Micro Control Systems
APPLICATION NOTE
APP-090

MCS-Magnum
Unsafe and Low Suction Control

Revision History

Date	Author	Description
02-06-14	John Walterick	Created application note
02-07-14	Brian Walterick	1. Assigned App note #090 to this document 2. Changed title to include “Unsafe Suction” 3. Added to Magnum set point description section. 4. Added to Magnum config changes required for the new low suction control. 5. Added to the running adjustment section.
02-23-14	John Walterick	Rewrote section 3.2 for easier implementation.
04-11-14	Will Powell	Changes to Low Suction Pressure Control (3.2)
07-08-14	Brian Walterick	1. Add leading zero to all decimal values. 2. Remove highlights on values in the set point grid.
07-10-14	Michael Wozny	1. Changed “MAX” value on “LOSUCTPSIDLY” to 35. 2. Combined tables 3.2 and 3.3. 3. Changed “Value” on “LOUSUCTPSIDLY” to 5. 4. Changed “Value” on “EXV rocFAST” to 1.5. 5. Changed “MIN” on “EXV rocFAST” to 0.5. 6. Changed “MAX” on “EXV rocFAST” to 2.
02-10-15	Don Walterick	Modified Setpoint Values
02-11-15	Don Walterick	1.Changes per Brian’s edit pgs 2,3,4 2. Change to chart pg 3
01-25-16	Don Walterick	Changes per Brian, add changes to Setpoint 49

1. Description of the Problem

1.1. Chiller suction pressure has reached a low value that could cause operational problems if allowed to continue.

1.1.1. Low refrigerant could be a possible cause.

1.1.2. A temporary condition occurs where a mix of gas and liquid refrigerant flowing from the condenser to the expansion valve could be a possible cause.

2. Magnum Set Points Used Description

2.1. **SP 77; "LOW SUCTION": The 'Value'** field specifies the low pressure trip value and its '**Time (SEC)**' field specifies the delay in seconds before causing a safety trip. Typically, this safety is setup for two trips within 2 hours of each other to cause a compressor lockout on low suction. The first occurrences place the compressor in a safety trip state for typically 10 minutes before an auto reset clears the safety and allows the compressor to run again when required. If a second occurrence within 2 hours of the first occurrence happens, the compressor is locked out and must be manually reset.

2.2. **SP 78** "**LO SUCT UNLD**": The **'Value**' field specifies the offset added to **SP 77's** value to calculate the suction pressure that will force the compressor into low suction unloading. The system will start to unload the compressor to avoid a safety/lockout trip.

2.3. **SP 79**; "**LO SUCT RELD**": The **'Value' field** specifies the offset added to **SP** 77's value to calculate the suction pressure to allow the compressor to operator normal (exit low suction unloading or low suction holding states). This will allow the compressor to follow the chilled water out capacity control.

2.4. **SP 79;** "**LO SUCT RELD**": The **'Value'** field is multiple by 2 and added to **SP 77's** value to calculate the suction pressure to force the Electronic Expansion Valve (EXV) into low suction pressure opening. The EXV control logic will rapidly take corrective action to avoid an unsafe or low suction safety/lockout.

2.5. **SP 65;** "**EXV ZONE X1**": The **'Night Setback'** field specifies the offset to add to **SP 9**'s value to calculate the lowest suction superheat value to allow the low suction pressure open logic to override normal superheat control of the EXV. **SP 65 "Type of Set point"** must be selected as **"Target"** to use the '**Night Setback**' field. If not setup as "**Target**" type, the low suction pressure open EXV logic is allowed to operate until the suction superheat falls below fine adjustment (Closing 1X state) zone.

2.6. **SP 13; "EXV COURSE"**: The **'Value'** field specifies the course adjustment to the EXV. If it's **"Type of Set point"** is **'Time'**, then the **'Time(SEC)'** field is used as a multiplier to the course adjust to calculate the adjustment to make to the EXV opening when in low suction pressure opening. The set point's '**Max Time Allowed (SEC)'** field defines the upper limit the multiplier can be set at.

3. Magnum changes required for new Low Suction Pressure control

3.1. Please use the latest V16 firmware version, **16.10-N or later**.

3.1.1. The CFG file must be version 14. If the CFG file is V11 "**CFG Type**" (for HVAC V8 & HVAC V9 Magnum firmware) it can be automatically converted to V14 "**CFG Type**". Open the **V11 CFG file** with **MCS-Config** (14.01-D or later). Then click on **"File"** in the upper left corner. Then select **V8/V9 (V11 CFG)** to **V14-CFG** option.

3.2. Using the latest version of MCS-Config make the following recommended changes, (Chiller Refrigerant 134A units in ºF & PSI):

ST/ PT	Name	Value	MIN	MAX	Adjust Value	Time (SEC)	MAX Time Allowed (SEC)	Active or Non-Active	Type of Set point	High Zone	High Zone	Night Setback
9	SUPERHT TRGT	12	10	16	0.5	3	10	Active	Alarm			
10	SPRHT ZONE+-	2	1.5	2	0.1	0	0	Active	Set point			
11	EXV LOAD ADJ	0.2	0.1	5	0.1	0	0	Active	Set point			
12	EXV FINE ADJ	0.1	0.1	.5	0.1	0	0	Active	Set point			
13	EXV COURSE	0.5	.2	1.5	0.1	4	6	Active	Time			
18	LOSUCTPSIDLY	3	2	5	1	0	0	Active	Set point			
19	EXV DELAY	60	60	120	5	0	0	Active	Set point			
65	EXV ZONE X1	2	1.5	2	0.5	0	0	Active	Target	0	0	-4
66	EXV ZONE X2	1.5	1	2	0.5	0	0	Active	Set point			
67	EXV rocZONE1	0.2	0	.5	0.1	5	15	Active	Alarm			
69	EXV rocZONE2	0.3	0.1	.7	0.1	5	10	Active	Alarm			
70	EXV rocZONE3	.4	.1	1	0.1	5	10	Active	Alarm			
71	EXV roc FAST	5.0	2	8	0.1	10	15	Active	Alarm			
72	EXV roc CHG	3.5	1	6	0.1	10	15	Active	Alarm			
77	LOW SUCTION	25	20	30	1	60	120	Active	Lockout			
78	LO SUCT UNLD	0.5	0.5	2	0.5	40	40	Active	Set point			

79	LO SUCT RELD	1	1	3	1	0	0	Active	Set point			
80	UNSAFE SUCT	5	0	5	1	5	10	Active	Lockout			
101	"SAFETY HOLD"	120	60	300	1	2	2	Active	Set point			
230	PSID EXV Adj.	5	1	10	1	3	6	**Inactive**	Lockout	120	1	16

3.3. **SP #9**: Change **'SUPERHT TRGT' 'Time (sec)**' field to 3 seconds.

3.4. **Set Point's 10, 11 and 12:** Set based on system response.

3.5. **SP #13**: Change '**EXV COURSE**' **'type of set point**' field to '**Time**'; set '**Time' (SEC)**' field to **4**; set '**Max Time Allowed (SEC)**' field to **6**.

3.6. **SP #18:** Change "**LOSUCTPSIDLY**": **'Value'** field to **3**, the **'Min'** field to **2** and **'Max'** field to **5**. It is important to set this value as low as possible to allow quick reaction of the EXV when a low suction pressure occurs.

3.7. **SP #19:** The '**EXV DELAY**' **'Value'** field must be between **48 and 60** seconds, with **60 being preferred**.

Verbatim Expansion Valve Changes for New Low Suction Pressure Control

SP 65; 'EXV ZONE X1': 'Active', 'Value 2.0F', 'Min 1F, Max 3F', Type = Target, High & Low Zone to 0 & Night Setback = -4.

3.8. **SP# 66; "EXV ZONE X2": Active, Value 1.5F, Min 1F, Max 3F, Type = Set point.**

3.9. **SP #67; "EXV rocZONE1": Active, Value 0.2F, Min 0.0F, Max 0.5F, Type = Alarm, Time (sec) 5, Max Time 15**

3.10. **SP #69; "EXV rocZONE2": Active, Value 0.3F, Min 0.1F, Max 0.7F, Type = Alarm, Time (sec) 5, Max Time 10**

3.11. **SP #70; "EXV rocZONE3": Active, Value 0.4F, Min 0.1F, Max 1.0F, Type = Alarm, Time (sec) 5, Max Time 10**

3.12. **SP#71; "EXV rocFAST": Active, Value 5.0F, Min 2.0F, Max 8.0F, Type = Alarm, Time (sec) 10, Max Time 15**

3.13. **SP #72; "EXV rocCHG": Active, Value 3.5F, Min 1.0F, Max 6.0F, Type = Alarm, Time (sec) 10, Max Time 15**

3.14. **SP #77; "LOW SUCTION":** value to a suction pressure at where ice will start to form in the evaporator (this is low suction freeze safety). Typically value for R134a refrigerant is 25psi.

3.15. Change Set Point #78 '**Low Suct Unld**' '**Time (sec)**' field to **40** seconds.

3.16. If the compressor has steps of capacity (recip with unload or step screw), make sure set point 153 **"SttyUnld Dly"** is active. This is the time delay between each stage of unliading when a compressor safety condition is near the trip point.

3.17. In the **"ROs"** screen, check the following items when using a compressor type with step loading/unloading:

3.17.1. Check **the "EXV Start"** value for each compressor relay. Make sure this value is not too large causing the compressor to be fooled with liquid refrigeration. A value between 25% and 45% is typical. Check the size of the EXV compared to the size of the compressor when it starts (unload). Best to set the **"EXV Start"** value a little low and then fine tune the value during testing/startup.

3.17.2. Check the **"EXV Load Adjust %"** value for each compressor and each step of unloading relays. This set point value is a percentage used to calculate a jump in the EXV position. The adjustment made to the position EXV is calculated by take percentage of the current EXV position.

3.17.3. Check the **"EXV Unld Adjust %"** value for each comp and step of unloading relay. This set point value is a percentage used to calculate a jump in the EXV position. The adjustment made to the position EXV is calculated by take percentage of the current EXV position.

3.17.4. Setup User Logic virtual points for each of the compressor's calculated values so they can be tracked in the MCS-Magnum history:

3.17.4.1. Saturated Suction temperature

3.17.4.2. Suction Superheat for each comp

3.17.4.3 Comp State

3.17.4.4 EXV State

4. Running Adjustments

4.12. Using either Magnum Keypad/Display or MCS-Connect, set History sample time to 1 second.

4.13. When a compressor starts, the suction superheat (SSH) will react as follows:

4.13.1. The EXV opening start % is set to the opening value as specified in the Relay Output in the cfg.

4.13.2. SSH stays at 0 for about 10 to 15 seconds as the compressor builds up momentum.

4.13.3. The SSH should then settle to the SSH target or slightly below. During the start period it is best to have the SSH slightly below the target. This allows the system to maintain adequate suction pressure. If the circuit's SSH is above the target you need to adjust the starting opening% lower. Do not adjust the **"EXV START"** value too large that it causes low superheat or low discharge superheat safety trips.

4.14. Watch the system loading and unloading. And if required adjust the Fine & Course EXV Set Points. In a system with steady load on the chiller, the suction superheat should remain in the superheat control zone.

4.15. At 1 second sample rate for history you have **16.7** minutes of data. Approximately **15 minutes** into startup, pull back the History. You can then verify the results by reviewing the runtime history of all the inputs and outputs.

4.16. Let the system continue to run until an unsafe or low suction occurs. After the system has corrected the problem again pull back the history and verify the results as follows:

4.16.1. As the compressor speed increases or decreases check the following:

4.16.2. With step loading adjust the **EXV %** change to match the Capacity change.

4.16.3. With infinite capacity, the unit will increase or decrease the Capacity based on Set Point 56 '**PULSE or CMP LOAD DELAY**' until the total change is made. Here the system uses Set Point 11, Load Adjust.

4.17. Adjust the low suction pressure open set point. Cause a Low Suction pressure condition and watch how the EXV recovers and how the SSH reacts. If opening the EXV causes too low of SSH, lower the multiplier in set point 13 "**EXV COURSE'**" time field. If suction pressure does not recover quickly and SSH is ok or high, increase the multiple in set point 13 "**Time**" field. Set point #18 value field can also be adjust to help fine tune the EXV reaction to low suction pressure condition.

4.18. Use the graph to see where the EXV adjustments stop being made during a Low Suction pressure condition. If you think an additional adjustment needed to be made increase the Time value in Set Point 9, '**SUPER HEAT TARG'**. If you think one less adjustment needed to be made decrease the Time value in Set Point 9, '**SUPER HEAT TARG'**.

4.19 **Make setpoint #49 "CND MIN RUN" non-active with a value of 0, min of 0 and max of 0, in all config files.**

4.20 For R134a suggest the following setting is a good starting point for air cooled condenser:

ST/ PT	Name	Value	MIN	MAX	Adjust Value	Time (SEC)	MAX Time Allowed (SEC)	Active or Non-Active
45	CND STG1 ON	150	140	170	1	0	0	Active
46	CND STG1 OFF	120	100	130	1	0	0	Active
47	CND DIFF ON	30	20	40	1	0	0	Active
48	CND DIFF OFF	10	5	20	1	0	0	Active
49	CND MIN RUN	0	0	0	1	0	0	Non-Active