**REFRIGERATION AND AIR CONDITIONING LABORATORY**

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**LAB SESSION 7**

**HEATINH, VENTILATING & AIR CONDITIONING CONTROL & FAULT SIMULATOR 814B**

**Objectives**

Description of MIMIC diagram and component of simulator. And Observation of boiler, chiller, main AHU, VT circuit, DHW and controlling them through potentiometer and illuminated switches.

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**OBJECTIVE 1:**

**Description of MIMIC diagram and component of simulator. And Observation of boiler, chiller, main AHU, VT circuit, DHW and controlling them through potentiometer and illuminated switches**

**THEORY and WORKING**

**OPERATOR DISPLAY PANEL:**

**Note:** When power is switched on, ensure that all green Differential Pressure Switches are illuminated (to alter state of lamps depress switches until they are illuminated).

1. On switching on the power the display comes up on the operators panel –DEMO CASE1
2. To access the unit press “Enter” Key
3. You now have access to the controller menu:-

(1)Info (2) Alarm (3) Boilers (4) Chiller (5) Main AHU

(6)VT Circuit (7) DHWS (8) Frost Status (9) Access Code

To scroll up and down through the menu use up ($∆$) and down ($∇$) keys (See Diagram on Page 9)..

The flashing cursor moves as you scroll through the menu.

If you want access to any of the menus scroll until your cursor is flashing on the menu you require; e.g. –select DHWS and press “Enter” key.

It will come up as:-

 Alarm DHWS

 Pump Enabled

 Flow Proven

 Temperature

 Set Point

 Valve Open

Using “$∆/∇$” keys select the display showing Temperature. The display now shows temperature values as set by the relevant potentiometer.

Altering the appropriate potentiometer alters the reading at the display, e.g. altering potentiometer No.9 will change the DHWS reading.

To return to the main menu, press “Home” Key.

By using the relevant function keys, alterations can be made to the five main functions as listed above.

Using Up/Down Keys select to following menus and press “Enter” Key.

**DESCRIPTION OF MAIN MENUS**

**7.1 Info:**

This gives the user information of the Outside and Room Temperatures, Manual Plant Enable and example of contact details (Note the contact numbers/programmers names are shown for example only).

Use “$∆/∇$” Keys select the page showing Outside Air and Room Temperature. By altering the relevant potentiometers (No.18 and No.38) you will see the display temperature alter. With these, temperature values can be altered to simulate changes.

Manual Plant Enable

This allows the user to switch the plant “On” or “Off”. Use the “$∆/∇$” keys to select the page showing Building Occupied.

 If a “No. 1” is displayed, Plant is on

 If a “No.0” is displayed, Plant is Off

By using the increase (+) Decrease (-) Keys (see diagram on page 9), the plant condition can be altered; e.g. – if plant is On (i.e. showing No.1) use the “-” Key to change to a No.0. Now press “Enter” Key and the plant now switches off.

Reverse the proven to switch back on (i.e. change back to No.1 and press “Enter” Key).

This is included in the exercise section of the book.

Use the “Home” Key to return to the Main Menu and now select Alarm using the “Enter” Key.

**7.2 ALARM:**

This display shows the alarm status of various components and will be included in the exercise section of the manual.

To acknowledge/clear an alarm press the “Enter” Key. If there is more than one alarm use the “$∆/∇$” Keys to acknowledge each one.

Using the “Home” Key return to the Main Menu and now select Boilers using the “Enter” Key.

**7.3 BOILERS:**

This allows the user to show and adjust the temperatures, and read the status of the boilers and constant Temperature Pumps.

The Display shows:-

 Boiler Demand

Boiler Flow Temperature

Boiler Return Temperature

Set Point

Boiler 1 Enabled

Boiler 1 Fault

Boiler 2 Enabled

Boiler 2 Fault

Flow Proven

Pump 1 Enabled

Pump 2 Enabled

The Flow and Return Temperatures can be adjusted by altering the relevant Potentiometers (No.6 and No. 7). By altering the potentiometer you will see the display temperature alter. With these, temperature values can be altered to simulate changes.

The status of the Boilers and Pumps can be altered by pressing the relevant DPS Switch e.g. pressing DPS1 (No.10) will show 0 for flow proven i.e. the pump is not operating, and will switch the Boilers off. Pressing DPS1 again so it is illuminated will reverse the above and the Boilers will start again.

Using the “Home “Key to return to the Main Menu and now select Chiller using the “Enter” Key.

**7.4 CHILLER:**

This allows the user to read the status of the Chiller and Chiller Pumps.

The Display shows:-

Pump 1 Run

Pump 2 Run

Flow Failure

Chiller Run

Chiller Fault

The Status of the Chiller and Pumps can be altered by pressing the relevant DPS Switch e.g. pressing DPS4 (No.19) will show 0 for flow proven i.e. the pump is not operating, and will switch the Chiller off. Pressing DPS4 again so it is illuminated will reverse the above and the Chiller will start again.

Using the “Home” Key return to the Main Menu and now select Main AHU using the “Enter” Key.

**7.5 MAIN AHU:**

This allows the user to show and adjust set points and temperatures, and read the status of the AHU plant.

The display now shows:-

Bag Filer

Panel Filler

Dampers

Cooling Valve

Heating Valve

 Supply Fan Enabled

Supply Fan Flow

Extract Fan Enabled

Extract Fan Flow

Room Temperature

Room Set Point

Supply Temperature

Supply Low Limit Set Point

Extract Humidity

Extract Relative Humidity Set Point

To adjust the set points use “$∆/∇$/ “Keys use the increase (+)/ decrease (-) keys. These are important values as they will be the control temperatures selected.

Now use the “$∆/∇"$ keys to select the page showing Room Temperature. By altering the relevant potentiometer (No. 38) you will see the display temperature alter. With these, temperature values can be altered to simulate changes.

Use the “Home” Key to return to the Main Menu and now select VT **C**ircuit using the “Enter” Key.

**7.6. V T CIRCUIT:**

This allows the user to show set points and adjust temperatures, and read the status of the V T Pumps.

The display now shows:-

Flow Temperature

Set Point

Valve Position

Pump 1 Enabled

Pump 2 Enabled

Flow Proven

The status of the VVT Pumps can be altered by pressing the relevant DPS Switch e.g. pressing DPS (No.2) will show 0 for flow proven i.e. the pump is not operating. Pressing DPS2 again so it is illuminated will reverse the above.

Use the “$∆/∇$“Keys to select the page showing Flow Temperature. By altering the relevant potentiometer

(No. 1) you will see the display temperature alter. With these, temperature values can be altered to simulate

Changes.

A compensated Heating Curve is already stored within the controller. This will give

 $60℃ Flow at 0℃ Out side Temperature and $

30$℃ Flow at 20℃ Outside Temperature$

These settings are used to control the heating curve for your compensated (i.e. variable temperature) circuit.

Note: A compensator varies the flow temperature to your radiators dependant on outside conditions.

**EXAMPLE OF COMPENSATION CURVE**

Maximum 82$℃$

Flow Temperature

Minimum 30$°$ $0℃$ outside Temperature $20℃$

As an example from the graph you can see that the heating curve is set to give a maximum flow temperature of 82$℃$ for the lowest outside temperature (i.e. the minimum design temperature) e.g. 0$℃$

It is also set to give a minimum flow temperature of 30$℃$ when the outside conditions are at 20$℃.$

By adjusting the Outside Temperature Potentiometer you will see the valve of the VT Circuit Set point change.

Now press the “Home” Key to return to the Main Menu and select DHWS using the “Enter” Key.

**7.7. DHWS:**

This allows the user to show set points and adjust temperatures, and read the status of the DHW plant.

The display now shows:-

Pump Enabled

Flow Proven

Temperature

Set Point

Valve Open

The set point for the Hot Water is set at 55$℃$. Use the “$∆/∇"$ keys to select the page showing the valve Open status. By altering the HWS Potentiometer (No.9) to lower than the set point you will see the display valve open reading change to show that the valve is open. Now turn the HWS Potentiometer to above 55$℃$ You will see that the reading had changed to 0, indicating that the valve has not closed.

**7.8. FROST STATUS:**

This allows the user to see whether the Room or Outside Frost condition is activated.

The display now shows:-

Room Frost

Outside Air Temperature Frost

By altering the relevant potentiometers (No.18. and No.38) you will see the display status with a 0 indicating no frost conditions and a 1 indicating frost conditions.

Now press the “Home” Key to return to the Main Menu and select Access codes using the “Enter” Key.

**7.9. ACCESS CODES:**

You will now be asked to enter an access code to enter the extended menu. Using the “+/-“keys change

Each of the four digits to 1, pressing “Enter” after each change i.e. the key strokes will be “+, Enter, +,

Enter, +, Enter,+, Enter”. Now press the “Home “Key and you will find the extended menu option below the Access Code on the Main Menu.

The display now shows:-

Date and Time

Boiler Configuration

Chiller Configuration

Main AHU Configuration

VT Circuit Configuration

DHWS Configuration

Alarm Status

Manual Commands

The only items required in this section are Date and Time. All other settings should be left as set and not

Adjusted unless you are told otherwise within the exercises.

**Date and Time:**

Use the “$∆/∇"$ keys to select Date and Time and press “Enter”Key.

This display allows the time and date to be entered.

Use the “Enter” Key to move the cursor, and the “=/-“ Keys to set the correct date and time.

When operating times have been selected press “Home” Key to return to Main menu.

These exercise are designed to show the user how to simulate various conditions and how items of plant

React to changes.

**Note:** Please ensure the following before commencing.

**8.1. PLANT ENABLE:**

This exercise shows how to initiate start up on the plant components.

1. Press “Enter” Key to go to the Main Menu.
2. Select “Info” and press “Enter” Key.
3. Use the “$∆/∇$” Keys to select the page showing:-

Building occupied 0

In this condition the plant is off. If the plant is on, adjust the Outside Air Temperature and Room Temperature potentiometers to read 15$℃$ as the plant is on under frost conditions.

Using the “+” Key, change to a No.1. and press “Enter” Key. Now press the “Home” Key to return to the Main Menu.

Plant initiates start up.

**8.2. BOILER SEQUENCE CONTROL:**

This is an application which is used when multiple boilers are the primary heat source for a heating system.

The control system brings the boilers on in sequence according to the demand for heat.

1. Select “Boilers” from the Main Menu and press “Enter” Key.
2. Use the “$∆/∇$” Keys to select the page showing:-

 Boiler Flow x $℃$ (Potentiometer No.7)

 Boiler Return X $℃$ (Potentiometer No.6)

Set both potentiometers full anti-clockwise and both values should drop to a low value. Both green Run Lamps on the boilers should not be on (No.14 and No.16).

Slowly increase both potentiometers, keeping No.6 approximately 15$℃$ below No.7

When the boiler flow temperature gets close to its control point (using potentiometer No.7.) one boiler will go off.

Slowly increase potentiometer No.7 further and Boiler No. 1 will now go off. Both boilers are now off because we have achieved the desired flow temperature.

Again slowly decrease boiler flow potentiometer No.7 and both boilers now come back on because of the demand for heat.

**8.3. COMPENSATED HEATING CIRCUIT:**

a) Select “V.T. Circuit from the main Menu and press “Enter” Key.

b) The display will now read :-

 Flow Temp x$℃$

 Set Point x$℃$

 Valve Pos x$℃$

Using the potentiometers set outside temperature to 20$℃$ (Potentiometer No.18)

**Note:** To check the value of this select the “info” menu and use the $∆/∇$ Keys to select the page showing Outside Air Temperature.

The set point on the VT Circuit display will now show 30$℃$ . this simulates the bottom end of the curve.

The variable temperature control valve (No. 4.) should be closed (i.e. 0 indication on the LED and the Display).

1. Now decrease the outside temperature slowly. You will see that the control valve is now opening to compensate for the lower outside temperature. The lower the outside temperature the more the control valve opens.

Drop the outside temperature to 0$℃$ and you will see that the control valve is fully open.

1. Now increase the variable temperature flow slowly (Potentiometer No.1.) As the temperature increases the control valve now closes off until your desired control temperature is achieved.

**8.4. HEATING AND COOLING THE CONTROLLED SPACE:**

For this exercise we now concentrate on the air conditioning system, employing dampers, cooling and heating. In this scheme the main control detector is in the room (Potentiometer No.38).

There is a duct detector in the supply duct, (Potentiometer No. 36) and this acts as a low limit.

Using “Home” to return to Main Menu.

1. Select “Access Codes” and enter the code as described above in section 7.9.
2. Select “Chiller CFG” from the Main Menu and press “Enter” key.
3. Use the $∆/∇$ keys to select thepage sowing hold off set point. Use the “+/-“ keys to alter this to read 15 , then press “Enter” key to store the new value.
4. Press “Home” key to return to the Main Menu. Select “Main AHU” and press “Enter” Key.
5. Use the $∆/∇$ keys to select the page reading Room Temp.

This will now display the following:-

 Room Temp x$℃$

 Room SP x$℃$

Use the “+/-“ keys to select a Room Set point of 21$℃$ , then press “Enter” to store the value.

1. Use the “$∆/∇$ ” keys to select the page reading Supply Temp.

This will now display the following:-

 Supply Temp x$℃$

 Supply Temp SP x$℃$

Using the potentiometer set the following temperatures

 Room Temperature 21$℃$ (Potentiometer No.38)

 Supply Low Limit Temp 18 $℃$ (Potentiometer No.36)

 Outside Air Temperature 15 $℃$ (Potentiometer No.18)

**Plant Conditions should now show the following:**

Supply Fan Run

Extract Fan Run

Supply Damper Closed (i.e. low reading on LED Display No.23)

Extract Damper Closed (i.e. low reading on LED Display No.24)

Recirculation Damper Closed (i.e. low reading on LED Display No.25)

Heating Valve Closed (i.e. low reading on LED Display No.29)

Cooling Valve Closed (i.e. low reading on LED Display No.26)

Chiller Plant On (i.e. Full Recirculation On Dampers)

**Note:** Adjust the potentiometers lowly until the above plant conditions are shown.

We are now at the control conditions

1. Lower room air temperature to 16$℃$ , heating valve now opens because heat is being called back for.
2. Increase return air temperature back to 21$℃$ and the heating valve now closes.

Increase further and the dampers now operate in sequence. Increase further and the cooling valve now opens.

**Plant Conditions:**

Supply Fan Run

Extract Fan Run

Supply Damper Open (i.e. High reading on LED Display no.23)

Extract Damper Open (i.e. high reading on LED Display No.24)

Recirculation Damper Closed (i.e. high reading on LED Display No. 25)

Heating Valve Closed (i.e. 0 on LED Display No.29)

Cooling Valve Open (i.e. reading on LED Display No.26)

**Economy on Refrigeration Load:**

The dampers are further controlled by the outside temperature detector (Potentiometer No.18)

This economizes the refrigeration load when cooling is required.

When the temperature of the outside air is greater than that in the room, the dampers will revert to maximum recirculation with the outside air damper set in the minimum position.

1. Now increase outside air temperature (Potentiometer No.18) until it is higher then the room air temperature. The dampers now change to a recirculation position.

Supply Damper Closed (i.e. low reading on LED Display No.23)

Extract Damper Closed (i.e. low reading on LED Display No.24)

Recirculation Damper Open (i.e. low reading on LED Display No.2)

**Low Limited Control:**

Low Limit Control is achieved by a detector in the supply duct (Potentiometer No.36). its function is to prevent the entering air temperature falling to a level which might bring discomfort to the room occupants.

1. Reset all Potentiometer to original control conditions

e.g. Room Air to 21$℃$ (Potentiometer No. 38)

Supply Low limit to 18$℃$ (Potentiometer No. 36)

Outside Temperature to 15$℃$ (Potentiometer No.18)

Plant is now running under control conditions.

1. Slowly decrease supply low limit potentiometer (No.36) to below your set valve. The heating valve (LED Display No.29) now opens.

**8.5. Frost Protection**:

These are setting designed to prevent the plant from freezing up and to protect the room space (anti-condensation) when the plant is off.

Using “Home” Key return to Main Menu.

1. Select “Info” from the Main Menu and press “Enter” key. Use the “$∆/∇$” keys to select the page showing:-

Building Occupied

Switch plant off i.e. set at No.0 (as described earlier).

Switch Supply/Extract Differential Pressure Switches OFF

You will now see that all plant items are off.

1. Set outside temperature (Potentiometer No.18) down to 0$℃$ .All pumps now come on to circulate the water through the pipes to prevent freezing up.
2. Now set the room air temperature (Potentiometer No.38) down below 10 $℃$ .

The Boilers now come on.

1. Now set the outside temperature and room air temperature to normal conditions. Using Potentiometer No. 18 and No. 38.
2. The plant now changes back to previous conditions i.e. all items off. (Pumps Delay Off)

**8.6. AUTOMATIC CHANGEOVER AND TRIP OF PLANT COMPONENTS:**

Alarm Functions—This is to show what happens if a plant component fails to trip out.

1. Set plant back to normal run conditions by changing the “Building Occupied” setting back to 1, and increasing the room temperature setting to 21$℃$ , and the outside temperature setting to 16$℃$ i.e.
* Both Boilers On
* All Pumps Running
* All Green Differential Pressure Switches illuminated (Switch ON)
* All Red differential Pressure Switches not illuminated (Switch OFF)
* Chiller Plant On

Using “Home” Key return to Main Menu

1. Go to “Alarms” and press “Enter” Key. Acknowledge any alarms shown as already described in Section 7.2.
2. Press “Home” Key twice to set display at the operator display panel to read CASE 1.
3. Press and illuminate Boiler No.1 trip lamp (No 17). The red light comes on. The green run light goes out (No.16)

The display at the operators panel now reads:-

 \*\*\*\*ALARM\*\*\*

 \*ALR\*CASE1

This is now telling the operator that a component has failed.

Using “Enter” Key to return to Main Menu

1. Select the “Alarm” menu at the operator display panel and press “Enter” Key.

The display now reads:-

ALARM 1/1

BOILER 1

BOILER 1 FAILS

DATR-TIME-ON

This is indicating that the alarm is 1 of 1, Boiler No 1 has failed, with the relevant time and date.

To accept and acknowledge the alarm press the “Enter” Key, the on symbol has now changed to ACK.

This means the alarm has been acknowledged.

No reset the boiler switches No. 17.

Boiler restarts and the Main Menu returns to its display.

Pressing any red lamp will result in fault condition showing at the operators display panel. More than on alarm can be stored at the same time. Ensure that all alarms are acknowledged or reset before returning to normal run.

1. Use “Home” Key to return to original display:-

CASE 1

1. Press switch DPS (No. 10) – constant temperature pumps ( illumination goes out).

This will simulate a pump fault on the one that is running. Automatic changeover to the other pump comes into effect after a few seconds, which will be show by the green lights changing from one pump to another.

1. Again the display sows that an alarm has triggered. As before acknowledge and reset.

Re-illuminate switch No. 10.

1. Press all switches to simulate all faults. Acknowledge all and reset.
2. Press switch DPS8 (No.32) supply fan light goes out and as a safety interlock the extract fan also goes off. As before acknowledge and reset switch.

**8.7 DOMESTIC HOT WATER CONTROL:**

This is to show the On/Off control of the primary water supply to the cylinder.

1. Set domestic hot water potentiometer (No.9) to fully clockwise.
2. The LED Display on the control valve (No.5) should read 0.
3. Rotate the Potentiometer fully anti-clockwise.
4. The LED Display on the control valve should read 100 to show the valve is open.

**8.8 HUMIDIFIER CONTROL:**

This is to show the On/Off control of the Humidifier within the AHU.

1. Set the Return Air Humidity Potentiometer (No.37)to fully anti-clockwise.
2. The Humidifier light should be illuminated to indicate that the Humidifier is operating (No.40)
3. Rotate the Potentiometer fully clockwise.
4. The Humidifier light should switch off to indicate that the Humidifier is not operating.