Choosing Magnetic Bearing Technology for Improved Performance

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INSTALL CONFIDENCE

Johnson Controls

Agenda

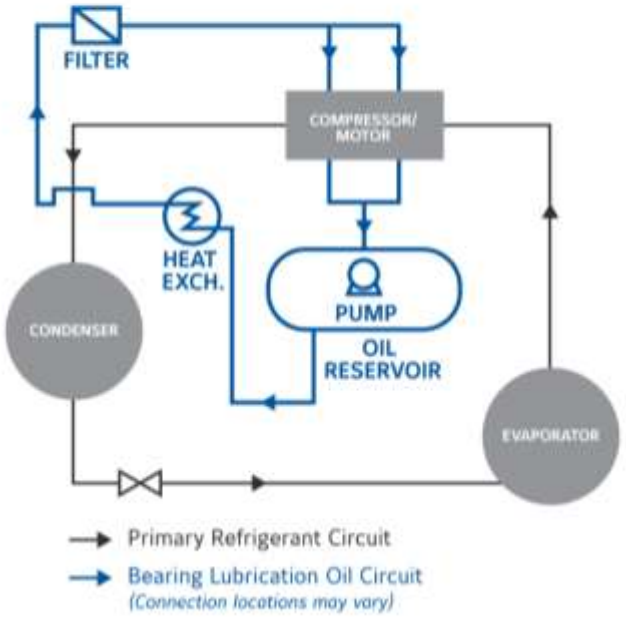
- Magnetic bearing background
- Core magnetic bearing benefits
- University of Texas at Austin background
- System performance
- Additional magnetic bearing benefits

History of Magnetic Bearing Technology

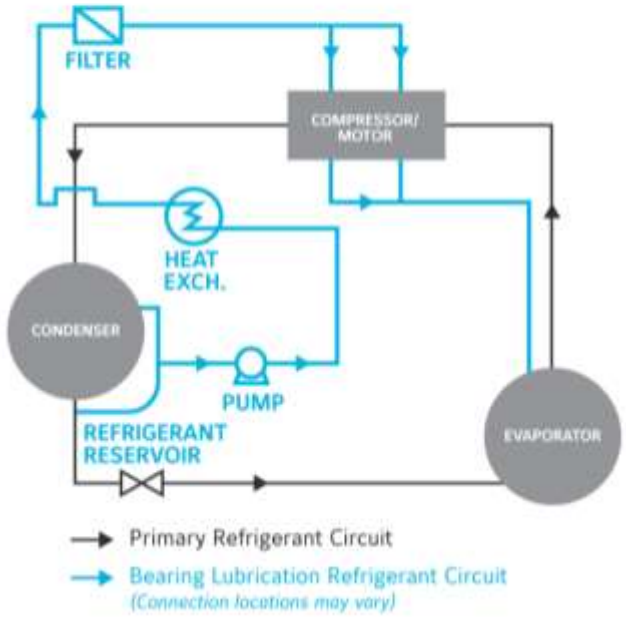
- First patents came during WWII
- Magnetic bearing technology introduced in 1998 on critical naval applications
- Introduced in commercial HVAC in 2002
- Bearings support load using magnetic levitation

Bearing Options for Centrifugal Chillers

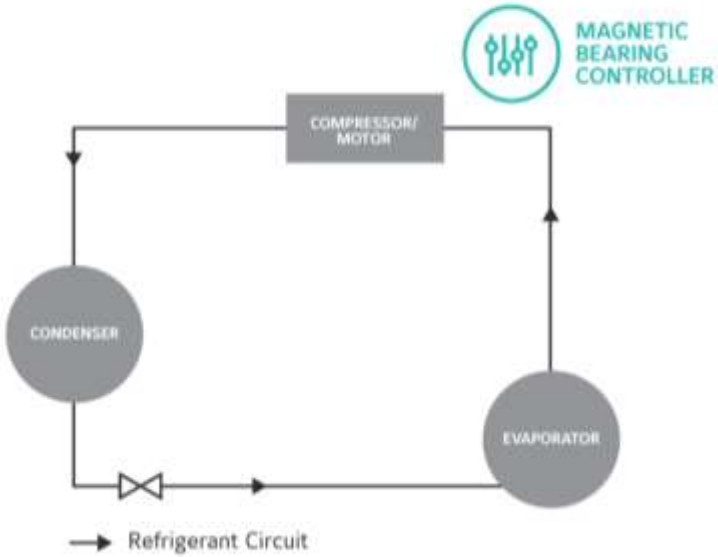
OIL-LUBRICATED BEARINGS



REFRIGERANT-LUBRICATED BALL BEARINGS



MAGNETIC BEARINGS



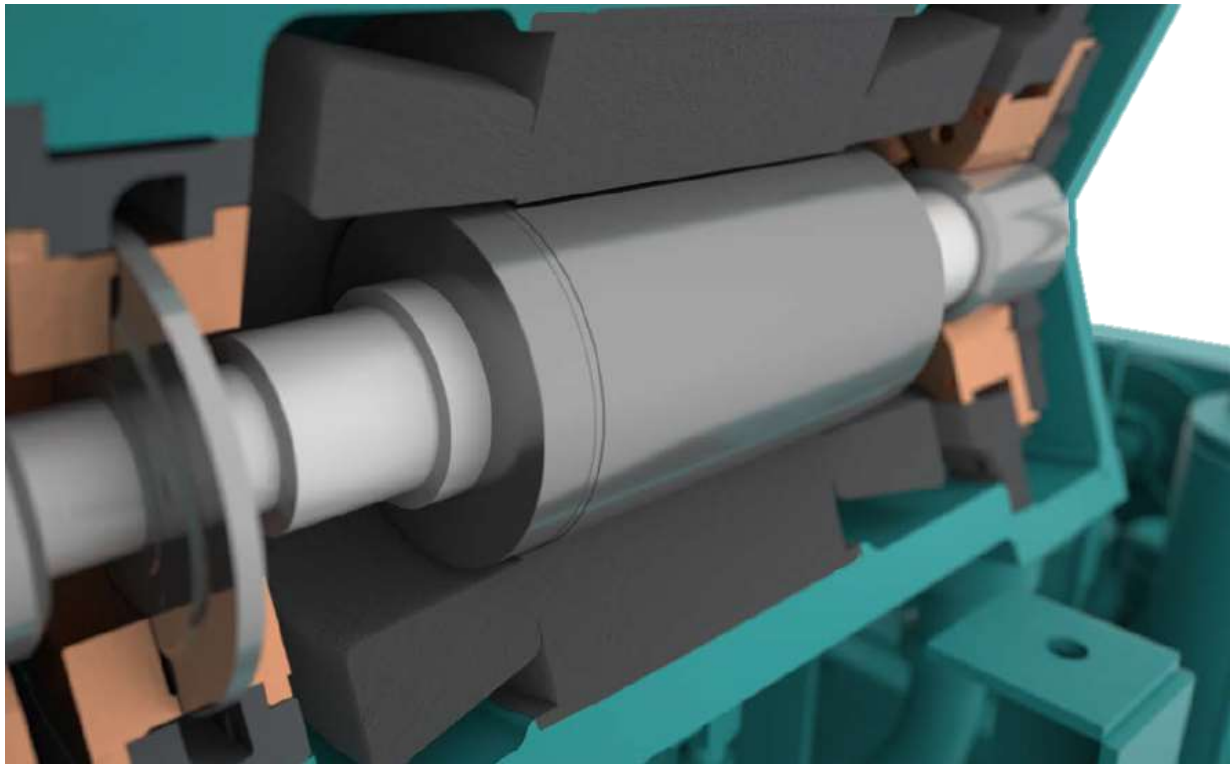
Magnetic Driveline Benefits

Single moving assembly suspended in a magnetic field with no lubrication system

- 80% fewer moving parts
- Non-contact design

Magnetic bearings deliver

- Extraordinary efficiency & wide operating map
- Superior durability
- Simplified maintenance

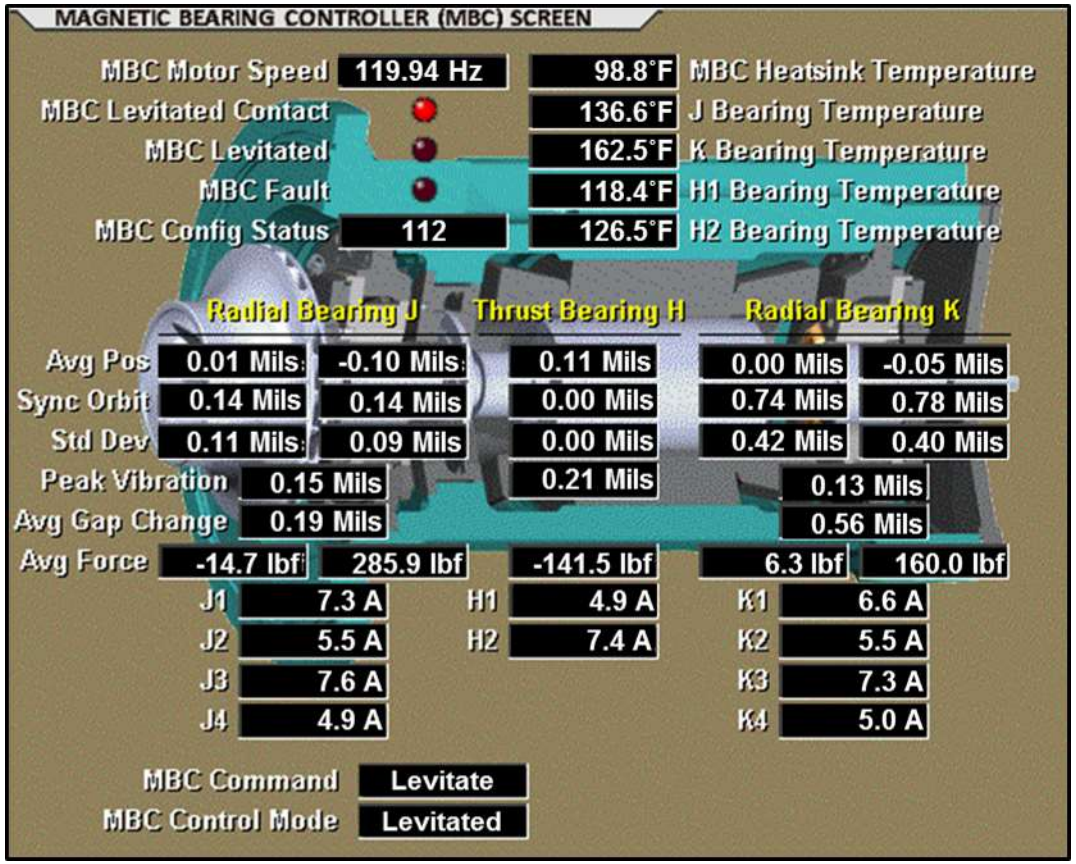


Enhanced longevity & reduced maintenance!

Highly Engineered Technology Offers Simplicity

- Highly complex design – behind the scenes
- Magnetic bearing controller is measuring and responding 20,000 times per second

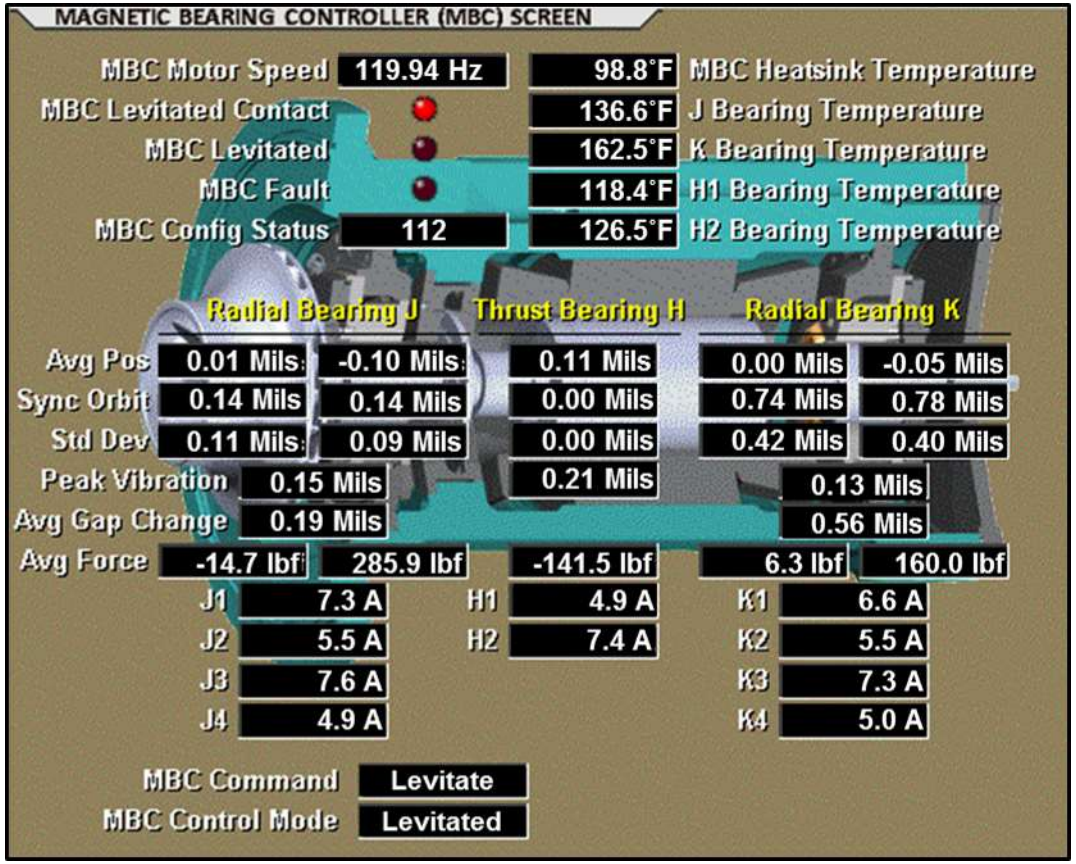
One mil is = 1/1000 th of an inch
= 0.025 mm
= “less than the width of a human hair”
Sensing position down to hundredth of a mil and correcting position to remain centered



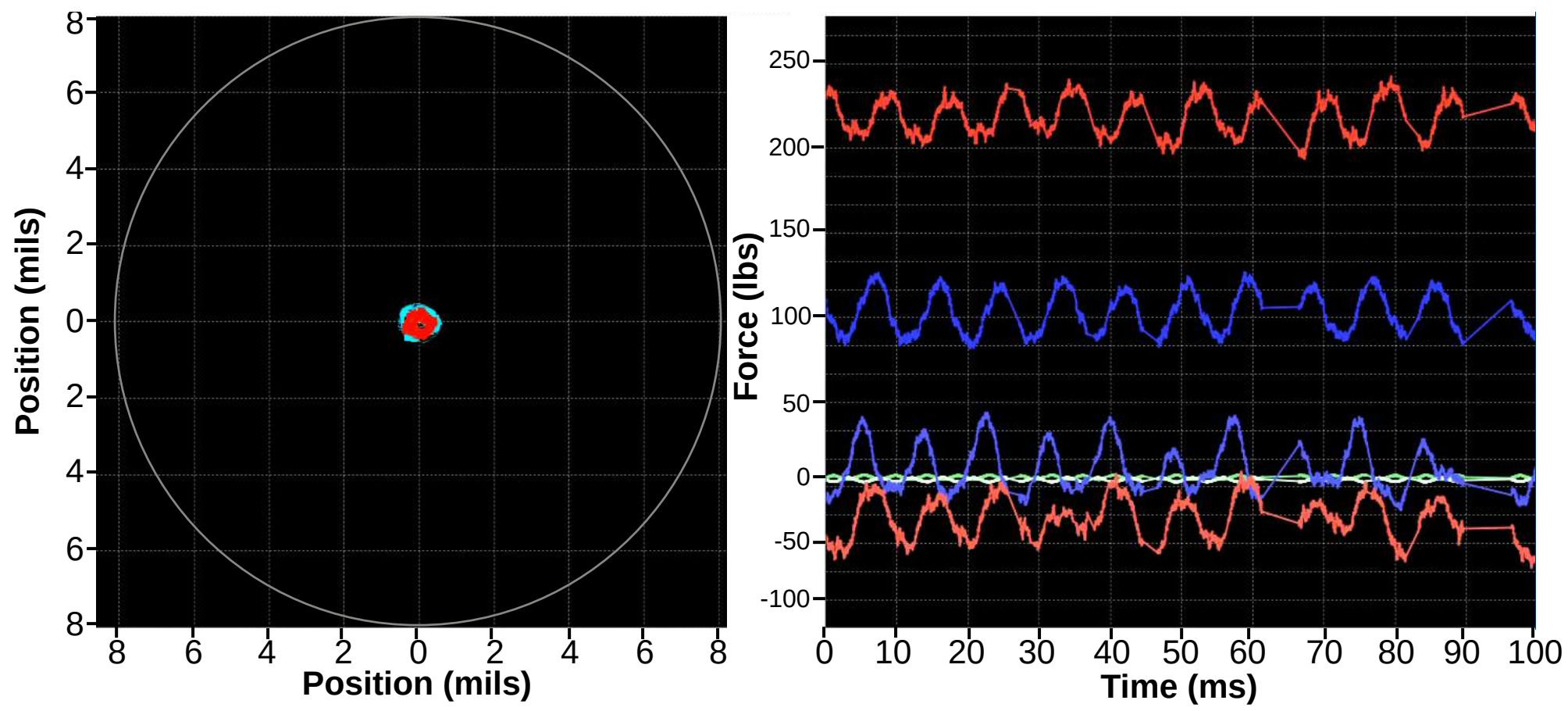
What happens during a power failure?

During a power failure

- An uninterruptable power supply (UPS) provides power to the bearings until rotation has stopped
- Additional backup bearings provide protection if power AND the UPS fail



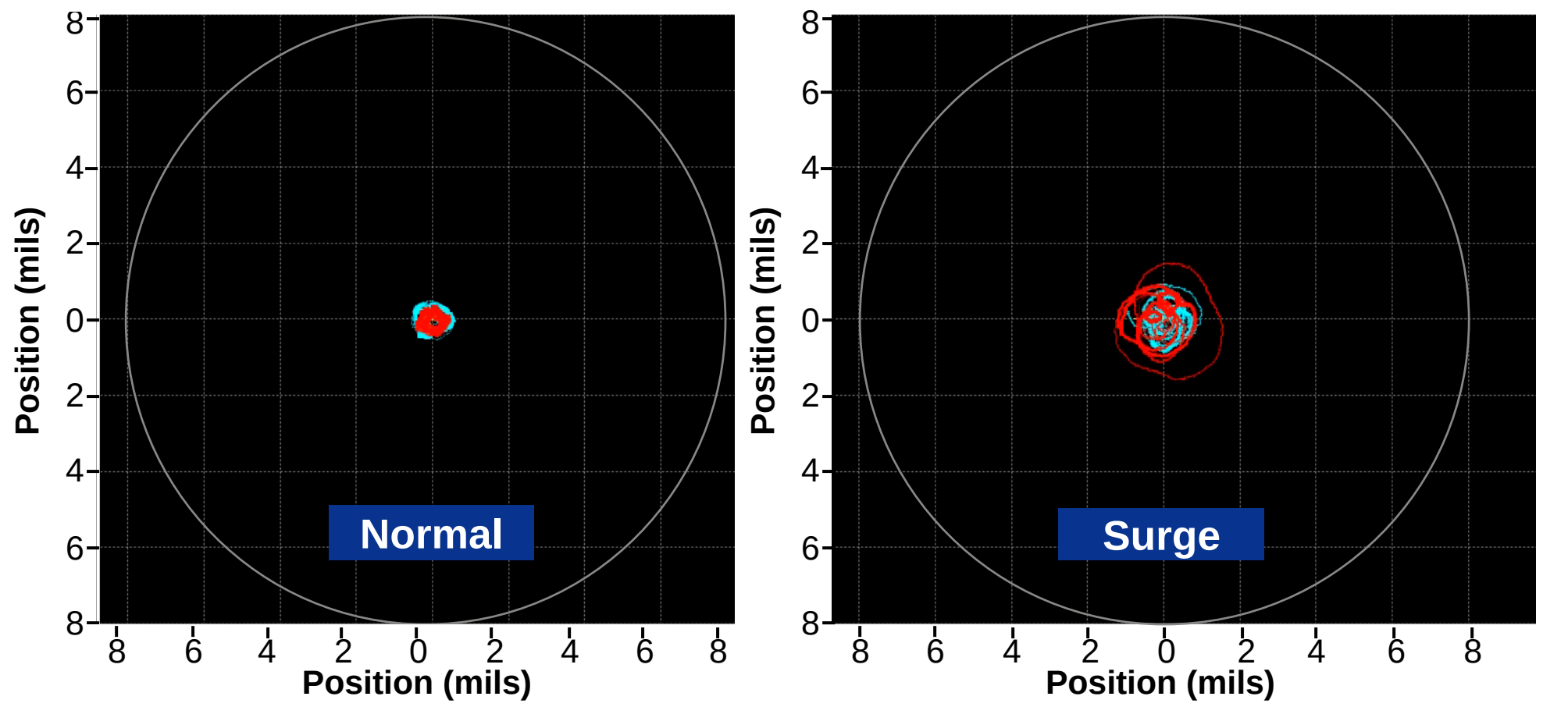
Normal Chiller Operation



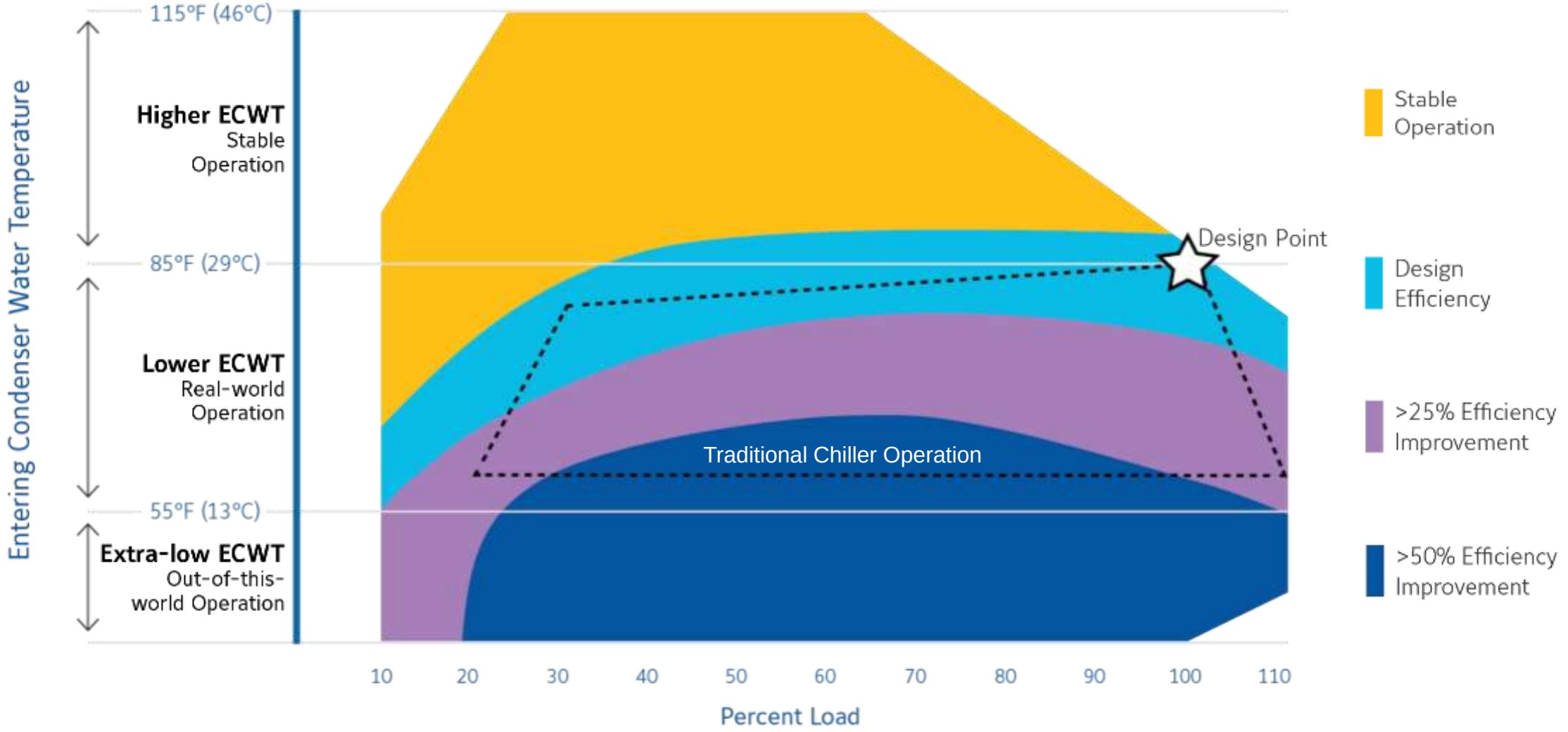
Legend:

- Radial J Bearing
- Radial K Bearing
- Thrust H Bearing

Magnetic Bearing Comparison During Normal Chiller Conditions and Surge



Magnetic Bearings Provide a Wide Operating Range



The operating map can vary, please contact your local sales representative for project specific details

Case Study Site – University of Texas at Austin

About UT

- Opened its doors in 1838 and employs over 20,000 Staff and serves over 51,000 students.
- Despite incredible growth in both served pace and energy output, carbon emissions are equivalent to 1976 levels due to efficiency improvements in both demand at the buildings and supply at the power and chiller plants.

Pickle Research Campus

- Developed in 1949 to perform research in the areas of defense, high speed computing, nuclear physics, and space flight.
- Separate from main campus cooling loop.

Upgrading of Facilities

- Cooling Tower System
- Chiller
- Controls

Upgrading Chiller System

Old System:

- 2 centrifugal chillers using R-11
- 600 tons and 200 tons
- Constant speed, oil-lubricated bearings
- Minimum entering condenser water temperature: 65˚F

Upgraded System:

- 1 centrifugal chiller using R-1233zd
- 300 ton machine
- Variable speed drive, magnetic bearings
- Minimum entering condenser water temperature: 40˚F

Upgraded System online May 2018

Magnetic bearing chiller installed in West Pickle Research Center mechanical room

Focus around Real World Performance

300 Ton Magnetic Bearing Chiller

- 12 foot shells
- Retrofit installation occurred in 1 piece
- Active filtered VSD to meet intent of IEEE

- Machine design to allow for wide operating map
- Improved performance at reduced load and lift

Data Collection:

- Start-up in May
- Data collection in 15-minute intervals using UTA BAS system

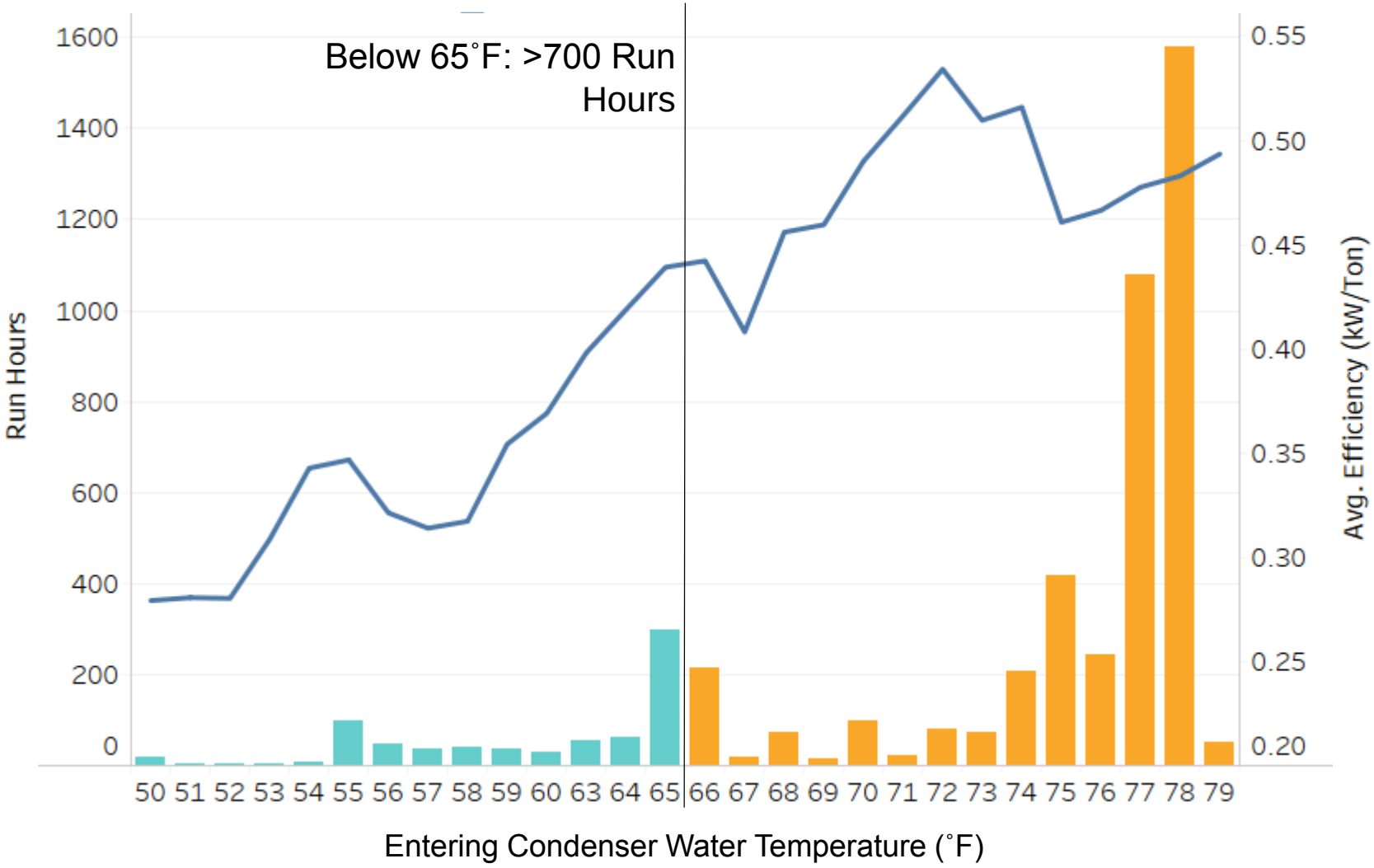
Partload Data (Minimum Condenser Water Temperature)										
CEFT (°F)	% LOAD									
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
85.00°	0.5489	0.5399	0.5413	0.5519	0.5682	0.5937	0.6261	0.6991	0.8450	1.540
80.00°	0.4781	0.4692	0.4710	0.4808	0.4943	0.5125	0.5407	0.5968	0.7224	1.133
75.00°	0.4287	0.4219	0.4188	0.4189	0.4252	0.4349	0.4553	0.5024	0.6171	0.9221
70.00°	0.3821	0.3719	0.3608	0.3551	0.3542	0.3594	0.3742	0.4086	0.4994	0.7660
65.00°	0.3320	0.3184	0.3062	0.3004	0.2999	0.3033	0.3093	0.3313	0.3986	0.6584
60.00°	0.2855	0.2708	0.2594	0.2504	0.2470	0.2455	0.2492	0.2635	0.3004	0.5202
55.00°	0.2471	0.2299	0.2174	0.2068	0.2004	0.1998	0.2004	0.2070	0.2341	0.3774
50.00°	0.2069	0.1914	0.1762	0.1667	0.1587	0.1531	0.1495	0.1537	0.1742	0.2611
45.00°	0.1749	0.1612	0.1485	0.1335	0.1205	0.1070	0.1018	0.1152	0.1430	0.2306
44.00°	0.1717	0.1581	0.1456	0.1298	0.1149	0.1005	0.1032	0.1203	0.1505	0.2485
43.00°	0.1684	0.1550	0.1423	0.1251	0.1093	0.1013	0.1069	0.1254	0.1580	0.2666
42.00°	0.1635	0.1500	0.1358	0.1174	0.1072	0.1033	0.1078	0.1262	0.1587	0.2676
41.00°	0.1581	0.1446	0.1289	0.1143	0.1096	0.1056	0.1088	0.1269	0.1594	0.2686
40.00°	0.1523	0.1385	0.1252	0.1172	0.1121	0.1079	0.1099	0.1276	0.1601	0.2698
*Values are in kW/Ton										

Report generated in YW 19.00, color added for emphasis

Stable Operation | Design Efficiency | >25% Efficiency Improvement | >50% Efficiency Improvement

Chiller Performance through Peak Season and Off-Design

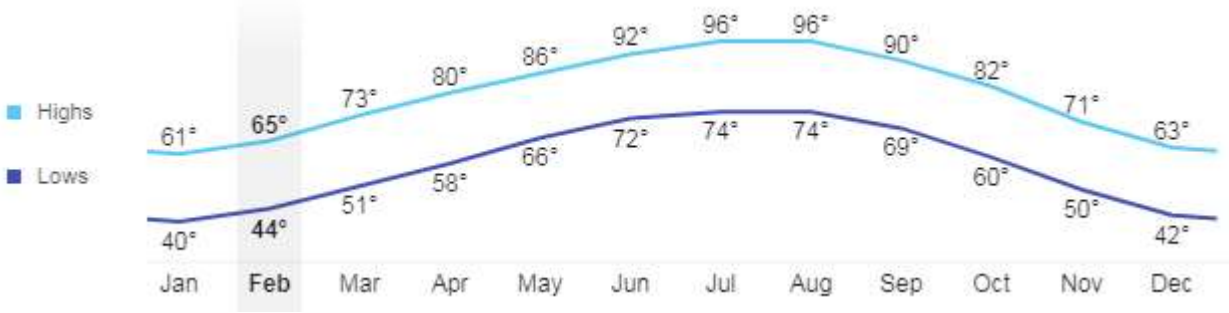
- Cooling tower able to maintain ~80˚F water temperature
- Average efficiency below 0.50 kW/Ton
  - Average on campus plant is 0.67 kW/Ton including auxiliaries
- Over 700 hours below 65˚F water between September and December
  - Efficiency below 0.3 kW/Ton



Low tower water temperatures happen here too!

Weather Averages (Temperatures ˚F)

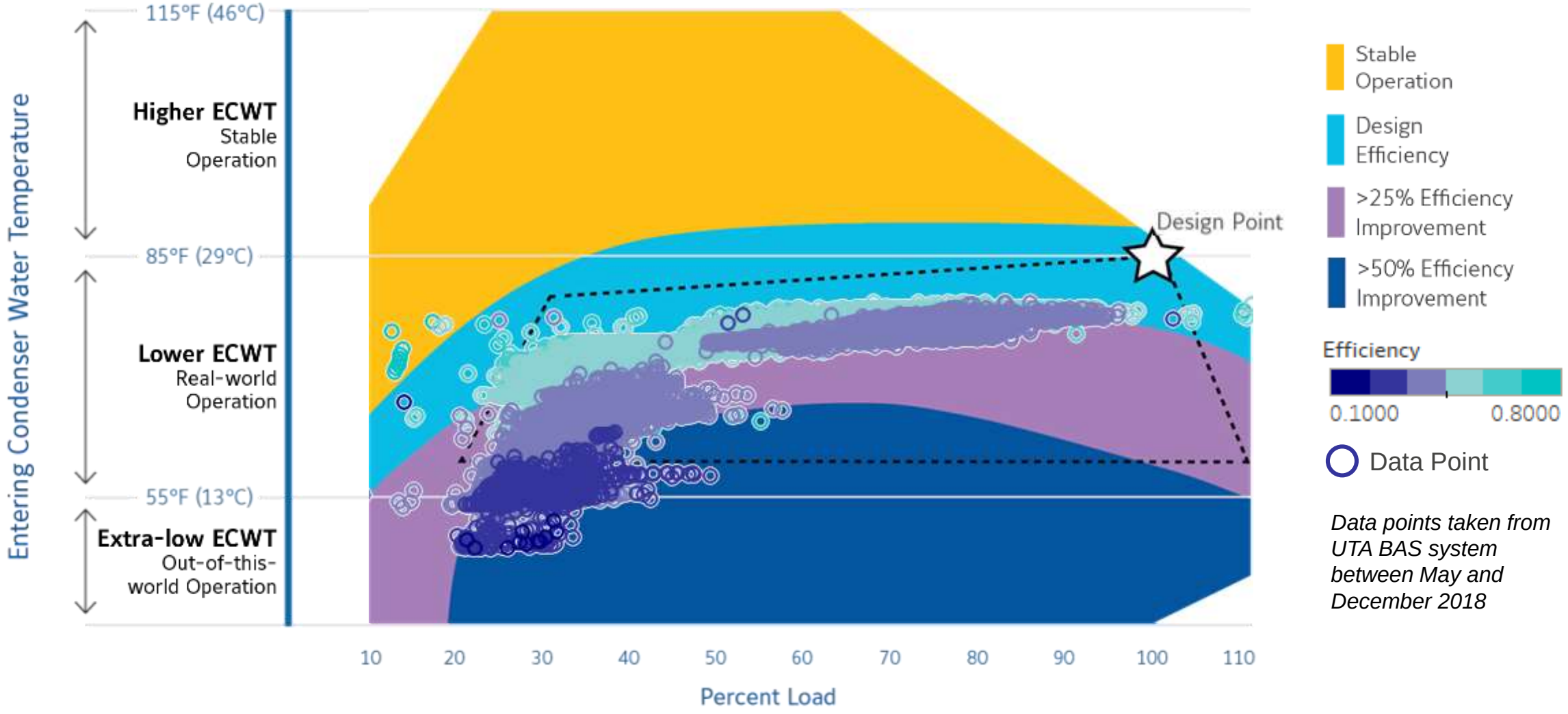
Austin, Texas



New Orleans, LA

- Southern climates can still achieve cooler tower temperatures
- Lower tower temperatures allow the system to operate more efficiently

UTA is able to take advantage of off-design conditions

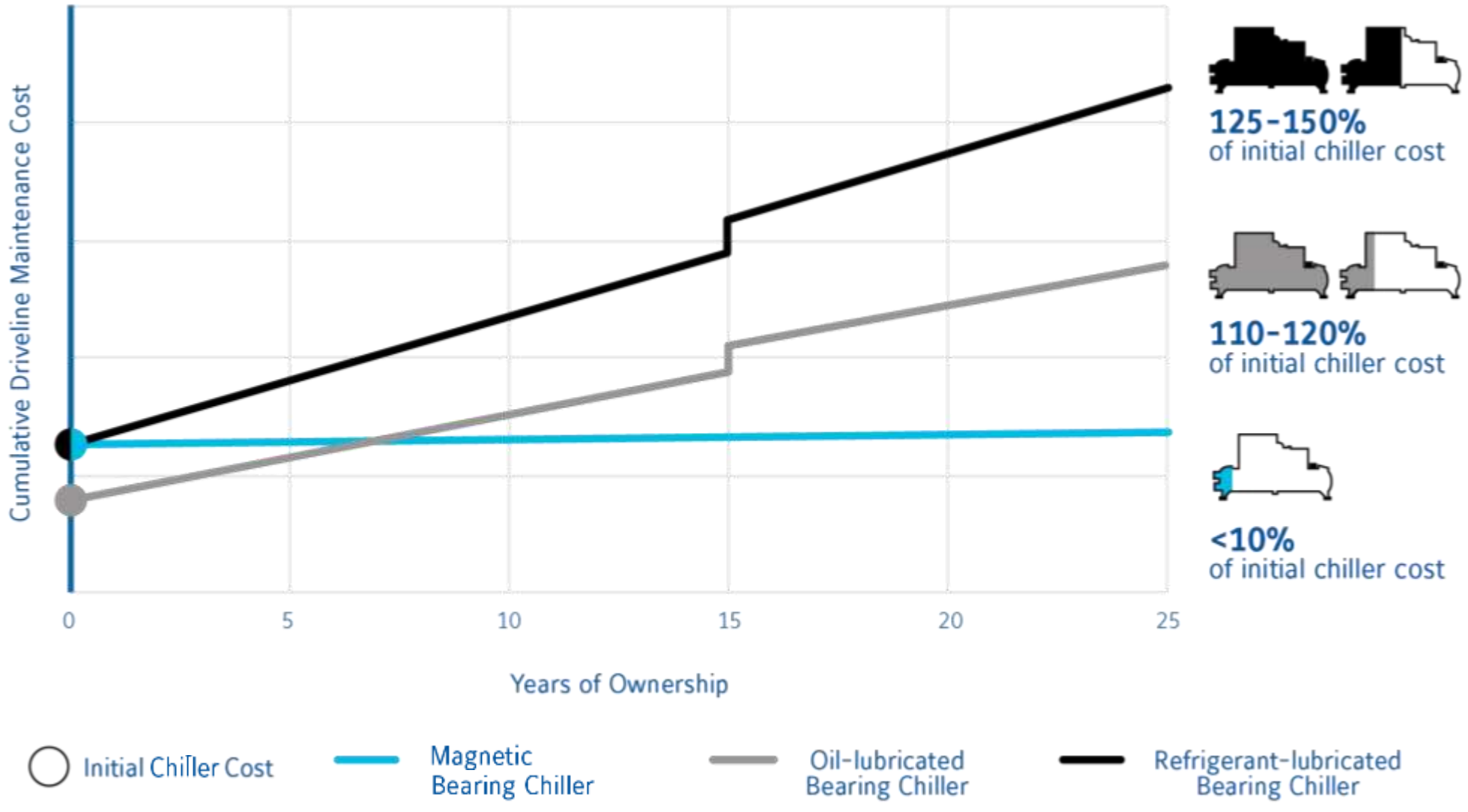


Data points taken from UTA BAS system between May and December 2018

Other Magnetic Bearing Benefits: Lower Driveline Maintenance

Driveline Maintenance Tasks	Magnetic Bearings	Oil-lubricated Bearings	Refrigerant-lubricated Bearings
Check lubricant sump & temperature control operation	–	Monthly	Monthly
Check lubrication eductors	–	Monthly	Monthly
Lubricant analysis	–	Annually	Annually
Replace lubricant filter(s)	–	Annually	Annually
Vibration analysis	–	–	Quarterly
Clean refrigerant pump strainer	–	–	Monthly
Battery health test	Periodically	–	Periodically

Other Magnetic Bearing Benefits: Lower Driveline Maintenance



QUESTIONS?

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Broad Offering to Meet a Variety of Project Needs

Magnetic Bearing Chillers Available 165 – 1,350 Tons

Johnson Controls Table #36