Alberta
INFRASTRUCTURE AND TRANSPORTATION

Management Strategy for the Phasing Out of CFCs and Halons at Alberta Infrastructure and Transportation Facilities

5th Revision, April 2005

This document can be found on the internet at:

http://aicm/Content/doctype404/production/cfchalon.htm

or http://www.infras.gov.ab.ca/Content/doctype404/production/cfchalon.htm

Management Strategy for the Phasing Out of CFCs and Halons at Alberta Infrastructure and Transportation Facilities

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EXECUTIVE SUMMARY

General

The purpose of the "Management Strategy for the Phasing Out of CFCs and Halons" is to provide guidelines to Property Management facility administrators and operations and maintenance personnel of a planned method to contain, conserve, and eventually phase out use of CFCs and Halons. Any surplus CFCs will be returned for recycling or suitable disposal through the Refrigerant Management Canada Program.

Chlorofluorocarbons (CFCs) are chemical compounds primarily developed for use as refrigerants. Other uses for CFCs were in manufacturing foam insulation as a blowing agent, cleaning solvents in the electronics industry and as aerosols in pressurised containers.

CFCs and Halons are primarily responsible for the depletion of the ozone layer in the stratosphere some 15 to 40 kilometres above the earth's surface. Ozone acts as a shield to protect the earth from harmful ultraviolet radiation from the sun. Use of CFCs and Halons is being discontinued except for use as a refrigerant in the short term and in some fire protection applications and to a minor degree as a carrying agent in gas sterilizers.

The Montreal Protocol, an international agreement, signed by most major countries, required that CFC production cease by December 31, 1995. This will result in decreased use of CFCs and their eventual phase out.

Two sites, one in Edmonton and one in Calgary, are being used in which CFC can be stored until needed. These same sites are also to be used for the storage of surplus Halons. An inventory control system is in place.

This strategy is proposed as the most cost-effective response to the eventual phase-out of CFCs and Halons.

CFC Management Strategy

.1 Initially, all chillers currently in use and operating on CFC-11 and 113 were fitted with a high efficiency purge unit and pressure relief valve assembly. The strategy recommended these units be installed prior to the 1995 spring start up and that they would meet the original regulations where the purge unit shall not emit more than 1.0 kg of refrigerant per kg of air removed from the system. Effective 2003, regulations requiring that the purge units emit no more than 0.1 kg of refrigerant per kg of air removed. This phase originally involved 45 chillers, all of which have been fitted. Refer to Appendix A to spreadsheet titled PRV AND PURGE UNIT INSTALLATION AND REFRIGERANT TABLE (Table A2) for update.

.2 Selected chillers that are approaching 10 years in age and over which have not had a major overhaul may be retrofitted for use with HCFC-123 during the overhaul. Retrofit cost is approximately $ 80,000 (2002 dollars) per chiller.

.3 Chillers around 20 years in age will continue to operate on CFC-11. Chillers of this vintage will require an economic evaluation to determine if it is more economical to do a conversion or to replace with a new more efficient chiller.

.4 Chillers more than 25 years in age shall not be converted, as the expected life of these units is approximately 30 years. Therefore if such a unit needs a major overhaul, these units shall be replaced with new units. Existing units shall be dismantled or disabled before leaving the site in such a manner that prevents them from being reused with a chlorofluorocarbon (CFC) refrigerant. Refer to Section 7 "CFC RECOMMENDATIONS".

.5 The purge units on the CFC-containing chillers shall be monitored for canister depletion to ensure that the purge unit continues to meet the requirements of 0.1 units of refrigerant per unit of air.

.6 All CFC-containing chillers must be converted or replaced at next overhaul effective 2005.

.7 A CFC Strategy spreadsheet, titled CENTRIFUGAL CHILLER GENERAL INFORMATION, located in Appendix A (Table A1), lists all current relevant information about Infrastructure Centrifugal Chillers currently in use, as well as a recommended actions.

.8 A spreadsheet, titled "REPLACED CHILLER VS. NEW OR CONVERTED CHILLER", located in Appendix A (Table A3), lists all the chillers that were reported in the original Management Strategy that have been replaced or converted.

.9 Alberta Infrastructure and Transportation owns a multitude of other refrigeration equipment ranging from roof top air conditioners, other types of chillers, to refrigerated water coolers. The general strategy is to maintain equipment as long as possible. Replacement, conversion, or repair to be based on the most economical approach and payback. Refer to Section 8 "OTHER REFRIGERATION SYSTEMS AND STRATEGIES".

Halon Management Strategy

.1 New and upgraded fire suppression systems must use a non-Halon fire suppressant such as FM-200, NOVEC 1230 or Inergen.

.2 All portable Halon equipment has been removed from Alberta Infrastructure and Transportation owned properties effective December 31, 2002.

.3 Existing Halon fire suppression systems shall be replaced as time and finances permit. Alberta's "Ozone-Depleting Substances and Halocarbons Regulation" requires that fixed Halon systems will be allowed only one refill between 2005-2010 provided the system is replaced within one year. Effective 2010, refills of fixed Halon systems will be prohibited.

.4 Halon from all decommissioned Halon fire suppression systems in Alberta Infrastructure and Transportation facilities shall be returned to the contractors.

.5 Spreadsheets in Appendix D (Tables D1 to D3) give details on Halon Fire Suppression Systems in all Alberta Infrastructure and Transportation Buildings.

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1.0 INTRODUCTION

.1 This manual presents the management strategy for the use and eventual phasing out of chlorofluorocarbons and halons at Alberta Infrastructure and Transportation facilities. It explains the method and reasons used in developing the management strategy, and provides a suggested process.

.2 The information in this manual is intended to provide the reader with background information relative to the problems resulting from the discharge of chlorofluorocarbons and halons into the atmosphere.

2.0 PURPOSE AND BACKGROUND

.1 The purpose of this study is to provide a management strategy to control and eventually phase out chlorofluorocarbons (CFCs) and halons in Infrastructure facilities. The strategy is in conformance with the Montreal Protocol and with current governing codes.

.2 In the seventies, the scientific community alerted World Nation leaders of the growing concerns on the depletion of the ozone layer by CFCs. This layer, which is located in the stratosphere, filters out the harmful solar ultraviolet (UV) rays. Excessive exposure to UV rays is known to cause skin cancer.

.3 In September 1987, fifty-five nations met in Montreal to initiate a program for the management and phasing out of chlorofluorocarbons (CFCs), halons, carbon tetrachloride and methyl chloroform. This is now known as the Montreal Protocol.

.4 In addition to the Montreal Protocol, subsequent negotiations were held in June 1990 in London and another meeting in November 1992 in Copenhagen. As a result of these meetings, the Canadian Council of Ministers of the Environment has directed that the production and import of CFCs be phased out by December 31, 1995 and the import of halons be discontinued by January 1, 1994. In order to comply with the Montreal Protocol, Alberta Infrastructure and Transportation has developed a management strategy, which ensures losses of CFCs into the atmosphere are reduced and that they are being phased out in an acceptable manner.

.5 There are several codes, standards and regulations in effect relative to the handling and control of losses to the atmosphere of CFCs and halons. These are:

- Alberta Environment Protection and Enhancement Act
- Alberta Regulation 181/2000 – Ozone-Depleting Substances and Halocarbons Regulation
- Mechanical Refrigeration Code CAN/CSA-B52-95
- Alberta Building Code
- Refrigerant Management Canada Program

.6 It is the departments' objective to inform managers in Infrastructure facilities on the management of CFCs and Halons to reduce the loss of all ozone depleting substances and for their eventual phase out. The management process calls for managers and operators to act in a responsible manner, to comply with governing codes, regulations and standards to protect the environment and reduce costs by containing, conserving and recycling CFCs.

3.0 CHLOROFLUOROCARBONS

.1 General

.1 Chlorofluorocarbons (CFCs) are versatile chemical compounds. They display properties of low toxicity, non-flammability, non-corrosiveness and compatibility with many materials. Refer to Appendix B, Table B-1 for refrigerant characteristics.

.2 The concern with CFCs relates to refrigerants CFC-11, CFC-12, CFC-113, CFC-114 and CFC-500. The most common low-pressure refrigerant is CFC-11, which is used in larger low-pressure refrigeration machines. CFC-11 has a boiling point of 23.6ºC (74.5ºF). This makes it an ideal refrigerant for use in commercial air conditioning applications. In the current inventory of 34 low-pressure chillers, 33 of them use CFC-11, and 1 uses CFC-113.

.3 Refrigerant CFC-12 is used in high-pressure refrigeration equipment, such as air-cooled chillers, domestic refrigerators and automotive air-conditioners. In the current inventory of chillers, there are no remaining chillers that use CFC-12.

.4 Some CFCs can be replaced with acceptable alternative refrigerants called hydrochlorofluorocarbons (HCFCs). The only replacement for CFC-11 is HCFC-123. HCFC refrigerants, which contain both hydrogen and chlorine, are identified as transitional refrigerants. They have a longer phase out period because of their significantly lower ozone depletion potential. The following table summarizes types of refrigerant (CFCs) in Infrastructure chillers.

TABLE 1

Refrigerant	Quantity
CFC-11	33
CFC-12	0
CFC-113	1
Out of Service	0
TOTAL	34

.5 Table 2 below provides a list of acceptable replacement refrigerants

TABLE 2		
Equipment	**From**	**To**
Chillers (Low Pressure)	CFC-11 CFC-113 CFC-114	HCFC-123 Blends HCFC-124
Chillers (High Pressure)	HCFC-22 CFC-12	HCFC-22 HFC-134a
Industrial (Recip.)	HCFC-22 R-717 CFC-12 R-502	HCFC-22, R410a, R407c R-717 HFC-134a, MP-39 HP-80
Commercial (Supermarkets)	HCFC-22 CFC-12 R-502	HCFC-22, R410a, R407c HFC-134a, MP-39 HP-80

.2 Chlorofluorocarbons and the Ozone Layer

.1 The CFCs issue has gained recognition because of environmental awareness and the public's concern over the alarming rate of increase in skin cancers caused by harmful ultra-violet radiation from the sun. The increase in ultra-violet radiation is directly related to the deterioration in the ozone layer in the stratosphere. The ozone layer filters out the ultra-violet rays. It is only recently that scientists have associated the rapid destruction of the ozone layer with chemical compounds such as fully halogenated chlorofluorocarbons that contain chlorine, fluorine and carbon.

.2 Ozone (O_3) is formed by the action of ultra-violet radiation from the sun on oxygen (O_2). A desirable characteristic of ozone is its natural ability to absorb the harmful ultra-violet radiation from the sun before reverting to molecular oxygen (O_2) through a natural process.

.3 The release of CFCs on the earth's surface into the atmosphere leads to a stable migration of chemicals such as chlorine at an altitude 15 to 45 kilometres above the earth's surface, where maximum concentrations of ozone are found. Over a period of time, the sun's high-energy radiation decomposes the CFCs. This decomposition releases the chlorine and chemicals that react with other gases; the net result is a reduction in ozone concentration.

.3 Use of Chlorofluorocarbons

.1 Chlorofluorocarbons have numerous applications in construction, manufacturing, electronics, and domestic use. They are used extensively in air-conditioning equipment such as large centrifugal chillers for cooling buildings. Other applications include window air conditioning units, cooling automobiles for personal comfort and in domestic refrigerators. Refer to Appendix B, Table B-2 for current use of CFCs.

.2 In the manufacturing industry, CFCs were used as blowing agents in manufacturing foam insulations. This use has been discontinued now for some time.

.3 The electronics industry was at one time a heavy user of CFCs. Chlorofluorocarbons were used as cleaning agents. This practise has been discontinued since the harmful effects have been exposed.

.4 Domestically, CFCs were once used as propellants in pressurised cans such as hair sprays, cleaners and insecticides.

.4 Montreal Protocol

.1 The Montreal Protocol was officially signed in Montreal, Canada, on September 16, 1987. It is an international agreement involving fifty-five leading countries that are concerned about the ozone layer depletion.

.2 The purpose of the Montreal Protocol is to control manufacturing, consumption and emission of chemical substances harmful to the ozone layer, such as chlorofluorocarbons and halons. Its goal is to eventually phase out the use of these substances.

.5 Production Deadlines

.1 Production and importation of CFCs into Canada was terminated on December 31, 1995. The original schedule proposed by the Montreal Protocol was for production of CFCs to be discontinued past the year 2000. Canada and Scandinavia later revised this to 1997. At the Canadian Council of the Ministers of the Environment Conference (CCME) in Vancouver on March 7, 1992, Canada further revised the production and import deadline to December 31, 1995.

.2 Hydrochlorofluorocarbons (HCFCs) are less harmful to the ozone than CFCs. However they have a higher global warming potential (GWP) with the exception of HCFC-123. For this reason, HCFC-22 will no longer be produced effective 2020. However, HCFC stocks will still be permitted for use as a refrigerant. Effective 2030, production of HCFC-123 will cease, but remaining HCFC-123 stocks will be permitted for use as a refrigerant.

4.0 LEGISLATION GOVERNING REFRIGERANTS

.1 General

.1 The following regulation, codes and standards are those that control the use of refrigerants. The notes that follow are a synopsis of the parts that may affect decisions as to conservation or replacement of equipment.

.2 Alberta Environmental Protection and Enhancement Act
Alberta Regulation 181/2000 – Ozone-Depleting Substances and Halocarbons Regulation (See Appendix C)

.1 Service work must follow the Environment Canada Code of Practice for the Reduction of CFC Emissions from Refrigeration and Air Conditioning Systems EPS1/RA/March 1996.

.2 Systems for purging of non-condensable gases must not exceed a release of more than 0.1 kilogram of an ozone depleting substance per kilogram of air effective 2003.

.3 Service personnel must be authorised under the Apprenticeship and Industry Training Act.

.4 The Alberta regulation was amended in 2004 to include additional CFC refill restrictions for the mobile and commercial refrigeration sectors, refill restrictions for halon fire extinguishers and implementation of seller take back provisions for surplus CFC refrigerants. The following amendment clauses are associated with low and high pressure CFC centrifugal chillers:

- On and after January 1, 2005, no person shall charge or permit the charge of a centrifugal chiller with CFC if that chiller has undergone an overhaul that includes the following procedures or repairs:
  - replacement or modification of an internal sealing device;
  - replacement or modification of an internal mechanical part other than:
    - an oil heater
    - an oil pump
    - a float assembly, and
    - a vane assembly, in the case of a chiller with a single-stage compressor;
  - any procedure or repair that resulted from the failure of an evaporator or a condenser heat exchanger tube.
- A person may charge a centrifugal chiller with CFC, but that person shall not operate that chiller later than one year after the day on which it is charged, unless it no longer contains CFC. The owner or person responsible for charging a chiller shall provide written notice to the Director, within 30 days after the chiller was charged.
- Effective 2015, no person shall charge a centrifugal chiller with CFC.

.3 Alberta Building Code

.1 Contains a reference to CAN/CSA-B52-95 Mechanical Refrigeration Code.

.4 Mechanical Refrigeration Code CAN/CSA-B52-95.

.1 Refers to ASHRAE Standard 34-1992 - Number Designation and Safety Classification of Refrigerants.

.2 All commonly used refrigerants (R-11, R-12, R-22, R-113, R-134a, R-500, etc.) are classified as Group A-1, which have the lowest toxicity and has no flame propagation.

.3 R-123 is classified as Group B-1 for a higher toxicity rating.

.4 When the kind of refrigerant is changed in a system containing more than 45 kg (100 lbs.) of refrigerant there must be a new sign installed indicating that a substitution has been made, and giving the required information on the new refrigerant.

.5 Any substitutions must have the permission of the Regulatory Authority, the user and the manufacturers of the equipment. Safety requirements must be met.

.6 There is a limit of 136-kg (300 lbs.) of refrigerant, which can be stored in the machine room in addition to the system charge.

.7 System application requirements.

.1 Chillers with A1 or B1 refrigerants have the same machine room requirements:

.1 Tight-fitting exit doors, swinging out, self-closing if opening into the building. No openings into other parts of the building.

.2 For all refrigerants, except ammonia, a refrigerant vapour detector is required and shall be located in an area where refrigerant from a leak is most likely to concentrate.

.3 Sensors shall sound an audible alarm and initiate mechanical ventilation.

.4 Mechanical ventilation includes:

- Exhaust inlets near the machinery.
- Exhaust amount Q (L/s) = 70 x $Kg^{0.5}$ or Q (CFM) = 100 x $lb^{0.5}$ for refrigerant charge of 7,000 Kg or less.
- Make-up air to replace air being exhausted.
- Constant ventilation rate of 2.54 L/s/m² (0.5 CFM/Ft²) minimum.

.5 An adequate number of positive-pressure self-contained breathing apparatuses (Scott Packs) with one refill each are required.

.6 Combustion equipment may be installed within the same machine room provided a) the combustion air is ducted directly to the combustion chamber, or b) the refrigerant vapour detector automatically shut down the combustion process when there is a refrigerant leak.

.7 Pressure relief devices shall discharge to the outdoors. Discharge shall not be less than 4.6 m above ground level, and 7.6 m from any window, ventilation opening or exit.

.5 Refrigerant Management Canada Program

.1 Refrigerant Management Canada (RMC) is an industry-led environmental care program committed to the responsible disposal of surplus ozone-depleting refrigerants from the stationary refrigeration and air conditioning industry.

.2 The RMC program has a formal process for the collection, transportation, storage and disposal of surplus CFC refrigerants. Detailed information of the program is available at www.hrai.ca/rmc.

.6 Other Standards

.1 ASHRAE Standard 15-1992, Safety Code for Mechanical Refrigeration.

This is the standard upon which B52 above is derived. The Canadian code is the legal requirement.

.2 ASHRAE Standard 34-1992, Number Designation and Safety Classification of Refrigerants.

This standard is referred to in B52 above, and is the basis for the Canadian Code's labelling of refrigerants.

.3 ASHRAE Guideline 3-1990, Reducing Emissions of Fully Halogenated Chlorofluorocarbon (CFC) Refrigerants in Refrigeration and Air-Conditioning Equipment and Applications.

5.0 METHODOLOGY

.1 General

.1 The initial step in developing the management strategy for CFCs and halons was with a questionnaire sent to all Infrastructure facilities. This questionnaire was relevant to all refrigeration equipment using chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and halogens. Information from the questionnaires was tabulated and low-pressure chiller information was transferred onto a spreadsheet. Using this information, each chiller was assessed on the following factors:

- chiller age (condition, remaining life)
- energy efficiency of chiller (kW per TON)
- refrigerant losses (annual)
- next planned major service
- availability of refrigerant (R-11)
- availability of new equipment and service
- chiller capacity vs. cooling load
- cost for containment, conversion or replacement

.2 All centrifugal chillers in Infrastructure facilities have been entered in the Facility Evaluation System (FES) according to Building/Location and BID number.

.2 Chiller Age

.1 Historically it has been determined that chillers in office buildings and hospitals operate approximately 2000 hours per year for building cooling. Chillers used for process load applications do not conform to this guideline since this load is not dependent on outdoor conditions. It is accepted that chillers have a life of approximately 30 years with planned maintenance. For this reason, older equipment rates a higher priority for replacement than newer equipment.

.3 Energy Efficiency of Chillers

.1 The efficiency of a chiller is rated on the energy used per ton of refrigeration i.e., kilowatts per ton. Older chillers are less energy efficient than newer chillers. Chillers installed prior to 1980 are generally operating at 0.80 to 0.95 kW/ton. Newer chillers commonly have an efficiency of 0.55 to 0.65 kW/ton.

.4 Refrigerant Losses

.1 Refrigerant losses in low-pressure chillers usually occur for two reasons; 1) through purging of air from the refrigerant, and 2) through a broken rupture disc.

.2 Gaskets in chillers harden and become less resilient with age and exposure to atmosphere and chemicals. If the gaskets do not adequately seal the unit, air will leak into the chiller and mix with the refrigerant. As a result, chiller efficiency will gradually decrease.

.3 Purge units are installed to separate air from the refrigerant and expel it from chillers. Older inefficient purge units remove up to 6 units of refrigerant per unit of air. The new high efficient purge units use carbon filters, which can initially have an efficiency less than 0.1 units of refrigerant per unit of air, but decrease with time. Therefore, the carbon filters must eventually be replaced.

.4 The rupture disc in a chiller is a safety device that protects a chiller from becoming overpressurised. Overpressuring of a chiller can occur because of high condenser or evaporator water temperature or fire in a machine room. This occurrence is not common, however when it does occur, it can result in the total loss of the refrigerant charge. There are currently ASME pressure relief valves available to reduce these losses. Relief valves either replace or are installed on the discharge side of the rupture disc. If the rupture disc breaks, the relief valve will relieve only sufficient refrigerant to a preset pressure and an alarm alerts the operators. This unit saves substantial refrigerant losses in case of a rupture disc breaking.

.5 Next Major Service

.1 Requirements for major overhaul will vary between manufacturers of chillers. Ideally, conversion, when considered, should be scheduled at the same time as a major overhaul to avoid duplicate costs, such as disassembly of chiller, replacement of gaskets, O-rings, and rewinding of motor.

.6 Availability of Refrigerant

.1 As of 2002, due to reduced consumption, supply of R-11 has not depleted as much as originally anticipated.

.7 Availability of New Equipment and Service

.1 An existing chiller may be replaced because of age or unavailability of refrigerant. Because of the uncertainty of some refrigerants and their projected life, it is necessary to consider various equipment alternatives. New equipment availability and service become major factors when selecting new equipment.

.8 Chiller Capacity Versus Load

.1 In some installations chillers are purposely oversized for future anticipated expansion. Frequently the expansion is delayed for several years or it may never occur resulting in some chillers operating at partial loads near mid range of the chiller capacity. The result is reduced energy efficiency. In such installations the chiller capacity compared to the cooling load become a determining factor for chiller replacement.

.9 Cost for Containment, Conversion or Replacement

.1 The management strategy considers three options, containment, conversion and replacement. Considering the influencing factors, conversion may be the choice when the chiller is relatively new and CFC-11 inventory is low and expensive. In the case where an aged CFC-11 chiller is due for replacement, an HFC or HCFC chiller will be considered. A life cycle costing analysis should be done when considering conversion and replacement.

.10 Other Considerations

.1 This methodology does not consider purchasing of CFCs. Since the strategy is to phase out CFCs, the purchasing of CFCs is not desirable. As chillers are converted and replaced, surplus CFCs can be stockpiled or reused in other existing chillers. Any surplus CFCs will be returned for recycling or disposal through the Refrigerant Management Canada Program.

6.0 CFC MANAGEMENT OPTIONS

.1 Options

.1 There are basically three management options with centrifugal chillers:

- Containment/Conservation/Stockpiling
- Conversion
- Equipment Replacement

.2 Explanation of Options

.1 Containment, Conservation and Stockpiling

This option maintains the current status with the use of CFC-11 refrigerant and can be considered as the first stage of an eventual conversion or replacement. Containment and conservation refers to limiting CFC-11 refrigerant losses from purging, venting and system leaks. Containment and conservation can include the following:

- Replacing existing low efficiency purges with high efficiency purge units. High efficiency purge units expel minimal amounts of refrigerant. Effective 2003 all purge units shall not release more than 0.1 unit of refrigerant per unit of air. The purge units shall be monitored for canister depletion to ensure that the purge unit continues to meet code requirements.
- Installation of a combination relief valve and alarm which re-sets with a pressure drop rather than allowing the entire refrigerant charge to escape.
- Elimination of all sources of refrigerant leaks. Refer to Appendix B, Table B-4 for listing of potential leaks.
- Stockpiling refers to the storage of refrigerant for topping up or for replacement of leaked refrigerant. The maximum allowable storage is 136 Kg (300 lbs.) in a machinery room as stated in the B52 Code. However much larger amounts can be stored in areas designated for such.

.2 Conversion

Conversion refers to the conversion of CFC-11 chillers to the use of HCFC-123. Open motor chillers are more readily converted than hermetically sealed unit. Currently HCFC-123 is the only refrigerant available as a replacement for low pressure CFC-11. The process of conversion includes:

- rewinding motor
- replacing all gaskets and O-rings
- replacing oil pump
- replacing orifices as necessary
- balancing and trimming impellers

A preparatory converted unit would continue to use R-11 as refrigerant. A full conversion would replace R-11 with R-123 and upgrade the machine room to comply with B52 Code.

.3 Equipment Replacement

Replacing existing CFC chillers with an HCFC or HFC refrigerant chiller is a third option. Chillers are now available that utilise HCFC-123 and HFC-134a.

.2 Advantages and Disadvantages of:

.1 Containment, Conservation and Stockpiling

Advantages

- High efficiency purge units are the most cost-effective method for reducing refrigerant loss, followed by combination relief valve/rupture disc and monitoring devices.
- Least first cost - major capital expenditure can be delayed.
- Maximises useful life of chillers.
- Shut down period for installation of high efficiency purge unit or other devices is minimal.

Disadvantages

- Containment and conservation are not the final solution, only a delay in either conversion or replacement.
- A small percentage of CFCs will still escape into the environment.
- A major chiller failure can still occur.

.2 Conversion

Advantages

- Conversion of chiller to R-123 will take the chiller to life expectancy (and may increase life expectancy) or near phase out of HCFCs.
- R-11 can still be used in preparatory converted chillers, thus units can become working stockpile for R-11 refrigerant.
- Less costly in certain situations.

Disadvantages

- High cost of conversion. This can be reduced somewhat by timing conversion with a scheduled overhaul.
- No opportunity to adjust size (capacity) of chiller to meet actual load.
- Capacity reduction of up to 8%.
- Industry concern as to the long-term toxicity of R-123 on people.
- Require improvements to facility such as a dedicated ventilation system, leak detection, etc.
- Self contained breathing apparatus required.

.3 Equipment Replacement

Advantages

- New equipment with a life expectancy of 25 to 30 years.
- This is a final solution for the life of the chiller, not an interim step.
- New chillers are more efficient per ton of cooling than older converted equipment.
- Can be sized accurately to match cooling load.

Disadvantages

- Highest capital cost of all options.
- Changes required to piping, valving, and perhaps pumps.
- Require improvements to facility such as a dedicated ventilation system, leak detection, etc.
- Self-contained breathing apparatus required.

7.0 CFC RECOMMENDATIONS

The Strategy recommends:

.1 Containment and conservation be implemented on all chillers to minimise the loss of refrigerant.

.2 Conversion on selected low-pressure chillers.

.3 Replacement of old chillers at the end of equipment life with chillers using, HCFC-123 or HFC-134a. Replacement also includes:

- refrigerant monitor
- mechanical ventilation
- self contained breathing apparatus
- open flame burner shut down when the monitor senses refrigerant levels above acceptable limit. This applies to rooms shared by chillers and combustion equipment.
- disposal of the existing units in a manner that prevents them from being reused with chlorofluorocarbon refrigerants.

8.0 OTHER REFRIGERATION SYSTEMS AND STRATEGIES

.1 General

.1 While other refrigerants have been mentioned briefly, this report has focused substantially on CFC-11 centrifugal chillers.

.2 In terms of numbers, other refrigeration equipment far outnumbers the CFC-11 systems. There are countless rooftop A/C packages, walk-in coolers, freezers, window air conditioners, etc. in Alberta Infrastructure and Transportation facilities.

Examples of Other Types of Refrigerant Systems

Systems (Equipment)	Refrigerant Used
1. Reciprocating Chillers	R-22
2. Air Cooled Centrifugal Chillers	R-12
3. Compressed Air Dryers	R-12
4. Walk-In-Coolers	R-12
5. Refrigerators (Household)	R-12, R-22
6. Walk-In-Freezers	R-502
7. Window A/C Units	R-12, R-22
8. Roof Top A/C - Packaged	R-22
9. Display Coolers	R-12
10. Juice, Milk Dispensers, etc.	R-12
11. Ice Makers	R-12, R-502
12. Split DX Systems	R-22, R12
13. Compressor Condenser Systems WC/AC	R-12, R-22
14. Rotary Chiller (Helical Rotor Compressor)	R-22

.3 The largest systems in terms of tonnage and individual refrigerant charge are reciprocating chillers (R-22), air-cooled centrifugal chillers (R-12), and roof-top packaged air conditioning units (R-22).

.4 Since HCFC-22 is currently an acceptable refrigerant, no remedial action is contemplated with this equipment.

.5 All other CFC equipment, mostly R-12 and a smaller number of equipment using R-502 will require some course of action in the future.

.6 As per the 2004 amendments to the Alberta "Ozone-Depleting Substances and Halocarbons Regulation", the CFC refill ban will be as follows:

- On and after January 1, 2005, no person shall charge or permit the charge of a refrigeration system or air conditioning system having a design refrigeration or cooling capacity of 19 kW (5.4 ton) or greater, with CFC or any mixture containing CFC.

.2 R-12 and R-502 Strategy

.1 Air Cooled Packaged Centrifugal Chillers (R-12)

.1 R-12 centrifugal chillers are medium pressure; therefore problems common to low-pressure CFC-11 chillers, such as air leaks due to vacuum, do not occur. High efficiency purge units are not required.
.2 R-134a can be used as a replacement for R-12.
.3 A chiller conversion requires a "gearset" change and possible impeller modifications. Motor does not have to be re-wound or replaced. (Estimated cost of $ 50,000 to $ 80,000, 1994 dollars).
.4 Efficiency after conversion can decrease by up to 15%.
.5 Existing refrigerant must be flushed out. Approximately twelve steps in converting from R-12.
.6 Conversion is a low priority and must be considered on an individual basis. Strategy is to operate system as long as possible on R-12. Conversion dependent on:
(1) Overhaul requirements
(2) Degree of repair/failure
(3) Availability of R-12
(4) Cost considerations
(5) Other factors - age, capacity, maintenance history, etc. (life expectancy is 20 to 25 years.)

.2 Walk-In-Coolers, Display Coolers, Split DX A/C Systems (R-12)

.1 Medium temperature refrigeration - Quite a few replacement refrigerants available for conversion, such as:
MP39 - walk-in coolers, beverage dispensers, etc.
MP66 - medium to lower temperature equipment
HFC-134a - walk-in coolers, dairy display cases - DX systems, etc.

.2 During conversion, existing refrigerant must be flushed out. Filters, dryers, etc. must also be changed.

.3 Capacity after conversion approximately the same in most cases.

.4 Strategy is to operate systems as long as possible on R-12. Replacement or conversion to other refrigerant use dependent on:

- Degree of repair/failure
- Refill restrictions
- Cost considerations
- Age (life expectancy of 20 years), maintenance history, capacity
- Where larger numbers of systems occur (such as in an institutional facility) they should be considered for upgrading to a central fluid cooler (from water-cooled condensers) or to a common air-cooled condenser.

.3 Walk-In-Freezers, Ice Makers, Display Freezers (R-502) (Low Temperature)

.1 Quite a few replacement refrigerants available for conversion, such as HP80, HFC-134a, HP81, HP-62, HFC-125, HFC-143a. Many of these are Blends and Azeotropes.

.2 Similar to R-12, existing refrigerant must be flushed out during conversion, and lubricants, filters, dryers, etc. changed.

.3 Capacity approximately the same after conversion.

.4 Strategy is to operate systems as long as possible with 502. Replacement or conversion dependent on:

- Degree of repair/failures
- Refill restrictions
- Cost consideration
- Age (life expectancy of 20 years), maintenance history, capacity

.4 Window A/C Units, Refrigerators and Other Small Refrigerant Systems (R-12, R-500)

.1 Strategy is to operate equipment as long as possible with the existing refrigerant. Most of these units are hermetically sealed and will not leak unless the enclosure is damaged.

.2 Conversion will in most cases not be a practical solution.

.3 Consideration:

- Age of unit, maintenance history
- Refill restrictions
- Cost of repair
- Cost of replacement

.4 Refrigerant must be removed, stored or acceptably disposed of by certified personnel before this equipment can be disposed.

9.0 HALONS

.1 General

.1 Halons are chemical compounds containing carbon, fluorine, bromine and chlorine. Both bromine and chlorine halogens act to deplete the ozone at a greater rate than CFCs. However, the use of halon is not as extensive as CFCs.

.2 Halons are effective fire extinguishing agents used to protect high value assets, such as computer rooms, electronic and telecommunication equipment. They dissipate quickly, leave minimal harmful residue and have a relatively low toxicity. Halogens used for fire protection systems are Halon 1301 bromotrefluoromethane (BTM) and Halon 1211 bromochlorodefluoromethane (BCF). See Appendix B, Table B-5 for characteristics of halon.

.3 As of January 1, 1994, by international agreement, the manufacturing of halon fire extinguishing agents has ceased in all countries signatory to the Montreal Protocol. Canada, as a signatory of the Montreal Protocol, is taking an aggressive stance in reducing national consumption of halons. In March 1992 the Canadian Council of Ministers of the Environment (CCME) announced an accelerated schedule whereby the importing of halons also ceased January 1, 1994.

.4 According to the proposed amendments to the Alberta "Ozone-Depleting Substances and Halocarbon Regulation", the use of Halons for fire extinguishing can continue in existing systems. However, effective 2005, all fixed Halon systems will be allowed one refill provided the system is replaced within one year of the refill. No refills on fixed systems will be permitted effective 2010.

.5 In some provinces the use of halon-based portable fire extinguishers is prohibited. The portable extinguishers may not be refilled effective 2003.

.6 Where retrofit systems, upgraded systems, or new systems are required, new ULC approved alternative fire suppressant agents are to be used.

.7 Detailed Information on all Halon Fire Suppression Systems in Alberta Infrastructure and Transportation Facilities can be found in Appendix D (Tables D1 to D3).

.2 Alternative Halon Agents

.1 Some of the alternative gaseous agents are FM-200 (HFC-227 ea), NOVEC 1230 (fluoro-ketone) and Inergen (IG-541). Refer to Appendix B, Table B-6 for properties of these alternatives.

.2 The new alternative agents are chemically similar to halons, but are substantially less damaging to the environment. Inergen is not chemically similar to halon, but acts to extinguish fires by physical processes that are very similar to those of CO_2.

.3 Other Fire Suppressant Systems

.1 Carbon dioxide (CO_2) has been used successfully for many years as a fire extinguishing gas. The CO_2 used is a by-product of industrial processes. It does not add to the amount of gas released to the atmosphere and has zero ozone depletion potential. CO_2 is stored in liquid form at approximately 58 bar at 20ºC, or for bulk storage at 20 bar. The hazard of CO_2 usually limits its use to unoccupied spaces.

.2 High pressure water mist systems, which produce fine and high velocity water mist during fires for efficient penetration and rapid cooling of the fire plume and adjacent gases, are being used.

.3 Pre-action, two-stage sprinkler system can be considered if additional safeguard against accidental discharge of sprinkler head is required.

.4 Halon Strategy

.1 All portable Halon extinguishers were removed as of December 31, 2002.

.2 Continue to maintain existing Halon 1301 systems until financially feasible to replace.

.3 Stockpile in either Edmonton or Calgary Halon 1301 cylinders from dismantled or decommissioned systems.

.4 Use "least cost" approach or system proposal methodology for determining alternative fire suppressant type for new systems, retrofit systems, or upgrade systems. New systems must conform to latest NFPA codes and fire suppressant agents must be ULC approved.

.5 Computer Listing

All fire suppressant systems, including Halons and CO_2 systems in Infrastructure facilities have been entered in the Facility Evaluation System (FES) according to Building/Location and BID number.

Detailed information about all Halon Fire Suppression systems in Alberta Infrastructure and Transportation Facilities can be found on the internet at http://aicm/Content/doctype404/production/cfchalon.htm or http://www.infras.gov.ab.ca/Content/doctype404/production/cfchalon.htm with recommended actions for phasing out the use of Halon's for fire suppression.

APPENDIX A

Low Pressure Centrifugal Chillers (R-11 & R-113)

Alberta
INFRASTRUCTURE AND TRANSPORTATION

No.	*City/Town*	*Building Name*	*Type*	*Year Installed*	*Manuf.*	*Cap. (Tons)*	*Chiller Eff. (kW/ton)*	*Chiller cap. to load*	*%*	*Chiller Charge (lbs)*	*Stock Amount (lbs)*	*Last Major O/haul*	*Next Major O/haul*	*Run Time @ O/haul*	*Current Run Time*	*Recommendations*	*Remarks*
1	Calgary	Bowness Storage	R-113								963					Install monitor and exhaust	Calgary CFC Storage
2	Calgary	Bowness Storage	R-11								108					Install monitor and exhaust	Calgary CFC Storgage
3	Edmonton	School for the Deaf	R-113	1955	Trane	150		About right		1100	0	2004				Replace Chiller as required	low hours (<10 days/year)
4	Edmonton	Legislature Annex	R-11	1962	Trane	235	0.910	About right	0 %	1000	0	2001	2011	15918	18234	Replace Chiller as required	Replacement in RAP (2005/06)
5	Edmonton	Legislature Annex	R-11	1962	Trane	235	0.910	About right	0 %	1000	0	2002	2012	17798	19943	Replace Chiller as required	Replacement in RAP (2005/06)
6	Edmonton	Provincial Museum	R-11	1967	Trane	425	0.750	About right		780	0	2002	2012	5255	6849	Replace Chiller as required	Old Equipment
7	Calgary	J.J. Bowlen Building	R-11	1968	Carrier	635		Oversize	+50%	1700	0	1991	2005	1927	6776	Replace Chiller as required	Replacement in RAP (2005/06)
8	Edmonton	Law Courts	R-11	1972	Trane	320	0.920	Insufficient	25 %	750	0	1989	2004	19074	22534	Replace Chiller as required	Replacement project underway
9	Edmonton	Law Courts	R-11	1972	Trane	320	0.920	Insufficient	25 %	750	0	1989	2004	14175	18279	Replace Chiller as required	Replacement project underway
10	Edmonton	Percy Page Centre	R-11	1972	Carrier	250	0.750	Oversize	+50%	600	0	2003	2013	46381	49097	Replace Chiller as required	Old Equipment
11	Calgary	Provincial Court	R-11	1973	Carrier	360	0.850	Oversize	+40%	450	0	1996		5814	13085	Replace Chiller as required	Replacement in RAP (2005/06)
12	Edmonton	O.S Longman	R-11	1975	Trane	500	0.800	About right		1100	200	2004		17289	18563	Replace Chiller as required	Overhauled in 2004
13	St. Paul	Provincial Building	R-11	1976	Trane	211	0.920	Oversize	+30%	585	125	2004	2014	11366	11374	Replace Chiller as required	Replacement in RAP (2005/06)
14	Lethbridge	Provincial Building	R-11	1977	Trane	370	0.850	About right		760	0	1999	2009	9836	17103	Replace Chiller as required	Replacement in progress.
15	Calgary	Red Cross	R-11	1978	Carrier	109	1.080	About right		450	0	2001	2009	25100	33034	Replace Chiller as required	Replacement in RAP (2005/06)
16	Edmonton	Remand Centre	R-11	1978	Trane	200	0.800	About right		650	0	2002	2011	40833	41533	Fully convert when R-11 needed	
17	Peace River	Provincial Building	R-11	1978	Carrier	198	0.780	Oversize	+20%	625	0	2002		17315	19409	Replace Chiller as required	Replacement in RAP (2012/13)
18	Red Deer	Provincial Building	R-11	1979	Trane	345	0.860	About right		634	0	2001	2008	11840	20813		Conversion underway
19	Ft. McMurray	Provincial Building	R-11	1981	Trane	250	0.800	Insufficient	-30%	640	10	1998	2010	13000	22932	Replace or convert as required	Prep. Conv in 98, RAP project 2009/10
20	Edmonton	Alberta Infrastructure	R-11	1982	Trane	250	0.710	About right		780	0	2001		73472	89872	Fully Convert when R-11 needed	Prep. Converted in 2001
21	Edmonton	Alberta Infrastructure	R-11	1982	Trane	250	0.710	About right		780	0	1997			96809	Fully Convert when R-11 needed	Prep. converted in 1997
22	Edmonton	John E. Brownlee	R-11	1983	Trane	500	0.640	Insufficient		975	0	1995	2004	18400	24827	Replace or convert as required	Conversion in RAP (2006/07)
23	Edmonton	Haultain Building	R-11	1984	Trane	500	0.660	About right		1000	190	1997	2007	15639	5986	Replace or convert as required	Replacement in RAP (2008/09)
24	Drumheller	Royal Tyrell	R-11	1985	Trane	200	0.810	About right	0 %	300	55	1998	2008	25294	38564		Replacement in design phase
25	Drumheller	Royal Tyrell	R-11	1985	Trane	160	0.720	About right	0 %	300	0	1998	2008	21285	4227		Replacement in design phase
26	Calgary	Correctional Centre	R-11	1986	Trane	350	0.670	Oversize	+40%	575	50				16965	Replace or convert as required	Replacement in RAP (2005/06)
27	Calgary	CYOC	R-11	1987	York	125	0.620	Oversize	+30%	600	110				19331	Replace or convert as required	Replacement in RAP (2005/06)
28	Edmonton	EYOC	R-11	1987	Trane	200	0.690	Oversize	+25%	390	110	2004	2014	15873	15873	Replace or convert as required	
29	Edmonton	Law Courts	R-11	1987	Trane	450	0.670	Oversize	25 %	900	0	1995	2005	14205	19377		Replacement project underway
30	Ft. Sask.	Correctional Centre	R-11	1987	Trane	450	0.700	Oversize	+40%	1000	255	1998	2008	8311	18276	Replace or convert as required	Project in RAP (2008/09)
31	Red Deer	Remand Centre	R-11	1987	Trane	120	0.660	Oversize	+30%	330	0	2001	2010	16050	21249		Conversion underway
32	Edmonton	ARC - Millwoods	R-11	1988	Trane	308	0.680	About right		545	0	2002		19779	22759	Replace or convert as required	Marginal capacity
33	Edmonton	ARC - Millwoods	R-11	1988	Trane	308	0.680	About right		545	0	2002		19192	22520	Replace or convert as required	Same room as boilers, Interlock difficulties
34	Edmonton	Provincial Museum	R-11	1988	Trane	300	0.710	About right		575	1102	2002	2012	24888	31004	Replace or convert as required	Conversion in RAP (2009/10)
35	Wetaskiwin	Reynolds Museum	R-11	1990	Carrier	210	0.700	Oversize	+50%	600	275				9967		Carrier does not convert
36	Wetaskiwin	Reynolds Museum	R-11	1990	Carrier	210	0.700	Oversize	+50%	600	0				10027		Carrier does not convert
										24369	3553						

PRV And Purge Unit Installation and Refrigerant Table

Low Pressure Centrifugal Chillers (R-11 & R-113)

Alberta INFRASTRUCTURE AND TRANSPORTATION

No.	City/Town	BID	Building Name	Year Installed	Manuf.	Model No	Serial Number	PRV Installation	Purge Installation	When was Purge Reclaim Cannister Filter Last Changed	Condition	Chiller Charge (lbs)	Stock Amount (lbs)	Annual Top Up in (lbs)			
														2001	2002	2003	2004
1	Calgary	B0067B	Bowness Storage										963		0		
2	Calgary	B0067B	Bowness Storage										108		0		
3	Edmonton	B0192A	School for the Deaf	1955	Trane	150 LB 4E 3C	I-042		2003	2003	Good	1100	0	0	0	0	0
4	Edmonton	B0001E	Legislature Annex	1962	Trane	F-GF1-GV2	4506(#1,SOUTH)	Jul-95	Jul-95	6-Jan-03	Good	1000	0	0	110	0	0
5	Edmonton	B0001E	Legislature Annex	1962	Trane	F-GF1-GV2	4507 (#2,NORTH)	Jul-95	Jul-95	6-Jan-03	Good	1000	0	0	0	0	0
6	Edmonton	B0252D	Provincial Museum	1967	Trane	PCV-3J-C3-D	6783(#1)	1994	1994	Spring 2003	Good	780	0	220	0	330	0
7	Calgary	B0086A	J.J. Bowlen Building	1968	Carrier	19C	675111896	1995	1995	April 2002	Good	1700	0	0	0	0	0
8	Edmonton	B0235A	Law Courts	1972	Trane	PCV-3F-C1-D1	L0F12603(#1)	1995	1995	Feb 2004	Fair	750	0	55	385	0	240
9	Edmonton	B0235A	Law Courts	1972	Trane	PCV-3F-C1-D1	L0F12602 (#2)	1995	1995	Feb 2004	Fair	750	0	0	110	0	0
10	Edmonton	B0272A	Percy Page Centre	1972	Carrier	19DH2145CE	26222	1995	07/20/1994	March 2004	Excellent	600	0	100	0	0	0
11	Calgary	B0073A	Provincial Court	1973	Carrier	19DG6667CQ	72-48-19109	01/31/95	01/31/95	8/19/96	Excellent	450	0	0	0	0	110
12	Edmonton	B0192M	O.S Longman	1975	Trane	PCV5B-C1-02	L4H18314	1995	1995		Good	1100	200	220	0	0	0
13	St. Paul	B0743A	Provincial Building	1976	Trane	PVC-2C-C1-D1	L5J20076	93/94	93/94	Sept 04	Good	585	125	0	0	0	0
14	Lethbridge	B0545A	Provincial Building	1977	Trane	PCV-3J-C101	L5K20370	1994	1994	2002	Good	760	0	0	0	0	0
15	Calgary	B0099A	Red Cross	1978	Carrier	19DG4119AD	78-15-27341	1995	1995	2001	Good	450	0	0	80	0	0
16	Edmonton	B0208A	Remand Centre	1978	Trane	CVHA-025	L77MD7745	Mar-95	Mar-95	2002	Excellent	650	0	0	0	0	0
17	Peace River	B0622A	Provincial Building	1978	Carrier	19DH5550CB	79 02 28121	1994	1994		Good	625	0	16	200	0	0
18	Red Deer	B0667A	Provincial Building	1979	Trane	CVHA-032E-HB	L78K16408	1995	1995	2001	Good	634	0	0	0	0	0
19	Ft. McMurray	B0351A	Provincial Building	1981	Trane	CVHA-025H-HG	L80M20039	Mar. 25/95	Mar. 22/95	April 2002	Good	640	10	0	40	0	20
20	Edmonton	B0192S	Alberta Infrastructure	1982	Trane	CVHA-025	L81M29564	1995	1995		Excellent	780	0	60	0	0	0
21	Edmonton	B0192S	Alberta Infrastructure	1982	Trane	CVHA-025	L81M29563(#1)	1995	1995		Excellent	780	0	50	0	0	0
22	Edmonton	B0208B	John E. Brownlee	1983	Trane	CVHE-050J-AC	L83A09370 (#1)	1995	1995		Excellent	975	0	0	0	0	0
23	Edmonton	B0001D	Haultain Building	1984	Trane	CVHE-050	L84K23113	94/95	94/95	Mar 2004	Good	1000	190	220	0	0	0
24	Drumheller	B0183A	Royal Tyrell	1985	Trane	CVHE 20H	L83M15945(#2)	1995	1995	23-Jul-03	Excellent	300	55	0	0	0	0
25	Drumheller	B0183A	Royal Tyrell	1985	Trane	CVHE 16 H	L83M15943 (#1)	1995	1995	23-Jul-03	Excellent	300	0	0	0	0	100
26	Calgary	B0068A	Correctional Centre	1986	Trane	CVHE-032H-2LB	L86F38522	1994	1994	May 2004	Good	575	50	0	0	0	146
27	Calgary	B0068AF	CYOC	1987	York	YT A1 A1 B1 CFDS	YMSM369934	1995	1995	June /01 by Concept	Good	600	110	0	0	0	0
28	Edmonton	B0888A	EYOC	1987	Trane	CVHE-020J	L87D0145	1995	1995	2004	Excellent	390	110	0	0	0	0
29	Edmonton	B0235A	Law Courts	1987	Trane	CVHE-045J-AH	L86D37488 (#3)	1995	1995	September 2002	Fair	900	0	0	0	0	100
30	Ft. Sask.	B0361M	Correctional Centre	1987	Trane	CVHE-045N SP	L87B00768	Sep-94	Sep-94	Feb 2004	Excellent	1000	255	0	0	0	40
31	Red Deer	B0663B	Remand Centre	1987	Trane	CVHE-020J-AH	L85K31928	1995	1995	2001	Good	330	0	0	0	0	0
32	Edmonton	B0287A	ARC - Millwoods	1988	Trane	CVHE-032H-AD	L83J14557 (#1)	1995	1995	May 2004	Good	545	0	0	0	0	0
33	Edmonton	B0287A	ARC - Millwoods	1988	Trane	CVHE-032H-AD	L83J14558(#2)	1995	1995	May 2004	Good	545	0	0	0	110	0
34	Edmonton	B0252D	Provincial Museum	1988	Trane	CVHE-028-K	L87K04994	1994	1994	Spring 2003	Excellent	575	1102	0	0	0	0
35	Wetaskiwin	B0833D	Reynolds Museum	1990	Carrier	19DK53173CB	1690J43154 (#1)	1995	1995	6/3/2003 Purge Filter	Excellent	600	275	0	0	0	0
36	Wetaskiwin	B0833D	Reynolds Museum	1990	Carrier	19DK53173CB	1690J49153 (#2)	1995	1995	6/3/2003 Purge Filter	Excellent	600	0	0	0	0	0
												24369	3553	941	925	440	756

* - Standards require that purge units have an efficiency less 0.1 [kg CFC] / [kg air removed]

Replaced Chiller vs. New or Converted Chiller Table

Alberta
INFRASTRUCTURE AND TRANSPORTATION

No.	*City/Town*	*BID*	*Building Name*	*Year Replaced*	*Old Chiller*				*New Chiller*				*Service Company Name*	*Additional Comments*
					Type	*Manufacturer*	*Capacity (Tons)*	*Charge (lbs)*	*Type*	*Manufacturer*	*Capacity (Tons)*	*Charge (lbs)*		
1	Calgary	B0085A	SAJA	1995	R-11	Trane	260	1600	R-22	Carrier	120	650	Carrier Canada	New Chiller
2	Calgary	B0085A	SAJA	1995	R-11	Trane	260	1600	R-22	Carrier	120	650	Carrier Canada	New Chiller
3	Calgary	B0087A	Courthouse Annex	1996	R-113	Trane	103	800	R-22	Trane	100	144	Southampton Trane	New Chiller
4	Calgary	B0093A	Bow Valley College (AVC) *	1996	R-11	Trane	665	1300	R-123	Trane	500	750	Compass	New Chiller
5	Devon	S0163	Coal Research	1998	R-12	Trane	180	950	R-134a	Trane	180	925	Weather Makers Ltd.	Converted Chiller
6	Grande Cache	S0381	Correctional Center	N/A	R-11	Trane	500	990	N/A	N/A			N/A	Leased to Cda Corrections
7	Edmonton	B0208B	John E. Brownlee	1999	R-11	Trane	500	975	R-123	Trane	500	975	Trane	Converted Chiller
8	Edmonton	B0259A	AVC	N/A	R-11	Carrier	730	2000	N/A	N/A	0	0	N/A	Tranferred to Board
9	Slave Lake	S0929	AVC	N/A	R-11	Trane	280	525	N/A	N/A	0	0	N/A	Tranferred to Board
10	Lac La Biche	S0517	AVC	N/A	R-12	Trane	130	725	N/A	N/A	0	0	N/A	Tranferred to Board
11	Lac La Biche	S0517	AVC	N/A	R-12	Trane	130	725	N/A	N/A	0	0	N/A	Tranferred to Board
12	Medicine Hat	B0951A	Provincial Building	2001	R-11	Trane	206	450	R-123	Trane	206	450	Southampton Trane	Converted Chiller
13	Vegreville	B0794B	ARC	2004	R-12	Trane	320	1700	R-123	Trane	650	1090	Under Warranty	2 Chillers replaced with 1
14	Vegreville	B0794B	ARC	2004	R-12	Trane	320	1700						2 Chillers replaced with 1
								16040				5634		

* - The Bow Valley College chiller was replaced by Infrastructure. The building has since been transferred to the Board so is no longer in the Infrastructure portfolio

ALBERTA INFRASTRUCTURE AND TRANSPORTATION

ALL $ AMOUNTS IN 1994 DOLLARS

CENTRIFUGAL CHILLER CONVERSION / REPLACEMENT SCHEDULE

AMOUNTS SHOWN ARE IN THOUSANDS

DATE: DEC 1994 CFCSCH(1994).XLS R-11 AND R-113 CHILLERS

* - CANNOT BE CONVERTED

NO.	CITY/TOWN	NAME OF BLDG.	RECOMMENDED ACTION	AGE	MANUF.	MAJOR O/HAUL	CAP. TONS	KW/TON	CHILLER CAP. TO LOAD	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)	1994/95 1995/96	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)	96/97	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)
1	EDMONTON	SCHOOL FOR DEAF	*-HOLD- SITE REVIEW (R-113)	39	TRANE	1993	150	?	AB. RGHT	1100	0		1100	0		1100	0
2	CALGARY	SAJA	REMOVAL 1994,	38	TRANE		260	?	0	1600	0		0	1600		0	1600
3	CALGARY	SAJA	REPLACE 1994	38	TRANE	1993	260	?	-20%	1600	110	$650	0	1710		0	1710
4	CALGARY	COURTHOUSE ANNEX	* REPLACE 1997 (R-113)	35	TRANE	93/94	103	?	+25%	800	0		800	0		800	0
5	EDMONTON	LEGISLATURE ANNEX	*- REPLACE BOTH LEG. ANNEX	34	TRANE		235	?	+40%	1000	0		1000	0		1000	0
6	EDMONTON	LEGISLATURE ANNEX	* CHILLERS WITH ONE IN 2001	34	TRANE		235	?	+40%	1000	220		1000	220		1000	220
7	EDMONTON	PROVINCIAL MUSEUM	HOLD -USED FOR PEAK SHAVING	27	TRANE	1986	425	0.75	AB. RGHT	780	0		780	0		780	0
8	CALGARY	JOHN J. BOWLEN BLDG.	REPLACE 2000	26	CARRIER	1991	620	?	+35%	2000	220		2000	220		2000	220
9	EDMONTON	AVC	REPLACE 2000 PART CONV. 1993	24	CARRIER	1992	730	0.80	+50%	2000	300		2000	300		2000	300
10	EDMONTON	PERCY PAGE CNTR	REPLACE 2002	22	CARRIER	1992	250	0.79	+30%	625	0		625	0		625	0
11	EDMONTON	LAW COURTS	REPLACE BOTH UNITS -ITEMS	22	TRANE	1989	325	0.92	+20%	800	300		800	300		800	300
12	EDMONTON	LAW COURTS	11 & 12 IN 1999	22	TRANE	1989	325	0.92	+20%	800	300		800	300		800	300
13	CALGARY	AVC	REPLACEMENT 1994	22	TRANE	1992	665	0.76	+50%	1300	0	$205	0	1300		0	1300
14	CALGARY	COURTHOUSE/REMAND	REPLACE 2002	21	CARRIER	1993	405	0.85	+30%	925	330		925	330		925	330
15	EDMONTON	O.S. LONGMAN BLDG.	REPLACE 2004	19	TRANE	1984	524	0.80	AB. RGHT	1100	200		1100	200		1100	200
16	ST. PAUL	PROVINCIAL BLDG.	REPLACE 2003	18	TRANE	1992	211	0.92	+40%	585	220		585	220		585	220
17	LETHBRIDGE	PROVINCIAL BLDG.	OVERHL 1996, REPLACE 2006	17	TRANE	1986	370	0.85	AB. RGHT	760	0		760	0		760	0
18	PEACE RIVER	PROVINCIAL BLDG.	REPLACE 2005	16	CARRIER		194	0.78	AB. RGHT	625	0		625	0		625	0
19	CALGARY	RED CROSS	OVERHL 1998, REPLACE 2008	16	CARRIER		110	1.09	SPARE	450	0		450	0		450	0
20	EDMONTON	REMAND CENTRE	OVERHL 1998, REPLACE 2009	16	TRANE	1988	225	0.80	AB. RGHT	650	0		650	0		650	0
21	RED DEER	PROVINCIAL BLDG.	REPLACE 2007	15	TRANE	1993	345	0.86	AB.RGHT	634	0		634	0		634	0
22	EDMONTON	JOHN E. BROWNLEE	BUILDING OCCUPANCY	13	TRANE		500	0.64	AB. RGHT	975	0		975	0		975	0
23	EDMONTON	JOHN E. BROWNLEE	UNDER REVIEW	13	TRANE		500	0.64	AB. RGHT	975	0		975	0		975	0
24	FT.MCMURRAY	PROVINCIAL BLDG.	REPLACE 2007	13	TRANE	1988	250	0.80	+50%	640	50		640	50		640	50
25	EDMONTON	PWSS BUILDING	CONVERSION 1998	12	TRANE	1993	250	0.71	SPARE	780	0		780	0		780	0
26	EDMONTON	PWSS BUILDING	CONVERSION 1998	12	TRANE	1993	250	0.71	SPARE	780	0		780	0		780	0
27	EDMONTON	HAULTAIN BUILDING	OVERHL 1995, CONVER 2004	10	TRANE		500	0.66	AB. RGHT	990	330		990	330		990	330
28	GRANDE CACHE	CORRECTIONAL CNTR.	CONVERSION 1994 R-11 IN CHIL.	9	TRANE	1995	500	0.70	+30%	1210	0		1210	0		1210	0
29	EDMONTON	ARC - MILLWOODS	CONVERSION 2005	9	TRANE		308	0.68	AB. RGHT	545	165		545	165		545	165
30	EDMONTON	ARC - MILLWOODS	CONVERSION 2005	9	TRANE		308	0.68	AB. RGHT	545	165		545	165		545	165
31	DRUMHELLER	ROYAL TYRRELL MUSEUM		9	TRANE	1994	150	0.68	AB. RGHT	330	110		330	110		330	110
32	DRUMHELLER	ROYAL TYRRELL MUSEUM		9	TRANE	1994	150	0.68	AB. RGHT	330	0		330	0		330	0
33	CALGARY	CORRECTIONAL CNTR.		8	TRANE		350	0.67	+80%	575	0		575	0		575	0
34	EDMONTON	LAW COURTS	CONVERSION 1997	7	TRANE		455	0.67	+20%	900	300		900	300		900	300
35	EDMONTON	YOUNG OFFENDERS CNTR		7	TRANE		200	0.69	+40%	590	100		590	100		590	100
36	CALGARY	YOUNG OFFENDERS CNTR.		7	YORK	2013	125	0.624	+80%	600	0		600	0		600	0
37	RED DEER	REMAND CENTRE		7	TRANE	1994	150	0.66	+30%	330	0		330	0		330	0
38	FT. SASK.	CORRECTIONAL CNTR.		7	TRANE	N/CSH	450	0.70	+35%	770	220		770	220		770	220
39	EDMONTON	PROVINCIAL MUSEUM	CONVERSION 2002	6	TRANE	2002	300	0.71	AB. RGHT	575	0		575	0		575	0
40	MEDICINE HAT	PROVINCIAL BLDG.		5	TRANE		200	0.63	INS. (80%)	450	0		450	0		450	0
41	WETASKIWIN	REYNOLDS MUSEUM		4	CARRIER	2000	210	0.70	+15%	600	275		600	275		600	275
42	WETASKIWIN	REYNOLDS MUSEUM		4	CARRIER	2000	210	0.70	+15%	600	275		600	275		600	275
43	SLAVE LAKE	AVC		3	TRANE		250	0.74	+20%	525	0		525	0		525	0
44	CALGARY	COURTHOUSE ANNEX	NOT IN SERVICE		CARRIER		256		N/A	0	0		0	0		0	0
45	CALGARY	HIGHWAYS BUILDING	NOT IN SERVICE		TRANE		405		N/A	0	0		0	0		0	0
CUMULATIVE ESTIMATED ANNUAL REFRIGERANT LOSS - 500 LBS/YR														-500			-1000
REFRIGERANT (LBS)										35749	4190		31249	8190		31249	7690
ESTIMATED EXPENDITURE												$855			$0		

TABLE A4-A

ALBERTA INFRASTRUCTURE AND TRANSPORTATION

ALL $ AMOUNTS IN 1994 DOLLARS

CENTRIFUGAL CHILLER CONVERSION / REPLACEMENT SCHEDULE

AMOUNTS SHOWN ARE IN THOUSANDS

DATE: DEC 1994 CFCSCH(1994).XLS R-11 AND R-113 CHILLERS

* - CANNOT BE CONVERTED

NO.	CITY/TOWN	NAME OF BLDG.	RECOMMENDED ACTION	97/98	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)	98/99	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)	1999/ 2000	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)	2000/ 2001	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)	01/02	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)
1	EDMONTON	SCHOOL FOR DEAF	*-HOLD- SITE REVIEW (R-113)		1100	0		1100	0		1100	0		1100	0		1100	0
2	CALGARY	SAJA	REMOVAL 1994,		0	1600		0	1600		0	1600		0	1600		0	1600
3	CALGARY	SAJA	REPLACE 1994		0	1710		0	1710		0	1710		0	1710		0	1710
4	CALGARY	COURTHOUSE ANNEX	* REPLACE 1997 (R-113)	$120	0	0		0	0		0	0		0	0		0	0
5	EDMONTON	LEGISLATURE ANNEX	*- REPLACE BOTH LEG. ANNEX		1000	0		1000	0		1000	0		1000	0		0	1000
6	EDMONTON	LEGISLATURE ANNEX	* CHILLERS WITH ONE IN 2001		1000	220		1000	220		1000	220		1000	220	$350	0	1220
7	EDMONTON	PROVINCIAL MUSEUM	HOLD -USED FOR PEAK SHAVING		780	0		780	0		780	0		780	0		780	0
8	CALGARY	JOHN J. BOWLEN BLDG.	REPLACE 2000		2000	220		2000	220		2000	220	$250	760	1460		760	1460
9	EDMONTON	AVC	REPLACE 2000 PART CONV. 1993		2000	300		2000	300		2000	300	$250	0	2300		0	2300
10	EDMONTON	PERCY PAGE CNTR	REPLACE 2002		625	0		625	0		625	0		625	0		625	0
11	EDMONTON	LAW COURTS	REPLACE BOTH UNITS -ITEMS		800	300		800	300	$280	0	1100		0	1100		0	1100
12	EDMONTON	LAW COURTS	11 & 12 IN 1999		800	300		800	300	$0	0	1100		0	1100		0	1100
13	CALGARY	AVC	REPLACEMENT 1994		0	1300		0	1300		0	1300		0	1300		0	1300
14	CALGARY	COURTHOUSE/REMAND	REPLACE 2002		925	330		925	330		925	330		925	330		925	330
15	EDMONTON	O.S. LONGMAN BLDG.	REPLACE 2004		1100	200		1100	200		1100	200		1100	200		1100	200
16	ST. PAUL	PROVINCIAL BLDG.	REPLACE 2003		585	220		585	220		585	220		585	220		585	220
17	LETHBRIDGE	PROVINCIAL BLDG.	OVERHL 1996, REPLACE 2006		760	0		760	0		760	0		760	0		760	0
18	PEACE RIVER	PROVINCIAL BLDG.	REPLACE 2005		625	0		625	0		625	0		625	0		625	0
19	CALGARY	RED CROSS	OVERHL 1998, REPLACE 2008		450	0		450	0		450	0		450	0		450	0
20	EDMONTON	REMAND CENTRE	OVERHL 1998, REPLACE 2009		650	0		650	0		650	0		650	0		650	0
21	RED DEER	PROVINCIAL BLDG.	REPLACE 2007		634	0		634	0		634	0		634	0		634	0
22	EDMONTON	JOHN E. BROWNLEE	BUILDING OCCUPANCY		975	0		975	0		975	0		975	0		975	0
23	EDMONTON	JOHN E. BROWNLEE	UNDER REVIEW		975	0		975	0		975	0		975	0		975	0
24	FT.MCMURRAY	PROVINCIAL BLDG.	REPLACE 2007		640	50		640	50		640	50		640	50		640	50
25	EDMONTON	PWSS BUILDING	CONVERSION 1998		780	0	$50	0	780		0	780		0	780		0	780
26	EDMONTON	PWSS BUILDING	CONVERSION 1998		780	0	$50	0	780		0	780		0	780		0	780
27	EDMONTON	HAULTAIN BUILDING	OVERHL 1995, CONVER 2004		990	330		990	330		990	330		990	330		990	330
28	GRANDE CACHE	CORRECTIONAL CNTR.	CONVERSION 1994 R-11 IN CHIL.		1210	0		1210	0		1210	0		1210	0		1210	0
29	EDMONTON	ARC - MILLWOODS	CONVERSION 2005		545	165		545	165		545	165		545	165		545	165
30	EDMONTON	ARC - MILLWOODS	CONVERSION 2005		545	165		545	165		545	165		545	165		545	165
31	DRUMHELLER	ROYAL TYRRELL MUSEUM			330	110		330	110		330	110		330	110		330	110
32	DRUMHELLER	ROYAL TYRRELL MUSEUM			330	0		330	0		330	0		330	0		330	0
33	CALGARY	CORRECTIONAL CNTR.			575	0		575	0		575	0		575	0		575	0
34	EDMONTON	LAW COURTS	CONVERSION 1997	$55	0	1200		0	1200		0	1200		0	1200		0	1200
35	EDMONTON	YOUNG OFFENDERS CNTR			590	100		590	100		590	100		590	100		590	100
36	CALGARY	YOUNG OFFENDERS CNTR.			600	0		600	0		600	0		600	0		600	0
37	RED DEER	REMAND CENTRE			330	0		330	0		330	0		330	0		330	0
38	FT. SASK.	CORRECTIONAL CNTR.			770	220		770	220		770	220		770	220		770	220
39	EDMONTON	PROVINCIAL MUSEUM	CONVERSION 2002		575	0		575	0		575	0		575	0		575	0
40	MEDICINE HAT	PROVINCIAL BLDG.			450	0		450	0		450	0		450	0		450	0
41	WETASKIWIN	REYNOLDS MUSEUM			600	275		600	275		600	275		600	275		600	275
42	WETASKIWIN	REYNOLDS MUSEUM			600	275		600	275		600	275		600	275		600	275
43	SLAVE LAKE	AVC			525	0		525	0		525	0		525	0		525	0
44	CALGARY	COURTHOUSE ANNEX	NOT IN SERVICE		0	0		0	0		0	0		0	0		0	0
45	CALGARY	HIGHWAYS BUILDING	NOT IN SERVICE		0	0		0	0		0	0		0	0		0	0
CUMULATIVE ESTIMATED ANNUAL REFRIGERANT LOSS - 500 LBS/YR						-1500			-2000			-2500			-3000			-3500
REFRIGERANT (LBS)					29549	8090		27989	9150		26389	10250		23149	12990		21149	14490
ESTIMATED EXPENDITURE				$175			$100			$280			$500			$350		

TABLE A4-B

ALBERTA INFRASTRUCTURE AND TRANSPORTATION

ALL $ AMOUNTS IN 1994 DOLLARS

CENTRIFUGAL CHILLER CONVERSION / REPLACEMENT SCHEDULE

AMOUNTS SHOWN ARE IN THOUSANDS

DATE: DEC 1994 CFCSCH(1994).XLS R-11 AND R-113 CHILLERS

* - CANNOT BE CONVERTED

NO.	CITY/TOWN	NAME OF BLDG.	RECOMMENDED ACTION	02/03	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)	03/04	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)	04/05	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)	05/06	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)	06/07	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)
1	EDMONTON	SCHOOL FOR DEAF	*-HOLD- SITE REVIEW (R-113)		1100	0		1100	0		1100	0		1100	0		1100	0
2	CALGARY	SAJA	REMOVAL 1994,		0	1600		0	1600		0	1600		0	1600		0	1600
3	CALGARY	SAJA	REPLACE 1994		0	1710		0	1710		0	1710		0	1710		0	1710
4	CALGARY	COURTHOUSE ANNEX	* REPLACE 1997 (R-113)		0	0		0	0		0	0		0	0		0	0
5	EDMONTON	LEGISLATURE ANNEX	*- REPLACE BOTH LEG. ANNEX		0	1000		0	1000		0	1000		0	1000		0	1000
6	EDMONTON	LEGISLATURE ANNEX	* CHILLERS WITH ONE IN 2001		0	1220		0	1220		0	1220		0	1220		0	1220
7	EDMONTON	PROVINCIAL MUSEUM	HOLD -USED FOR PEAK SHAVING		780	0		780	0		780	0		780	0		780	0
8	CALGARY	JOHN J. BOWLEN BLDG.	REPLACE 2000		760	1460		760	1460		760	1460		760	1460		760	1460
9	EDMONTON	AVC	REPLACE 2000 PART CONV. 1993		0	2300		0	2300		0	2300		0	2300		0	2300
10	EDMONTON	PERCY PAGE CNTR	REPLACE 2002	$230	0	625		0	625		0	625		0	625		0	625
11	EDMONTON	LAW COURTS	REPLACE BOTH UNITS -ITEMS		0	1100		0	1100		0	1100		0	1100		0	1100
12	EDMONTON	LAW COURTS	11 & 12 IN 1999		0	1100		0	1100		0	1100		0	1100		0	1100
13	CALGARY	AVC	REPLACEMENT 1994		0	1300		0	1300		0	1300		0	1300		0	1300
14	CALGARY	COURTHOUSE/REMAND	REPLACE 2002	$160	715	540		715	540		715	540		715	540		715	540
15	EDMONTON	O.S. LONGMAN BLDG.	REPLACE 2004		1100	200		1100	200	$240	0	1300		0	1300		0	1300
16	ST. PAUL	PROVINCIAL BLDG.	REPLACE 2003		585	220	$140	0	805		0	805		0	805		0	805
17	LETHBRIDGE	PROVINCIAL BLDG.	OVERHL 1996, REPLACE 2006		760	0		760	0		760	0		760	0	$175	0	760
18	PEACE RIVER	PROVINCIAL BLDG.	REPLACE 2005		625	0		625	0		625	0	$140	0	625		0	625
19	CALGARY	RED CROSS	OVERHL 1998, REPLACE 2008		450	0		450	0		450	0		450	0		450	0
20	EDMONTON	REMAND CENTRE	OVERHL 1998, REPLACE 2009		650	0		650	0		650	0		650	0		650	0
21	RED DEER	PROVINCIAL BLDG.	REPLACE 2007		634	0		634	0		634	0		634	0		634	0
22	EDMONTON	JOHN E. BROWNLEE	BUILDING OCCUPANCY		975	0		975	0		975	0		975	0		975	0
23	EDMONTON	JOHN E. BROWNLEE	UNDER REVIEW		975	0		975	0		975	0		975	0		975	0
24	FT.MCMURRAY	PROVINCIAL BLDG.	REPLACE 2007		640	50		640	50		640	50		640	50		640	50
25	EDMONTON	PWSS BUILDING	CONVERSION 1998		0	780		0	780		0	780		0	780		0	780
26	EDMONTON	PWSS BUILDING	CONVERSION 1998		0	780		0	780		0	780		0	780		0	780
27	EDMONTON	HAULTAIN BUILDING	OVERHL 1995, CONVER 2004		990	330		990	330	$55	0	1320		0	1320		0	1320
28	GRANDE CACHE	CORRECTIONAL CNTR.	CONVERSION 1994 R-11 IN CHIL.		1210	0		1210	0		1210	0	$55	0	1210		0	1210
29	EDMONTON	ARC - MILLWOODS	CONVERSION 2005		545	165		545	165		545	165	$50	0	710		0	710
30	EDMONTON	ARC - MILLWOODS	CONVERSION 2005		545	165		545	165		545	165	$50	0	710		0	710
31	DRUMHELLER	ROYAL TYRRELL MUSEUM			330	110		330	110		330	110		330	110		330	110
32	DRUMHELLER	ROYAL TYRRELL MUSEUM			330	0		330	0		330	0		330	0		330	0
33	CALGARY	CORRECTIONAL CNTR.			575	0		575	0		575	0		575	0		575	0
34	EDMONTON	LAW COURTS	CONVERSION 1997		0	1200		0	1200		0	1200		0	1200		0	1200
35	EDMONTON	YOUNG OFFENDERS CNTR			590	100		590	100		590	100		590	100		590	100
36	CALGARY	YOUNG OFFENDERS CNTR.			600	0		600	0		600	0		600	0		600	0
37	RED DEER	REMAND CENTRE			330	0		330	0		330	0		330	0		330	0
38	FT. SASK.	CORRECTIONAL CNTR.			770	220		770	220		770	220		770	220		770	220
39	EDMONTON	PROVINCIAL MUSEUM	CONVERSION 2002	$46	0	575		0	575		0	575		0	575		0	575
40	MEDICINE HAT	PROVINCIAL BLDG.			450	0		450	0		450	0		450	0		450	0
41	WETASKIWIN	REYNOLDS MUSEUM			600	275		600	275		600	275		600	275		600	275
42	WETASKIWIN	REYNOLDS MUSEUM			600	275		600	275		600	275		600	275		600	275
43	SLAVE LAKE	AVC			525	0		525	0		525	0		525	0		525	0
44	CALGARY	COURTHOUSE ANNEX	NOT IN SERVICE		0	0		0	0		0	0		0	0		0	0
45	CALGARY	HIGHWAYS BUILDING	NOT IN SERVICE		0	0		0	0		0	0		0	0		0	0
CUMULATIVE ESTIMATED ANNUAL REFRIGERANT LOSS - 500 LBS/YR						-4000			-4500			-5000			-5500			-6000
REFRIGERANT (LBS)					19739	15400		19154	15485		17064	17075		14139	19500		13379	19760
ESTIMATED EXPENDITURE				$436			$140			$295			$295			$175		

TABLE A4-C

ALBERTA INFRASTRUCTURE AND TRANSPORTATION

ALL $ AMOUNTS IN 1994 DOLLARS

CENTRIFUGAL CHILLER CONVERSION / REPLACEMENT SCHEDULE

AMOUNTS SHOWN ARE IN THOUSANDS

DATE: DEC 1994 CFCSCH(1994).XLS R-11 AND R-113 CHILLERS

* - CANNOT BE CONVERTED

NO.	CITY/TOWN	NAME OF BLDG.	RECOMMENDED ACTION	07/08	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)	08/09	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)	09/10	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)	10/11	CHILLER CHARGE (LBS)	STOCK AMT. (LBS)
1	EDMONTON	SCHOOL FOR DEAF	*-HOLD- SITE REVIEW (R-113)		1100	0		1100	0		1100	0		1100	0
2	CALGARY	SAJA	REMOVAL 1994,		0	1600		0	1600		0	1600		0	1600
3	CALGARY	SAJA	REPLACE 1994		0	1710		0	1710		0	1710		0	1710
4	CALGARY	COURTHOUSE ANNEX	* REPLACE 1997 (R-113)		0	0		0	0		0	0		0	0
5	EDMONTON	LEGISLATURE ANNEX	*- REPLACE BOTH LEG. ANNEX		0	1000		0	1000		0	1000		0	1000
6	EDMONTON	LEGISLATURE ANNEX	* CHILLERS WITH ONE IN 2001		0	1220		0	1220		0	1220		0	1220
7	EDMONTON	PROVINCIAL MUSEUM	HOLD -USED FOR PEAK SHAVING		780	0		780	0		780	0		780	0
8	CALGARY	JOHN J. BOWLEN BLDG.	REPLACE 2000		760	1460		760	1460		760	1460		760	1460
9	EDMONTON	AVC	REPLACE 2000 PART CONV. 1993		0	2300		0	2300		0	2300		0	2300
10	EDMONTON	PERCY PAGE CNTR	REPLACE 2002		0	625		0	625		0	625		0	625
11	EDMONTON	LAW COURTS	REPLACE BOTH UNITS -ITEMS		0	1100		0	1100		0	1100		0	1100
12	EDMONTON	LAW COURTS	11 & 12 IN 1999		0	1100		0	1100		0	1100		0	1100
13	CALGARY	AVC	REPLACEMENT 1994		0	1300		0	1300		0	1300		0	1300
14	CALGARY	COURTHOUSE/REMAND	REPLACE 2002		715	540		715	540		715	540		715	540
15	EDMONTON	O.S. LONGMAN BLDG.	REPLACE 2004		0	1300		0	1300		0	1300		0	1300
16	ST. PAUL	PROVINCIAL BLDG.	REPLACE 2003		0	805		0	805		0	805		0	805
17	LETHBRIDGE	PROVINCIAL BLDG.	OVERHL 1996, REPLACE 2006		0	760		0	760		0	760		0	760
18	PEACE RIVER	PROVINCIAL BLDG.	REPLACE 2005		0	625		0	625		0	625		0	625
19	CALGARY	RED CROSS	OVERHL 1998, REPLACE 2008		450	0	$130	230	220		230	220		230	220
20	EDMONTON	REMAND CENTRE	OVERHL 1998, REPLACE 2009		650	0		650	0	$160	0	650		0	650
21	RED DEER	PROVINCIAL BLDG.	REPLACE 2007	$175	0	634		0	634		0	634		0	634
22	EDMONTON	JOHN E. BROWNLEE	BUILDING OCCUPANCY		975	0		975	0		975	0		975	0
23	EDMONTON	JOHN E. BROWNLEE	UNDER REVIEW		975	0		975	0		975	0		975	0
24	FT.MCMURRAY	PROVINCIAL BLDG.	REPLACE 2007	$160	0	690		0	690		0	690		0	690
25	EDMONTON	PWSS BUILDING	CONVERSION 1998		0	780		0	780		0	780		0	780
26	EDMONTON	PWSS BUILDING	CONVERSION 1998		0	780		0	780		0	780		0	780
27	EDMONTON	HAULTAIN BUILDING	OVERHL 1995, CONVER 2004		0	1320		0	1320		0	1320		0	1320
28	GRANDE CACHE	CORRECTIONAL CNTR.	CONVERSION 1994 R-11 IN CHIL.		0	1210		0	1210		0	1210		0	1210
29	EDMONTON	ARC - MILLWOODS	CONVERSION 2005		0	710		0	710		0	710		0	710
30	EDMONTON	ARC - MILLWOODS	CONVERSION 2005		0	710		0	710		0	710		0	710
31	DRUMHELLER	ROYAL TYRRELL MUSEUM			330	110		330	110		330	110		330	110
32	DRUMHELLER	ROYAL TYRRELL MUSEUM			330	0		330	0		330	0		330	0
33	CALGARY	CORRECTIONAL CNTR.			575	0		575	0		575	0		575	0
34	EDMONTON	LAW COURTS	CONVERSION 1997		0	1200		0	1200		0	1200		0	1200
35	EDMONTON	YOUNG OFFENDERS CNTR			590	100		590	100		590	100		590	100
36	CALGARY	YOUNG OFFENDERS CNTR.			600	0		600	0		600	0		600	0
37	RED DEER	REMAND CENTRE			330	0		330	0		330	0		330	0
38	FT. SASK.	CORRECTIONAL CNTR.			770	220		770	220		770	220		770	220
39	EDMONTON	PROVINCIAL MUSEUM	CONVERSION 2002		0	575		0	575		0	575		0	575
40	MEDICINE HAT	PROVINCIAL BLDG.			450	0		450	0		450	0		450	0
41	WETASKIWIN	REYNOLDS MUSEUM			600	275		600	275		600	275		600	275
42	WETASKIWIN	REYNOLDS MUSEUM			600	275		600	275		600	275		600	275
43	SLAVE LAKE	AVC			525	0		525	0		525	0		525	0
44	CALGARY	COURTHOUSE ANNEX	NOT IN SERVICE		0	0		0	0		0	0		0	0
45	CALGARY	HIGHWAYS BUILDING	NOT IN SERVICE		0	0		0	0		0	0		0	0
CUMULATIVE ESTIMATED ANNUAL REFRIGERANT LOSS - 500 LBS/YR						-6500			-7000			-7500			-8000
REFRIGERANT (LBS)					12105	20534		11885	20254		11235	20404		11235	19904
ESTIMATED EXPENDITURE				$335			$130			$160			$0		

TABLE A4-D

APPENDIX B

TABLE B-1 - REFRIGERANT CHARACTERISTICS									
	ENVIRONMENT			SAFETY			PERFORMANCE		
Refrigerant	(6) ODP	(3) GWP	(4) Life (yrs)	(5) ASHRAE Safety Group	Toxicity TLV (ppm)	Flammability LFL (%)	Normal Boiling Point (°C)	Ideal COP	(1) Cycle
CFC-11	1.0	3500	60	A1	1000	NONE	24	7.78	VC
CFC-12	1.0	7300	130	A1	1000	NONE	-30	6.91.	VC
HCFC-22	0.05	1500	15	A1	1000	NONE	-41	7.06	VC
HCFC-123	0.02	85	2	B1	30	NONE	28	7.63	VC
HFC-134a	0.0	1200	16	A1	1000	NONE	-26	6.77	VC
R-500 (2) - 74% - CFC-12 - 26% - HFC-152a	 1.0 0.0	 7300 140	 130 2	A1	 1000 1000	 NONE 3.7%	-33	--	VC
R-502 (2) - 49% - HCFC-22 - 51% - CFC-115	 0.05 0.52	 1500 6900	 15 400	A1	 1000 1000	 NONE NONE	-45	--	VC
R-717 (Ammonia)	0	0	< 1	B2	25	14.8%	-33	7.28	VC
R-718 (Water)	0	0	-	A1			100	4.1	ABS
R-290 (Propane)	0	3	> 1	A3	-	2.1%	-42	--	VC

References:
1. Montreal Protocol
2. 1991 Assessment Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee, December 1991
3. United Nations Environment Program
4. ASHRAE Standard 34-1992

(1) Vapour compression Cycle

(2) Mixture of Refrigerants

(3) Global Warming Potential relative to CO_2 given for 100 year integration time horizon.

(4) Life in atmosphere

(5) ASHRAE Standard 34, relates to flammability and toxicity level

(6) Ozone depleting factor relative to CFC-11

TABLE B-2 - CURRENT USE OF CFC'S		
	Primary Refrigerant	**Other Refrigerants**
Domestic Refrigeration	CFC-12*	Propane absorption
Commercial Refrigeration - moderate temperature - low temperature	CFC-12	R-502 HCFC-22 R-717 (ammonia)
Cold Storage & Food Processing	R-717	CFC-12, R502* HCFC-22**
Industrial Refrigeration - very low temperature - low temperature - moderate temperature	CFC-13* R-717	BFC-13* R-502* HCFC-22** CFC-12*
Unitary Air Conditioning & Heating Pumps	HCFC-22**	absorption
Air Conditioning (Liquid Chillers) - positive displacement (reciprocating, screw) - centrifugal low pressure medium pressure high pressure	HCFC-22** CFC-11* CFC-12* HCFC-22**	absorption CFC-12* R-500*
Heat Pumps (Heat Recovery & Heating Only)	CFC-12* HCFC-22**	R-502* CFC-11*
Transport Refrigeration & Air Conditioning	CFC-11* CFC-12* HCFC-22**	CFC-114* R-502*
Automotive Air Conditioning	CFC-12*	Propane

References: 1. Montreal Protocol
2. 1991 Assessment Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee, December 1991
3. ASHRAE Standard 34-1992

* Phase out by end of 1995
** Phase out by 2020

TABLE B-3 CHILLERS IN SERVICE*			
Chillers	**Approximate No. of Units in Service**	**Refrigerant in use (thousand tonnes)**	**1990 Shipments of New Units**
Centrifugal & Screw Chillers:			
CFC-11	100,000	12.5	5,000
CFC-12	12,500	17.5	635
HCFC-22	5,000	9.5	300
R-500	6,250	---	315
Other Refrigerants	1,250	---	---

References: 1. Montreal Protocol
2. 1991 Assessment Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee, December 1991
3. ASHRAE Standard 34-1992

* Chillers in service worldwide

TABLE B-4 - POTENTIAL REFRIGERANT LEAKS IN CHILLERS

Purger	Defective parts
Charging procedure	Rounded valve stems
Compressor seals	Condition of transfer equipment
Tube leaks	Improper installation or repair
Isolating for repair	Environmental conditions
Screwed piping (or brazed)	Line breakage
Instrument or tubing leaks	Not properly evacuating units prior to maintenance
Transferring refrigerant	Overcharging
Receiver leaks	Improper storage (55-gal drums)
Rupture disks/relief valves	Improper recovery of refrigerant/water
Valve packing	Wrong equipment in acid areas
Expansion Joints	Scattered equipment
Gaskets	Multiple people/crews involved in refrigerant transfer
Valves on cylinders	Improper equipment used in transfer
Rusty piping	Stopped-up transfer lines
Sight glasses	Not enough time allowed by production to make proper repairs
Misoperation (operations or maintenance)	Refusal to shut down a leaking piece of equipment for repairs
Balance in rotors	Lack of training in operation and maintenance
Blowdown (intentional - to remove air)	Changing refrigerant filter
Charging hoses	Deterioration of shell
Improper storage	Flanges
Refrigerant left in large cylinders	Lack of uniform evacuation procedure
Carelessness	Purger repair
Missing valve caps	Air leaks
Leak testing (or lack of it)	
Inaccurate measuring devices	
Remote instruments - panel board, for example	
Deteriorated "O" rings	
Seal leak	

TABLE B-5
HALON CHARACTERISTICS

COMPOUND	ODP	LIFE [(1)] (YEARS)	AMOUNT USED IN U.S.
Halon 1211	3.0	25	2.8 million kg
Halon 1301	10.0	110	3.5 million kg

Reference: Fire Journal, September/October 1990

(1) Atmospheric Life

TABLE B-6

Properties of Some Alternative Gaseous Extinguishing Agents
(Based on available information at time of preparation)

	Halon 1301	**FM200**	**NOVEC 1230**	**Inergen**
Design Concentration (v/v %)	5.0	7.5-8.7	5.0-6.0	38-40
Specific Volume (cu ft/lb)	2.5605	2.2075	1.175	
Pounds of agent required (per 100 cu ft) % increase over Halon 1301	2.06 N/A	3.41 66.0%		
Cylinder space required (cubic inches) % increase over Halon 1301	51.0 0.0%	95.0 86.0%		
Vapour Pressure (psia @ 70°F)	214	59	5.85	2205
Cylinder Types (psig)	360/600	360/600	360	HP
Ozone Depletion Potential	12.0	0	0	0
Global Warming Potential	6900	3500	1	N/A
Atmospheric Lifetime (years)	65	33	0.014	N/A
Toxicity LC50	>800,000	>800,000	>100,000	
Cardiac Sensitization (NOAEL v/v)	7.5%	7%	10%	
Boiling Point (deg F)	-71.95	2.55	120.2	-320.8
Liquid Density (lb/cu ft @ 70°F)	97.8	87.6	99.9	

APPENDIX C

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(Consolidated up to 132/2004

ALBERTA REGULATION 181/2000
Environmental Protection and Enhancement Act

OZONE-DEPLETING SUBSTANCES AND HALOCARBONS REGULATION

Table of Contents

Definitions

1 In this Regulation,

(a) "charge" means to add an ozone-depleting substance or halocarbon to a refrigeration or air conditioning system;

(a.1) "chiller" means an air conditioning system or refrigeration system that has a compressor, an evaporator and a secondary refrigerant;

(a.2) "critical use application" means a situation where a technically and financially feasible alternative does not exist;

(b) "Director" means the person designated as Director for the purposes of this Regulation;

(c) "halocarbon" means a substance listed in Schedule 3 or 4, and includes a substance that contains such a substance;

(c.1) "mobile refrigeration system" means a refrigeration system that is installed in or normally operates in or in conjunction with or is attached to a means of transportation;

(d) "ozone-depleting substance" means a substance listed in Schedule 1 or 2, and includes a substance that contains such a substance;

(e) "servicing procedure" means a procedure associated with the installation, maintenance, inspection, testing, leak detection, repair, labelling, alteration, conversion or temporary or permanent decommissioning of a refrigeration or air conditioning system or white goods or components of a refrigeration or air conditioning system or white goods;

(e.1) "small refrigeration system" means any refrigeration system other than a mobile refrigeration system that is not contained in a motor vehicle and that has a rated refrigeration capacity of less than 19 kilowatts;

(f) "white goods" means cooling and refrigeration appliances including, without limitation, refrigerators and freezers.

AR 181/2000 s1;132/2004

General prohibition

2(1) Unless subsection (3) or (4) is not contravened or unless permitted by any enactment of Alberta or Canada or by approval, no person shall release or permit the release of an ozone-depleting substance or halocarbon into the environment.

(2) Subsection (1) does not apply to the release of an ozone-depleting substance or halocarbon into the environment from any thing while it is used

(a) in the course of fighting fires;

(b) in human or animal health care applications, such as the following:

(i) bronchial dilators;

(ii) inhalable steroids;

(iii) topical anaesthetics;

(iv) veterinary powder wound sprays;

(v) sterilization of medical equipment;

(c) in laboratory analytical procedures.

(3) No person shall charge or permit the charge of an air conditioning system, that is designed for passengers in motor vehicles, with a chlorofluorocarbon or any mixture containing a chlorofluorocarbon listed in items (a) to (e) in Schedule 1.

(4) No person shall release or permit the release of more than 0.1 kilogram of an ozone-depleting substance or halocarbon per kilogram of air from an air purge system for purging non-condensable gases from a low pressure centrifugal chiller on or used on a refrigeration system or air conditioning system.

(5) On and after January 1, 2005, no person shall charge or permit the charge of a mobile refrigeration system with a chlorofluorocarbon or any mixture containing a chlorofluorocarbon listed in items (a) to (e) in Schedule 1.

(6) On and after January 1, 2005, no person shall charge or permit the charge of a refrigeration system with a chlorofluorocarbon or any mixture containing a chlorofluorocarbon listed in items (a) to (e) in Schedule 1.

(7) Subsection (6) does not apply to a chiller, a mobile refrigeration system or a small refrigeration system.
(8) On and after January 1, 2005, no person shall charge or permit the charge of a chiller with a chlorofluorocarbon or any mixture containing a chlorofluorocarbon listed in items (a) to (e) in Schedule 1 if that chiller has undergone an overhaul that includes the following procedure or repair:
(a) the replacement or modification of an internal sealing device;
(b) the replacement or modification of an internal mechanical part other than
(i) an oil heater,
(ii) an oil pump,
(iii) a float assembly, or
(iv) a vane assembly, in the case of a chiller with a single-stage compressor;
(c) any procedure or repair that resulted from the failure of an evaporator or a condenser heat-exchanger tube.
(9) Notwithstanding subsection (8), a person may charge a chiller with a chlorofluorocarbon or with a mixture containing a chlorofluorocarbon listed in items (a) to (e) in Schedule 1, but that person shall not operate that chiller later than one year after the day on which it is charged unless it no longer contains a chlorofluorocarbon or mixture containing a chlorofluorocarbon listed in items (a) to (e) in Schedule 1.
(10) The owner or person responsible for charging a chiller pursuant to subsection (9) shall provide written notice to the Director within 30 days after the chiller is charged.
(11) On and after January 1, 2015, no person shall charge or permit the charge of a chiller with a chlorofluorocarbon or any mixture containing a chlorofluorocarbon listed in items (a) to (e) in Schedule 1.
(12) On and after January 1, 2005, no person shall charge or permit the charge of a portable fire extinguisher with a halon or any mixture containing a halon listed in items (f) to (i) in Schedule 1, except for critical use applications.
(13) During the period from January 1, 2005 to December 31, 2009, no person shall charge or permit the charge of a fixed fire extinguishing system with a halon or any mixture containing a halon listed in items (f) to (i) in Schedule 1 more than once on that system, except for critical use applications.
(14) On or after January 1, 2010, no person shall charge or permit the charge of a fixed fire extinguishing system with a halon or any mixture containing a halon listed in items (f) to (i) in Schedule 1, except for critical use applications.
AR 181/2000 s2;132/2004

Refillable container

3 No person shall sell or purchase an ozone-depleting substance or halocarbon used as a refrigerant in refrigeration or air conditioning, unless it is in a container that is designed to be refilled and to contain that substance.
AR 181/2000 s3;132/2004

Manufacture or sale

4(1) Subject to subsections (2) to (4), no person shall manufacture, offer for sale or sell
(a) any thing containing an ozone-depleting substance listed in Schedule 1 that acts as a propellant,

(b) packaging, wrapping or containers that contain an ozone-depleting substance listed in Schedule 1 or that are manufactured by a process that uses an ozone-depleting substance listed in Schedule 1,

(c) a portable hand-held fire extinguisher that contains an ozone-depleting substance listed in Schedule 1 or that is manufactured by a process that uses an ozone depleting substance listed in Schedule 1,

(d) rigid foam insulation or flexible furniture foam made with any ozone-depleting substance listed in Schedule 1, or

(e) any thing that contains an ozone-depleting substance listed in Schedule 1 that is

(i) a release agent for molds used in the manufacture of plastic materials,

(ii) a cleaning solvent for commercial use on electronic or electrical equipment,

(iii) a protective spray for application to photographs, or

(iv) a lubricant for use in mining operations.

(2) Subsection (1)(c) does not apply to the sale or offering for sale of a fire extinguisher that was manufactured before September 1, 1993.

(3) Subsection (1)(d) does not apply to the following:

(a) the sale or offering for sale of rigid foam insulation, other than rigid foam insulation used in white goods after July 1, 1994 if it was manufactured before July 1, 1994;

(b) the sale or offering for sale of rigid foam insulation used in white goods after January 1, 1996 if it was manufactured before January 1, 1996;

(c) the sale or offering for sale of flexible furniture foam after January 1, 1994 if it was manufactured before January 1, 1994.

(4) Subsection (1)(e) does not apply to the sale or offering for sale of any thing referred to in clause (e) after January 1, 1994 that was manufactured before January 1, 1994.

AR 181/2000 s4;132/2004

Refrigeration and air conditioning equipment

5 A person who services a refrigeration system or air conditioning system that contains or may contain an ozone-depleting substance or a halocarbon must conduct the servicing procedures in accordance with the Environment Canada Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems EPS 1/RA/2 March 1996, as amended from time to time.

Halon servicing

6(1) A person who services a fire suppression system or equipment that contains or may contain a halon listed in Schedule 1 must conduct the servicing procedures in accordance with the publication ULC/ORD-C1058.18-1993, entitled The Servicing of Halon Extinguishing Systems, as amended from time to time.

(2) No person shall install a fire suppression system or equipment containing halon listed in Schedule 1.

(3) No person shall use an ozone-depleting substance for the purpose of testing for leaks in a fire suppression system.

(4) No person shall add a halon listed in Schedule 1 to a fire suppression system unless the system has been tested for leaks and all the leaks have been repaired.

(5) A person responsible for a fire suppression system that

contains a halon listed in Schedule 1 in a combined amount of 40 kilograms or greater must prepare a halon management plan applicable to the facility where the system is located that includes

(a) written procedures for servicing of the fire suppression system, and

(b) a plan and time schedule for phase-out and replacement of halon.

(6) Repealed AR 132/2004 s6.

(7) The halon management plan referred to in subsection (5) must be available at the facility for inspection by an inspector of Alberta Environment on request.

AR 181/2000 s6;132/2004

Apprenticeship and Industry Training Act

7 No person shall service equipment that contains or may contain an ozone-depleting substance or a halocarbon unless that person is qualified to do such servicing under the Apprenticeship and Industry Training Act and the regulations under that Act.

Returns and reports

8(1) The Director may by notice in writing directed to the person responsible for an ozone-depleting substance or a halocarbon

(a) require any returns or reports respecting a release of the ozone-depleting substance or halocarbon into the environment resulting from the construction, operation or reclamation of a plant, structure or thing,

(b) specify the manner and frequency of sampling, recording and reporting of the performance of a plant, structure or thing from which the ozone-depleting substance or halocarbon is or could be released into the environment, and

(c) specify an analytical method for determining the presence of the ozone-depleting substance or halocarbon at a plant, structure or thing that has affected, is affecting or may affect air emissions from the plant, structure or thing.

(2) A person who receives a notice in writing under subsection (1) must comply with it in accordance with its terms.

Label, mark is evidence

9 In a prosecution or proceeding under this Regulation, evidence that a container, vessel or equipment bore a mark or label indicating that a container, vessel or equipment contained an ozone-depleting substance or halocarbon is, in the absence of evidence to the contrary, proof that the container, vessel or equipment contained the substance so identified.

Refrigerant and halon take back

9.1(1) On and after January 1, 2005, where a person purchases an ozone-depleting substance or other halocarbon, other than as part of or contained in refrigeration or air conditioning equipment, and returns the substance or halocarbon to the seller, the seller shall accept and store the substance or halocarbon until the seller can deliver it to a person to recycle, convert or destroy it.

(2) A person returning an ozone-depleting substance or other halocarbon to the seller shall return it in a container that is designed to contain it.

AR 132/2004 s7

Offences

10 Any person who contravenes section 2(1), (3), (4), (5), (6), (8), (9), (10), (11), (12), (13) or (14) or section 3, 4(1), 5, 6, 7, 8(2) or 9.1 is guilty of an offence and liable,

(a) in the case of an individual, to a fine of not more than $50 000, or
(b) in the case of a corporation, to a fine of not more than $500 000.
AR 181/2000 s10;132/2004
Due diligence defence
11 No person may be convicted of an offence under this Regulation if that person establishes on a balance of probabilities that the person took all reasonable steps to prevent its commission.

12 Repealed AR 132/2004 s9.
Coming into force
13 This Regulation comes into force on September 1, 2000.
Schedule 1

Chlorofluorocarbons (CFCs) Halons and Chlorocarbons
(a) CFC-11, also known as fluorotrichloromethane;
(b) CFC-12, also known as dichlorodifluoromethane;
(c) CFC-113, also known as 1,1,2-trichloro-1,2,2-trifluoroethane;
(d) CFC-114, also known as 1,2-dichloro- 1,1,2,2-tetrafluoroethane;
(e) CFC-115, also known as 1-chloro- 1,1,2,2,2-pentafluoroethane;
(f) Halon-1211, also known as bromochlorodifluoromethane;
(g) Halon-1301, also known as bromotrifluoromethane;
(h) Halon-2402, also known as dibromotetrafluoroethane;
(i) All other bromofluorocarbons and bromochlorofluorocarbons;
(j) Carbon tetrachloride;
(k) Methyl chloroform, also known as 1,1,1-trichloroethane.
Schedule 2

Hydrochlorofluorocarbons (HCFCs)
(where used as a refrigerant in refrigeration and air conditioning)
(a) HCFC-21 (hydrochlorofluorocarbon-21), also known as dichlorofluoromethane;
(b) HCFC-22 (hydrochlorofluorocarbon-22), also known as chlorodifluoromethane;
(c) HCFC-31 (hydrochlorofluorocarbon-31), also known as chlorofluoromethane;
(d) HCFC-121 (hydrochlorofluorocarbon-121), also known as tetrachlorofluoroethane;
(e) HCFC-122 (hydrochlorofluorocarbon-122), also known as trichlorodifluoroethane;
(f) HCFC-123 (hydrochlorofluorocarbon-123), also known as dichlorotrifluoroethane;
(g) HCFC-124 (hydrochlorofluorocarbon-124), also known as chlorotetrafluoroethane;
(h) HCFC-131 (hydrochlorofluorocarbon-131), also known as trichlorofluoroethane;
(i) HCFC-132 (hydrochlorofluorocarbon-132), also known as dichlorodifluoroethane;
(j) HCFC-133 (hydrochlorofluorocarbon-133), also known as chlorotrifluoroethane;
(k) HCFC-141 (hydrochlorofluorocarbon-141), also known as

dichlorofluoroethane;
(l) HCFC-142 (hydrochlorofluorocarbon-142), also known as chlorodifluoroethane;
(m) HCFC-221 (hydrochlorofluorocarbon-221), also known as hexachlorofluoropropane;
(n) HCFC-222 (hydrochlorofluorocarbon-222), also known as pentachlorodifluoropropane;
(o) HCFC-223 (hydrochlorofluorocarbon-223), also known as tetrachlorotrifluoropropane;
(p) HCFC-224 (hydrochlorofluorocarbon-224), also known as trichlorotetrafluoropropane;
(q) HCFC-225 (hydrochlorofluorocarbon-225), also known as dichloropentafluoropropane;
(r) HCFC-226 (hydrochlorofluorocarbon-226), also known as chlorohexafluoropropane;
(s) HCFC-231 (hydrochlorofluorocarbon-231), also known as pentachlorofluoropropane;
(t) HCFC-232 (hydrochlorofluorocarbon-232), also known as tetrachlorodifluoropropane;
(u) HCFC-233 (hydrochlorofluorocarbon-233), also known as trichlorotrifluoropropane;
(v) HCFC-234 (hydrochlorofluorocarbon-234), also known as dichlorotetrafluoropropane;
(w) HCFC-235 (hydrochlorofluorocarbon-235), also known as chloropentafluoropropane;
(x) HCFC-241 (hydrochlorofluorocarbon-241), also known as tetrachlorofluoropropane;
(y) HCFC-242 (hydrochlorofluorocarbon-242), also known as trichlorodifluoropropane;
(z) HCFC-243 (hydrochlorofluorocarbon-243), also known as dichlorotrifluoropropane;
(aa) HCFC-244 (hydrochlorofluorocarbon-244), also known as chlorotetrafluoropropane;
(bb) HCFC-251 (hydrochlorofluorocarbon-251), also known as trichlorofluoropropane;
(cc) HCFC-252 (hydrochlorofluorocarbon-252), also known as dichlorodifluoropropane;
(dd) HCFC-253 (hydrochlorofluorocarbon-253), also known as chlorotrifluoropropane;
(ee) HCFC-261 (hydrochlorofluorocarbon-261), also known as dichlorofluoropropane;
(ff) HCFC-262 (hydrochlorofluorocarbon-262), also known as chlorodifluoropropane;
(gg) HCFC-271 (hydrochlorofluorocarbon-271), also known as chlorofluoropropane.
All isomers of the above.
All mixtures and azeotropes of the above.
Schedule 3

Hydrofluorocarbons (HFCs)
(where used as a refrigerant in refrigeration and air conditioning)
(a) HFC 23 - trifluoromethane;
(b) HFC 32 - difluoromethane;
(c) HFC 125 - pentafluoroethane;
(d) HFC 134 - tetrafluoroethane;
(e) HFC 143 - trifluoroethane;
(f) HFC 152 - difluoroethane;

(g) HFC 161 - monofluoroethane;
(h) HFC 281 - fluoropropane;
(i) HFC 272 - difluoropropane;
(j) HFC 263 - trifluoropropane;
(k) HFC 254 - tetrafluoropropane;
(l) HFC 245 - pentafluoropropane;
(m) HFC 236 - hexafluoropropane;
(n) HFC 227 - heptafluoropropane;
(o) HFC 218 - octafluoropropane.

Mixtures
All isomers of the above.
All mixtures and azeotropes of the above.
Mixtures or azeotropes of the above with HCFCs are part of Schedule 2.
Mixtures or azeotropes of the above containing CFCs are part of Schedule 1.

Schedule 4

Perfluorocarbons (PFCs)
(where used as a refrigerant in refrigeration and air conditioning)

(a) FC-14, also known as tetrafluoromethane;
(b) FC-116, also known as hexafluoroethane;
(c) FC-218, also known as octafluoropropane;
(d) FC-3-1-10, also known as decafluorobutane;
(e) FC-4-1-12, also known as dodecafluoropentane;
(f) FC-5-1-14, also known as tetradecafluorohexane.

Mixtures
A mixture containing one of the above.
Any azeotropes of the above.
Mixtures or azeotropes of the above with HCFCs are part of Schedule 2.

APPENDIX D

Halons Inventory

Alberta
INFRASTRUCTURE AND TRANSPORTATION

No.	*City/Town*	*Building Name*	*BID #*	*Manufacturer*	*Room protected by Halon 1301*	*1301 Weight (lbs)*	*Storage (lbs)*	*1211 Weight (lbs)*	*Recommended Actions*	*Remarks:*
1	Calgary	John J. Bowlen	B0086A	Chemetron	Computer Room 4th Floor	1610	0	0	Replace with alternative agent	Currently in RAP (2005/06)
2	Edmonton	Alberta Infrastructure	B0192S	N/A	Central Halon Storage (Not a system	0	3851	0		
3	Edmonton	Beaver House	B0255A	Edwards	2nd floor Art Vault	1640	0	0	Replace with alternative agent	In RAP as Deferred Maintenance (2005/06)
4	Edmonton	Bowker Building	B0001C	Chubb	B-17 (Justice File Storage)	91	0	0	Replace with alternative agent	In RAP as deferred maintenance (2005/06)
5	Edmonton	Bowker Building	B0001C	Chubb	B-16 (Justice File Storage)	114	0	0	Replace with alternative agent	In RAP as deferred maintenance (2005/06)
6	Edmonton	Bowker Building	B0001C	Chubb	B-14 (Justice Photocopiers)	83	0	0	Replace with alternative agent	In RAP as deferred maintenance (2005/06)
7	Edmonton	Bowker Building	B0001C	Chubb	B-13B (Justice File Storage)	93	0	0	Replace with alternative agent	In RAP as deferred maintenance (2005/06)
8	Edmonton	Bowker Building	B0001C	Chubb	B-13A (Justice File Storage)	25	0	0	Replace with alternative agent	In RAP as deferred maintenance (2005/06)
9	Edmonton	Bowker Building	B0001C	Chubb	B-11 (Justice File Storage)	51	0	0	Replace with alternative agent	In RAP as deferred maintenance (2005/06)
10	Edmonton	Bowker Building	B0001C	Chubb	B-18 (Justice File Storage)	85	0	0	Replace with alternative agent	In RAP as deferred maintenance (2005/06)
11	Edmonton	Bowker Building	B0001C	Chubb	B8 & B9 (Justice File Storage)	159	0	0	Replace with alternative agent	In RAP as deferred maintenance (2005/06)
12	Edmonton	Forestry Warehouse	B0237A	Fenwal	Telecommunications Room	263	0	0	Replace with alternative agent	Two spherical cylinders.
13	Edmonton	Infra. Supply Centre	B0189A	Chemetron	1st Floor computer room	87	0	0	Replace with alternative agent	Computer may be moving soon.
14	Edmonton	Pedway	B0001S	Chubb	Corp. Tax Computer Room (Treasury	1078	0	0	Replace with alternative agent	Replacement Project Underway
15	Edmonton	Queens Printer	B0262A	Fenwal	Film Storage vault	440	0	0	Replace with alternative agent	
						5819	3851	0		

Halon 1301 (Part 1)

Alberta
INFRASTRUCTURE AND TRANSPORTATION

No.	City/Town	Bulding Name	BID	Contact Person	Name of Protected Area	Area Protected	Manufacturer	Year Installed	Service Company Name	Weight (lbs)	Storage (lbs)
1	Calgary	John J. Bowlen	B0086A	Bogdan Motyl	Computer Room 4th Floor	Room and Under-Floor	Chemetron	1985	SimplexGrinnell	1610	0
2	Edmonton	Alberta Infrastructure	B0192S	Ken Grey	Central Halon Storage (Not a system)	N/A	N/A		Simplex Grinnell	0	3851
3	Edmonton	Beaver House	B0255A	Otto Schienmann	2nd floor Art Vault	Room Only	Edwards	1992	Top Fire Safety	1640	0
4	Edmonton	Bowker Building	B0001C	Ella Ethier	B-17 (Justice File Storage)	Room Only	Chubb	1979	Vipond	91	0
5	Edmonton	Bowker Building	B0001C	Ella Ethier	B-16 (Justice File Storage)	Room Only	Chubb	1979	Vipond	114	0
6	Edmonton	Bowker Building	B0001C	Ella Ethier	B-14 (Justice Photocopiers)	Room Only	Chubb	1990	Vipond	83	0
7	Edmonton	Bowker Building	B0001C	Ella Ethier	B-13B (Justice File Storage)	Room Only	Chubb	1979	Vipond	93	0
8	Edmonton	Bowker Building	B0001C	Ella Ethier	B-13A (Justice File Storage)	Room Only	Chubb	1979	Vipond	25	0
9	Edmonton	Bowker Building	B0001C	Ella Ethier	B-11 (Justice File Storage)	Room Only	Chubb	1978	Vipond	51	0
10	Edmonton	Bowker Building	B0001C	Ella Ethier	B-18 (Justice File Storage)	Room Only	Chubb	1978	Vipond	85	0
11	Edmonton	Bowker Building	B0001C	Ella Ethier	B8 & B9 (Justice File Storage)	Room Only	Chubb	1979	Vipond	159	0
12	Edmonton	Forestry Warehouse	B0237A	Eugene Hawryluk	Telecommunications Room	Room Only	Fenwal	1981	Grinnel Fire Protection	263	0
13	Edmonton	Infra. Supply Centre	B0189A	Eugene Hawryluk	1st Floor computer room	Room Only	Chemetron	1986	Vipond	87	0
14	Edmonton	Pedway	B0001S	Ella Ethier	Corp. Tax Computer Room (Treasury)	Room and Under-Floor	Chubb		Vipond	1078	0
15	Edmonton	Queens Printer	B0262A	Eugene Hawryluk	Film Storage vault	Room Only (7 rooms)	Fenwal	unknown	Firex	440	0
										5819	3851

Halon 1301 (Part 2)

Alberta
INFRASTRUCTURE AND TRANSPORTATION

No.	City/Town	Bulding Name	Name of Protected Area	Weight (lbs)	System Active?	Can system be decomm'd?	Sprinkler System?	Replace Halon with Sprinkler	Recommendations	Remarks
1	Calgary	John J. Bowlen	Computer Room 4th Floor	1610	Yes	No	Yes	No	Replace with alternative agent	Currently in RAP (2005/06)
2	Edmonton	Alberta Infrastructure	Central Halon Storage (Not a system	0						
3	Edmonton	Beaver House	2nd floor Art Vault	1640	Yes		Yes	No	Replace with alternative agent	In RAP as Deferred Maintenance (2005/06)
4	Edmonton	Bowker Building	B-17 (Justice File Storage)	91	Yes	Yes	Yes		Replace with alternative agent	In RAP as deferred maintenance (2005/06)
5	Edmonton	Bowker Building	B-16 (Justice File Storage)	114	Yes	Yes	Yes		Replace with alternative agent	In RAP as deferred maintenance (2005/06)
6	Edmonton	Bowker Building	B-14 (Justice Photocopiers)	83	Yes	Yes	Yes		Replace with alternative agent	In RAP as deferred maintenance (2005/06)
7	Edmonton	Bowker Building	B-13B (Justice File Storage)	93	Yes	Yes	Yes		Replace with alternative agent	In RAP as deferred maintenance (2005/06)
8	Edmonton	Bowker Building	B-13A (Justice File Storage)	25	Yes	Yes	Yes		Replace with alternative agent	In RAP as deferred maintenance (2005/06)
9	Edmonton	Bowker Building	B-11 (Justice File Storage)	51	Yes	Yes	Yes		Replace with alternative agent	In RAP as deferred maintenance (2005/06)
10	Edmonton	Bowker Building	B-18 (Justice File Storage)	85	Yes	Yes	Yes		Replace with alternative agent	In RAP as deferred maintenance (2005/06)
11	Edmonton	Bowker Building	B8 & B9 (Justice File Storage)	159	Yes	Yes	Yes		Replace with alternative agent	In RAP as deferred maintenance (2005/06)
12	Edmonton	Forestry Warehouse	Telecommunications Room	263	Yes		Yes	No	Replace with alternative agent	Two spherical cylinders.
13	Edmonton	Infra. Supply Centre	1st Floor computer room	87	Yes		Yes	No	Replace with alternative agent	Computer may be moving soon.
14	Edmonton	Pedway	Corp. Tax Computer Room (Treasury	1078	Yes	Yes	Yes		Replace with alternative agent	Replacement Project Underway
15	Edmonton	Queens Printer	Film Storage vault	440	Yes		Yes	No	Replace with alternative agent	
				5819						