Project Management of Air Conditioning system: Lessons learned in system balancing

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Abstract

HVAC (Heating, Ventilation and Air conditioning) system is one of the important aspects in project management of commercial and industrial buildings. In tropical country like India, for commercial applications, the emphasis is more on air conditioning compared to heating and ventilation. The commissioning activity of air conditioning system is very exhaustive and critical in ensuring required comfort conditions at lowest operating cost. The present paper discusses some of the important aspects in balancing of air conditioning system. The lessons learned are compiled for ready reference to the architects, consultants, contractors, project managers and end users.

Keywords: HVAC, Project Management, Commissioning, Balancing

1. Introduction

Testing, Adjusting and Balancing (TAB) is one of the important activities during Project Management of HVAC (Heating, Ventilation and Air conditioning) system, used for comfort or process application. Testing indicates to evaluate the quantitative performance of the equipment. Adjusting refers to modulating the flow rates and balancing indicates proper distribution of air and water flow within the HVAC system.

India has seen exponential growth in HVAC segment in the past few years. In tropical country like India, the need of air conditioning is more significant than heating. Hence, the present study focuses on TAB for air conditioning systems. TAB ensures that the occupant comfort is achieved at lower energy cost (Gladstone and Bevirt, 2008).This results in huge savings in the energy requirement for air conditioning system. TAB also avoids the cost overruns in a project.

The initial and supplementary testing and balancing requirements for commissioning must be considered at the design stage (ASHRAE, 2007). Balancing of an air or water based HVAC system will make it more energy efficient, provide better thermal comfort and reduce the operating cost (ECBC, 2009).

The present study deals with few cases, wherein the lessons learned are discussed and recommendations are highlighted. The scope of the present study is limited to balancing of AHU (Air handling unit) of air conditioning systems.

The cases cited are based on authors own research experience as well as with the discussions with the experts in this area.The authors wish to highlight the limited literature available that summarizes the lessons learned in TAB of air conditioning systems.

2. HVAC system and measuring instruments

The common instruments used for air and water balancing of HVAC system includes Pitot tube, Velocity matrix, Air capture hood, Hot wire (or Thermal anemometer), Rotating vane anemometer, Ultrasonic flow meter, etc.

Figure 1 and 2 shows the possible use of various balancing instruments.

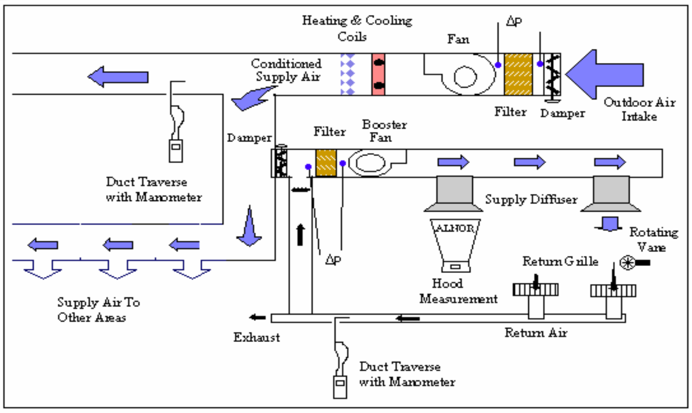

Fig.1 Typical HVAC system showing some measurement locations (Alnor, 2014)

Fig.2 Water flow measurement using Ultrasonic flow meter

3. Lesson learned

3.1 Common mistakes

The common mistakes during project management of HVAC systems include:

1. **Absence of pre TAB checklist:** Pre TAB checklist is necessary to ensure that all the necessary precautions are carried out before the TAB activity starts. This avoids unnecessary delay during testing and also prevents repetition of activities.
2. **Improper instrument selection:** This is the most important blunder as it causes inaccurate and ineffective TAB activity.

The pre TAB checklist and instrument selection is specified in NEBB (2015).

3.2 AHU balancing

Figure 3 shows a schematic of low side - air conditioning system.

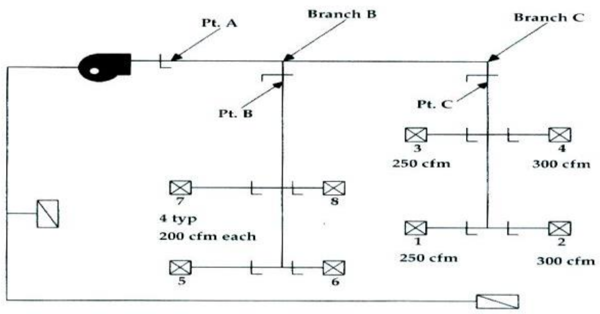

Fig.3AHU balancing (Sugarman, 2006)

Lessons learned:

1. **Fan air capacity:**In majority of the existing plants, it has been observed that there is no provision to measure fan air capacity. For e.g., in Fig. 3, the total air to be delivered is 800 + 1100 = 1900 cfm (cubic feet per minute). The testing engineer verifies at each outlet whether there is required air flow. This unanswers the question, what is the fan air flow at the supply side (point A)? In case, the air flow is significantly higher, it indicates duct leakages resulting in unnecessary fan power consumption.

   Recommendation: Provision of straight length of duct is necessary at the AHU outlet (supply side of fan). This ensures that Pitot tube traverse can be done to determine the fan air quantity. If sufficient straight length of duct is not available (refer Fig. 3, between point 'A' and 'B'), then measurement of air flow with Pitot tube gives inaccurate results, due to turbulence. Since there is lot of turbulence, immediately at the fan outlet (supply side), use of single point measuring instruments such as rotating vane or hot wire anemometer is also not feasible. If there is significant deviation between fan air quantity and air quantity in the room (room outlets), then duct leakage needs to be conducted. If the quantity of air is more than required, the fan air quantity can be adjusted using variable frequency drive (VFD) instead of dampers. Use of VFD will ensure significant energy savings in the AHU fan.

2. **Fan Performance Curves:**The system resistance is predicted based on internal and external resistances occurring inside and outside the AHU. When the system is new (newly commissioned), the resistance offered is less, resulting in more air flow and vice versa. In addition, the fan performance curve also gives better clarity during fine tuning of AHU fan.The parameters such as static pressure and air quantity are better understood through fan performance curve.

Recommendation: A copy of fan performance curve must always be attached to the AHU test report. The Project Engineer as well as the Facility Engineer must always insist for fan performance curve, from the AHU manufacturer or the HVAC consultant.

3. **Air flow at the supply outlets:** The measurement of air flow at the supply outlets 1 to 8 (Fig. 3) are measured using single point instruments such as rotating vane or hot wire anemometer. These instruments are single point instruments and are recommended especially when there is laminar air flow. Across the supply outlets, the flow is turbulent and the position of the measuring instrument (rotating vane or hot wire anemometer) affects the accuracy of the readings. Further, multiple readings needs to be taken for better

averaging. However, the repeatability of the results is a major challenge.

Recommendation: Use of air capture hood is recommended as it has inbuilt grid of Pitot tube. It is a multipoint measuring instrument and averages 16 readings at a time. This not only reduces the time but also ensures better accuracy and repeatability.

4. **Importance of duct leakage testing:** Consider the situation indicated in Table 1.

Table 1 Air flow readings

S. No	Parameters	Design	Actual
1	Total air quantity	42500 m^3/hr	43000 m^3/hr
2	Fresh air quantity	500 m^3/hr	1836 m^3/hr
3	Fan speed	1160 rpm	1130 rpm

Table 1 indicates that the actual total air quantity in the occupied area matches with the design parameter. However to match the total air quantity, the actual fresh air has been increased by almost 4 times than the required fresh air. This indicates that there is huge exfiltration either occurring from the occupied space or through the return air ducting. The increase in the fresh air quantity (than design), will have significant effect on the cooling coil capacity, thereby leading to increase energy consumption.

Recommendation: Duct leakage testing is one of the important aspects to be implemented during balancing of air conditioning systems. Avoidance and inaccurate duct leakage testing leads to excess energy consumption of air conditioning system and poor occupant comfort.

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Conclusions

The authors have highlighted the importance of TAB for air conditioning projects through the lessons learned. In India, with increasing demand of air conditioning, both for process and comfort application, the project management of air conditioning system needs to be more scientific and systematic.

The lessons learned will provide valuable insights to the architects, consultants, contractors, project managers and end users in their current and upcoming air conditioning projects.

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