BY JOHNSON CONTROLS

Quick Start Feature for YORK YK Centrifugal Water Chillers

TECHNICAL DATA	Supersedes: 160.75-TD4 (1009)	Form 160.75-TD4 (1114)

SCOPE

This document provides an overview and control detail for the Quick Start Feature. This document also contains: a Comparison of Normal Start to Quick Cold Start Mode to Quick Restart, Quick Start Tuning Parameters, and Quick Start Performance based on chiller testing in the lab and at customer installations.

This feature applies only to YK Chillers with Variable Speed Drives (VSD). The following are required for Quick Start:

- Control panel software version C.OPT.01.21.307 or later.
- Any YK Compressor
- Low or medium voltage Optispeed Variable Speed Drive (VSD)

QUICK START FEATURE OVERVIEW

The Quick Start feature is designed for critical cooling installations, such as data centers and process applications, where the goal is to re-establish cooling as fast as possible after a power failure. The Quick Start feature accomplishes this goal by minimizing time to restart and loading the chiller as quickly as possible, to rapidly achieve the leaving chilled water temperature setpoint. The main objective is to provide minimum down time and the fastest restart/loading as possible. Once the chiller is running and close to setpoint, it will return to standard YK control to minimize risk.

Thermal storage applications can take advantage of the quick load capabilities of the QuickStart feature during initial cold starts. Because the chiller loads faster, the engineer at the thermal storage site doesn't need to be fearful of disrupting the facilitiy's tank with warmer water.

In order to accomplish the goals of Quick Start, a VSD, whose last three digits of the VSD part number must end in -7XX, will be required to implement this feature. The low inrush current starting of a VSD allows more starts per hour and allows the machine to start with the vanes open. This will help get back to setpoint much more quickly. This feature will not be developed for legacy chillers running with an ACC board and cannot be used with such.

The quick starting and loading will be after a shutdown and for normal (cold) starts. In order to start the most quickly, the control panel and VSD control circuit (except the trigger board) must be powered by an Uninterruptible Power Supply (UPS). This will prevent a reboot of both circuits on a power failure and keep communications between them active throughout the event, providing the fastest operation to clear faults and to restart the chiller once generator or line power has been restored. If a slightly longer restart time can be tolerated, the UPS would not be required. See the "IV. QUICK START PERFORMANCE" on page 4 for performance plots. See the "V. UPS Sizing and Wiring Information" on page 14 for more information on the UPS.

In order for a quick restart to be performed, the power failure must be no more than about 60 seconds in length. Data centers, generally, can guarantee stable generator power to be available 15 seconds or less following a power failure. Longer power failures will result in a normal quick start rather than a quick restart once power has been restored.

COMPARISON OF NORMAL START TO QUICK COLD START TO QUICK RESTART

When enabled, this feature will allow quicker cold starts and restarts than standard control. Once the chiller is running and has reached the Quick Pulldown Setpoint Offset (see page 2 for more details), or the Pulldown Override Time has elapsed (see page 3 for more details), control will return to standard logic. When the Quick Start feature is disabled, control will be the same as standard logic. See Form 160.54-M1; Service Instructions for the OptiView Control Center, located on the portal for additional information.

A quick cold start has a prelube time period, just like a standard start. However, during a quick cold start prelube, the capacity control inlet guide vanes will start to open at the beginning of this period. After the prelube has completed, the VSD is started. Once the VSD reaches its start frequency, the initial ramp rate will be faster than with standard control.

After a power fault, a quick restart is allowed to occur if power is restored by the end of the coastdown cycle. If conditions validate safe operation, the chiller will be started

with no prelube. The vanes will be given a constant load pulse and once the VSD reaches its start frequency, the initial ramp will be faster than with standard control.

The following table compares a normal start to a quick cold start and a quick restart. This is a high level comparison and does not include all details of Quick Start Mode.

QUICK START TUNING PARAMETERS

Following are the Quick Start programmable settings. These settings can be used to tune the performance of the Quick Start Feature to what is desired. These settings can allow for optimization of pulldown time, restart time, undershoot of setpoint and other characteristics.

Quick Start Mode

Quick Start Mode can only be enabled when the Motor Drive Type is VSD or MVVSD and the Motor Communications Protocol is Modbus, for YORK YK centrifugal chillers with OptiView. This mode is programmable from the Quick Start Screen. When Quick Start is disabled, the Quick Start Screen can only be enabled or activated through the Admin login. Once enabled, it can be accessed through the Service login.

Coastdown Time

When Quick Start is enabled, the minimum programmable coastdown time is lowered from 150 to 60 seconds for Q compressor models, from 150 to 90 seconds for P, H and K1-K4 compressors, and from 240 to 150 seconds for K7 compressor models. The shorter the programmed Coastdown Time, the less time it takes from a power failure until the compressor is started again. This value is programmable from the Setup Screen. The actual mechanical coast down time should be observed while performing several hard stops on the chiller at various load/head conditions and visually checking when rotation stops. This time period for the coast down timer needs to be longer than the longest physical time it takes the compressor rotation to stop.

Quick Pulldown Setpoint Offset

The Quick Pulldown Setpoint Offset is the positive offset to the Active Leaving Chilled Liquid Temperature (LCHLT) setpoint that transitions from Quick Start to standard operation. Once the leaving chilled liquid temperature falls below the Active LCHLT Setpoint + Quick Pulldown Setpoint Offset, PRV and speed control revert to standard automatic control. This value is programmable from the Quick Start Screen. Lower values of this Offset result in

TABLE 1 – COMPARISON OF NORMAL START TO QUICK COLD START TO QUICK RESTART

NORMAL START (STANDARD LOGIC)	QUICK COLD START	QUICK RESTART
Minimum Coastdown Time 240 sec (J7/K7 Compressors) 150 sec (All other Compressors)	Minimum Coastdown Time 150 sec (J7, K7 Compressors) 60 sec (Q Compressors) 90 sec (All other Compressors)	Minimum Coastdown Time 150 sec (J7, K7 Compressors) 60 sec (Q Compressors) 90 sec (All other Compressors)
Chiller Off PRV Closed Variable Orifice Opened Hot Gas Closed *	Chiller Off PRV Closed Variable Orifice Opened Hot Gas Opened *	Coastdown PRV Held (Open) Variable Orifice Held (Open) Hot Gas Opened*
Prelube PRV Closed Variable Orifice Preset/Held Hot Gas Closed *	Prelube PRV Opened Variable Orifice Preset/Held Hot Gas Opened *	No Prelube
VSD Run Signal Enabled	VSD Run Signal Enabled	VSD Run Signal Enabled
PRV Controlled by Capacity Control Variable Orifice Preset/Held/Ramp VSD to Start Frequency Hot Gas Standard Control	PRV Controlled by Capacity Control Variable Orifice Preset/Held/Ramp VSD to Start Frequency Hot Gas Closed (Std Control) *	PRV Given Constant Open Signal Variable Orifice Ramp VSD to Start Frequency Hot Gas Closed (Std Control) *
Slow Ramp-up of Speed	Quick Ramp-up of Speed	Quick Ramp-up of Speed
	Speed Control Returns to Standard when LCHLT < Active LCHLT Setpoint + Quick Pulldown Setpoint Offset OR when Run Time > Pulldown Override Time	PRV and Speed Control Return to Standard when LCHLT < Active LCHLT Setpoint + Quick Pulldown Setpoint Offset OR when Run Time > Pulldown Override Time

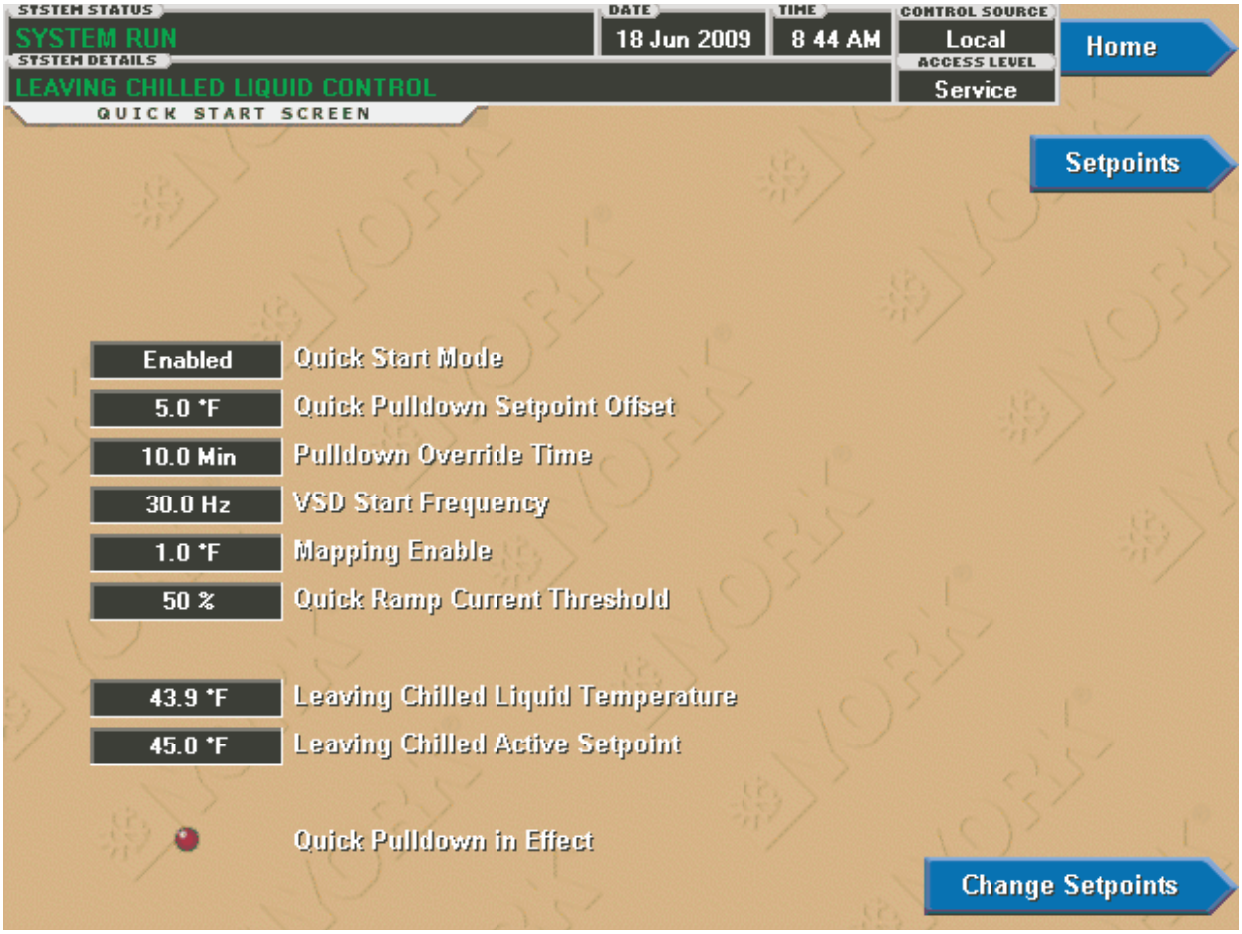


FIGURE 1 – OPTIVIEW QUICK START SCREEN

faster pulldown times but can result in undershoot of the LCHLT setpoint. When this value is set to its minimum of 0, the fastest pulldown time will be achieved and undershoot of setpoint is essentially guaranteed. This can present a problem if the LCHLT setpoint is close to the Low Chilled Liquid Temperature Shutdown.

Pulldown Override Time

The Pulldown Override Time setpoint is the length of time the PRV is held open and the ACC speed increased on startup if the Quick Pulldown Setpoint Offset is not reached. This could be due to hitting current limit on pull-down. If the Quick Pulldown Setpoint Offset is not reached within the Pulldown Override Time, PRV and ACC speed control will revert back to standard automatic control. This value is programmable from the Quick Start Screen. See Figure 1 above for a screen shot of the Quick Start feature from the OptiView panel.

VSD Start Frequency

This provides a target minimum drive frequency on start-ing. The VSD Start Frequency will be programmable on the Quick Start Screen. It will use the same ranges as defined by the same programmable setting on the ACC Details Screen. Higher Start Frequencies can result in faster pulldown times to a point. Setting this value too high can actually negatively impact pulldown time, due to hitting current limit sooner on pulldown, due to the PRV being wide open on startup or shortly thereafter.

ACC Mapping Enable

The Mapping Enable will be programmable on the Quick Start Screen. It will use the same ranges as defined by the same programmable setting on the ACC Details Screen.

Quick Ramp Current Threshold

The Quick Ramp Current Threshold is the motor current threshold where the VSD speed command ramp rate changes. At or below this threshold the speed command ramp is 4x that of standard control. Over this threshold the ramp rate is 2x that of standard control until it hits the standard current limiting over 80 % FLA. This value is programmable from the Quick Start Screen. Higher Current Threshholds can result in faster pulldown times to a point. Setting this value too high can actually

negatively impact pulldown time due to hitting current limit sooner on pulldown due to the PRV being wide open on startup or shortly thereafter.

QUICK START PERFORMANCE

The following performance information is based on testing of chillers in both lab and customer installation environments. Individual chiller performance is related to many things, including compressor size, shell sizes, gear, motor, water loop, plant design, building load, running conditions and actual coastdown time. The following performance plots and tables are intended as a relative guide to show the performance increase due to the Quick Start Feature. They are not intended to be guaranteed numbers applicable to all chillers.

Restart Time

Plots of the minimum restart times from a power failure are shown below. See Figures 4, 5, and 6. These plots show the time to restart using standard logic with no UPS, Quick Start logic with no UPS and Quick Start logic with a UPS. From the plots it becomes clear that Quick Start alone provides the greatest reduction in restart time. In some cases the UPS can further reduce the restart time after a power failure.

The horizontal bar charts, Figures 2 & 3 below, highlight the difference between a chiller with the Quick-Start feature and a UPS, and a chiller with a QuickStart feature without a UPS.

The times are also based on the assumption that the minimum allowed programmable coastdown time applies for the given chiller. Coastdown time must be measured on site over a range of conditions to be sure the programmed coastdown time is greater than the longest measured coastdown time. Longer coastdown times will result in longer times to restart.

The times are also based on a 60Hz application. For 50Hz applications, the PRV actuator runs at 5/6 the speed and will take longer to close, resulting in the standard logic restart time being longer.

Other assumptions are that a run signal still exists at the time coastdown is complete and that all chiller faults have been cleared. Additionally, evaporator and condenser pumps must be providing flow and the VSD must have completed precharge.

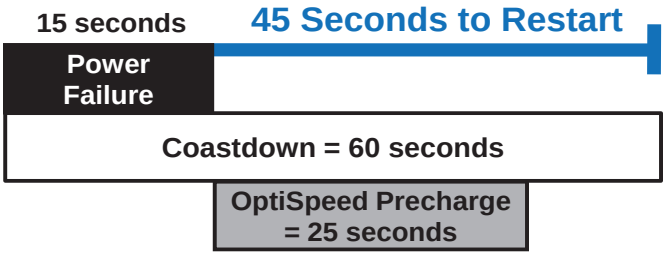


FIGURE 2 – YK CHILLER WITH Q7 COMPESSOR WITH UPS

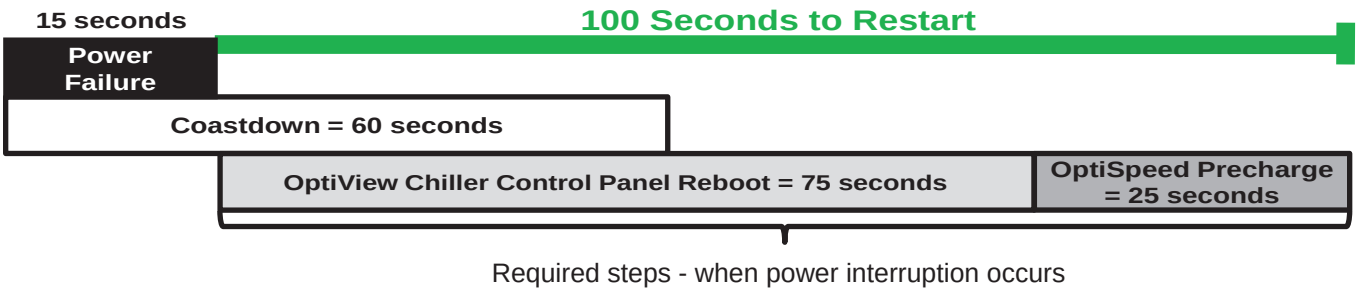


FIGURE 3 – YK CHILLER WITH Q7 COMPESSOR WITHOUT UPS

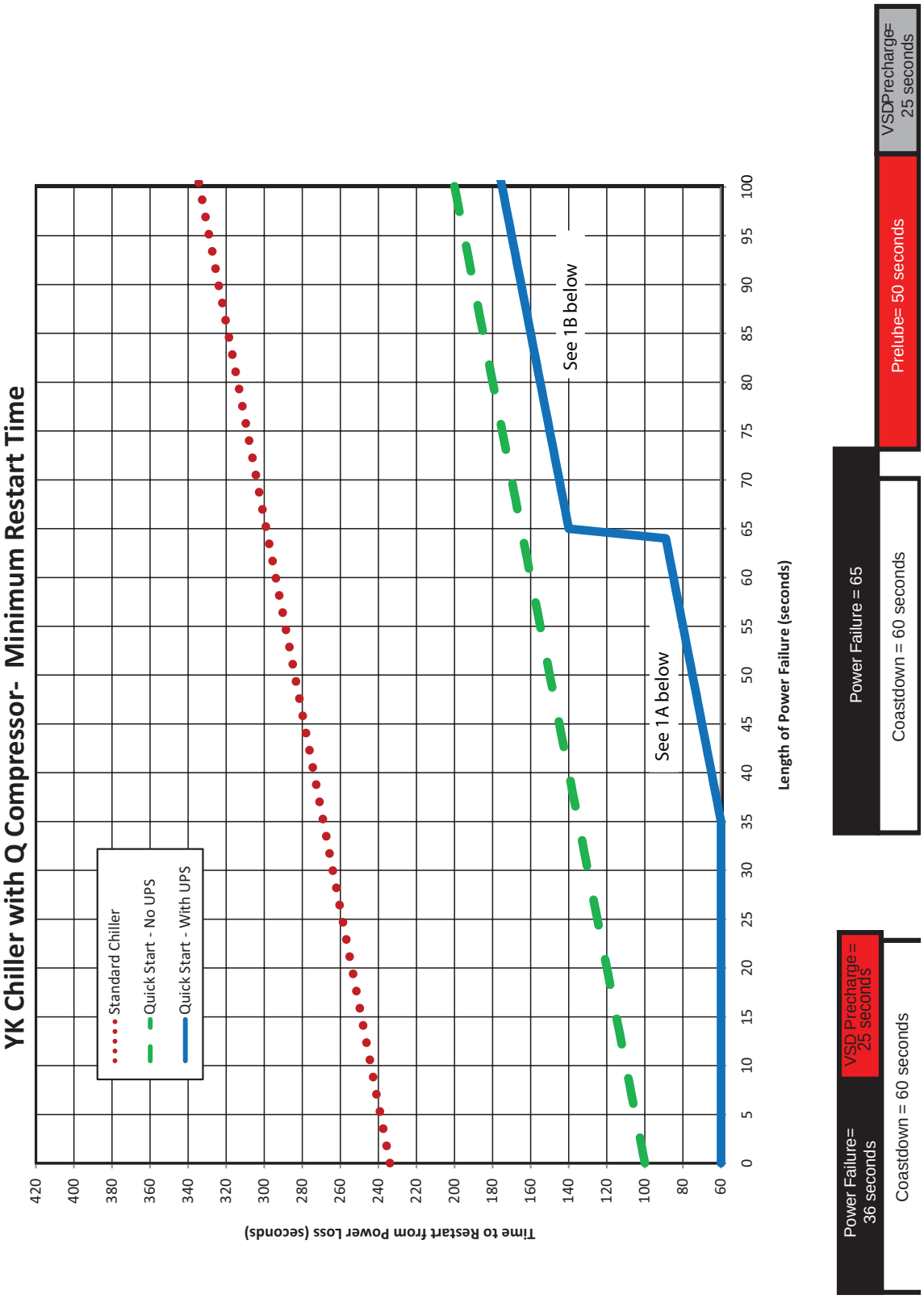
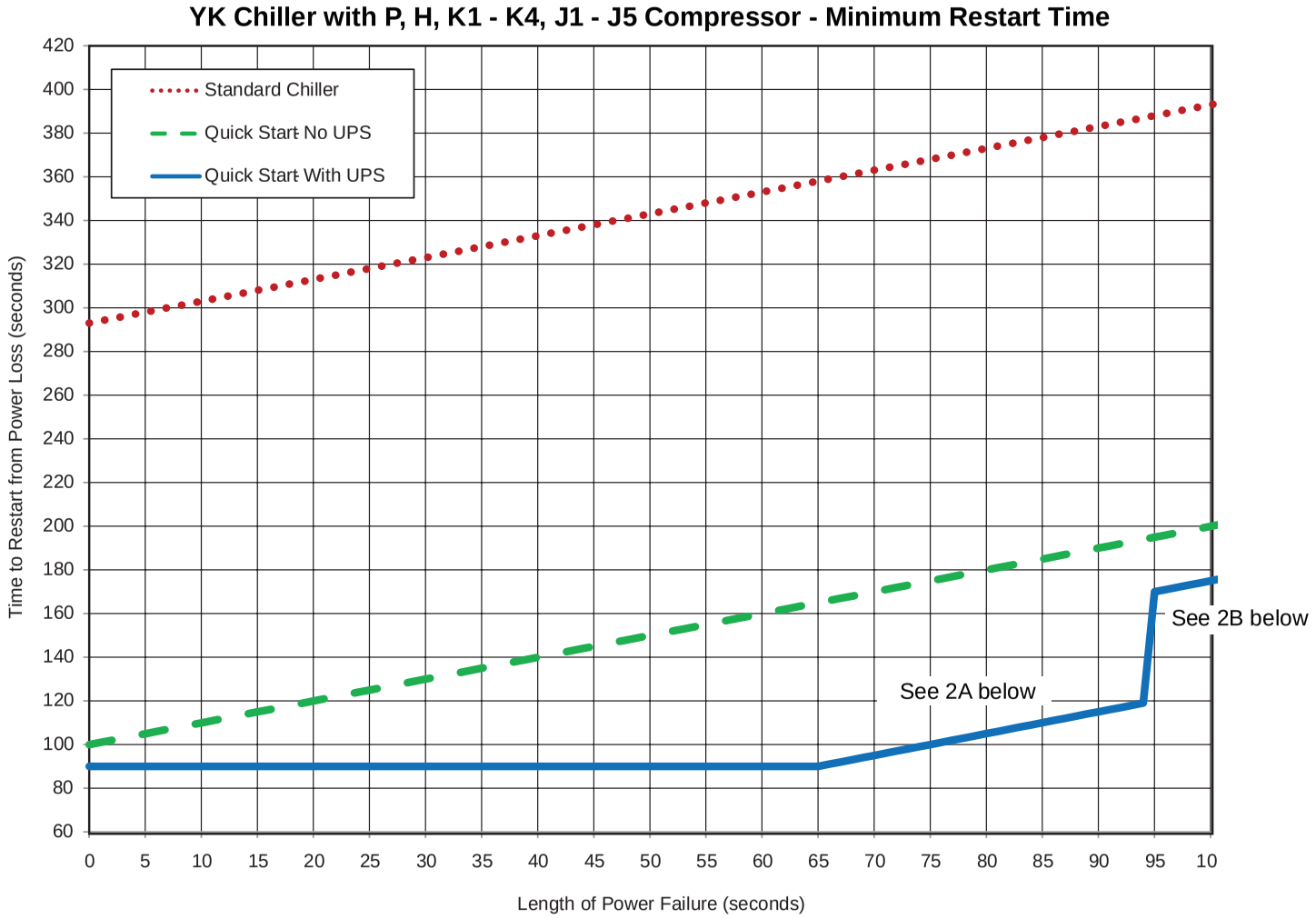
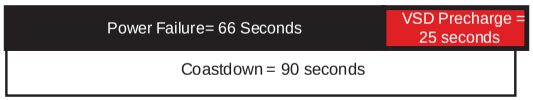


FIGURE 4 – RESTART TIMES FOR YK CHILLERS WITH Q COMPRESSORS

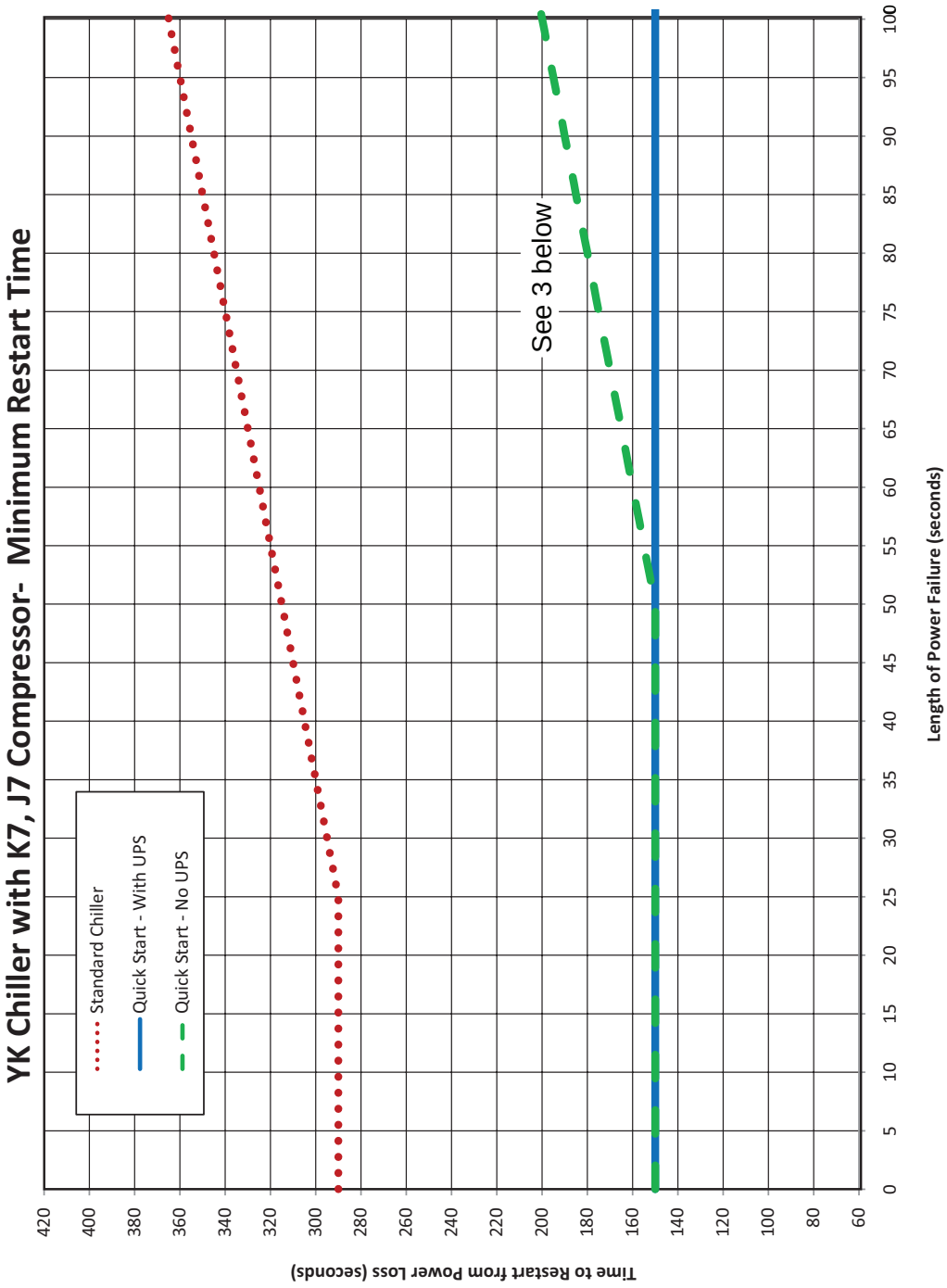


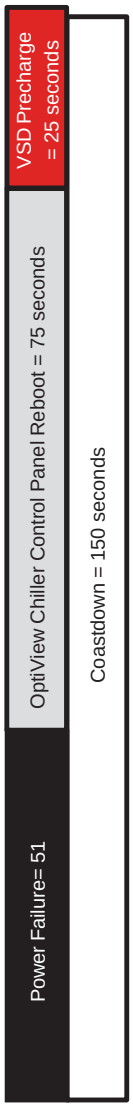


2A - When the power failure is longer than 65 seconds, the OptiSpeed VSD precharge becomes the limiting factor.

2B - When the power failure is longer than 60 seconds, prelube is required before the OptiSpeed VSD precharge can occur.

FIGURE 5 – RESTART TIMES FOR YK CHILLERS WITH P, H, K1-K4, J1-J5 COPRESSORS





3 - When the power failure is longer than 50 seconds, the OptiSpeed VSD precharge becomes the limiting factor.

FIGURE 6 – RESTART TIMES FOR YK CHILLERS WITH K7, J7 COMPRESSORS

Pulldown Time/Return to Setpoint Time

When Quick Start is enabled, the time to reach setpoint is reduced over standard logic. This time is highly dependent on restart time and conditions and cannot easily be generalized. The following tables list the results of lab and customer installation testing. These results only apply to these specific machines on the loops towhich they are connected.

See Table 2 below for YK Chiller with K2 compressor data. The coastdown time was set to 150 seconds for the testing on the YK chiller with K2 compressor. The pulldown times with Quick Start enabled would be further improved by setting the Coastdown Time to 90 seconds. This would likely improve pulldown times by a minute or more and are shown as estimates in italics in the table below. Following were the Quick Start settings for these tests:

- Quick Start Mode: Per column heading
- Coastdown Time: 150 seconds (90 seconds estimated results)
- Quick Pulldown Setpoint Offset: Per column heading
- Pulldown Override Time: 15 min
- VSD Start Frequency: 30 Hz

TABLE 2 – TIME TO RETURN TO LCHLT SETPOINT AFTER 15 SEC POWER FAILURE FOR YK-K2 CHILLER

YK K2 Chiller – 15 Second Power Failure						
	Time to 1°F (-17.2°C) Over LCHLT Setpoint			Time to LCHLT Setpoint		
Load	QS Disabled	QS Enabled 5°F (-15°C) Offset	QS Enabled 0°F (-17.8°C) Offset	QS Disabled	QS Enabled 5°F (-15°C) Offset	QS Enabled 0°F (-17.8°C) Offset
High – Actual (150 sec Coastdown)	8 min	4.75 min	4.75 min	13 min	5.25 min	5 min
High – Est. (90 sec Coastdown)	-	3.75 min	3.75 min	-	4.25 min	4 min
Low – Actual (150 sec Coastdown)	7 min	4 min	3.75 min	> 20 min	17.5 min	4 min
Low – Est. (90 sec Coastdown)	-	3 min	2.75 min	-	16.5 min	3 min

NOTE: The table above lists the results of lab and customer installation testing. These results only apply to these specific machines on the loops to which they are connected.

- ACC Mapping Enable: 1.0 °F (-17.2°C)
- Quick Ramp Current Threshold: 50 %FLA

See Table 3 below for YK Chiller with Q7 compressor data. The coastdown time was set to 60 seconds for the testing on the YK chiller with Q7 compressor. Following were the Quick Start settings for these tests:

- Quick Start Mode: Per column heading
- Coastdown Time: 60 seconds
- Quick Pulldown Setpoint Offset: Per column heading
- Pulldown Override Time: 15 min
- VSD Start Frequency: 30 Hz
- ACC Mapping Enable: 1.0 °F (-17.2 °C)
- Quick Ramp Current Threshold: 50 %FLA

TABLE 3 – TIME TO RETURN TO LCHLT SETPOINT AFTER 15 SEC POWER FAILURE FOR YK-Q7 CHILLER

YK Q7 Chiller – 15 Second Power Failure						
	Time to 1°F Over LCHLT Setpoint			Time to LCHLT Setpoint		
Load	QS Disabled	QS Enabled 5°F Offset	QS Enabled 0°F Offset	QS Disabled	QS Enabled 5°F Offset	QS Enabled 0°F Offset
High	12.5 min	4.75 min	4.5 min	13 min	5.5 min	5 min
Low	7.5 min	3 min	2.75 min	10.5 min	3.25 min	2.9 min

Following are the plots from the testing of the Quick Start feature on a K2 chiller and a Q7 chiller. The plots show the LCHLT over time for various Quick Start settings and with Quick Start disabled. Time 0 is when the power failure occurred for all data series. Note that the K2 chiller was tested with a 150 second coastdown time. The restart and pulldown times would be improved with a 90 second coastdown time.

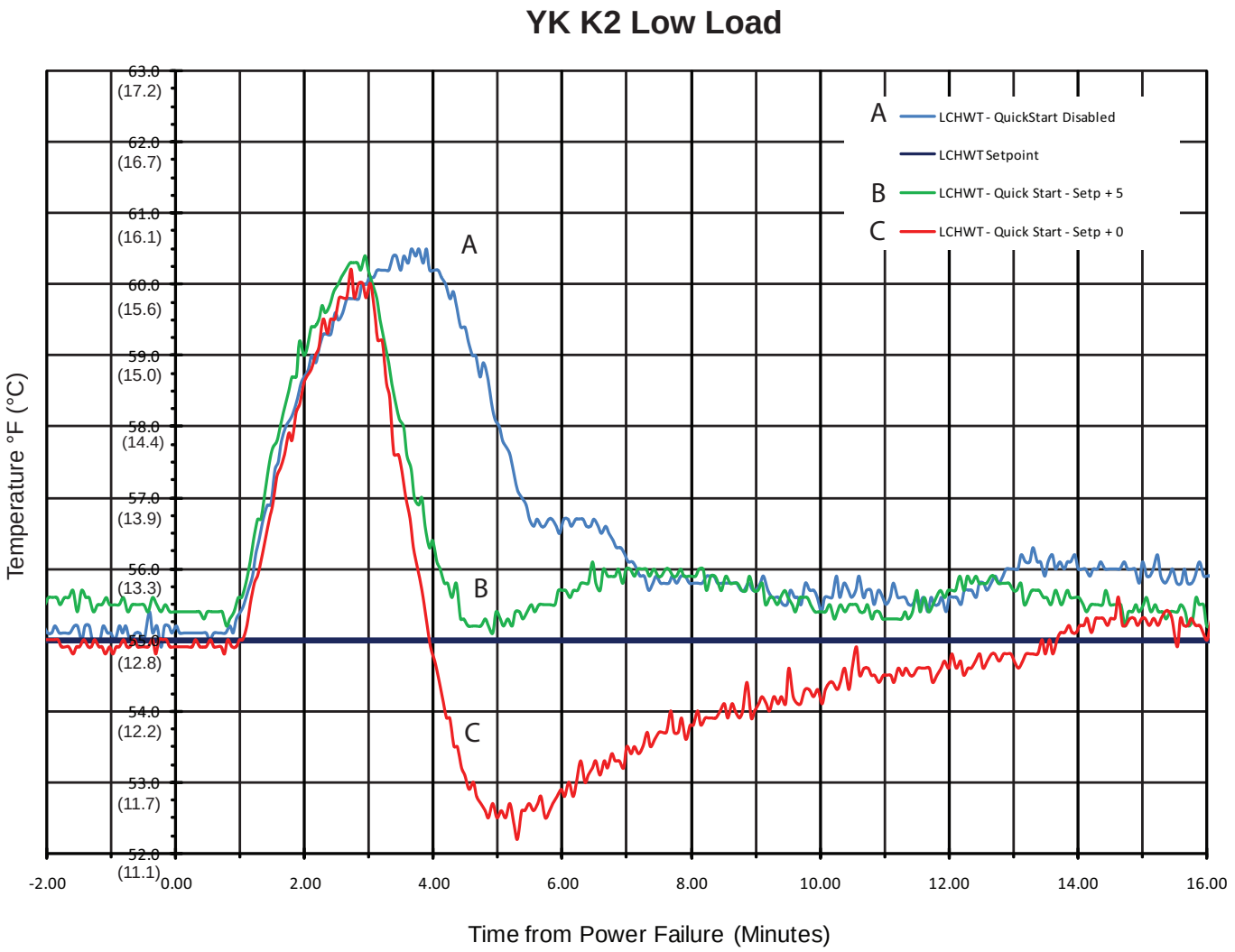


FIGURE 7 – TIME TO RETURN TO LCHLT SETPOINT AFTER 15 SEC POWER FAILURE FOR YK-K2 CHILLER AT LOW LOAD CONDITIONS

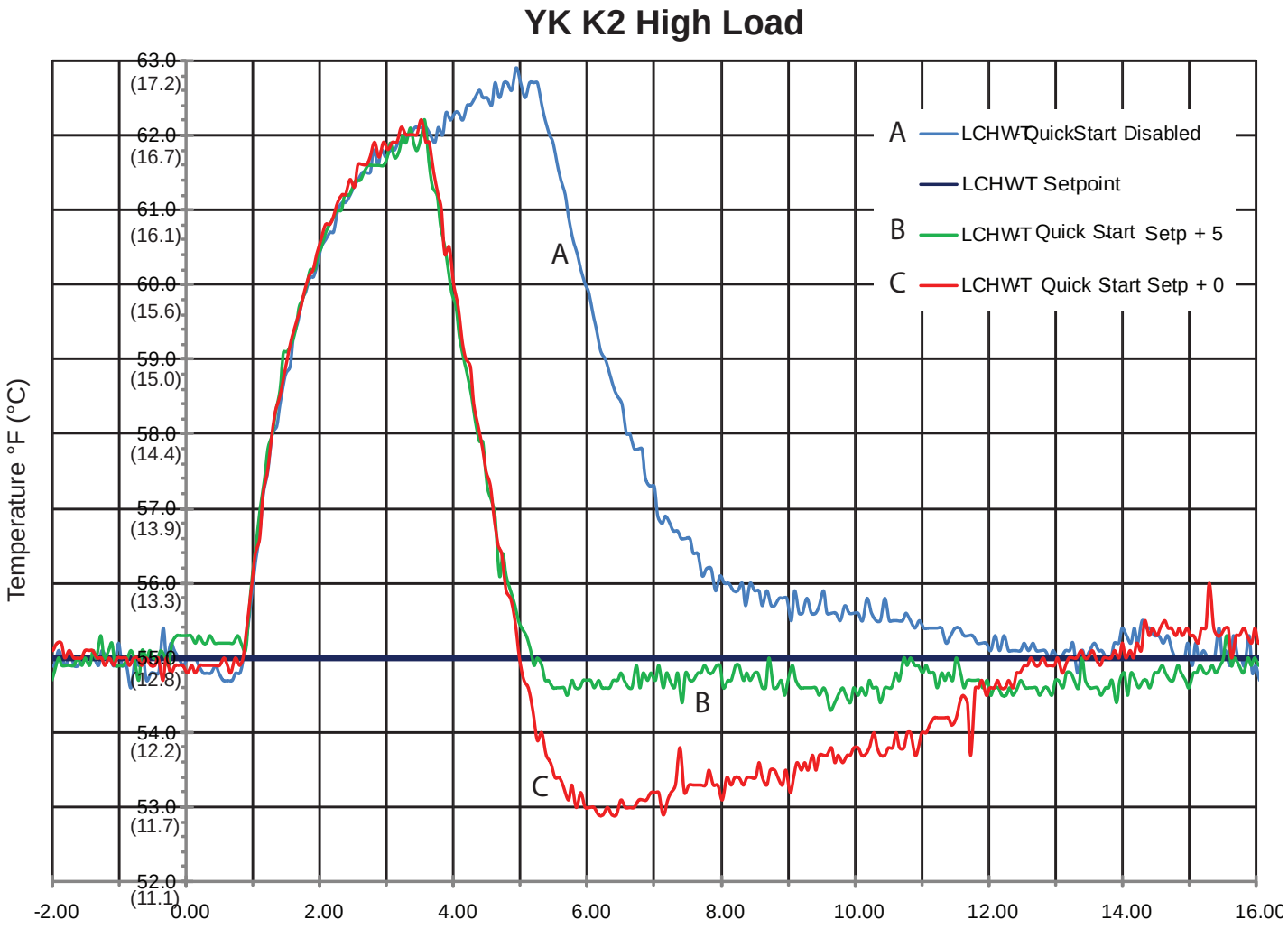


FIGURE 8 – TIME TO RETURN TO LCHLT SETPOINT AFTER 15 SEC POWER FAILURE FOR YK-K2 CHILLER AT HIGH LOAD CONDITIONS

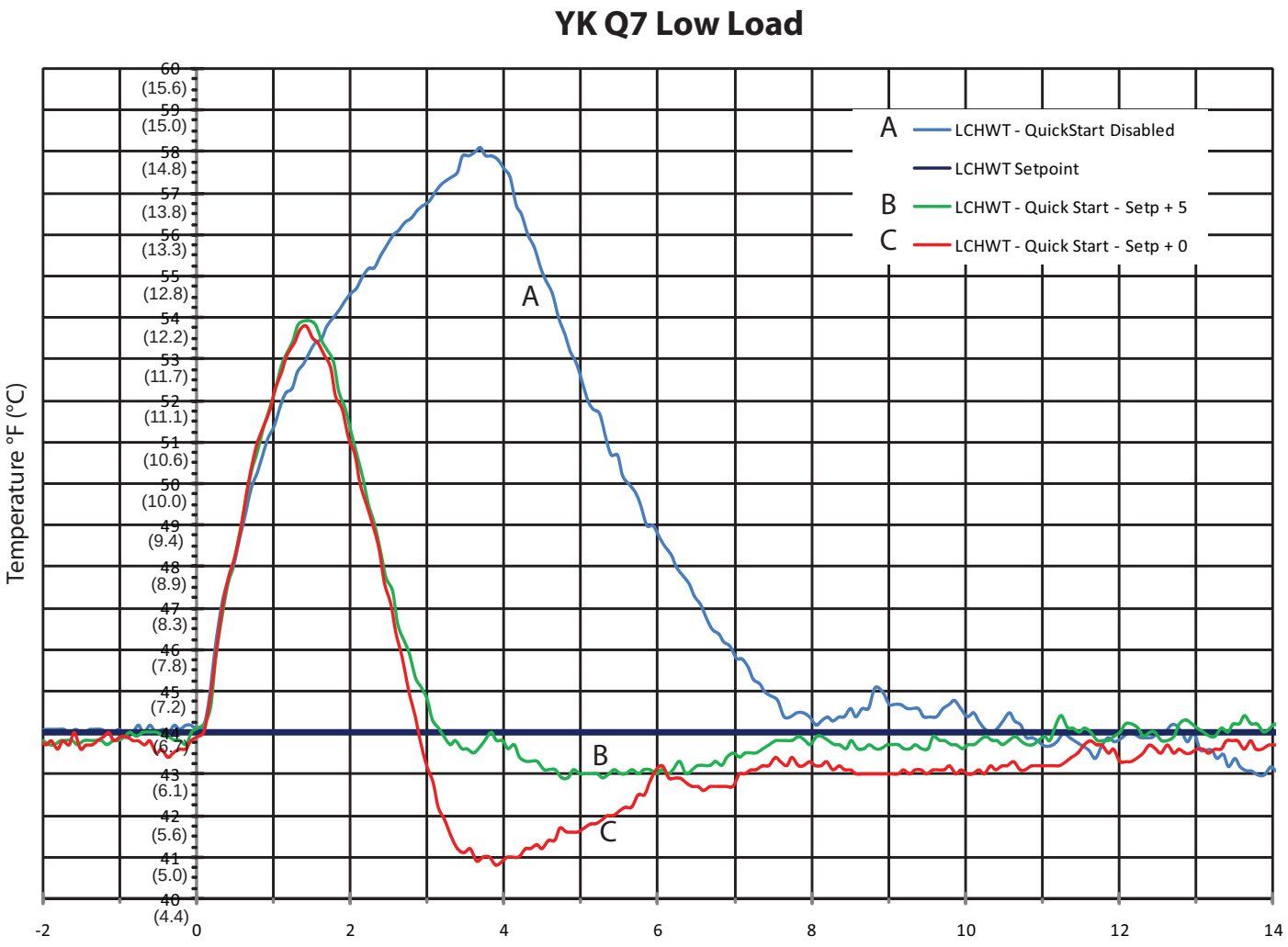


FIGURE 9 – TIME TO RETURN TO LCHLT SETPOINT AFTER 15 SEC POWER FAILURE FOR YK-Q7 CHILLER AT LOW LOAD CONDITIONS

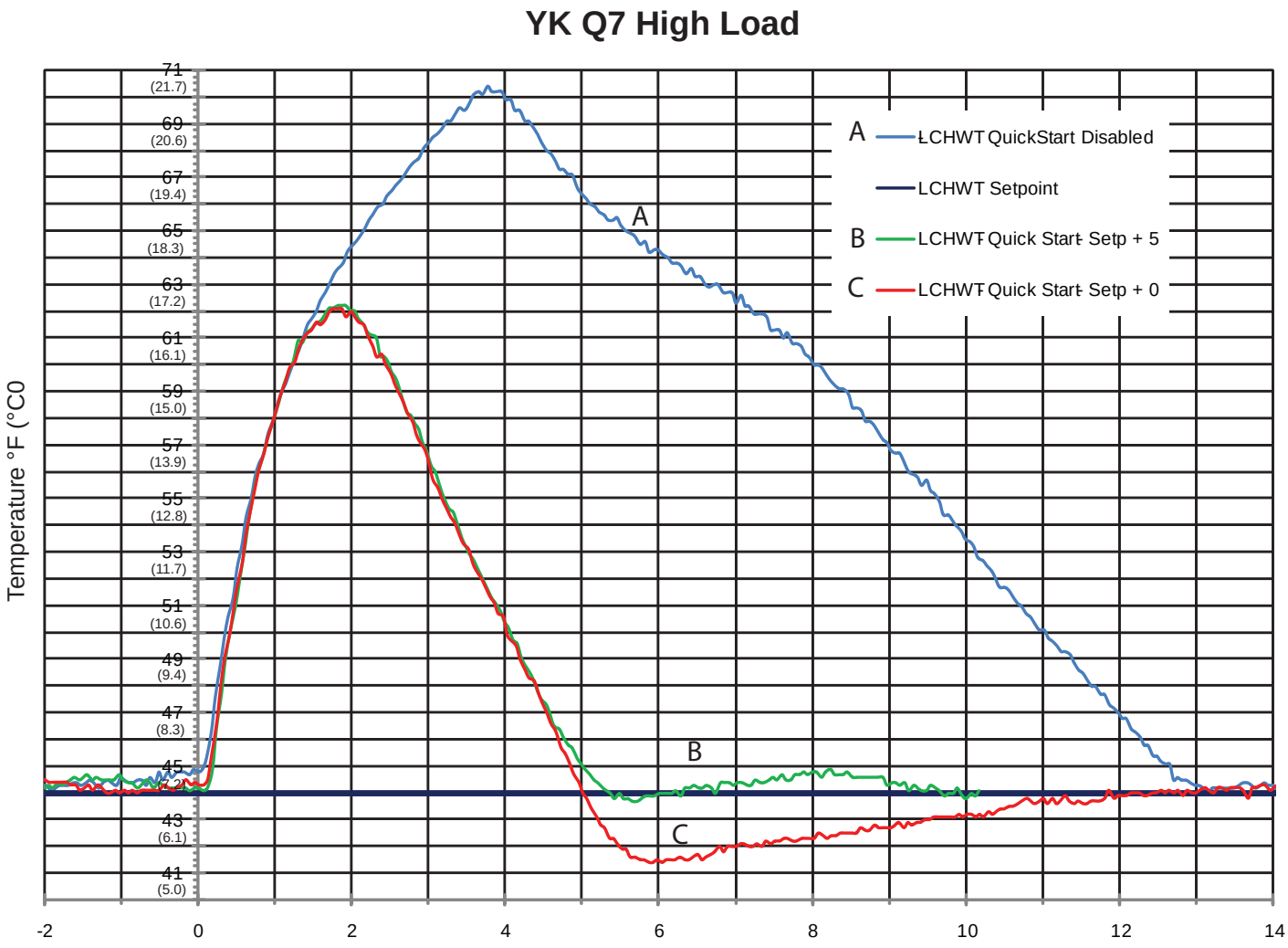


FIGURE 10 – TIME TO RETURN TO LCHLT SETPOINT AFTER 15 SEC POWER FAILURE FOR YK-Q7 CHILLER AT HIGH LOAD CONDITIONS

UPS SIZING AND WIRING INFORMATION

If an application warrants the quickest possible start, a UPS (Uninterruptible Power Supply) is recommended. A 3 or 4 kVA UPS (supplied by others) with sine wave output is required to power the OptiView and required portions of the low voltage VSD control circuit to 115v - 1 phase - 60hz. The size of the UPS required depends on the VSD voltage/horsepower as well as the OptiView panel. Add the kVA required for the VSD to the kVA required for the OptiView to get the total kVA required for the UPS. See Table 4 below for details.

For example, a YK chiller with a Q compressor and a 503 hp (460V) variable speed drive would require a 3 kVA UPS (2kVA for the OptiView panel and 1 kVA for the VSD, totaling 3 kVA.

YORKworks will calculate the kVA required when the "Quick Start with UPS Supplied by Others" option is ordered. The kVA requirement will be displayed on the Factory Order Form.

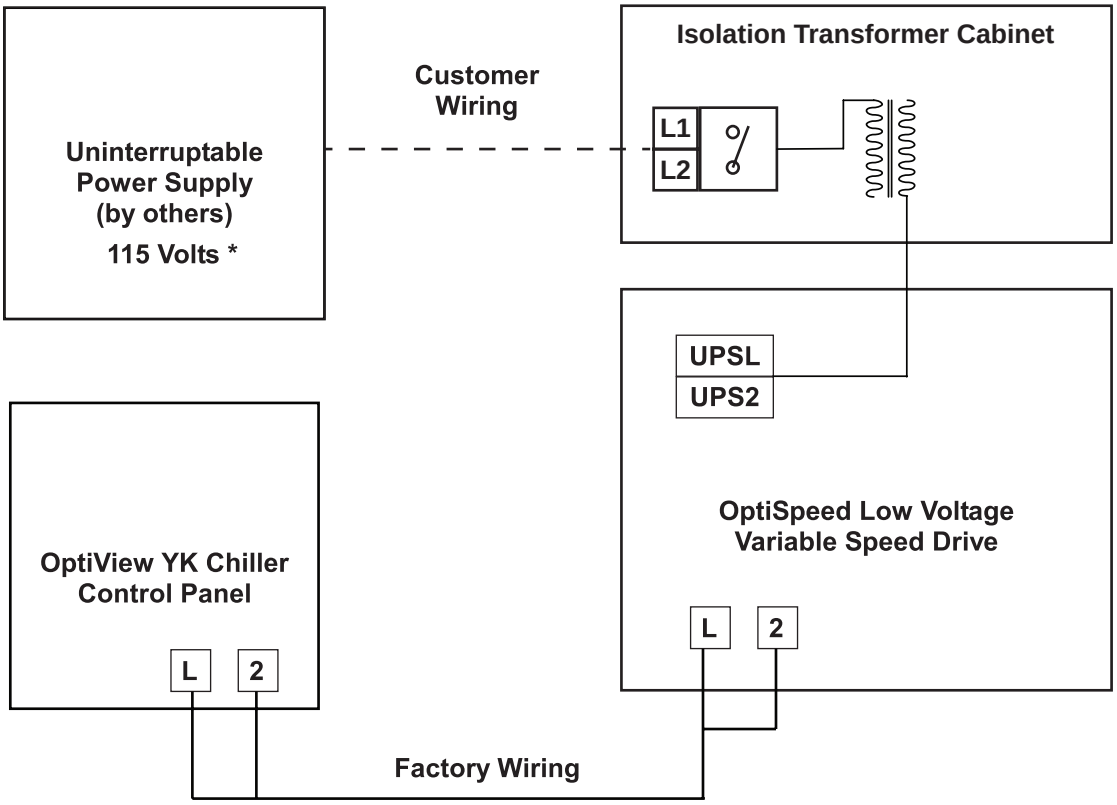
Currently Quick Start with UPS is available on low voltage applications only in YORKworks. However a Medium Voltage solution may be possible via Special Quote. Contact Chiller Marketing to discuss any Medium Voltage Quick Start with UPS opportunities.

When the UPS option is ordered, the Optiview YK chiller panel control power wiring and relevant logic boards in the VSD are disconnected from the normal control power transformer secondary, and are connected to terminals in the variable speed drive that are powered from the UPS through an isolation transformer in a separate chiller-mounted cabinet.

TABLE 4 – UPS SIZING REQUIREMENTS

HZ	MOTOR VOLTAGE	JOB MAX HP	APPLICABLE MOTOR CODES
60	380	270	CF - CK EF - EK
		385	CL - CP EL - EP
		608	CR - CV ER - EV
		845	CW - CZ, CA EW - EZ, EA
	460	351	CF - CN EF - EN
		503	CP - CT EP - ET
		790	CU - CZ EU - EZ
		1048	CA - DB EA - FB
	575	424	CF - CR EF - ER
		608	CS - CV ES - EV
50	380/400	292	5CC - 5CI 5EC - 5EI
		419	5CJ - 5CM 5EJ - 5EM
		658	5CN - 5CS 5EN - 5ES
		917	5CT - 5DA 5ET - 5FA
	415	292	5CC - 5CI 5EC - 5EI
		419	5CJ -5CM 5EJ - 5EM
		704	5CN - 5CT 5EN - 5ET
		900	5CU - 5CX 5EU - 5EX

KVA REQUIRED FOR OPTIVIEW	
APPLICABLE COMPRESSOR CODES	KVA REQUIRED
Q	2
P, H, J, or K	1



* UPS power supply frequency should match the input frequency of the drive

FIGURE 11 – WIRING OF UPS TO CHILLER

The installing contractor will be responsible to connect the UPS to the terminals in the Isolation Transformer Cabinet, which are identified L1 and L2 at the input to the disconnect switch. The terminals accept copper stranded conductor from 4 to 12 AWG wire size. The control power cable shall be sized according NEC or local Codes according to the length of wire and the kVA rating of the UPS.

Once configured for the UPS option, the chiller will not operate without an external control power source (UPS or other 115VAC source).

Printed on recycled paper
Form 160.75-TD4 (1114) Supersedes:160.75-TD4 (1009)

www.johnsoncontrols.com
Issued on 11/03/2014

Johnson Controls