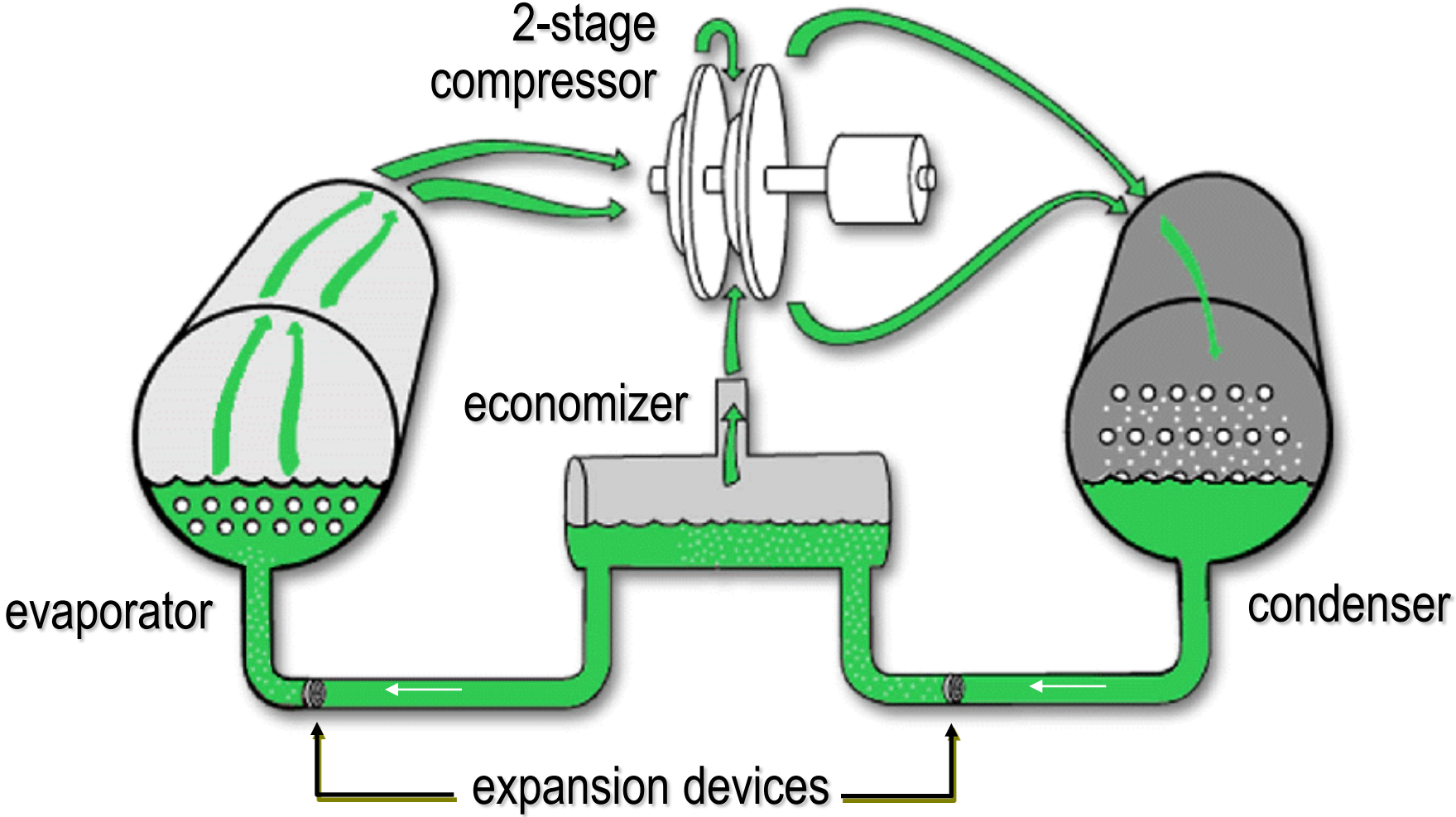
Centrifugal Water Chillers

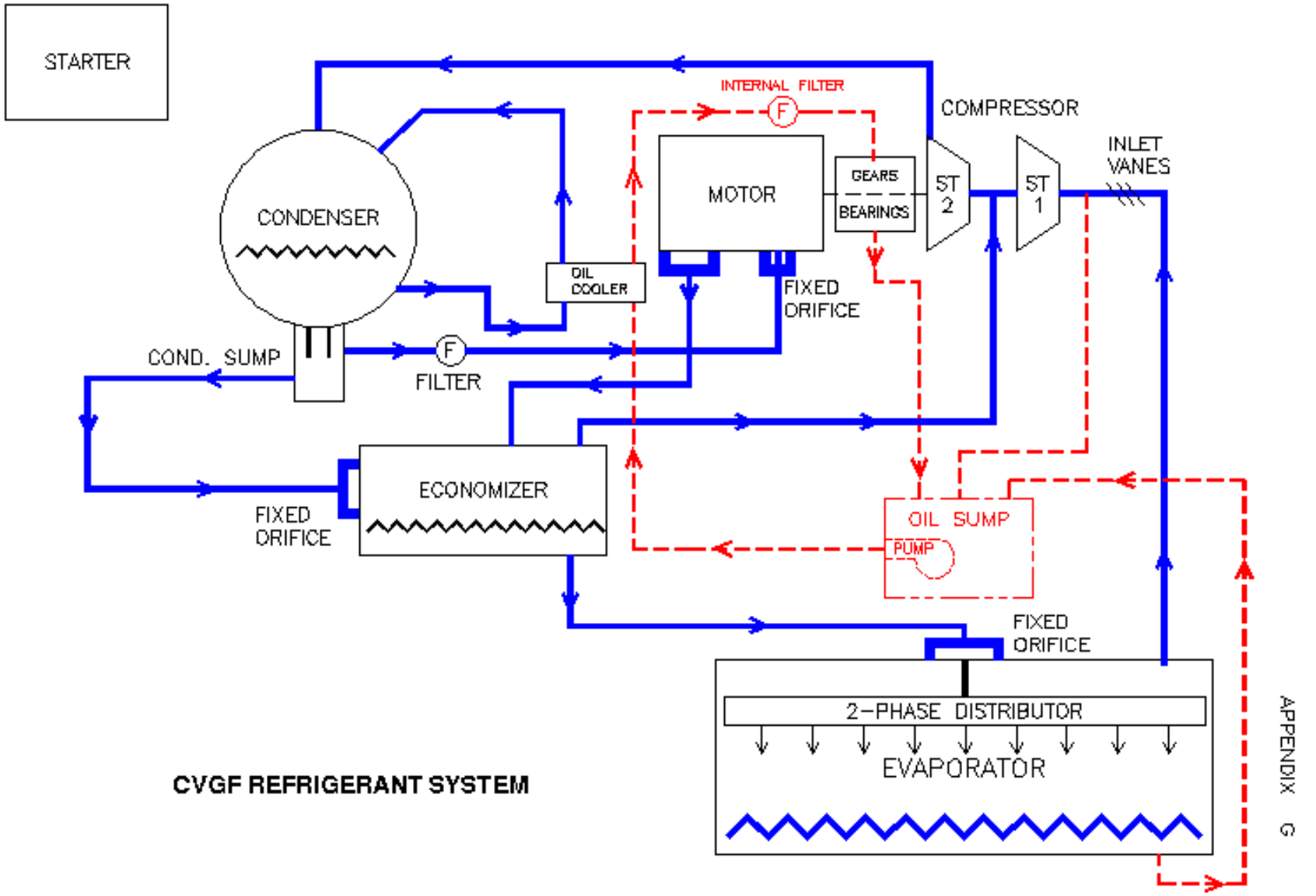
period three

Refrigeration Cycle

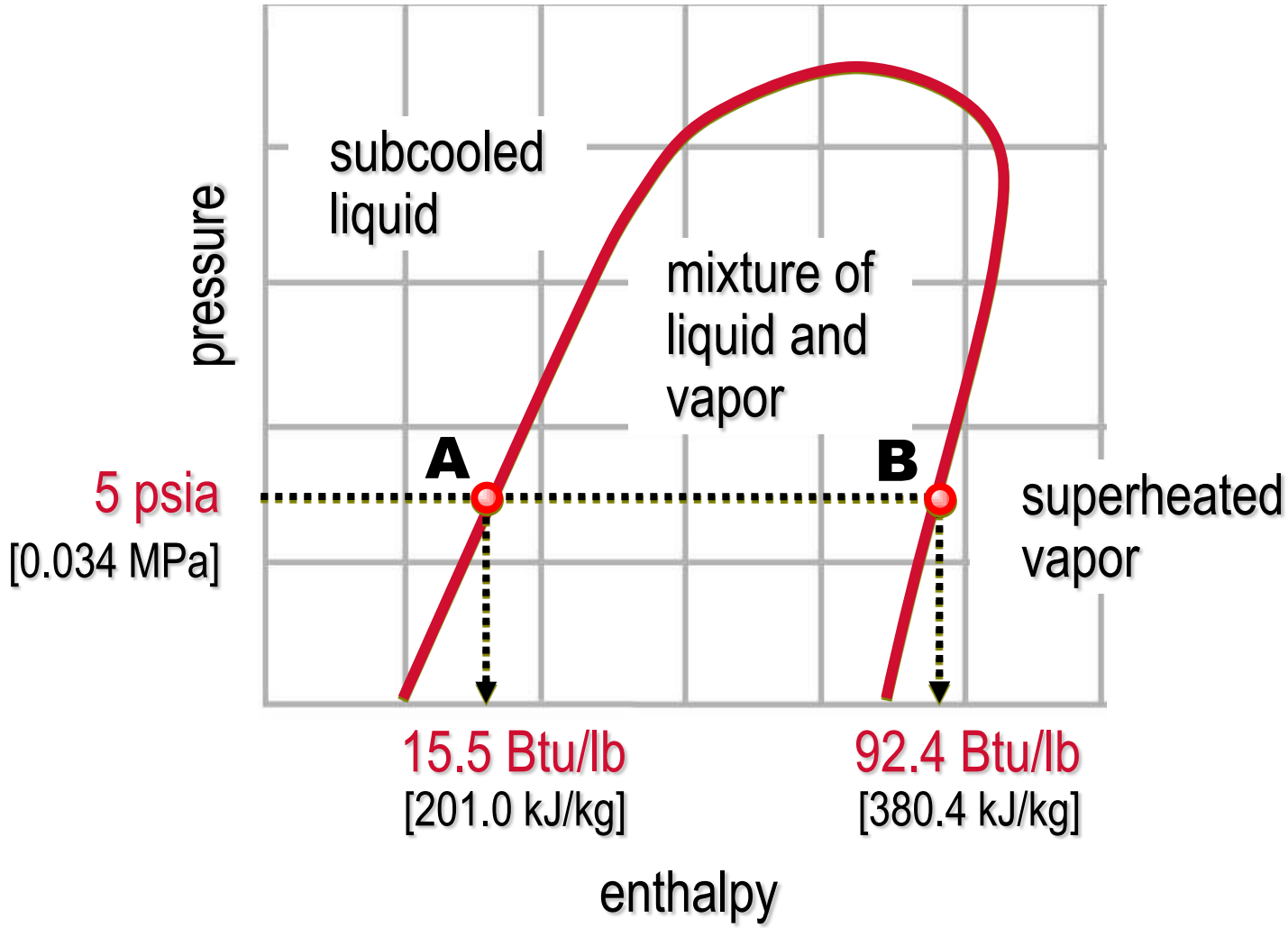
Lubrication System

2-stage centrifugal chiller
Refrigeration Cycle

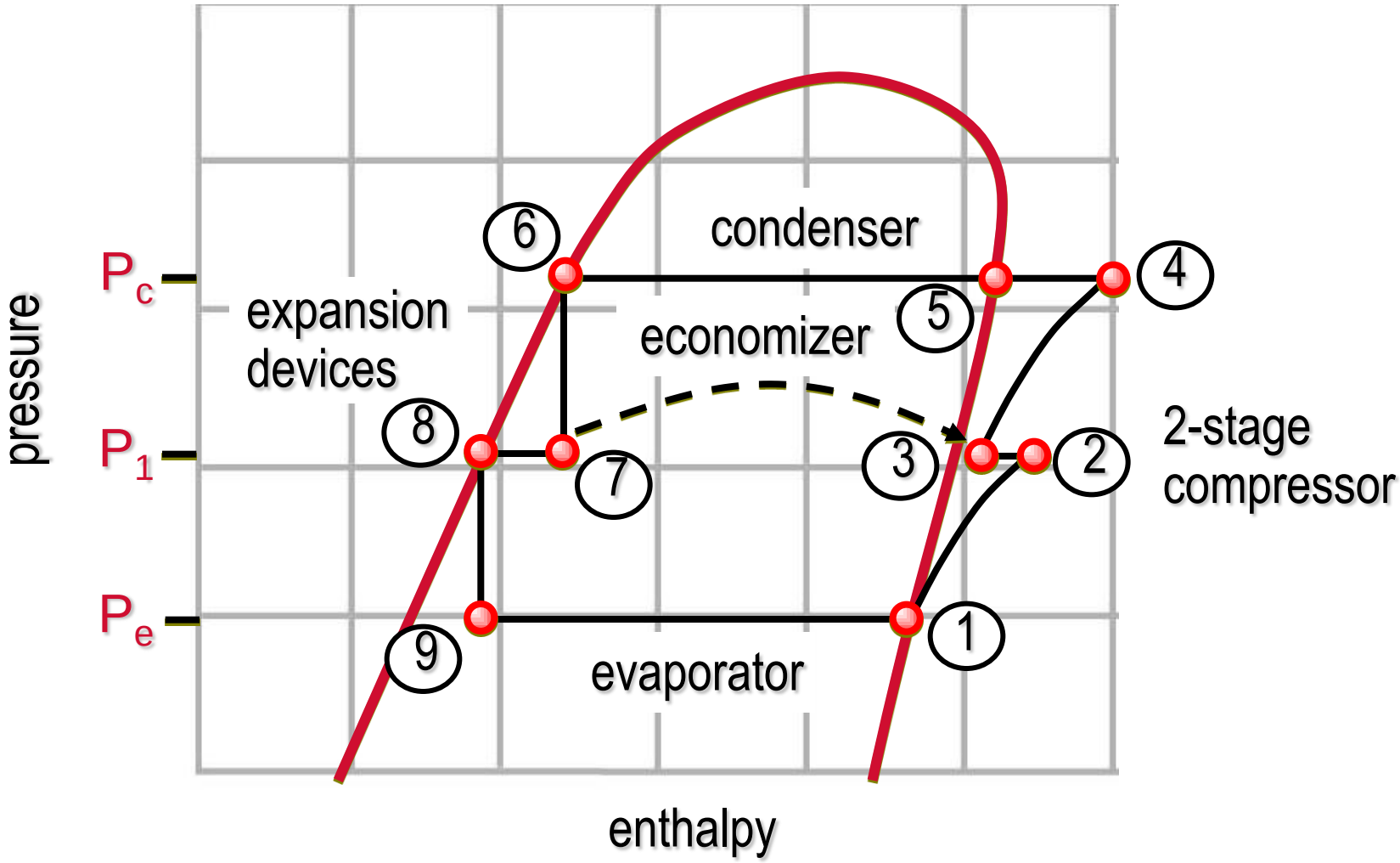



STARTER
INTERNAL FILTER
F
COMPRESSOR
INLET VANES
CONDENSER
MOTOR
GEARS
BEARINGS
ST 2
ST 1
OIL COOLER
FIXED ORIFICE
COND. SUMP
F
FILTER
ECONOMIZER
FIXED ORIFICE
OIL SUMP
PUMP
FIXED ORIFICE
2-PHASE DISTRIBUTOR
EVAPORATOR
CVGF REFRIGERANT SYSTEM
APPENDIX G
FILE: C:\CVGF\RB_APP_G.DWG
REV 9/10/98

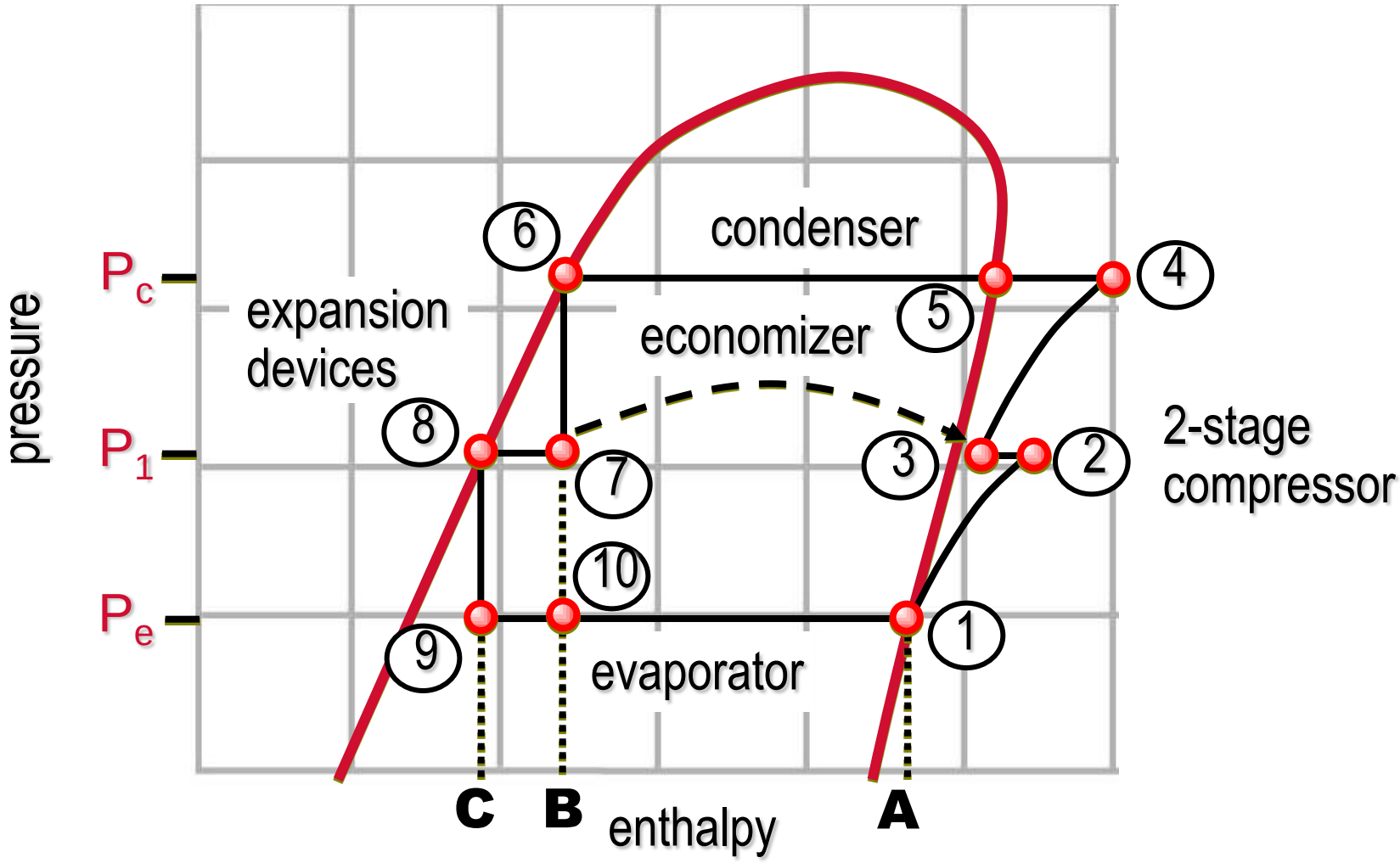
Pressure-Enthalpy (*p-h*) Chart



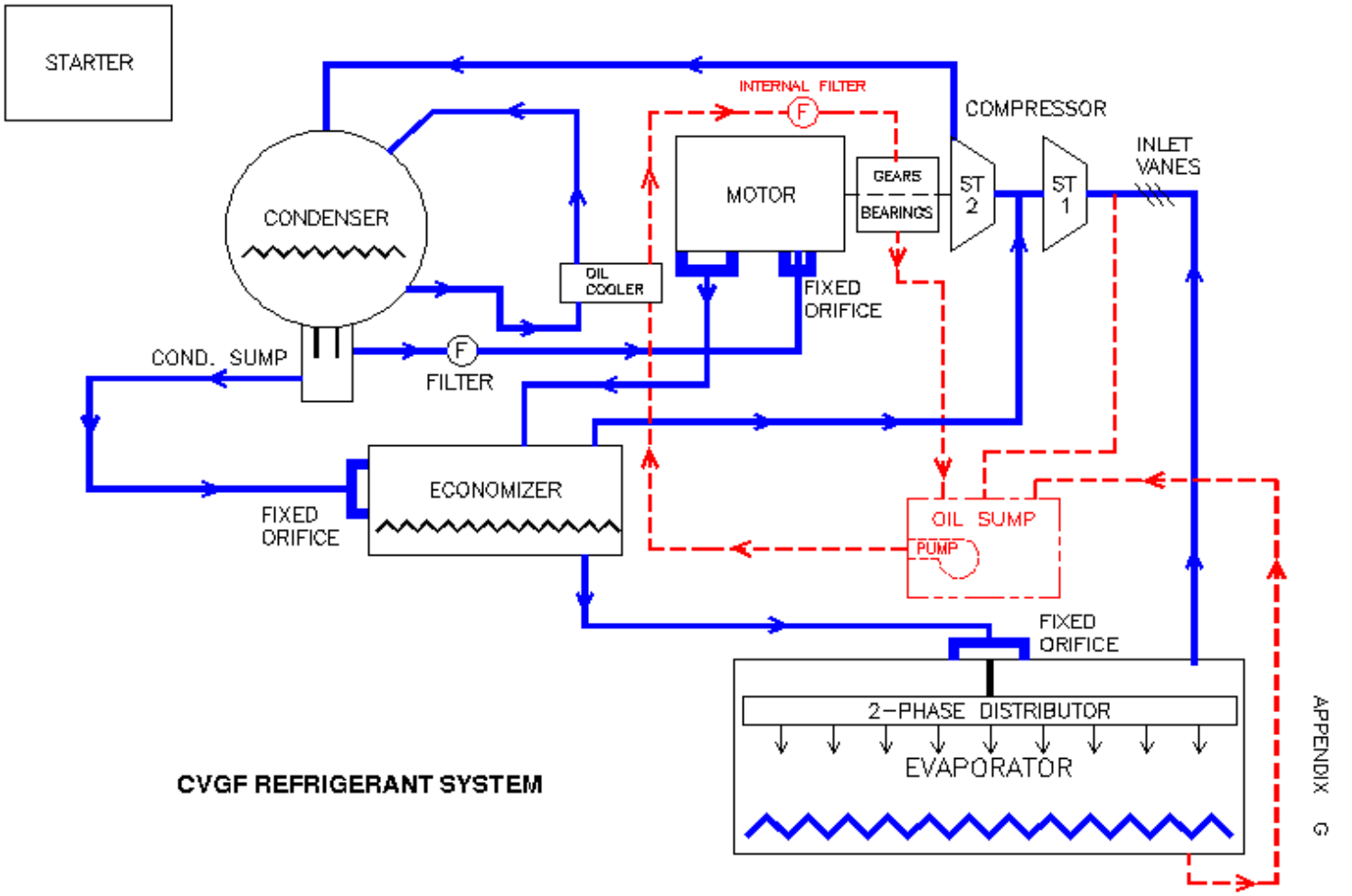
2-stage centrifugal chiller
Refrigeration Cycle



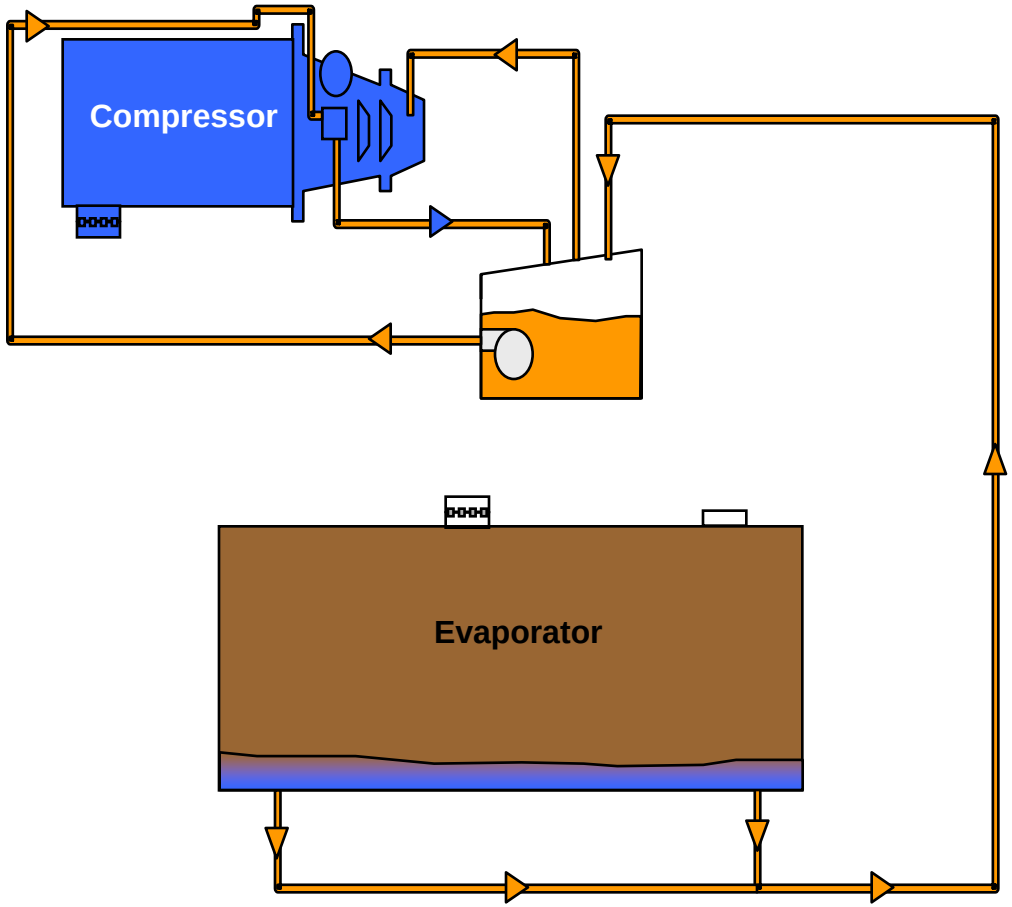
2-stage centrifugal chiller
Refrigeration Cycle



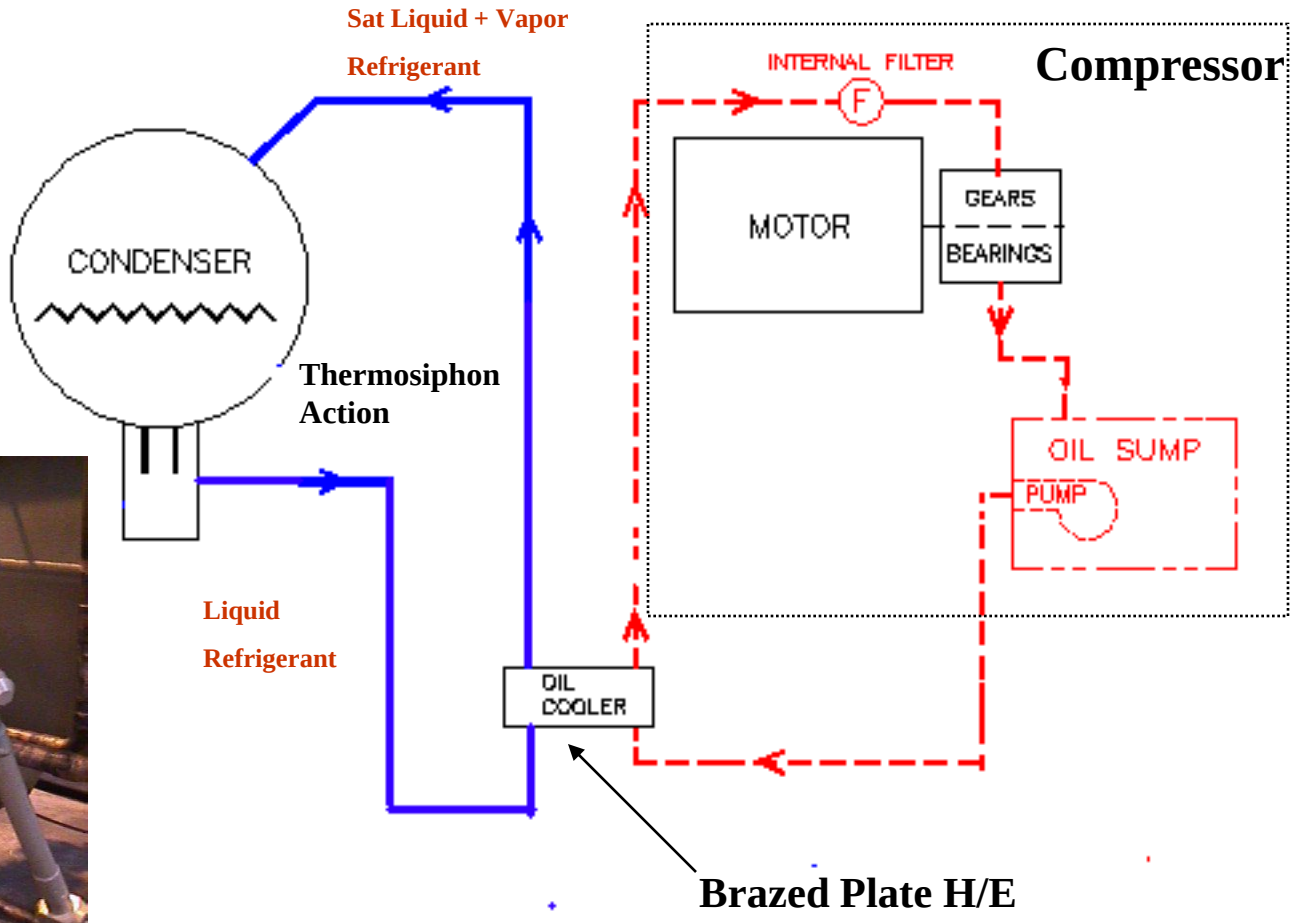
Motor Cooling & Lubrication System



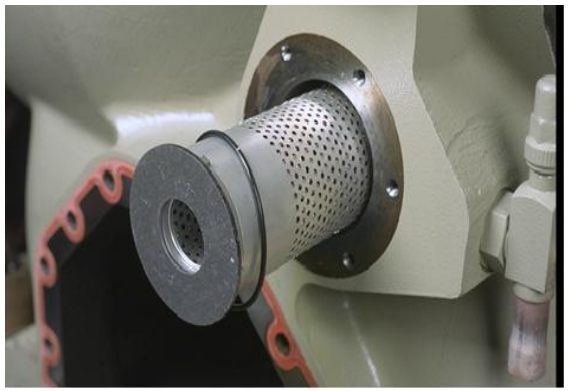
CVGF Oil System Flow

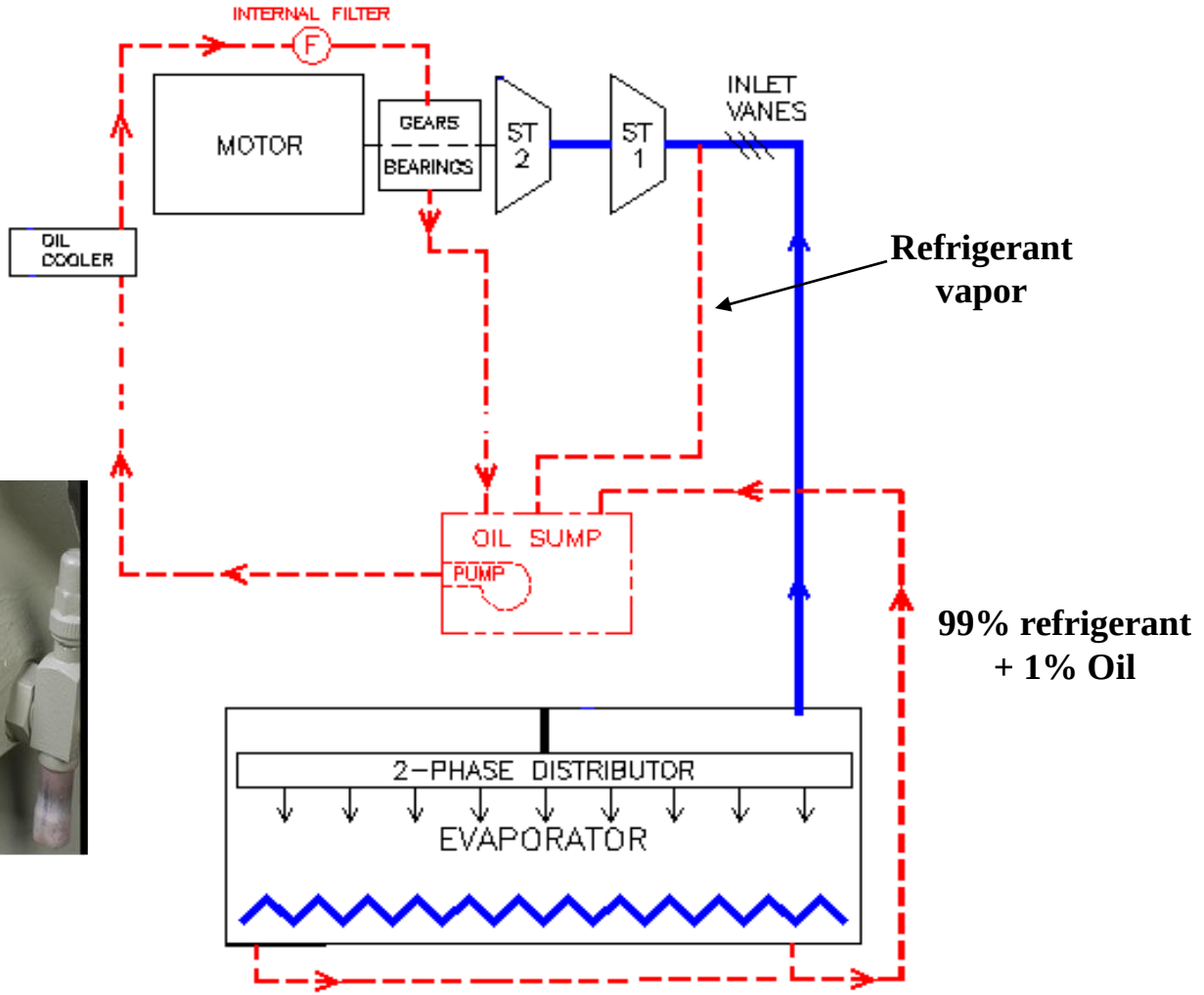


CVGF Oil Cooling System

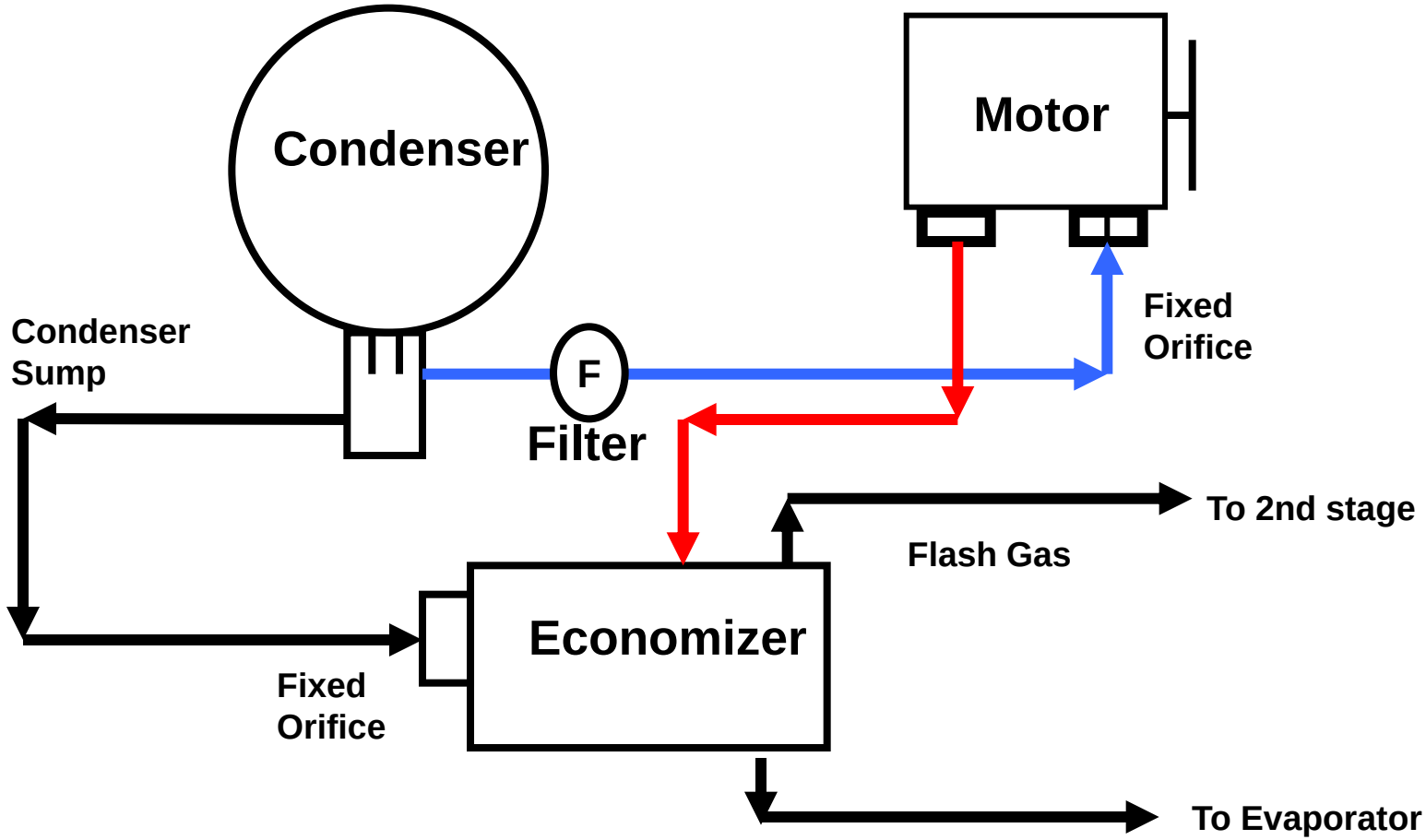


CVGF Oil Return System

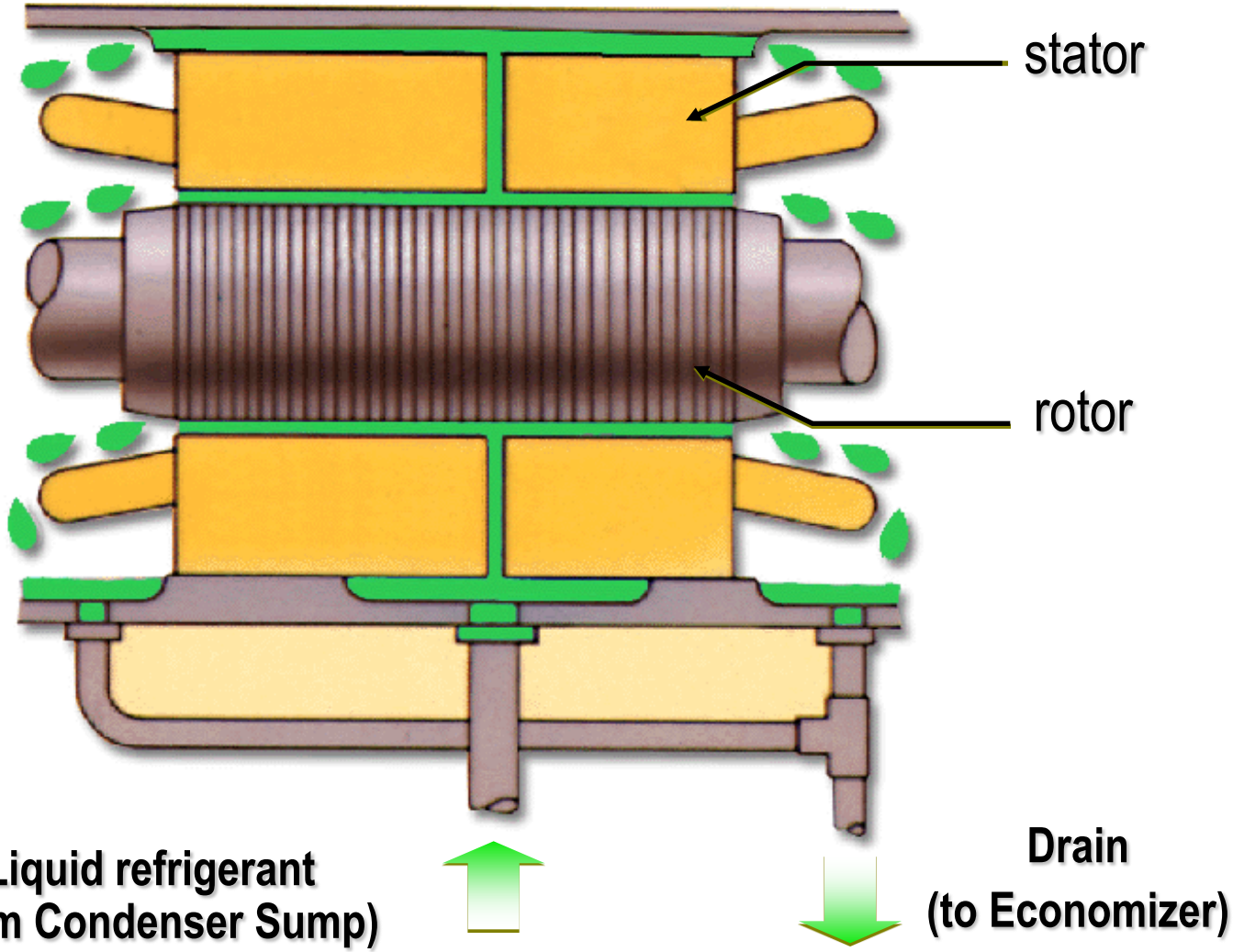




CVGF Motor Cooling System



Hermetic Motor Cooling

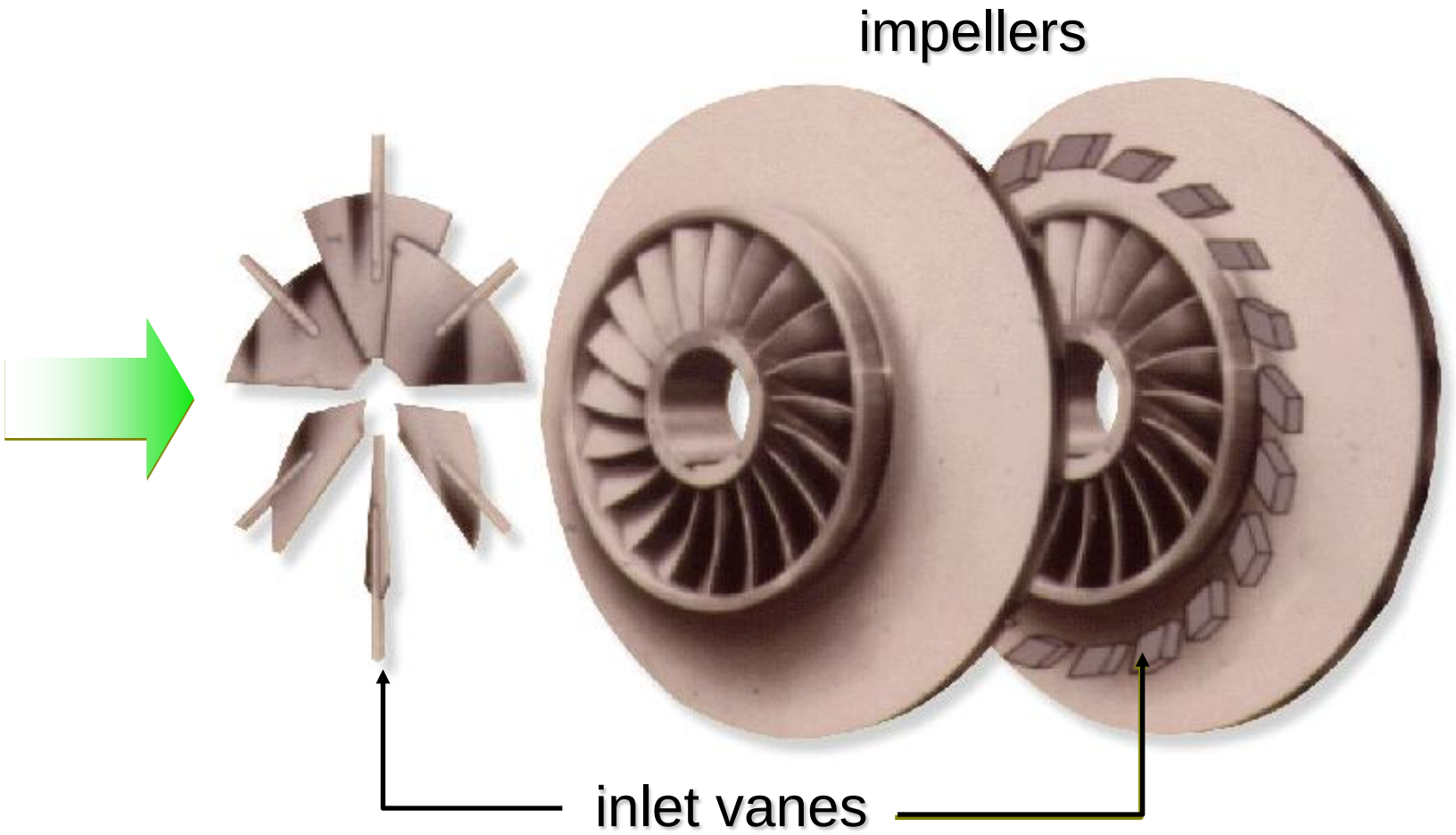


Centrifugal Water Chillers

period four

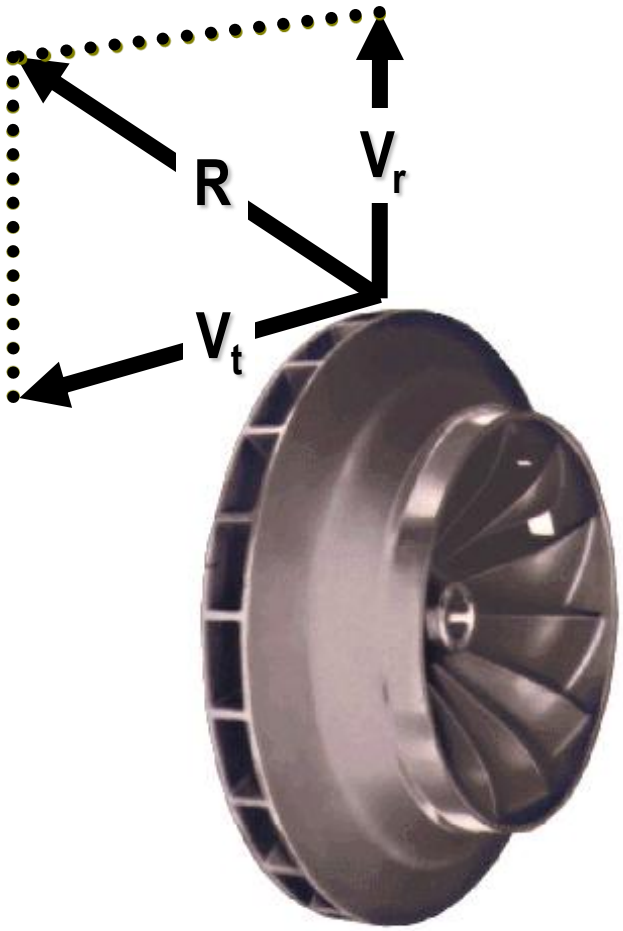
Compressor Capacity Control

Multistage Compressor



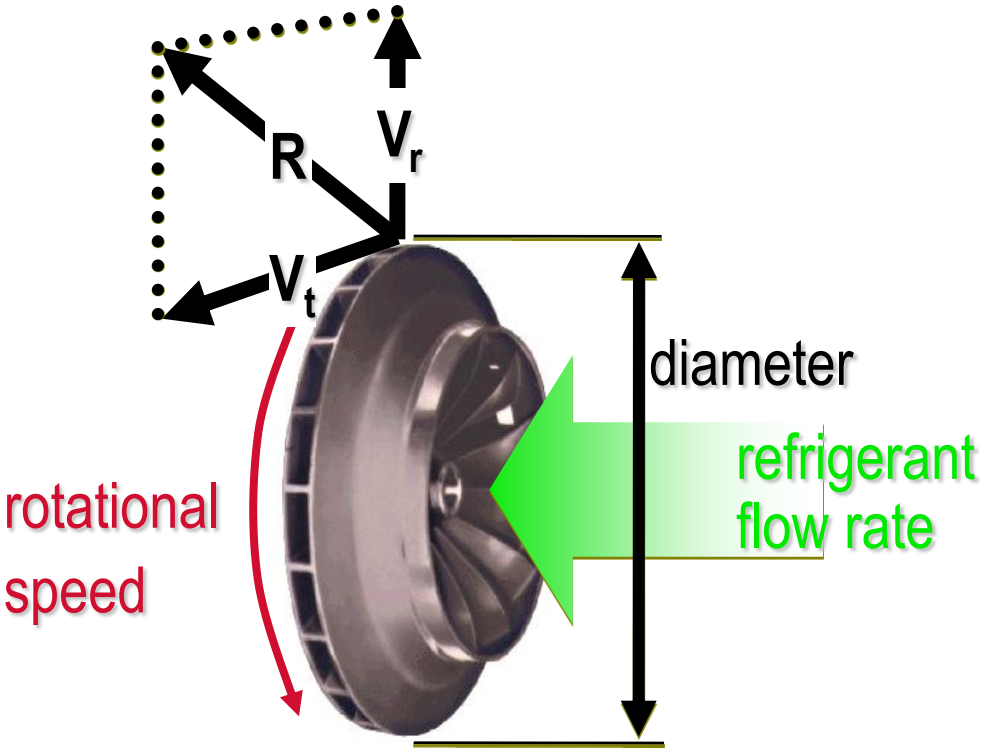
Impeller

- Negative Pressure is in The Center
- Positive Pressure is on the outside wheel
- Made of Aluminum
- Velocity Has Two Components:
  - Tangential Velocity
  - Radial Velocity
- Tangential Velocity Changes With The Impeller Speed X the Diameter
- Radial Velocity is Dependent on the Static Pressure of The Gas
- Higher Static Pressure on The Discharge equals lower Radial Velocity



Impeller Dynamics

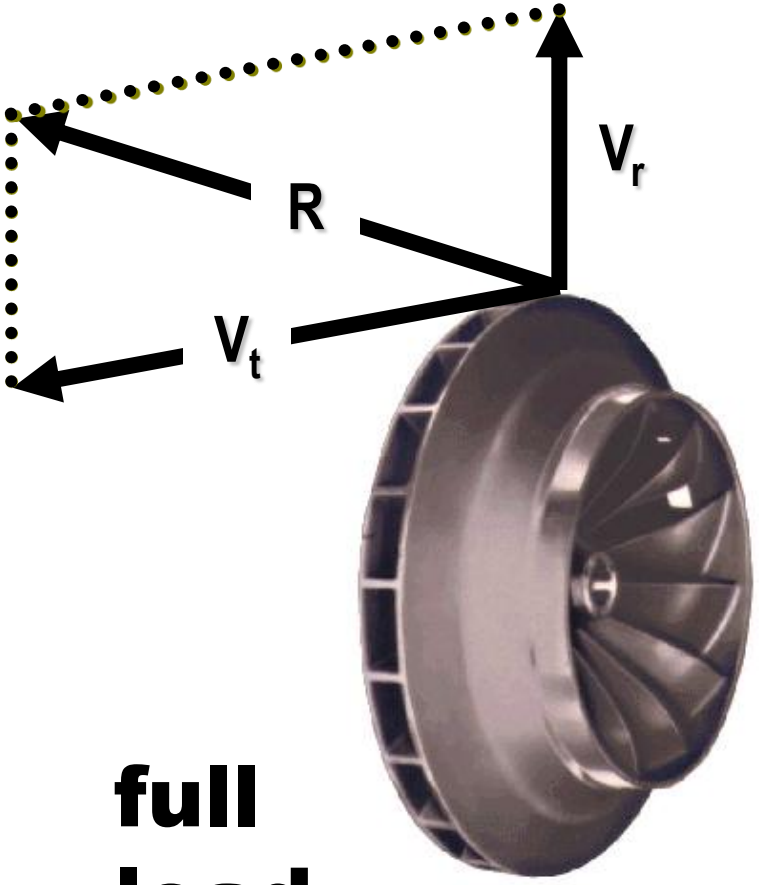
- Output is Equal to the Diameter, Speed and Volume of the Impeller.
- Change the Static Pressure, Output Changes
- Static Pressure Can Rise Due To:
  - Water Flow
  - Dirty Coils
  - High Differential Compressor Pressures
  - High Discharge Pressures



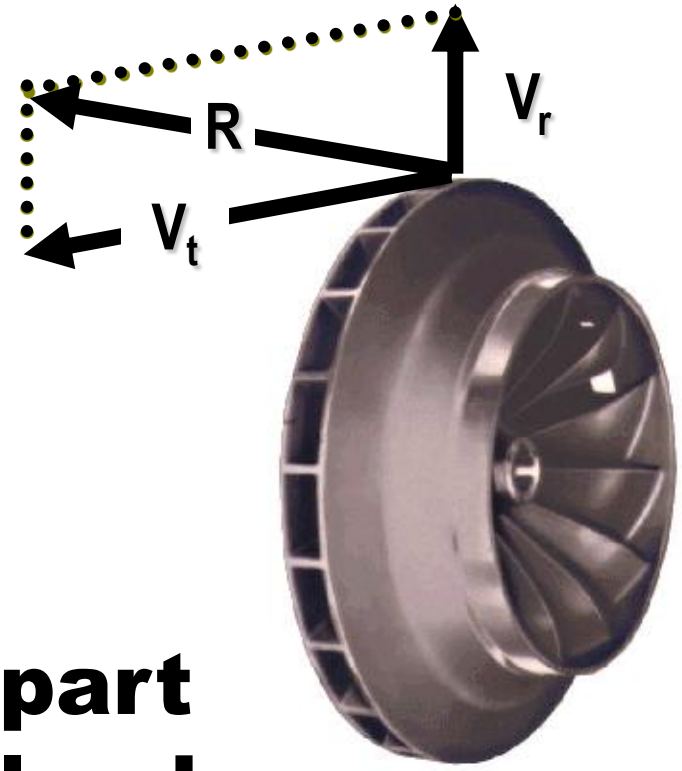
$V_r \propto$ refrigerant flow rate

$V_t \propto$ rotational speed × diameter

Compressor Unloading



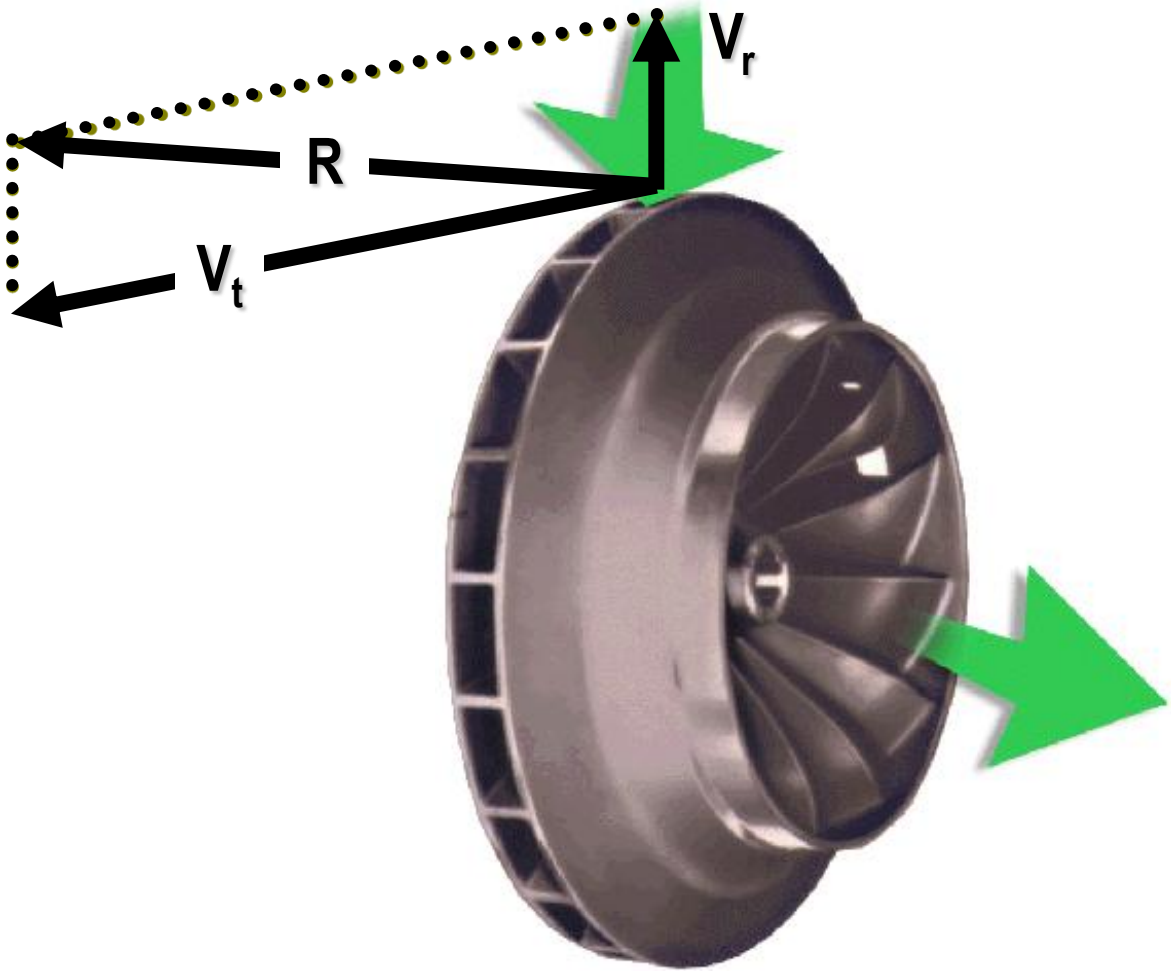
full load



part load

Surge

- High Condenser Water Temperature Causes Surge
- Low Load Conditions Causes Surge
- Surge Causes:
  - Inefficiency
  - Static Pressure Fluctuations
  - Vibration
  - Noise

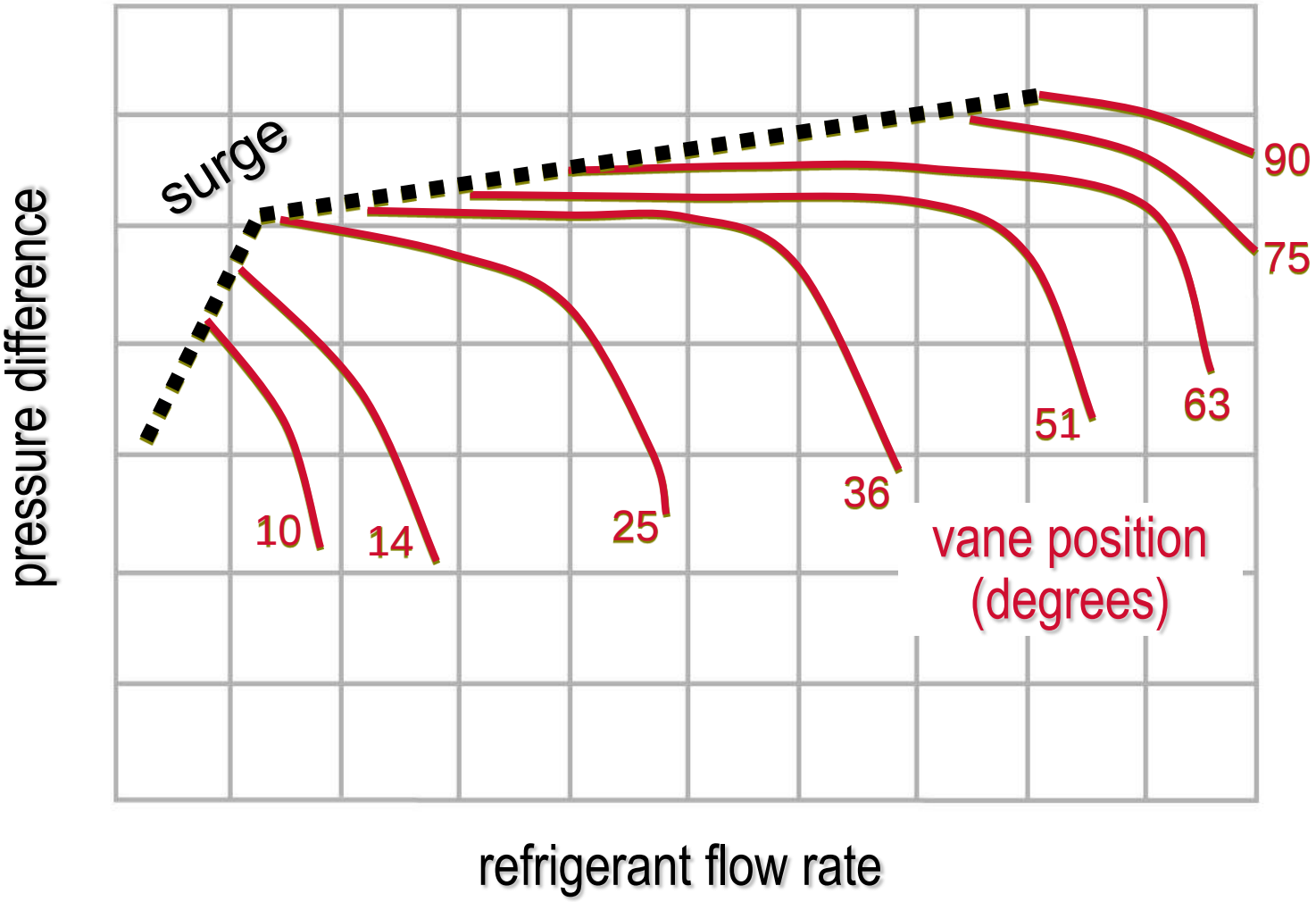


V_r < static pressure

Inlet Vanes

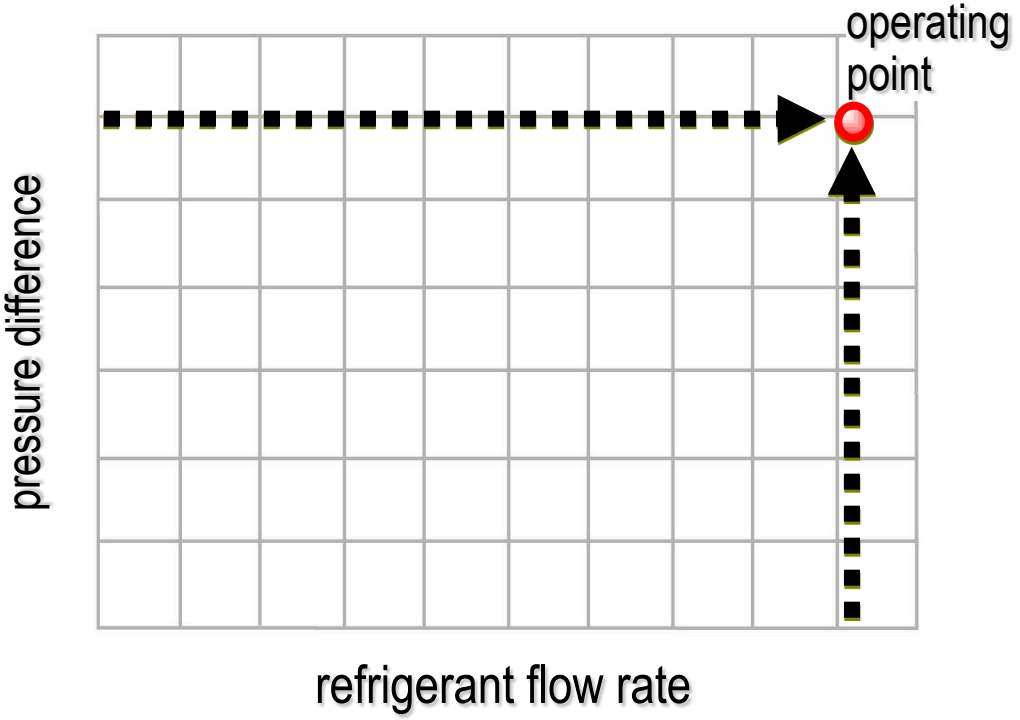
- Impeller Volume Changes Are Controlled By Inlet Vanes
- Inlet Vanes Pre-spin The Entering Gas
- Inlet Vanes are Electronically Controlled By a Stepper Motor
- System Design Curves Tell The Story

Compressor Map



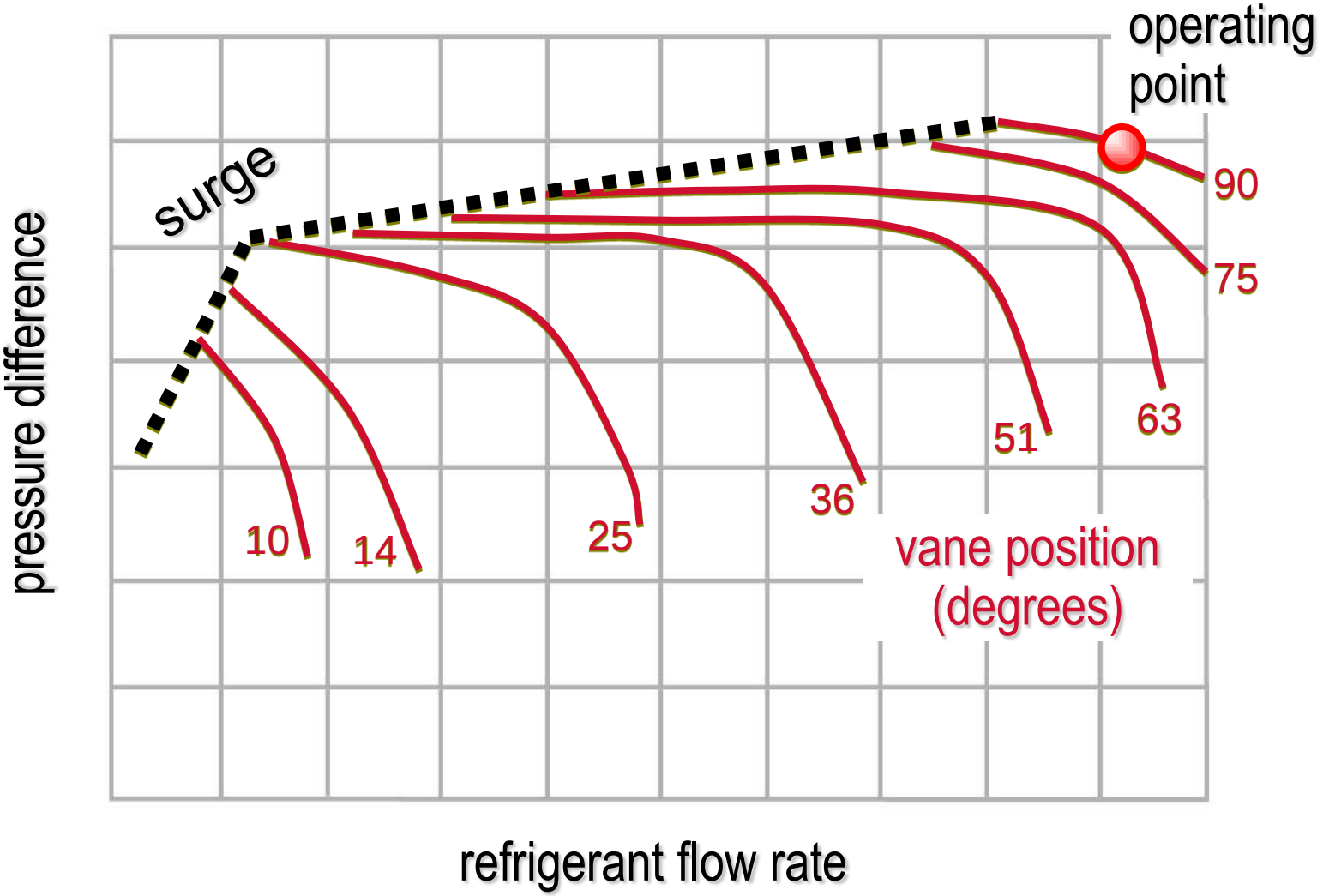
Operating Point

- Operating Point at Design Conditions
- Specific Unit Tonnage or kW
- Specific Wheel Design



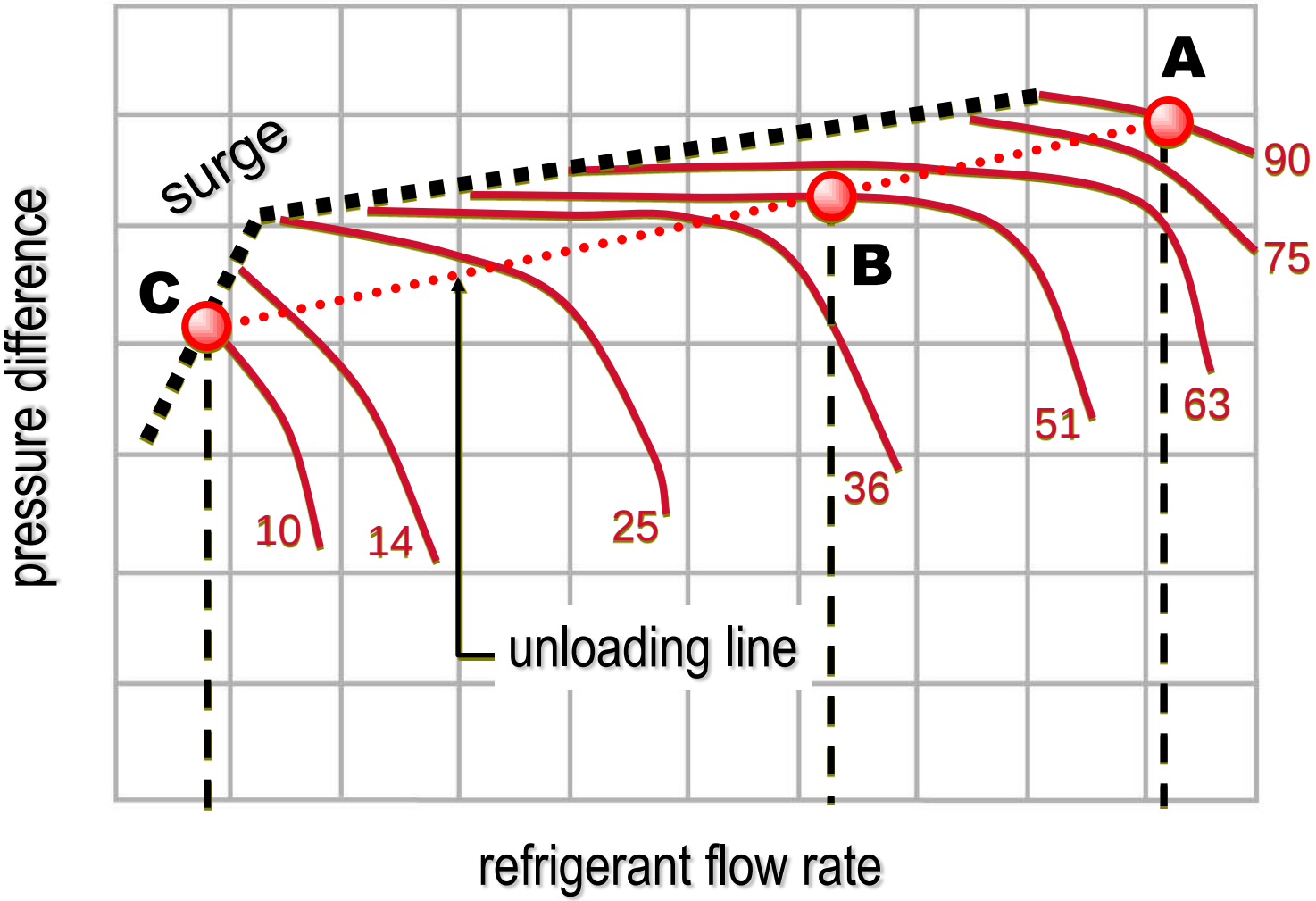
compressor map for a

2-Stage Compressor



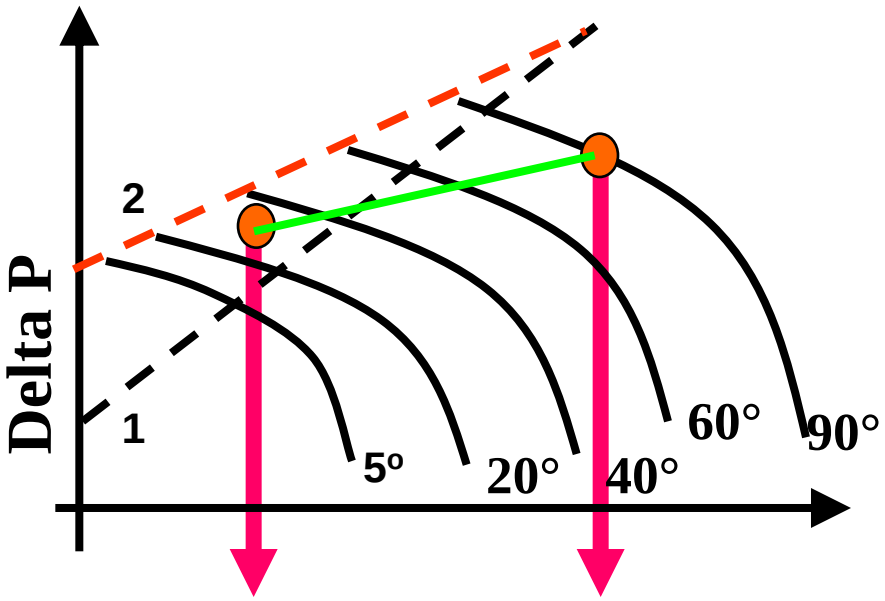
compressor map for a

2-Stage Compressor



CVGF Impeller Curve Load Charts

- Operating Point Unloader Changes
- As Vanes Close, CFM - m^3/s Changes

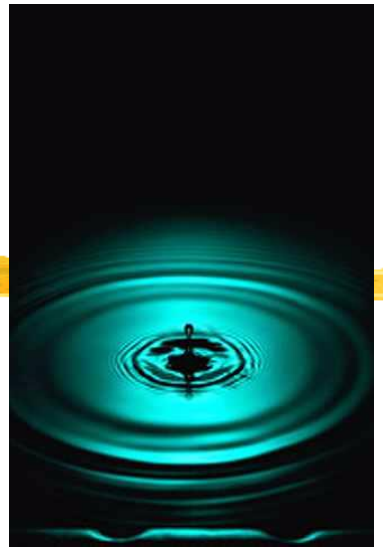


Centrifugal Water Chillers

period five

Features and Benefits

CVGF Features and Benefits



- Performance
  - Competitive Performance
    - High efficiency (0.59 Kw/Ton @ARI)
    - Standard efficiency (0.64 Kw/Ton @ARI)
  - With two stage compressor and inter stage economizer
  - Economizer cycle adds 3% improvement on efficiency
  - Advanced heat transfer technology
  - Advanced evaporator design reduces the refrigerant charge (1.3 ~ 1.5 lbs Refrigerant per ton)
  - No eliminator necessary with an advanced suction baffle design
  - Low noise

CVGF Features and Benefits

REFRIGERANT CHARGE

Refrigerant Charge - 134a			
Evaporator		Single	
Size	Bundle	Condenser	
		LBS	KG
500	A	650	295
	B	701	318
	C	750	340
700	A	875	397
	B	924	419
	C	974	442
1000	A	1225	556
	B	1275	578
	C	1325	601
	D	1375	624

Constant for LBS. Conversion
2.20462

CVGF Features and Benefits

MODEL CVGF 400 – 500

Sound Level

Sound pressure level (at 1 meter) at full load, 50 % and 25 % part load conditions:

CVGF 400 – 500 NTON	100 % load	50 % load	25 % load
Asia Conditions ** Without condenser relief	82 dBA	85 dBA	86 dBA

Sound Pressure Levels (anticipated) – dB re 20 micropascal

Octave Band	Constant Condenser Water		
	100 % load	50% load	25% load
63 Hz	67	73	75.5
125 Hz	70	84.5	82
250 Hz	69	74	75.5
500 Hz	70.5	72	76
1000 Hz	79	78	81.5
2000 Hz	74.5	81.5	81
4000 Hz	71	74.5	76
8000 Hz	60.5	62.5	70

* ARI Standard 550 / 590 rating conditions.

** Asia conditions LEWT = 44.6 ° F / ECWT = 89.6 ° F.

Test conducted in accordance with ARI Standard 575.

CVGF Features and Benefits

MODEL CVGF 650 (Nominal)

Sound Level

Sound pressure level (at 1 meter) at full load, 50 % and 25 % part load conditions:

CVGF 560 – 700 NTON	100 % load	50 % load	25 % load
Asia Conditions ** Without condenser relief	83.5 dBA	88.5 dBA	88 dBA

Sound Pressure Levels (anticipated) – dB re 20 micropascal

Octave Band	Constant Condenser Water		
	100 % load	50% load	25% load
63 Hz	70.5	81	82.5
125 Hz	73.5	89	85.5
250 Hz	71.5	80.5	82.5
500 Hz	68	75.5	76
1000 Hz	74	76.5	77
2000 Hz	80.5	86	85.5
4000 Hz	75.5	77	75.5
8000 Hz	66	66.5	66.5

* ARI Standard 550 / 590 rating conditions.

** Asia conditions LEWT = 44.6 ° F / ECWT = 89.6 ° F.

Test conducted in accordance with ARI Standard 575.

CVGF Features and Benefits

MODEL CVGF 800 -1000

Sound Level

Sound pressure level (at 1 meter) at full load, 50 % and 25 % part load conditions:

CVGF 800 – 1000 NTON	100 % load	50 % load	25 % load
Without condenser relief **	81 dBA	79.5 dBA	88 dBA

Sound Pressure Levels (anticipated) – dB re 20 micropascal

Octave Band	Constant Condenser Water		
	100 % load	50% load	25% load
63 Hz	66.5	70	67.5
125 Hz	74	76	81
250 Hz	73	73.5	79
500 Hz	70.5	70.5	72
1000 Hz	72	71.5	75.5
2000 Hz	77.5	76	86.5
4000 Hz	73	69	72.5
8000 Hz	63	61	67

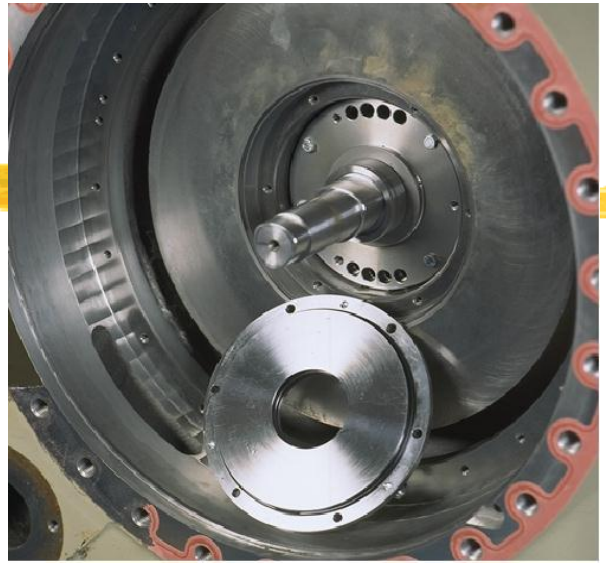
** Rating conditions LEWT = 44 ° F / ECWT = 85 ° F.

Test conducted in accordance with ARI Standard 575

CVGF Features and Benefits

- Reliability
  - With hermetic motor design, motor is cooled by liquid refrigerant. Better motor efficient
  - Patented integral heater imbedded into the compressor casting, no seals, no leaks
  - Beaded flat gasket technology instead of O-rings, lower susceptibility to developing leaks
  - No NPT pipe threads on compressor, SAE O-ring boss fitting, lower leak potential
  - Oil sump internal to Compressor / motor assembly with internal pump / motor, eliminates vent & drain lines, less leak paths.

CVGF Features and Benefits



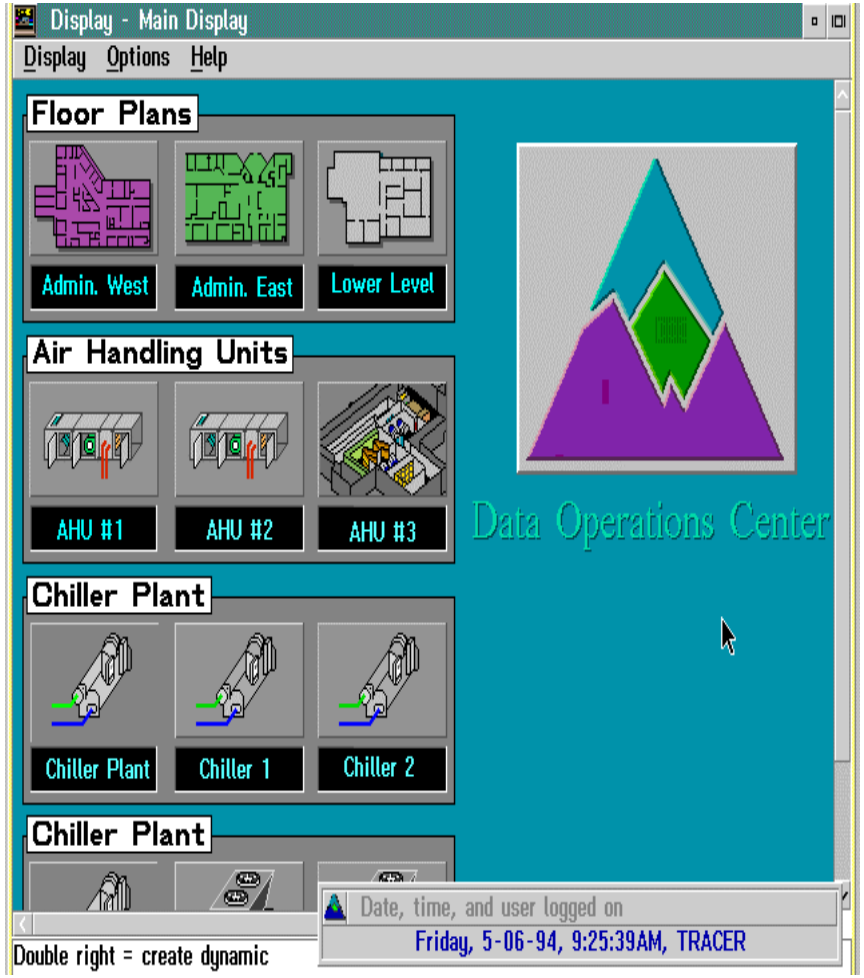
- Reliability
  - UL / CUL recognized
  - CE / PED
  - ASME shell design
  - Patented polygon attachment instead of a keyed shaft, self balancing
  - Heaters, oil filter, oil differential pressure switch and temp sensors are all replaceable w/o removing system charge

CVGF Features and Benefits

- Reliability
  - UCP-2 Intelligent Control
  - Provides over 120 Diagnostics and Operating Points
  - Standard Report Groupings
  - User Tailored Custom Reports
  - Levels of Security

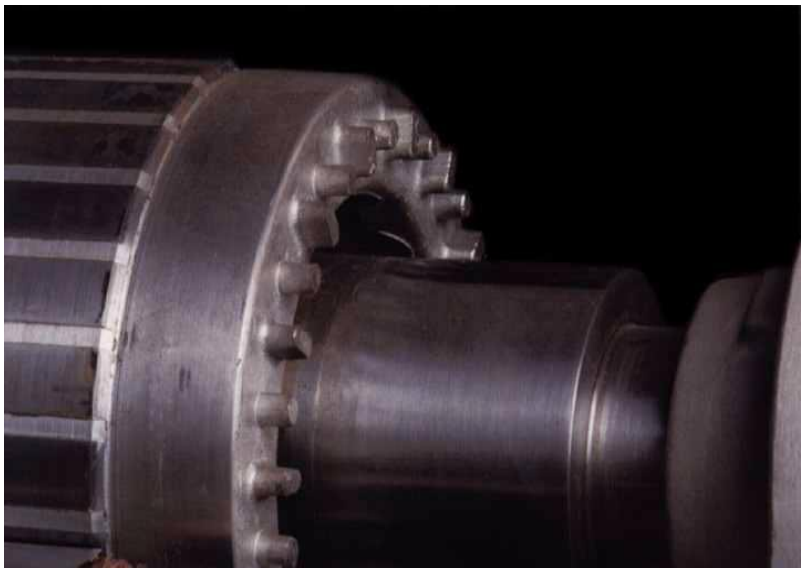
CVGF Features and Benefits

- Reliability
  - Integrated Comfort System Trane Tracer Summit Control
  - Chiller Plant Manager Control
  - ICS -- UCP-2 Chiller Control System
  - BACNet Compatible and Modbus Compatible



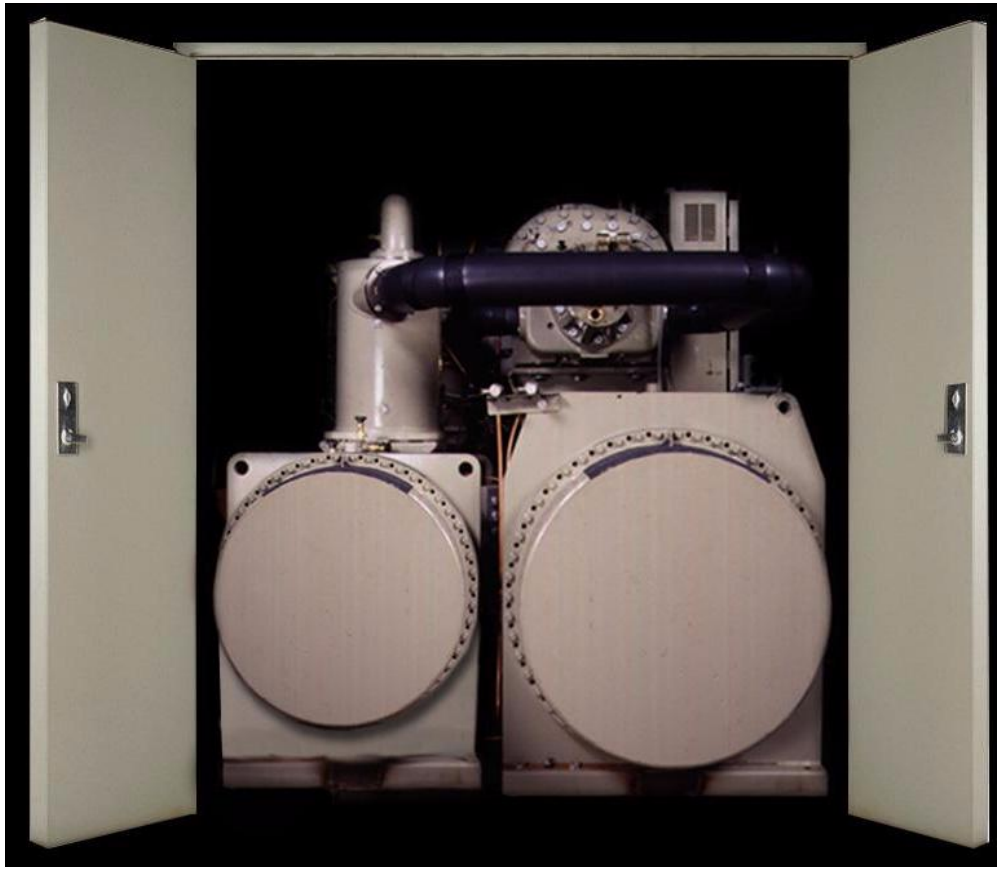
CVGF Features and Benefits

- Low maintenance
  - Zero maintenance motor, liquid cooled
  - No shaft seal will make sure no risk of refrigerant loss through shaft
  - No shaft alignment problem
  - No couplings
  - No purge



CVGF Features and Benefits

- Ease of installation
  - Compact size
    - CVGF500 fits through a double-width door
  - Excellent choice for retrofit and replacement jobs due to compact size
  - No oil cooler or purge system connections
  - Unit mounted starter eliminates additional jobsite labor requirements
  - Factory wired UCP2 and united mounted starter



CVGF Features and Benefits

- Optional Features
  - Special tubing material (CuNi, Titanium)
  - Special thickness
  - Titanium clatted tubesheet
  - Heresite coated waterbox
  - IQD (digital ammeter and digital voltmeter)
  - PFCC (power factor correction capacitor)
  - NEMA 4A for control panel; NEMA 12/3R for starter
  - 150# / 300# MAR waterboxes for evap or cond
  - Factory-applied thermal insulation
  - Spring Isolators
  - BAS Interface
  - Factory testing

CVGF Features and Benefits

- Optional Features
  - Medium / High Voltage (60Hz : 3300, 4160, 6600V)
    (50Hz : 3300, 6600V)

50 Hz				
KW	HP	Volt Range		
		Low	Medium	High
240	298			
266	332		440E	
301	376	400 &	Frame	
338	424	440E		
374	470	Frame		
430	541			
484	609			
535	675		5000	
594	750		Frame	
674	854	5000		
751	950	Frame		

60 Hz			
KW	HP	Volt Range	
		Low	Medium
221	276		
254	318		
285	358		
316	398	400 &	440E
357	452	440E	Frame
401	509	Frame	
444	564		
511	650		
574	731		
641	810	5000	5000
719	910	Frame	Frame
808	1025		

Available **NOW**

Available **NOW**

Available **NOW**

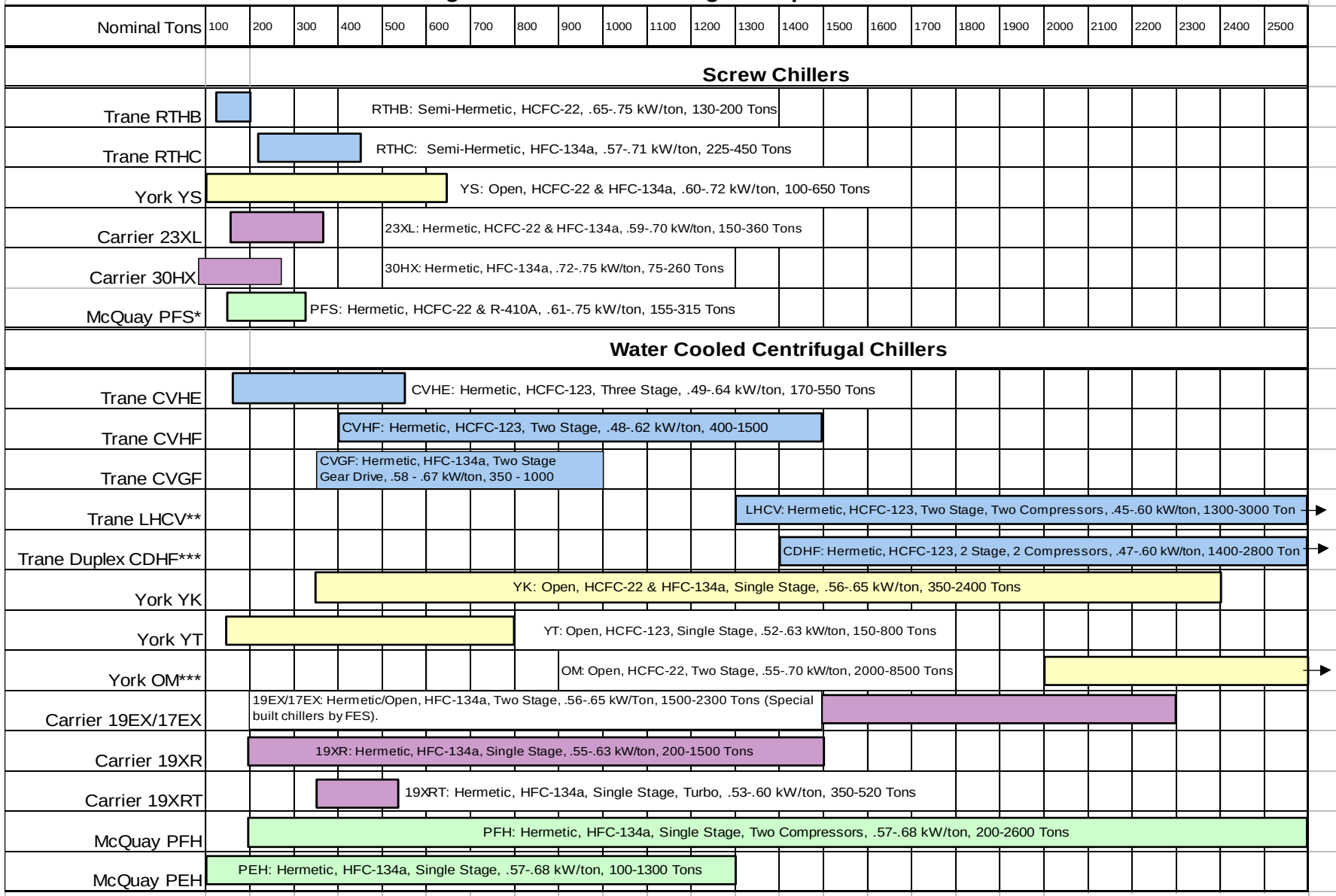
Available 5/9/01

Centrifugal Water Chillers

period six

Competitions

Centrifugal/Screw Chiller Tonnage Comparison - 60 Hz



*67-215 tons using R-22, 230-

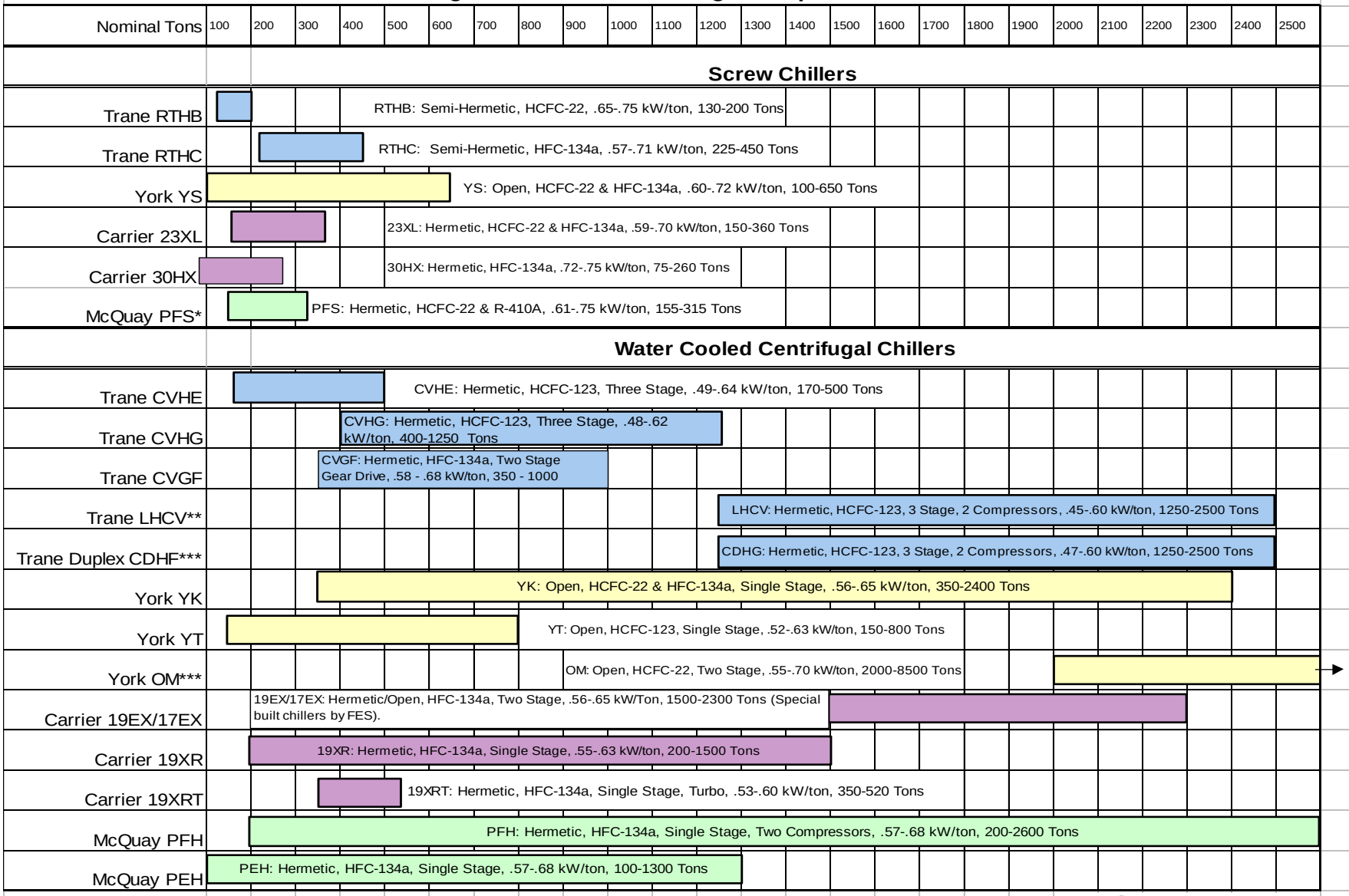
**LHCV most feasible 2000-

***Large tonnage chillers:

Note: Above efficiencies are at ARI conditions. For Asia conditions add 0.03 kW/Ton to above efficiencies.

TRANE

Centrifugal/Screw Chiller Tonnage Comparison - 50 Hz



*67-215 tons using R-22, 230-

**LHCV most feasible 2000-

***Large tonnage chillers:

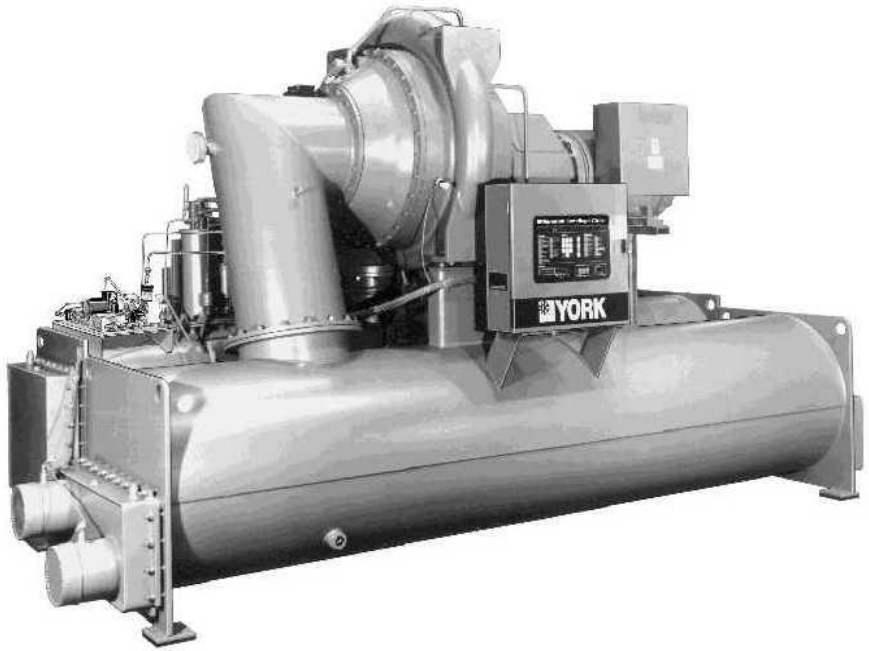
Note: Above efficiencies are at ARI conditions. For Asia conditions add 0.03 kW/Ton to above efficiencies.

TRANE

Competition

YORK YT

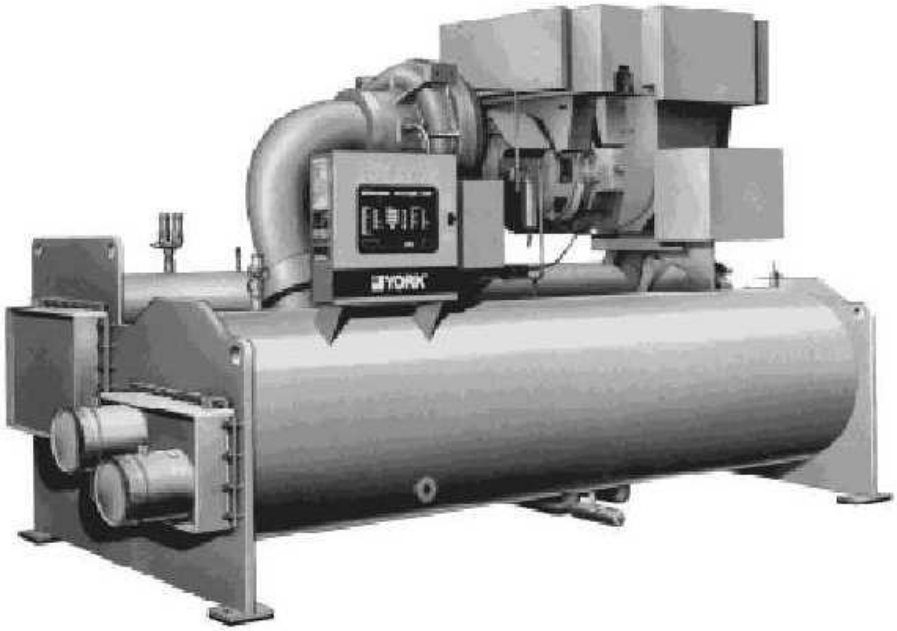
- Tonnage Range
  150~850 RT
- Single stage Comp.
- Open Motor - heat rejection, shaft alignment, shaft seal.
- Efficiency 0.52kw/RT~ 0.63kW/RT
- HCFC-123



Competition

York YK

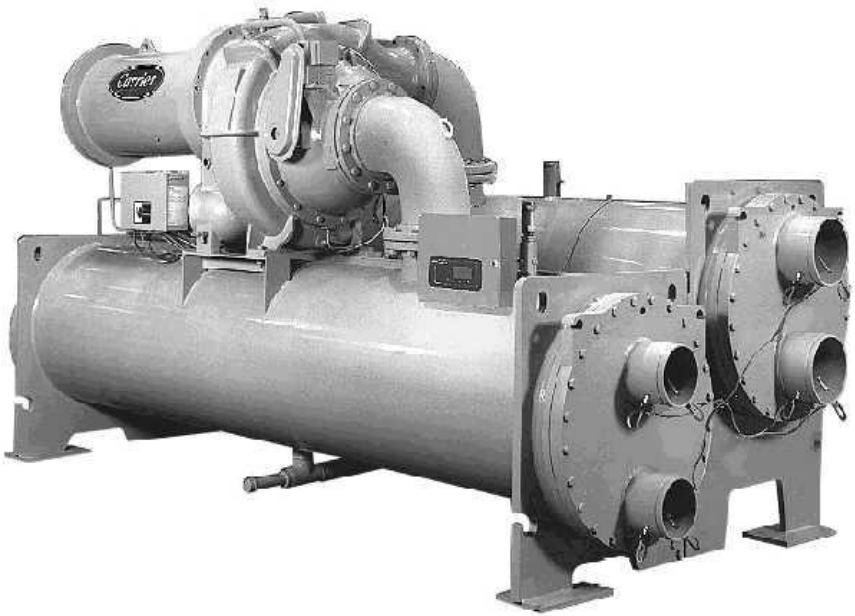
- Tonnage Range
  350~2000RT
- Single stage Comp
- Open Motor - heat rejection, shaft alignment, shaft seal.
- Efficiency
  0.56kW/RT~0.65kW/RT
- HFC-134a



Competition

Carrier 19XR

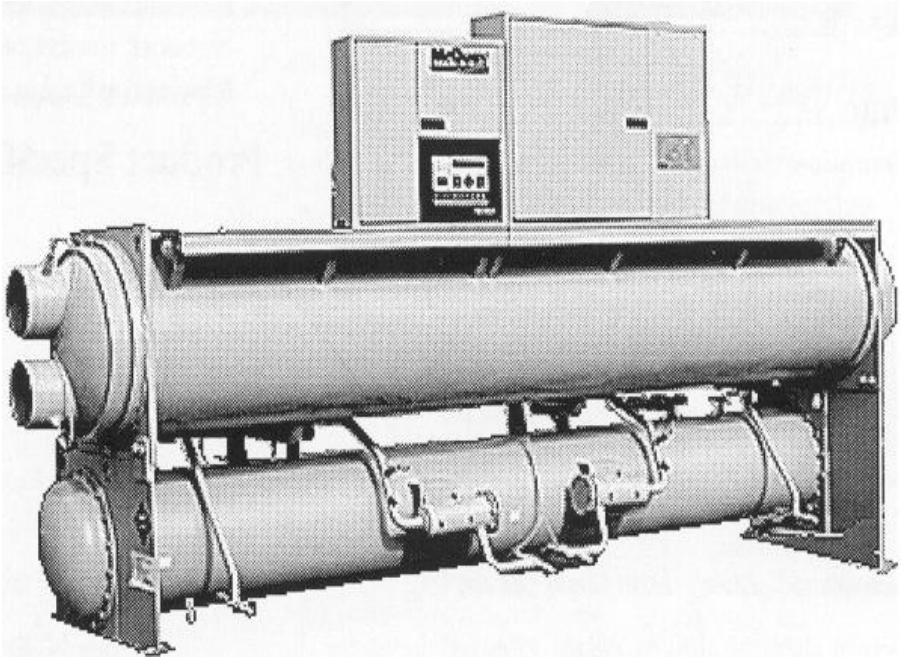
- Tonnage Range
  - 19XR; 200~1500RT
  - 19XRT; 350~525RT
- Single stage Comp
- Slight efficiency improvement over 19XL
  - 19XR; .55~.63 kW/RT
  - 19XRT; .53~.60 kW/RT
- HFC-134a only
- Still Noisy like 19XL



Competition

McQuay PEH

- Tonnage Range
  70~1350 RT
- HFC134a only
- Efficiency
  0.57~.68kW/RT
- Single stage Comp.
- Noisy
- Old technology



Competition

Manufacturer	Trane	McQuay	McQuay	Carrier	Carrier	Carrier	York
Model	**CVGF**	**PEH**	**PFH**	**19XL**	**17/19EX**	**19XR/19XRT**	**YK**
Tonnage	350 ~ 1000	70~1350	130~2350	200~530	800-2200/1500-2300	350~1500/350~525	325~2100
Stage	2	1	1 (2 comp)	1	2	1	1
- better stability	Yes	No	No	No	Medium	No	No
- sound level	Lower	Higher	Higher	Higher	Higher	Higher	Higher
- better cycle eff	Yes	No	No	No	No	No	No
RPM	7.3~10.4K	16~36K	16~36K	7~16K	7~12K	7~16K	7.5~12K
No. of gear sets	1	1	1*2	1	2	1	1
No. of bearing	7	6	6*2	6	5	6	8
Hot gas bypass	N/A	often spec	often std	often spec	often spec	sometime spec	Yes
Refrigerant	R-134a	R-134a	R-134a	R-134a	R-134a	R-134a	R-134a
Ref. Charge (#/ton)	1.3 ~ 1.5	3 ~ 5	3~5	3~5	3~5	3~5	2~4
Expansion device	orifice	Exp. Valve	Exp. Valve	Float vavle	Float valve	Float valve	orifice
Motor Type	S-hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic	Open
- cooling	liquid ref.	liquid ref.	liquid ref.	liquid ref.	liquid ref.	liquid ref.	
- heat to eg.room	No	No	No	No	No	No	Yes
- power factor	89~90%	89~90%	89~90%	87~89%	89~90%	89~90%	86~89%