



ATMO
sphere

- HIGH EXPECTATIONS

- LOW ENERGY CONSUMPTION

- LOW NH₃ INVENTORY

- LOW OCCUPATIONAL RISK

- LOW DIRECT EMISSIONS



LOW CHARGE NH_3 – FROM CHINA TO AUSTRALIA

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THE CHALLENGES:

- Global HFC phase-down
- Rising energy costs
- Increasing demand for refrigeration
- Increasing regulatory pressures for toxic/flammable refrigerants

THE SOLUTION:

- Low charge, central NH₃ systems featuring:
 - No NH₃ pumps
 - SH/X injection control
 - Dry suction lines
 - VFD's on everything
 - Superior part load efficiency
 - Simplicity
 - Low friction pipe lines
 - 30-50 times lower evaporator operating charge
 - 3-5 times lower system NH₃ inventory
 - Minimization of risk to occupants
 - Energy performance 40-70% better
 - Proven technology & reliability

HOW DOES IT LOOK?

Lower ceiling = no sprinklers

Evaporator air supply



NH_3 inventory 850 kg

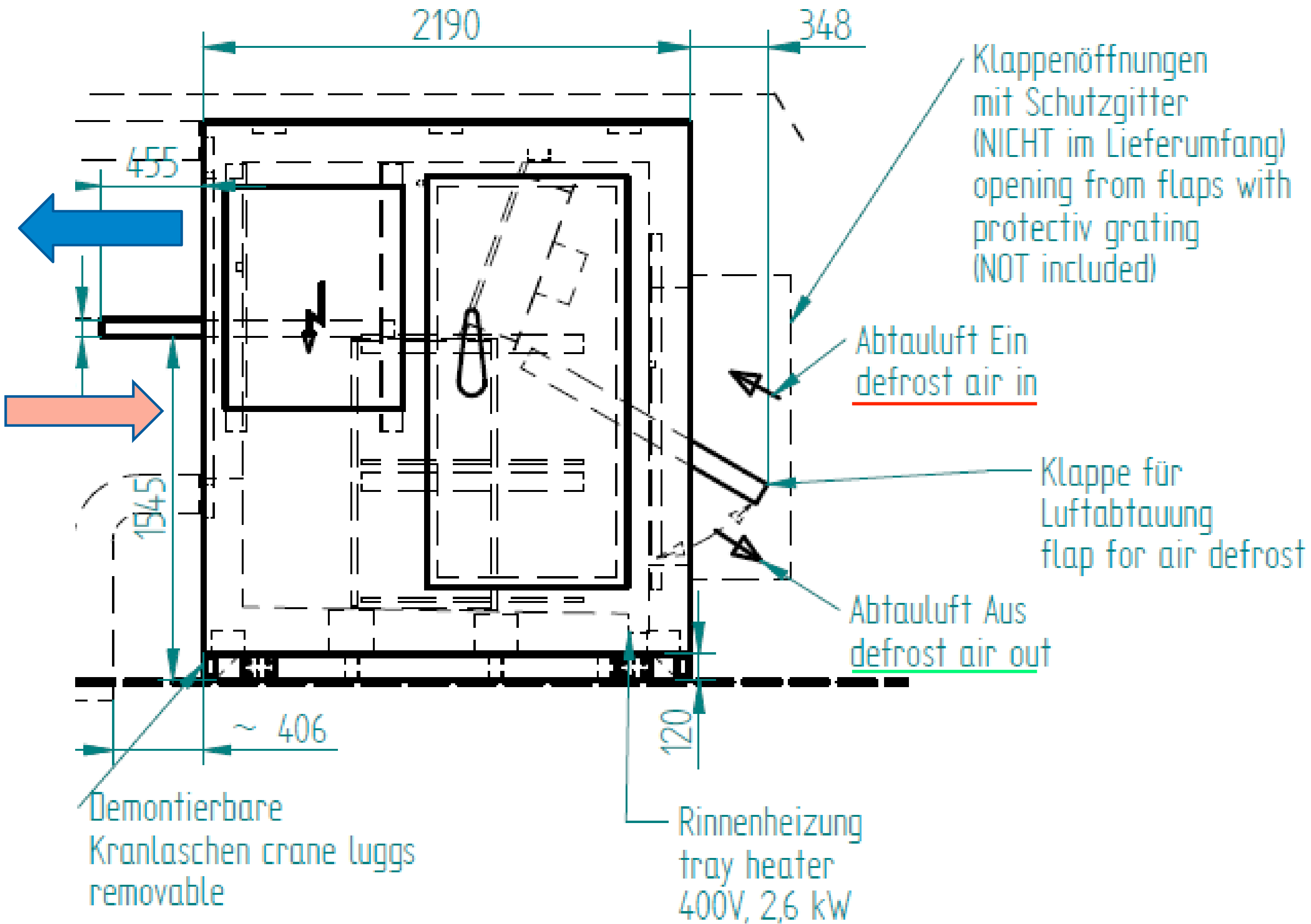


Total NH₃ operating charge 5 kg

155 kW

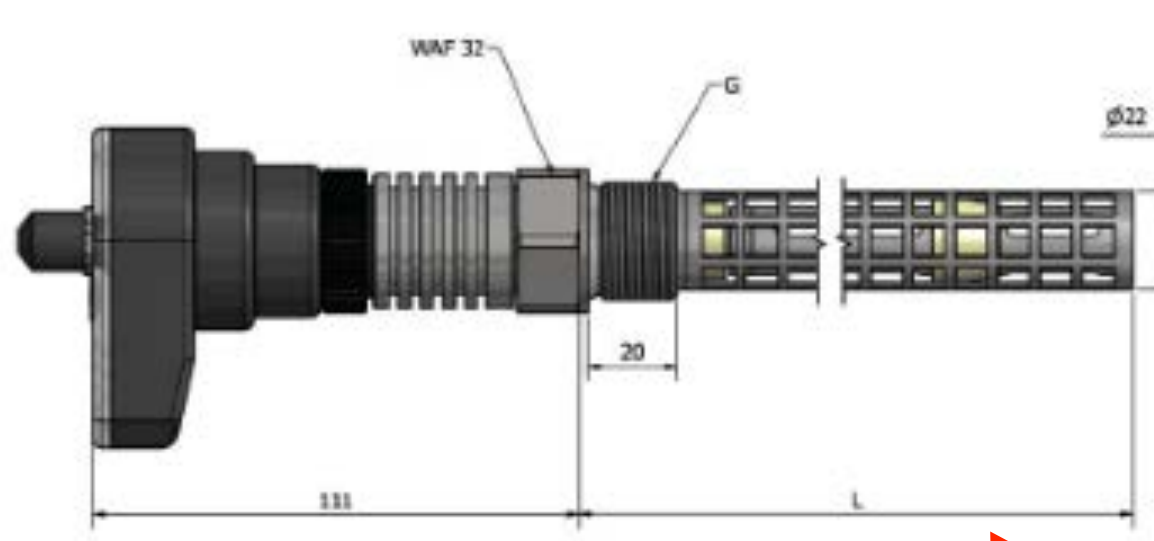
Valve stations and pipelines outside building

HOW DOES IT WORK?

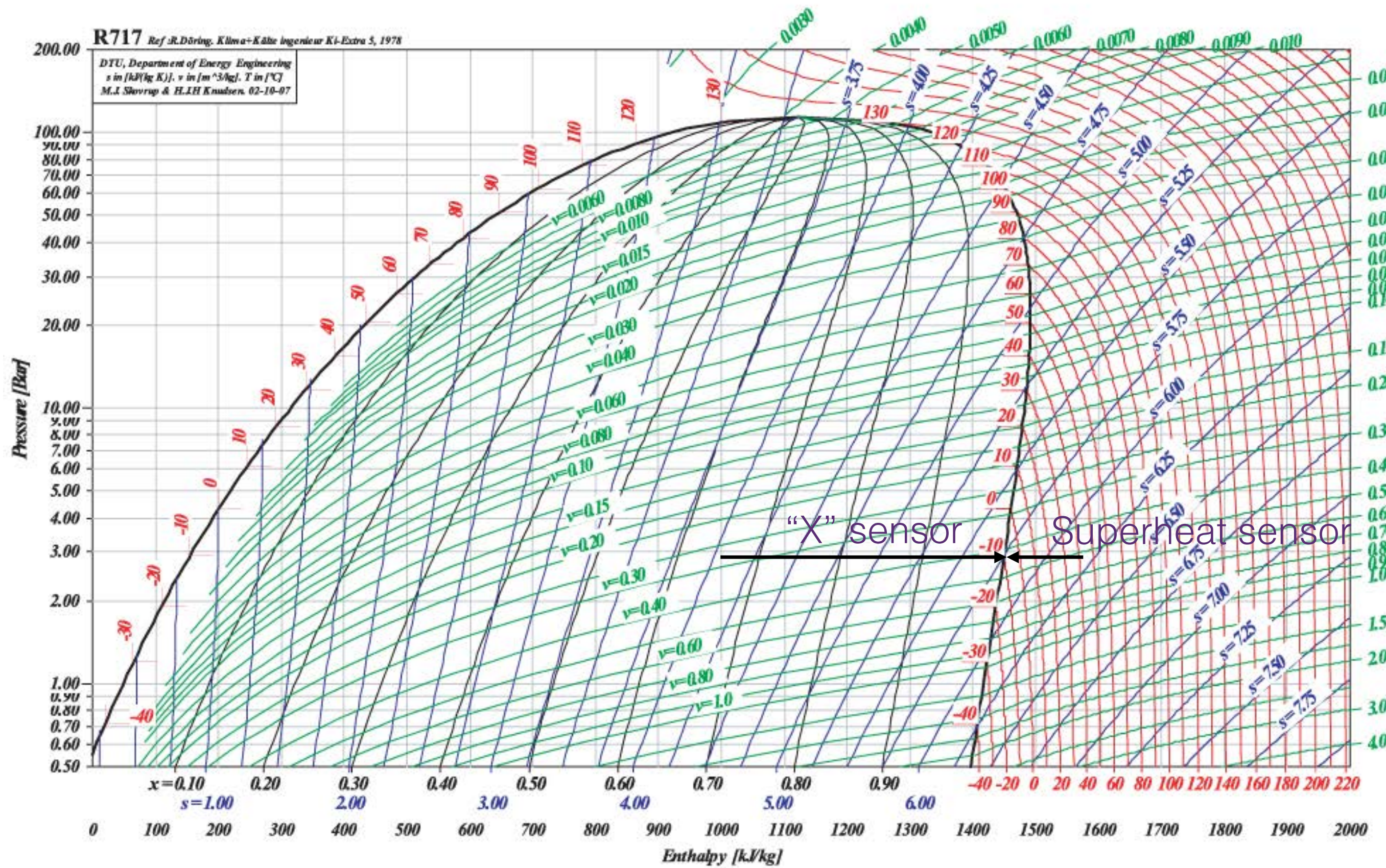


HOW DOES IT WORK?

Proprietary control algorithm controlling refrigerant injection using refrigerant quality at evaporator exit as control signal



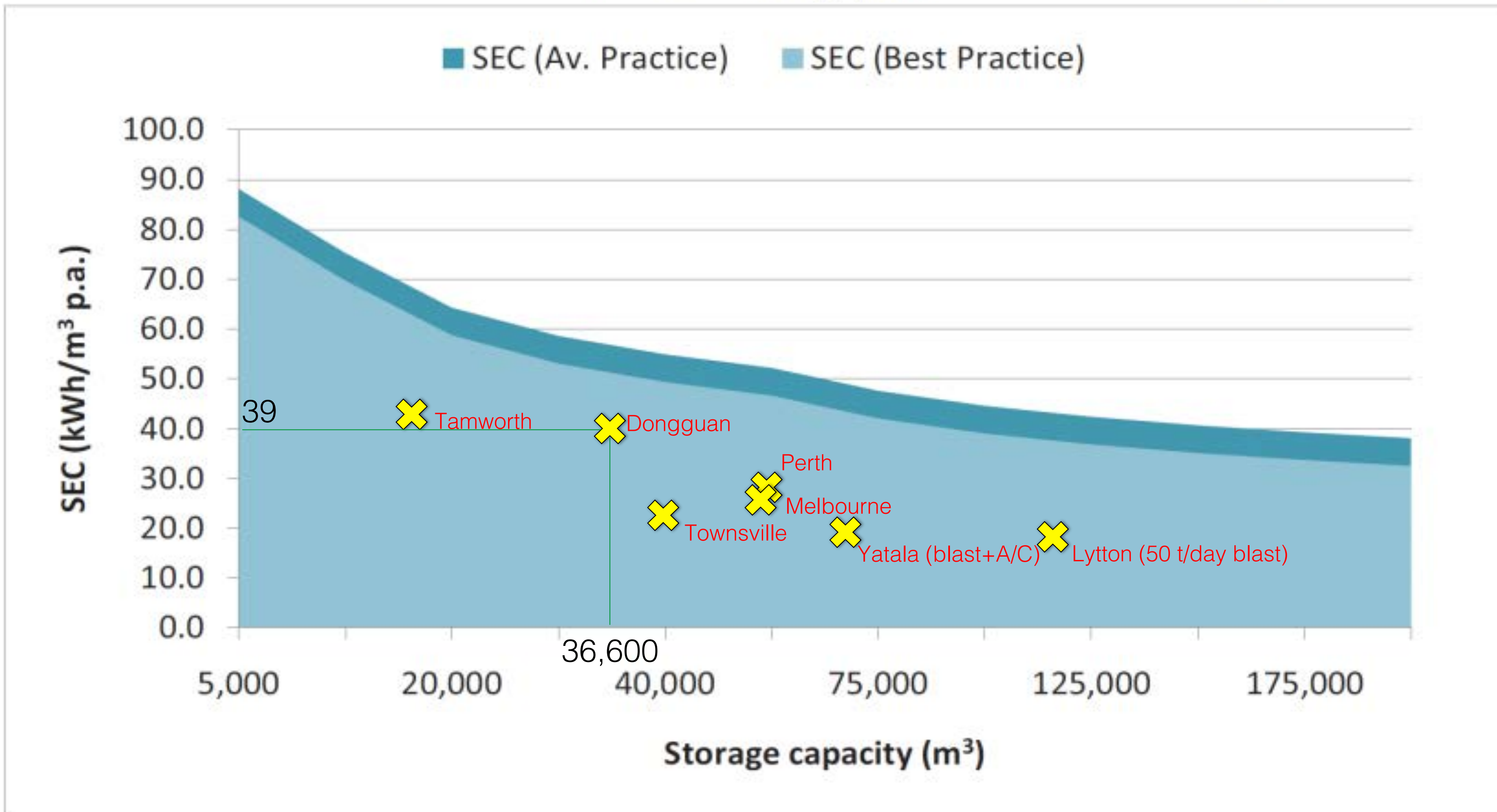
Quality or "x" sensor



The dielectric spectroscopy (capacitance) measurement method uses the difference in dielectric properties of gas and liquid

HOW DOES IT PERFORM?

$$\text{SEC (kWh/ft}^3\text{) average practice} = 38.978 \times \text{storage volume}^{-0.2275}$$



HOW DOES IT PERFORM?

Previous conversions of large scale industrial plant from liquid overfeed R22 to liquid overfeed NH_3 indicate SEC reductions of 20 to 40%.

Switching from liquid overfeed NH_3 to low charge NH_3 results in Specific Energy Consumption (SEC) reductions of 18 to 38% depending on plant layout. This is a result of the removal of liquid from wet return lines and risers.

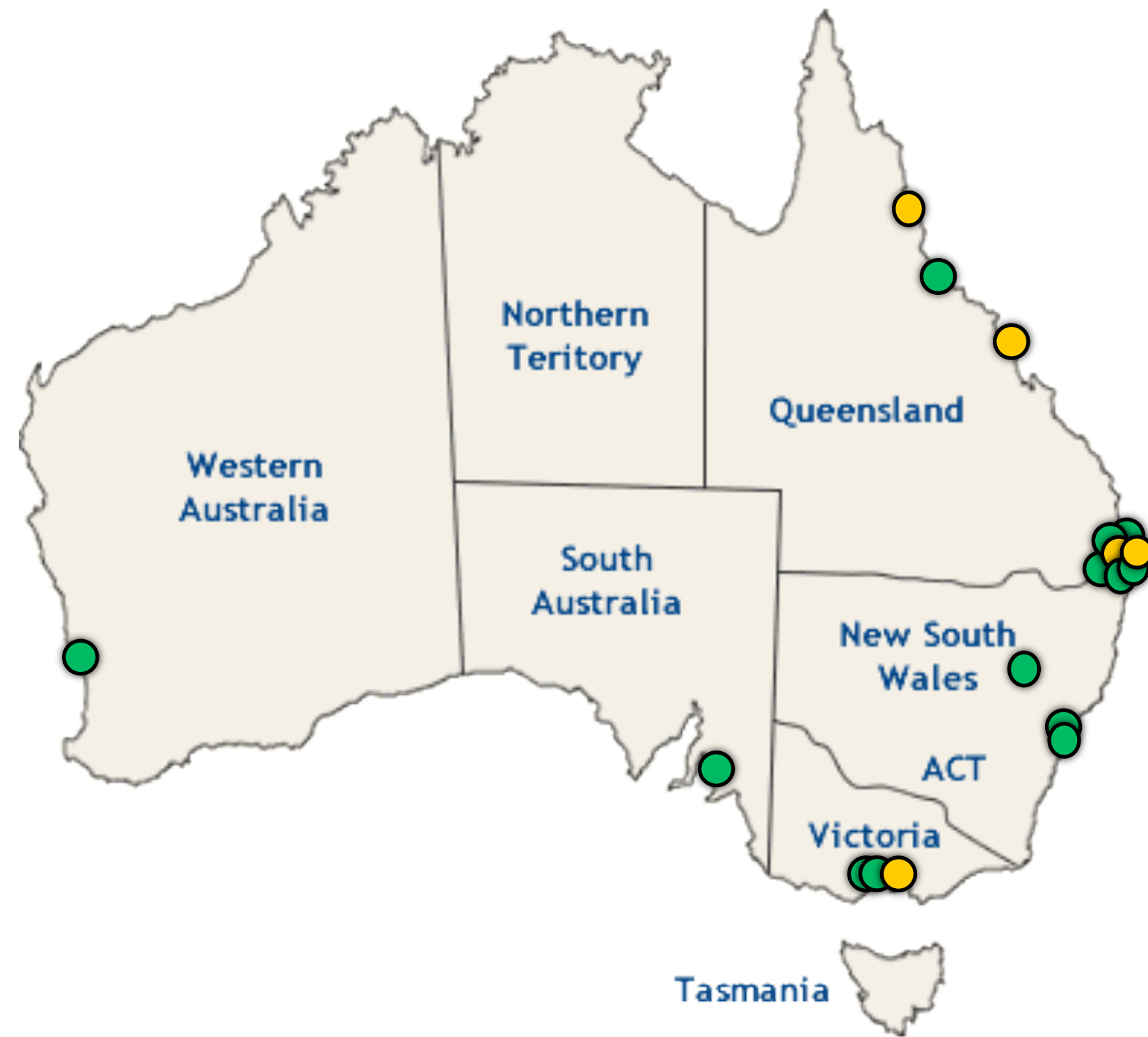
Sources:

Jensen, S. and CZYCZELI, S. (2008). CONVERSION FROM HCFC22 TO NH_3 – PRACTICAL EXPERIENCES FROM A LARGE DISTRIBUTION CENTER. Gustav Lorentzen Conference, Copenhagen, Denmark

Jensen, S. and Forbes, M. (1996). CONVERSION FROM R22 TO R717. PRACTICAL EXPERIENCES FROM THREE INDUSTRIAL PLANTS. Gustav Lorentzen Conference, Aarhus, Denmark

GCCA; 13-15 June, 2017, Chicago – R. Watters, AMS

HOW WELL IS IT ACCEPTED?



- Completed
- Under construction

HOW WILL THE FUTURE BE?



Smaller tubes for lower NH₃ inventories

304SS piping for low friction, high corrosion resistance, low leakage probability

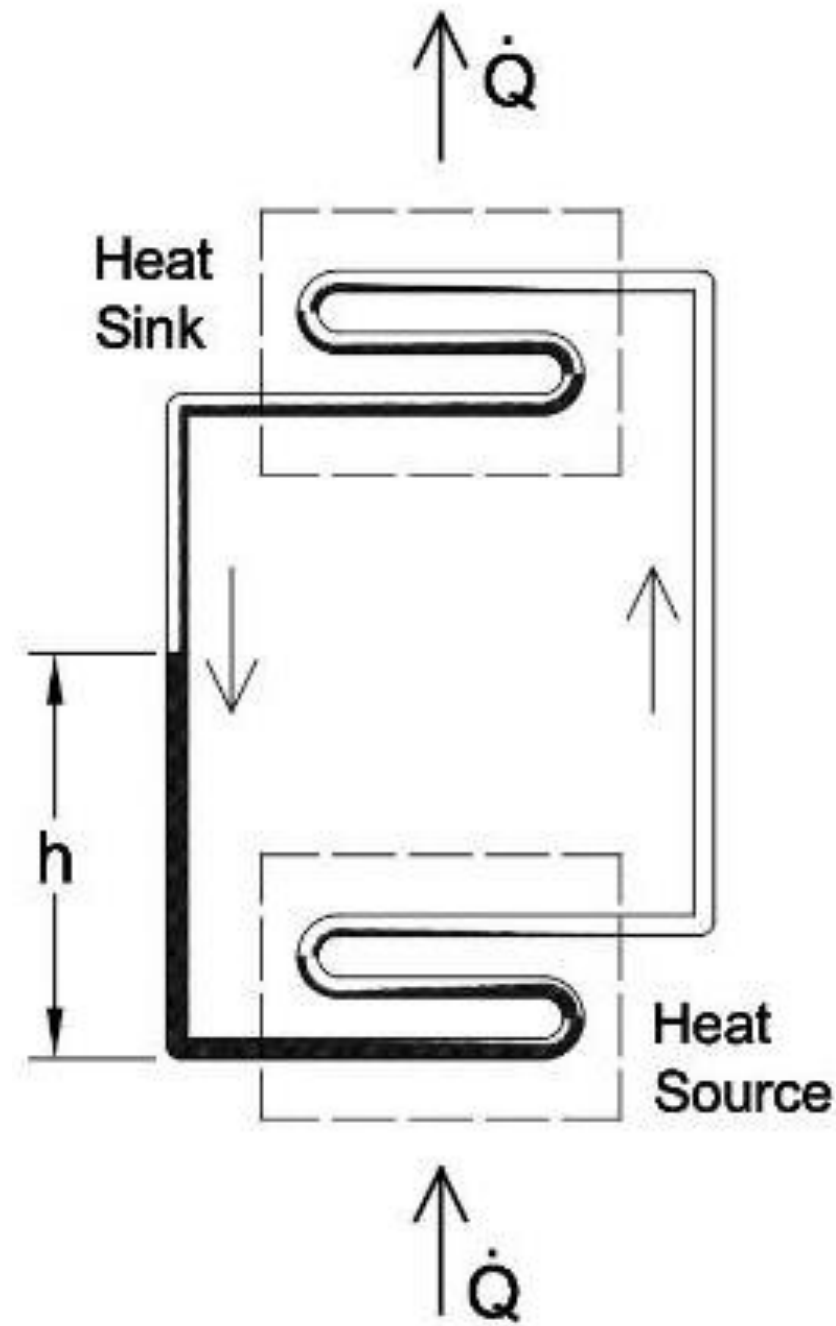
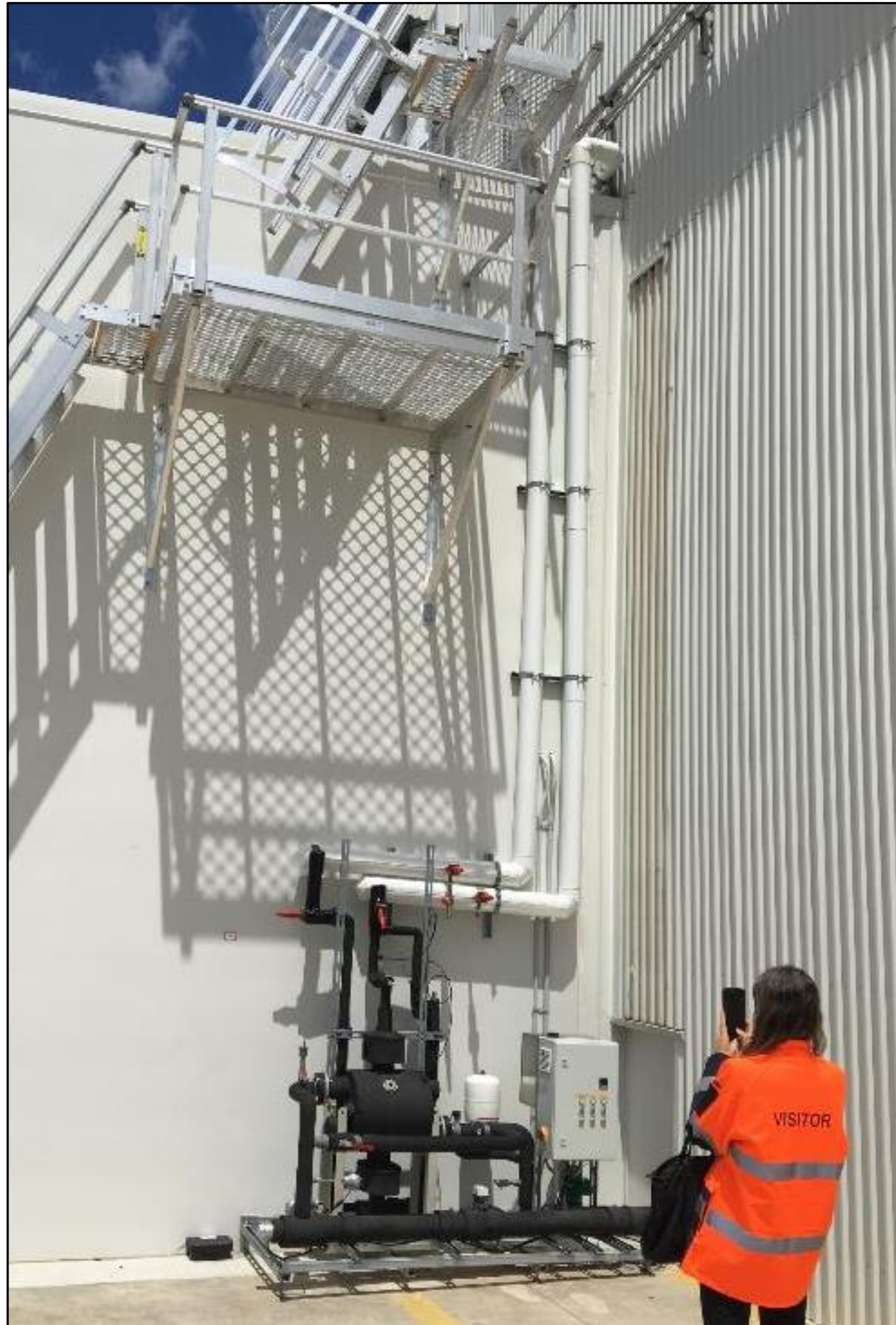


NH₃ DX S&T's



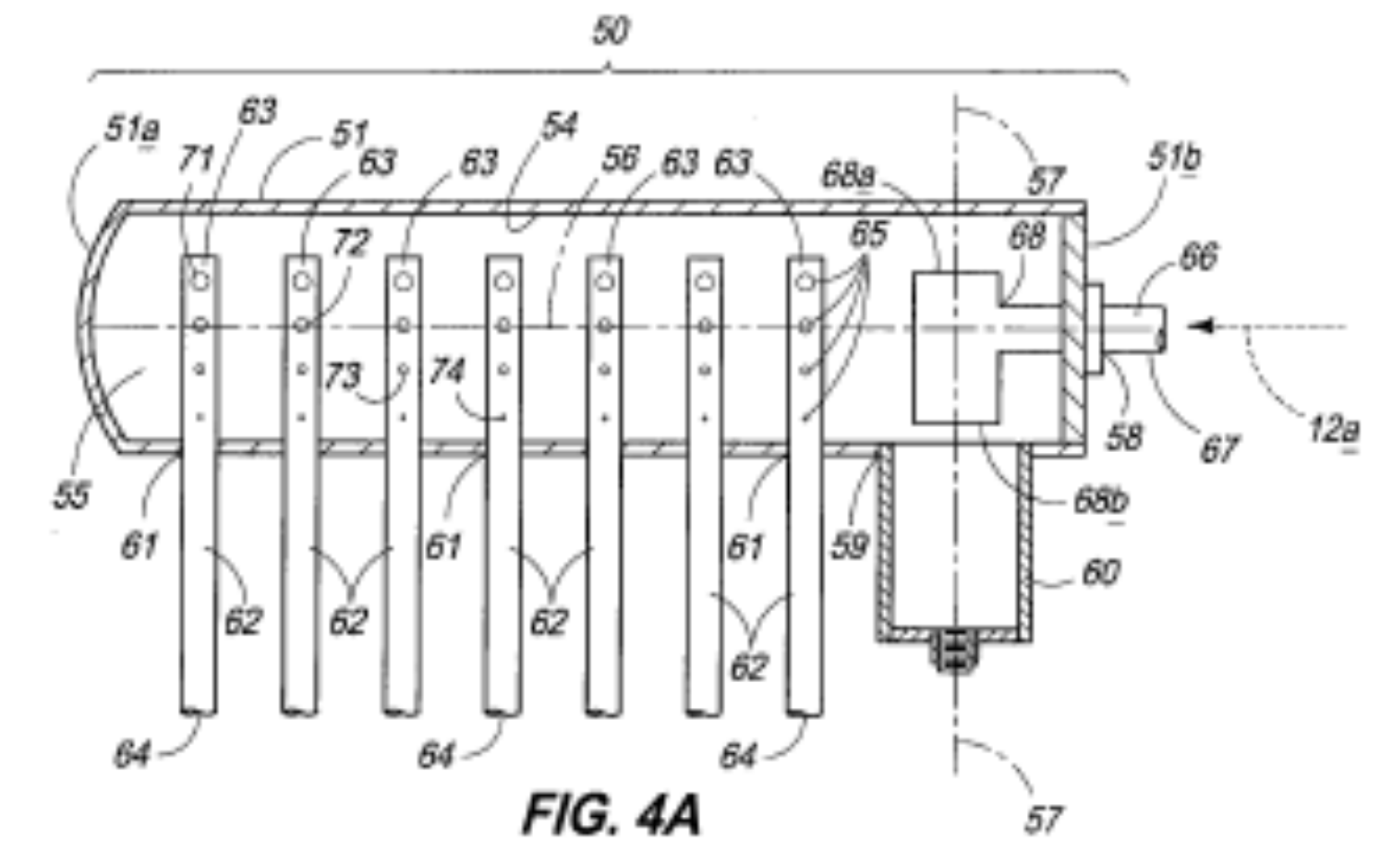
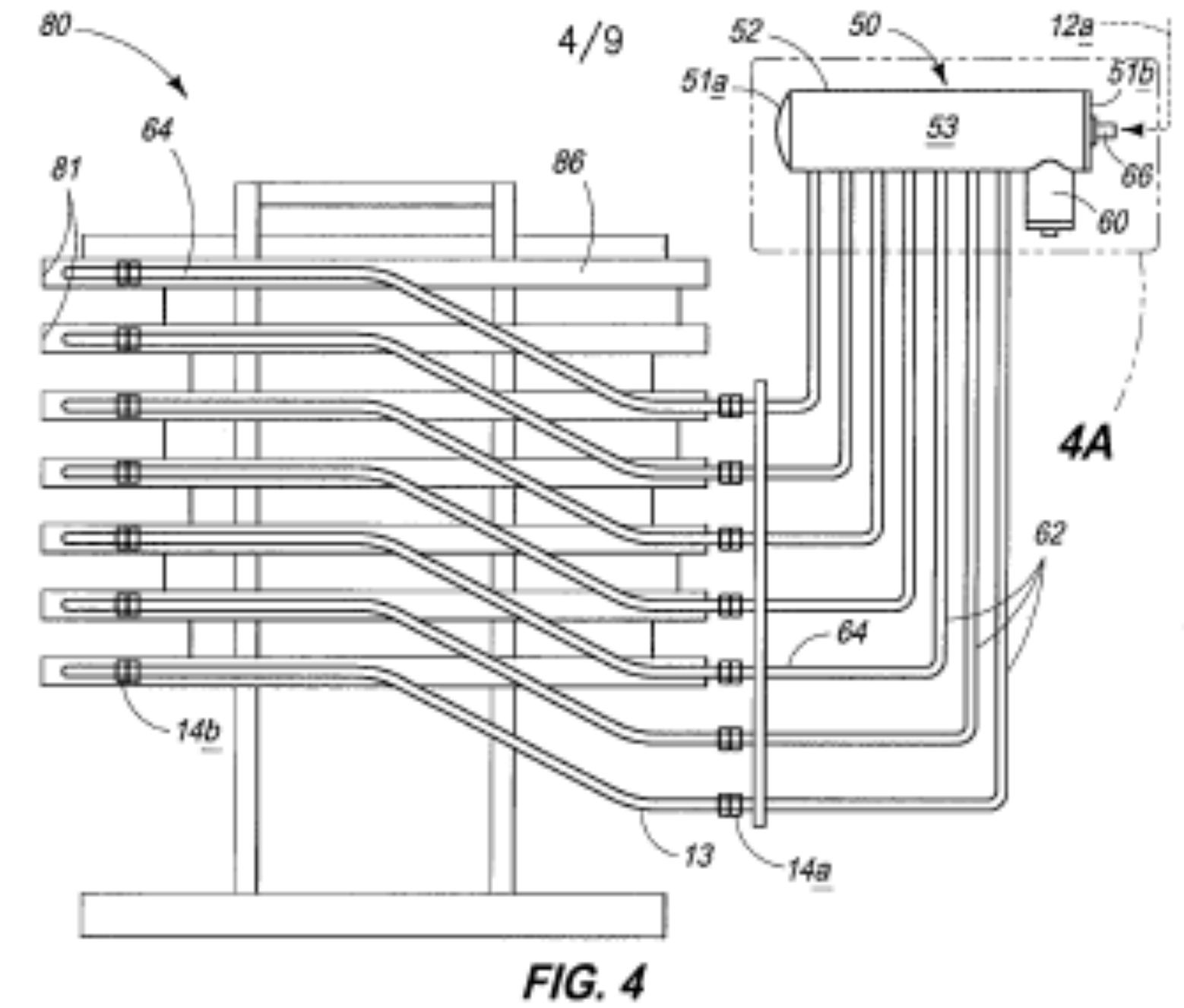
NH₃ DX PHE's

HOW WILL THE FUTURE BE?



Secondary loop defrost for further NH_3 inventory minimization, prevention of liquid hammer, energy efficiency and better defrost efficiency

Low Charge Plate Freezers



CONCLUSIONS

- Loss of the total operating refrigerant inventory from one freezer evaporator circuit (2.5 kg) will not cause an NH_3 concentration >300 ppm (IDL)
- In the event of an NH_3 leak from the freezer evaporator(s), the entire evaporator enclosure is isolated from the refrigerated space on the air side and NH_3 is vented automatically to ambient
- No NH_3 pipelines within the building enclosure excepting the plant room
- Significantly lower specific energy consumption (SEC) than CEC 2008 best practice
- Capital costs approximately the same as conventional liquid overfeed NH_3
- Of the 14 plants constructed since 2013, none have required compressor overhauls to date
- No issues to date with moisture accumulation in the refrigerant
- Recorded SEC values around 1.3x to 2x lower than TC CO_2 systems with air cooled gas coolers and electric defrost servicing cold stores of similar volumes in identical jurisdictions

ONCE YOU GO AMMONIA YOU NEVER GO BACK



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Thank you very much!



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