All belts must be checked for belt guards

A Sound Installation Check List

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Introduction

Installation and commissioning of buildings/systems requires an empathetic understanding of the application, usage and criticality of the space. Commissioning of an air conditioning system involves a high level of responsibility, since it not only impacts the proper operation of the system, inside conditions, variables of temperature, RH, air pressure, cleanliness, sound, vibration and odour, but also affects the physiology and health of the occupants and process support.

Before carrying out the commissioning, one needs to ensure that the installation of equipment and systems is done correctly, measurement ports enabling performance checks, testing and balancing are provided and serviceability of the equipment and systems is adequately taken care of.

In this article, we shall define the responsibility and the way to go about creating the check lists and carrying out installation checks.

About the Author

Rakesh Sahay is a Founder Director of Veratatva Engineering Consultants, which is involved in ultra high efficiency building and campus designs in both commercial and industrial sectors. He is a BEE Accredited Energy Auditor and GRIHA Certified Trainer with over 20 years of experience in auditing, commissioning and performance engineering of facilities, in addition to design.He also practices energy targeted and profit sharing SLA driven Operation and Maintenance.

Installation Check List Basics

The responsibility for installation check list commences at the stage of concept design. Careful study of the application and its needs and matching the basis of design to them is of utmost importance. This may overlap with the responsibility of a designer for the project, but two heads are always better than one. One should not look at it as a review of the design, but as a collaborative effort of making the systems perform and deliver during the life of the project.

If the application is clearly understood, i.e. the nuances of the operations are appreciated, the control logic will be properly schemed. For the control logic to be functioning beneficially, the location of sensors and speed of reaction matters. For sensors to give correct inputs to the controller to give the desired outputs, understanding of sensors and their abilities is important. For accurate reading and best response time of the sensors, understanding their limitations and providing the best possible environment for them to function accurately is equally important. Reading the specifications and data sheets of sensors and matching them to the design intent at the time of detailed design is required. This leads to the designer and the commissioning

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authority specifying the right sensor for the application and locating it at the right position for best effect.

As an example, sensors for room temperature and RH should be located based on the designer's intent of maintaining average room conditions, or maintaining the conditions at the work bench where a critical process is being carried out, or maintaining the air inlet condition to server racks. If a designer intends to maintain the temperature within ±1°C in the space, where the possibility of change in the condition is based on operations that change or fluctuate within a minute, the least count of the sensor should not exceed 0.2°C, its response time should not exceed 0.5 seconds, and the actuating time of the actuator controlling the space temperature should be within 10-15 seconds. If there is a hot or cold surface near the process location, sensor selection should factor in the anti-radiation effect in sensing the air temperature. All instruments and equipment together perform as a team to maintain the process condition within the desired tolerance of ±1°C.

Equipment performs best when it is operating at its design conditions, and so also the instruments. Hence care is necessary to ensure that diversity of the application is understood well and delivery mechanisms are properly sized. Oversizing of ducts and pipes may lead to difficulty in controlling the flow to create the easiest path for the fluid to reach where desired. As an example, if the chilled water pipe is oversized by 50% for peak load, and the diversified load for 50-60% of the operating time is 50% of peak load, the actual demand flow would be 25% of the pipe capacity for 50-60% of the operating time. For simplicity, we assume that the network has 4 equally sized branches. The circuit with the least resistance will have the capacity for taking 100% of the flow at an instant where the pump is operating at 25% flow for the entire circuit.

A common perception is that the control valve will only open to the extent required and hence the rest of the flow will automatically be balanced. To limit the flow to 25% in the circuit, the control valve will have to create a pressure drop 16 times its pressure drop at 100% fully open position. (Pressure drop is proportional to the square of velocity or square of the flow ratio.) To achieve this, the valve and actuator should have the valve authority and linearity of performance to match the input voltage coming from the controller, which is normally programmed proportionally. All this is achievable but not without complications.

Some Dos and Don'ts for Installation

Photo 1 to *14*, taken from projects where the author has been involved, depict some good installation practices and some poor practices to be avoided. These would be handy while preparing a check list.

Dos

Photo 1: Anti-bird net for safety

Photo 2: Cables routed neatly and wrapped with tie

Photo 3: Commissioning filters used during AHU commissioning

Photo 4: Equipment covered during construction

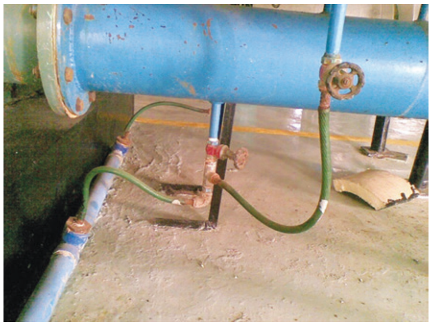

Photo 5: Drain facility provided for all drain connections

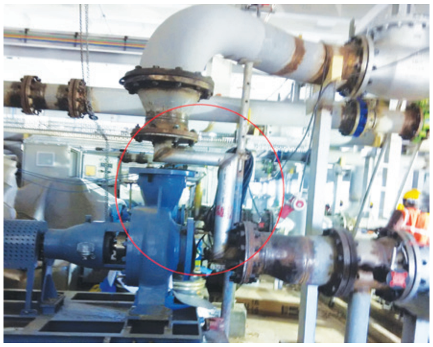

Photo 6: Bypass line for initial flushing to avoid pump impeller damage

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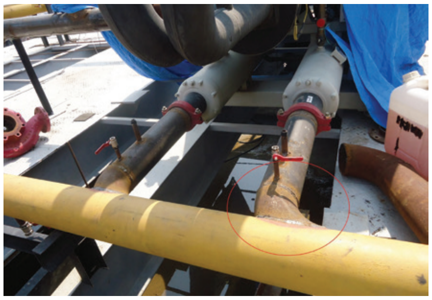

Photo 7: Shoe piece provided to reduce friction loss

Don'ts

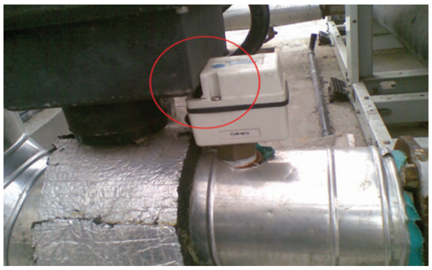

Photo 8: Flow switch terminal cover damaged due to inadequate gap

Photo 9: Debris inside AHU

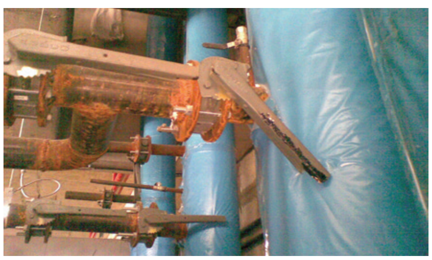

Photo 10: Not possible to operate valves due to inadequate space

Preparing the Check List

After proper selection and specification to match the design intent, it is important to ensure that the instruments, equipment and ancillaries are installed correctly. This process starts at the submission and approval of data sheets. Normally, the data sheet approval process is limited to design and performance data submission and approval. However, it is strongly recommended that installation, operation

Photo 11: AHU fins damaged

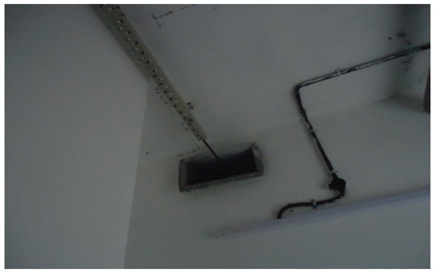

Photo 12: Cable passing through duct

Photo 13: Gauge installed at location that is not visible

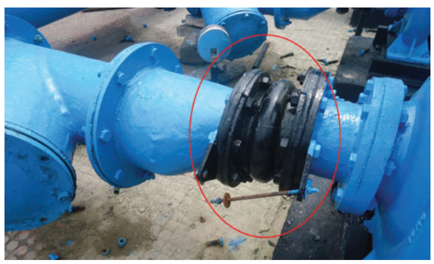

Photo 14: Pipeline not properly aligned

and maintenance manuals also be submitted at this time. These documents can be shared with the commissioning team, which uses the information and OEM recommendations onthe correct installation procedures and creates the check lists accordingly. Adequate space requirement for operations and service must be included in the check list. Vibration isolation, noise reduction, heat dissipation and avoidance of short cycling of resources should be carefully observed and included in the check lists. A check list should have two columns – one for the design stage and the other for the site installation stage.

On approval of data sheets, the contractor is expected to submit shop drawings for approval and co-ordination. While the designer checks the shop drawings in relation to design parameters, specifications and co-ordination issues, the responsibility of the commissioning team is to cross-check with the check list whether these provisions and adequacy have been addressed in the shop drawings. The same check list is used at site for cross-reference during installation.

Sample Check List

The key to preparing a good installation check list is to list down its deliverables. For example, an AHU check list should include:

1. Provision at site for lifting, shifting and locating the largest item in the AHU, if the AHU is being delivered in dismantled condition. If the AHU is specified to be factory-tested and delivered in assembled condition, provisions for the above matching the AHU size should be listed.
2. The check list should not limit the check point subjectively, e.g. *adequate space* for shifting and positioning the AHU. A more appropriate check point would be the space allocated for lifting and shifting. (The inspector has to measure and write down the actual dimension.)
3. Compare the above dimension with the packed dimension of the component and not the installed dimension.
4. List down the confirmation of adequacy of space allocation.
5. Space for assembly post completion of construction (not keeping one wall open for assembly and to close the wall after assembly), since the same space would be required for dismantling the AHU for servicing or replacement at a later date, if required.
6. Location of AHU panel in terms of safety, visibility, operability and ventilation.
7. Routing of power and control cables keeping in mind aspects like safety, obstruction to service personnel and entry to AHU, and provision for earthing and rubber mats.

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8. Completion of civil works, sealing of AHU room, shafts, pipe openings, fresh air openings, supply and return air duct openings.
9. Provision of floor drain, floor traps, wall finishing, painting and acoustic insulation.
10. Completion of conduits for lighting, power and control cabling.
11. Alignment of supply and return duct positions with respect to AHU connections and openings.
12. Door size with respect to the AHU blower size.
13. Space around the AHU.
14. Space for valve handles to turn full 90°.
15. Space for control valve actuator to be accessed.
16. In case BTU meters are to be used, their correct location (provision of straight line upstream and downstream for accurate flow readings).
17. Providing proper thermowells, installation of thermowell of adequate length, correct location and correct angle for accurate temperature measurement and proper response time, provision to remove and refill thermic fluid in the thermowell.
18. Provision for pressure gauges, their isolation, replacement ease, fouling of gauge isolator handles with pipe line and insulation.
19. Provision of purge points, and provision for purged water to flow into drain points.
20. Adequate 'U' depth to match the AHU static.
21. Provision to measure the AHU performance to the extent required.
22. Vibration isolation of rotating equipment, vibrating equipment, ducts and pipes to the extent required.
23. Space and provision for filter and coil cleaning.
24. In case a heat recovery wheel (HRW) is part of the AHU, access and approach for its moving parts and motors; check specifically for leakage possibilities between the various sections for proper heat recovery and avoidance of air bypass across sections.
25. In case of re-heater packages, their locations, distance from filters, location of control sensors, safety stats, terminal points and ease of visibility of ON/OFF status display; similarly for humidifiers and dehumidifiers.
26. Quality of workmanship.

Conclusion

For special equipment it is important to study the installation, operation and maintenance manuals for its proper and effective operation. It may be useful to visit websites and blogs and to obtain expert opinion on the usage and common errors in the use of special and new equipment before preparing installation check lists. Feedback of operations and service teams from existing sites is important and comes handy to keep improving the check lists. Similar references and thought process are required for creating installation check lists for every equipment and ancillary.

A chain is as weak as its weakest link. Hence, remember that no part of the system can be ignored. If we respect systems and procedures, we derive their benefits, else we have only ourselves to blame.