Troubleshoot 23XL

INSTRUCTIONS FOR USAGE OF THIS DIAGNOSTIC GUIDE

This spreadsheet is intended to provide comprehensive guidance for troubleshooting 23XL chiller "system" problems. These problems are always characterized by at least one of the following, and are often attributed to float valve malfunction:

(1) Evaporator refrigerant temperature is low, and cooler Leaving Temperature Difference (LTD) is high. Cooler is "starved".
(2) Chilled water and evaporator refrigerant temperatures are both pulled down well below setpoint.
(3) Capacity is noticeably reduced.

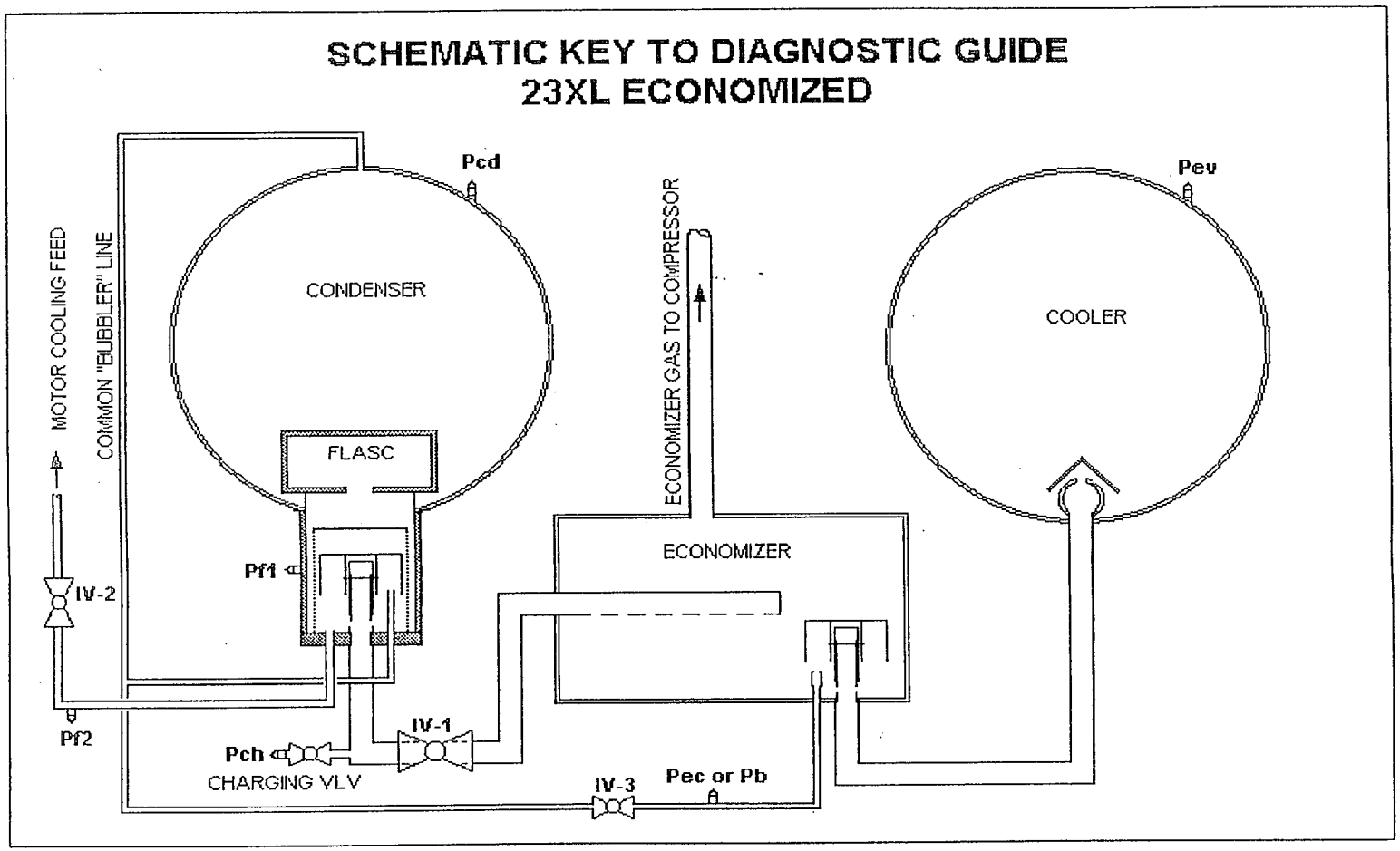
While this was written specifically to apply to economized 23XL chillers, it can be applied in general to noneconomized 23XL, 19XL, and 19XR chillers as well. In those cases, symptoms and root causes which are obviously limited to the economized 23XL design should be ignored.

PROCESS:

1. Examine the schematic diagram on the tab labeled "Schematic". *This guide assumes that all of the pressure taps identified (with the exception of optional tap Pf1) are installed.* Taps Pf2 and Pb will be provided by design as Schrader valve fittings beginning in first quarter of 2000; for older machines such taps should be field-installed. Other taps, which can be mechanically installed, should be provided as temporary fittings by service technicians during troubleshooting at the jobsite.

2. Use either the Diagnostic Key provided here or the simplified flowchart provided in the MSWORD file "DGFLOW.DOC" to arrive at one or more most likely root causes for the problem(s) observed. To begin the process, click the "Start Diagnosis" button ---> On each "form" shown, click the button that best matches the symptoms you observe. By using the "Go Back" button on each form, you can return to the prior set of questions to explore another path. The paths are numbered if you want to keep track of the path you followed. In the end you will be shown a portion of a spreadsheet headed by a "CAUSE". Review the SYMPTOMS list (which should match the buttons you already clicked, and the associated LIKELY ROOT CAUSES. (You may have to grab the top of a displayed form which lies over the spreadsheet to see all of the text.) Note that you are conveniently brought back to the schematic when you go through the process. Click the "Exit" button to end the process and return to this spreadsheet.

3. If you used the flow chart DGFLOW.DOC, the branches similarly lead to one or more CAUSES. Look up the CAUSEs in the Likely Root Causes sheet in this spreadsheet. Note that, when using the flow chart, the process is not really completed until the corresponding Root Causes descriptions are reviewed.



Condenser pressure	=	measured at Pcd
"True" flasc pressure	=	measured at Pf1
Flasc pressure	=	measured at Pf2 with IV-2 shut (briefly) (downstream of float screen)
Pressure at charging valve	=	measured at Pch
Bubbler (vapor feed) line pressure	=	measured at Pb with IV-3 open
Economizer pressure	=	measured at Pec with IV-3 shut
Cooler (evaporator) pressure	=	measured at Pev

CAUSE1	**Flasc orifices too restrictive**	
SYMPTOMS:	Always or almost always...	Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
	Always or almost always...	Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
	Always or almost always...	Problem is apparent during steady-state operation.
	Always or almost always...	Max capacity noticeably limited (by evaporator refrigerant level or by low evaporator refrigerant temperature override).
	Always or almost always...	In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).
	Always or almost always...	Compressor unloads at least somewhat when commanded.
	Always or almost always...	Flasc pressure as measured at Pf2 is lower than expected.
	Always or almost always...	True flasc pressure is low.
	Always or almost always...	Economizer pressure is lower than expected.
	Always or almost always...	Condenser-to-flasc pressure differential is higher than expected.
	Always or almost always...	Temperature difference between condenser drain sump and motor cooling line tap is not noticeable.
	Always or almost always...	Liquid backs up in condenser at full load
	Always or almost always...	No evidence of economizer liquid carryover at full load, such as lowered discharge superheat.
	Always or almost always...	Condition improved by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)
	Always or almost always...	Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
	Always or almost always...	Condition is worse at higher loads.
	Always or almost always...	Problem is repeatable, most likely not changing with time
	Always or almost always...	Problem unaffected by length of time since prior run.
	Always or almost always...	In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.
LIKELY ROOT CAUSES:	**Flasc orifices too small (as specified by E-CAT, or parts or assembly faulty)**	
	Flasc orifices blocked by loose object or material broken from other part of system	
	Flasc orifices blocked by foreign object(s).	
	Chiller was operating with condenser water flow much higher than that specified in design conditions.	

CAUSE2.1	**Cond FV screen is restrictive**	
SYMPTOMS:	Always or almost always...	Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
	Always or almost always...	Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
	Always or almost always...	Problem is apparent during steady-state operation.
	Always or almost always...	Max capacity noticeably limited (by evaporator refrigerant level or by low evaporator refrigerant temperature override).
	Always or almost always...	In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).
	Always or almost always...	Compressor unloads at least somewhat when commanded.
	Always or almost always...	Flasc pressure as measured at Pf2 is lower than expected.
	Always or almost always...	True flasc pressure is high.
	Always or almost always...	Economizer pressure is lower than expected.
	Always or almost always...	Condenser-to-flasc pressure differential is lower than expected.
	Always or almost always...	Flasc pressure is close to condenser pressure at steady-state.
	Always or almost always...	Flasc-to-charging valve (incl. condenser FV) pressure differential is higher than expected. Temperature difference between flasc and piping downstream of condenser FV is noticeable.
	Always or almost always...	Temperature difference between condenser drain sump and motor cooling line tap is noticeable.

Always or almost always... Liquid backs up in condenser at full load
Always or almost always... Liquid fails to drain from condenser during startup.
Always or almost always... No evidence of economizer liquid carryover at full load, such as lowered discharge superheat.
Always or almost always... Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)

Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
Always or almost always... Condition is worse at higher loads.
Always or almost always... Problem unaffected by length of time since prior run.
Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.
Sometimes... Problem is repeatable, most likely becoming worse with time

LIKELY ROOT CAUSES: **Screen plugged by fibers**
Oil separator felt gasket disintegrated (small 23XL).
Oil filter element has disintegrated
Screen plugged by metallic particles
Excessive wear of condenser tubes generates filings which get carried with refrigerant through flasc to the screen.
Excessive wear in compressor generates filings which get carried through condenser and flasc to the screen.
Screen plugged by dirt from factory or prior servicing

CAUSE2.2 **Cond FV screen is restrictive**

SYMPTOMS:
Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always... Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
Always or almost always... Problem is apparent during steady-state operation.
Always or almost always... Max capacity noticeably limited (by evaporator refrigerant level or by low evaporator refrigerant temperature override).

Always or almost always... In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).

Always or almost always... Compressor unloads at least somewhat when commanded.
Always or almost always... Flasc pressure as measured at Pf2 is lower than expected.
Always or almost always... True flasc pressure is high.
Always or almost always... Economizer pressure is lower than expected.
Always or almost always... Condenser-to-flasc pressure differential is lower than expected.
Always or almost always... Flasc pressure is close to condenser pressure at steady-state.
Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is higher than expected. Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Always or almost always... Temperature difference between condenser drain sump and motor cooling line tap is noticeable.
Always or almost always... Liquid backs up in condenser at full load
Always or almost always... Liquid fails to drain from condenser during startup.
Always or almost always... No evidence of economizer liquid carryover at full load, such as lowered discharge superheat.
Always or almost always... Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)

Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
Always or almost always... Condition is worse at higher loads.
Always or almost always... Problem is repeatable, most likely not changing with time
Always or almost always... Problem unaffected by length of time since prior run.
Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.
Sometimes... Economizer pressure is lower than expected.

LIKELY ROOT CAUSES: **Screen plugged by fibers**

CAUSE3 **Economizer spray holes restrictive**

SYMPTOMS:

Always or almost always...	Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always...	Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
Always or almost always...	Problem is apparent during steady-state operation.
Always or almost always...	Max capacity noticeably limited (by evaporator refrigerant level or by low evaporator refrigerant temperature override).
Always or almost always...	In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).
Always or almost always...	Compressor unloads at least somewhat when commanded.
Always or almost always...	Economizer pressure is lower than expected.
Always or almost always...	Condenser-to-flasc pressure differential is lower than expected.
Always or almost always...	Flasc pressure is close to condenser pressure at steady-state.
Always or almost always...	Flasc-to-charging valve (incl. condenser FV) pressure differential is lower than expected. Temperature difference between flasc and piping downstream of condenser FV is slight, if any.
Always or almost always...	Charging valve-to-economizer pressure differential is higher than expected.
Always or almost always...	Liquid backs up in condenser at full load
Always or almost always...	No evidence of economizer liquid carryover at full load, such as lowered discharge superheat.
Always or almost always...	Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)
Always or almost always...	Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
Always or almost always...	Condition is worse at higher loads.
Always or almost always...	Problem is repeatable, most likely not changing with time
Always or almost always...	Problem unaffected by length of time since prior run.
Always or almost always...	In MAINT01 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.
Sometimes...	Flasc pressure as measured at Pf2 is higher than expected and equal to true flasc pressure.
Sometimes...	Liquid fails to drain from condenser during startup.

LIKELY ROOT CAUSES: **Econ.spray bar hole machining or weld assembly is faulty.**
Econ spray bar holes blocked by foreign object(s) in flow path downstream of condenser FV.

CAUSE4 **Cooler distribution holes restrictive**

SYMPTOMS:

Always or almost always...	Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always...	Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
Always or almost always...	Problem is apparent during steady-state operation.
Always or almost always...	Max capacity noticeably limited (by evaporator refrigerant level or by low evaporator refrigerant temperature override).
Always or almost always...	In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).
Always or almost always...	Compressor unloads at least somewhat when commanded.
Always or almost always...	Flasc pressure is "normal".
Always or almost always...	Economizer pressure is higher than expected.
Always or almost always...	Condenser-to-flasc pressure differential is "normal".
Always or almost always...	Flasc-to-charging valve (incl. condenser FV) pressure differential is "normal". Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Always or almost always...	Economizer-to-cooler pressure differential is higher than expected.
Always or almost always...	Pressure differential between economizer and downstream piping is lower than expected. Temperature difference between economizer and downstream piping is slight, if any.
Always or almost always...	No evidence of liquid backing up in condenser at full load.
Always or almost always...	Economizer liquid carryover to compressor occurs at full load, resulting in lowered discharge superheat.

Always or almost always... Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)

Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
Always or almost always... Condition is worse at higher loads.
Always or almost always... Problem is repeatable, most likely not changing with time
Always or almost always... Problem unaffected by length of time since prior run.
Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.

LIKELY ROOT CAUSES: **Cooler distribution pipe flow area too small (machining or weld assembly faulty).**
Holes blocked by foreign object(s) in flow path downstream of economizer.

CAUSE5 **Liquid isolation valve throttled**

SYMPTOMS:
Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always... Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
Always or almost always... Problem is apparent during steady-state operation.
Always or almost always... Max capacity noticeably limited (by evaporator refrigerant level or by low evaporator refrigerant temperature override).

Always or almost always... In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).

Always or almost always... Compressor unloads at least somewhat when commanded.
Always or almost always... Economizer pressure is lower than expected.
Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is lower than expected. Temperature difference between flasc and piping downstream of condenser FV is slight, if any.
Always or almost always... Charging valve-to-economizer pressure differential is higher than expected.
Always or almost always... Temperature difference across isolation valve is noticeable.
Always or almost always... No evidence of economizer liquid carryover at full load, such as lowered discharge superheat.
Always or almost always... Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)

Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
Always or almost always... Condition is worse at higher loads.
Always or almost always... Problem is repeatable, most likely not changing with time
Always or almost always... Problem unaffected by length of time since prior run.
Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.
Sometimes... Flasc pressure as measured at Pf2 is higher than expected and equal to true flasc pressure.
Sometimes... Condenser-to-flasc pressure differential is lower than expected.
Sometimes... Flasc pressure is close to condenser pressure at steady-state.
Sometimes... Liquid backs up in condenser at full load

LIKELY ROOT CAUSES: **Isolation valve not open fully.**
Isolation valve handle misaligned or broken.

STICKING

CAUSE6.1 **Condenser float not buoyant or stuck closed or not opening while running (post-startup only)**

SYMPTOMS:
Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always... Problem is apparent during steady-state operation.
Always or almost always... Max capacity noticeably limited (by evaporator refrigerant level or by low evaporator refrigerant temperature override).

Always or almost always... In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).

Always or almost always... Compressor unloads at least somewhat when commanded.

Always or almost always... Flasc pressure as measured at Pf2 is higher than expected and equal to true flasc pressure.
Always or almost always... Economizer pressure is lower than expected.
Always or almost always... Condenser-to-flasc pressure differential is lower than expected.
Always or almost always... Flasc pressure is close to condenser pressure at steady-state.
Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is higher than expected. Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Always or almost always... Temperature difference between condenser drain sump and motor cooling line tap is not noticeable.
Always or almost always... Liquid backs up in condenser at full load
Always or almost always... No evidence of economizer liquid carryover at full load, such as lowered discharge superheat.
Always or almost always... Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)

Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
Always or almost always... Condition is worse at higher loads.
Always or almost always... Problem unaffected by length of time since prior run.
Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.
Sometimes... Problem is sporadic, symptoms may be variable

LIKELY ROOT CAUSES: **Float not free to move against FV body.**
FV body surface finish poor at top OD.
Float surface finish poor at top ID.
Momentum from bubbler 90o to support pin axis tilts float against body
Top hat missing, liquid draining from flasc impinges on top of float
Lowered static pressure beneath FV sleeve edge pulls down float at high flow conditions

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JAMMED

CAUSE6.2 **Condenser float not buoyant or stuck closed or not opening while running (post-startup only)**

SYMPTOMS:
Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always... Problem is apparent during steady-state operation.
Always or almost always... Max capacity noticeably limited (by evaporator refrigerant level or by low evaporator refrigerant temperature override).

Always or almost always... In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).

Always or almost always... Compressor unloads at least somewhat when commanded.
Always or almost always... Flasc pressure as measured at Pf2 is higher than expected and equal to true flasc pressure.
Always or almost always... Economizer pressure is lower than expected.
Always or almost always... Condenser-to-flasc pressure differential is lower than expected.
Always or almost always... Flasc pressure is close to condenser pressure at steady-state.
Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is higher than expected. Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Always or almost always... Temperature difference between condenser drain sump and motor cooling line tap is not noticeable.
Always or almost always... Liquid backs up in condenser at full load
Always or almost always... No evidence of economizer liquid carryover at full load, such as lowered discharge superheat.
Always or almost always... Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)

Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
Always or almost always... Condition is worse at higher loads.
Always or almost always... Problem is repeatable, most likely not changing with time
Always or almost always... Problem unaffected by length of time since prior run.
Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.

LIKELY ROOT CAUSES: **Float not free to move against FV body.**
Debris jammed between sleeve and FV body.

STICKING

CAUSE7.1 **Condenser FV float not buoyant or stuck closed or not opening in startup.**

SYMPTOMS:

Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.

Always or almost always... Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).

Always or almost always... Economizer pressure is lower than expected.

Always or almost always... Condenser-to-flasc pressure differential is more than 2 psi during startup.

Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is higher than expected. Temperature difference between flasc and piping downstream of condenser FV is noticeable.

Always or almost always... Temperature difference between condenser drain sump and motor cooling line tap is not noticeable.

Always or almost always... Liquid fails to drain from condenser during startup.

Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).

Always or almost always... Problem is sporadic, symptoms may be variable

Always or almost always... Problem unaffected by length of time since prior run.

Sometimes... Liquid backs up in condenser at full load

LIKELY ROOT CAUSES: **Float not free to move against FV body.**

FV body surface finish poor at top OD.

Float surface finish poor at top ID.

Momentum from bubbler 90o to support pin axis tilts float against body

JAMMED

CAUSE7.2 **Condenser FV float not buoyant or stuck closed or not opening in startup.**

SYMPTOMS:

Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.

Always or almost always... Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).

Always or almost always... Economizer pressure is lower than expected.

Always or almost always... Condenser-to-flasc pressure differential is more than 2 psi during startup.

Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is higher than expected. Temperature difference between flasc and piping downstream of condenser FV is noticeable.

Always or almost always... Temperature difference between condenser drain sump and motor cooling line tap is not noticeable.

Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).

Always or almost always... Problem is repeatable, most likely not changing with time

Always or almost always... Problem unaffected by length of time since prior run.

Sometimes... Liquid fails to drain from condenser during startup.

LIKELY ROOT CAUSES: **FV assembly can't provide adequate flow area.**

Wrong FV parts or FV misassembled.

Float not free to move against FV body.

Debris jammed between sleeve and FV body.

BLOCKED @ COND SUMP

CAUSE7.3 **Condenser FV float not buoyant or stuck closed or not opening in startup..**

SYMPTOMS:

Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.

Always or almost always... Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).

Always or almost always... Economizer pressure is lower than expected.

Always or almost always... Condenser-to-flasc pressure differential is more than 2 psi during startup.

Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is higher than expected. Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Always or almost always... Temperature difference between condenser drain sump and motor cooling line tap is not noticeable.
Always or almost always... Bubbler line pressure at Pb is more than 10 psi above flasc pressure, or just below condenser pressure.
Always or almost always... Problem is repeatable, most likely not changing with time
Always or almost always... Problem unaffected by length of time since prior run.
Sometimes... Condenser-to-flasc pressure differential is lower than expected.
Sometimes... Liquid backs up in condenser at full load

LIKELY ROOT CAUSES: **Bubbler not working: bubbler flow path restricted in line to condenser float sump.**
Bubbler line to condenser FV blocked/plugged/not drilled.
Bubbler tube blocked at outlet.
Bubbler tube crimped somewhere.

NOT ENOUGH FLASC DP

CAUSE7.4 **Condenser FV float not buoyant or stuck closed or not opening in startup.**

SYMPTOMS:
Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always... Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
Always or almost always... Flasc pressure as measured at Pf2 is higher than expected and equal to true flasc pressure.
Always or almost always... Economizer pressure is lower than expected.
Always or almost always... Condenser-to-flasc pressure differential is less than 2 psi during startup.
Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is higher than expected. Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Always or almost always... Bubbler line pressure at Pb is roughly equal to flasc pressure.
Sometimes... Liquid backs up in condenser at full load
Sometimes... Problem is sporadic, symptoms may be variable
Sometimes... Problem unaffected by length of time since prior run.
Sometimes... Problem doesn't occur if short time has passed since prior run.

LIKELY ROOT CAUSES: **Vapor pocket reabsorbed, not refilled quickly enough.**
Bubbler not working: insufficient pressure differential to displace liquid for bubbler.
Flasc orifices not restrictive enough.
Excessive leakage around flasc tubes at support sheet(s).
Initial condensing pressure too far below initial evaporator pressure.

VAPOR FEED BLOCKED UPSTREAM

CAUSE7.5 **Condenser FV float not buoyant or stuck closed or not opening in startup.**

SYMPTOMS:
Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always... Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
Always or almost always... Economizer pressure is lower than expected.
Always or almost always... Condenser-to-flasc pressure differential is more than 2 psi during startup.
Always or almost always... Temperature difference between condenser drain sump and motor cooling line tap is not noticeable.
Always or almost always... Bubbler line pressure at Pb is roughly equal to flasc pressure.
Always or almost always... Problem is repeatable, most likely not changing with time
Always or almost always... Problem unaffected by length of time since prior run.
Sometimes... Condenser-to-flasc pressure differential is lower than expected.
Sometimes... Flasc-to-charging valve (incl. condenser FV) pressure differential is "normal". Temperature difference between flasc and piping downstream of condenser FV is noticeable.

Sometimes... Flasc-to-charging valve (incl. condenser FV) pressure differential is higher than expected. Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Sometimes... Liquid backs up in condenser at full load
Sometimes... Problem is sporadic, symptoms may be variable

LIKELY ROOT CAUSES: **Bubbler not working: bubbler flow path restricted upstream of common junction.**
Bubbler tube blocked at condenser.
Bubbler tube crimped somewhere.

ROBBED

CAUSE7.6 **Condenser FV float not buoyant or stuck closed or not opening in startup.**

SYMPTOMS:
Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always... Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
Always or almost always... Economizer pressure is lower than expected.
Always or almost always... Condenser-to-flasc pressure differential is more than 2 psi during startup.
Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is higher than expected. Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Always or almost always... Temperature difference between condenser drain sump and motor cooling line tap is not noticeable.
Always or almost always... Bubbler line pressure at Pb is below flasc pressure.
Always or almost always... Bubbler line pressure at Pb is boosted by shutting bubbler isolation valve IV-3.
Always or almost always... Problem is repeatable, most likely not changing with time
Always or almost always... Problem unaffected by length of time since prior run.
Sometimes... Condenser-to-flasc pressure differential is lower than expected.
Sometimes... Liquid backs up in condenser at full load
Sometimes... Bubbler line pressure at Pb is roughly equal to flasc pressure.

LIKELY ROOT CAUSES: **Bubbler "robbed" from condenser FV to economizer FV.**
Economizer bubbler line orifice missing or too large.

STICKING

CAUSE8.1 **Economizer float not buoyant or stuck closed or not opening while running (post-startup only)**

SYMPTOMS:
Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always... Problem is apparent during steady-state operation.
Always or almost always... Max capacity noticeably limited (by evaporator refrigerant level or by low evaporator refrigerant temperature override).
Always or almost always... In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).
Always or almost always... Compressor unloads at least somewhat when commanded.
Always or almost always... Flasc pressure is "normal".
Always or almost always... Economizer pressure is higher than expected.
Always or almost always... Condenser-to-flasc pressure differential is "normal".
Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is "normal". Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Always or almost always... Economizer-to-cooler pressure differential is higher than expected.
Always or almost always... Temperature difference between economizer and downstream piping is noticeable.
Always or almost always... No evidence of liquid backing up in condenser at full load.
Always or almost always... Economizer liquid carryover to compressor occurs at full load, resulting in lowered discharge superheat.
Always or almost always... Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)
Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).

Always or almost always... Condition is worse at higher loads.
Always or almost always... Problem unaffected by length of time since prior run.
Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.
Sometimes... Problem is sporadic, symptoms may be variable

LIKELY ROOT CAUSES: **Float not free to move against FV body.**
FV body surface finish poor at top OD.
Float surface finish poor at top ID.
Momentum from bubbler 90o to support pin axis tilts float against body
Lowered static pressure beneath FV sleeve edge pulls down float at high flow conditions

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JAMMED

CAUSE8.2 **Economizer float not buoyant or stuck closed or not opening while running (post-startup only)**

SYMPTOMS:
Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always... Problem is apparent during steady-state operation.
Always or almost always... Max capacity noticeably limited (by evaporator refrigerant level or by low evaporator refrigerant temperature override).
Always or almost always... In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).
Always or almost always... Compressor unloads at least somewhat when commanded.
Always or almost always... Flasc pressure is "normal".
Always or almost always... Economizer pressure is higher than expected.
Always or almost always... Condenser-to-flasc pressure differential is "normal".
Always or almost always... No evidence of liquid backing up in condenser at full load.
Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is "normal". Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Always or almost always... Temperature difference between economizer and downstream piping is noticeable.
Always or almost always... Economizer-to-cooler pressure differential is higher than expected.
Always or almost always... Economizer liquid carryover to compressor occurs at full load, resulting in lowered discharge superheat.
Always or almost always... Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)
Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
Always or almost always... Condition is worse at higher loads.
Always or almost always... Problem is repeatable, most likely not changing with time
Always or almost always... Problem unaffected by length of time since prior run.
Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.

LIKELY ROOT CAUSES: **Float not free to move against FV body.**
Debris jammed between sleeve and FV body.

STICKING

CAUSE9.1 **Economizer FV float not buoyant or stuck closed or not opening in startup.**

SYMPTOMS:
Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always... Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
Always or almost always... Economizer pressure is higher than expected.
Always or almost always... Condenser-to-flasc pressure differential is more than 2 psi during startup.
Always or almost always... Economizer-to-cooler pressure differential is higher than expected.
Always or almost always... Temperature difference between economizer and downstream piping is noticeable.
Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
Always or almost always... Problem unaffected by length of time since prior run.

Sometimes... Economizer liquid carryover to compressor occurs, resulting in liquid carryover to compressor and flooding of oil separator.

Sometimes... Problem is sporadic, symptoms may be variable

LIKELY ROOT CAUSES: **Float not free to move against FV body.**
FV body surface finish poor at top OD.
Float surface finish poor at top ID.
Momentum from bubbler 90o to support pin axis tilts float against body

---

JAMMED

CAUSE9.2 **Economizer FV float not buoyant or stuck closed or not opening in startup.**

SYMPTOMS:
Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always... Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
Always or almost always... Economizer pressure is higher than expected.
Always or almost always... Condenser-to-flasc pressure differential is more than 2 psi during startup.
Always or almost always... Economizer-to-cooler pressure differential is higher than expected.
Always or almost always... Temperature difference between economizer and downstream piping is noticeable.
Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
Always or almost always... Problem is repeatable, most likely not changing with time
Always or almost always... Problem unaffected by length of time since prior run.
Sometimes... Economizer liquid carryover to compressor occurs, resulting in liquid carryover to compressor and flooding of oil separator.

LIKELY ROOT CAUSES: **FV assembly can't provide adequate flow area.**
Wrong FV parts or FV misassembled.
Float not free to move against FV body.
Debris jammed between sleeve and FV body.

VAPOR FEED BLOCKED @ ECON.

CAUSE9.3 **Economizer FV float not buoyant or stuck closed or not opening in startup.**

SYMPTOMS:
Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always... Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
Always or almost always... Economizer pressure is higher than expected.
Always or almost always... Condenser-to-flasc pressure differential is more than 2 psi during startup.
Always or almost always... Economizer-to-cooler pressure differential is higher than expected.
Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
Always or almost always... Bubbler line pressure at Pb does not drop immediately to expected economizer pressure when isolation valve is shut.

Always or almost always... Problem is repeatable, most likely not changing with time
Always or almost always... Problem unaffected by length of time since prior run.
Sometimes... Economizer liquid carryover to compressor occurs, resulting in liquid carryover to compressor and flooding of oil separator.

LIKELY ROOT CAUSES: **Economizer bubbler path blocked.**
Tip orifice closed (inside economizer).
Bubbler line to economizer FV blocked/plugged/not drilled.
Bubbler tube crimped somewhere.

VAPOR FEED ISOLN VALVE SHUT

CAUSE9.4 **Economizer FV float not buoyant or stuck closed or not opening in startup.**

SYMPTOMS:

Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always... Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
Always or almost always... Economizer pressure is higher than expected.
Always or almost always... Condenser-to-flasc pressure differential is more than 2 psi during startup.
Always or almost always... Economizer-to-cooler pressure differential is higher than expected.
Always or almost always... Bubbler line pressure at Pb equals economizer pressure.
Always or almost always... Problem is repeatable, most likely not changing with time
Always or almost always... Problem unaffected by length of time since prior run.
Sometimes... Economizer liquid carryover to compressor occurs, resulting in liquid carryover to compressor and flooding of oil separator.

LIKELY ROOT CAUSES: **Economizer bubbler path blocked.**
Vapor line isolation valve is shut.

STICKING OPEN

CAUSE10.1 **Condenser FV sticking open.**

SYMPTOMS:

Always or almost always... Cooler LTD (leaving temperature difference) is normal, low evaporator refrigerant temperature override alert or alarm state does not occur.
Always or almost always... Problem is apparent during steady-state operation.
Always or almost always... In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).

Always or almost always... Compressor unloads at least somewhat when commanded.
Always or almost always... Flasc pressure as measured at Pf2 is lower than expected.
Always or almost always... Condenser-to-flasc pressure differential is higher than expected.
Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is lower than expected. Temperature difference between flasc and piping downstream of condenser FV is slight, if any.
Always or almost always... Charging valve-to-economizer pressure differential is higher than expected.
Always or almost always... No evidence of liquid backing up in condenser at full load.
Always or almost always... Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)

Always or almost always... Condition is worse at higher loads.
Always or almost always... Problem unaffected by length of time since prior run.
Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.
Sometimes... Maximum capacity appears limited (by vapor bypass).
Sometimes... Problem is sporadic, symptoms may be variable

LIKELY ROOT CAUSES: **Float not free to move against FV body.**
FV body surface finish poor at top OD.
Float surface finish poor at top ID.
Momentum from bubbler 90o to support pin axis tilts float against body

---

JAMMED OPEN

CAUSE10.2 **Condenser FV sticking open.**

SYMPTOMS:

Always or almost always... Cooler LTD (leaving temperature difference) is normal, low evaporator refrigerant temperature override alert or alarm state does not occur.
Always or almost always... Problem is apparent during steady-state operation.
Always or almost always... In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).

Always or almost always... Compressor unloads at least somewhat when commanded.
Always or almost always... Flasc pressure as measured at Pf2 is lower than expected.
Always or almost always... Condenser-to-flasc pressure differential is higher than expected.

Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is lower than expected. Temperature difference between flasc and piping downstream of condenser FV is slight, if any.
Always or almost always... Charging valve-to-economizer pressure differential is higher than expected.
Always or almost always... No evidence of liquid backing up in condenser at full load.
Always or almost always... Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)

Always or almost always... Condition is worse at higher loads.
Always or almost always... Problem is repeatable, most likely not changing with time
Always or almost always... Problem unaffected by length of time since prior run.
Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.
Sometimes... Maximum capacity appears limited (by vapor bypass).

LIKELY ROOT CAUSES: **Float not free to move against FV body.**
Debris jammed between sleeve and FV body.

STICKING OPEN

CAUSE11.1 **Economizer FV sticking open.**

SYMPTOMS:
Always or almost always... Cooler LTD (leaving temperature difference) is normal, low evaporator refrigerant temperature override alert or alarm state does not occur.
Always or almost always... Problem is apparent during steady-state operation.
Always or almost always... Maximum capacity appears limited (by vapor bypass).
Always or almost always... In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).

Always or almost always... In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).

Always or almost always... Compressor unloads at least somewhat when commanded.
Always or almost always... Flasc pressure is "normal".
Always or almost always... Economizer pressure is lower than expected.
Always or almost always... Condenser-to-flasc pressure differential is "normal".
Always or almost always... Economizer-to-cooler pressure differential is lower than expected. Temperature difference between economizer and piping downstream is slight, if any.
Always or almost always... No evidence of liquid backing up in condenser at full load.
Always or almost always... Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)

Always or almost always... Condition is worse at higher loads.
Always or almost always... Problem unaffected by length of time since prior run.
Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.
Sometimes... Flasc-to-charging valve (incl. condenser FV) pressure differential is higher than expected. Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Sometimes... Problem is sporadic, symptoms may be variable

LIKELY ROOT CAUSES: **Momentum from bubbler 90o to support pin axis tilts float against body**
Economizer bubbler line orifice missing or too large AND orientation roll pin missing.
Float not free to move against FV body.
FV body surface finish poor at top OD.
Float surface finish poor at top ID.
Momentum from bubbler 90o to support pin axis tilts float against body

---

JAMMED OPEN

CAUSE11.2 **Economizer FV sticking open.**

SYMPTOMS:
Always or almost always... Cooler LTD (leaving temperature difference) is normal, low evaporator refrigerant temperature override alert or alarm state does not occur.
Always or almost always... Problem is apparent during steady-state operation.

Always or almost always... Maximum capacity appears limited (by vapor bypass).
Always or almost always... In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).

Always or almost always... Compressor unloads at least somewhat when commanded.
Always or almost always... Flasc pressure is "normal".
Always or almost always... Economizer pressure is lower than expected.
Always or almost always... Condenser-to-flasc pressure differential is "normal".
Always or almost always... Economizer-to-cooler pressure differential is lower than expected. Temperature difference between economizer and piping downstream is slight, if any.
Always or almost always... No evidence of liquid backing up in condenser at full load.
Always or almost always... Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)

Always or almost always... Condition is worse at higher loads.
Always or almost always... Problem is repeatable; most likely not changing with time
Always or almost always... Problem unaffected by length of time since prior run.
Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.
Sometimes... Flasc-to-charging valve (incl. condenser FV) pressure differential is higher than expected. Temperature difference between flasc and piping downstream of condenser FV is noticeable.

LIKELY ROOT CAUSES: **Float not free to move against FV body.**
Debris jammed between sleeve and FV body.
Momentum from bubbler 90o to support pin axis tilts float against body
Economizer bubbler line orifice missing or too large AND orientation roll pin missing.

LOW CHARGE

CAUSE12 **Insufficient charge to keep evaporator full or poor evaporator heat exchanger performance.**

SYMPTOMS:
Always or almost always... Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always... Problem is apparent during steady-state operation.
Always or almost always... Max capacity noticeably limited (by evaporator refrigerant level or by low evaporator refrigerant temperature override).

Always or almost always... In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).

Always or almost always... Compressor unloads at least somewhat when commanded.
Always or almost always... Flasc pressure is "normal".
Always or almost always... Economizer pressure is "normal".
Always or almost always... Condenser-to-flasc pressure differential is "normal".
Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is "normal". Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Always or almost always... Charging valve-to-economizer pressure differential is "normal". Temperature difference between these two points is noticeable.
Always or almost always... Economizer-to-cooler pressure differential is higher than expected.
Always or almost always... No evidence of liquid backing up in condenser at full load.
Always or almost always... No evidence of economizer liquid carryover at full load, such as lowered discharge superheat.
Always or almost always... Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)

Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
Always or almost always... Condition is worse at higher loads.
Always or almost always... Problem is repeatable, most likely not changing with time
Always or almost always... Problem unaffected by length of time since prior run.
Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.

LIKELY ROOT CAUSES: **Machine refrigerant charge low.**

(Frame 4 23XL only) Failure to add 2 gal. oil to cooler when machine was charged.
Evaporator heat exchanger performance is poor.
Cooler waterbox division plate(s) leak(s).
Evaporator tubes' water side is fouled.
Cooler fluid (e.g., brine) transfer properties are poorer than expected.
Evaporator tubes are different from design.

CAUSE13 **Capacity control unload command not working consistently.**

SYMPTOMS:

Always or almost always...	Chilled water is pulled below setpoint AND cooler refrigerant temperature is abnormally low. Low evaporator refrigerant temperature override alert or alarm state may occur.
Always or almost always...	Problem is apparent during steady-state operation.
Always or almost always...	Leaving chilled water is pulled down below setpoint by capacity control.
Always or almost always...	Compressor unloads at least somewhat when commanded.
Always or almost always...	Flasc pressure is "normal".
Always or almost always...	Economizer pressure is "normal".
Always or almost always...	Condenser-to-flasc pressure differential is "normal".
Always or almost always...	Flasc-to-charging valve (incl. condenser FV) pressure differential is "normal". Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Always or almost always...	Charging valve-to-economizer pressure differential is "normal". Temperature difference between these two points is noticeable.
Always or almost always...	Economizer-to-cooler pressure differential is "normal". Temperature difference between these two points is noticeable.
Always or almost always...	No evidence of liquid backing up in condenser at full load.
Always or almost always...	In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.

LIKELY ROOT CAUSES: **Slide valve won't stop loading.**
Slide valve piston seal leaks
Valve solenoids swapped
Slide valve won't unload.
Oil pressure to unload valve port is low or flow is limited.
Unload oil line is restricted or crimped, or unload valve port restricted.

CAUSE14 **Compressor can't unload.**

SYMPTOMS:

Always or almost always...	Chilled water is pulled below setpoint AND cooler refrigerant temperature is abnormally low. Low evaporator refrigerant temperature override alert or alarm state may occur.
Always or almost always...	Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
Always or almost always...	Problem is apparent during steady-state operation.
Always or almost always...	Leaving chilled water is pulled down below setpoint by capacity control.
Always or almost always...	Compressor won't unload (by manual command or in test).
Always or almost always...	Flasc pressure is "normal".
Always or almost always...	Economizer pressure is "normal".
Always or almost always...	Condenser-to-flasc pressure differential is "normal".
Always or almost always...	Flasc-to-charging valve (incl. condenser FV) pressure differential is "normal". Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Always or almost always...	Charging valve-to-economizer pressure differential is "normal". Temperature difference between these two points is noticeable.
Always or almost always...	Economizer-to-cooler pressure differential is "normal". Temperature difference between these two points is noticeable.
Always or almost always...	No evidence of liquid backing up in condenser at full load.
Always or almost always...	In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.

LIKELY ROOT CAUSES: **Slide valve won't stop loading.**

Machine wiring faulty
Power panel or control panel miswired
Six-pack relay faulty
PSIO module channel output faulty
Valve solenoids swapped
Valve solenoids swapped
Slide valve won't unload.
Oil pressure to unload valve port is low or flow is limited.
Unload oil line is restricted or crimped, or unload valve port restricted.
Slide valve unload valve passage doesn't open
Machine wiring faulty
Component or wiring failure
Solenoid coil faulty
Valve solenoids swapped
Power panel or control panel miswired
Six-pack relay faulty
PSIO module channel output faulty
Slide valve mechanically failed.
Slide valve shaft broken.
Slide valve assembly retaining nut(s) came off.

CAUSE15 **Controls command chiller to load when it apparently shouldn't.**

SYMPTOMS:

Always or almost always...	Chilled water is pulled below setpoint AND cooler refrigerant temperature is abnormally low. Low evaporator refrigerant temperature override alert or alarm state may occur.
Always or almost always...	Problem is apparent during steady-state operation.
Always or almost always...	Leaving chilled water is pulled down below setpoint by capacity control.
Always or almost always...	Compressor unloads at least somewhat when commanded.
Always or almost always...	Flasc pressure is "normal".
Always or almost always...	Economizer pressure is "normal".
Always or almost always...	Condenser-to-flasc pressure differential is "normal".
Always or almost always...	Flasc-to-charging valve (incl. condenser FV) pressure differential is "normal". Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Always or almost always...	Charging valve-to-economizer pressure differential is "normal". Temperature difference between these two points is noticeable.
Always or almost always...	Economizer-to-cooler pressure differential is "normal". Temperature difference between these two points is noticeable.
Always or almost always...	No evidence of liquid backing up in condenser at full load.
Always or almost always...	In MAINT02 screen, error and reset values don't equal Total Error, indicating oil loss reset is active.

LIKELY ROOT CAUSES: **Oil Loss Reset algorithm is operational.**
Temperature sensor in error.
Rotor inlet temperature sensor reading too high.

CAUSE16 **Poor evaporator heat exchanger performance.**

SYMPTOMS:

Always or almost always...	Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
Always or almost always...	Problem is apparent during steady-state operation.
Always or almost always...	Max capacity noticeably limited (by evaporator refrigerant level or by low evaporator refrigerant temperature override).
Always or almost always...	In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).
Always or almost always...	Compressor unloads at least somewhat when commanded.

Always or almost always... Flasc pressure is "normal".
Always or almost always... Economizer pressure is "normal".
Always or almost always... Condenser-to-flasc pressure differential is "normal".
Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is "normal". Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Always or almost always... Charging valve-to-economizer pressure differential is "normal". Temperature difference between these two points is noticeable.
Always or almost always... Economizer-to-cooler pressure differential is higher than expected.
Always or almost always... No evidence of liquid backing up in condenser at full load.
Always or almost always... No evidence of economizer liquid carryover at full load, such as lowered discharge superheat.
Always or almost always... Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)

Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
Always or almost always... Condition not affected by shutting bubbler isolation valve IV-3 during startup.
Always or almost always... Condition is worse at higher loads.
Always or almost always... Problem is repeatable, most likely not changing with time
Always or almost always... Problem is repeatable, most likely becoming worse with time
Always or almost always... Problem unaffected by length of time since prior run.
Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.

LIKELY ROOT CAUSES: **Evaporator heat exchanger performance is poor.**
Evaporator tubes' water side is fouled.
Cooler fluid (e.g., brine) transfer properties are poorer than expected.
Cooler waterbox division plate(s) leak(s).
Evaporator tubes are different from design.

DIAGNOSTIC GUIDE - 23XL ECONOMIZED CHILLERS

Instructions:

version of October 29, 1999

Follow the key below, starting at 1. Go to the number following "Go To...", or when this process leads you to an "CAUSE" number, select the "CAUSE" cell and key "Ctrl+h". (Key "Ctrl+PageUp" to return to your spot on this sheet.)

1	1a	S01.1	Always or almost always...	Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature override alert or alarm state may occur. Cooler LTD is high.
			Go To... 2	
	1b	S01.2	Always or almost always...	Chilled water is pulled below setpoint AND cooler refrigerant temperature is abnormally low. Low evaporator refrigerant temperature override alert or alarm state may occur.
			Go To... 30	
	1c	S01.3	Always or almost always...	Cooler LTD (leaving temperature difference) is normal, low evaporator refrigerant temperature override alert or alarm state does not occur.
		S03.3	And...	Maximum capacity appears limited (by vapor bypass).
			Go To... 40	
2	2a	S30.2	Always or almost always...	Condition improved by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)
		S20.2	And...	Liquid backs up in condenser at full load
		S13.1	And...	Condenser-to-flasc pressure differential is "normal".
		S13.3	Or...	Condenser-to-flasc pressure differential is higher than expected.
			Then CAUSE1	**Flasc orifices too restrictive**
	2b	S51.1		Not as above.
			Go To... 3	
3	3a	S31.6	Always or almost always...	Bubbler line pressure at Pb does not drop immediately to expected economizer pressure when isolation valve is shut.
			Then CAUSE9.3	**Economizer FV float not buoyant or stuck closed or not opening in startup.**
	3b	S51.1		Not as above.
			Go To... 4	
4	4a	S31.4	Always or almost always...	Bubbler line pressure at Pb is more than 10 psi above flasc pressure, or just below condenser pressure.
			Then CAUSE7.3	**Condenser FV float not buoyant or stuck closed or not opening in startup.**
	4b	S31.3	Always or almost always...	Bubbler line pressure at Pb is below flasc pressure.

S32.2 And... Bubbler line pressure at Pb is boosted by shutting bubbler isolation valve IV-3.
Then **CAUSE7.6** **Condenser FV float not buoyant or stuck closed or not opening in startup.**

4c S31.5 Always or almost always... Bubbler line pressure at Pb equals economizer pressure.
Then **CAUSE9.4** **Economizer FV float not buoyant or stuck closed or not opening in startup.**

4d S31.1 Always or almost always... Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
Go To... 5

4e S31.2 Always or almost always... Bubbler line pressure at Pb is roughly equal to flasc pressure.
S02.1 And... Quick pulldown of evaporator refrigerant temperature occurs during ramping (possibly including low refrigerant temperature shutdown).
Go To... 6

6 6a S13.5 Always or almost always... Condenser-to-flasc pressure differential is less than 2 psi during startup.
Then **CAUSE7.4** **Condenser FV float not buoyant or stuck closed or not opening in startup.**

6b S13.4 Condenser-to-flasc pressure differential is more than 2 psi during startup.
Then **CAUSE7.5** **Condenser FV float not buoyant or stuck closed or not opening in startup.**

5 5a S15.31 Always or almost always... Temperature difference across isolation valve is noticeable.
Then **CAUSE5** **Liquid isolation valve throttled**

5b S51.1 Not as above.
Go To... 7

7 7a S20.2 And, if not in startup... Liquid backs up in condenser at full load
S20.21 Or... Liquid fails to drain from condenser during startup.
Go To... 8

7b S51.1 Not as above.
Go To... 9

8 8a S14.3 Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is higher than expected. Temperature difference between flasc and piping downstream of condenser FV is noticeable.
Go To... 10

8b S51.1 Not as above.
Then **CAUSE3** **Economizer spray holes restrictive**

10 10a S18.2 Always or almost always... Temperature difference between condenser drain sump and motor cooling line tap is not noticeable.
S11.3 And... Flasc pressure as measured at Pf2 is higher than expected and equal to true flasc pressure.
Go To... 13

	10b	S51.1 S18.1	Not as above. Temperature difference between condenser drain sump and motor cooling line tap is noticeable. *Go To...* 14
13	13a	S41.1	Always or almost always... Problem is repeatable, most likely not changing with time *Then* CAUSE6.2 **Condenser float not buoyant or stuck closed or not opening while running (post-startup only)** *Or...* CAUSE7.2 **Condenser FV float not buoyant or stuck closed or not opening in startup.**
	13b	S41.3	Sometimes... Problem is sporadic, symptoms may be variable *Then* CAUSE6.1 **Condenser float not buoyant or stuck closed or not opening while running (post-startup only)** *Or...* CAUSE7.1 **Condenser FV float not buoyant or stuck closed or not opening in startup.**
14	14a	S41.1	Always or almost always... Problem is repeatable, most likely not changing with time *Then* CAUSE2.2 **Cond FV screen is restrictive**
	14b	S41.2	Sometimes... Problem is repeatable, most likely becoming worse with time *Then* CAUSE2.1 **Cond FV screen is restrictive**
9	9a	S21.3	Always or almost always... Economizer liquid carryover to compressor occurs, resulting in liquid carryover to compressor and flooding of oil separator. *Go To...* 11
	9b	S21.1 S02.2	Always or almost always... No evidence of economizer liquid carryover at full load, such as lowered discharge superheat. And... Problem is apparent during steady-state operation. *Then* CAUSE12 **Insufficient charge to keep evaporator full or poor evaporator heat exchanger performance.**
11	11a	S17.2	Always or almost always... Pressure differential between economizer and downstream piping is lower than expected. Temperature difference between economizer and downstream piping is slight, if any. *Then* CAUSE4 **Cooler distribution holes restrictive**
	11b	S17.1	Always or almost always... Temperature difference between economizer and downstream piping is noticeable. *Go To...* 12
12	12a	S41.1	Always or almost always... Problem is repeatable, most likely not changing with time *Then* CAUSE8.2 **Economizer float not buoyant or stuck closed or not opening while running (post-startup only)** *Or...* CAUSE9.2 **Economizer FV float not buoyant or stuck closed or not opening in startup.**
	12b	S41.3	Sometimes... Problem is sporadic, symptoms may be variable *Then* CAUSE8.1 **Economizer float not buoyant or stuck closed or not opening while running (post-startup only)** *Or...* CAUSE9.1 **Economizer FV float not buoyant or stuck closed or not opening in startup.**
30	30a	S05.1	Always or almost always... Compressor unloads at least somewhat when commanded.

Go To... 31

30b S05.2 Always or almost always... Compressor won't unload (by manual command or in test).
Then **CAUSE14 Compressor can't unload.**

31 31a S50.1 Always or almost always... In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.
Then **CAUSE13 Capacity control unload command not working consistently.**

31b S50.2 Always or almost always... In MAINT02 screen, error and reset values don't equal Total Error, indicating oil loss reset is active.
Then **CAUSE15 Controls command chiller to load when it apparently shouldn't.**

40 40a S12.2 Always or almost always... Economizer pressure is lower than expected.
S16.2 Always or almost always... Economizer-to-cooler pressure differential is lower than expected. Temperature difference between economizer and piping downstream is slight, if any.
Go To... 41

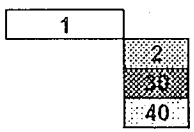
40b S11.2 Always or almost always... Flasc pressure as measured at Pf2 is lower than expected.
S14.2 Always or almost always... Flasc-to-charging valve (incl. condenser FV) pressure differential is lower than expected. Temperature difference between flasc and piping downstream of condenser FV is slight, if any.
S15.3 Always or almost always... Charging valve-to-economizer pressure differential is higher than expected.
Go To... 42

41 41a S41.1 Always or almost always... Problem is repeatable, most likely not changing with time
Then **CAUSE11.2 Economizer FV sticking open.**

41b S41.3 Sometimes... Problem is sporadic, symptoms may be variable
Then **CAUSE11.1 Economizer FV sticking open.**

42 42a S41.1 Always or almost always... Problem is repeatable, most likely not changing with time
Then **CAUSE10.2 Condenser FV sticking open.**

42b S41.3 Sometimes... Problem is sporadic, symptoms may be variable
Then **CAUSE10.1 Condenser FV sticking open.**



SYMPTOM LIST

S01.1	Chilled water is controlled to setpoint, but evap.refrigerant temperature is low. Low evaporator refrigerant temperature overr
S01.2	Chilled water is pulled below setpoint AND cooler refrigerant temperature is abnormally low. Low evaporator refrigerant tem
S01.3	Cooler LTD (leaving temperature difference) is normal, low evaporator refrigerant temperature override alert or alarm state
S02.1	Quick pulldown of evaporator refrigerant temperature occurs *during ramping* (possibly including low refrigerant temperature
S02.2	Problem is apparent during steady-state operation.
S03.1	Max capacity noticeably limited (by evaporator refrigerant level or by low evaporator refrigerant temperature override).
S03.2	Max capacity ***not*** noticeably limited.
S03.3	Maximum capacity appears limited (by vapor bypass).
S04.1	In steady-state operation, leaving chilled water is being properly controlled (although setpoint may not be achievable).
S04.2	Leaving chilled water is pulled down below setpoint by capacity control.
S05.1	Compressor unloads at least somewhat when commanded.
S05.2	Compressor won't unload (by manual command or in test).
S11.1	Flasc pressure is "normal".
S11.2	Flasc pressure as measured at Pf2 is lower than expected.
S11.3	Flasc pressure as measured at Pf2 is higher than expected and equal to true flasc pressure.
S11.4	True flasc pressure is high.
S11.5	True flasc pressure is low.
S12.1	Economizer pressure is "normal".
S12.2	Economizer pressure is lower than expected.
S12.3	Economizer pressure is higher than expected.
S13.1	Condenser-to-flasc pressure differential is "normal".
S13.2	Condenser-to-flasc pressure differential is lower than expected.
S13.3	Condenser-to-flasc pressure differential is higher than expected.
S13.4	Condenser-to-flasc pressure differential is more than 2 psi during startup.
S13.5	Condenser-to-flasc pressure differential is less than 2 psi during startup.
S13.6	Flasc pressure is close to condenser pressure at steady-state.
S14.1	Flasc-to-charging valve (incl. condenser FV) pressure differential is "normal". Temperature difference between flasc and pi
S14.2	Flasc-to-charging valve (incl. condenser FV) pressure differential is lower than expected. Temperature difference between f
S14.3	Flasc-to-charging valve (incl. condenser FV) pressure differential is higher than expected. Temperature difference between
S15.1	Charging valve-to-economizer pressure differential is "normal". Temperature difference between these two points is noticea
S15.2	Charging valve-to-economizer pressure differential is lower than expected. Temperature difference between these two poin.
S15.3	Charging valve-to-economizer pressure differential is higher than expected.
S15.31	Temperature difference across isolation valve is noticeable.
S16.1	Economizer-to-cooler pressure differential is "normal". Temperature difference between these two points is noticeable.

S16.2	Economizer-to-cooler pressure differential is lower than expected. Temperature difference between economizer and piping
S16.3	Economizer-to-cooler pressure differential is higher than expected.
S17.1	Temperature difference between economizer and downstream piping is noticeable.
S17.2	Pressure differential between economizer and downstream piping is lower than expected. Temperature difference between
S18.1	Temperature difference between condenser drain sump and motor cooling line tap is noticeable.
S18.2	Temperature difference between condenser drain sump and motor cooling line tap is not noticeable.
S20.1	No evidence of liquid backing up in condenser at full load.
S20.2	Liquid backs up in condenser at full load
S20.21	Liquid fails to drain from condenser during startup.
S21.1	No evidence of economizer liquid carryover at full load, such as lowered discharge superheat.
S21.2	Economizer liquid carryover to compressor occurs at full load, resulting in lowered discharge superheat.
S21.3	Economizer liquid carryover to compressor occurs, resulting in liquid carryover to compressor and flooding of oil separator.
S30.1	Condition unaffected by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)
S30.2	Condition improved by reducing condenser water flow rate (increasing condenser water delta T and, thus, flasc delta P)
S31.1	Bubbler line pressure at Pb is above flasc pressure (by less than 10 psi).
S31.2	Bubbler line pressure at Pb is roughly equal to flasc pressure.
S31.3	Bubbler line pressure at Pb is below flasc pressure.
S31.4	Bubbler line pressure at Pb is more than 10 psi above flasc pressure, or just below condenser pressure.
S31.5	Bubbler line pressure at Pb equals economizer pressure.
S31.6	Bubbler line pressure at Pb does not drop immediately to expected economizer pressure when isolation valve is shut.
S32.1	Condition not affected by shutting bubbler isolation valve IV-3 during startup.
S32.2	Bubbler line pressure at Pb is boosted by shutting bubbler isolation valve IV-3.
S40.1	Condition is worse at higher loads.
S40.2	Condition appears to be the same for low or high loads.
S41.1	Problem is repeatable, most likely not changing with time
S41.2	Problem is repeatable, most likely becoming worse with time
S41.3	Problem is sporadic, symptoms may be variable
S42.1	Problem unaffected by length of time since prior run.
S42.2	Problem doesn't occur if short time has passed since prior run.
S50.1	In MAINT02 screen, Total Error = Control Pt. Error +ECW Delta T +ECW Reset +LCW Reset.
S50.2	In MAINT02 screen, error and reset values don't equal Total Error, indicating oil loss reset is active.
S51.1	Not as above.
S51.2	Not as above or can't tell.

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conomizer and downstream piping is slight, if any.

RC1.1	Flasc orifices too small (as specified by E-CAT, or parts or assembly faulty)
RC1.2	Flasc orifices blocked by loose object or material broken from other part of system
RC1.3	Flasc orifices blocked by foreign object(s).
RC1.4	Chiller was operating with condenser water flow much higher than that specified in design conditions.
RC12.1	Flasc orifices too large (as specified by E-CAT, or parts or assembly faulty)
RC2.1	Screen fabrication or material is faulty.
RC2.2	Screen plugged by metallic particles
RC2.2.1	Excessive wear of condenser tubes generates filings which get carried with refrigerant through flasc to the screen.
RC2.2.2	Excessive wear in compressor generates filings which get carried through condenser and flasc to the screen.
RC2.3	Screen plugged by dirt from factory or prior servicing
RC2.4	Screen plugged by fibers
RC2.4.1	Oil separator felt gasket disintegrated (small 23XL).
RC2.4.2	Oil filter element has disintegrated
RC3.1	Econ.spray bar hole machining or weld assembly is faulty.
RC3.2	Econ spray bar holes blocked by foreign object(s) in flow path downstream of condenser FV.
RC4.1	Cooler distribution pipe flow area too small (machining or weld assembly faulty).
RC4.2	Holes blocked by foreign object(s) in flow path downstream of economizer.
RC5.1	Isolation valve not open fully.
RC5.2	Isolation valve handle misaligned or broken.
RC6.1	Top hat missing, liquid draining from flasc impinges on top of float
RC6.2	Lowered static pressure beneath FV sleeve edge pulls down float at high flow conditions
RC6.3	Float jammed against FV body by friction (intermittent)
RC6.3.1	Tip orifice closed (inside economizer).
RC6.3.2	Vapor line isolation valve is shut.
RC6.3.3	Bubbler line to condenser FV blocked/plugged/not drilled.
RC6.3.4	Bubbler line to economizer FV blocked/plugged/not drilled.
RC6.4	Condensing pressure goes too far below evaporator pressure (expect oil pressure fault normally)
RC6.4.1	Condensing water temperature drops substantially, chilled water temperature high.
RC6.5	Not enough differential across flasc orifices.
RC6.5.1	Condensing water flow rate too high.
RC7.1	Bubbler not working: insufficient pressure differential to displace liquid for bubbler.
RC7.1.1	Restriction exists somewhere downstream in main refrigerant flow path
RC7.1.2	Flasc orifices not restrictive enough.
RC7.1.3	Initial condensing pressure too far below initial evaporator pressure.
RC7.1.4	Condenser water flow rate excessive (low temperature & pressure differential across flasc).
RC7.1.5	Excessive leakage around flasc tubes at support sheet(s).
RC7.1.6	
RC7.2	Bubbler not working: bubbler flow path restricted upstream of common junction.
RC7.2.1	Bubbler tube blocked at condenser.
RC7.2.2	Bubbler tube blocked at outlet.
RC7.2.3	Bubbler tube crimped somewhere.
RC7.2.4	Tip orifice closed (inside economizer).
RC7.2.5	Vapor line isolation valve is shut.
RC7.2.6	Bubbler line to condenser FV blocked/plugged/not drilled.
RC7.2.7	Bubbler line to economizer FV blocked/plugged/not drilled.

RC7.2.8 Economizer bubbler line orifice missing or too large AND orientation roll pin missing.
RC7.2.9 Economizer bubbler line orifice missing or too large.
RC7.2.10 Vapor line isolation valve is throttled.
RC7.3 Float not free to move against FV body.
RC7.3.1 FV body surface finish poor at top OD.
RC7.3.2 Float surface finish poor at top ID.
RC7.3.3 Momentum from bubbler 90° to support pin axis tilts float against body
RC7.3.4 Debris jammed between sleeve and FV body.
RC7.4 Bubbler "robbed" from condenser FV to economizer FV.
RC7.5 FV assembly can't provide adequate flow area.
RC7.5.1 Wrong FV parts or FV misassembled.
RC7.6 Economizer bubbler path blocked.
RC7.7 Vapor pocket reabsorbed, not refilled quickly enough.
RC7.8 Bubbler not working: bubbler flow path restricted in line to condenser float sump.
RC8.1 Liquid spraying from spray bar hits top of float
RC8.2 Lowered static pressure beneath FV sleeve edge pulls down float at high flow conditions
RC8.3 Float jammed against FV body by friction (intermittent)
RC9.1 Machine refrigerant charge low.
RC9.1.1 (Frame 4 23XL only) Failure to add 2 gal. oil to cooler when machine was charged.
RC10.1 Slide valve **won't stop loading.**
RC10.2 Slide valve **won't unload.**
RC10.2.1 Machine wiring faulty
RC10.2.2 Power panel or control panel miswired
RC10.2.3 Six-pack relay faulty
RC10.2.4 PSIO module channel output faulty
RC10.1.1 Valve solenoids swapped
RC10.2.5 Slide valve unload valve passage doesn't open
RC10.1.2 Valve solenoids swapped
RC10.1.3 Component or wiring failure
RC10.1.4 Solenoid coil faulty
RC10.1.5 Slide valve piston seal leaks
RC10.2.6 Oil pressure to unload valve port is low or flow is limited.
RC10.2.7 Unload oil line is restricted or crimped, or unload valve port restricted.
RC10.2.8 Slide valve mechanically failed.
RC10.2.9 Slide valve shaft broken.
RC10.2.10 Slide valve assembly retaining nut(s) came off.
RC11.1 Oil Loss Reset algorithm is operational.
RC11.1.1 Temperature sensor in error.
RC11.1.2 Rotor inlet temperature sensor reading too high.
RC16.1 Evaporator heat exchanger performance is poor.
RC16.1.1 Evaporator tubes' water side is fouled.
RC16.1.2 Cooler fluid (e.g., brine) transfer properties are poorer than expected.
RC16.1.3 Cooler waterbox division plate(s) leak(s).
RC16.1.4 Evaporator tubes are different from design.

screen blockage	CAUSE1	Flasc orifices too restrictive	
screen blockage	CAUSE2.1	Cond FV screen is restrictive	3
	CAUSE2.2	Cond FV screen is restrictive	28
	CAUSE3	Economizer spray holes restrictive	59
	CAUSE4	Cooler distribution holes restrictive	85
	CAUSE5	Liquid isolation valve throttled	110
sticky cond. FV, ss	CAUSE6.1	Condenser float not buoyant or stuck closed or not opening while running (post-startup only)	134
jammed cond. FV, ss	CAUSE6.2	Condenser float not buoyant or stuck closed or not opening while running (post-startup only)	160
sticky cond. FV, startup	CAUSE7.1	Condenser FV float not buoyant or stuck closed or not opening in startup.	188
jammed cond. FV, startup	CAUSE7.2	Condenser FV float not buoyant or stuck closed or not opening in startup.	212
bubbler blocked to cond. FV	CAUSE7.3	Condenser FV float not buoyant or stuck closed or not opening in startup.	230
insufficient flasc delta P	CAUSE7.4	Condenser FV float not buoyant or stuck closed or not opening in startup.	247
bubbler blocked at cond.	CAUSE7.5	Condenser FV float not buoyant or stuck closed or not opening in startup.	265
bubbler robbed by econ	CAUSE7.6	Condenser FV float not buoyant or stuck closed or not opening in startup.	284
sticky econ. FV, ss	CAUSE8.1	Economizer float not buoyant or stuck closed or not opening while running (post-startup onl	303
jammed econ. FV, ss	CAUSE8.2	Economizer float not buoyant or stuck closed or not opening while running (post-startup onl	321
sticky econ. FV, startup	CAUSE9.1	Economizer FV float not buoyant or stuck closed or not opening in startup.	348
jammed econ. FV, startup	CAUSE9.2	Economizer FV float not buoyant or stuck closed or not opening in startup.	372
econ. bubbler blocked	CAUSE9.3	Economizer FV float not buoyant or stuck closed or not opening in startup.	389
econ. bubbler valve shut	CAUSE9.4	Economizer FV float not buoyant or stuck closed or not opening in startup.	406
sticking open	CAUSE10.1	Condenser FV sticking *open*.	423
jammed open	CAUSE10.2	Condenser FV sticking *open*.	437
sticking open	CAUSE11.1	Economizer FV sticking open.	459
jammed open	CAUSE11.2	Economizer FV sticking open.	479
charge	CAUSE12	Insufficient charge to keep evaporator full or poor evaporator heat exchanger performance.	505
	CAUSE13	Capacity control unload command not working consistently.	528
	CAUSE14	Compressor can't unload.	556
	CAUSE15	Controls command chiller to load when it apparently shouldn't.	576
	CAUSE16	Poor evaporator heat exchanger performance.	612
			629