

# Project Challenges at T2 - Mumbai International Airport

Part 2 of 2

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## Commissioning Activities

The design, execution, testing and commissioning of the air conditioning system – the largest mega HVAC system in India's history – at Mumbai airport Terminal 2 building, and its integration with other services, was a huge challenge. The responsibility for

executing a project at this scale called for resource management of more than 15.50 lakh man-hours across various trades. Testing, Commissioning and Balancing the HVAC system to ensure optimum performance of the equipment and the overall system was equalling challenging, requiring the deployment of adequate qualified and skilled commissioning manpower, fully equipped with the required set of tools and instruments. The Project Manager was required to estimate the man hours for each trade involved in the testing and commissioning activities.

The system was required to be validated for the design performance of equipment and the entire air conditioning load.

## About the Author

**Ketan Soni** graduated in mechanical engineering from L. D. College of Engineering, Ahmedabad in 1983, and has more than 30 years of experience in the field of HVAC project management at Blue Star, including engineering, project planning, testing and commissioning, sales and marketing and overseas assignments. He is a BEE qualified energy auditor and an active life member and past president of ISHRAE Vadodara Chapter. He has presented papers at CII, National Productivity Council and IGBC platforms, and delivered lectures in various engineering and architectural institutes. He has written several articles for magazines.



Figure 1: NEBB certificate of the firm carrying out TAB at Terminal 2

After the installation of all the equipment with the necessary controls, electrical, BMS and other integrated services as per the approved GFC, the Installation Protocol was required to be documented and duly certified by the approval authorities. Around 4050 protocols were to be certified for the installation work carried out as per drawings.

For such mega HVAC projects, it is mandatory to carry out the testing, adjusting and balancing of the system (TAB) by a National Environmental Balancing Bureau (NEBB) certified firm. Established in 1971, NEBB is the premier international association of certified firms that perform Building Systems Commissioning, Testing, Adjusting, and Balancing of HVAC systems. When applied by an NEBB certified firm, the NEBB Procedural Standards provide consistently high levels of commissioning results based on rigorous requirements. There are more than 650 NEBB certified firms worldwide, and over 1800 NEBB certified professionals and technicians. They are recognized by the industry and building

Table 1: Summary of equipment for installation, testing and commissioning

Sr.No	Description	Scope	Installed	Inspection Completed	Power Available	Electrical Pre-commissioning Done	Mechanical Pre-commissioning Done	BMS Commissioning Done	Commissioning Done	Performance Testing Done
<b>Utility Building</b>										
1	Chilled Water Primary Pumps	7	7	7	7	7	7	0	7	7
2	Chilled Water Secondary Pumps	7	7	7	7	7	7	0	7	7
3	Condenser Pumps	7	7	7	7	7	7	0	7	7
4	Cooling Tower	6	6	6	6	6	6	0	6	0
5	Pressurisation Unit and Air Separator	1	1	1	1	1	1	0	1	1
6	FCU	13	13	13	13	13	13	13	13	7
7	Axial Fans	23	23	23	23	23	23	23	23	23
8	Chemical Dosing System	1	1	1	1	1	1	1	1	1
<b>Total (A)</b>		<b>65</b>	<b>65</b>	<b>65</b>	<b>65</b>	<b>65</b>	<b>65</b>	<b>37</b>	<b>65</b>	<b>53</b>
<b>T2 Building</b>										
1	FCU	208	208	208	208	208	198	197	198	176
2	CAHU	90	90	90	83	90	90	89	90	62
3	AHU	64	64	64	64	64	64	64	64	64
4	HRU	8	8	8	8	8	8	8	8	3
5	OHU	5	5	5	5	5	5	5	5	3
6	FAU	3	3	3	3	3	3	3	3	3
7	IDU & ODU	8	8	8	8	8	8	8	8	5
8	CRAC Units	6	6	6	6	6	6	0	6	0
9	Split Units	2	2	2	2	2	2	0	2	2
10	Inline Centrifugal Fans (Cabinet Fan)	89	89	89	89	89	89	87	89	88
11	Axial Fans	174	174	174	174	174	174	172	173	151
<b>Total (B)</b>		<b>657</b>	<b>657</b>	<b>657</b>	<b>650</b>	<b>657</b>	<b>647</b>	<b>633</b>	<b>646</b>	<b>557</b>
<b>Total (A + B)</b>		<b>722</b>	<b>722</b>	<b>722</b>	<b>715</b>	<b>722</b>	<b>712</b>	<b>670</b>	<b>711</b>	<b>610</b>

Table 2: Groups of engineers for equipment under commissioning

Commissioning Status in Groups							
Type	Group No.	Scope Qty.	Installed Qty.	Commissioning Status			
				Electrical Pre-commissioning	Mech Pre-commissioning	Commissioning	Performance
AHU	Group 1	9	9	9	9	9	9
	Group 2	45	45	45	45	45	45
	Group 3	10	10	10	10	10	10
FCU Non TC	Group 1	37	37	37	37	37	29
	Group 2	32	32	29	29	29	28
	Group 3	6	6	7	7	7	7
FCU-TC AC	Group 1	26	26	25	25	25	21
	Group 2	32	32	30	30	30	28
	Group 3	6	6	7	7	7	6
CAHU	Group 1	63	63	61	61	61	41
	Group 2	23	23	22	22	22	16
	Group 3	4	4	4	4	4	2
Inline Centrifugal Exhaust Fan	Group 1	15	15	16	16	16	15
	Group 2	16	16	14	14	14	14
	Group 3	6	6	10	10	10	10
Inline Centrifugal Toilet Exhaust	Group 1	16	15	16	16	16	16
	Group 2	13	13	13	13	13	13
	Group 3	7	6	7	7	7	7
Inline Supply Fan	Group 1	6	6	4	4	4	4
	Group 2	8	7	7	7	7	7
	Group 3	0	0	0	0	0	0
Axial Fan BHS	Group 1	8	8	8	8	8	8
	Group 2	26	26	26	26	26	26
	Group 3	0	0	0	0	0	0
Axial Fan Exhaust	Group 1	6	6	5	5	5	5
	Group 2	8	8	8	8	7	7
	Group 3	1	1	1	1	1	1
Axial Fan Kitchen Supply/Exhaust	Group 1	4	3	3	3	3	3
	Group 2	2	2	3	3	3	3
	Group 3	2	0	1	1	1	1
Axial Fan Lift Well	Group 1	19	19	19	19	19	15
	Group 2	13	13	13	13	13	9
	Group 3	9	9	9	9	9	4
Axial Fan Supply	Group 1	3	3	5	5	5	5
	Group 2	4	4	4	4	4	4
	Group 3	1	1	1	1	1	1
Axial Fan Staircase Pressurisation	Group 1	15	15	15	15	15	12
	Group 2	10	10	10	10	10	10
	Group 3	6	6	6	6	6	6
Axial Fan Smoke Exhaust	Group 1	17	17	17	17	17	17
	Group 2	14	14	14	14	14	14
	Group 3	6	6	6	6	6	0

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It is mandatory for an NEBB certified firm to have all tools and testing instruments calibrated and registered with NEBB during the testing. Testing professionals will find the list of instruments in Table 4, used for this mega HVAC project, useful.

Table 4: Testing and commissioning tool kits for T2

S. No.	Name of the tool	Qty	Preferred make
<b>I Floor Mounted AHU</b>			
1	Belt tension meter	1	Fenner
2	Tachometer	1	Standard
3	Megger	1	Motwani
4	Clamp-on meter	1	Fluke
5	Vibration meter	1	SPM
6	dB meter	1	Testo
7	Air matrix	1	TSI
8	Vane anemometer	1	Lutron
9	Manometer	1	TSI
9	Static tube	2	TSI
10	CO2 meter	1	Testo
11	Sling psychrometer	1	JRM
12	Thermometer	1	Fluke/ Testo
<b>II Ceiling Suspended AHU</b>			
1	Megger	1	Motwani
2	Clamp-on meter	1	Fluke
3	dB meter	1	Testo
4	Vane anemometer	1	Lutron
5	Manometer	1	TSI
6	Static tube	2	TSI
7	Sling psychrometer	1	JRM
8	Thermometer	1	Fluke/ Testo
<b>III FCU</b>			
1	Clamp-on meter	1	Fluke
2	dB meter	1	Testo
3	Vane anemometer	1	Lutron
4	Manometer	1	TSI
5	Static tube	2	TSI
6	Sling psychrometer	1	JRM
7	Thermometer	1	Fluke/ Testo
<b>IV Dual Coil DX Unit</b>			
1	Megger	1	Motwani
2	Clamp-on meter	1	Fluke
3	dB meter	1	Testo
4	Vane anemometer	1	Lutron
5	Manometer	1	TSI
6	Static tube	2	TSI
7	Sling psychrometer	1	JRM
8	Thermometer	1	Fluke/ Testo
9	Refrigerant gauge manifold	1	Rothenberger
<b>V Axial Fans</b>			
1	Tachometer	1	Standard
2	Megger	1	Motwani
3	Clamp-on meter	1	Fluke
4	Vibration meter	1	SPM
5	dB meter	1	Testo

6	Vane anemometer	1	Lutron
7	Manometer	1	TSI
8	Static tube	2	TSI
9	Pitot tube	2	TSI
<b>VI Inline Fans</b>			
1	Belt tension meter	1	Fenner
2	Tachometer	1	Standard
3	Megger	1	Motwani
4	Clamp-on meter	1	Fluke
5	Vibration meter	1	SPM
6	dB meter	1	Testo
7	Vane anemometer	1	Lutron
8	Manometer	1	TSI
9	Static tube	2	TSI
10	Pitot tube	1	TSI
<b>VII Pumps</b>			
1	Tachometer	1	Standard
2	Megger	1	Motwani
3	Clamp-on meter	1	Fluke
4	Vibration meter	1	SPM
5	dB meter	1	Testo
6	Pressure gauge	2	Standard
<b>VIII Cooling Tower</b>			
1	Megger	1	Motwani
2	Clamp-on meter	1	Fluke
3	Vibration meter	1	SPM
4	Vane anemometer	1	Lutron
5	Sling psychrometer	1	JRM
6	Thermometer	1	Fluke/ Testo
<b>IX Water Balancing</b>			
1	Ultrasonic flow meter	1	Panametrics
2	Pressure gauge	2	Standard
<b>X Air Balancing</b>			
1	Air volume hood	1	TSI
2	Manometer with pitot tube	1	TSI
3	Vane anemometer	1	Lutron
4	Foldable ladder	1	Standard
5	Hand tools	1	Standard
6	Beam torch	1	Standard
7	Thermometer	1	Fluke/ Testo

Table 5 lists the total number of tool kits deployed at the project site.

Table 5: Tool kits deployed at project site

S. No.	Tool kit	Qty
1	Centralised tool kit for TAB water	1
2	Centralised tool kit for TAB air	1
3	Centralised tool kit electrical	1
4	Electrician's tool kit	3
5	Individual team tool kit TAB air side	5
6	Plant room commissioning tool kit	1

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Figure 3 through 16 show some of the equipment and instruments used for testing, adjusting and balancing the various systems in the project.

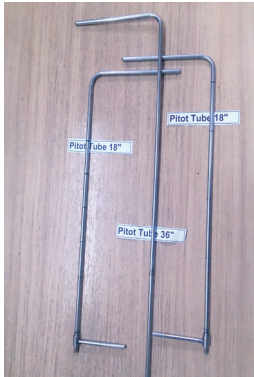


Figure 3: Pitot tube



Figure 4: Manometer



Figure 5: Clamp-on meter



Figure 6: Anemometer



Figure 7: Tachometer



Figure 8: Air volume hood



Figure 9: Ultrasonic water flow meter



Figure 10: Thermocouple thermometer



Figure 11: Thermal imager



Figure 12: Vibrometer



Figure 13: CO2 sensor



Figure 14: Alignment of a 25000cfm fan with motor inside a floor mounted double skin AHU, housing two such fans



Figure 15: Air velocity measurement on a cooling coil with an air matrix station comprising 16 pitot tube manometers in a 50000cfm floor mounted AHU



Figure 16: Measurement of electrical parameters on HVAC rotary equipment MCC

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Table 6: A sample tracking summary sheet for equipment

MIAL HVAC EQUIPMENTS TESTING & COMMISSIONING STATUS													
SR NO	Building	Level	Type	Equipment Location	Tag No	Installation Status	Inspection Status	Electrical Pre-Commissioning	Mechanical Pre-Commissioning	BMS Commissioning	Mechanical Commissioning	Performance Test	Current Stage
								Ele-Comm OK	Pre-Comm OK	BMS Comm OK	Commissioning	Completed	
<b>ELECTRICAL BUILDING</b>													
<b>FANS:09</b>													
1	PLANT ROOM	2	AXIAL FAN	PASSAGE	FF EF 01	OK	OK	OK	OK	OK	OK	OK	Completed
2	PLANT ROOM	2	AXIAL FAN	PASSAGE	FF EF 02	OK	OK	OK	OK	OK	OK	OK	Completed
3	PLANT ROOM	2	AXIAL FAN	PASSAGE	FF EF 03	OK	OK	OK	OK	OK	OK	OK	Completed
4	PLANT ROOM	2	AXIAL FAN	PASSAGE	FF EF 04	OK	OK	OK	OK	OK	OK	OK	Completed
5	PLANT ROOM	1	AXIAL FAN	PASSAGE	GR EF 01	OK	OK	OK	OK	OK	OK	OK	Completed
6	PLANT ROOM	1	AXIAL FAN	PASSAGE	GR EF 02	OK	OK	OK	OK	OK	OK	OK	Completed
7	PLANT ROOM	1	AXIAL FAN	PASSAGE	GR EF 03	OK	OK	OK	OK	OK	OK	OK	Completed
8	PLANT ROOM	1	AXIAL FAN	PASSAGE	GR EF 04	OK	OK	OK	OK	OK	OK	OK	Completed
9	PLANT ROOM	1	AXIAL FAN	BATTERY ROOM	GR EF 05	OK	OK	OK	OK	OK	OK	OK	Completed
<b>FCU : 05</b>													
10	PLANT ROOM	1	FCU	DG RELAY ROOM	FCU 01	OK	OK	OK	OK	OK	OK	OK	Completed
11	PLANT ROOM	2	FCU	UPS ROOM	FCU 02	OK	OK	OK	OK	OK	OK	OK	Completed
12	PLANT ROOM	2	FCU	CMS SCADA ROOM	FCU 03	OK	OK	OK	OK	OK	OK	OK	Completed
13	PLANT ROOM	2	FCU	OPERATOR ROOM	FCU 04	OK	OK	OK	OK	OK	OK		Commissioning OK
14	PLANT ROOM	2	FCU	TCAC CLOSET	FCU 05	OK	OK	OK	OK	OK	OK	OK	Completed
<b>PLANT ROOM</b>													

## Conclusion

During the tenure of testing and commissioning of such projects, it is important to involve the operation and maintenance team to get them trained and take over the system for smooth

operation in future. In addition, such systems need a well planned and exhaustive routine maintenance schedule for interruption free operation. ❖