Design to Clean

PLANT ENVIRONMENTAL AIR PRACTICES FOR PATHOGEN CONTROL

MAY 18, 2022

Plant Environmental Air Practices for Pathogen Control

Agenda

- Intros (photos and short bios)
- Why are we here and what you should get out of this
- Factory level considerations
- Best practices
- Air system engineering
- Top issues and questions

Plant Environmental Air Practices for Pathogen Control

Your Presenters

Tom DeBoom

- B.S. Chem Eng; University of MN-Twin Cities
- 32 Years of Food Industry Experience
  - 31 years at General Mills, Inc
  - <1 year at Mead & Hunt
- Process & Project Engineer
- Manufacturing; QC; Retail Ops
- Capital Portfolio & Resource Management
- Sanitation by Design

Roger Porter

- B.S.M.E, University of WI-Madison
- 25 years of F&B project experience, all with M&H
- Sanitary HVAC, mechanical utility, plumbing engineering
- Project management
- Dairy, meat, bakery, confections,
- Licensed Professional Engineer in 29 states

Plant Environmental Air Practices for Pathogen Control

Why are we here?

To give you some insight as to best current practices and emerging trends in building and HVAC designs as they relate to 3-A's Standard 612 – Accepted Practice for Plant Environmental Air Quality

Plant Environmental Air Practices for Pathogen Control

Why is plant air quality important?

People

- Wellness
- OSHA
  - Employee health
  - Exposure to safety risks
- Retention

Process:

- Process & Packaging system dependencies on air quality
- Optimized production
- Costs:
  - Capital
  - Operational
- Regulatory: Food safety and quality
- Protection of assets

Plant Environmental Air Practices for Pathogen Control

Three primary steps to safeguard plant environmental air quality

1. Site level design and management
2. Integrate zoning plan and manufacturing flow
3. Engineered systems to deliver air quality requirements

Site Level Design and Management

Buttoning up the building….

- Assess and identify risks and required controls
- Secure the grounds and building to keep pests, moisture, and other contaminants out
- Traffic flow – managing movement of the workforce, ingredients, packaging materials, products and waste

Site Level Design and Management

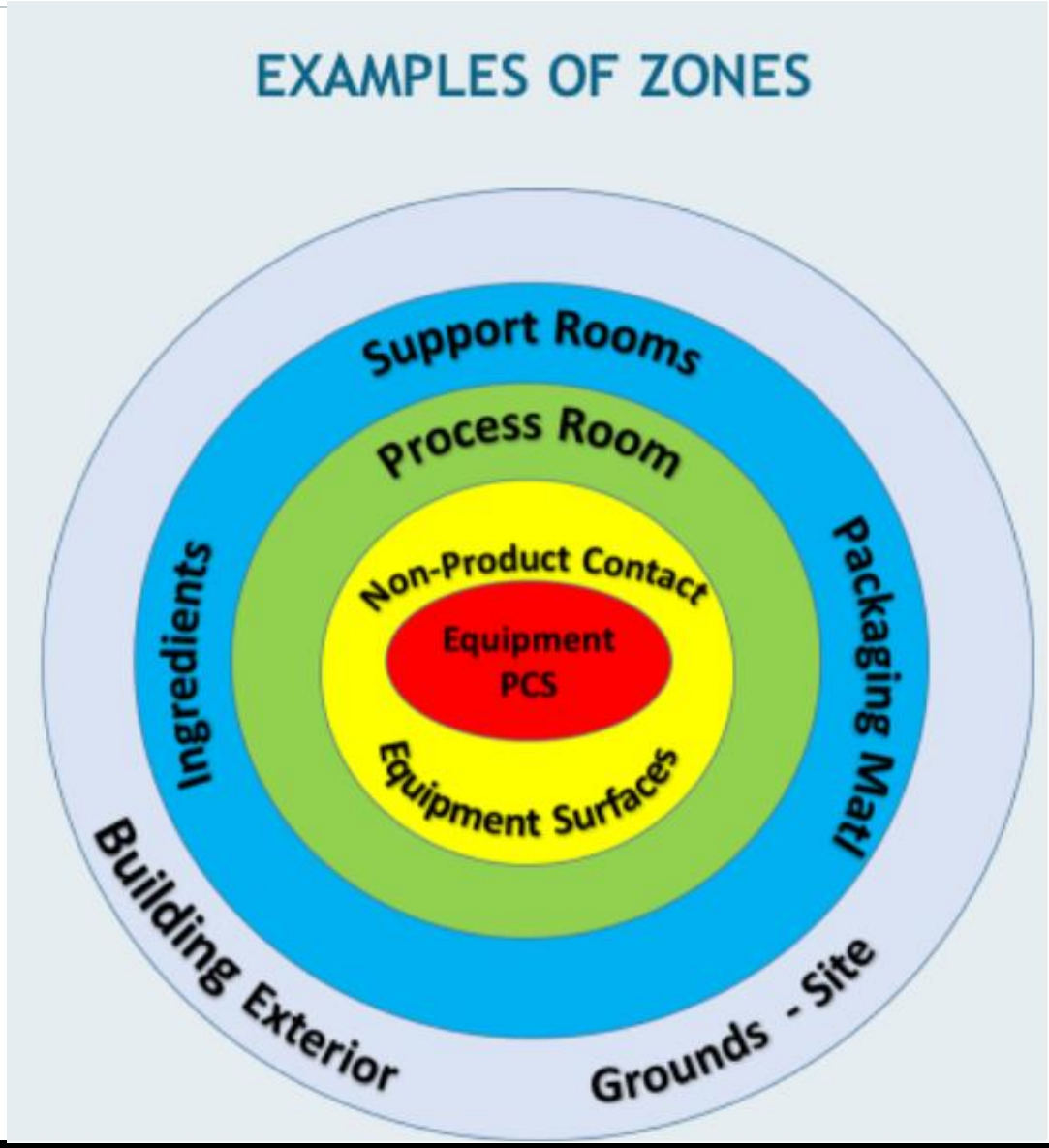
Important Considerations:

- Drying up the factory is a large part of pathogen management
- Humidity control can get expensive…understand the minimum requirements
- What is your company position on refrigerants (Freon vs Ammonia)?

Integrated Zoning Plan and Manufacturing Flow

Building Assessment

- Zones and Boundaries
  - Separate raw, finished product, storage, utility, waste, and employee support areas
- Special Requirements
  - Rigid Temperature or Humidity Control
  - High micro risk (culture room, fillers)
- Isolate hazardous areas (chemical storage, engine rooms, boiler rooms, etc..)
  - Isolating areas being modified (construction, etc..)
  - temporary situation



Source: 3A Module 3: Facility Design and Env Controls

Integrated Zoning Plan and Manufacturing Flow

Room Design Criteria
(System Assessment & Requirements)

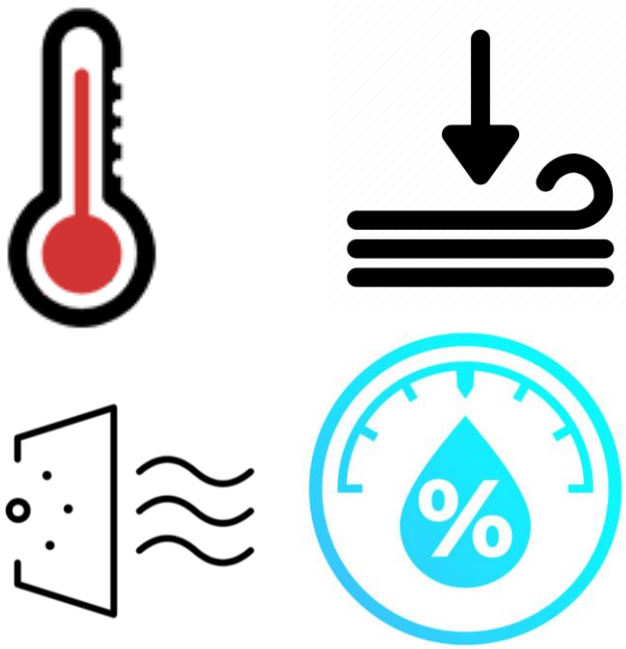
1. Hygienic Zone Plan
2. Wet or Dry?
3. Equipment and materials
4. Manufacturing cycle
5. Occupants: Numbers and duration
6. Cleaning Methods
7. Traffic flows
8. Air requirements
9. Special hazards (dust, gasses, allergens)

Integrated Zoning Plan and Manufacturing Flow

The job the air has in a space is determined by the *Room Design Criteria*

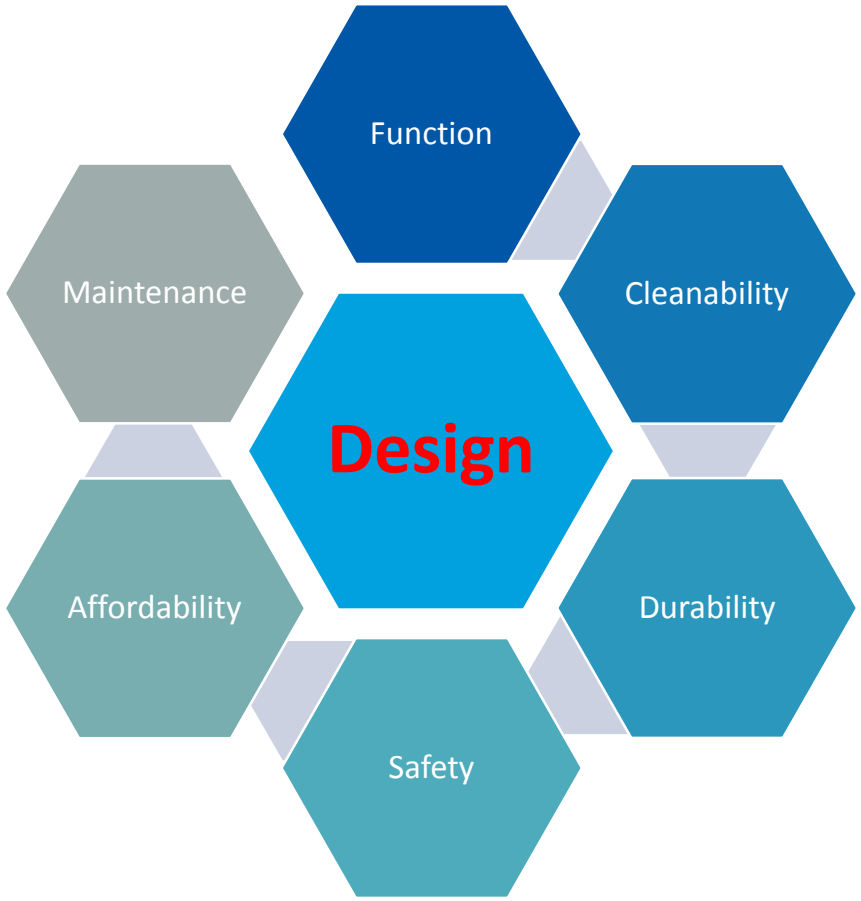
The air system supports and/or maintains control of:

- Temperature
- Humidity
- Contaminants
  - Particles
  - Pathogens
  - Aromas
  - Gasses
- Air Related Safety
  - Explosion risk
  - Exposure
  - Corrosion
- Space pressure (relative to adjacent spaces)



Engineered Systems to Deliver Air Quality Requirements

HVAC Key Considerations:



Engineered Systems to Deliver Air Quality Requirements

Air System Engineering and Design:

- Air treatment system:
  - HVAC unit (Heating, Ventilation, Air Conditioning)
  - Filtration
  - Heating/Cooling source utilities
  - Controls
  - Location and roof/floor support
  - Maintenance and sanitation
- Air distribution system:
  - Ductwork
  - Supply & return air; make-up air
  - Accessibility
  - Diffusion points

Engineered Systems to Deliver Air Quality Requirements

Moisture and condensation control

TOP ISSUE

- Moisture and condensation control are becoming more critical as we condition more spaces. As rooms dry up, paying specific attention to product zone points of condensation becomes more important. Some examples include:
  - Product forming chilled rolls
  - Air or plate coolers for product; impingement air sources
  - Steam flashing off product (extrusion or batch cooking)
  - Steam takeaway ductwork
  - Water from pump seals; water used as lubricant; steam traps draining to floor
  - Dairy fillers
  - CIP condensation

Engineered Systems to Deliver Air Quality Requirements

Operational Support Demands

- Approaches
  - AHU system production mode: lower air change rates to meet production space requirements
    - Trending: required airflows calculated to meet cooling needs, not ACH
    - Prescribed air change rates and calculated cooling airflow rates are often mutually exclusive with simple systems. To achieve both often a complex expensive AHU system is required – engineering intensive
    - More production requiring higher air change rates at higher air quality
  - AHU system clean-up mode: higher air change rates to dry wet washed rooms more quickly
    - Results in larger two-speed AHU's
    - 20 ACH minimum, 30 ACH preferred
    - Requires one or more dedicated remote EF(s) or EF(s) in AHU

Engineered Systems to Deliver Air Quality Requirements

Special Situations

- Micro-zones: Sub-spaces within a room with its own microclimate
  - Use localized enclosures or air envelopes to reduce or contain humidity in special situations
- Source capture (spice rooms, powder bagging, etc..)
  - General HVAC system should NOT be used for dust collection
- Low temp rooms with high moisture gain
  - Desiccant systems required – expensive and engineering intensive
- For rooms kept at 50 degF or lower to increase time interval between room cleanings, move from room hung evaporators or penthouse to traditional AHU's requires LARGE AHU's

Engineered Systems to Deliver Air Quality Requirements

Air Handling Unit (AHU) Systems Construction

- Casing
  - 3-A standard 612-00, E1 defines basic Equipment requirements (cleanable, inspectable, min. seams)
  - Housings need to be industrial gauge, not commercial, to withstand pressurized water and chemical cleaning
    - 304 S.S washdown interior liners
  - AHU thermal break construction – units suppling air below 50°F
  - Access sections/doors for improved accessibility for cleaning and maintenance
  - Fully welded AHU floors or floor pans with integral drains
  - moving away from self-tapping gasketed screws
  - Closed cell insulation in housing panels– NO mineral fiber insulation anywhere

Engineered Systems to Deliver Air Quality Requirements

Air Handling Unit (AHU) Systems Construction

- Fans
  - Fan walls (Redundancy and volume control)
  - Unhoused fans – easier to clean
  - Direct drive fans with VFD's – no belts generating dust
  - Special duty fan motors (TEFC) in AHU's
- Heating/Cooling coils
  - UV lights to eliminate coil cleaning
  - No copper/bronze coil components (NH3 corrosion - applies to entire AHU interior)
  - Max 12 fins per inch (FPI) for cooling coils (E1.4)
- Eliminating hollow cavity unit components such as dampers and conduit
- Exterior air inlets/outlets prevent insect/animal building penetration
- Moving away from galvanized steel to stainless steel

Engineered Systems to Deliver Air Quality Requirements

Air Handling Unit (AHU) Systems Construction

- Filter banks:
  - 3-A standard 612-00, D2 defines basic filter material requirements
  - SS racks
  - Means of positively pressing filters against rack face to minimize filter bypass
  - Pressure gauges on outside of unit to indicate time for filter change
  - Pre-filter upstream of system components
  - Final filter at discharge of the unit (F4.1)
  - Consider medium efficiency filter upstream of final filters

Engineered Systems to Deliver Air Quality Requirements

3-A Standard 612-00

I4 Room filtration efficiencies recommendations

1. Milk and milk product processing area, ≥ 25% at 3.0 µm (MERV8)
2. Silo tank area, ≥ 25% at 3.0 µm (MERV8)
3. Non-aseptic liquid, ≥ 90% at 1.0 µm (MERV14)
4. ESL, aseptic, ≥ 99.97% at 0.3 µm, laminar flow (MERV18)
5. Cheese processing, ≥ 90% at 1.0 µm (MERV14)
6. Cheese wrapping, ≥ 90% at 1.0 µm (MERV14)
7. Dry milk products, ≥ 90% at 1.0 µm (MERV14)
8. Culture room, 99.97% at 0.3 µm (MERV18)
9. Frozen dessert freezing, ≥ 90% at 1.0 µm (MERV14)
10. Frozen dessert packaging, ≥ 90% at 1.0 µm (MERV14)
11. Egg processing, ≥ 90% at 1.0 µm (MERV14)
12. Product contact packaging storage, ≥ 25% at 3.0 µm (MERV8)

Engineered Systems to Deliver Air Quality Requirements

Air distribution – Ducts and grilles (F2)

- Corrosion resistant materials (typically 304 SS) (D1.1.1)
- Limit ductwork to reduce cleaning efforts and keep it out of process spaces.
- Design for longer air grille throws.
- Return duct should be minimized compared to supply. RA is the dirtiest
- Use round duct – more efficient and easier to clean
- Minimize seams – NO spiral wound duct
- Supply air diffusers
  - Long throw
  - Heavy gauge SS (to prevent rattling/vibration)
  - NOT directly over product or process equipment (I1)

Engineered Systems to Deliver Air Quality Requirements

Air distribution – Fabric duct

- Can consider fabric duct in lieu of metallic duct.
  - 3-A standard 612-00, D3 defines basic Air Sock material requirements
  - Lower velocity air distribution
  - Install spare duct while primary is being washed
  - More duct required which needs to be in the process space
  - Velocity/pressure limitations
  - Fabric can wear out or tear/rip
  - Some fittings may still need to be metal
  - Available in colors
  - Cost much less than SS or metal duct

Questions?

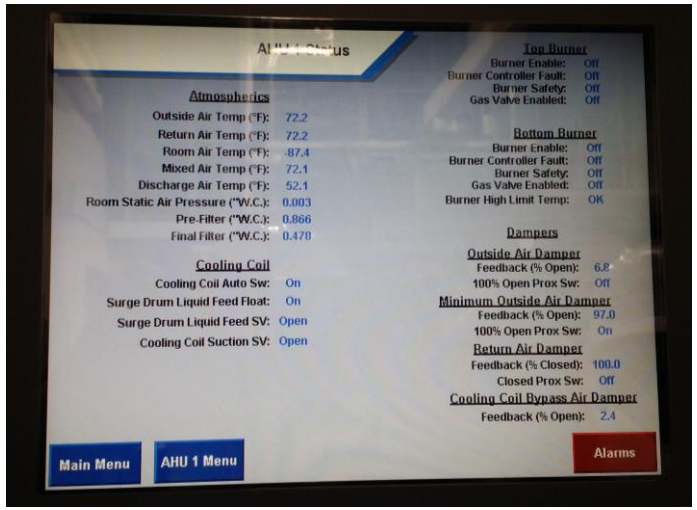
Thank you.

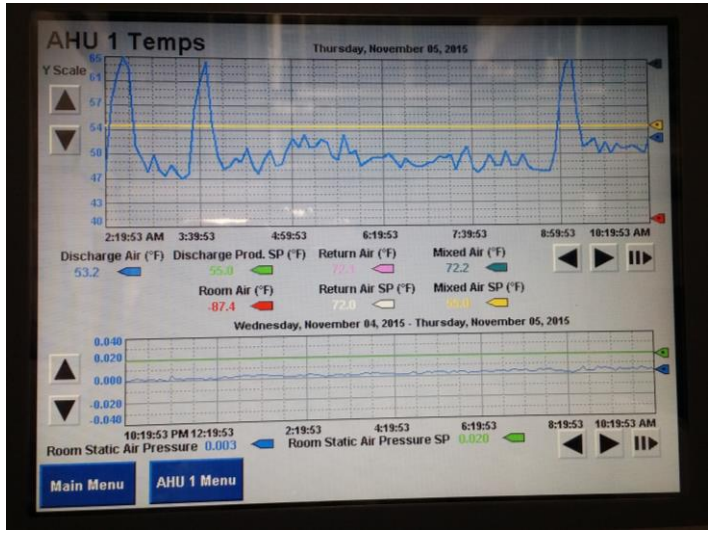
Appendix

Engineered Systems to Deliver Air Quality Requirements

Controls

- Integrating HVAC controls in plant process PLC systems
  - More robust and accurate than commercial grade controls
  - Setback controls
  - Space temperature, humidity, pressure monitoring, trending, and remote alarming
  - Filter bank pressure drop monitoring
  - Custom programming sometimes required
  - Consider limiting access





Engineered Systems to Deliver Air Quality Requirements

AHU efficiency improvements

- Heat recovery – related costs
- Economizer controls
- Easier to maintain and faster to get up and running after failure

Future technologies

- HVAC equipment design evolving towards process equipment standards
  - Built-in CIP wash systems
  - More/better sanitary welding
  - More robust materials