PALO VERDE
NUCLEAR GENERATING STATION

HVAC

Classroom Lesson

HVAC Training	**Date: 01/13/2005**
LP Number: NMH10X000102	**Rev Author: Paula Stapleton**
Title: CO2 Units	**Technical Review:** Digitally signed by: Sherman, John L(Z85359) Date: 01/14/2005 13:44:05 Reason: I have reviewed this document Location: PVNGS
Duration : 1.5 Hours	
	Teaching Approval: Digitally signed by: Edmunds, Derek S(Z99318) Date: 01/18/2005 08:10:56 Reason: I am approving this document Location: PVNGS

INITIATING DOCUMENTS:

15DP-OTR69 Training and Qualification Administration

HVAC Technician Training Requirements

Training Program Description for HVAC Maintenance

REQUIRED TOPICS

NONE

CONTENT REFERENCES

Maintenance Standard and Expectations handbook

MI# HFP00001 Inspect/adjust compressor belts, oil & refrigerant

System Description Manual, Fire Protection - Chemical System

System Training Manual vol. 64 Fire Protection and Detection System (FP/QK)

VTD-C285-0006-2 CO2 Storage Unit

Maintenance Prevent Events Strategy

Palo Verde Safety Manual

CRDR 36535 Documents the obsolescence of the FP carbon dioxide storage tank refrigeration machines.

MEE - 03626 Substitution evaluation on a Chemetron refrigeration skid with R404a as a replacement for the R12.

VTD-C285-00019 Chemetron Fire System R12 to R404a retrofit instruction manual. (PUB # S/N 30000040)

Lesson Plan Revision Data

Jan 13, 2005	Paula Stapleton	Developed LP for CBT TCSAI# 2686951 Revision includes more P.E., Standards & Expectations, and R404a refrig skid on CO2 system. Moved task ACU27 - Troubleshoot the CO2 storage refrigertion unit to HVAC General 2.

Tasks and Topics Covered

The following tasks are covered in CO2 Units:

Task or Topic Number*	Task Statement
Lesson:	CO2 Units
ACU26	Check the operation of the CO2 storage refrigeration unit

Total tasks or topics: 1

TERMINAL OBJECTIVE:

1.1 Given a CBT presentation, describe the purpose, operation and good maintenance practices of the CO2 refrigeration unit. Mastery will be demonstrated by successfully completing the questions at the end of the CBT presentation with a score of 80% or greater.

1.1.1 State the purpose of the Cardox low pressure carbon dioxide storage system

1.1.2 Identify the controls and safety devices used on the Cardox CO2 storage unit utilizing the R-12 refrigeration circuitry.

1.1.3 Identify the controls and safety devices used on the Cardox CO2 storage unit utilizing the R-404a refrigeration circuitry.

1.1.4 Identify the safety devices used on the Cardox CO2 storage vessel.

1.1.5 Identify good Maintenance practices when working on the CO2 Storage System

Lesson Introduction: CO2 Units

The following items are things to consider in your Lesson Introduction. They are not mandatory. You should develop your own introduction and place that material in the Program Hierarchy in the Lesson Introduction Tab or appropriate Training Unit.

CLASSROOM GUIDELINES

- If applicable, remind students of class guidelines as posted in the classroom.
- Pass the attendance sheet around and have it signed in Dark ink.
- Ensure that student materials needed for the class are available for each student.
- Emphasize student participation and remind them of your philosophy on asking and answering questions, if applicable.

ATTENTION STEP

- Give a brief statement or story to get student concentration focused on the lesson subject matter.

LESSON INTRODUCTION

- Give a brief statement that introduces the specific lesson topic. Should be limited to a single statement.

MOTIVATION

- Focus student's attention on the benefits they derive from the training. At Instructor's discretion. The need for motivation in each succeeding lesson must be analyzed by the Instructor and presented as necessary.
- Instructor should include how the STAR process can be used to improve or enhance Operator Performance, if applicable.
- Read and discuss lesson terminal objective and review lesson enabling objectives, if desired.
- If applicable, briefly preview the lesson topic outline and introduce the major points to be covered. The objective review may have been sufficient.
- REINFORCE the following PVNGS management expectations as opportunities become available
  - Nuclear Safety
  - Industrial Safety Practices
  - STAR and Self-Checking
  - Procedure Compliance
  - Communication Standards
  - ALARA
  - Prevent Events

COURSE INTRODUCTION
Prevent Events & STAR
Achieving Breakthrough Performance

It is everyone's responsibility to perform their work activities safely and prevent events. Ask yourself before each step in the job these five prevent events questions….

1. **What is the task I am going to perform?** Your task is to successfully complete this course, NMH10, A/C Units. This course covers the Diesel Starting Air Dryers, the PAMU, the Switch Yard and Cooling Tower PMUX units, the Generex, and the Carbon Dioxide Storage air conditioning units. The HVAC Technician will state the purpose of each of these units and discuss how their operation supports other equipment
   Each of these units is covered in a separate section. When you begin each section you will focus on that job and review the terminal objective applicable to that section.
2. **Do you understand it?** As you progress through this CBT course you will demonstrate your understanding of the material by completing the review questions for each enabling objective. Mastering the enabling objectives will ensure you master the terminal objectives.
3. **What is the worst thing that could happen and how can I prevent it?** What would be the impact to the plant if you do not master the critical steps (enabling objectives) identified in each section? You could make assumptions that might increase the potential for mistakes. You could place yourself or co-workers in an unsafe situation. Lessons learned are incorporated were applicable in each section.
4. **What else could go wrong?** Interruptions and distractions of our attention during this training must be minimized. If you need to attend to an important issue, the course may be stopped by exiting the program. A bookmark is automatically placed at the point that you exited. When you return you will be asked if you want to continue for that point or start over.
5. **What safety and/or radiation protection equipment is needed?** There are no specific requirements for safety or radiation protection equipment during the CBT training. Your hazard assessment of your current location will dictate what you need. When you begin each section you will focus on that job and review the safety and radiation protection equipment applicable to that section.
6. **Is my training and are my qualifications up-to-date?** Prerequisites to this CBT course are:

- NMH05, Chiller Control Panel Troubleshooting
- HVAC-0001-00 EPA Certification, This documents the completion of an HVAC apprenticeship program or HVAC trade school or current refrigeration journeyman license.

Always check your qualifications for a task prior to performing work. If you do not know how to check, or you are in doubt, ask your Leader.

T.Obj 1.1	**Given a CBT presentation, describe the purpose, operation and good maintenance practices of the CO2 refrigeration unit. Mastery will be demonstrated by successfully completing the questions at the end of the CBT presentation with a score of 80% or greater.**

1.1.1 Introduction

This lesson material covers the CO_2 storage unit and describes how its refrigeration system operates to support the effective storage of CO_2.

1.1.2 Main Idea

Prevent Events & STAR
Achieving Breakthrough Performance
What is the first thing we do when we have a new task?
STOP!!
That's right……..Every task begins with a **Pre-Job Brief.** The minimum Pre-Job Briefing will consist of the five prevent events questions….
What is the task I am going to perform?
TERMINAL OBJECTIVE:
Given a CBT presentation, describe the purpose, operation and good maintenance practices of the CO2 refrigeration unit.

Do you understand it?
The enabling objective that are going to help you understand the terminal objectives are;
State the purpose of the Cardox low pressure carbon dioxide storage system
Identify the controls and safety devices used on the Cardox CO2 storage unit utilizing the R-12 refrigeration circuitry.
Identify the controls and safety devices used on the Cardox CO2 storage unit utilizing the R-404a refrigeration circuitry.
Identify the safety devices used on the Cardox CO2 storage vessel.
Identify good Maintenance practices when working on the CO2 Storage System
What is the worst thing that could happen and how can I prevent it?
The refrigeration skid can auto start at any time. Keep your hands away from fans and belts. Keep all tools and equipment a safe distance from moving parts. Watch your body position when reaching into the cabinet.

What else could go wrong?
The refrigerant system maintains cooling for the CO_2 system. When maintenance activities cause the refrigeration unit to be out of service for an extended period the CO_2 system pressure will increase. This may cause the CO_2 system to start relieving pressure. Minimize the down time if possible.

What safety and/or radiation protection equipment is needed?
The carbon dioxide storage is located in the Radwaste yard of each of the units.
What are the radiological concerns? You will need to be signed on to the appropriate REP. If you have questions contact the Unit Radiation Protection desk.
Required PPE; Hard hats, safety glasses with side shields, and a pair of work gloves.
Is my training and are my qualifications up-to-date?
Prerequisites to this CBT course are:
NMH05, Chiller Control Panel Troubleshooting
HVAC-0001-00 EPA Certification,
Always check your qualifications for a task prior to performing work. If you do not know how to check, or you are in doubt, ask your Leader

EO 1.1.1	State the purpose of the Cardox low pressure carbon dioxide storage system

1.1.1.1 Main Idea

One of the subsystems of the Fire Protection system, FP – Chemical, is the Carbon Dioxide system.

The carbon dioxide system provides CO_2 for fire suppression in selected areas in the plant as well as

CO_2 used in main generator purging before startup and after shutdown.

The Fire Protection – Carbon Dioxide, CO_2 Fire Suppression system design requires that at least 10,000 pounds of CO_2 be stored at a pressure of greater than 275 psig. This capacity is adequate to permit two separate discharges in the largest single protected areas immediately after two complete purges of the main generator.

The Carbon Dioxide Storage Unit (M-FPN-X01) provides physical storage of the carbon dioxide. The storage unit is located in the Radwaste yard of each power block unit west of the Radwaste building.

The carbon dioxide storage unit consists of the following major components:

Pressure Vessel designed to store 7.5 tons of CO_2 .

Refrigeration System designed to maintain the pressure vessel at 0°F and 300 psig.

EO 1.1.2	Identify the controls and safety devices used on the Cardox CO2 storage unit utilizing the R-12 refrigeration circuitry.

1.1.2.1 Main Idea

The basic refrigeration system for the R-12 unit consists of :

a. an external drive compressor

b. an air cooled condenser

c. an evaporator mounted internally in the pressure vessel

d. an expansion valve set to maintain approximately 5 psi in the evaporator coil

e. a liquid refrigerant receiver

f. low refrigerant pressure controls set for 0 psig

g. high refrigerant pressure controls set for 210 psig

The basic refrigeration control circuit for the R-12 unit consists of:

the magnetic starter switch

refrigerant high and low pressure switches

tank pressure switch

On the R-12 unit the refrigeration system is controlled by CO_2 tank pressure control switch.

The CO_2 storage unit is equipped with a pressure gage, which indicates the pressure within the pressure vessel.

When pressure inside the storage tank increases to 305 psig, the tank pressure switch closes and starts the compressor. The compressor runs until the CO_2 cools, decreasing the pressure in the storage tank to 290 psig, which shuts off the compressor.

EO 1.1.3	Identify the controls and safety devices used on the Cardox CO2 storage unit utilizing the R-404a refrigeration circuitry.

1.1.3.1 Main Idea

The basic refrigeration system for the R-404a unit consists of :

a. a compressor

b. an air cooled condenser

c. an evaporator mounted internally in the pressure vessel

d. an expansion valve set to maintain an evaporator pressure of 25 psig with a 10 degree superheat.

e. a liquid refrigerant receiver

f. a refrigerant pressure safety switch which guards against compressor operation at too low a suction pressure or too high a discharge pressure.

g. a solenoid valve that is controlled by the tank pressure switch.

The basic refrigeration control circuit for the R-404a unit consists of:

The magnetic starter, the power transformer and the Hi and Lo pressure switches are incorporated into the new (R-404a) refrigeration skid.

The refrigerant (Hi/Lo) pressure control switch is a combination of two separate control switches.

High Pressure Cut-Out
This portion of the switch protects the system against potentially damaging over pressure. The electrical circuit opens when the discharge pressure rises above the cut-out setting of 425 PSI. This automatically trips a manual reset, locking the switch contacts open.
If pressure is reduced, the contacts will not close automatically. They can be closed only when the discharge pressure drops below the high pressure fixed differential of approximately 60 PSI and the manual reset button is pushed.

Low Pressure Cut-Out
This side of the switch is used in control of the refrigeration system and the pump down cycle. It also prevents the compressor from drawing the system into a vacuum and possibly damaging refrigeration system components. The mechanism on this side operates independently of the high pressure side. The electrical circuit closes when the suction pressure rises above the cut-in setting, 18 PSI, and it opens when suction pressure drops below the cut-out setting of 6 to 8 PSI. Cut-in and cut-out are both automatic. This side includes an adjustable differential and does not require manual resetting.

On the R-404a unit the solenoid valve is controlled by the CO2 tank pressure control switch.

When the CO2 pressure is approximately 305 PSIG, the pressure switch contact closes to energize (open) the refrigerant line solenoid valve. This cause the pressure in the low side to increase.

At 18 PSI the refrigerant low pressure control switch will automatically cut-in , starting the compressor.
The compressor runs until the CO2 cools, decreasing the storage tank pressure to approximately 290 PSIG. At this point the tank pressure switch opens to de-energize (close) the refrigerant line solenoid valve.

This starts the refrigeration shutdown (pump-down) cycle.
The compressor continues to operate until the low pressure differential cut-out (suction side) automatically cuts-out at 0 PSI, stopping the compressor.

The High pressure range cut-out (discharge side) adjusting screw. This screw should be adjusted to automatically cut-out at 425 PSI, stopping the compressor and automatically tripping a manual reset.

EO 1.1.4	Identify the safety devices used on the Cardox CO2 storage vessel.

1.1.4.1 Main Idea

Should tank pressure fall to 275 psig or increase to 325 psig, the alarm pressure switch closes, activating a local bell and sending a signal to PSS.

A long duration of refrigeration system in-operability could cause the CO_2 storage tank pressure to exceed the set point.

When the tank pressure raises to 341 psig the safety bleeder valve opens, allowing a small amount of carbon dioxide vapor to escape to the atmosphere.

If the heat input to the tank is abnormally high and causes the tank pressure to rise more rapidly than the capacity of the bleeder valve can handle, the safety relief valve will open. This relief valve is a much larger capacity valve than the bleeder valve, which allows it to arrest tank pressure rise even at very high outside temperatures. This valve is set to lift at 357 psig.

EO 1.1.5	Identify good Maintenance practices when working on the CO2 Storage System

1.1.5.1 Main Idea

HVAC performs yearly PM tasks on the Cardox CO2 refrigeration system which includes:

inspect/adjust compressor belts
check the refrigerant charge and compressor oil level
calibrate the refrigerant high and low pressure controls

In this lesson you have seen that there are currently two styles of refrigeration skids used on the Cardox units.
The original refrigeration system is an R12, air-cooled condensing unit assembly with a 3HP compressor motor and a condenser with a motor driven cooling fan (V-belt and pulley drive).
Two externally installed pressure switches (Hi and LO), a magnetic starter and transformer control the refrigeration system.
Currently the unit capacity is approximately 23 Lbs. of R-12 Freon.

The new refrigeration system is an R404a air-cooled condensing unit assembly with a 2HP Copeland condensing unit this is equiped with a direct drive fan.
The conversion retrofit kit consisted of a filter dryer, sight glass, vibration absorber, an expansion valve and a one gallon ploy ester lubricant.
The new refrigeration skid will require about 18 Lbs. of R-404a refrigerant.

The controls on the R-12 skid were located in the external control panel.

The magnetic starter, Hi and Low pressure switches and the power transformer are incorporated into the new refrigeration skid and are an integral part of the system.

This is a good example of a situation were conducting a 2-Minute Drill when you arrive at the CO2 storage unit prior to starting work could help prevent you from making a mistake. It will give you the opportunity to perform an assessment of the hazards applicable to the equipment.
It is also a good time to validate any assumptions you made during the pre-job brief. Are you working on the R-12 unit or the R-404a unit?

R-404a is the most suitable replacement product for medium and low temperature applications.

R-404a is a zero ozone depletion near azerotropic blend of HFC refrigerants R-125, R-143a, and R-134a.

One significant difference that will affect you when trimming the refrigerant charge is that any addition of R-404a has to be done in liquid form. If excessive refrigerant is lost the remaining refrigerant may have to be recovered and discarded and a new charge added to the system.

When performing maintenance that will cause the refrigeration system to become inoperative for extended periods of time, notify the fire department and the control room supervisor.

The tank pressure will eventually rise to a point that the bleeder valve and possibly the relief valve will open, resulting in a loss of carbon dioxide.

At hot times of the year the CO_2 refrigeration system may cycle excessively. To resolve this problem, access panels can be removed (per the tech manual) to reduce the temperature.

In addition, air movers may be positioned to aid in reducing the temperature. The covers shall be replaced as soon as possible to provide protection.

Opening the power feed breaker for the control of the refrigeration unit when the main generator is being purged should be avoided.

Remember to always exercise caution when servicing this equipment since the compressor will auto start. The R-12 skid has a compressor with an external drive without belt guards.

SUMMARY OF MAIN PRINCIPLES

The following items are things to consider in your lesson summary. They are not mandatory. You should develop your own summary.,

Objectives Review

Review the Lesson Objectives

Topic Review

Restate the main principles or ideas covered in the lesson. Relate key points to the objectives. Use a question and answer session with the objectives.

Questions and Answers

Oral questioning

Ask questions that implement the objectives. Discuss students answers as needed to ensure the objectives are being met.

Problem Areas

Review any problem areas discovered during the oral questioning, quiz, or previous tests, if applicable. Use this opportunity to solicit final questions from the students (last chance).

Concluding Statement

If not done in the previous step, review the motivational points that apply this lesson to students needs. If applicable, end with a statement leading to the next lesson.

You may also use this opportunity to address an impending exam or practical exercise.

Should be used as a transitional function to tie the relationship of this lesson to the next lesson. Should provide a note of finality.