ITB-DOT-15/16-4014PM
ATTACHMENT 1 – HVAC REPORT

ATTACHMENT 1

HVAC INVESTIGATION REPORT

TEC HVAC PLUMBING ELECTRICAL
Thompson & Youngross
ENGINEERING CONSULTANTS, LLC

HVAC INVESTIGATION REPORT

Date: **June 22, 2015**
Job Name: **Florida Department of Transportation – Palm Beach Operations**
Administration Building
7900 Forest Hill Boulevard
West Palm Beach, FL 33413

Contact: **Anthony Puccio**
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Emergency Management Coordinator
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Ft. Lauderdale, FL 33309
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Job Number: **15058**
Site Visit: **June 9th, 2015**
Disciplines: **Mechanical HVAC Investigation**

1 - OVERVIEW

This report is to provide a visual assessment of the existing Mechanical systems serving the Administration building, which was constructed in 1993. An orientation meeting was attended on June 3rd, 2015 to discuss existing cooling and mechanical problems being experienced inside the office and conference areas. The purpose of this report is to provide recommendations for developing an operation and maintenance plan that will result in optimizing the energy operation costs of the HVAC systems. Conditions seen will be listed and recommendations provided to upgrade or replace the existing systems in order to improve the indoor air quality and energy efficiency of the HVAC systems.

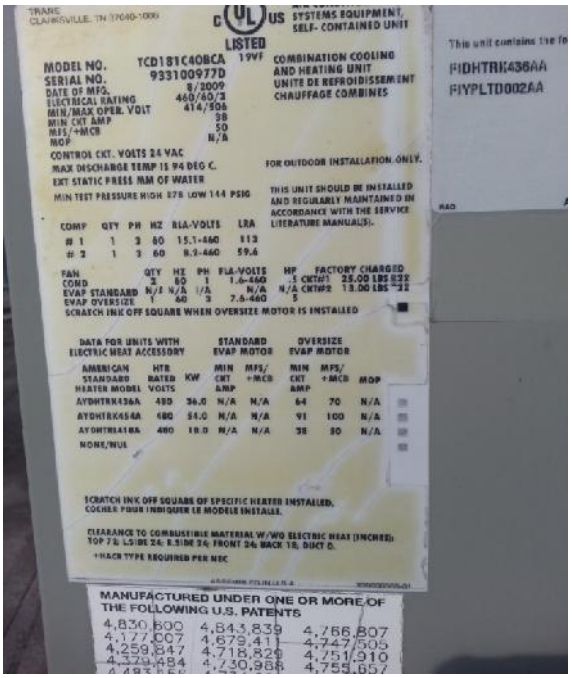
Zone	AC Unit	Existing Size
Reception/Conference	RTU-1	15 Tons
Northwest Offices	RTU-2	12.5 Tons
Southwest Offices	RTU-3	8.5 Tons
Southeast Offices	RTU-4	12.5 Tons

Northeast Offices	RTU-5	10 Tons
Computer Room	AHU-1	2.5 Tons

A site survey was performed to verify the existing building dimensions, wall orientations, window sizes and glazing, personnel population, and equipment use. The base building cooling loads were calculated using this information. The current zoning by the AC systems and the duct routing and types were verified to accurately model the existing layout. The thermostats of all AC systems set to 72 degrees F. The following equipment conditions and sizing is listed below.

RTU-1

Located in the center section of the building, RTU-1 serves the Reception area, two (2) conference rooms, and one large Conference room. RTU-1 was manufactured in 2009. This area is served with four (4) zone dampers with wall mounted thermostats located in each zone. During the orientation meeting, it was mentioned that the large Conference room #104 could be occupied with up to 100 people during a weekly morning meeting.



RTU-1 (15 tons)-2009

Conference Room 104

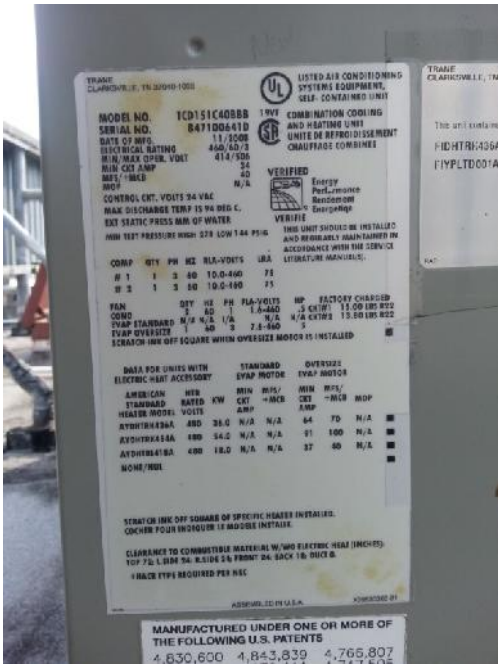
The load calculations confirmed the correct size for the RTU-1 to be 15 tons. In order to help provide humidity and capacity control for the rooms, a larger zone damper will be specified for Zone Damper 1-3 (serving the large Conference Room 104) from the existing 14” round to a 16” round to provide more supply air to this space during high occupancy periods. The new RTU-1 will be specified with a dehumidification coil to provide extra air drying when this zone is fully occupied. For the remaining areas, the zone damper sizes appear to be adequate.

Reception 101

Typical Zone Thermostat

RTU-2

Located on the west section of the building, RTU-2 serves the Northwest open and enclosed Offices. RTU-2 was manufactured in 2008. This area is served with five (5) zone dampers with wall mounted thermostats located in each zone.



RTU-2 (12.5 tons) - 2008

The load calculations confirmed the correct size for the RTU-2 to be 12.5 tons. The zone dampers appear to be sized correctly so they may remain as existing. The new RTU-2 will be specified with a variable speed supply fan and multiple compressors so

so that the AC unit capacity will modulate to not overcool the space and provide energy savings. Since the supply fan speed will be reduced during low loads, the bypass damper activation will be minimized, reducing noise and saving energy since a minimal amount of preconditioned air will be dumped into the return air plenum.

RTU-3

Located on the west section of the building, RTU-3 serves the Southwest open and enclosed Offices. RTU-3 was manufactured in 2011. This area is served with six (6) zone dampers with wall mounted thermostats located in each zone.

RTU-3 (8.5 tons) - 2011

The load calculations confirmed the correct size for the RTU-3 to be 8.5 tons. The zone dampers appear to be sized correctly so they may remain as existing. The new RTU-3 will be specified with a variable speed supply fan and multiple compressors so so that the AC unit capacity will modulate to not overcool the space and provide energy savings. Since the supply fan speed will be reduced during low loads, the bypass damper activation will be minimized, reducing noise and saving energy since a minimal amount of preconditioned air will be dumped into the return air plenum.

It was noted that the ductwork for zone damper ZD 3-2 had been severed when the Computer Room AHU-1 was installed. This zone damper now only feeds the adjacent Corridor 120 and is therefore oversized. This zone damper may be repurposed to include serving the Computer Office 118

RTU-4

Located on the east section of the building, RTU-4 serves the Southeast open and enclosed Offices, Training room and Restrooms. RTU-4 was manufactured in 2010.

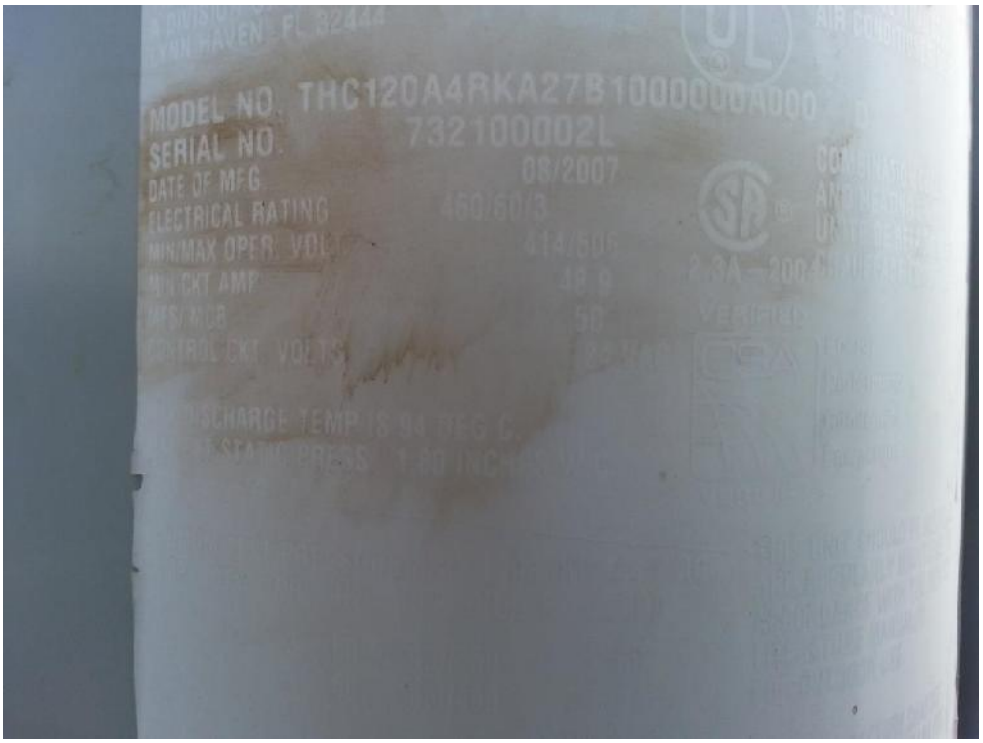
This area is served with five (5) zone dampers with wall mounted thermostats located in each zone.

RTU-4 (12.5 tons) - 2010

The load calculations confirmed the correct size for the RTU-4 to be 12.5 tons. The zone dampers appear to be sized correctly so they may remain as existing. The new RTU-4 will be specified with a variable speed supply fan and multiple compressors so so that the AC unit capacity will modulate to not overcool the space and provide energy savings. Since the supply fan speed will be reduced during low loads, the bypass damper activation will be minimized, reducing noise and saving energy since a minimal amount of preconditioned air will be dumped into the return air plenum.

RTU-5

Located on the east section of the building, RTU-5 serves the Northeast open and enclosed Offices, Lunch Room and Conference room. RTU-5 was manufactured in 2007. This area is served with four (4) zone dampers with wall mounted thermostats located in each zone.



RTU-5 (10 tons) - 2007

The load calculations confirmed the correct size for the RTU-5 to be 10 tons. The zone dampers appear to be sized correctly so they may remain as existing. The new RTU-5 will be specified with a variable speed supply fan and multiple compressors so so that the AC unit capacity will modulate to not overcool the space and provide energy savings. Since the supply fan speed will be reduced during low loads, the bypass damper activation will be minimized, reducing noise and saving energy since a minimal amount of preconditioned air will be dumped into the return air plenum.

AHU-1

Located on the Northwest exterior wall of the building, AHU-1 serves the Computer Room office 118 and the Tele-data equipment room 117. AHU-1 was manufactured in 2010. This unit is a constant volume 2.5 ton split unit with ceiling mounted air handling unit and pad mounted outside condensing unit. The thermostat for this unit is currently located in the Computer Room office 118 and not in the adjacent Tele-data room where the servers are located. The Tele-data room is warm.

AHU-1 (2.5 tons) - 2010

The load calculations estimated that the 2.5 ton unit is undersized and that a 3 ton air conditioning unit would better serve the cooling requirements for these two rooms. A new AHU-1 3 ton unit will be specified with variable speed supply fan and the main thermostat located in the Tele-data room so that the equipment is cooled properly. It is also suggested that the existing zone damper ZD 3-2 can be repurposed to serve the Computer Office and the adjacent Corridor 120.

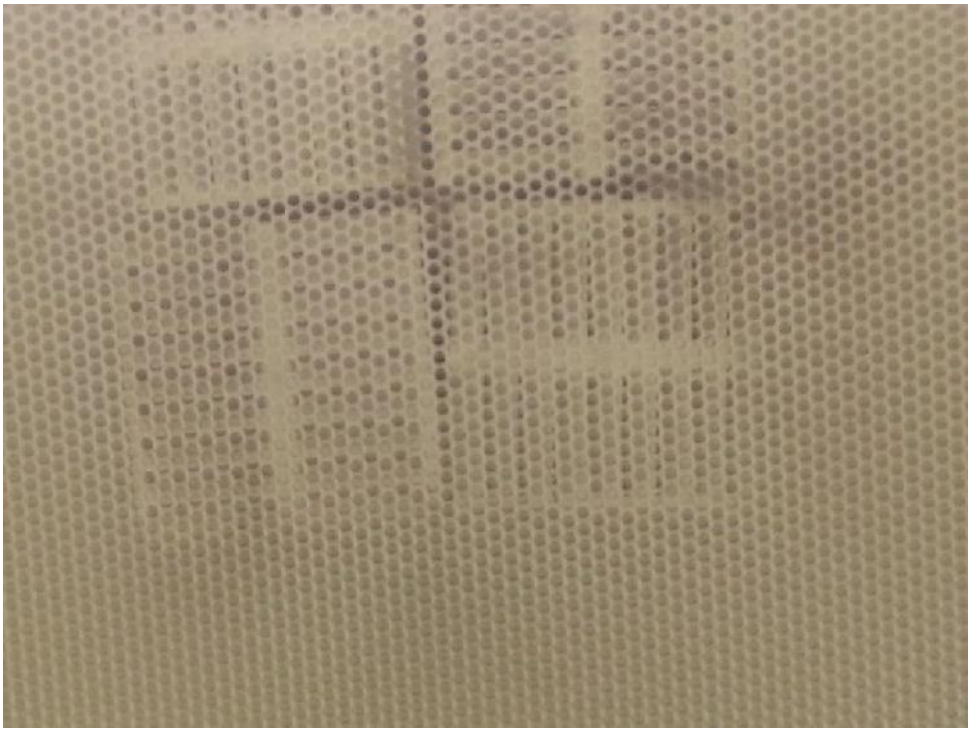
EXISTING DUCTWORK

In the orientation meeting it was suggested that the existing supply ductwork may need to be replaced. Upon observation above the ceiling, it was verified that the ductwork is all metal with wrapped insulation and appears to be in excellent condition. The insulation was seen to be intact and the ductwork solid. This report does not recommend that the exiting metal supply ductwork need to the replaced.

EXISTING MAIN SUPPLY DUCT AND FLEXIBLE CONNECTIONS

EXISTING CEILING DIFFUSERS

The existing diffusers are perforated type with pattern deflectors. This type of diffuser is less efficient in distributing the supply air across the ceiling and away from the seated occupants. This type of diffusers may cause drafts in some areas and higher noise levels.



EXISTING CEILING PERFORATED TYPE SUPPLY DIFFUSERS

EXISTING ZONE DAMPERS

The existing zone damper locations and areas served were identified. The zone dampers are electric operated blade type with controllers regulated by wall mounted thermostats. The controllers are connected to a main interface for each of the five (5) rooftop unit systems.

EXISTING ZONE DAMPERS

112 SOUTHEAST 10TH STREET
VOICE: (561) 274-0200
FAX: (561) 274-0222 / (561) 272-7950
DELRAY BEACH, FLORIDA 33483-3426
E-MAIL: TEC@TECFLA.COM

2 - RECOMMENDATIONS

The purpose of this investigation was to review the existing AC systems condition and controls and provide recommendations on replacement equipment to provide the following:

- Provide better indoor comfort and humidity control
- Provide energy savings by upgrading the existing AC equipment
- Suggest staging of equipment replacement
- Provide general energy savings estimates based on the increased efficiency of the new AC equipment
- Provide recommendations on equipment selections and cost estimates
- Provide recommendations on new building controls system to provide web based and remote monitoring, with non-proprietary controls for flexibility in equipment communication capabilities.

A Trane Controls Inspection Report was provided as a supporting document. This document stated a general problem with the bypass dampers and their controls. There was also refrigerant leaking and cooling equipment failure in several of the rooftop units. Several of the zone dampers were malfunctioning with failures of the controllers.

A. Building Load Calculations (Exhibit 1), (Exhibit 6A, 6B, 7A, 7B)

Attached are the building load calculation reports (Exhibit 1) that verify the proper sizing of the rooftop air conditioning units. The sizes of the new equipment are listed below.

Zone	AC Unit	Calculated Size
Reception/Conference	RTU-1	15 Tons
Northwest Offices	RTU-2	12.5 Tons
Southwest Offices	RTU-3	8.5 Tons
Southeast Offices	RTU-4	12.5 Tons
Northeast Offices	RTU-5	10 Tons
Computer Room	AHU-1	3 Tons

The Zoning layout for the building is shown in attached Exhibit 6A and 6B.

The rooftop equipment layout for the building is shown in attached Exhibit 7A and 7B.

B. Carrier Brand Rooftop Unit Selections (Exhibit 2)

A selection of new rooftop units was presented by Carrier Corporation. Attached are the equipment specifications for each of the five (5) replacement rooftop units. The equipment has the following features:

- 3 stage capacity compressors to provide capacity regulation. This allows the rooftop unit to modulate the cooling temperature to follow the load requirements of the zone. This feature allows the unit to use less energy and to provide just enough cooling to the spaces, saving energy and reducing occupant discomfort. The existing rooftop units are constant speed meaning they run continuously when cooling it required. The only capacity modulation is from bypassing the supply air to the return air plenum. This function wastes energy since the supply fan is always running at full speed.
- The supply fans will be provided with a variable frequency drive which shall modulate the power and therefore quantity of supply air as required for propser space cooling. Since the supply fan speed will be reduced during low loads, the bypass damper activation will be minimized, reducing noise and saving energy since a minimal amount of preconditioned air will not be dumped into the return air plenum.
- The existing zone dampers can remain and operate as existing, with the option to upgrade the existing building automation controls system and the zone damper controllers to provide system remote control and monitoring.

COST

The approximate cost of the new Carrier equipment, with installation is $150,000.

Note: The cost of curb adaptors to fit the new rooftop units on the existing curbs is not included.

C. York Brand Rooftop Unit Selections (Exhibit 3)

A selection of new rooftop units was presented by York/Johnson Controls. Attached are the equipment specifications for each of the five (5) replacement rooftop units. The equipment has the following features:

- 2 stage capacity compressors to provide capacity regulation. This allows the rooftop unit to modulate the cooling temperature to follow the load requirements of the zone. This feature allows the unit to use less energy and to provide just enough cooling to the spaces, saving energy and reducing occupant discomfort. The existing rooftop units are constant speed meaning they run continuously when cooling it required. The only capacity modulation is from bypassing the supply air to the return air plenum. This function wastes energy since the supply fan is always running at full speed.
- The supply fans will be provided with a variable frequency drive which shall modulate the power and therefore quantity of supply air as required for propser space cooling. Since the supply fan speed will be reduced during low loads, the bypass damper activation will be minimized, reducing noise and saving energy since a minimal amount of preconditioned air will not be dumped into the return air plenum.
- The existing zone dampers can remain and operate as existing, with the option to upgrade the existing building automation controls system and the zone damper

controllers to provide system remote control and monitoring.

COST

The approximate cost of the new York/Johnson Controls equipment, with installation is $140,000.

Note: The cost of curb adaptors to fit the new rooftop units on the existing curbs is not included.

D. Johnson Controls (Exhibit 4, 5)

A selection of a new building automation system was presented by Johnson Controls. Attached are the equipment specifications and controls diagram for the proposed system. The equipment has the following features:

- One (1) Central control station with desktop work station and monitor.
- Web based communication for remote monitoring and controls of AC equipment.
- Motor driven actuator for each zone damper, with wireless control back to central control station.
- Wireless controls to each zone damper actuator and wireless thermostat.
- Wireless controlled thermostats AND/OR wall mounted temperature sensors, eliminating the need for wiring and allowing temperature sensors to be relocated as needed for comfort control or future office reconfiguration.

COST

The approximate cost of the new /Johnson Controls equipment, with installation is $75,000.

3 - ENERGY SAVINGS

I have created a simple energy savings calculation comparing the operation of the existing five (5) rooftop units and the operation of the new replacement rooftop units. These calculations are only rough approximations of energy use based on the manufacturer listed equipment efficiencies and running times listed below. The purpose of these calculations is just to provide a sense of the cost savings of operation. The increased occupant comfort and system control will add more value to the project.

A. Efficiencies of Rooftop Units

Existing Trane Rooftop Units

Rooftop Unit	Energy Efficiency Ratio	Capacity ton	Average kW/ton	Efficiency Average EER
1	11.8	15.0		
2	11.0	12.5		
3	10.1	8.5		
4	11.0	12.5		
5	11.2	10.0	**1.08 kW/ton**	**11.1 EER**

New Carrier Rooftop Units

Rooftop Unit	Integrated Energy Efficiency Ratio	Capacity ton	Average kW/ton	Efficiency Average IEER
1	18.5	15.0		
2	19.3	12.5		
3	19.9	8.5		
4	19.3	12.5		
5	20.8	10.0	**0.6173 kW/ton**	**19.43 IEER**

New York Rooftop Units

Rooftop Unit	Integrated Energy Efficiency Ratio	Capacity ton	Average kW/ton	Efficiency Average IEER
1	11.0	15.0		
2	12.6	12.5		
3	12.6	8.5		
4	12.6	12.5		
5	12.0	10.0	**.9917 kW/ton**	**12.1 IEER**

B. Cost of electricity

Cost of Electricity based on FPL rates of $0.11 per kW.

1. Hours of Operation

a. Monday – Friday: 6 am – 8 pm (14 hours/day) at 58.5 tons (100%)
b. Monday – Friday: 8 pm – 6 am (10 hours/day) at 14.6 tons (25%)
c. Saturday – Sunday: 6 am - 6 am (24 hours/day) at 14.6 tons (25%)

2. Cost of Operation ($)

A. Existing five (5) rooftop units

a. M-F (6 am – 8 pm): 14 hour x 58.5 tons x 1.08 kW/ton x $0.11/kW-hr x 5 days
= $486 / week
b. M-F (8 pm – 6 am): 10 hour x 14.6 tons x 1.08 kW/ton x $0.11/kW-hr x 5 days
= $87 / week
c. S-S (6 am – 6 am): 24 hour x 14.6 tons x 1.08 kW/ton x $0.11/kW-hr x 2 days

= $83 / week

Total Operational Cost = $656 / week x 52 weeks = $34,100 / year

B. New Carrier five (5) rooftop units

d. M-F (6 am – 8 pm): 14 hour x 58.5 tons x 0.6173 kW/ton x $0.11/kW-hr x 5 days
= $278 / week
e. M-F (8 pm – 6 am): 10 hour x 14.6 tons x 0.6173 kW/ton x $0.11/kW-hr x 5 days
= $49 / week
f. S-S (6 am – 6 am): 24 hour x 14.6 tons x 0.6173 kW/ton x $0.11/kW-hr x 2 days
= $47 / week

Total Operational Cost = $374 / week x 52 weeks = $19,469 / year

C. New York five (5) rooftop units

g. M-F (6 am – 8 pm): 14 hour x 58.5 tons x 0.9917 kW/ton x $0.11/kW-hr x 5 days
= $447 / week
h. M-F (8 pm – 6 am): 10 hour x 14.6 tons x 0.9917 kW/ton x $0.11/kW-hr x 5 days
= $79 / week
i. S-S (6 am – 6 am): 24 hour x 14.6 tons x 0.9917 kW/ton x $0.11/kW-hr x 2 days
= $76 / week

Total Operational Cost = $602 / week x 52 weeks = $31,304 / year

As a comparison, it is suggested that replacing the existing rooftop units with high efficiency systems with multiple stages of compressors and variable speed fans may provide an energy savings of up to 40% to 50%.

4 – Phasing of Replacement and Conclusions

This report was created to provide a visual assessment of the existing air conditioning and ventilation system for the existing five (5) rooftop units and provide recommendations on possible replacement in order to improve the indoor comfort and decrease energy usage and improve the operability of the systems by suggesting a new building automation controls system.

a. The existing rooftop units should be replaced with new rooftop units that will integrate into the existing zone damper system. These units will require roof curb adaptors so that they may be mounted on the existing curbs.
b. The new roof top units will be provided with multiple stages of compression for load capacity control. This will reduce energy use and improve building comfort by reducing the supply air quantity and regulate the supply air temperature to match the actual cooling loads during the day. The use of variable frequency drives on the supply fan will also help supplant the operation of the existing bypass dampers because the fan speed will decrease as loads decrease and minimize the operation of the bypass dampers (which are controlled by pressure sensors in the supply duct which signal the bypass damper to open to relieve pressure increases when zone damper boxes move to the closed position). The existing rooftop units run continuously and the supply fan is operating at full power, with the bypass dampers redirecting air from the ductwork to the return air plenum. There is no savings in energy use since the fans operate continuously at high speed.
c. The units may be replaced individually to accommodate the building operations schedule. The new building automation system can be installed during the first rooftop unit change-out without effecting the operation of the other systems. Therefore, as budgets are available, the rooftop units can be replaced on the owner's schedule.
d. As mentioned, the Johnson Controls building automation system is composed of one (1) central control station. The existing zone dampers will be provided with new wireless controllers and electric actuators while leaving the existing damper boxes in place. The wall mounted thermostats will be replaced with either new wall mounted thermostats or wall mounted temperature sensors (securing the programming and set points of the thermostats by the building engineer at the building automation system). The wireless nature of the temperature sensors will allow them to be easily moved due to comfort issues or office reconfiguration.
e. The existing computer room AC-1 can be replaced with a new 3 ton split system which has capacity control by a variable speed supply fan. The thermostat would be relocated to the IT/Server room so that the AC-1 is dedicated to the cooling of this room only. The existing zone damper ZD 3-2 can be repurposed to serve the Computer room Office 118 and the adjacent Corridor 120. This unit had previously been changed to only serve the corridor and has enough capacity to serve the Office also.
f. The existing ductwork is metal with exterior insulation. Both the main supply duct and the branch ductwork before and after the zone dampers is also metal with exterior insulation. Any spot repairs can be made on existing duct leaks but it is recommended that the existing ductwork remain.
g. One other item that may be considered is replacing the existing perforated ceiling diffuser with new louvered faced diffusers. The existing diffusers provide poor directional control of the discharge air. New diffusers can be adjusted to help eliminate drafts and reduce air noise. See attached Exhibit 8 for reference.

Please contact me with any questions or comments. If the client requests, TYEC would be available to offer engineering services to provide construction documents for the suggested equipment replacement as described in the report.

Sincerely,

Michael Bassford, P.E.; Ext: 452

"We put problem solving, solution providers on all of our client's projects."

TYEC HVAC PLUMBING ELECTRICAL
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Signed: Michael Bassford, P.E. – Mechanical

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