MDOT BUILDING HVAC IMPROVEMENTS
ALPENA, MICHIGAN

Prepared By:
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PROJECT BACKGROUND

Building Summary: Alpena County owns a 6,000 ft^2 single-story facility located at 1540 Airport Rd. in Alpena, MI, constructed in 2000. It is currently being rented by the Michigan Department of Transportation (MDOT), therefore the County and this report refer to this structure as the 'MDOT Building'. The previous tenants utilized a commercial laboratory, but the current usage is only office space.

HVAC Systems Summary: The MDOT Building HVAC system is a constant-volume VVT system. The system is comprised of a single ground-mounted rooftop unit and (5) variable air volume (VAV) zone boxes and a single bypass damper (See Figure 1 below). Each VAV zone box is controlled by a thermostat intended to provide temperature control to (5) independent zones within the building. The single electronic bypass damper near the unit allows supply air to be bypassed into the return ductwork when the VAV boxes are not providing the *minimum* airflow required for safe supply fan operation. This combination of constant fan speed with zone boxes is called a Variable Volume and Temperature (VVT) system. Unlike more common and robust "true VAV" systems a VVT System does not have reheat coils at each zone box and due to the constant-volume fan arrangement, is more limited with the ability to effectively control each heating and cooling zone independently --- these system limitations are very common to VVT systems and are currently observed in the MDOT Building.

On-going HVAC Comfort Issues: Historically, there have been significant comfort issues within the MDOT Building and the tenants have ongoing complaints regarding overall comfort. Throughout the year, spaces are often too warm or too cold and humidity remains high in the summer months. The staff at Alpena County have investigated the complaints and suspect the VAV boxes and/or RTU is not functioning properly for optimal occupant comfort. To try to solve the issues some improvements have been attempted including the 2023 installation of new digital thermostats and VVT control boards and diagnostics testing.

Due to the ongoing comfort control issues, Spicer Group has been tasked with reviewing all available data to determine the causes of the discomfort and to recommend actions to resolve these issues.

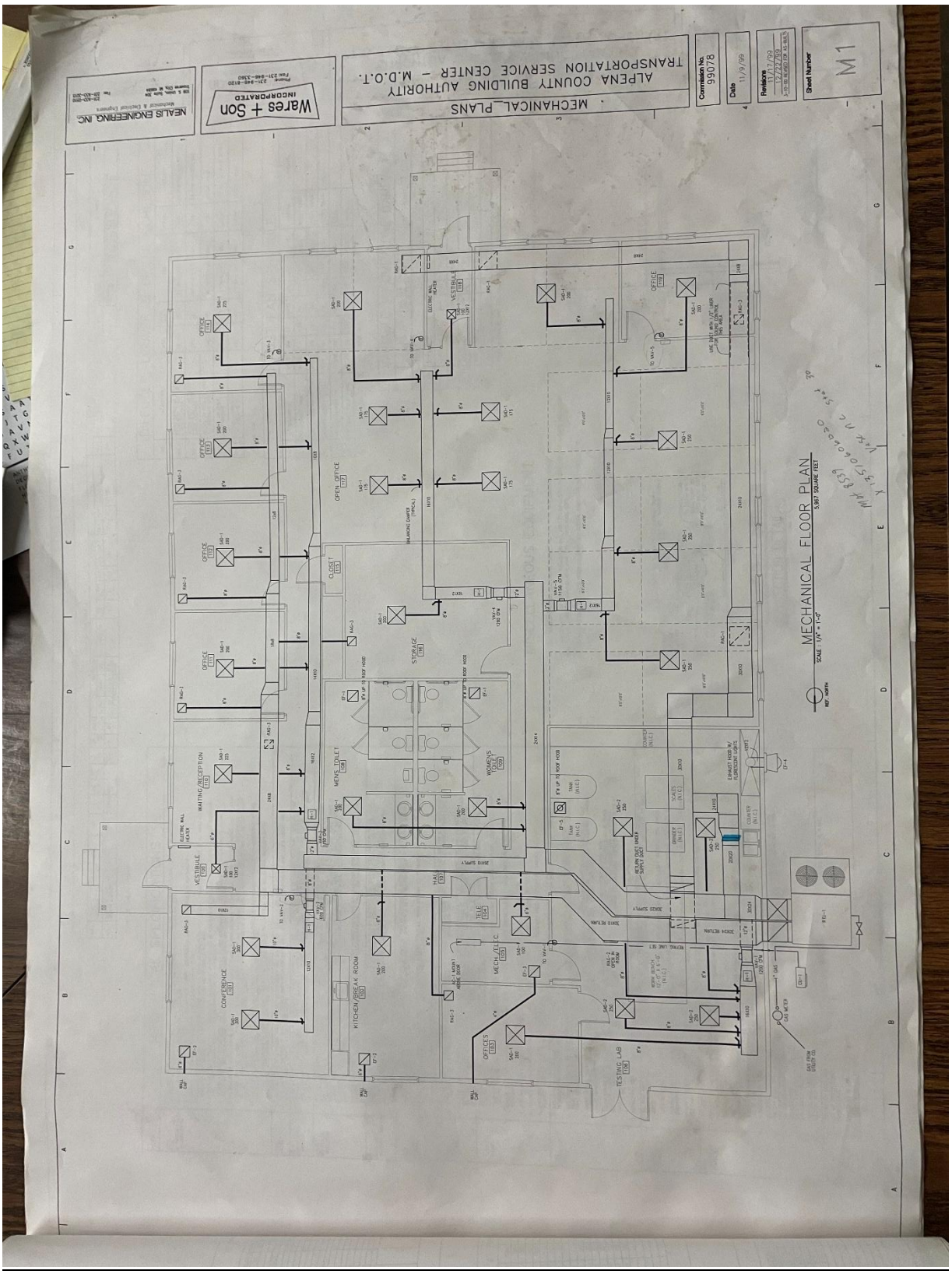

Figure 1: MDOT Building HVAC Floor Plan

SUMMARY OF FINDINGS

In addition to the insights obtained during our site visit, the contributors of this report provided Spicer Group with histories, drawings, reports, and submittals to best understand the causes of the comfort issues observed. The following are the findings of our investigation, with additional information in the *Investigation Details* section and additional resolutions explained in the *Recommendations* section of this report.

The primary cause of comfort issues is the 26-year-old rooftop unit RTU-1. This unit has only (2) stages of heating, (1) stage of cooling and (1) constant-volume fan speed. This lack of modulation when combined with the (5) zones of the VVT system, creates a system that cannot effectively respond to the changes in heating, cooling and ventilation that vary across the building. Simply put, the unit can only operate as on/off where the zones are constantly adjusting to occupant comfort requirements.

If a single rooftop unit is being used in a VVT system, the unit should have the ability to modulate the amount of heating, cooling, and airflow being provided to best match the needs of the building at any given time. The proper control of these variables will better match comfort needs and reduce the humidity within the building. To improve these variables Spicer Group has provided a preliminary selection and budget price for a new modulating packaged rooftop unit. See Recommendations section below for further information.

In addition to a new modulating roof top unit, the bypass damper needs to be relocated for proper operation. Currently, the excess airflow not utilized by the VVT boxes is “bypassed” from the supply ductwork to the return ductwork and sent back to RTU-1. As currently configured, the supply air bypasses into an undersized branch of the return ductwork instead of the main return duct near the unit. This incorrect bypass damper position positively pressurizes the branch of return ductwork and causes conditioned supply air to be discharged out of return grilles --- this effective change in directional airflow is highly problematic and depending on whether the roof top unit is in heating or cooling mode, causes a departure from space temperature setpoint and causes discomfort for the occupants.

Once the bypass damper is relocated, the existing sequences of operation and setpoints must be adjusted. Currently, too much airflow is being allowed into the zones that are not requesting heating or cooling, which greatly reduces the ability to control temperature in these areas.

In addition to recommendations above there are (4) rooms being served with uncontrolled supply air. and it is recommended that (2) new zone boxes and thermostats be installed to properly control the temperatures of these rooms.

As further explained in the *Recommendations* section below, Spicer Group suggests proceeding with the Engineering, Bidding, and Construction Administration Services defined in the attached proposal. This will allow for the necessary improvements to be designed, competitively bid, constructed, and inspected.

INVESTIGATION DETAILS

Alpena County provided the project background, historical observations, construction drawings from 2000, and access to the new web-based temperature controls system installed in 2023. Control Solutions provided additional insights to the HVAC system operation and enabled additional data points of the system to be tracked over time (trending). Trane West Michigan provided documentation for the RTU-1 rooftop unit currently installed and a preliminary selection of a replacement unit referenced in the *Recommendation* section below.

Spicer began the investigation by reviewing all provided documentation and generating a list of possible causes for the noted issues. By utilizing the web-based building management system, Spicer was able to observe operating conditions in real time. The trending feature allowed Spicer to select specific data points of interest to track over time, which then provided valuable insight to the system operation during a wide range of seasonal conditions.

Spicer Group corresponded with Control Solutions to better understand the sequence of operations utilized by the Temperature Control System and to obtain additional opinions on the list of possible causes of discomfort. Spicer Group then performed a site visit on 12/3/25 where the system was inspected and staff was interviewed.

Lastly, the trending data that was enabled last winter was thoroughly reviewed. Now with 6 months of data, many of the initial suspicions were quantitatively confirmed.

Spicer Group has made the following observations:

1. **Condition of existing RTU-1** – While it has been well maintained, the existing RTU-1 is 26 years old and does not allow for modulation of the heating, cooling, or fan speed. The unit is not mounted on a curb, likely causing snow to block some/all of the fresh air intake louver (bottom of *Figure 2*).

Figure 2: RTU-1 mounted on concrete pad with snow near intake louver.

2. **Excess Outdoor Airflow –** The fresh air being introduced to RTU-1 was measured higher than originally designed causing higher humidity and energy usage. The original design value is likely much higher than required by code due to the original use including a laboratory hood which is no longer utilized.

3. **Bypass Damper Location** – As mentioned above, RTU-1 does not have the ability to reduce airflow when zone dampers begin closing. Instead, a bypass damper allows conditioned supply air to bypass the spaces and return to RTU-1. While this was a common design at the time of construction, it's known to be inefficient. Furthermore, a bypass damper should always be installed between the main supply and main return ductwork to allow path of least resistance back to the unit. In this case as shown in *Figure 3*, the bypass ties into a branch of return ductwork, not the main. This branch is significantly undersized for this additional airflow which causes a positive pressure in the duct designed to maintain a negative pressure. This pushes the now conditioned air out of the openings in the return duct, acting as uncontrolled supply air into the nearby spaces - specifically the Testing Lab and open offices in the southwest corner of the building.

Figure 3: Bypass damper (orange actuator), return branch, and supply/return mains.

4. **Too much airflow when satisfied** – The functionality of this VVT system is based on zone dampers opening when a space requires more airflow (during a call for heat or cooling) and closing when a space is satisfied to allow that hot/cold air to reach other spaces without overheating/cooling the satisfied space. Since RTU-1 requires a constant airflow and the bypass ductwork is underperforming, the current controls strategy significantly limits the amount a

damper can close. With fully open being 100%, these are the current MINIMUM damper positions:

a. **VAV-1: 30%**
b. **VAV-2: 30%**
c. **VAV-3: 53%**
d. **VAV-4: 53%**
e. **VAV-5: 70%**

To summarize this point, when VAV box minimum airflow percentages (or minimum damper position) exceed approximately 20% each there is a tendency to over-supply air and spaces will overheat of overcool.

5. **Rooms without temperature control** – The typical design of a VAV or VVT system would ensure that every supply register would be downstream of a zone box. It's not common to have supply register directly connected to the main supply ductwork since these areas would be constantly receiving conditioned airflow during all hours of operation. When mixed with a zoned system that is modulating airflow, these uncontrolled zones will quickly overheat and overcool. In the MDOT Building, (4) supply registers are currently connected directly to the supply ductwork with no thermostat or zone box providing control as highlighted in **Figure 4**. These areas were noted as unacceptably warm during our site visit:
    a. Kitchen/Break Room 102
    b. Mechanical/Electrical 105
    c. Men's Toilet 108
    d. Women's Toilet 109

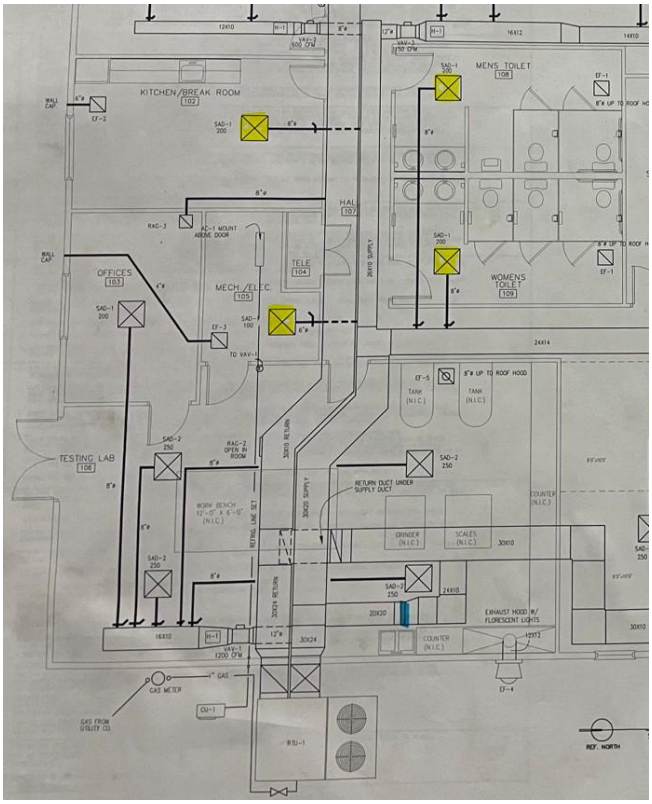

Figure 4: Supply registers without VAV box control

RECOMMENDATIONS

Considering the goals of this report and the findings identified in the above *Investigation Details* section, Spicer Group is recommending that Alpena County proceeds with the design, bidding, and construction of HVAC system improvements to correct the noted deficiencies. More specifically, we recommend the following actions:

1. **Replace RTU-1** – Replace the existing rooftop unit with a new Trane Horizon model or equal with nominal 6000 CFM, 250,000 Btu/hr, and 15 cooling-tons of capacity. Include ECM blower motor, modulating gas heat, digital scroll compressor, demand control CO2 economizer with barometric relief, and an 18" uninsulated curb. Modify exterior ductwork as required and reinsulate with VentureClad casing or equivalent.

2. **Recalculate and rebalance fresh air –** Reducing the fresh air will reduce utility bills, increase humidity in the winter and decrease humidity in the summer. Since the usage of this building has changed since construction, a licensed engineer shall recalculate the fresh air requirements per Michigan Mechanical Code and a Test and Balance (TAB) contractor shall adjust the outdoor air damper accordingly.

3. **Relocate the bypass damper and modify ductwork** – Installing the bypass damper within properly sized ductwork between the supply and return main ductwork will prevent many of the issues observed. The return duct will no longer be positively pressurized, pushing unwanted conditioned air into the southeast offices and lab. Also, the (5) VAV boxes and (4) uncontrolled supply registers will no longer need to operate as bypasses since the damper and rooftop unit will properly communicate to provide the required minimum airflow. A licensed engineer shall size and route the new bypass ductwork and confirm the existing damper and actuator are sufficient for the new operational requirements and can be relocated and reused.

4. **Recalculate and rebalance zone boxes** – As mentioned above, a functioning bypass damper and modulating unit will allow the zone boxes minimum damper position to be closed more than what is currently allowed. This will provide significantly greater temperature control and comfort to each space. These minimum positions must provide the necessary ventilation air per Michigan Mechanical Code and are to be specified by a licensed engineer and set by a TAB contractor.

5. **Select and install (2) additional zone boxes and thermostats** -
    a. Install a new VAV box and reconnect to the existing ductwork that serves Kitchen/Break Room 102 and Mechanical/Electrical 105. Install a new thermostat that controls this VAV box in the Kitchen/Break Room 102.
    b. Install a new VAV box and reconnect to the existing ductwork that serves Men's Toilet 108 and Women's Toilet 109. Install a new temperature sensor that controls this VAV box in Women's Toilet 109.

As of June 2026, the budget for this work including engineering fees and 5% construction contingency is $178,000 and is expected to increase by roughly 5% per year.