Technical Issues Faced on Completed Government Hospital Project

Forensic Findings

Mesyuarat Tahunan Jurutera Mekanikal 2016

Cawangan Kejuruteraan Mekanikal, Ibu Pejabat JKR

5 September 2016

Introduction

- Forensic Division had conducted 75 nos of inspections for various types of government buildings since 2011 until august 2016
- **17 no's of inspections** were carried out in the **hospital building**
- Statistic is not included with others health facilities such as Clinics and District Health Office

Problem Statements

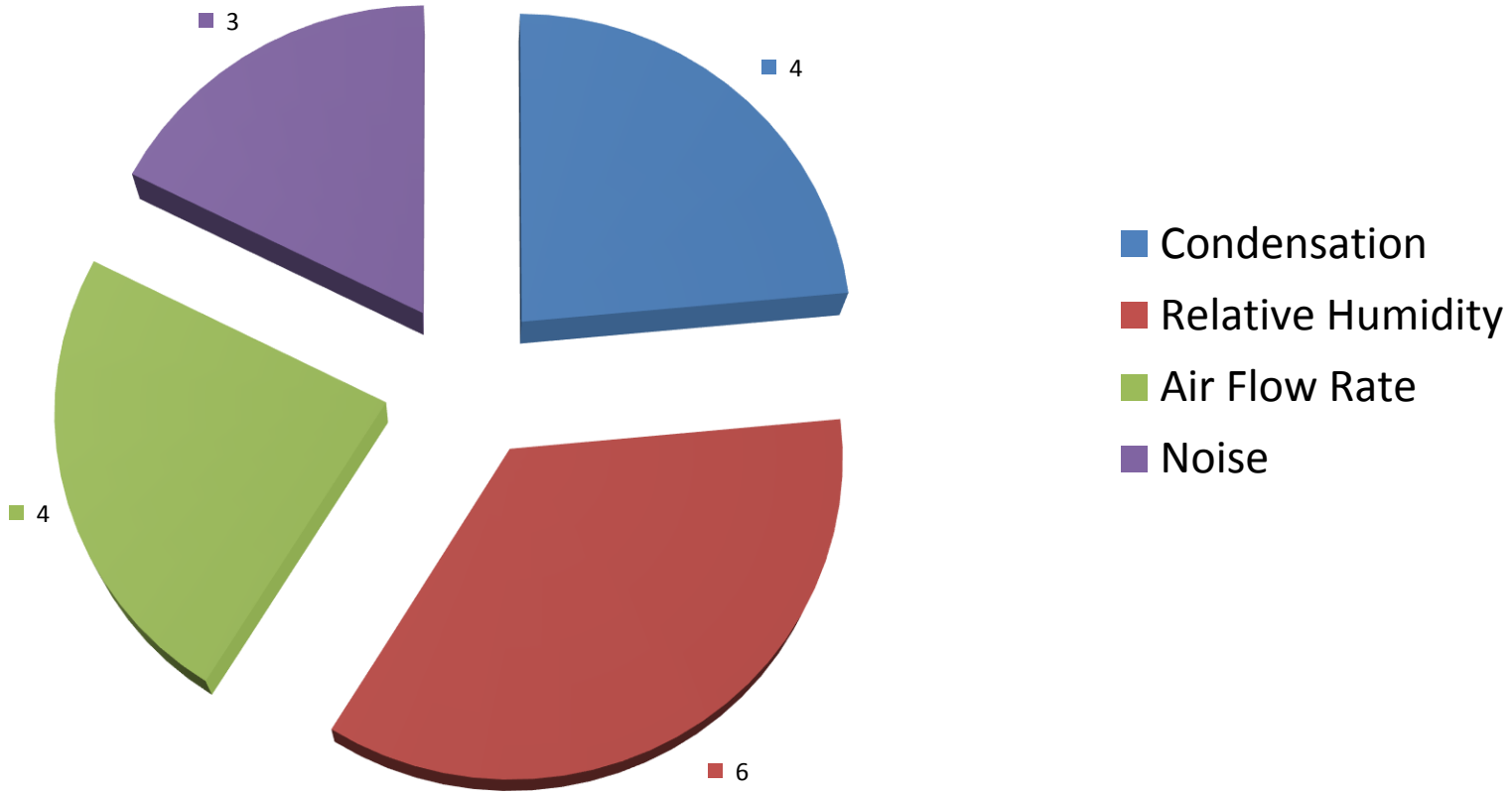
Mold

High Space Humidity

Condensation

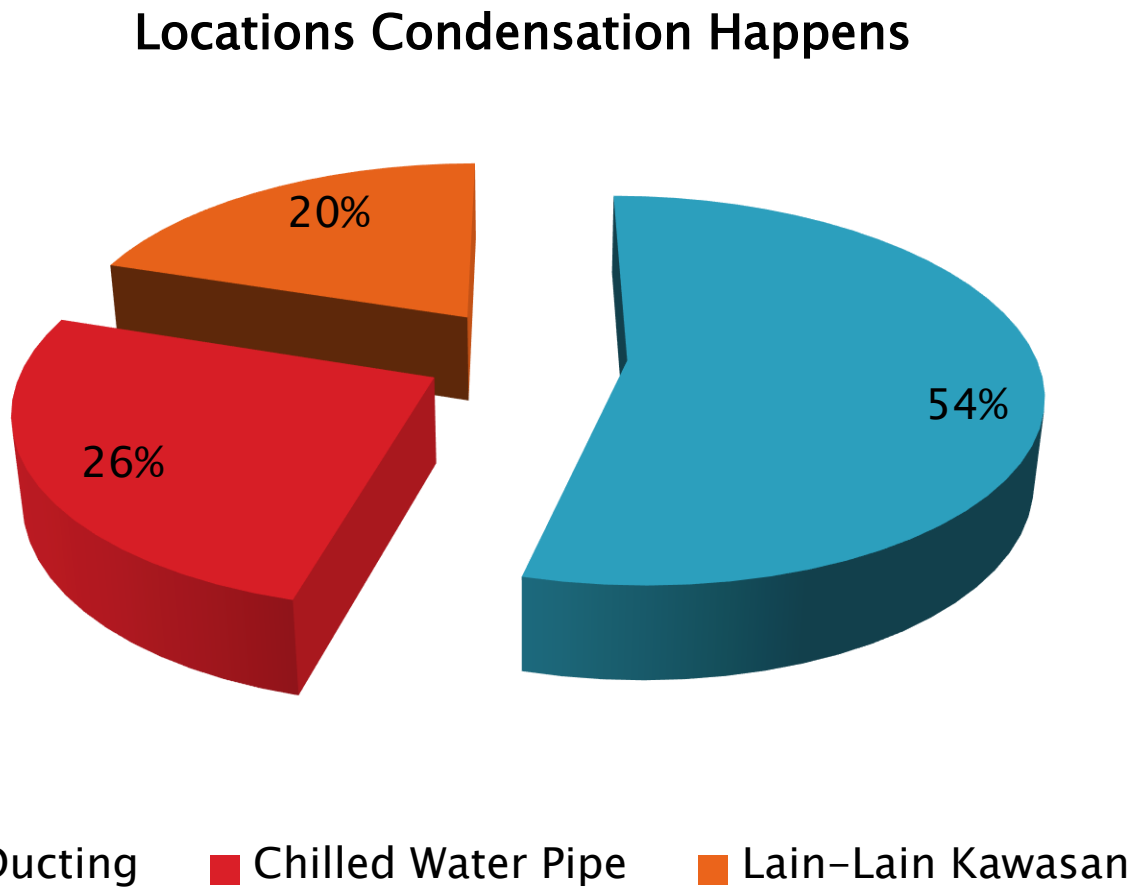
Noise Issues

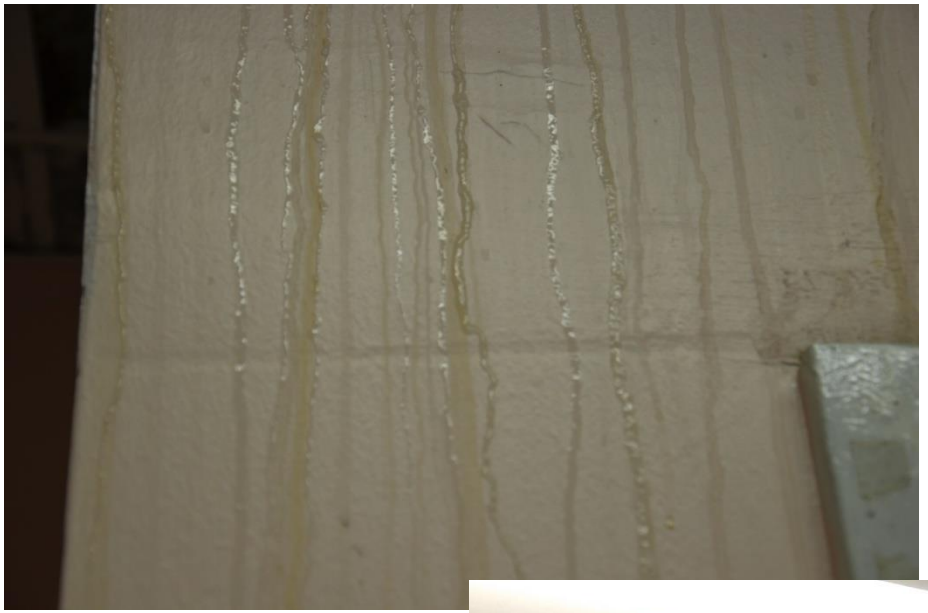
Statistic 2011-2016 (17 Case)



1.0 *Condensation*

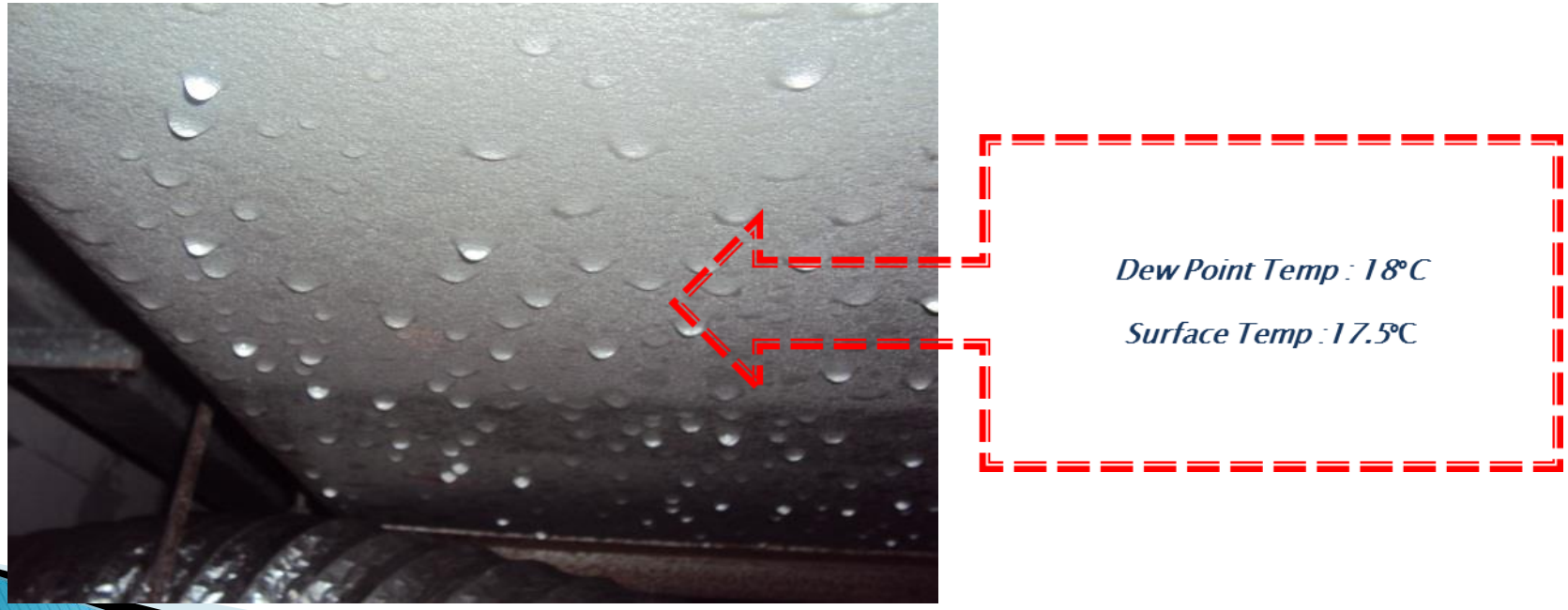
Condensation





Reason

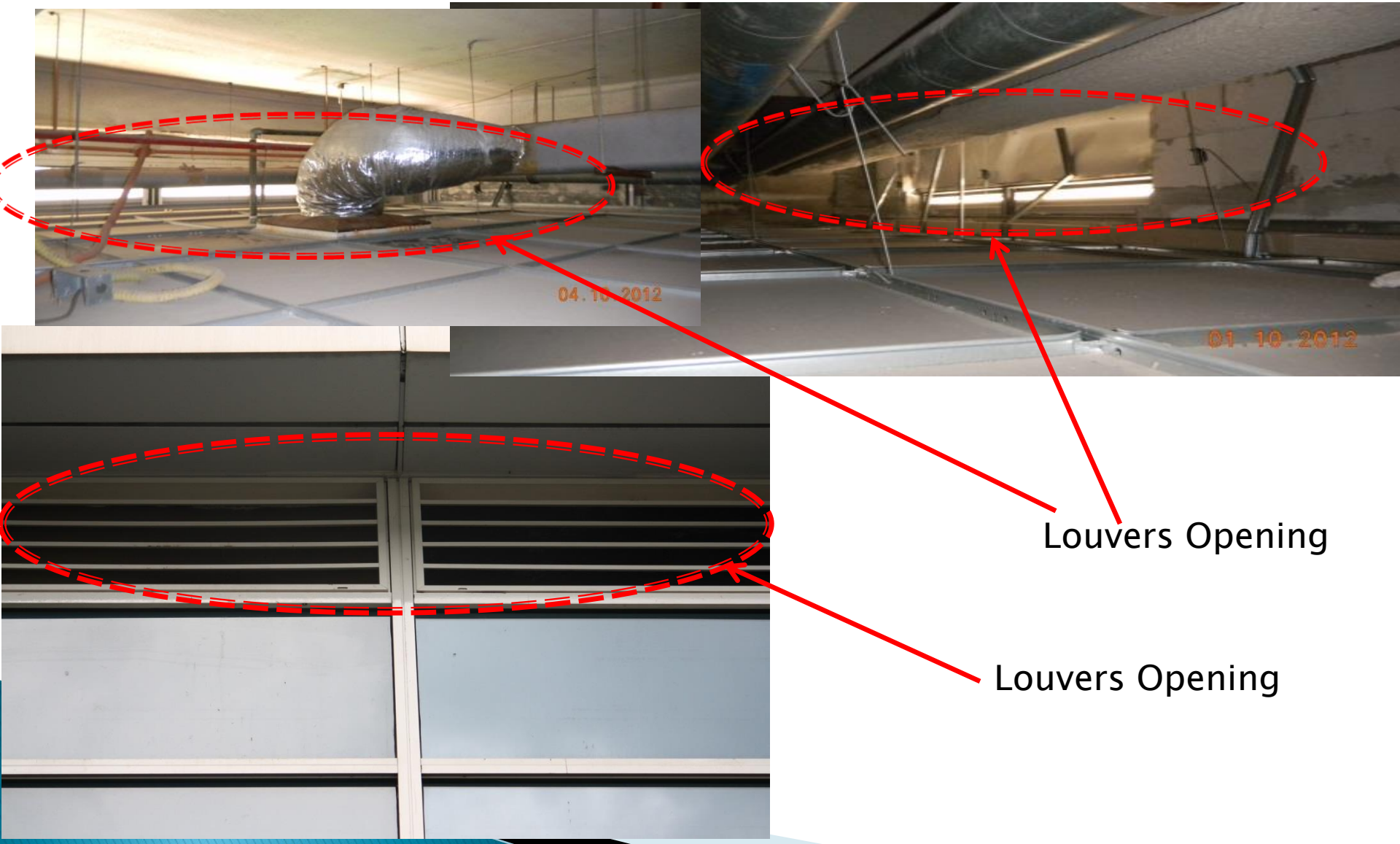
- This condition occurs due to reasons as below:
  - Surface Temp Lower Than Dew Point Temp



Duct Insulation Retrofitting

Before	
	Duct condensation on ducting. Duct thickness 10 mm
After Retrofitting	
	Ducting Insulation 20mm (PE Foam Laminated With Aluminums Foil).

Perimeter Opening (Cross Ventilation)



2.0 HIGH RH

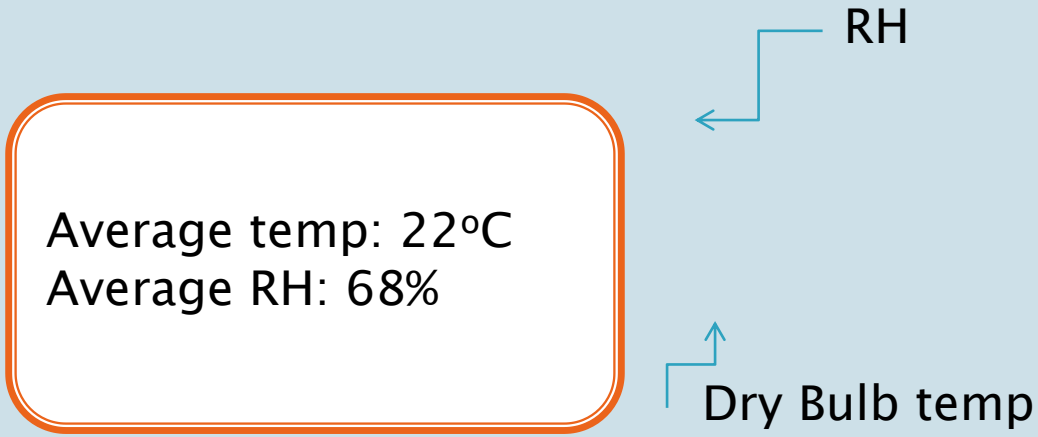
Reason

- This condition occurs due to reasons as below:
  - Building Load – Building Load Less Than Design Load
  - Coil Capacity – Oversized
  - System Failure – The Possibility of System Failure

2.1 Cooling Coil Retrofitting

Retrofitting- *Cooling coil area reduction*

Before Retrofit

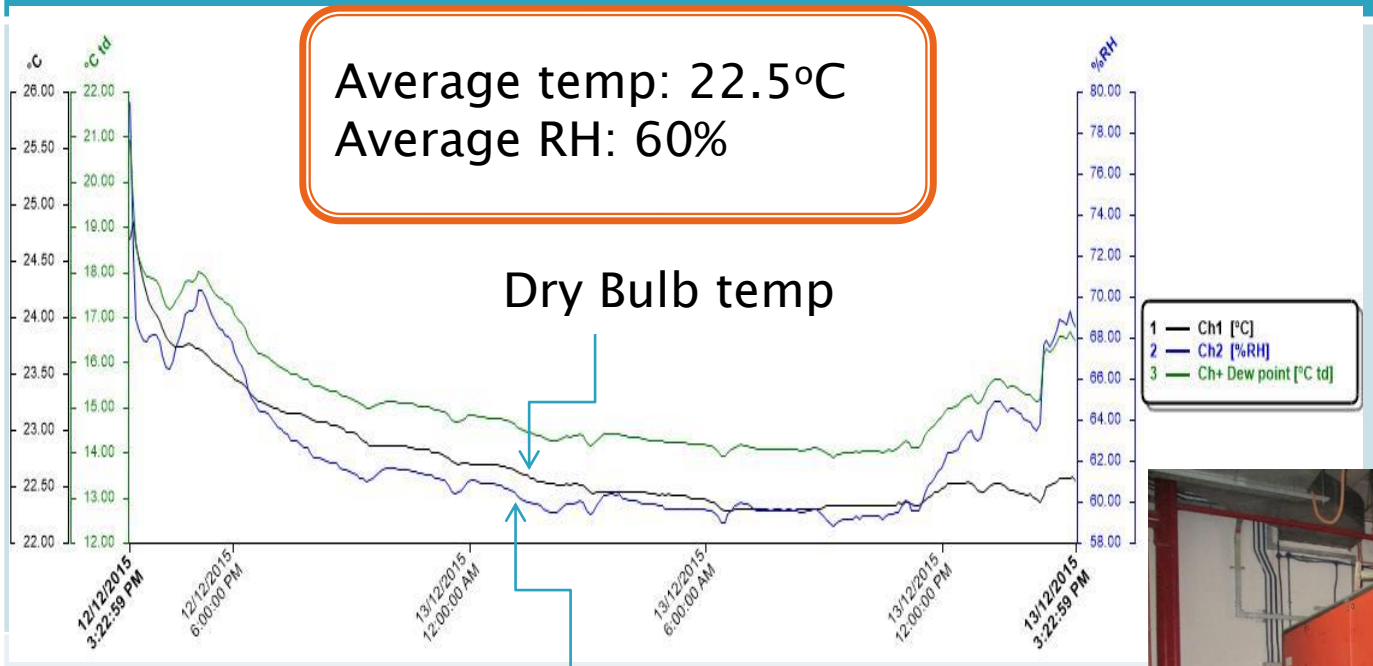


Load density: 53 btu/hr.sq.ft

Retrofitting- *Cooling coil area reduction*

After Retrofit

Average temp: 22.5°C
Average RH: 60%



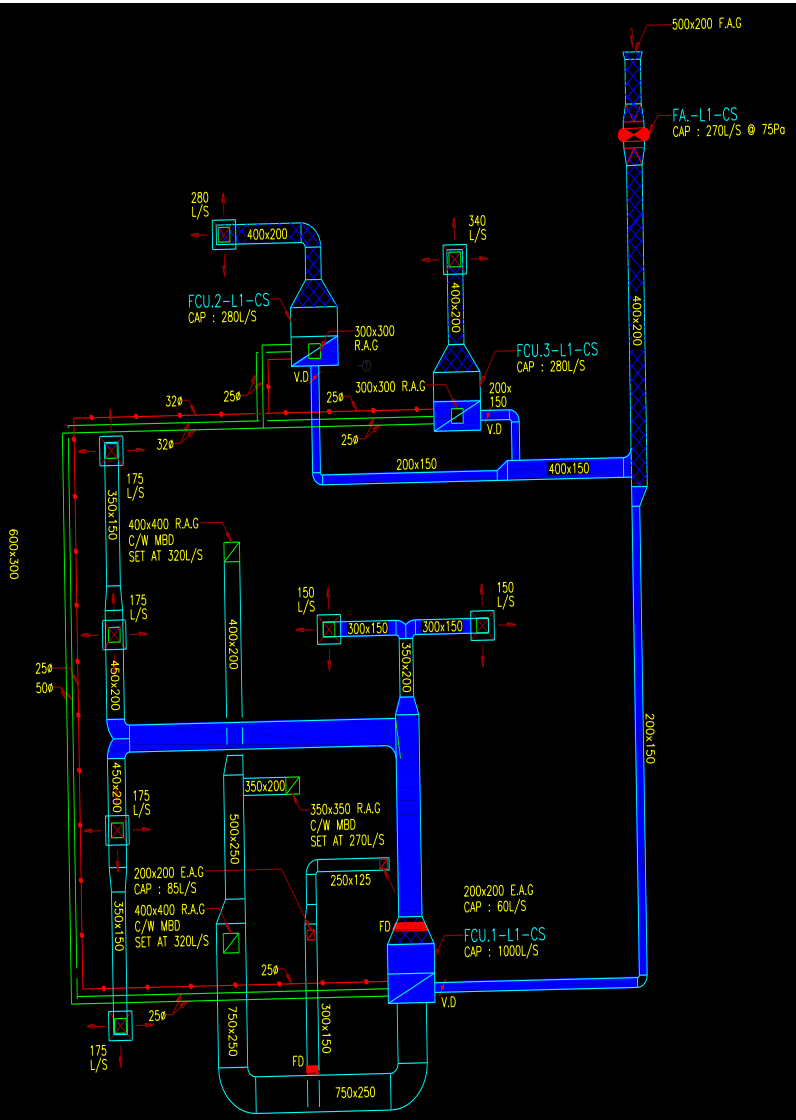
Dry Bulb temp

RH

RH reduction from 68% to 60%

Cooling coil area reduction

Possibility of System Failure



3.0 Low Supply Air Flow Rate /Air Change Rate

Reason

- This factor occurs due to reasons below:
  - Insufficient effective duct length immediately after AHU
  - Poor fan discharge ducting arrangement
  - AHU fan wrong direction installation
  - Wrong guide vane installation
  - Duct leakages
  - Insufficient return grille

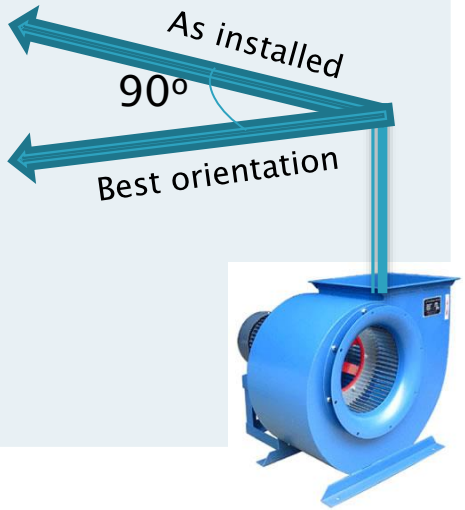
Retrofitting- *System Effect*

DUCT REROUTING
Before

AHU duct outlet for General Medicine zone is at 90 deg relative to flow discharge direction from fan.

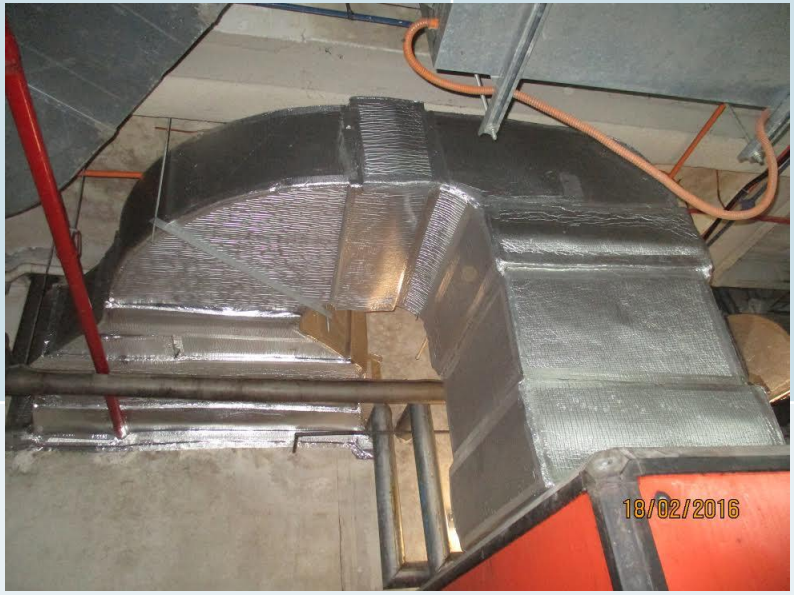
Design AirFlow >6250 l/s ~ 13000cfm
Measured AirFlow >3108 l/s~6500cfm

Propose Ducting Wall Penetration



Retrofitting– *System Effect*

DUCT REROUTING
After



Design AirFlow >6250 l/s ~ 13000cfm
Measured AirFlow >3108 l/s~6500cfm (Before Retrofit)
Measured AirFlow >4351 l/s~9100cfm (After Retrofit)

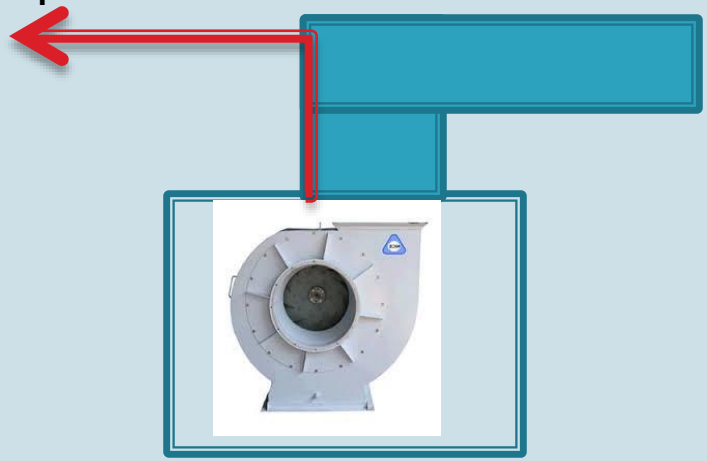
40% Air Flow Improvement

Retrofitting – *System Effect*

FAN REORIENTATION
Before

Recommended practice

As installed



Design AirFlow >5550 l/s ~ 12000cfm
Measured AirFlow >2500 l/s~5300cfm (Before Retrofit)

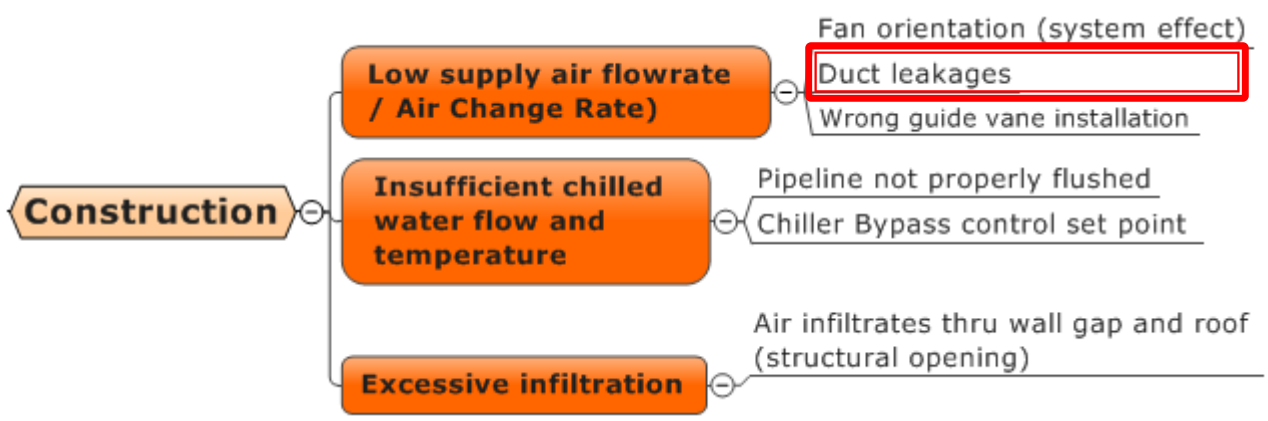
Retrofitting – *System Effect*

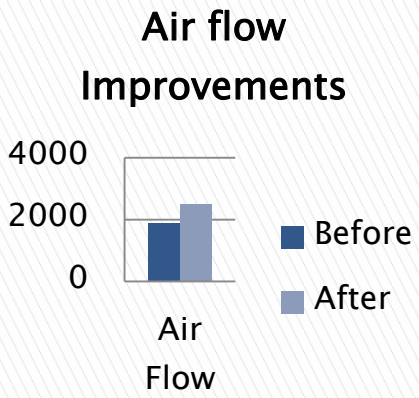
FAN REORIENTATION
After

Design AirFlow >5550 l/s ~ 12000cfm
Measured AirFlow >2500 l/s~5300cfm (Before Retrofit)
Measured AirFlow >3000 l/s~6400cfm (After Retrofit)

Improved 20 % Air Flow

Low Air Flow Rate

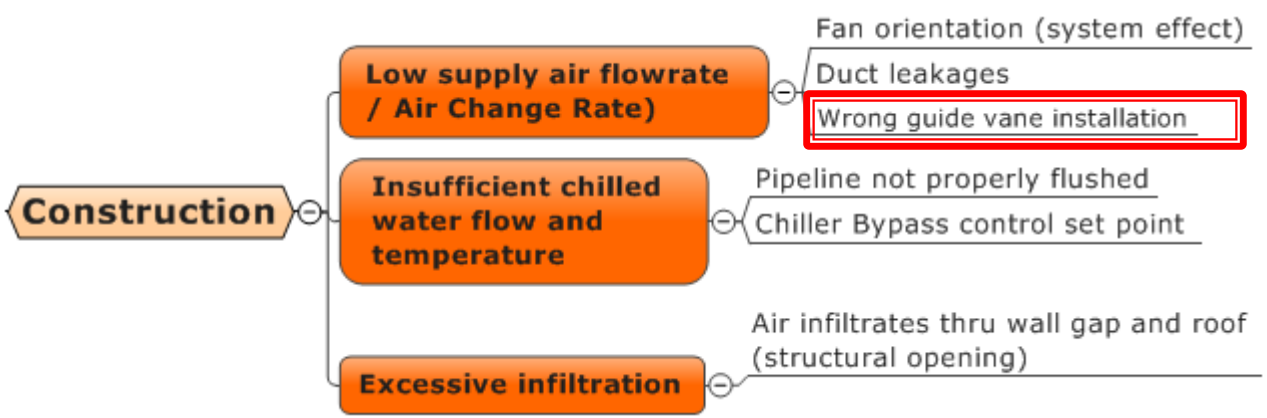


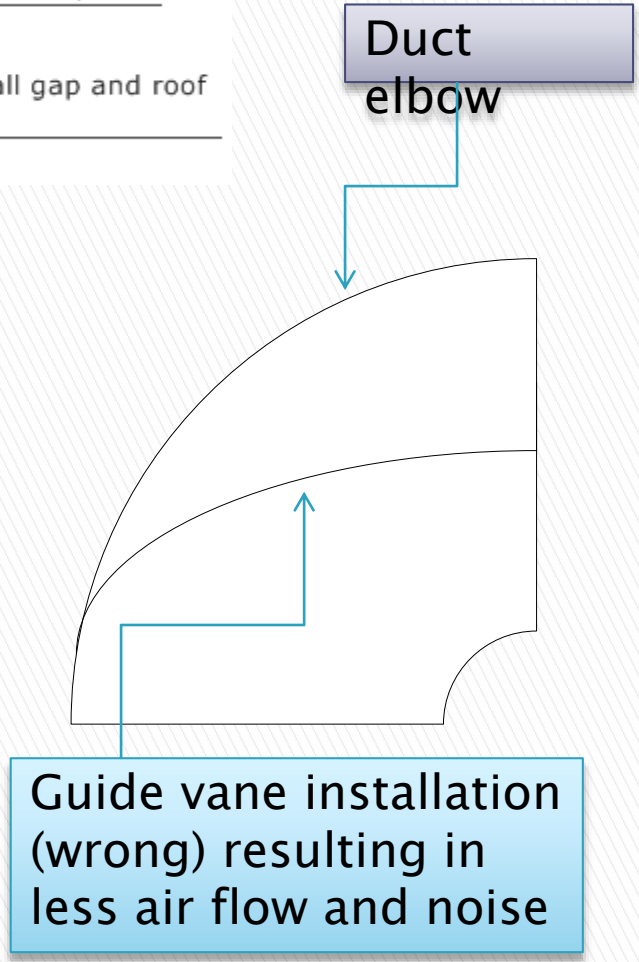


Ref case:
Retrofitting works
After duct reseal, supply air flow rate increases from 1900 cfm to 2500 cfm. An improvement of 32%.

Existing duct seal was applied at duct corner only. New duct seal was applied along all transverse joint perimeter.

Low Air Flow Rate





Low Air Flow Rate

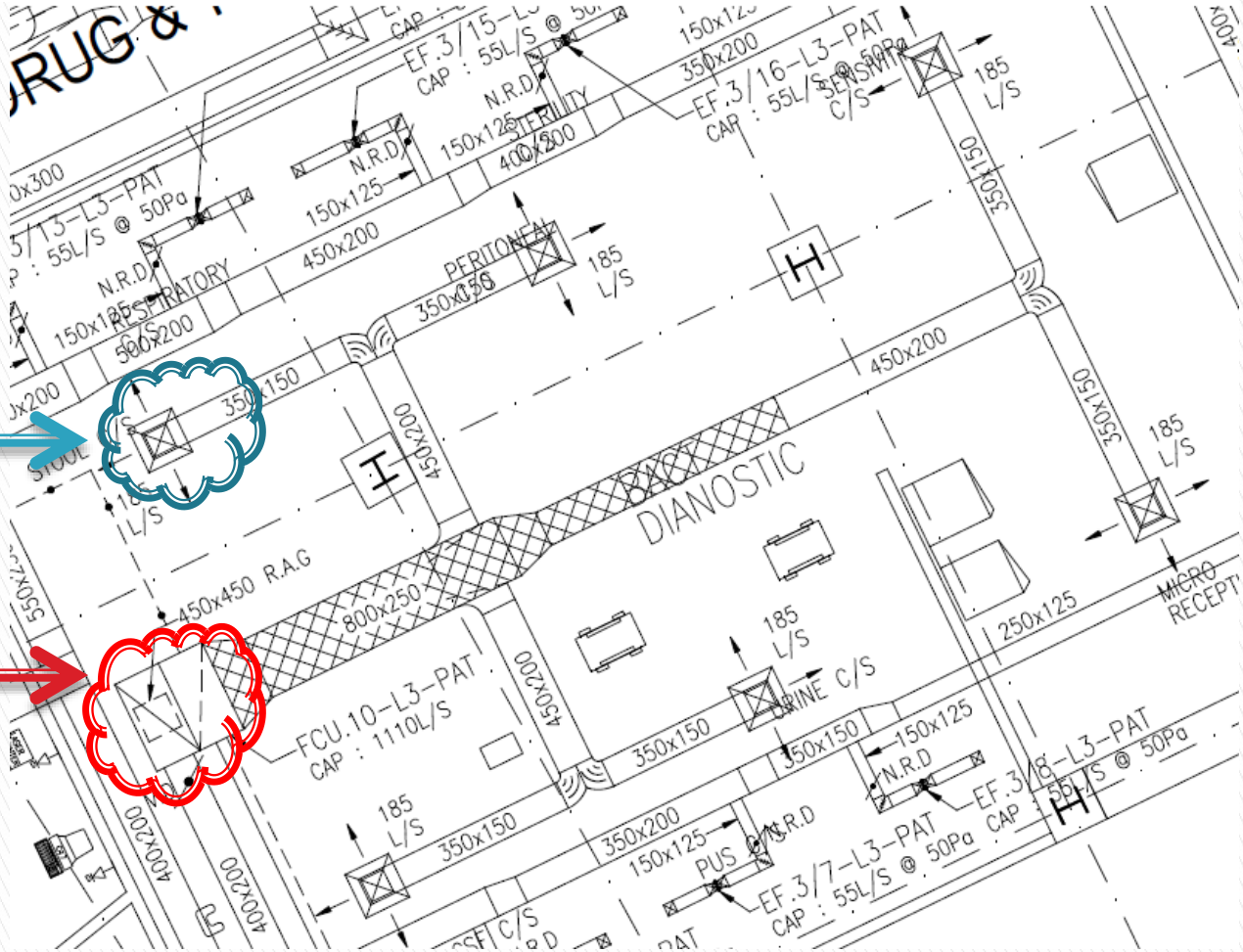
Low supply air flowrate / Air Change Rate)

Insufficient effective duct length (system effect)

Insufficient return air grilles

Insufficient number of return grilles. Added static loss and reduction of flow

1 return grille vs 6 supply diffusers



4.0 Excessive FCU/AHU CFM

Reason

- FCU Capacity not meet/ the design parameter

Wrong Capacity Selection

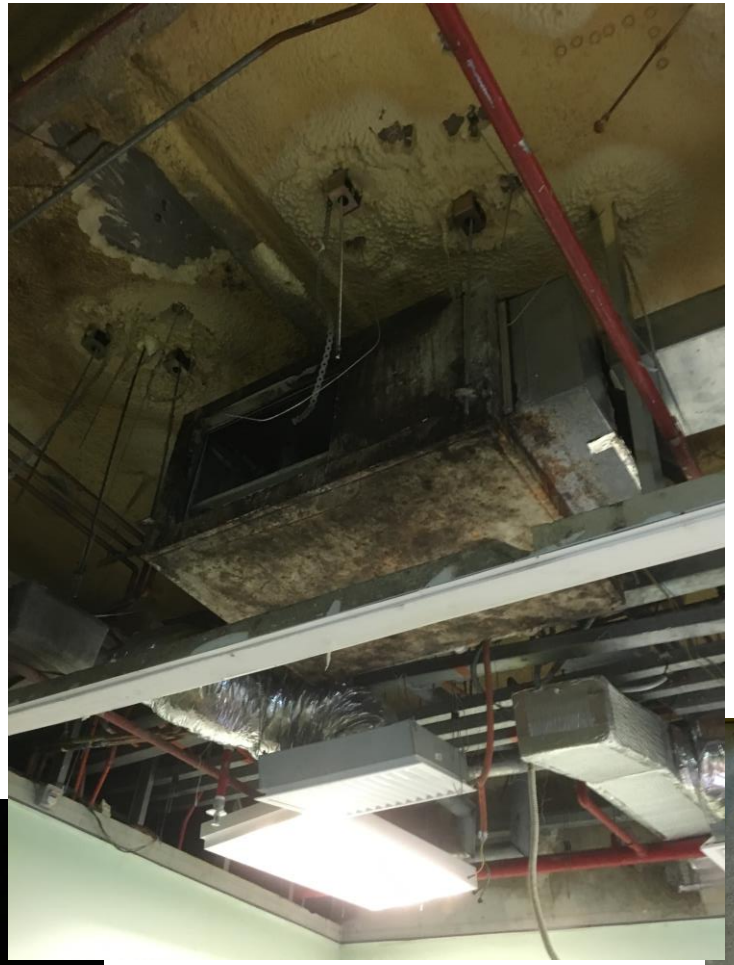
Suggestions

- VSD installation
- New FCU with suitable room capacity

5.0 Operations & Maintenance

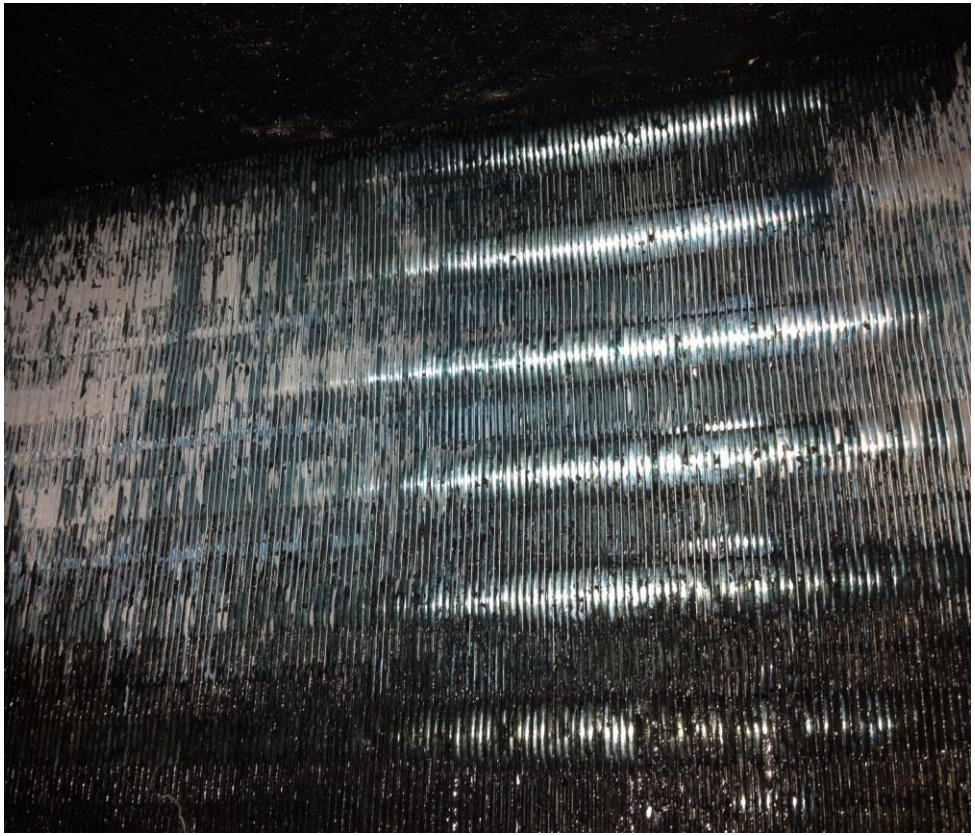
Reason

- Poor maintenance supervisory



DIRTY AIR FILTER

COOLING COIL CHOKE

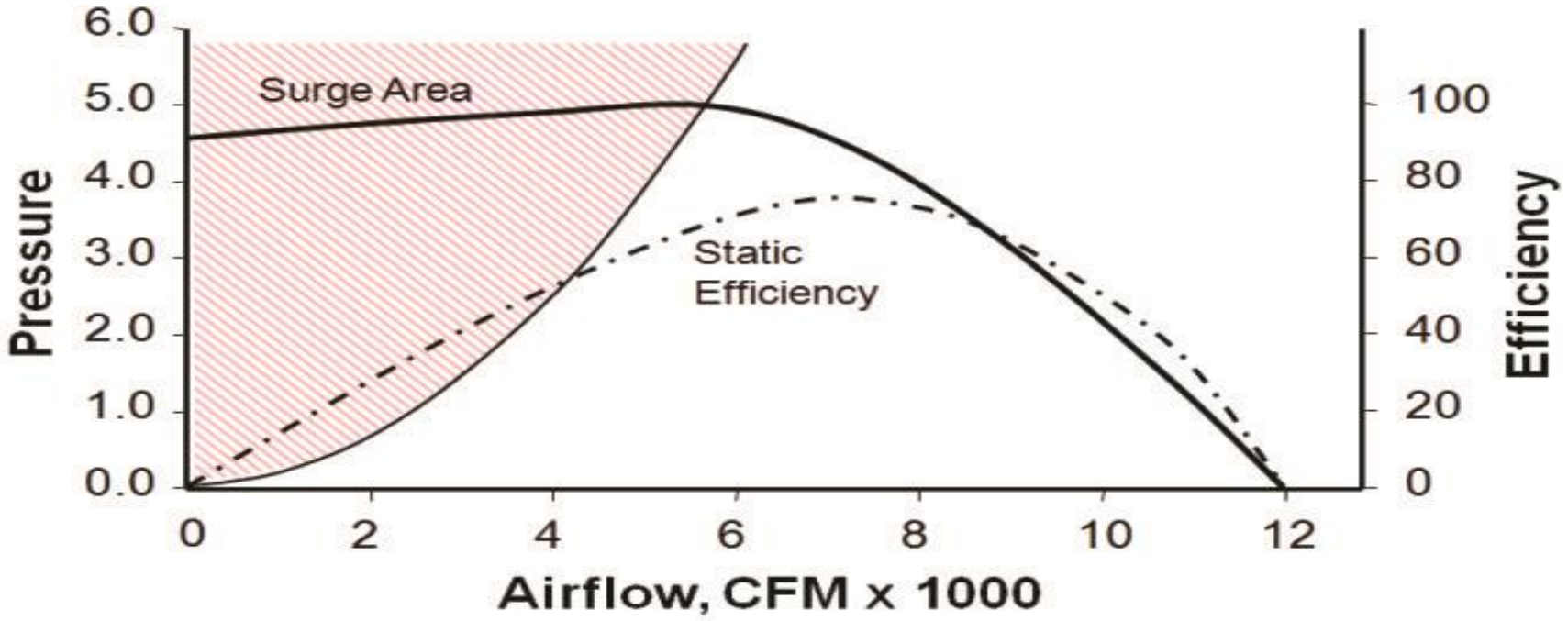


Impact of Poor Maintenance

VIBRATION IN CEILING SPACE 4 (WITH ADDITIONAL TIE-ROD)

Air Filter clog

Fan Selection



Conclusion

- High relative humidity and duct condensation are among the highest number of reported forensic cases in healthcare facility.

So..We must focus to

- Comprehensive design review
- Equipment Selection Review
- Close Supervision of Installation
- Proper Testing & Commissioning
- Operations & Maintenance