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Diocese of Cleveland Facilities Services Corporation

Troubleshooting an HVAC Project

When an HVAC project reaches the start-up phase of the building equipment and systems, and the work is implemented followed by the commissioning of the mechanical and electrical systems, sometimes expectations are not always met. This can be when finger pointing begins and quick-fix solutions are proposed by some involved with the project. Others, who are less reactive and have the years of experience associated with building systems and particularly heating, ventilating, and air-conditioning (HVAC) systems know there is a process to be followed, in lieu of jumping to the solution.

With 20-20 hindsight looking at a situation after the fact can bring a new perspective to the issue(s) at-hand but jumping to a quick-fix often makes the troubleshooting solution to the HVAC system become worse instead of better. Even when the solution is apparent to the experienced design engineer or contractor, having a methodical process can often be the optimum solution.

Sure it takes years of experience to reach a point in one's professional career to take on this role of problem solver. That said, troubleshooting is not something every engineer or contractor can do effectively. It takes a skill level to do so requiring the following:

- Be proficient in HVAC design, construction, and operation and maintenance
- Be a good listener; listen-listen-listen
- Perception is reality but don't believe everything you hear
- Experienced with time-tested quality control steps help prevent one from jumping to the solution based on their years of experience.
- Apply "Engineering 101", which is the need to collect basic data and analyze it before solution plans can reviewed and the optimum solution selected.

Trained in quality control, the troubleshooter should

follow the WV Diagram process created by international expert on quality control Shoji Shiba. This approach is a 7-step process modified for HVAC troubleshooting as follows:

1. Document the theme e.g., "HVAC system AHU-1 does not provide adequate space temperature control."
2. Collect the data e.g., review construction drawings and specifications, equipment submittals, automation points trending, etc. followed by walking the construction site verifying the installation collecting more data.
3. Analyze the data a.k.a. "Cause Analysis"
4. Develop possible solutions with the trouble-shooting team implement the optimum solution
5. Implementation" of the solution plan is the next step in trouble-shooting.
6. "Monitor and Measure" the effects
7. "Evaluation of Effects" and make the changes necessary

Integral with this 7-step process is the application of Engineering 101:

- Long before the troubleshooting team kickoff meeting there should be a standardized checklist of "things to do" and "questions to ask"
- Ask questions and document these comments and/ or perceptions
- Review record drawings and automatic temperature control record documents in sync with a review of the original "Basis of Design" and "Design Criteria" to understand the building owner's expectation of the HVAC system performance.
- Create a system flow diagram based on the above and, for example, if the problematic system is an air system collect and review the following:

  ⇒ Past and/or current air balancing report(s)
  ⇒ Review the equipment submittals and in particular the fan curve(s)
  ⇒ Review the fan curve and compare it to the air balancer's report as well as the design criteria
  ⇒ Inspect the installation and document observations using a camera to capture existing conditions (a picture can be is worth a 1,000 words)
  ⇒ Using the automation system trend pertinent control point data such as outdoor air temperature and humidity, indoor space temperature and humidity, etc.

- Now the team is ready to study the results and analyze the solution options

With this basic data at hand, one can begin to analyze the questions raised and begin to assess if this is a design issue, an installation issue, a lack of commissioning, a change in Basis of Design, or some other issue. Wherever the direction this data and analysis takes the troubleshooter team, it will be based on fundamentally sound facts, calculations, and reasoning. This will lead one to a solution plan that may include further test data collection and then recommended corrections before re-commissioning or retro-commissioning this system(s).

There will be a final report with recommendations the troubleshooting team will need to complete to achieve a solution. Included in this report as backup data should include existing condition photographs of the problematic HVAC system along with relevant before and after readings e.g., temperature, humidity, hot water heating temperatures, chilled water cooling temperatures, etc.

Problematic HVAC installation arises from mistakes made by the designer or the contractor but more often than not new construction issues and concerns occur because the system wasn't commissioned. If the problematic project is an existing HVAC installation it may still be that the original system was never commissioned or it may be the use of the facility has changed over the years, so the basis of design and original design intent is in conflict with the current system operation. Another reason existing HVAC systems become problematic is that the automatic control set points, equipment schedules, etc. have been changed and maybe the automatic control system had been switched over to manual operation sometime in the past and has remained in this manual mode of operation.

Another issue that often gets blended in with the HVAC problem is the question, "Who is at fault". Often times when the focus is directed towards "who could have done this" rather than "how do we fix this" the problem solving can't seem to move ahead until the culprit is identified which is silly because of the amount of time and conversation that is wasted while the HVAC system continued to be problematic.

When troubleshooting an HVAC system problem the problem solver and his or her team should make sure that this "Who done it" theme is put aside so the attention is focused on the system. One can always return to this question if required but in the meantime it will contribute nothing to solving the problem.

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