

# INLAND EMPIRE CHAPTER

## The AHU From

# Hell

*A Case Study Presented by*

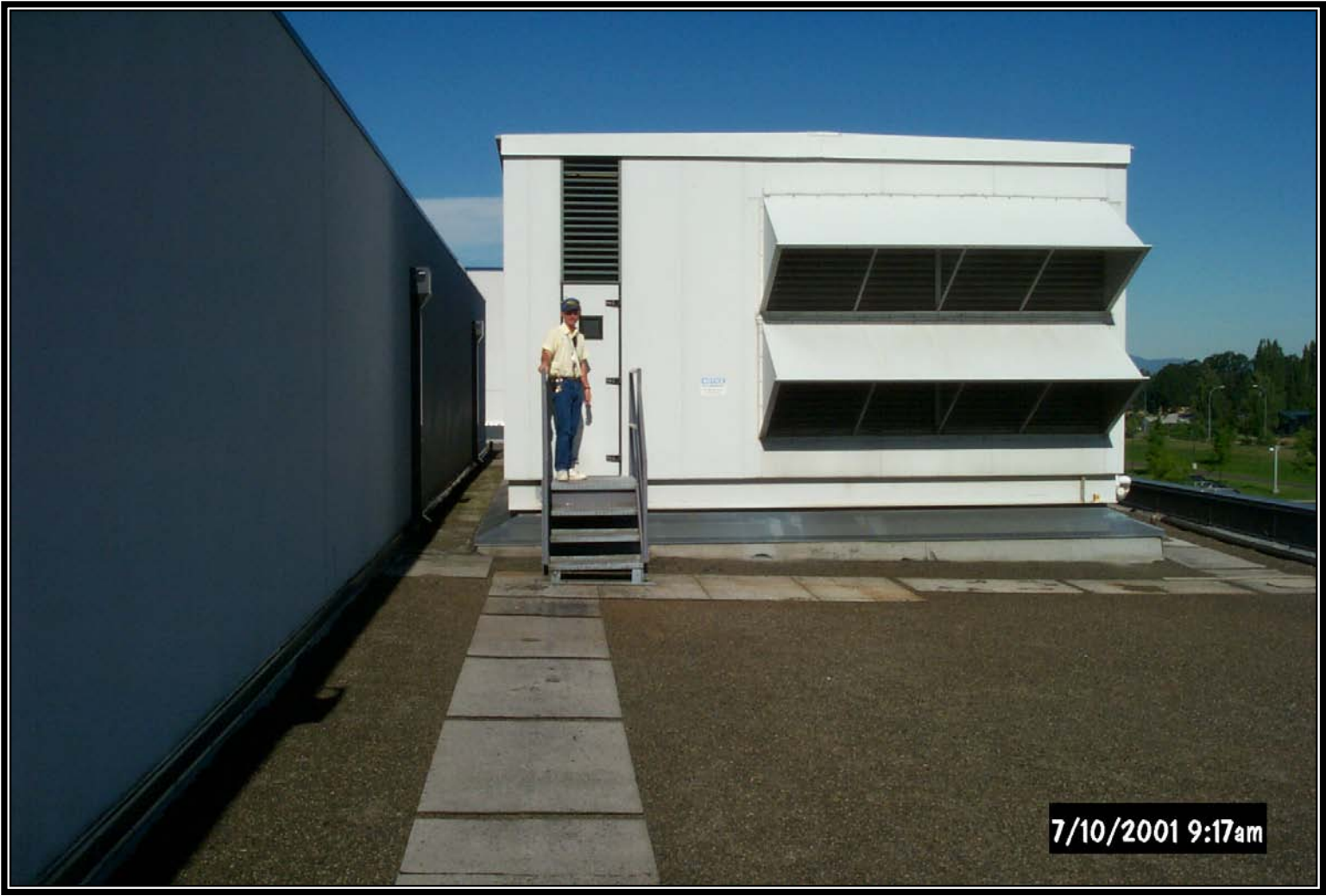
*David Sellers*

*Portland Energy Conservation Inc.*



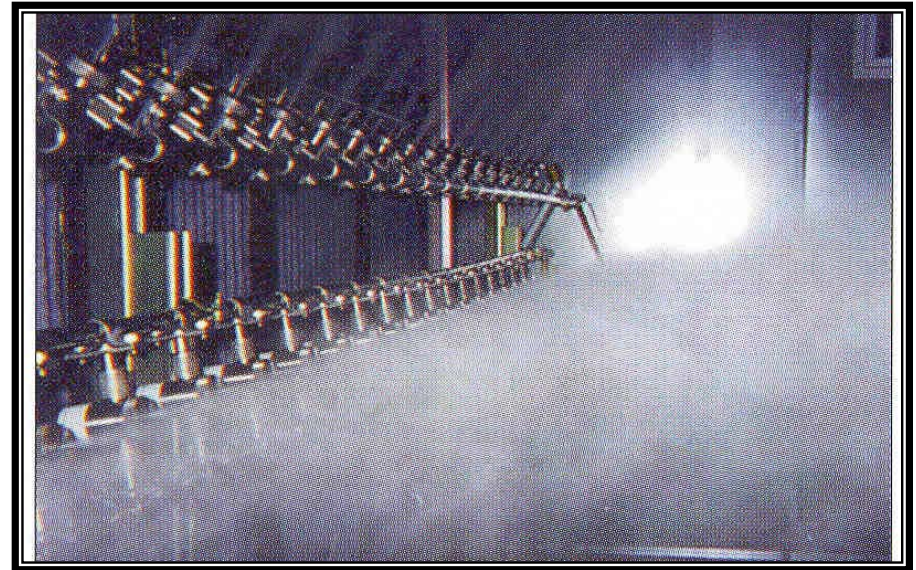


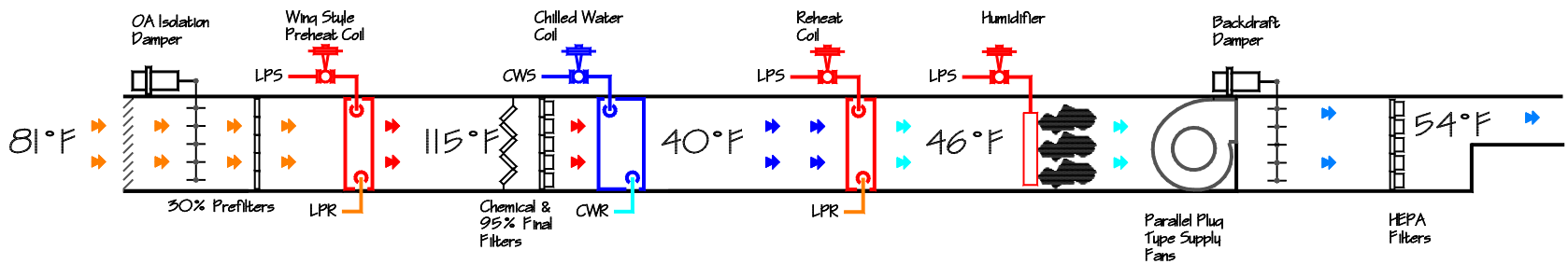
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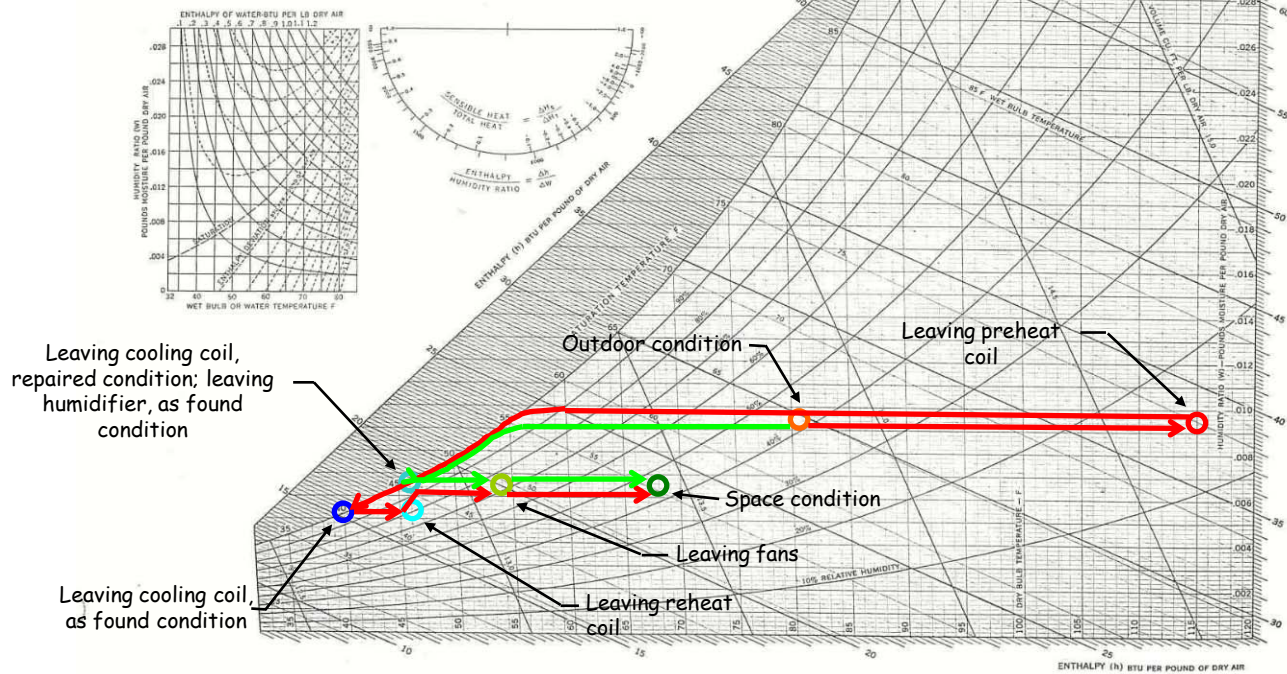


**At the time this was all going on, the clean room conditions were stable and within specifications; 68°F+1-1/2°F, 45%+3% relative humidity.**



ASHRAE PSYCHROMETRIC CHART NO. 1  
NORMAL TEMPERATURE  
BAROMETRIC PRESSURE 29.92 INCHES OF MERCURY  
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SEA LEVEL



The process as found was using \$5,000 - \$7,000 of unnecessary energy per month.



# How Could This Be?

- **Clean room conditions were at spec**
- **Fast track design build project**
  - Specific clean room requirements
  - Non-specific HVAC process requirements
- **Clean room qualification based commissioning focus**
- **The nature of the semi-conductor industry business cycle**





# Preheat Problems

- **Shut down steam when its not needed**
  - Integral face and bypass type preheat coil
  - Valve in place, not control signal
- **Calibrate sensor**
- **Add Alarms**





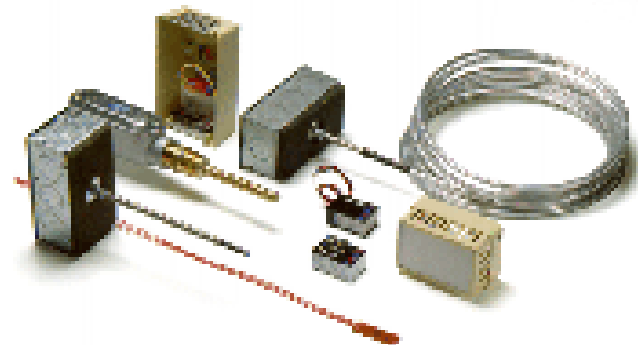
# Preheat Problems

- **Integrate control cycle**
  - Eliminate multimode control approach
    - Operating cycles based on OAT rather than clean room
    - Inconsistent operation
  - Sequence with chilled water and reheat
  - Lock out when not required
  - Maintain an independent low limit



# Cooling Problems

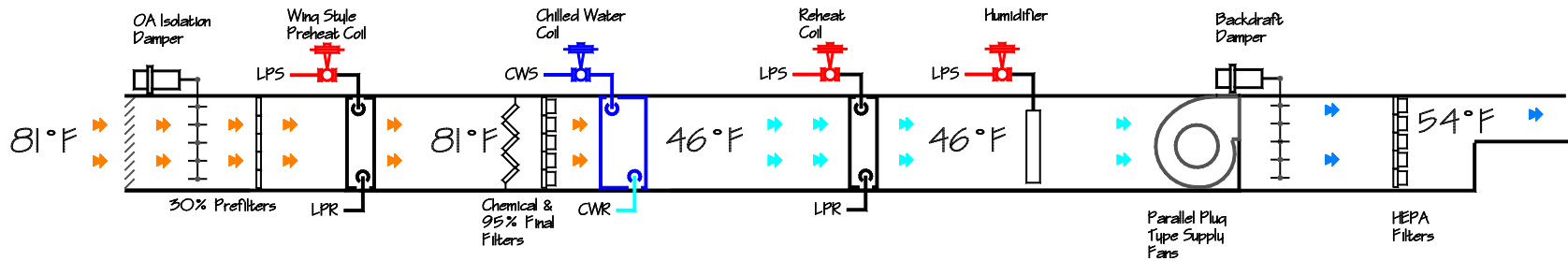
- **Calibrate sensor**
  - A little tricky with an averaging element
  - Relative calibration more important than absolute calibration
- **Lock out when not required**
- **Add alarms**





# Humidification and Reheat Problems

- **Eliminated by the other fixes**
- **Improved space sensor calibration routine**
- **Add alarms**
- **Fan heat provided most of the reheat**



**The cost of correction is projected to be between \$4,700 and \$8,000.**

- Exact value depends on the hourly rate used.
- Most of the cost was in facilities engineering labor.
- Some modest costs were associated with hardware.



# Educating the Operators Ensured Persistence

- **Diligent, talented operators**
  - Lacking training in psychrometrics
  - Lacking training in clean room process
- **Informal training provided empowerment**
  - Kept a psych chart by the operators console
  - Nature of engineering support requests changed
  - Acted on their own initiative



# Systems Integration Problems

## 24 hour per day plant operating spec taken literally

- No light switches in the clean rooms
- No provisions for coordinated start-up and shut down

## Power failures and equipment failures caused severe pressure fluctuations in the fab

- Contamination issue
- Safety issue
- Restart issue



# Systems Integration Problems

## Multiple power sources on the same system

- Controls on uninterruptible power supply
- Drives on emergency power with different auto-restart options selected
- Control interlock circuit on normal power







# Power Coordination Coupled with an Assembly Problem for a **DISASTER!!!**





# Fab Leakage = Energy Burden + Operational Danger

## Two parallel, redundant fans designed so:

- Only one fan runs
- Provides 27,000 cfm at 3.5 inches w.c.

## Clean room leakage resulted in running both fans to achieve pressurization required

- 14,000 extra cfm of outside air to move and condition
- Static requirement increased to 7 in.w.c.
- **Duct pressure class was 4 in.w.c.!!**



# Pressure Relief Doors Provide Protection

- Protect from air hammer effects due to sudden damper position changes.
- Protect over-pressurized ducts to the extent possible





# Improved Damper Reinforcement



## Simply matched factory instructions

- Reinforcing plate between sections
- Bracing is an alternative approach



# Permissive Interlocks and Better Quality Limit Switches

- **Start command opens dampers**
- **Limit switches proving starts the fan**
  - Wired to work in all selector switch positions
  - “Local” control mode on the drive disabled





# HVAC Process/Efficiency Commissioning Benefits

- **Reduction in operating cost and improved performance and reliability in retrocommissioning arena.**
- **Reduction in operating cost and first cost with improved performance and reliability in new construction.**
- **Reduction in CO<sub>2</sub> emissions.**
  - Complements energy savings.
  - Potential for additional financial leverage.



# Barriers to Moving from Qualification Based Approach

- **Rapid fluctuations in the semiconductor market cycle.**
  - Short paybacks demanded.
  - Design innovations not embraced.
  - Drive to get on line and in production ASAP.
- **Production process tolerances.**
  - Run on detection limits.
  - Extremely costly to ship bad product.