# Part A : Specification

## Contents



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# 1. Contract Details

**J & E Hall International Contract Number**: 910184

**Customer**: IMA Cooling Systems

**Customer's Job Number**: 1286

**For:** Thurlow Nunn Standen

**Location**: Marshall of Butterwick, The Mill, Butterwick, Boston, Linconshire

**Instruction Manual Issue Date**: 17th November 2010

# 2. Package Units

2 x HSO 4222 HallScrew Air Cooled Propylene Glycol Chiller Units.

# 3. Compressor and Oil Support System

## 3.1. Compressor

**Type**: Single Screw
**Model**: J & E Hall Limited HSO 4222 VR 3.0
**Serial Numbers**:

| | Operating Conditions | |
|---|---|---|
| | Condition 1 Ambient 25 °C | Condition 2 Ambient 30 °C |
| **Duty** | 405.6 kW | 391.4 kW |
| **Power Absorbed** | 123.2 kW | 138.6 kW |
| **Suction Gauge** | -8.9 °C | -8.7 °C |
| **Discharge Gauge** | 39.5 °C | 44.6 °C |

**Table 1(a) Compressor Operating Parameters**

## 3.2. Compressor Drive Motor

**Model**: Leroy Somer Frame Size PLS 315 S
**Serial Numbers**:

**Motor Power**: 160.0 kW
**Speed**: 2985 rpm
**Electrical Supply**: 400 Volts 50 Hz 3 Phase

## 3.3. Oil Separator/Reservoir

**Oil Level Indication**: 2 x Sight-glasses SG-020 and SG-021

**Oil Low Flow (Trip)**: Opto Sensor FS-024

**Oil Heater**: 250 W H-022
**Oil Heater Electrical Supply**: 240 Volts 50 Hz 1 Phase

**Oil Charge**: 35 litres Shell Clavus 68

**Relief Valve**: Caen Dual Relief Valve Comprising VTB 3-Way Valve V014 + 2 x VBS Single Relief Valves PSV-007A/B. Set to Open at 20.7 bar g, Relieves to Atmosphere

### 3.4. Oil Lubrication/Injection Lines

**Oil Filter**: Fairy Arlon H374X-0N00-TF323 STR-025

### 3.5. Secondary Oil Separator

**Model**: Domnick Hunter AO-0620F

**Strainer**: Robinet DN20 FADS STR-028
**Drainer**: Armstrong 11-LD LCV-030
**Sight-Glass**: Henry SG-1006 SG-029

### 3.6. Liquid Injection Line

**Discharge Temperature Controller**: Danfoss EKC 319A TC-036
**Electronic Expansion Valve**: Danfoss AKVA 15-1 TCV-034
**Temperature Sensor**: Danfoss AKS 21A TT-035

**Strainer**: Robinet DN20 FYDS STR-032
**Sight-glass**: Henry SG-1006 SG-033

### 3.7. Suction Line

**Non-Return Valve**: Saxon SR03-2-L-S-S-I-S V013

### 3.8. Discharge Line

**Non-Return Valve**: Robinet D040 CRDS V003

## 4. Condenser

**Type**: Air Cooled
**Model**: Coolers and Condensers 10-3R12-600-SST

**Fans:** 10 x 800 mm Diameter Fans (10 Fans Variable Speed Drive)

**Fan Speed Control:** Ziehl-Abegg Fcontrol FXDM Frequency Inverter

**Fan Motors**: Ziehl

**Motor Power**: 1.8 kW (Each)
**Speed**: 935 rpm (Maximum)
**Electrical Supply**: 400 Volts 50 Hz 3 Phase

| | Operating Conditions | |
|---|---|---|
| | Condition 1 Ambient 25 °C | Condition 2 Ambient 30 °C |
| **Duty** | 528.8 kW | 529.0 kW |
| **Condensing Temperature** | 38.0 °C | 43.1 °C |

**Table 2(a) Condenser Operating Parameters**

## 5. Evaporator

**Model**: APV LR4 MGS-16/3
**No Off Plates**: 179

| | | Operating Conditions | |
|---|---|---|---|
| | | Condition 1 Ambient 25 °C | Condition 2 Ambient 30 °C |
| **Duty** | | 405.6 kW | 391.4 kW |
| **Evaporating Temperature (Full Load)** | | -7.9 °C | -7.7 °C |
| **Liquid R717 Inlet Temperature** | | 36.2 °C | 41.1 °C |
| **Aqueous Propylene Glycol 30.0 % by Weight** | **Inlet Temperature** | 0.0 °C | |
| | **Outlet Temperature** | -5.1 °C | -4.9 °C |
| | **Flow Rate** | 71.3 $m^3$/hr | |

**Table 3(a) Evaporator Operating Parameters**

**Glycol Pressure Drop**: 24.0 kPa (Worse Case, at Condition 1)
**Fouling Factor**: 0.00018 $m^2$ K/W

**Flowswitch in Glycol Outlet Line**: Kelco F26S FS-015

**Priority Pot Sight-glasses**: Henry LI-50 SG-008 and SG-009

**Relief Valve**: Caen Dual Relief Valve Comprising VTB 3-Way Valve V015 + 2 x VBS Single Relief Valves PSV-037A/B. Set to Open at 16.0 bar g, Relieves to Atmosphere

### 5.1. Evaporator Glycol Specification

**Concentration**: Aqueous Propylene Glycol 30.0 % by Weight, 29.4 % by Volume
**Specific Gravity**: 1.029 at 16.0 °C
**Freezing Point**: -12.6 °C

### 5.2. Evaporator LP Regulator

**Electronic Evaporator Controller**: Danfoss EKC 315A TC-019
**Electronic Expansion Valve**: Danfoss ICV 20-25A + ICS 20B + ICAD 900 XV-013

**Temperature Sensor**: Danfoss AKS 21A TT-017
**Pressure Transmitter**: Danfoss AKS 33 PT-018

**Solenoid Valve**: Danfoss EVRAT 20 XV-011

**Strainer**: Robinet DN40 FYDS STR-010

### 5.3. Evaporator Oil Recovery

**Oil Reclaim Chamber Sight-glass**: Henry LI-50 SG-046

**Sight-glass Oil Return Line**: Henry SG-1006 SG-031

## 6. Refrigerant Charge

**Refrigerant**: R717 (Ammonia)
**First Charge**: 90.0 kg (approx)

## 7. Electrical Supplies

**Motors**: 400 Volts 50 Hz 3 Phase
**Heaters**: 230 Volts 50 Hz 1 Phase
**Control**: 115 V and 24 V dc Volts dc

## 8. Plant Control

The HSO 4222 HallScrew package unit is fitted with a MicroTech Controller, responsible for compressor starting, stopping and safety monitoring, and condenser fan operation (head pressure control).

Unit operation can be made subject to an external run request signal via MicroTech Controller Remote Switch ON/OFF.

The MicroTech Controller starts the compressor when glycol temperature, sensed at the evaporator outlet, exceeds the Set Point value. The evaporator glycol pump must be running before the compressor can start, flowswitch contacts closed to provide a permit start signal to the MicroTech Controller.

The MicroTech Controller supplies load/unload pulses, according to the PID algorithm, to maintain glycol temperature at the Set Point value.

This process continues until only the compressor is running at minimum pumping capacity (minimum slide valve position). The MicroTech Controller stops the compressor when the Remote Switch (if used) is OFF or when glycol temperature falls below the Set Point value.

# 9. Control Settings

| PARAMETER | | SETTING |
|---|---|---|
| PSHH-002 | High discharge pressure cut-out | High discharge pressure cut-out Danfoss KP 7ABS 060-120066 (manual reset).<br>External: contacts open at 18.6 bar g on discharge pressure rise.<br>Internal: contacts open at 18.1 bar g on discharge pressure rise. |
| TE-040 (TE-041) | High discharge temperature | Thermistors (auto reset). Trip at 100 °C on discharge temperature rise. |
| TC-023 | Oil heater thermostat | Oil heater thermostat Danfoss RT 101 0175-502266<br>Energise at 35.0 °C on oil temperature fall<br>De-energise at 45.0 °C on oil temperature rise |

**Table 4(a) Compressor Package Unit Control Settings**

| DANFOSS EKC 319A CONFIGURATION SETTINGS | | | | | |
|---|---|---|---|---|---|
| Software version 1.1x. Refer to controller instructions in Section 9. | | | | | |
| The following setting values are 'as commissioned' | | | | | |
| DESCRIPTION | PARAMETER | MINIMUM | MAXIMUM | DEFAULT | INPUT VALUE |
| **Reference** | | | | | |
| Set point (temperature reference) for controlling the electronic expansion valve in the liquid injection line | - | -70.0 ℃ | 160.0 ℃ | 125.0 ℃ | |
| Units: 0 = ℃ and bar, 1 = ℉ and psig | r05 | 0 | 1 | 0 | |
| Start/stop of regulation: 0 = off, 1 = on | r12 | 0 | 1 | 1 | |
| **Alarms** | | | | | |
| Alarm limit | A16 | -50.0 ℃ | 150.0 ℃ | 135.0 ℃ | |
| Alarm delay | A17 | 0 | 999 sec | 0 | |
| Alarm function | A19 | 0 | 1 | 1 | |
| **Regulating Parameters** | | | | | |
| P: Amplification factor $K_p$ | n04 | 0.5 | 30.0 | 15.0 | |
| I: Integration time $T_n$ | n05 | 60 sec | 600 sec | 120 sec | |
| Period time | n13 | 3 sec | 10 sec | 3 sec | |
| **Miscellaneous Parameters** | | | | | |
| Controller address | o03 | 0 | 119 | 0 | |
| On/off switch (service-pin message) | o04 | OFF | ON | - | |
| Supply frequency: 0 = 50 Hz, 1 = 60 Hz | o12 | 0 | 1 | 0 | |
| Selection of normal display contents | o17 | 0 | 1 | 0 | |
| Manual control of outputs | o18 | OFF | 2 | OFF | |

**Table 5(a) Danfoss EKC 319A Discharge Temperature Controller Settings Record**

| DANFOSS EKC 315A CONFIGURATION SETTINGS | | | | | |
|---|---|---|---|---|---|
| Software version 1.3x. Refer to controller instructions in Section 8 | | | | | |
| The following setting values are 'as pre-commissioned' | | | | | |
| **DESCRIPTION** | **PARAMETER** | **MINIMUM** | **MAXIMUM** | **DEFAULT** | **INPUT VALUE** |
| **Reference** | | | | | |
| Set point for thermostat function for controlling a liquid line solenoid valve | - | -60.0 ℃ | 50.0 ℃ | 10.0 ℃ | |
| Differential for thermostat function | r01 | 0.1 K | 20.0 K | 2.0 K | |
| Units: 0 = ℃ and bar, 1 = ℉ and psig | r05 | 0 | 1 | 0 | |
| Maximum displacement of thermostat setting or reference | r06 | -50.0 K | 50.0 K | 0 K | |
| Offset of temperature sensor S2 signal | r09 | -10.0 K | 10.0 K | 0 K | |
| Offset of temperature sensor S3 signal | r10 | -10.0 K | 10.0 K | 0 K | |
| Start/stop of refrigeration: 0 = off, 1 = on | r12 | 0 | 1 | 1 | |
| Thermostat function for controlling a liquid line solenoid valve: 0 = off, 1 = on | r14 | 0 | 1 | 0 | 0 |
| **Alarms** | | | | | |
| Alarm for high temperature (sensor S3) | A01 | 3.0 K | 20.0 K | 5.0 K | |
| Alarm for low temperature (sensor S3) | A02 | 1.0 K | 10.0 K | 3.0 K | |
| Alarm delay (min) | A03 | 0 | 90 | 30 | |
| **Regulating Parameters** | | | | | |
| P: Amplification factor $K_p$ | n04 | 0.5 | 20.0 | 3.0 | |
| I: Integration time $T_n$ | n05 | 30 sec | 600 sec | 120 sec | |
| D: Differentiation time $T_d$ | n06 | 0 sec | 90 sec | 0 sec | |
| Maximum value for superheat reference | n09 | 2.0 K | 50.0 K | 6.0 K | |
| Minimum value for superheat reference | n10 | 1.0 K | 12.0 K | 4.0 K | |
| MOP (maximum = off) | n11 | 0 bar | 60.0 bar | 60.0 bar | |
| Period time for AKV & AKVA pulse valves | n13 | 3 sec | 10 sec | 6 sec | |
| Stability factor for superheat regulation | n18 | 0 | 10 | 5 | |
| Damping of application near the reference value | n19 | 0.2 | 1.0 | 0.3 | |
| Amplification factor for superheat (only in 1:1 systems) | n20 | 0.0 | 10.0 | 0.4 | |
| Definition of superheat regulation | n21 | 1 | 2 | 1 | |
| Value of minimum superheat reference for loads under 10 % | n22 | 1.0 K | 15.0 K | 2.0 K | |
| [1]Standby TQ valve temperature when valve closed | n26 | -15.0 K | 20.0 K | 0 K | |
| [1]Standby TQ valve temperature when valve open | n27 | -15.0 K | 70.0 K | 20.0 K | |
| Maximum opening degree | n32 | 0 % | 100 % | 100 % | |
| Minimum opening degree | n33 | 0 % | 100 % | 0 % | |

**Table 6(a) Danfoss EKC 315A Controller Settings Record**

| No | [1]Parameter | Units |
|---|---|---|
| WIE | Evaporator chilled water inlet temperature TE-016 | °C |
| WOE | Evaporator chilled water outlet temperature TE-014 | °C |
| WL1 | Suction pressure PT-004 | bar g |
| ST1 | Suction temperature TE-044 | °C |
| WH1 | Discharge pressure PT-043 | bar g |
| WD1 | Discharge temperature TE-045 | °C |
| WO1 | Oil injection pressure PT-006 | bar g |

**Table 7(a) MicroTech Controller Pressure/Temperature Analogue Inputs**

| MicroTech Controller Configuration Settings | |
|---|---|
| The following setting values are 'as pre-commissioned' | |
| **Setting** | **Value** |
| CHLW temperature set point limits | |
| | |
| Set point reset | |
| Enable double set point | |
| Regulator band | |
| Neutral dead-band | |
| Pull-down rate | |
| Start up discharge temperature | |
| Shut down discharge temperature | |
| Enable softload | |
| High CHLWT start | |
| Outside ambient | |
| Current enable | |
| Minimum current | |
| Maximum current | |
| Limiting current | |
| Fan silent mode enable | |
| Maximum inverter output in FSM | |
| Delay time between evaporator pump/compressor | |
| Delay time for switch off evaporator pump | |
| Digital input remote on/off | |
| Supervisor remote | |
| Auto start after power trip | |
| Switch off unit on external alarm | |
| Time scheduling programme | |

**Table 8(a) MicroTech Controller Configuration Settings Record**

| MICROTECH CONTROLLER MANUFACTURER'S SET-UP | | |
|---|---|---|
| The following setting values are 'as pre-commissioned' | | |
| **SETTING** | | **VALUE** |
| Unit configuration | | |
| Probes enable - master board | | |
| Probes enable - slave board | | |
| Discharge probe type | | |
| Phase monitor type | | |
| Economiser | | |
| Temperature regulation | Internal | |
| | Derivative | |
| Compressor configuration | Number of comp | |
| | Number of evap | |
| Maximum number of load pulses | | |
| Maximum number of unload pulses | | |
| Minimum time compressor start | | |
| Minimum time different compressor start | | |
| Minimum time compressor on | | |
| Minimum time compressor off | | |
| Interstage timer | | |
| Double pulse load/unload compressor | | |
| Compressor unload pulse time | | |
| Minimum unload pulse period | | |
| Maximum unload pulse period | | |
| Compressor load pulse time | | |
| Minimum load pulse period | | |
| Maximum load pulse period | | |
| Pump-down configuration | | |
| Maximum pump-down time | | |
| Minimum pressure | | |
| Condenser pressure hold | | |
| Condenser pressure down | | |
| Evaporator pressure hold | | |
| Evaporator pressure down | | |
| Freeze protection | | |
| Condenser enable mode | | |
| Condenser type | | |
| Condenser fan steps | | |

**Table 9(a) MicroTech Controller Manufacturer's Set-up Record**

| MICROTECH CONTROLLER MANUFACTURER'S SET-UP | | |
|---|---|---|
| The following setting values are 'as pre-commissioned' | | |
| **SETTING** | | **VALUE** |
| Fan step 1 | Set point | |
| | Differential | |
| Fan step 2 | Set point | |
| | Differential | |
| Fan step 3 | Set point | |
| | Differential | |
| Fan step 4 | Set point | |
| | Differential | |
| Inverter configuration | Maximum speed | |
| | Speed up | |
| | Minimum speed | |
| | Set point | |
| | Differential | |
| Enable oil heating | | |
| Enable evaporator flow | | |
| Evaporator flow alarm delay | Start | |
| | Run | |
| Transducer high alarm | Set point | |
| | Differential | |
| Transducer low alarm | Set point | |
| | Differential | |
| Low pressure alarm delay timer | Start | |
| | Run | |
| Oil pressure ratio | Minimum load | |
| | Maximum load | |
| | Start delay timer | |
| | Run delay timer | |
| Low oil pressure alarm | Start | |
| | Run | |
| Oil high pressure differential alarm | Set point | |
| | Delay timer | |
| Antifreeze | Set point | |
| | Differential | |
| Liquid injection | Set point | |
| | Differential | |
| Anti-freeze heater | Set point | |
| | Differential | |
| Reset parameters to default | | |

**Table 9(a) (continued) MicroTech Controller Manufacturer's Set-up Record**

| MICROTECH CONTROLLER PROGRAMME + TOOL | | |
|---|---|---|
| The following setting values are 'as pre-commissioned' | | |
| **SETTING** | | **VALUE** |
| B1 offset | | |
| B7 offset | | |
| B8 offset | | |
| Compressor load sensor | | |
| B6 offset | Minimum | |
| | Maximum | |
| Compressor at maximum load | | |
| Time to unload compressor | | |
| Compressor at minimum load | | |
| DT to reload/unload compressor | | |

**Table 10(a) MicroTech Controller Programme + Tool**

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