Optimizing Hot Gas Defrost

Presented by:

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COLMAC COIL

Hot Gas Defrost is:

- Effective*
- Automatic*
- Reliable*
- Safe*

* If designed, installed, and operated correctly…

Why Effective?

- Evaporator becomes a condenser.
- Latent heat is used (>>sensible heat).
- Condensed liquid returned to LPR or MPR and is “recycled”.
- Heat is “moved” to where it is needed in the system.

Defrost Efficiency, h_D

$$h_D = \frac{Q_f}{Q_{total}}$$

$where:$

$h_D =$ *Defrost Efficiency*

$Q_f =$ *Heat to warm and melt frost*

$Q_{total} =$ *Total energy input for defrost*

How Efficient?

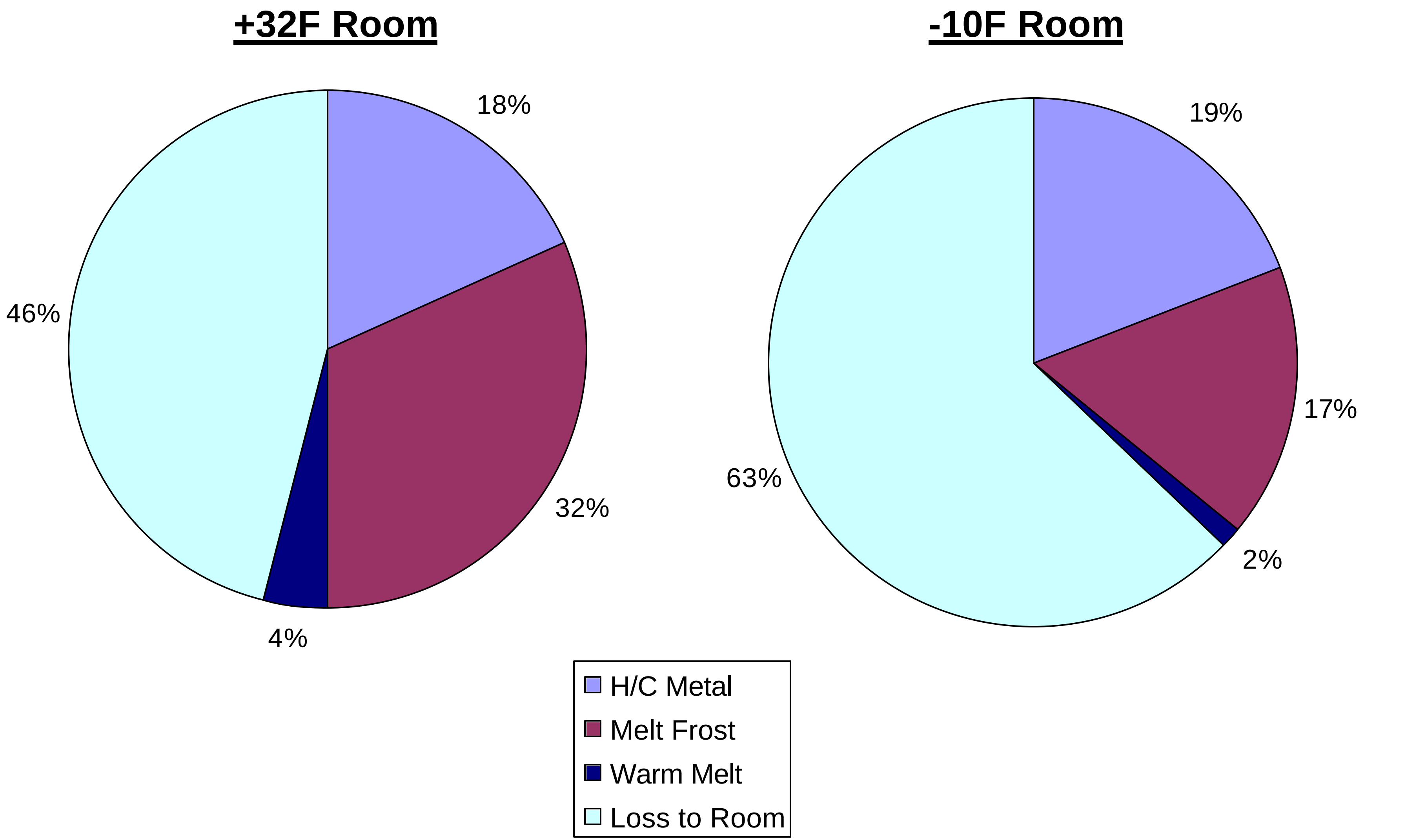
- Typical h_D is 15 to 20% for freezers.
- Of total energy input:
  - 15 to 20% to melt frost,
  - 60% to room via convection/radiation,
  - 20% to heat/cool metal.
  - <5% gas bypass losses.
- Maximum theoretical h_D is 60 to 70%…
- Cole (1989)

Defrost Efficiency, h_D

- How is h_D affected by:
  - Room Temperature?
  - Duration of Defrost?
  - Frost Thickness?
- Calculate Defrost Energy and compare…

Hot Gas Defrost Energy vs Room Temp

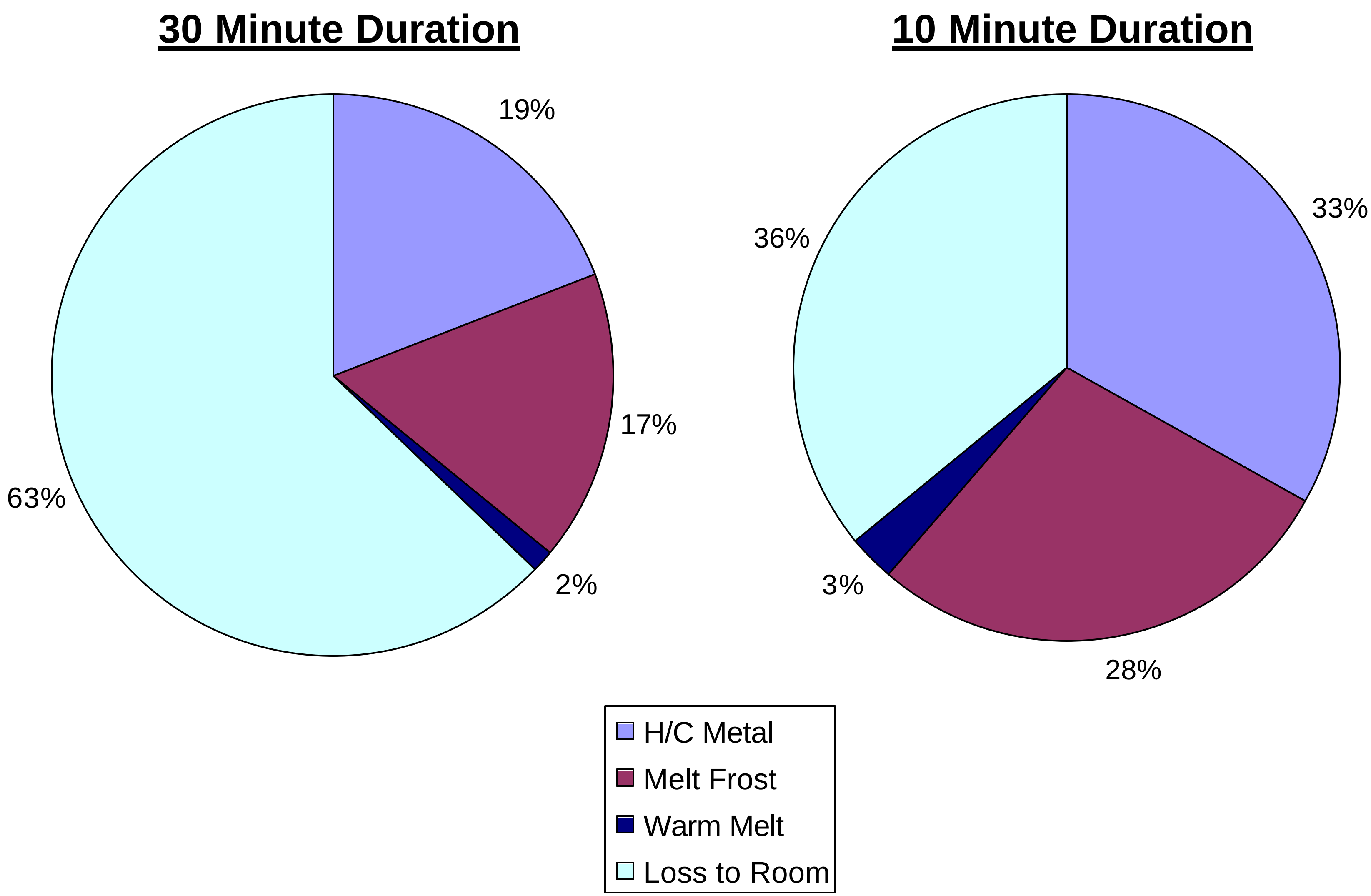
SST/Al, 7/8x8R-3F, 50F NH3, 10F TD
30 Minute Duration, 1 mm Frost Thickness



Hot Gas Defrost Energy vs Defrost Duration

SST/Al, 7/8x8R-3F, 50F NH3, -10F Room, 10F TD

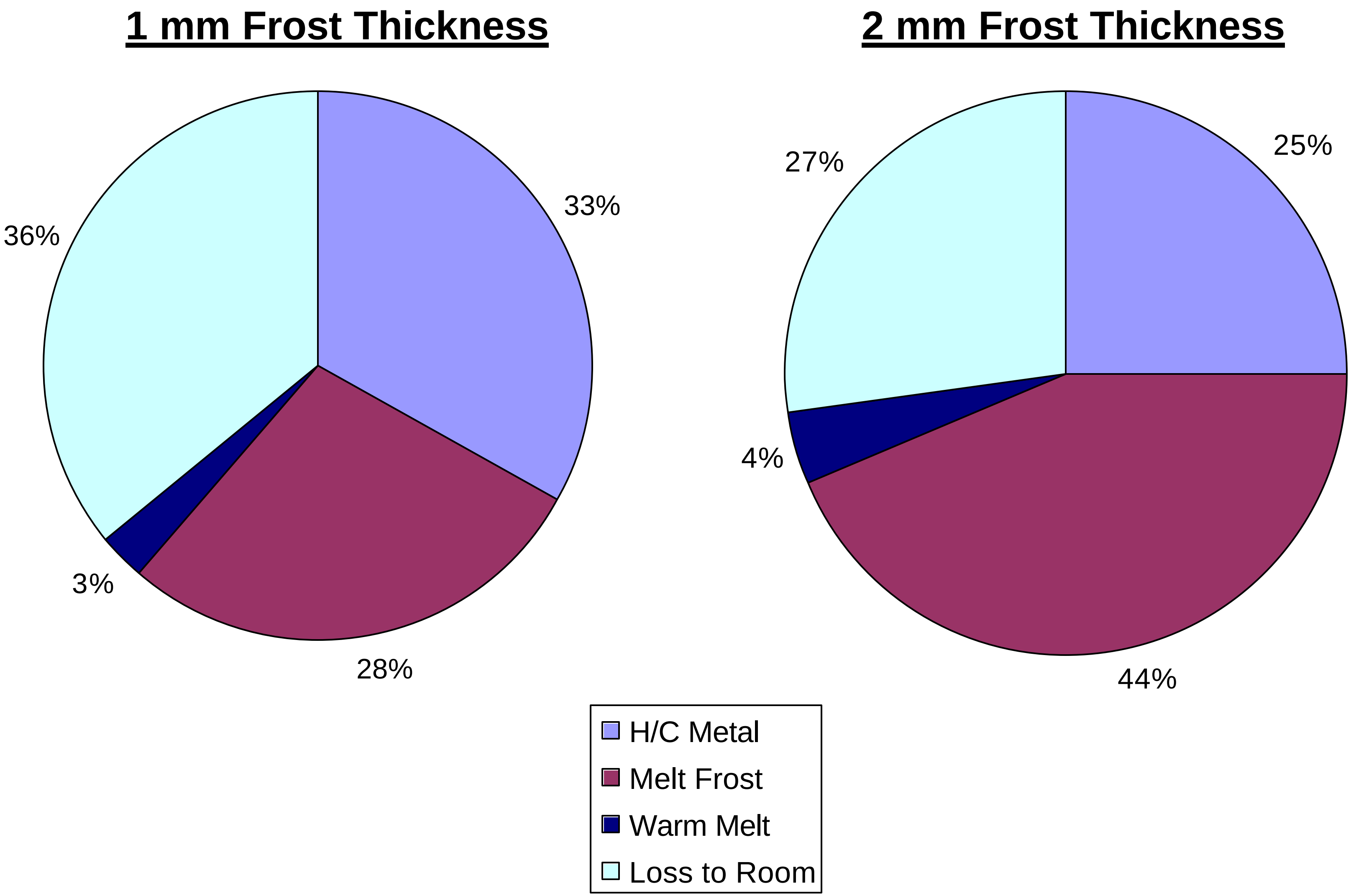
1 mm Frost Thickness



Hot Gas Defrost Energy vs Frost Thickness

SST/Al, 7/8x8R-3F, 50F NH_3, -10F Room, 10F TD

10 Minute Defrost Duration



Defrost Efficiency, h_D

Conclusions:

1. Lower room temperatures will have lower h_D.
2. h_D gets better as defrost duration is shortened.
3. h_D gets better as frost thickness increases.
4. Reducing *duration* and increasing *frost thickness* improved h_D from 17% to 44% in the freezer.

Convective Heat Loss is Significant…

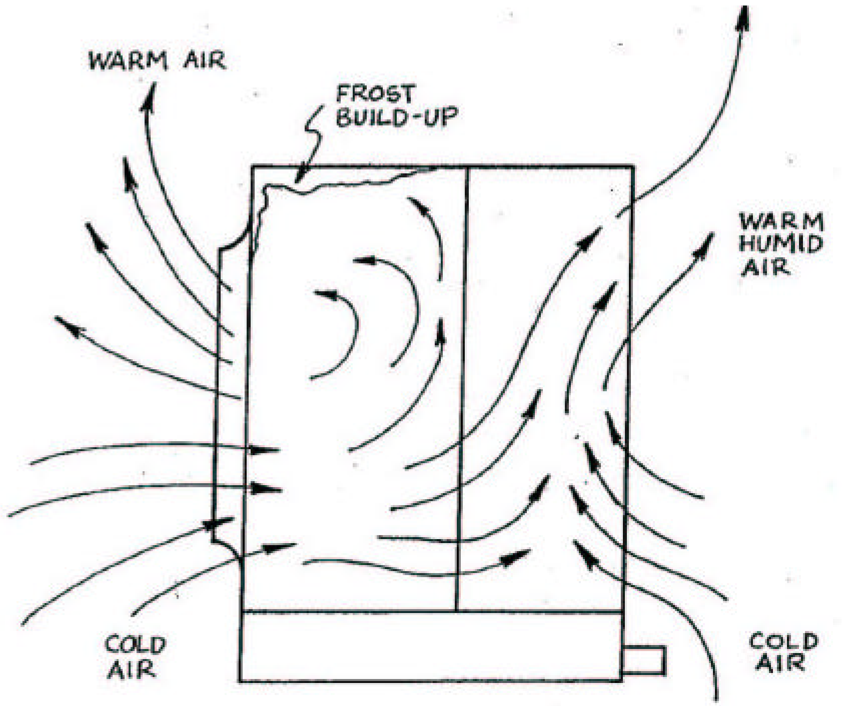


Figure 3

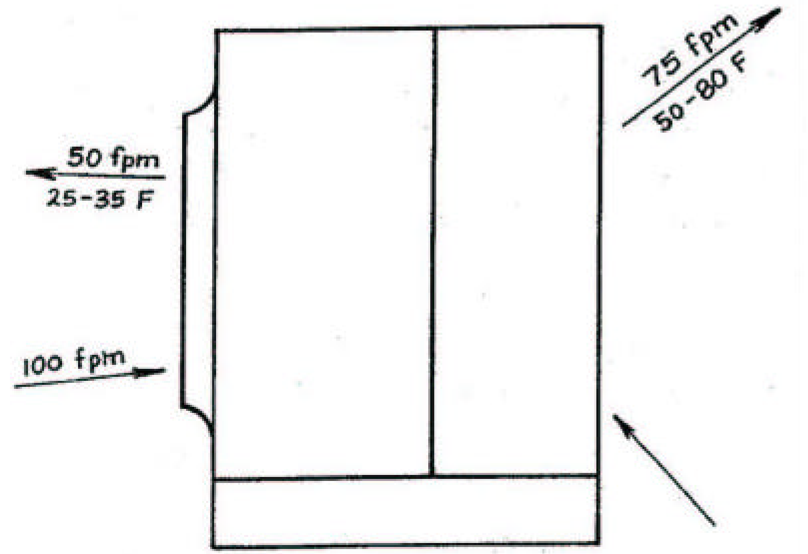


Figure 5

Taken from: Cole, R.A. 1989. “Refrigeration Loads in a Freezer Due to Hot Gas Defrost and Their Associated Costs.” *ASHRAE Transactions,* V.95, Pt.2.

Optimize Efficiency by:

1. Minimizing convective heat loss.
    - 75 to 90 psig (50 to 60F) for Ammonia is adequate.
    - If higher pressures are needed, look for problems elsewhere.
    - Capture defrost heat (i.e. install Return Air Hoods).
2. Shortening defrost duration.
    - Open HG Solenoid only long enough to clear coil (5-8 minutes).
    - Post-defrost pan heat (separate regulator or electric pan heating).
3. Reducing number of defrosts.
    - Adjust defrost frequency to frost load.
    - Wider fin spacings with fewer defrosts makes sense…

Return Air Hood w/ Discharge Sock

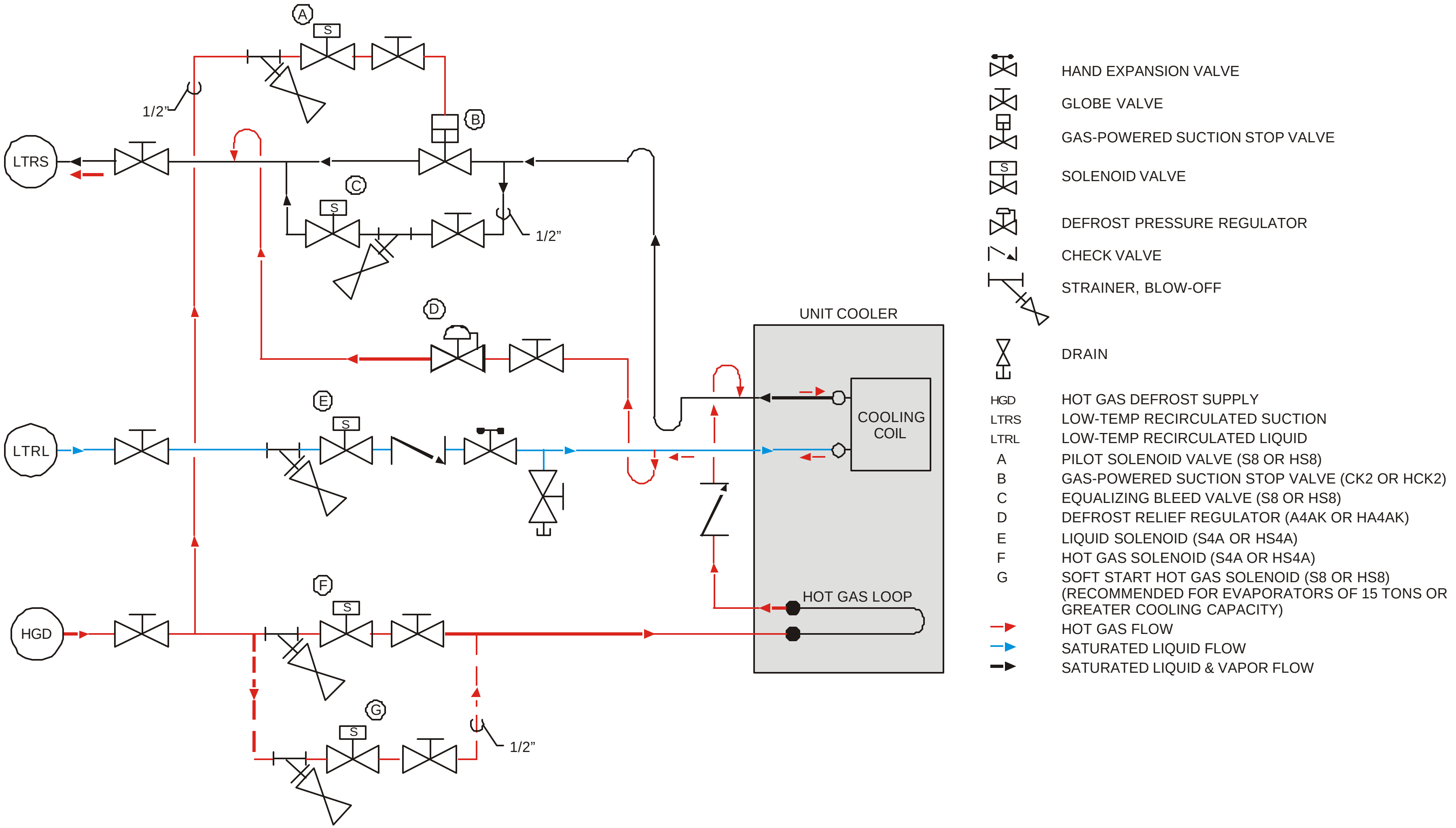
Sequence of Operation:

1. Close Liquid Solenoid *with fans running*.
2. Pump down to remove liquid.
3. Stop fans.
4. Close Suction Stop Valve.
5. On coils >15TR open Soft Start Hot Gas Solenoid to gradually bring coil up to near defrost pressure.

Sequence of Operation (cont.):

6. Open Hot Gas Solenoid and start defrost.
7. Close Hot Gas Solenoid to end defrost.
8. Open Equalizing Bleed Valve to gradually bring coil down to suction pressure.
9. Open Suction Stop Valve.
10. Open Liquid Line Solenoid to start cooling.
11. After delay, restart fans.

Recirc Bottom Feed Hot Gas Defrost Piping



Design for Reliability:

- Insure adequate supply of hot gas by:

1. Correctly sizing and insulating hot gas lines (IIAR 2004).
2. Make sure 2 coils are running for every coil that is defrosting (i.e. coils will have approx. twice the condensing capacity as evaporating capacity).
3. Control system head pressure to maintain minimum hot gas supply pressure 15-20 psi above defrost regulator setting. Supply hot gas at 100-120 psig to coils.

- Correctly select and size valves.
- Bottom feed circuiting will defrost faster than top feed (orifice PD).

Design for Reliability:

- Simple controls are good.
  – Time initiated, time terminated is simple.
- Other controls have been proposed.
  – Demand initiated…
    - Air PD based
    - IR sensor based
    - Coil TD/time based
  – Temperature terminated…
    - Coil temperature based

Design for Reliability:

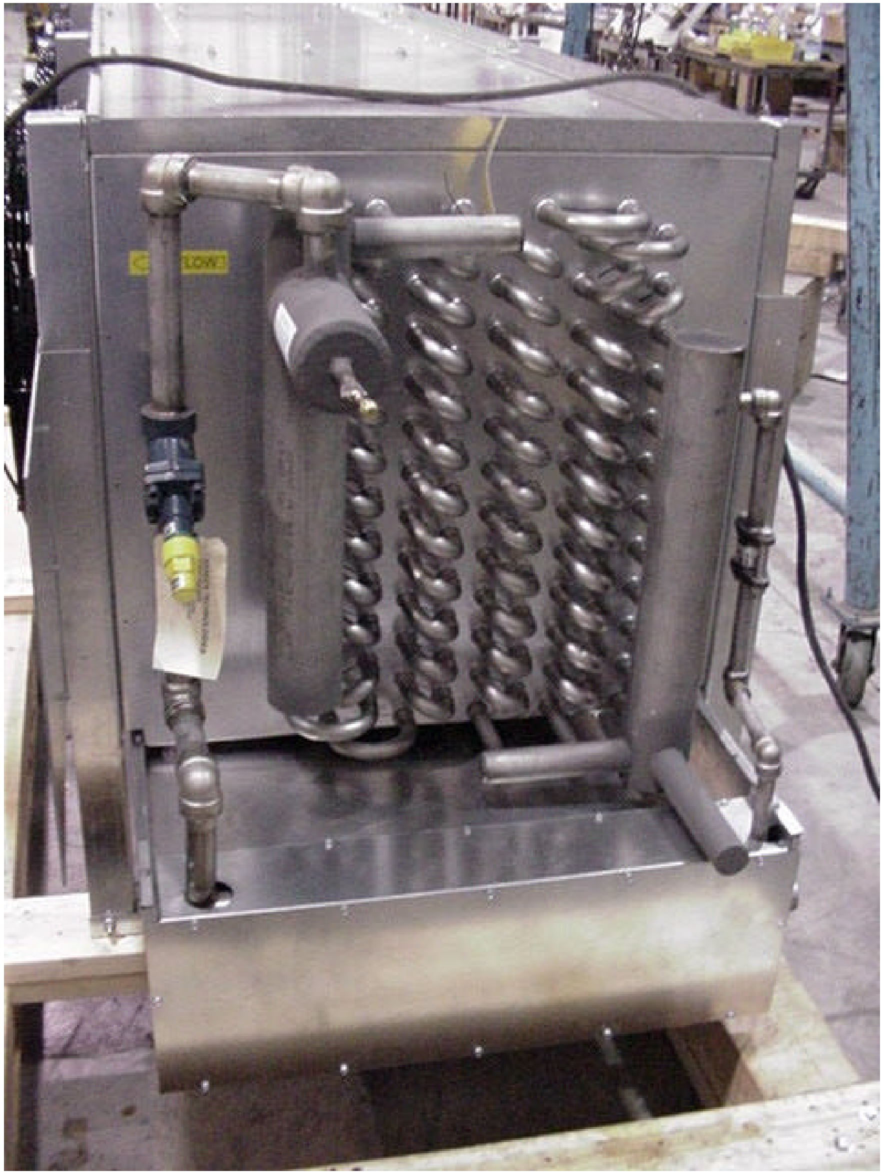
3-pipe vs 2-pipe:

I. 3-pipe
   1. Use diagrams shown above.
   2. Full flow through pan and coil.
   3. Keeps pan and coil clear of liquid.

II. 2-pipe
   1. Fewer room penetrations.
   2. Flow to pan and coil in parallel requires balancing.
   3. Keeping pan and coil clear of liquid may be challenging.

3-Pipe Hot Gas Defrost Arrangement

2-Pipe Hot Gas Defrost Arrangement



Safety:

1. Use good piping practice per IIAR Piping Handbook (2004).
2. Keep hot gas lines clear of liquid by pitching down toward liquid drainers.
3. Always equalize pressure after defrost before opening Suction Stop Valve.
4. On coils >15TR always use Soft Start Hot Gas Solenoid to gradually come up to defrost pressure.

Bibliography:

- Cole, R.A. 1989. “Refrigeration Loads in a Freezer Due to Hot Gas Defrost and Their Associated Costs.” *ASHRAE Transactions*, V.95, Pt.2.
- IIAR. 2004. Ammonia Refrigeration Piping Handbook. *International Institute of Ammonia Refrigeration*.
- Colmac Coil Manufacturing, Inc. 2003. Bulletin ENG00014424: “Unit Coolers, Installation, Operation, and Maintenance.” *Colmac Coil Manufacturing, Inc. Colville, WA*.
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