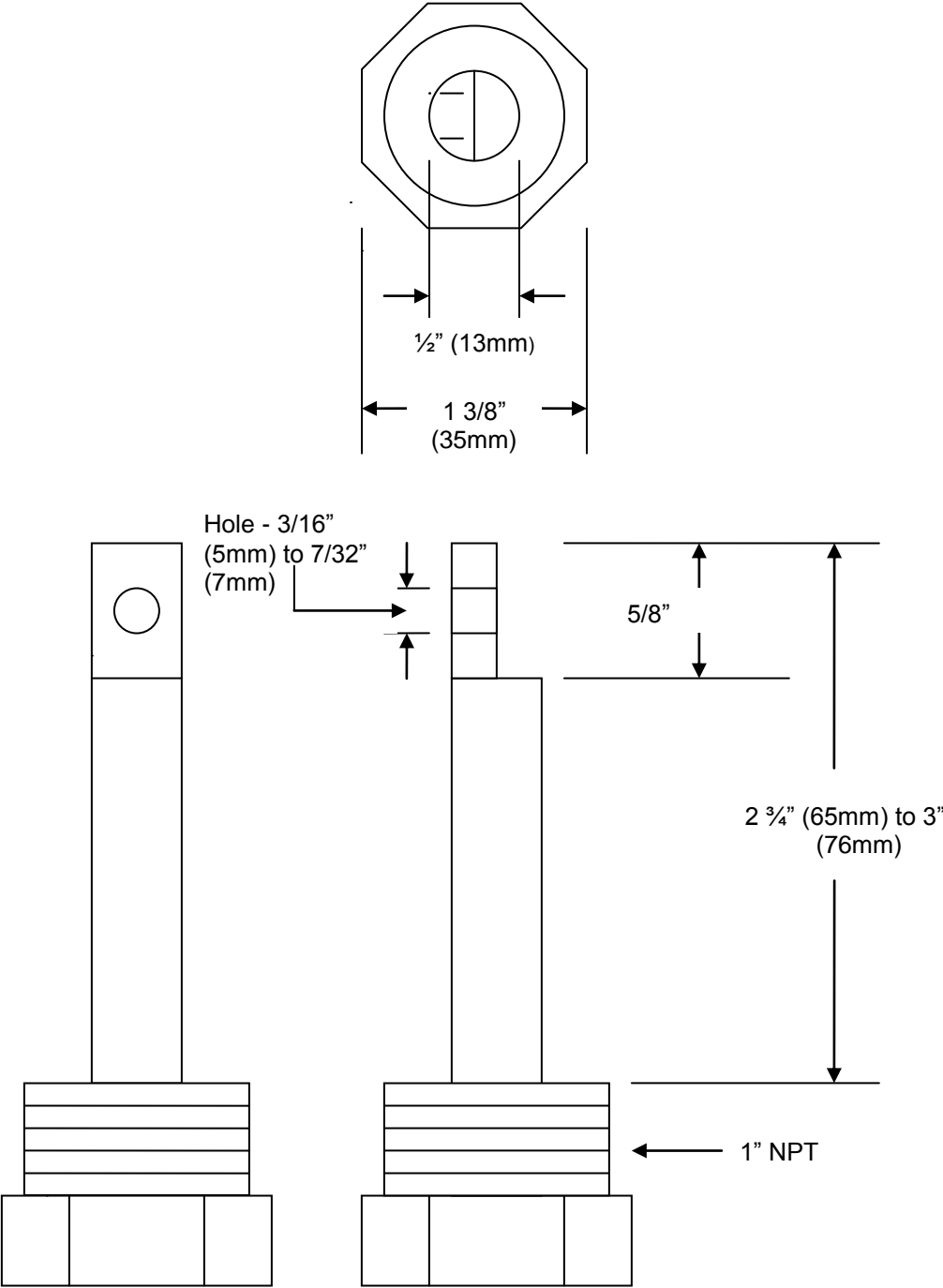


Figure E-2: Corrosion Coupon Holder Schematic

Note: All Coupon Holders shall be constructed of 316 Stainless Steel and conform to the above noted dimensions. Fasteners shall consist of 316 Stainless Steel or nylon machine screws, nuts and washers.

**Chemicals, Supplies and Miscellaneous Programs (cont'd)**

*Corrosion Coupon Installation and Removal Procedure (cont'd)*

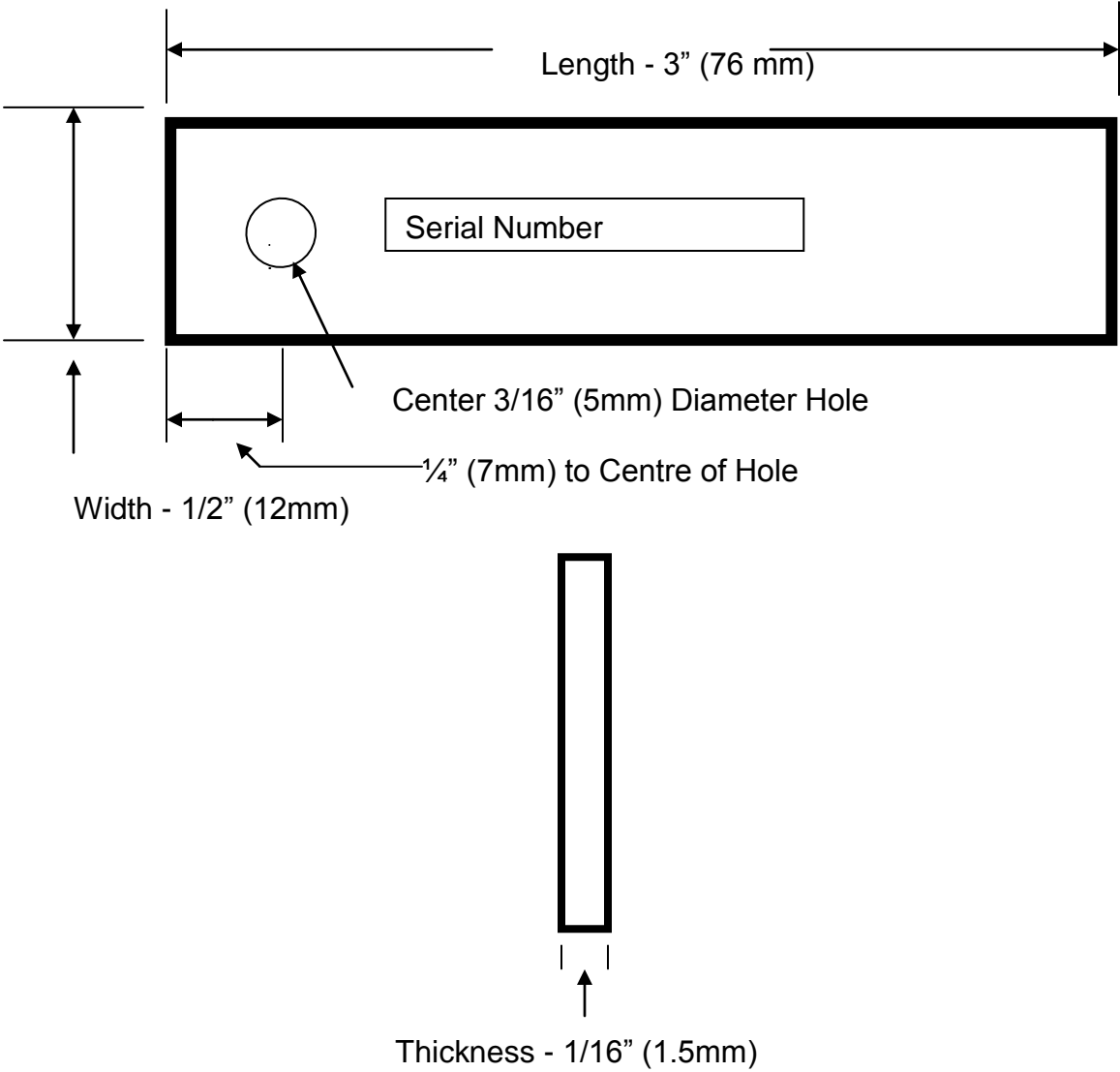


Figure E-3: Corrosion Coupon Schematic

**Note:** Mild Steel and Copper Corrosion Coupons to be identified by a stamped serial number for tracking purposes. Coupons will also have a noted pre-weight value on the packaging in reference to the serial number.

## **Chemicals, Supplies and Miscellaneous Programs (cont'd)**

### *Corrosion Coupon Installation and Removal Procedure (cont'd)*

#### **3.2 Corrosion Coupon Rack Installation Notes**

1. The corrosion coupon rack should be piped to valved connections (3/4" minimum to 1" maximum) in the inlet & outlet piping of the system circulating pumps or to existing connections in parallel with the by-pass filter, with due regard to the water flow direction – see above drawing;
2. The corrosion coupon rack must be located at the operating level, away from any electrical devices, and adequately supported;
3. Access must be provided so that the coupon holders and attached corrosion coupons may be easily removed from the corrosion coupon rack;
4. The piping to and from the corrosion coupon rack may be copper or iron (3/4" minimum to 1" maximum), but the corrosion coupon rack itself must be fabricated in accordance with the above drawing (carbon steel piping and fittings (degreased)).

#### **4.0 Purchase of Chemicals, Reagents and Test Equipment**

The appropriate chemicals, reagents, test equipment and accessories are ordered directly from the supplier(s) by the Building Operator.

##### **4.1 Reagent Shelf Life**

The shelf life of the reagents is dependent on such factors as temperature, light, contamination, and the reagent itself. Generally, the reagents will be consumed before their shelf life expires. However, such activities as storage at room temperature away from light, and replacement at the beginning of each heating season and/or prior to the expiry date on the reagent bottle will ensure continued reagent activity.

#### **5.0 Test Equipment**

##### Equipment

- (a) pH meter  
Digital read-out, pocket type  
Range: 0.0 to 14.0 pH  
Resolution: 0.1 pH  
Accuracy: +/- 0.1 pH  
Calibration: Slope and Offset trimmers  
Temperature Compensation: Automatic  
Operating Temperature: 0 to 50 Degrees Celsius

## **Chemicals, Supplies and Miscellaneous Programs (cont'd)**

### *Test Equipment (cont'd)*

- (b) TDS meter  
Digital read-out, pocket type  
Range: 100 to 10,000 ppm  
Resolution: 100 ppm  
Accuracy: +/- 2% of full scale  
Calibration: Adjustment Trimmer  
Temperature Compensation: Automatic  
Operating Temperature: 0 to 50 Degrees Celsius

## **6.0 Test Kits**

- (a) Chemical Test Kits  
There are many types of tests kits available on the market. Contact the Chemical Supplier for the appropriate test kit for the system.
- (b) Microbiological test kit - Iron Related Bacteria  
Test kit for Iron Related Bacteria (IRB), easy to use, with room temperature incubation, c/w self-contained on-site bacteria tester and comparator charts.
- (c) Microbiological test kit - Sulphate Reducing Bacteria  
Test kit for Sulphate Reducing Bacteria (SRB), easy to use, with room temperature incubation, c/w self-contained on-site bacteria tester and comparator charts.
- (d) Microbiological test kit - Total Aerobic Bacteria  
Test kit for Total Aerobic Bacteria (TAB), easy to use, with room temperature incubation, c/w self-contained on-site bacteria tester and comparator charts.
- (e) Swimming Pool and Potable Water Test Kit (chlorine and pH tests)
- (f) Standardization Solution used to calibrate TDS or pH meters



**GUIDELINE FOR COMPLETION OF APPLICATION TO USE  
ALTERNATE CHEMICAL TREATMENT**

This guideline is meant to assist in the completion of the request to convert a building system to a different chemical treatment product. Without this core information, approvals will be delayed and depending on the complexity of the issues more information may be requested. Please submit the following information to the “Water Treatment Specialist”:

- 1. Building Name:**
- 2. Address:**
- 3. Building ID:**
- 4. Project ID:**
- 5. Proposed Date of Chemical change:**
- 6. *System Identification.***
- 7. *Current Chemical Treatment.***
- 8. *Relevant history and rationale for change request.***
- 9. *Requested Chemical Treatment Program Information.***
  - 9a New Product description
  - 9b New Product MSDS
  - 9c Environmental compliance assurance
  - 9d Testing equipment supplied
  - 9e Chemical Treatment guidelines to maintain
  - 9f Estimate annual cost of proposed treatment
  - 9g Reference sites currently using proposed treatment
- 10. *Timeframe, cost and procedure for conversion***
  - 10a Ensure all environmental concerns are met regarding the disposal of the existing chemically treated system. Describe actions taken.

## SECTION F — WATER TESTS

### 1.0 General Instructions

#### 1.1 Sample Collection

The goal of sampling is to obtain for analysis a portion of the main body of water that is truly representative. The most critical factors necessary to achieve this are:

- point(s) of sampling;
- time of sampling;
- frequency of sampling;
- maintenance of system, or sample integrity prior to sampling.

Sample points should be remote from excessive amounts of particulate matter, incoming feed or make-up water, and chemical feed points.

Samples should be collected during normal operation prior to system blowdown and chemical dosing if these are batch operations.

The frequency of sampling is determined by the amount of deviation of the control parameters from their control points.

Before collecting a sample, establish a flow of not less than 500 ml/min (16 oz/min) for a minimum purge period of 10-15 seconds for every foot of sample line.

Note 1: When collecting samples for all analysis, rinse bottle and cap with the sample, place cap tightly on the bottle, and identify the sample.

#### 1.2 Sample Analysis

Samples should be analysed as quickly as possible after collection, provided that they have been cooled to room temperature.

The operator must be familiar with the specific test procedures provided by the chemical supplier. The Water Treatment Specialist can provide additional advice as required.

The following section provides brief descriptions of the methods used for testing system parameters. There are new testing technologies available that may follow different principles than those described.

## **Water Tests (cont'd)**

### **1.2 Sample Analysis (cont)**

For more information, refer to the following selection of reference materials:

1. Annual Book of ASTM Standards  
American Society for Testing Materials
2. Methods for Chemical Analysis of Water and Wastes  
U.S. Environmental Protection Agency
3. Standard Methods for the Examination of Water and Wastewater  
American Water Works Association
4. Methods Manual for Chemical Analysis of Water and Wastes  
Alberta Environmental Centre, Vegreville

Typical water test record sheets are included in Section C.

## **2.0 Total Dissolved Solids (TDS)**

### **2.1 Principles of Test**

The conductivity of the sample is measured and a specific factor is applied to determine the total dissolved solids concentration.

Different ions increase the conductivity by different amounts, but in most cases there is sufficient similarity in the composition of the water so that a direct relationship can be used. This is especially true if the high conductivity acid or hydroxide ions are neutralized.

The concentration of total dissolved solids is in any system limited by its scaling potential. The scaling potential depends on many factors, which include the temperature of the water, the chemicals added to the system, and the physical properties of the dissolved solids and their interactions with other compounds in the water and the metal surface. Each HVAC system has limits to the maximum allowed total dissolved solids concentration. The recommendations have to be followed strictly.

## **Water Tests (cont'd)**

### **3.0 Hydroxide (OH) Alkalinity**

#### **3.1 Principle of Test**

In a steam boiler, hardness is precipitated by phosphate. This process requires excess alkalinity, however, too high levels can cause caustic embrittlement. The determination of OH alkalinity is therefore crucial to the monitoring of a steam boiler system. Minimum and maximum limits of OH alkalinity are specified.

Barium chloride is added to a sample containing OH alkalinity in order to precipitate alkalinity due to carbonates and phosphates. The free hydroxide alkalinity is then titrated with standard acid to the phenolphthalein end-point.

The OH alkalinity can also be determined using the formula  $2P-M$ .

### **4.0 Sulphite**

#### **4.1 Principle of Sulphite Test**

Sulphite is an oxygen-scavenger. It reacts with dissolved oxygen entering the system before the oxygen can corrode the metal surface. An excess level of sulphite is required in solution at any given time to ensure that the scavenging of oxygen is successful. The sulphite must be catalyzed, containing cobaltous chloride, for the reaction to take place within a very short period of time.

The water sample, containing sulphite, is acidified and titrated with a standardized potassium iodide-iodinate titrant. Free iodine is released when the sulphite has been completely oxidised, resulting in the formation of a persistent blue colour in the presence of a starch indicator.

#### **4.2 Principal of Phosphonate (Organic) Test**

Phosphonates are organically bound phosphate compounds which come in various forms. This advanced organic corrosion inhibitor technology provides powerful corrosion resistance, equaling and often exceeding the performance of molybdenum as a ferric metal inhibitor while meeting environmental standards for corrosion inhibitors

Phosphonate tests vary in procedures for determining actual inhibitor levels. Some test methods determine trace potassium; while others use a UV photochemical oxidation (digestion) for determining orthophosphate- (this involves a conversion factor to determine the Phosphonate concentration).

## **Water Tests (cont'd)**

### **5.0 Total Hardness, High**

#### **5.1 Principle of Test**

Excess total hardness will scale a water system. The conditions of scaling are different for each system and depend on all system parameters including the temperature of the water, the chemicals added to the system, and the other dissolved compounds. The hardness determination of the supply water is important for the development of the treatment program.

This test should be used for hardness determination greater than 10 ppm as  $\text{CaCO}_3$ .

The water sample, containing calcium and magnesium hardness, is buffered to a pH of 10.0 and titrated with a standardized hardness titrant (sodium salt of EDTA). When the hardness is fully complexed (i.e., combined with the EDTA), the sample turns from wine red to blue in the presence of Eriochrome Black T indicator.

Total hardness consists of calcium, magnesium, strontium, iron, aluminum, zinc, and manganese ions. However, in most applications of this test, calcium and magnesium constitute the major portion of these ions. Therefore, this test is referred to as being a total hardness test even though only the calcium and magnesium concentrations are actually determined.

### **6.0 Total Hardness, Low**

#### **6.1 Principle of Test**

The determination of low concentrations of hardness is most important for monitoring the performance of a water softener. The regeneration cycle of the softener must be monitored to ensure a total hardness concentration of less than 2 ppm in the water supplied to the systems.

This test should be used for hardness determinations less than 10 ppm as  $\text{CaCO}_3$ .

The water sample, containing calcium and magnesium hardness, is buffered to a pH of 10.0 and titrated with a standardized hardness titrant (sodium salt of EDTA). When the hardness is fully complexed (i.e., combined with the EDTA), the sample turns from wine red to blue in the presence of Eriochrome Black T indicator.

## **Water Tests (cont'd)**

### **6.1 Principle of Test (cont'd)**

Total hardness consists of calcium, magnesium, strontium, iron, aluminum, zinc, and manganese ions. However, in most applications of this test, calcium and magnesium constitute the major portion of these ions. Thus, this test is referred to as being a total hardness test even though only the calcium and magnesium concentrations are actually determined.

## **7.0 P, M & OH Alkalinity**

### **7.1 Principle of Test**

Limits for the M and OH alkalinity are specified for steam boilers. The determination of the P-alkalinity can be used to monitor condensate return systems. The determination of P and M-alkalinity of the supply water can be important to develop an appropriate water treatment program.

A water sample containing alkalinity is titrated with standardized sulphuric acid titrant. The end-point for the titration of phenolphthalein alkalinity (i.e., P Alkalinity), which is a measure of that alkalinity fraction contributed by the hydroxide and one-half of the carbonate alkalinities, is indicated by a change in sample colour from pink to colourless in the presence of phenolphthalein indicator (i.e., a pH of 8.3).

The total alkalinity (i.e., M Alkalinity) is a measure of the alkalinity contributed by the hydroxide, carbonate, and bicarbonate alkalinities and is determined by the continued titration past the phenolphthalein end-point to the mixed indicator end-point (i.e., a pH of 4.6) which is an orange colour in the presence of mixed indicator.

The OH-alkalinity is determined using the formula  $2P-M$ .

## **8.0 Phosphate, ortho**

### **8.1 Principle of Test**

Phosphates precipitate hardness. An excess of phosphate and alkalinity are required to perform this task. Limits for the phosphate concentration in a steam boiler are specified.

There are two principal types of phosphates, namely the ortho and the poly types. This test covers the analysis of the ortho phosphates such as tri-sodium phosphate and di-sodium phosphate. Poly phosphates such as hexameta phosphate are responsive to this test only after they have been

## **Water Tests (cont'd)**

### **8.1 Principle of Test (cont'd)**

converted to the ortho phosphate form upon heating (i.e., in a steam boiler, a hot water boiler, a hot plate, etc.).

The addition of ammonium molybdate to a clear sample containing ortho phosphate forms the characteristic yellow colour of phosphomolybdic acid. This acid is subsequently reduced by the addition of stannous chloride to produce a blue colour with an intensity that is proportional to the phosphate present in the sample. The ortho phosphate concentration is read directly from a slide comparator.

## **9.0 Phosphate, poly**

### **9.1 Principle of Test**

Phosphates precipitate hardness. An excess of phosphate and alkalinity are required to perform this task. Limits for the phosphate concentration in a steam boiler are specified.

There are two principal types of phosphates, namely the ortho and the poly phosphates. This test covers the determination of poly phosphates such as hexameta phosphate.

A clear sample containing poly phosphate boiled to convert the poly phosphate to the ortho phosphate form. The addition of ammonium molybdate forms the characteristic yellow colour of phosphomolybdic acid. This acid is subsequently reduced by the addition of stannous chloride to produce a blue colour whose intensity is proportional to the phosphate present in the sample. Assuming that only poly phosphate is present in the sample, its concentration is read directly from a slide comparator.

## **10.0 Chloride, Low**

### **10.1 Principle of Test**

Chloride solutions are corrosive. The water supplied by a water softener must be monitored for chloride to ensure that salt used for regeneration does not enter the water systems.

This test should be used for chloride determinations less than 200 ppm as NaCl.

## **Water Tests (cont'd)**

### **10.0 Chloride, Low (cont'd)**

#### **10.1 Principle of Test (cont'd)**

A neutralised water sample containing chloride is titrated with a standardized silver nitrate titrant. In the presence of a potassium chromate indicator, white silver chloride is preferentially precipitated until the chloride is consumed, the end-point being indicated by the first formation of the pinkish yellow silver chromate. Continued titration past the end-point will result in the formation of the brick-red silver dichromate.

### **11.0 pH**

#### **Principle of Test**

The pH is the negative logarithm of the hydrogen-ion concentration, a measure of the acidity or alkalinity, of a water solution. The pH scale ranges from 0 – 14. A  $\text{pH} < 7$  means that a solution is acidic; a  $\text{pH} > 7$  means the solution is alkaline.

To prevent acidic corrosion in a water system the pH is usually kept above 8.5 for all systems. Specific limits are set for different systems.

The pH is measured either with pH-paper or with a pH selective electrode combined with a handheld or stationary meter.

### **12.0 Specific Gravity**

#### **12.1 Principle of Test**

The hydrometer is a standard weighted bulb with a graduated stem. The depth to which the hydrometer sinks in a fluid is determined by the density of that fluid. The specific gravity is read directly from the graduated stem.

#### **12.2 Reagents Required**

Nil

#### **12.3 Equipment Required**

Cylinder, container for hydrometer  
Hydrometer for brine concentrations  
Hydrometer for acid/caustic regenerant concentrations



## **Water Tests (cont'd)**

### **12.0 Specific Gravity (cont'd)**

#### **12.4 Procedure**

- (a) Fill the cylinder with the sample and carefully immerse the hydrometer;
- (b) Twirl the hydrometer so that it rotates slowly and floats freely without touching the sides of the cylinder;
- (c) Record the specific gravity reading directly from the graduated stem of the hydrometer at the fluid level line.

#### **12.5 Calculation of Results**

Specific Gravity = reading on hydrometer stem at fluid level line

The concentrations of regenerant solutions are related to a specific gravity as indicated overleaf.

If a salometer is used, its reading (i.e., percent of saturation) may also be used for control purposes.

## Water Tests (cont'd)

### Concentrations of Regenerants Versus Specific Gravity

Regenerant (wt%)	NaCl	NaOH	H <sub>2</sub> SO <sub>4</sub>	HCl
1	1.0073	1.0095	1.0051	1.0032
2	1.0145	1.0207	1.0118	1.0082
3	1.0217	1.0318	1.0184	1.0132
4	1.0290	1.0428	1.0250	1.0181
5	1.0362	1.0538	1.0317	1.0230
6	1.0437	1.0648	1.0385	1.0279
7	1.0511	1.0758	1.0453	1.0328
8	1.0585	1.0869	1.0522	1.0376
9	1.0659	1.0979	1.0591	1.0425
10	1.0734	1.1089	1.0661	1.0474
11	1.0810	1.1199	1.0731	1.0524
12	1.0866	1.1309	1.0802	1.0574
13	1.0962	1.1420	1.0874	1.0625
14	1.1038	1.1530	1.0947	1.0675
15	1.1115	1.1641	1.1020	1.0726
16	1.1194	1.1751	1.1094	1.0776
17	1.1273	1.1862	1.1168	1.0827
18	1.1352	1.1972	1.1243	1.0878
19	1.1432	1.2082	1.1318	1.0929
20	1.1511	1.2191	1.1394	1.0980
21	1.1593	1.2301	1.1471	1.1032
22	1.1676	1.2411	1.1548	1.1083
23	1.1758	1.2520	1.1626	1.1135
24	1.1840	1.2629	1.1704	1.1187
25	1.1923	1.2739	1.1783	1.1239

## **Water Tests (cont'd)**

### **13.0 Bacteria (dip slide test)**

#### 13.1 Principle of Test:

Bacteria, yeasts, and fungi will grow in a media, which supplies them with water and nutrients. This media is called an "Agar". The Dip slide is a plastic support material, which is holding two different agars, one on each side, to promote the growth of aerobic bacteria and yeast & fungi respectively. Determined is the colony density, which is the number of colonies formed, and not their size. Follow the manufacturers instructions supplied with the dip slides.

### **14.0 Chlorine, total & free**

#### 14.1 Principles of Test:

Chlorine can be present in water as free available chlorine and as combined available chlorine. Both forms can exist in the same water and be determined together as the total available chlorine. Free chlorine is present as hypochlorous and /or hypochlorite ion. Combined chlorine exists as monochloramine, dichloramine, nitrogen trichloride and other chloro derivatives.

The free available chlorine reacts immediately with DPD (N,N,-diethyl-p-phenylenediamine) indicator to form a magenta color, which is proportional to the chlorine concentration. This test determines the Free Available Chlorine concentration. The combined chlorine oxidizes added iodide to iodine, which then reacts along with free chlorine with DPD. This test determines the Total Available Chlorine concentration.

To obtain the combined available chlorine concentration the results of the free chlorine test are subtracted from the total chlorine test.

## SECTION G – SAFETY

### 1.0 General

All water treatment chemicals and test reagents must be handled with safety upper-most in mind. The operator must familiarize themselves with the characteristics, hazards, precautions and emergency procedures to be taken when using these chemicals or test reagents. The following outlines the protective measures aimed at minimizing the risk when handling water treatment chemicals and test reagents.

- Current Material Safety Data Sheets (MSDS) must be within close proximity for each chemical and test reagent on site.
- Always refer to the MSDS, prior to use, for precautionary measures when working with chemicals and reagents.
- Ensure chemicals and reagents are labeled as per Workplace Hazardous Materials Information System (WHMIS) regulations.
- Personal protective equipment (PPE) must be worn when handling products as outlined on the MSDS.
- Ensure appropriate emergency response equipment (eyewash, shower, etc) is available within close proximity.
- In the event of accidental exposure, always follow the First Aid Measures indicated on the MSDS.
- Store chemicals in a dry and well ventilated location as outlined on the MSDS.
- Storage and test cupboards should be kept clean and uncluttered.
- Ensure bottles and containers are capped or closed immediately after use.
- Reagents should not be transferred to different bottles.
- DO NOT mix different chemicals together.
- Clean up all chemical spills immediately as per the instructions on the MSDS.
- Site storage containers should be well labelled and kept clean.
- Expired or contaminated chemicals and reagents and their bottles, must be disposed of in accordance with the procedures indicated in Section I – Environmental Guideline.
- Refrain from handling dry chemicals in areas of air turbulence.

## **SECTION H — ENVIRONMENTAL GUIDELINE**

### **1.0 Introduction**

The water treatment program implemented in Alberta Government buildings generates waste material. Consequently, the purpose of the Environmental Guideline is to provide an acceptable procedure for the disposal of waste material. The manager is responsible to ensure compliance with the municipal by-laws and environmental regulations governing chemical disposal and accidental spill containment.

Larger Municipalities have discharge limits and guidelines in place for control. This information can be found on their respective websites under bylaws.

Some smaller municipalities do not have such bylaw legislation in place for control at this time.

Efforts are being made to incorporate bylaw control across the province.

### **2.0 Definitions**

In the context of this Environmental Guideline, the expression:

**Approved Land Fill Site:** means a municipal landfill site.

**Biocide:** means a generic or proprietary chemical which is added to a water system in order to kill or inhibit the growth of living organisms.

**Building Operator:** means an individual/company who is responsible for the operation and maintenance of the water systems within the Owner's building.

**Cleaning Waste:** means the unwanted cleaning solution within the water system.

**Corrosion Products:** means the material which is produced from the corrosion of metal.

**Environmental Guideline:** means a procedure for the disposal of waste material associated with the water treatment program in place within the Owner's buildings, with the intent of minimising the impact of this activity on the environment.

**Inhibitor:** means a generic or proprietary chemical which is added to a water system in order to prevent the deterioration of the mechanical components of the water system.

## ***Environmental Guidelines (cont'd)***

### *2.0 Definitions (cont'd)*

Owner: means the Province of Alberta.

Restricted Inhibitor: means an inhibitor which has maximum concentration limits associated with its discharge to a waste sewer system.

Scale: means a deposit which is formed by the evaporation of a solution directly in place upon a confined surface, usually composed mainly of hardness salts.

Site Test Point: means the sample location where the total waste water from the building enters the waste sewer system.

Storm Sewer System: means a municipal sewer system for the collection and transmission of storm run-off water.

Waste Fluid: means the unwanted operational solution that is discharged from a water system.

Waste Material: means the unwanted material associated with the water treatment program.

Waste Sewer System (Sanitary Sewer System): means a municipal sewer system for the collection and transmission of waste water.

Waste Water: means the unwanted solution resulting from the normal business activity within a building.

Water Course: means a lake, river, or creek.

Water System: means a hot water heating system, chilled water system, steam boiler system, condenser water/cooling tower system, air washer humidifier system, glycol heating system, glycol cooling system, water softener system, contact steam cooking system.

Water Test Reagent: means a generic or proprietary chemical which is used to test water samples of the water system.

Water Treatment Program: means a program which incorporates an inhibitor and/or biocide addition to a water system and routine water testing.

## ***Environmental Guideline (cont'd)***

### **3.0 Compliance with Other Laws**

- 3.1 Nothing in this Environmental Guideline relieves any building operator from complying with any provision of any Federal, Provincial, or Municipal legislation.

### **4.0 Scheduled Disposal of Waste Material**

- 4.1 Empty paper containers of inhibitors and biocides shall be disposed of at an approved landfill site.
- 4.2 Empty plastic and metal containers of inhibitors, biocides, and water test reagents shall preferably be returned to the supplier otherwise they shall either be recycled for other uses or be disposed of at an approved land fill site.
- 4.3 Scale and corrosion products, in solid form, shall be disposed of at an approved landfill site.
- 4.4 Concentrated or diluted inhibitors, biocides, and water test reagents shall not be discharged to a watercourse, storm sewer system, or land fill site.
- 4.5 Waste fluid or cleaning waste shall not be discharged to a watercourse, storm sewer system, or landfill site.
- 4.6 Waste fluid containing the following inhibitors, as indicated on Material Safety Data Sheets, shall not be used in any water system. Furthermore, water systems that contain the following inhibitors shall be drained into containers, and this waste fluid shall be transported off site for disposal by an approved commercial waste disposal firm.
- (a) chromium/chromate
- 4.7 Waste fluid associated with water system operational sampling, water testing, bleed-off, and blow-down shall be discharged to the waste sewer system.

## **Environmental Guideline (cont'd)**

### *Scheduled Disposal of Waste Material (cont'd)*

- 4.8 Waste fluid containing biocides and/or the following inhibitors, as indicated on Material Safety Data Sheets, shall be discharged to the waste sewer system, provided that their concentrations within the water system are within their normal operating control limits as well as the general parameter limits indicated in the attached Appendix B of this Section H:
- (a) All organic
  - (b) Nitrite (without boron, molybdenum)
  - (c) Phosphate
  - (d) Phosphonate (without zinc)
  - (e) Silicate (without boron)
  - (f) Sulphite
- 4.9 Waste fluid containing restricted inhibitors, as indicated on Material Safety Data Sheets, shall be diluted with building waste water and discharged to the waste sewer system such that the concentration of the restricted inhibitor and the concentrations of the general parameters at the site test point are in compliance with the limits indicated in the attached Appendix B of this Section H.
- 4.10 Cleaning Waste and expired water test reagents shall be diluted with building waste water and discharged to the waste sewer system such that their concentrations at the site test point are in compliance with the general parameter limits indicated in the attached Appendix B of this Section H.

## **5.0 Accidental Disposal of Waste Material**

- 5.1 A building operator who causes or permits the accidental disposal of waste fluid containing restricted inhibitors or cleaning waste to a waste sewer system such that their concentrations and/or the concentrations of the general parameters at the site test point are greater than the limits indicated in the attached Appendix B of this Section H shall immediately report the incident to the Owner's Manager and to the local Waste Treatment Plant, providing the following information:
- (a) Name of Owner's Manager and telephone number where he/she may be contacted;
  - (b) Location where the release occurred;
  - (c) Time and date of the release;
  - (d) Type of waste material released and any known associated hazards;



## **Environmental Guideline (cont'd)**

### *Accidental Disposal of Waste Material (cont'd)*

- (e) Volume of waste material released;
- (f) Corrective action being taken, or anticipated to be taken, in order to prevent future accidental releases.

**Environmental Information or inquiries are located at the following links:**

<http://environment.alberta.ca/>

<mailto:ESRD.Info-Centre@gov.ab.ca>

<http://aep.alberta.ca/air/objectives-directives-policies-and-standards/air-monitoring-directive/documents/GuideReleaseReporting-2005.pdf>

<http://aep.alberta.ca/focus/compliance-assurance-program/documents/ReportingSpillsReleases-2010.pdf>

## **Appendix B**

Schedule of Limits for the Disposal of Restricted Inhibitor Waste, Cleaning Waste, and Expired Water Test Reagents to Municipal Waste (Sanitary) Sewer Systems

Parameters	Control Limits *
General Parameters	pH of 6.0 minimum pH of 10.0 maximum temperature of 65°C maximum suspended solids of 200 ppm maximum copper of 0.5 ppm Cu maximum iron of 50 ppm Fe maximum oil & grease of 100 ppm maximum BOD <sub>5</sub> (biochemical oxygen demand) of 200 ppm maximum
Restricted Inhibitors	
glycol (ethylene, propylene)	BOD <sub>5</sub> (biochemical oxygen demand) of 200 ppm maximum
Molybdenum/molybdate	Molybdenum of 5.0 ppm Mo maximum Boron of 1.0 ppm B maximum
Nitrite	Molybdenum of 5.0 ppm Mo maximum Boron of 1.0 ppm B maximum
Silicate	Boron of 1.0 ppm B maximum
Phosphonate	Zinc of 1.0 ppm Zn maximum

- \* Note 1: Dilution with domestic water for the sole purpose of meeting these limits is prohibited.
- \* Note 2: Where possible, glycol shall be reclaimed using an approved commercial waste disposal firm.