Lampiran 1.

Surat Permohonan Izin Penelitian

KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
UNIVERSITAS NEGERI JAKARTA

Kampus Universitas Negeri Jakarta, Jalan Rawamangun Muka, Jakarta 13220
Telp/Fax.: Rektor (021) 4893854, PR I: 4895130, PR II: 4893918, PR III: 4892926, PR IV: 4893982,
BAUK: 4750930, BAAK: 4759081, BAPSI: 4752180
Bag. UHTP: Telp. 4893726, Bag. Keuangan: 4892414, Bag. Kepegawaian: 4890536, HUMAS: 4898486
Laman : www.unj.ac.id

Building Future Leaders

Nomor : 3213/UN39.12/KM/2015 — 30 September 2015
Lamp. : 1 Lembar
H a l : Permohonan Izin Mengadakan Penelitian untuk Penulisan Skripsi

Yth. Kepala Bagian Perlengkapan BPPT
Sub. Pemeiliharaan Lt.7
Jl. M.H. Thamrin I
Jakarta Pusat

Kami mohon kesediaan Saudara untuk dapat menerima Mahasiswa Universitas Negeri Jakarta :

N a m a	Adityo Rahman
Nomor Registrasi	5115110267
Program Studi	Pendidikan Teknik Elektro
Fakultas	Teknik Universitas Negeri Jakarta
No. Telp/HP	08561237255

Dengan ini kami mohon diberikan ijin mahasiswa tersebut untuk dapat mengadakan penelitian guna mendapatkan data yang diperlukan dalam rangka Penulisan Skripsi. Skripsi tersebut dengan judul :
"Analisis Tingkat Akurasi Termometer Pada Mesin Pendingin (Chiller) di Gedung BPPT Terhadap MC5 (Multifunction Calibration)"

Atas perhatian dan kerjasama Saudara, kami sampaikan terima kasih.

Kepala Biro Administrasi
Akademik dan Kemahasiswaan

Drs. Syaifullah
NIP. 195702161984031001

Tembusan :
1. Dekan Fakultas Teknik
2. Kaprog / Jurusan Teknik Elektro

Lampiran 2.

Surat Keterangan Penelitian

BADAN PENGKAJIAN DAN PENERAPAN TEKNOLOGI
Jalan M.H. Thamrin No. 8, Jakarta 10340
Telepon (021) 316.8200-8244, Faksimile 390.4537, Website http://www.bppt.go.id

Nomor : S-552/BPPT/BUH/Perl /ND/10/2015 Jakarta, 12 Oktober 2015
Lampiran : -
Perihal : Balasan

Yth. Drs. Syaifullah
Kepala BAAK, Universitas Negeri Jakarta
di Tempat

Dengan Hormat,
Yang bertanda tangan di bawah ini :

Nama	: Ir. Ardi Matutu
NIP	: 196008181987031005
Jabatan	: Kepala Bagian Perlengkapan
Unit	: Biro Umum dan Humas - Sekretaris Utama

Menerangkan bahwa,

Nama	: Adityo Rahman
Nomor Registrasi	: 5115110267
Program Studi	: Pendidikan Teknik Elektro
Fakultas	: Teknik Universitas Negeri Jakarta
No Telp/ HP	: 08561237255

Telah kami setujui untuk mengadakan penelitian di Badan Pengkajian dan Penerapan Teknologi untuk skripsi dengan judul : ***"Analisis Tingkat Akurasi Termometer Pada Mesin Pendingin (Chiller) Terhadap MC5 (Multifunction Calibration)" (Studi pada Gedung BPPT – Jakarta).***

Demikian surat ini kami sampaikan, atas kerjasamanya diucapkan terima kasih.

Kepala Bagian Perlengkapan,
Badan Pengkajian dan Penerapan Teknologi

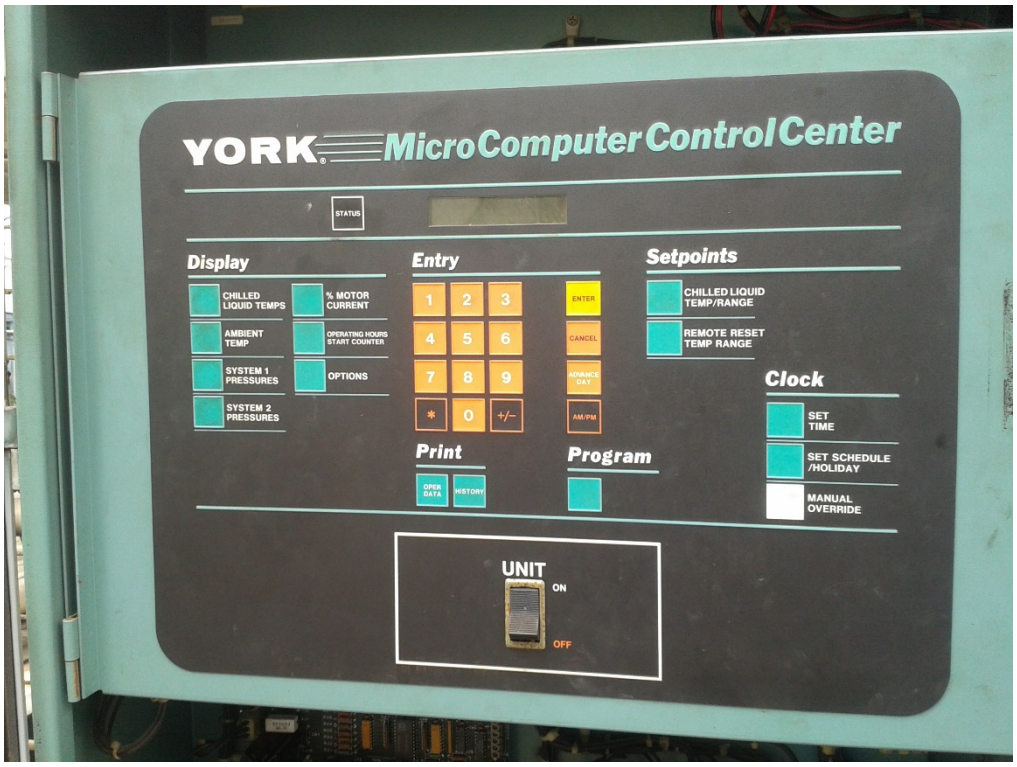
Ir. Ardi Matutu
NIP. 196008181987031005

Lampiran 3.

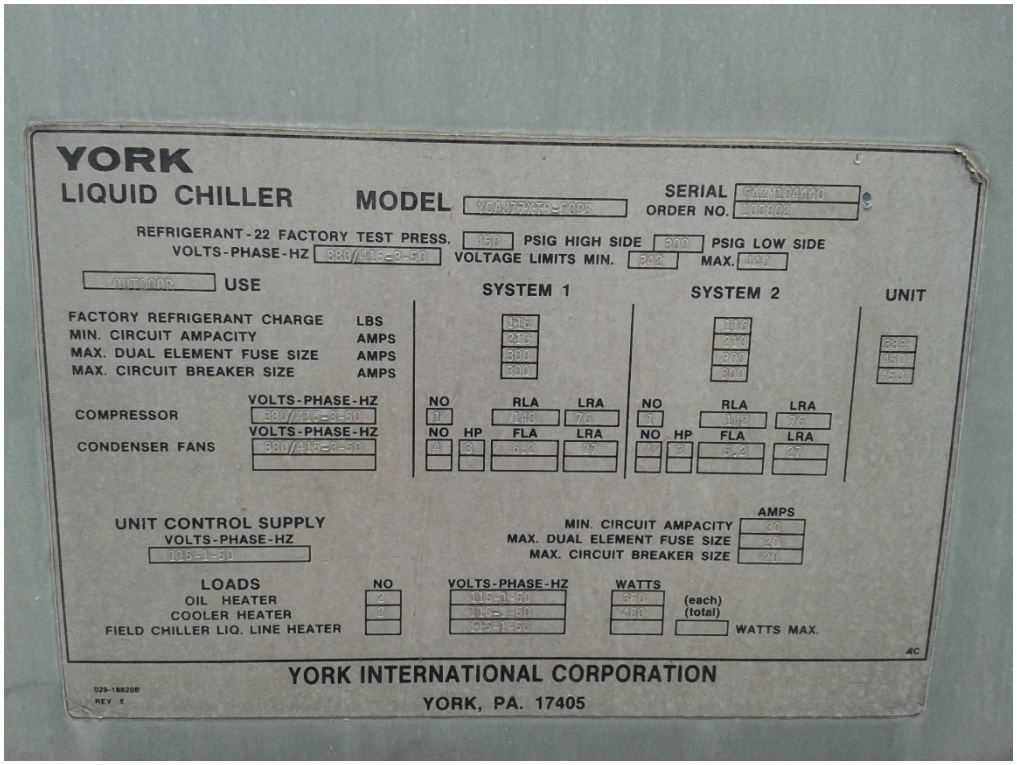
Dokumentasi Penelitian

***Chiller* Gedung BPPT**

***Chiller* Gedung BPPT (Tampak dari Atas)**



Tampilan *Display* Kontrol *(Micro Computer Control Center)*



Name Plate Chiller

Sensor Termistor *Chiller*

Sensor Termistor dan Termokopel dimasukkan bersamaan ke dalam *Chiller*

Peneliti sedang meletakkan Sensor Termokopel ke dalam *Chiller*

Peneliti sedang meletakkan Sensor Termokopel ke dalam *Chiller* (tampak dari Kejauhan)

Peneliti sedang melakukan kalibrasi menggunakan MC5

(Multifunction Calibration)

Peneliti sedang melakukan kalibrasi menggunakan MC5

***(Multifunction Calibration)*. Tampak dari kejauhan**

Peneliti sedang mengamati *display* monitor *chiller*

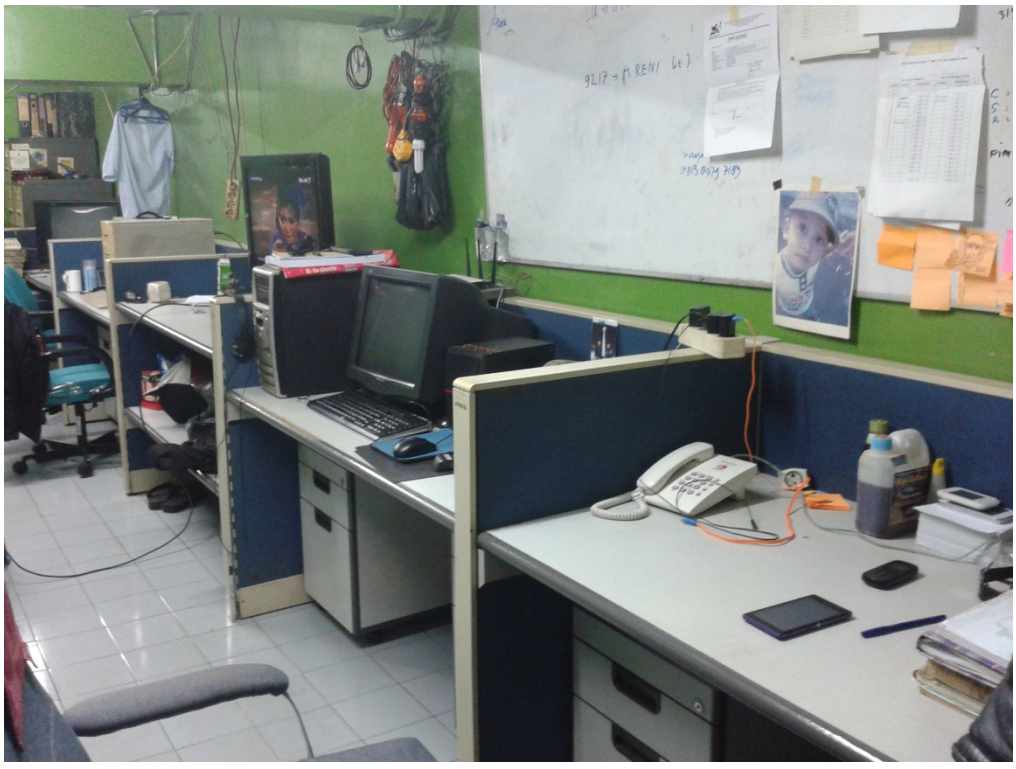


Foto Ruang *Engineering Dept.* Gedung BPPT - Jakarta

Lampiran 4.

Hasil Wawancara Narasumber

LEMBAR WAWANCARA NARASUMBER

Lokasi : Ruang Ruang *Engineering,* Gedung BPPT
Jl. M.H. Thamrin No.8, Menteng, Kota Jakarta Pusat, Daerah Khusus Ibukota Jakarta 10340

Waktu : Jum'at, 20 November 2015
Pukul 13.00 s.d. 13.30 WIB

Narasumber : Bapak Empur Pursada
Kepala *Engineering* Gedung BPPT

Point Pertanyaan dan Jawaban:

1.	Sejak kapan Bapak mulai bekerja di Gedung BPPT ? *Jawaban :* sejak Bulan Maret 1994
2.	Kapan *chiller* mulai beroperasi ? *Jawaban : chiller* mulai beroperasi pada tahun 1994
3.	Kapan jam pengoperasian *chiller* setiap harinya ? *Jawaban : chiller* dioperasikan mulai pukul 06.30 s.d. 15.40 WIB. *Chiller* bekerja pada hari kerja yaitu Senin s.d. Jum'at
4.	Ada berapa jumlah *chiller* yang ada pada gedung BPPT ? *Jawaban :* total *chiller* ada 10 unit. 8 unit untuk pendingin gedung dan 2 unit untuk ruang auditorium.
5	Berapa kapasitas auditorium yang menggunakan *chiller* sebagai pendingin ruangan ? *Jawaban :* auditorium mampu menampung sebanyak 1500 orang
6.	Apakah selama Bapak Bekerja di Gedung BPPT pernah dilakukan kalibrasi alat ukur khususnya termometer yang ada pada *chiller* ? *Jawaban :* belum pernah
7.	Bagaimana kondisi *chiller* yang ada saat ini ?

	Jawaban : dari total 10 unit *chiller*, ada 2 unit yang rusak. Unit IIIA rusak dan tidak bisa digunakan. Dan unit IIIB masih bisa digunakan.
8.	Sejak kapan *chiller* mengalami kerusakan ? *Jawaban :* untuk unit IIIA *chiller* mengalami kerusakan sejak bulan Maret 2014. Sedangkan unit IIIB mengalami kerusakan pada bulan September 2015 lalu.
9.	Kerusakan apa yang terjadi di *chiller* tersebut ? *Jawaban :* unit IIIA rusak pada bagian kompressor. Piston pada kompressor mengalami patah. Rencana ke depan akan ada penggantian 1 unit *chiller* untuk pengganti unit IIIA di tahun 2016. Sedangkan unit IIIB pada sistem 2 rusak akibat motor pada kompresssor terbakar pada bulan September 2015 lalu. Tetapi *chiller* masih bisa digunakan kurang optimal.
10.	Sensor apa yang digunakan untuk mengukur suhu pada *chiller* ? *Jawaban* : menggunakan sensor termistor kemudian di konversi ke dalam bentuk digital yang ditampilkan dalam pada *display* kontrol

Jakarta, 20 November 2015

Kepala *Engineering*

Gedung BPPT – Jakarta

Empur Pursada

NIP. 197104261994031003

Lampiran 5.

Technical Data Sheet* MC5 *(Multifunction Calibration)

MC5

All you need for field calibration.

ACCURACY GUARANTEED

MC-calibrators come with a traceable, accredited calibration certificate.

PROFI BUS

HART COMMUNICATION PROTOCOL

beamex

MC5 Multifunction Calibrator – all you need for field calibration.

Accuracy meets versatility. You won't find this calibrator collecting dust on the shelf in your workshop; it is always on the go. Beamex's MC5 is the all-in-one documenting multifunction calibrator for calibrating pressure, temperature, electrical and frequency signals. The modular construction of the MC5 provides flexibility for user-specific requirements. For example, the MC5 can be ordered as a pressure or temperature stand-alone calibrator, and then later be expanded into a datalogging, versatile multifunction calibrator.

The MC5 is made for tough use. The robust IP65-rated casing, along with integrated impact protectors, makes MC5 an ideal calibrator for use in wet and dusty environments subject to wide temperature variations.

When accuracy, versatility and robustness are what you are looking for, MC5 is the solution.

Intrinsically safe MC5-IS – made for extreme environments.

The ATEX certified MC5-IS is designed for use in potentially explosive environments, such as offshore platforms, oil refineries, chemical and petrochemical plants where inflammable gases may be present. There is probably no other intrinsically safe calibrator that can outperform the MC5-IS in terms of functionality. The MC5-IS is a documenting, multifunction calibrator that has calibration capabilities for pressure, temperature, electrical and frequency signals. Its modular design allows configuration based on your specific needs.

MC5 and MC5-IS

MC5 Multifunction Calibrator

MC5-IS Intrinsically Safe Multifunction Calibrator

MC5 Features

MC5 Main Features
Accurate, all-in-one calibrator – calibration capabilities for pressure, temperature, electrical and frequency signals
Documenting – communicates perfectly with calibration software
Field compatible, IP65-rated dust and waterproof casing
Modular design allows configuration based on your needs
Internal and/or external pressure modules
HART® communication
Foundation Fieldbus H1 or Profibus PA communication

MC5-IS Features

MC5-IS Main Features
Designed for use in potentially explosive environments
ATEX certified (EEx ia IIC T4 and ATEX directive II 1 G)
Calibration capabilities for pressure, temperature, electrical and frequency signals
Documenting – communicates perfectly with calibration software
Modular design allows configuration based on your needs
HART® Communication
Foundation Fieldbus H1 or Profibus PA communication

Common Features of the MC5 and MC5-IS

Functions
Internal pressure modules
External pressure modules
RTD measurement / simulation
Resistance measurement / simulation
TC measurement / simulation
Current measurement / generation
Voltage measurement / generation
Low voltage measurement / generation
Frequency measurement / generation
Pulse counting / generation
Switch testing
PRT sensor customization functionality

Optional features
Communication with software
HART® communication
Multichannel datalogging
Pressure controller communication *)
Temperature dry-block communication *)
Foundation Fieldbus H1 or Profibus PA communication

*) Excluding MC5-IS

Features of MC5

Accuracy guaranteed.

The MC5 is among the most accurate process calibrators available. As proof of this, each MC5 calibrator is delivered with a traceable, accredited calibration certificate.

The MC5 is made for tough use.

The IP65-rated robust casing, along with integrated impact protectors, makes MC5 an ideal calibrator for use in wet and dusty environments subject to wide temperature variations.

Modularity means versatility.

The MC5 is an extremely versatile calibrator with many different functions. The modular construction of MC5 provides flexibility for the user. For instance, the MC5 can be ordered as a pressure or temperature stand-alone calibrator, and then later expand it into a data-logging, documenting multifunction calibrator.

Communication with calibration software.

Using the MC5 together with calibration software provides you with a complete documenting calibration system that produces calibration certificates automatically. The benefits of the system include automated calibration procedures and paperless calibration management.

Make it safe with MC5-IS.

The MC5-IS is the intrinsically safe, ATEX certified (EEx ia IIC T4 and ATEX directive II 1 G) version of the MC5 Multifunction Calibrator. It is designed for use in potentially explosive environments, such as offshore platforms, oil refineries, chemical and petrochemical plants where inflammable gases may be present.

Fieldbus instruments must also be calibrated.

Fieldbus installations are growing rapidly worldwide. Beamex is the first company in the world to answer to this demand: we have introduced the MC5 Fieldbus Calibrator, which can be used for calibrating Foundation Fieldbus H1 or Profibus PA transmitters. Also the MC5-IS provides capability for calibrating Foundation Fieldbus H1 or Profibus PA transmitters. It offers the safest possible way for calibrating fieldbus transmitters.

General Specifications

MC5 / MC5-IS General Specifications

General	
Display	96 x 72 mm (3.78" x 2.83"), 320 x 240 pixels, back lit *1) LCD
Weight	1.7 - 2.3 kg (3.7 - 5.1 lbs)
Dimensions	245 mm (9.6") x 192 mm (7.5") x 74 mm (2.9") (d/w/h)
Case protection	IP65 (dust and water proof)
Keyboard	Membrane protected individual keys
Battery type	MC5; Rechargeable NiMH, 4000 mAh, 7.2V DC MC5-IS; Rechargeable NiMH, 1200 mAh, 8.4V DC
Battery operation	MC5; Average 10 hours MC5-IS; Average 5 hours
Charger supply	100...240 VAC, 50-60 Hz
Operating temperature	-10...50°C (14...122°F)
Storage temperature	-20 to 60°C (-4 to 140°F)
Humidity	0 to 80 % R.H. non-condensing
Measurement sample rate	2.5 / second
Warranty	Standard: 3 years for MC5; 1 year for battery pack. The warranty of the MC5 will be extended up to 6 years if the product is calibrated on a yearly basis at Beamex's Calibration Laboratory.

Features of modules

Feature	INT	EXT	E	ET	RJ
Internal pressure modules	•				
External pressure modules		•			
Current measurement			•		
Voltage measurement			•		
Low voltage measurement			•		
Frequency measurement			•		
Pulse counting			•		
Switch sensing			•		
Internal 24 VDC loop supply *1)			•		
RTD measurement / simulation				•	
Resistance measurement / simulation				•	
TC measurement / simulation				•	
Low voltage measurement / generation				•	
Voltage generation				•	
Current generation *2)				•	
Frequency generation				•	
Pulse generation				•	
Internal TC reference junction compensation					•

INT = Internal pressure module
EXT = External pressure module
E = Electrical measuring module
ET = Electrical and temperature module
RJ = Thermocouple reference junction module

*1) Excluding MC5-IS
*2) Sink generation in MC5-IS (requires external supply)

Pressure Measurement

Internal & External Pressure Modules for MC5 and MC5-IS

Internal Modules[1)]	External Modules	Range[2)]	Reso-lution	Accuracy[3)] (±)	1 Year Uncertainty[4)] (±)
INT B INT B-IS	EXT B EXT B-IS	80 to 120 kPa a 800 to 1200 mbar a 11.6 to 17.4 psi a	0.01 0.1 0.001	0.03 kPa 0.3 mbar 0.0044 Psi	0.05 kPa 0.5 mbar 0.0073 psi
INT10mD INT10mD-IS	EXT10mD EXT10mD-IS	±1 kPa diff ±10 mbar diff ±4 iwc diff	0.0001 0.001 0.001	0.05 % Span	0.05 % Span + 0.1 % RDG
INT100m INT100m-IS	EXT100m EXT100m-IS	0 to 10 kPa 0 to 100 mbar 0 to 40 iwc	0.0001 0.001 0.001	0.015 % FS + 0.0125 % RDG	0.025 % FS + 0.025% RDG
INT400mC INT400mC-IS	EXT400mC EXT400mC-IS	±40 kPa ±400 mbar ±160 iwc	0.001 0.01 0.001	0.01 % FS + 0.0125 % RDG	0.02 % FS + 0.025% RDG
INT1C INT1C-IS	EXT1C EXT1C-IS	±100 kPa ±1 bar -14.5 to 15 psi	0.001 0.00001 0.0001	0.007 % FS + 0.0125 % RDG	0.015 % FS + 0.025% RDG
INT2C INT2C-IS	EXT2C EXT2C-IS	-100 to 200 kPa -1 to 2 bar -14.5 to 30 psi	0.001 0.00001 0.0001	0.005 % FS + 0.01 % RDG	0.01 % FS + 0.025% RDG
INT6C INT6C-IS	EXT6C EXT6C-IS	-100 to 600 kPa -1 to 6 bar -14.5 to 90 psi	0.01 0.0001 0.001	0.005 % FS + 0.01 % RDG	0.01 % FS + 0.025% RDG
INT20C INT20C-IS	EXT20C EXT20C-IS	-100 to 2000 kPa -1 to 20 bar -14.5 to 300 psi	0.01 0.0001 0.001	0.005 % FS + 0.01 % RDG	0.01 % FS + 0.025% RDG
INT60 INT60-IS	EXT60 EXT60-IS	0 to 6000 kPa 0 to 60 bar 0 to 900 psi	0.1 0.001 0.01	0.005 % FS + 0.0125 % RDG	0.01 % FS + 0.025% RDG
INT100 INT100-IS	EXT100 EXT100-IS	0 to 10 MPa 0 to 100 bar 0 to 1500 psi	0.0001 0.001 0.01	0.005 % FS + 0.0125 % RDG	0.01 % FS + 0.025% RDG
INT160 INT160-IS	EXT160 EXT160-IS	0 to 16 MPa 0 to 160 bar 0 to 2400 psi	0.0001 0.001 0.01	0.005 % FS + 0.0125 % RDG	0.01 % FS + 0.025% RDG
-	EXT250 EXT250-IS	0 to 25 MPa 0 to 250 bar 0 to 3700 psi	0.001 0.01 0.1	0.007 % FS + 0.0125 % RDG	0.015 % FS + 0.025% RDG
-	EXT600 EXT600-IS	0 to 60 MPa 0 to 600 bar 0 to 9000 psi	0.001 0.01 0.1	0.007 % FS + 0.01 % RDG	0.015 % FS + 0.025% RDG
-	EXT1000 EXT1000-IS	0 to 100 MPa 0 to 1000 bar 0 to 15000 psi	0.001 0.01 0.1	0.007 % FS + 0.01 % RDG	0.015 % FS + 0.025% RDG

Temperature coefficient ±0.001 % Rdg/°C outside 15 … 35°C (59 … 95 °F)
INT10mD / INT10mD-IS / EXT10mD / EXT10mD-IS < ±0.002 % Span/°C outside 15 … 35°C (59 … 95°F)

1) The MC5 / MC5-IS Calibrators can hold three internal pressure modules.
2) Every internal/external pressure module's range may also be displayed in absolute pressure if the Barometric Module (B) is installed.
3) 'Accuracy' includes hysteresis, nonlinearity, repeatability and reference standard uncertainty (k=2).
4) '1 Year Uncertainty' includes hysteresis, nonlinearity, repeatability and typical long-term stability for mentioned period (k=2).

All external pressure modules (EXT) are also compatible with Beamex MC2 and MC5P Calibrators.

Supports the following pressure units as standard:
Pa, hPa, kPa, MPa, mbar, bar, lbf/ft2, psi, gf/cm2, kgf/cm2, kgf/m2, kp/cm2, at, mmH2O, cmH2O, mH2O, iwc, ftH2O, mmHg, cmHg, mHg, inHg, mmHg(0°C), inHg(0°C), mmH2O(4°C), inH2O(4°C), ftH2O(4°C), inH2O(60°F), mmH2O(68°F), inH2O(68°F), ftH2O(68°F), torr, atm.

INT B / EXT B; M5 (10/32") female.
INT10mD and EXT10mD; Two M5 (10/32") female threads with a hose nipple included.
INT100m/EXT100m – INT20C/EXT20C; G1/8" (ISO228/1) female. A conical 1/8" BSP male with 60° internal cone adapter included for Beamex hose set.
INT60, INT100, INT160; G1/8" (ISO228/1) female. EXT60, EXT100, EXT160, EXT250, EXT600, EXT1000; G ¼" (ISO228/1) male.
Wetted parts AISI316 stainless steel, Hastelloy, Nitrile rubber.

Maximum overpressure;
B module; 1200 mbar abs. 10mD module; 200 mbar. EXT600; 900 bar. EXT1000; 1000 bar.
For all other modules, the maximum overpressure is twice the nominal range.

MC5 and MC5-IS

Electrical Module (E)

Model	Function	Range	Resolution	1 Year Uncertainty[1] (±)
MC5	mV measurement[2]	±1000 mV	0.001 - 0.01 mV	0.02 % RDG + 5 µV
MC5-IS	mV measurement[2]	±250 mV	0.001 mV	0.02 % RDG + 5 µV
MC5	V measurement[3]	±50 V	0.00001 - 0.001 V	0.02 % RDG + 0.25 mV
MC5-IS	V measurement[3]	±30 V	0.00001 - 0.001 V	0.02 % RDG + 0.25 mV
MC5 & MC5-IS	mA measurement[4]	±100 mA	0.0001 - 0.001 mA	0.02 % RDG + 1.5 µA
MC5 & MC5-IS	Hz measurement[5]	0.0028 to 50000 Hz	0.000001 - 0.1 Hz	0.01 % RDG
MC5 & MC5-IS	Pulse counting[5]	0 to 9 999 999 pulses	1 pulse	N/A
MC5	mA generation[6]	0 to 25 mA	0.0001 mA	0.02 % RDG + 1.5 µA
MC5-IS	mA Sink	0 to 25 mA	0.0001 mA	0.02 % RDG + 1.5 µA

Temperature coefficient < ±0.001% RDG / °C outside of 15...35°C (59...95°F)

1) Uncertainty includes reference standard uncertainty, hysteresis, nonlinearity, repeatability and typical long-term stability for mentioned period (k=2).
2) Bias current <10 nA
3) Impedance >1 MΩ
4) Impedance < 7.5 Ω
5) MC5; Impedance > 1 MΩ. Frequency measurement minimum amplitude 0.5 Vpp (< 5 kHz),
   1 Vpp (5...50 kHz). Pulse counting minimum amplitude 0.5 Vpp (pulse length > 100 µs),
   1 Vpp (pulse length 100 µs...10 µs).
   Trigger level range -1…+15 V.
5) MC5-IS; Impedance > 1 MΩ. Frequency measurement minimum amplitude 1 Vpp (< 10 kHz),
   3 Vpp (10...50 kHz). Pulse counting minimum amplitude 1 Vpp (pulse length > 50 µs),
   3 Vpp (pulse length 50 µs...10 µs).
   Trigger level range -1…+15 V.
6) Maximum load impedance 800 Ω

RTD Measurement and Simulation

Function	Range (°C)	Range (°C)	Measurement 1 Year Uncertainty[1] (±)	Simulation 1 Year Uncertainty[1] (±)
Pt-sensors	-200 to 850°C	-200 to 0°C	0.06°C	0.1°C
		0 to 850°C	0.025% RDG + 0.06°C	0.025% RDG + 0.1°C

1) Uncertainty includes reference standard uncertainty, hysteresis, nonlinearity, repeatability and typical long-term stability for mentioned period (k=2).

RTD types available as standard:				
Pt50 (385)	Pt400 (385)	Pt100 (3923)	Pt100 (3926)	Cu10 (427)
Pt100 (385)	Pt500 (385)	Pt100 (391)	Ni100 (618)	
Pt200 (385)	Pt1000 (385)	Pt100 (375)	Ni120 (672)	

To improve uncertainty with PRT (platinum RTD) sensors, the MC5 / MC5-IS includes a standard possibility that allows you to create customized PRT sensors using the Callendar van Dusen correction coefficients. The easy-to-use *Beamex PRT Tool* PC software is used to create the sensor and to send it to the MC5. Up to 100 customized PRT sensors can be stored in MC5 at one time.

This function may be also used to create new, non-supported PRT sensors in the MC5. Both measurement and simulation can be done with the customized sensors.

MC5 Temperature Electrical Module (ET)

Function	Range	Resolution	1 Year Uncertainty[1] (±)
mV generation[2]	±500 mV	0.001 - 0.01 mV	0.02 % RDG + 4 µV
V generation[3]	±12 V	0.00001 - 0.0001 V	0.02 % RDG + 0.1 mV
mA generation[4]	±25 mA	0.0001 mA	0.02 % RDG + 1 µA
Hz generation[5]	0.00028 to 50 000 Hz	0.000001 - 0.1 Hz	0.01 % RDG
Pulse generation[6]	0 to 9 999 999 pulses	1 puls	N/A
Ohm simulation[7]	1 to 4000 Ω	0.01 - 0.1 Ω	0.04 % RDG or 30 mΩ[8]
Ohm measurement[9]	0 to 4000 Ω	0.001 - 0.1 Ω	0.02 % RDG + 3.5 mΩ
mV measurement[10]	±500 mV	0.001 - 0.01 mV	0.02 % RDG + 4 µV

Temperature coefficient < ±0.001% RDG / °C outside of 15...35°C (59...95°F)

1) Uncertainty includes reference standard uncertainty, hysteresis, nonlinearity, repeatability and typical long-term stability for mentioned period. (k=2)
2) Load effect < 5 µV/mA. Maximum output current 5 mA.
3) Load effect < 100 µV/mA. Maximum output current 10 mA (0 … 10 V), 3 mA (10 … 12 V).
4) Maximum load impedance 400 Ω.
5) Amplitude range 0 … 12 Vpp. Amplitude setting accuracy up to 5 kHz ±(200 mV + 5% of set value).
   Waveforms: Square wave (positive / symmetric) and sinewave (above 40 Hz).
6) Pulse generation frequency range 0.1 ... 1000 Hz. Amplitude setting 0 ... 12 Vpp.
7) Valid with measurement current 0.2 ... 5 mA (1 ... 1000 Ω), 0.1 .. 1mA (1 ... 4 kΩ). Ω/RTD simulation speed 1 ms.
8) Whichever is greater.
9) Specification valid with 4 wire connection. In 3 wire connection add 10 mΩ.
10) Bias current < 10 nA.

MC5-IS Temperature Electrical Module (ET)

Function	Range	Resolution	1 Year Uncertainty[1] (±)
mV generation[2]	±250 mV	0.001 mV	0.02 % RDG + 4 µV
V generation[3]	-2.5 to 10 V	0.00001 - 0.0001 V	0.02 % RDG + 0.1 mV
mA sink	0 to 25 mA	0.0001 mA	0.02 % RDG + 1 µA
Hz generation[4]	0.00028 to 50 000 Hz	0.000001 - 0.1 Hz	0.01 % RDG
Pulse generation[5]	0 to 9 999 999 pulses	1 pulse	N/A
Ohm simulation[6]	1 to 4000 Ω	0.01 - 0.1 Ω	0.04 % RDG or 30 mΩ[7]
Ohm measurement[8]	0 to 4000 Ω	0.001 - 0.1 Ω	0.02 % RDG + 3.5 mΩ
mV measurement[9]	±250 mV	0.001 mV	0.02 % RDG + 4 µV

Temperature coefficient < ±0.001% RDG / °C outside of 15...35°C (59...95°F)

1) Uncertainty includes reference standard uncertainty, hysteresis, nonlinearity, repeatability and typical long-term stability for mentioned period. (k=2)
2) Load effect < 5 µV/mA. Maximum output current 1 mA.
3) Load effect < 100 µV/mA. Maximum output current 1 mA (0 ... 10 V)
4) Amplitude range 0 … 5 Vpp (positive), 0 … 5 V (symmetric). Amplitude setting accuracy up to 5kHz ±(200 mV + 5% of set value).
   Waveforms: Square wave (positive / symmetric) and sinewave (above 40 Hz).
5) Pulse generation frequency range 0.1 ... 1000 Hz. Amplitude range 0 … 5 Vpp (positive), 0 … 5 V (symmetric).
6) Valid with measurement current 0.2 ... 2 mA (1 ... 250 Ω), 0.05 < I_{meas}•Rsim < 0.5 V (250 … 4000 Ω). Ω/RTD simulation settling time 1 ms.
7) Whichever is greater.
8) Specification valid with 4 wire connection. In 3 wire connection add 10 mΩ.
9) Bias current < 10 nA.

MC5 and MC5-IS

Thermocouple Measurement and Simulation

Type	Range (°C)	Range (°C)	1 Year Uncertainty[1] (±)
B[2]	0 ... 1820	0 ... 200 200 ... 500 500 ... 800 800 ... 1820	[3] 2.0 °C 0.8 °C 0.6 °C
R[2]	-50 ... 1768	-50 ... 0 0 ... 150 150 ... 1400 1400 ... 1768	1.0 °C 0.7 °C 0.5 °C 0.6 °C
S[2]	-50 ... 1768	-50 ... 0 0 ... 50 50 ... 1500 1500 ... 1768	1.0 °C 0.7 °C 0.6 °C 0.7 °C
E[2]	-270 ... 1000	-270 ... -200 -200 ... 0 0 ... 600 600 ... 1000	[3] 0.08 % RDG + 0.07°C 0.015 % RDG + 0.07°C 0.026 % RDG
J[2]	-210 ... 1200	-210 ... -200 -200 ... 0 0 ... 1200	[3] 0.07 % RDG + 0.08°C 0.02 % RDG + 0.08°C
K[2]	-270 ... 1372	-270 ... -200 -200 ... 0 0 ... 1000 1000 ... 1372	[3] 0.1 % RDG + 0.1 °C 0.02 % RDG + 0.1 °C 0.03 % RDG
N[2]	-270 ... 1300	-270 ... -200 -200 ... -100 -100 ... 0 0 ... 750 750 ... 1300	[3] 0.2 % RDG 0.05 % RDG + 0.15°C 0.01 % RDG + 0.15°C 0.03 % RDG
T[2]	-270 ... 400	-270 ... -250 -250 ... -200 -200 ... 0 0 ... 400	[3] 0.7 °C 0.1 % RDG + 0.1°C 0.01 % RDG + 0.1°C
U[4]	-200 ... 600	-200 ... 0 0 ... 600	0.1 % RDG + 0.15°C 0.01 % RDG + 0.15°C
L[4]	-200 ... 900	-200 ... 0 0 ... 900	0.07 % RDG + 0.13°C 0.02 % RDG + 0.13°C
C[5]	0 … 2315	0 … 900 900 … 2000 2000 … 2315	0.4 °C 0.045 % RDG 1.2 °C
G[6]	0 … 2315	0 … 70 70 … 200 200 … 1600 1600 … 2000 2000 … 2315	[3] 1.0 °C 0.5 °C 0.7°C 1.0 °C
D[5]	0 … 2315	0 … 1000 1000 … 2000 2000 … 2315	0.4 °C 0.04 % RDG 1.2 °C

Resolution 0.01°C.
With internal reference junction (module RJ) add 0.1°C uncertainty.
Other thermocouple types also available as an option.

1) Uncertainty includes reference standard uncertainty, hysteresis, nonlinearity, repeatability and typical long-term stability for mentioned period. (k=2)
2) IEC 584, NIST MN 175, BS 4937, ANSI MC96.1
3) ±(0.02 % of thermovoltage + 4 µV)
4) DIN 43710
5) ASTM E 988 - 96
6) ASTM E 1751 - 95e1

Reference Junction Module (RJ)

Range (°C)	1 Year Uncertainty[1] (±)
-10 … 50 °C	0.1 °C

1) Uncertainty includes reference standard uncertainty, hysteresis, nonlinearity, repeatability and typical long-term stability for mentioned period. (k=2)

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Lampiran 6.

Sertifikat Kalibrasi MC5 *(Multifunction Calibration)*

Beamex Oy Ab
Ristisuonraitti 10
Fi-68600 Pietarsaari
Finland
Tel. +358 10 550 5000
Fax +358 10 550 5404

www.beamex.com

Certificate of Calibration No
Kalibrointitodistus n:o
Kalibreringsbevis nr

K026-11E377

MC5

S/N: 25518808

Calibration

Certificate

EAMEX OY AB
alibration Laboratory
isuonraitti 10, 68600 PIETARSAARI
LAND
+358 10 550 5000 Fax.+358 10 550 5404

ACCREDITED CALIBRATION LABORATORY

FINAS
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K026 (EN ISO/IEC 17025)

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Certificate of Calibration No K026-11E377

stomer	Universitas Negeri Jakarta Fakultas Teknik, Jurusan Teknik Elektro, Jl. Rawamangun Muka, *Jakarta* Indonesia
n	Multifunction Calibrator
nufactured by	Beamex Oy Ab
del	MC5
rial Number	25518808
:e	07.02.2011
natures	Mika Pennanen, Production Technician Jari Kivelä, Calibration Engineer
ge	1(8)
cuments Attached	

lectrical Module (E) S/N: 38609

ow Voltage Measurement
ange: ± 1 V, 1 Year Uncertainty: ±(5 µV + 0.02% RDG)

Input [V]	Indicated Value [V]	Difference [V]	Expanded Uncertainty (k=2) [V]	Specification Low Limit [V]	Specification High Limit [V]	Status
-1.000014	**-1.00006**	-0.000046	±0.000017	-1.000219	-0.999809	**PASS**
-0.0000020	**-0.000002**	0.0000000	±0.0000020	-0.0000070	0.0000030	**PASS**
0.2499900	**0.249991**	0.0000010	±0.0000040	0.2499350	0.2500450	**PASS**
0.499988	**0.49999**	0.000002	±0.000015	0.499883	0.500093	**PASS**
0.749982	**0.74999**	0.000008	±0.000016	0.749827	0.750137	**PASS**
0.999991	**1.00000**	0.000009	±0.000017	0.999786	1.000196	**PASS**

oltage Measurement
ange: ± 50 V, 1 Year Uncertainty: ±(0.00025 V + 0.02% RDG)

Input [V]	Indicated Value [V]	Difference [V]	Expanded Uncertainty (k=2) [V]	Specification Low Limit [V]	Specification High Limit [V]	Status
-49.9898	**-49.992**	-0.0022	±0.0015	-50.0000	-49.9796	**PASS**
-0.000002	**0.00001**	0.000012	±0.000014	-0.000252	0.000248	**PASS**
9.99819	**9.9984**	0.00021	±0.00017	9.99594	10.00044	**PASS**
19.99572	**19.9960**	0.00028	±0.00030	19.99147	19.99997	**PASS**
29.9937	**29.994**	0.0003	±0.0014	29.9875	29.9999	**PASS**
39.9918	**39.992**	0.0002	±0.0014	39.9836	40.0000	**PASS**
49.9898	**49.990**	0.0002	±0.0015	49.9796	50.0000	**PASS**

urrent Measurement
ange: ± 100 mA, 1 Year Uncertainty: ±(0.0015 mA + 0.02% RDG)

Input [mA]	Indicated Value [mA]	Difference [mA]	Expanded Uncertainty (k=2) [mA]	Specification Low Limit [mA]	Specification High Limit [mA]	Status
-100.0003	**-100.004**	-0.0037	±0.0057	-100.0218	-99.9788	**PASS**
0.00000	**0.0000**	0.00000	±0.00014	-0.00150	0.00150	**PASS**
3.99996	**4.0001**	0.00014	±0.00022	3.99766	4.00226	**PASS**
11.99975	**12.0001**	0.00035	±0.0011	11.99585	12.00365	**PASS**
19.99977	**20.0001**	0.00033	±0.0015	19.99427	20.00527	**PASS**
49.9998	**49.999**	-0.0008	±0.0033	49.9883	50.0113	**PASS**
100.0004	**100.001**	0.0006	±0.0057	99.9789	100.0219	**PASS**

lectrical Module (E) S/N: 38609

urrent Generation
ange: 0...25 mA, 1 Year Uncertainty: ±(0.0015 mA + 0.02% RDG)

ienerated Value [mA]	Measured Value [mA]	Difference [mA]	Expanded Uncertainty (k=2) [mA]	Specification Low Limit [mA]	Specification High Limit [mA]	Status
0.0000	**0.0000**	0.0000	±0.00014	-0.0015	0.0015	**PASS**
5.0000	**5.0001**	0.0001	±0.00024	4.9975	5.0025	**PASS**
10.0000	**9.9996**	-0.0004	±0.00038	9.9965	10.0035	**PASS**
15.0000	**14.9995**	-0.0005	±0.0013	14.9955	15.0045	**PASS**
20.0000	**20.0001**	0.0001	±0.0015	19.9945	20.0055	**PASS**
25.0000	**25.0000**	0.0000	±0.0018	24.9935	25.0065	**PASS**

requency Measurement
ange: 0.0028...50000 Hz, 1 Year Uncertainty: ±0.01% RDG

Input [Hz]	Indicated Value [Hz]	Difference [Hz]	Expanded Uncertainty (k=2) [Hz]	Specification Low Limit [Hz]	Specification High Limit [Hz]	Status
1.000002	**1.00000**	-0.000002	±0.000014	0.999902	1.000102	**PASS**
10.00002	**10.0000**	-0.00002	±0.00014	9.99902	10.00102	**PASS**
100.0002	**100.000**	-0.0002	±0.0014	99.9902	100.0102	**PASS**
1000.002	**1000.00**	-0.002	±0.014	999.902	1000.102	**PASS**
10000.02	**10000.0**	-0.02	±0.14	9999.02	10001.02	**PASS**
50000.08	**50000.1**	0.02	±0.29	49995.08	50005.08	**PASS**

lectrical & Temperature Module (ET) S/N: 59135

ow Voltage Measurement
ange: ± 500 mV, 1 Year Uncertainty: ±(0.004 mV + 0.02% RDG)

Input [mV]	Indicated Value [mV]	Difference [mV]	Expanded Uncertainty (k=2) [mV]	Specification Low Limit [mV]	Specification High Limit [mV]	Status
-500.001	**-500.01**	-0.009	±0.015	-500.105	-499.897	**PASS**
-0.0025	**-0.003**	-0.0005	±0.0017	-0.0065	0.0015	**PASS**
99.9961	**99.995**	-0.0011	±0.0024	99.9721	100.0201	**PASS**
199.9975	**199.996**	-0.0015	±0.0033	199.9535	200.0415	**PASS**
299.996	**300.00**	0.004	±0.014	299.932	300.060	**PASS**
399.996	**400.00**	0.004	±0.014	399.912	400.080	**PASS**
499.994	**499.99**	-0.004	±0.015	499.890	500.098	**PASS**

ow Voltage Generation
ange: ± 500 mV, 1 Year Uncertainty: ±(0.004 mV + 0.02% RDG)

Generated Value [mV]	Measured Value [mV]	Difference [mV]	Expanded Uncertainty (k=2) [mV]	Specification Low Limit [mV]	Specification High Limit [mV]	Status
-500.00	**-499.99**	0.01	±0.015	-500.10	-499.90	**PASS**
0.00	**0.000**	0.000	±0.0017	-0.004	0.004	**PASS**
100.00	**100.001**	0.001	±0.0024	99.976	100.024	**PASS**
200.00	**200.000**	0.000	±0.0033	199.956	200.044	**PASS**
300.00	**300.00**	0.00	±0.014	299.94	300.06	**PASS**
400.00	**400.00**	0.00	±0.014	399.92	400.08	**PASS**
500.00	**500.00**	0.00	±0.015	499.90	500.10	**PASS**

oltage Generation
ange: ± 12 V, 1 Year Uncertainty: ±(0.0001 V + 0.02% RDG)

Generated Value [V]	Measured Value [V]	Difference [V]	Expanded Uncertainty (k=2) [V]	Specification Low Limit [V]	Specification High Limit [V]	Status
-12.0000	**-11.9997**	0.0003	±0.00022	-12.0025	-11.9975	**PASS**
0.00000	**-0.00001**	-0.00001	±0.000014	-0.00010	0.00010	**PASS**
2.5000	**2.5000**	0.0000	±0.00014	2.4994	2.5006	**PASS**
5.0000	**5.0000**	0.0000	±0.00015	4.9989	5.0011	**PASS**
7.5000	**7.4999**	-0.0001	±0.00016	7.4984	7.5016	**PASS**
10.0000	**10.0000**	0.0000	±0.00017	9.9979	10.0021	**PASS**
12.0000	**11.9999**	-0.0001	±0.00022	11.9975	12.0025	**PASS**

urrent Generation
ange: ± 25 mA, 1 Year Uncertainty: ± (0.001 mA + 0.02% RDG)

Generated Value [mA]	Measured Value [mA]	Difference [mA]	Expanded Uncertainty (k=2) [mA]	Specification Low Limit [mA]	Specification High Limit [mA]	Status
-25.0000	**-24.9996**	0.0004	±0.0018	-25.0060	-24.9940	**PASS**
0.0000	**-0.0001**	-0.0001	±0.00014	-0.0010	0.0010	**PASS**
5.0000	**4.9998**	-0.0002	±0.00024	4.9980	5.0020	**PASS**
10.0000	**9.9998**	-0.0002	±0.00038	9.9970	10.0030	**PASS**
15.0000	**14.9996**	-0.0004	±0.0013	14.9960	15.0040	**PASS**
20.0000	**19.9997**	-0.0003	±0.0015	19.9950	20.0050	**PASS**
25.0000	**25.0000**	0.0000	±0.0018	24.9940	25.0060	**PASS**

lectrical & Temperature Module (ET) S/N: 59135

requency Generation
ange: 0.00028...50000 Hz, 1 Year Uncertainty: ±0.01% RDG

Generated Value [Hz]	Measured Value [Hz]	Difference [Hz]	Expanded Uncertainty (k=2) [Hz]	Specification Low Limit [Hz]	Specification High Limit [Hz]	Status
1.00000	**1.00000**	0.00000	±0.000014	0.99990	1.00010	**PASS**
10.0000	**10.0000**	0.0000	±0.00014	9.9990	10.0010	**PASS**
100.000	**100.000**	0.000	±0.0014	99.990	100.010	**PASS**
1000.00	**1000.00**	0.00	±0.014	999.90	1000.10	**PASS**
10000.0	**10000.0**	0.0	±0.14	9999.0	10001.0	**PASS**
50000.0	**50000.0**	0.0	±0.29	49995.0	50005.0	**PASS**

esistance Measurement
ange: 0...4000 ohm, 1 Year Uncertainty: ±(0.0035 ohm + 0.02% RDG)

Input [ohm]	Indicated Value [ohm]	Difference [ohm]	Expanded Uncertainty (k=2) [ohm]	Specification Low Limit [ohm]	Specification High Limit [ohm]	Status
5.0080	**5.008**	0.0000	±0.0014	5.0035	5.0125	**PASS**
80.2572	**80.257**	-0.0002	±0.0024	80.2376	80.2768	**PASS**
159.9107	**159.910**	-0.0007	±0.0034	159.8752	159.9462	**PASS**
320.244	**320.24**	-0.004	±0.015	320.176	320.312	**PASS**
1000.232	**1000.23**	-0.002	±0.021	1000.028	1000.436	**PASS**
2000.251	**2000.25**	-0.001	±0.040	1999.847	2000.655	**PASS**
4000.72	**4000.7**	-0.02	±0.15	3999.92	4001.52	**PASS**

esistance Simulation
ange: 1...4000 ohm, 1 Year Uncertainty: ±0.030 ohms or 0.04% RDG

Simulated Value [ohm]	Measured Value [ohm]	Difference [ohm]	Expanded Uncertainty (k=2) [ohm]	Specification Low Limit [ohm]	Specification High Limit [ohm]	Status
5.00	**5.00**	0.00	±0.014	4.97	5.03	**PASS**
130.00	**130.00**	0.00	±0.014	129.95	130.05	**PASS**
145.00	**145.00**	0.00	±0.014	144.94	145.06	**PASS**
270.00	**270.00**	0.00	±0.014	269.89	270.11	**PASS**
290.00	**290.00**	0.00	±0.014	289.88	290.12	**PASS**
540.00	**540.00**	0.00	±0.016	539.78	540.22	**PASS**
570.00	**570.01**	0.01	±0.017	569.77	570.23	**PASS**
1050.0	**1050.0**	0.0	±0.14	1049.6	1050.4	**PASS**
1200.0	**1200.0**	0.0	±0.14	1199.5	1200.5	**PASS**
2100.0	**2100.0**	0.0	±0.14	2099.2	2100.8	**PASS**
2300.0	**2300.1**	0.1	±0.14	2299.1	2300.9	**PASS**
4000.0	**3999.7**	-0.3	±0.15	3998.4	4001.6	**PASS**

ectrical & Temperature Module (ET) S/N: 59135

:100 Measurement

ange: -200°C...850°C ITS90, 1 Year Uncertainty: -200°C to 0°C ±(0.06°C), 0°C to 850°C ±(0.025% of temp. + 0.06°C)

Input [ohm]	Corresponding Temperature [°C]	Indicated Value [°C]	Difference [°C]	Expanded Uncertainty (k=2) [°C]	Specification Low Limit [°C]	Specification High Limit [°C]	Status
18.956	-198.99	**-198.99**	0.00	±0.014	-199.05	-198.93	**PASS**
99.986	-0.03	**-0.03**	0.00	±0.015	-0.09	0.03	**PASS**
138.499	99.98	**99.98**	0.00	±0.015	99.89	100.07	**PASS**
280.999	500.06	**500.06**	0.00	±0.020	499.87	500.25	**PASS**
390.217	849.10	**849.09**	-0.01	±0.027	848.83	849.37	**PASS**

:100 Simulation

ange: -200°C ...850°C ITS90, 1 Year Uncertainty: -200°C to 0°C ±(0.1°C), 0°C to 850°C ±(0.025% of temp. + 0.1°C)

;imulated Value [°C]	Corresponding Resistance [ohm]	Measured Value [ohm]	Corresponding Temperature [°C]	Difference [°C]	Expanded Uncertainty (k=2) [°C]	Specification Low Limit [°C]	Specification High Limit [°C]	Status
-199.00	18.952	**18.951**	-199.00	0.00	±0.014	-199.10	-198.90	**PASS**
0.00	100.000	**99.997**	-0.01	-0.01	±0.015	-0.10	0.10	**PASS**
100.00	138.506	**138.503**	99.99	-0.01	±0.015	99.87	100.13	**PASS**
500.00	280.978	**280.980**	500.01	0.01	±0.020	499.77	500.23	**PASS**
849.00	390.188	**390.189**	849.00	0.00	±0.027	848.69	849.31	**PASS**

ıermocouple Measurement, Type K (without cold junction compensation RJ=0°C)

ange: -270°C ...1372°C ITS90, 1 Year Uncertainty: -270°C to -200°C ±(0.02% of thermovoltage + 0.004 mV),
00°C to 0°C ±(0.1% of temp. + 0.1°C), 0°C to 1000°C ±(0.02% of temp. + 0.1°C), 1000°C to 1372°C ±(0.03% of temp.)

Input [mV]	Corresponding Temperature [°C]	Indicated Value [°C]	Difference [°C]	Expanded Uncertainty (k=2) [°C]	Specification Low Limit [°C]	Specification High Limit [°C]	Status
-6.405	-250.35	**-250.52**	-0.17	±0.46	-251.42	-249.28	**PASS**
-0.002	-0.05	**-0.07**	-0.02	±0.029	-0.15	0.05	**PASS**
20.642	499.93	**499.92**	-0.01	±0.031	499.73	500.13	**PASS**
41.272	999.92	**999.90**	-0.02	±0.039	999.62	1000.22	**PASS**
54.849	1370.89	**1370.87**	-0.02	±0.048	1370.48	1371.30	**PASS**

ıermocouple Simulation, Type K (without cold junction compensation RJ=0°C)

ange: -270°C ...1372°C ITS90, 1 Year Uncertainty: -270°C to -200°C ±(0.02% of thermovoltage + 0.004 mV),
00°C to 0°C ±(0.1% of temp. + 0.1°C), 0°C to 1000°C ±(0.02% of temp. + 0.1°C), 1000°C to 1372°C ±(0.03% of temp.)

imulated Value [°C]	Corresponding Voltage [mV]	Measured Value [mV]	Corresponding Temperature [°C]	Difference [°C]	Expanded Uncertainty (k=2) [°C]	Specification Low Limit [°C]	Specification High Limit [°C]	Status
-250.00	-6.404	**-6.402**	-249.61	0.39	±0.53	-251.07	-248.93	**PASS**
0.00	0.000	**0.000**	0.01	0.01	±0.042	-0.10	0.10	**PASS**
500.00	20.644	**20.644**	500.00	0.00	±0.042	499.80	500.20	**PASS**
1000.00	41.276	**41.276**	1000.01	0.01	±0.050	999.70	1000.30	**PASS**
1371.00	54.852	**54.853**	1371.01	0.01	±0.060	1370.59	1371.41	**PASS**

100: Temperature/resistance conversions are based on standard IEC 751 AMENDMENT 2 (1995-07)
ıermocouple: Temperature/voltage conversions are based on the IEC 584-1 (1995-09) standard.

Internal Reference Junction Module (RJ) S/N: 79332

Thermocouple, Type K (Not part of Beamex's accredited competencies)

Compensated Type K in ice bath [°C]	Ambient temperature [°C]	Indicated value [°C]	Difference [°C]	Expanded Uncertainty (k=2) [°C]	Specification Low Limit [°C]	Specification High Limit [°C]	Status
0.00	23	**0.00**	0.00	±0.10	-0.20	0.20	**PASS**

Temperature / voltage conversion is based on the IEC 584-1 (1995-09) standard.

Calibration of the internal reference junction compensation has been made by measuring in ice bath (0°C) with the K type thermocouple specified in the calibration procedures.

lultifunction Calibrator MC5 **Serial No: 25518808**

alibration Procedure

alibration was carried out according to the internal instruction no.7.1.4.1.32.

efore starting the calibration of the unit, the unit was allowed to stabilise to the
ɔnstant laboratory conditions for 2 hours.

alibration Equipment Used

quipment	Model	Serial No.	Cert. No.	Calibrated
igital Multimeter	HP 3458A	2823A16899	K026-10E4496	22.12.2010
niversal Counter	HP 53131A	3736A20701	K026-10E1048	23.03.2010
hermocouple	Beamex Type K	26	K004-09L306	12.05.2009

alibrations are traceable to national or international measurement standards.

alibration Uncertainty

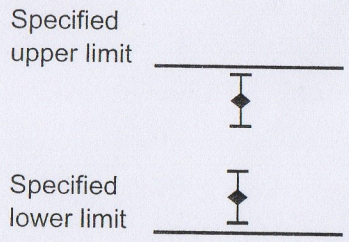
he uncertainty of calibration has been calculated separately for each calibration
ɔint. The coverage factor of the uncertainty is 2 (k=2), which for a normal distribution
ɔrresponds to a coverage probability of approximately 95%.
he standard uncertainty of measurement has been determined in accordance with
A Publication EA-4/02.

alibration Conditions

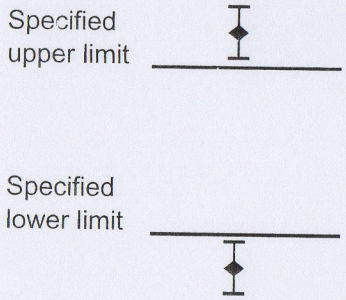
he calibrations were made in controlled conditions where the temperature was
3°C ± 1°C / 73°F ± 2°F and the humidity was 50% ±10%.

ASSESSMENT OF COMPLIANCE WITH MANUFACTURER'S SPECIFICATION

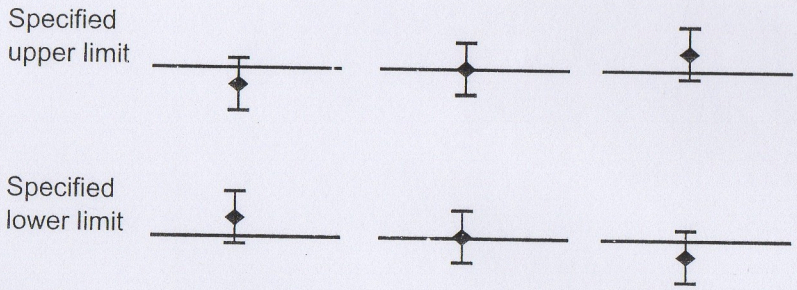
PASS = The measurement result is within the specification limit (the specification limits are not breached by the measurement result, extended by half of the expanded uncertainty interval at a level confidence of 95%).



FAIL = The measurement result is outside the specification limit even though it is extended downwards/upwards by half of the expanded uncertainty interval at a level confidence of 95%.



UD = The measurement result is above/below/equal to the specification limit by a margin less than the half of the expanded uncertainty interval; it is therefore not possible to state PASS/FAIL based on 95% level of confidence (UD=UNDEFINED).



(Based on ILAC G8:1996)

Lampiran 7.

Spesifikasi Termometer

Quality by tradition

Possible areas of application

Long service and measurement accuracy without wear for large-scale heating systems, district heating, and cold-water circulation systems in air conditioning. OEM version, only for volume quantities.

Description

Casing
Nominal size 110, 150 or 200 mm, aluminium, v-shaped, painted in a gold colour. Alternatively, versions with plastic casing top section made from polyamide PA6, black-coloured, are available. The numbers of the display range are printed on the right side and are long-lasting. Connection of casing and immersion tube through grooved adapter piece and locking screw. Advantage: When mounting the thermometer, it is not necessary to turn the casing. Max. ambient temperature 160 °C.

Glass inserts (Capillaries)
Capillary tube of solid glass, bar-shaped, prismatic, diameter approx. 6 to 8 mm, with white background for blue fluid column. Scale is deeply burnt in black, thus being absolutely resistant. The main graduations, which correspond with the printing on the casing, are especially clearly outlined

Thermometric liquid
In the standard version up to 200 °C blue wetting fluid („Fü").

Immersion tube
Standard version made from brass, type B with connection thread G½. The diameter of this immersion tube is 10 mm, with a wall thickness of 1 mm. Stainless steel available as an option.

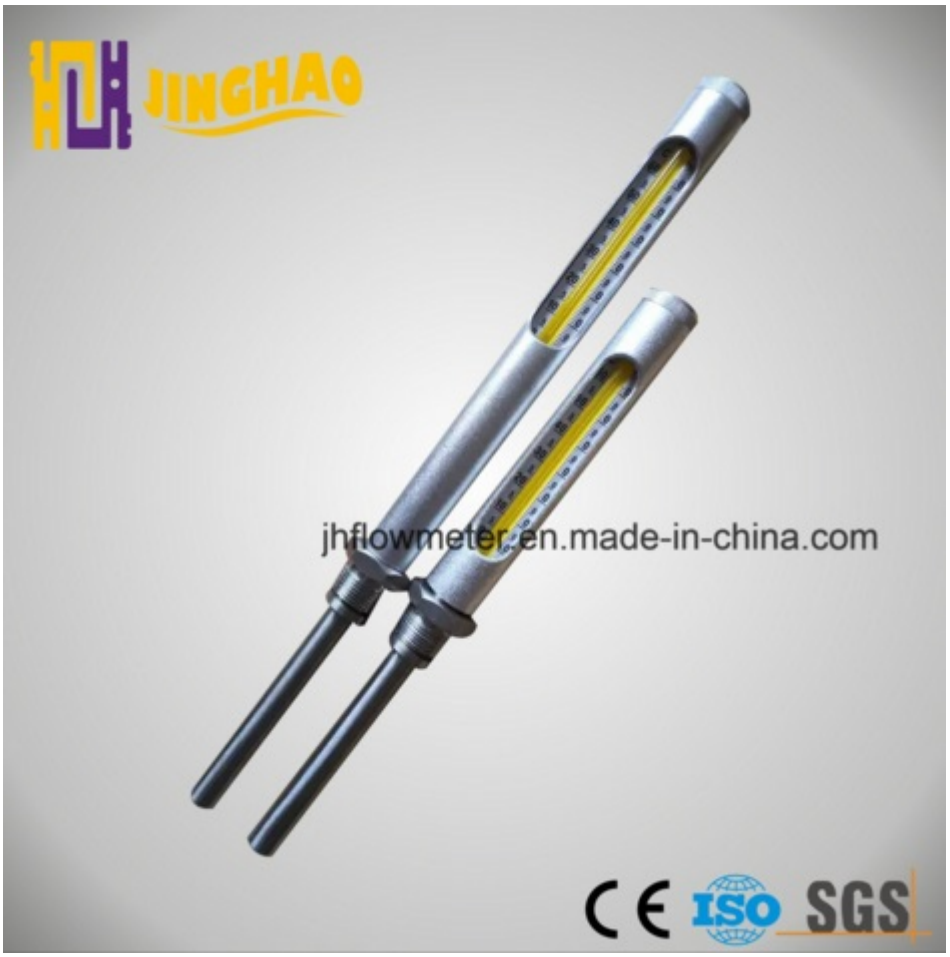
Scale intervals and error limits
SIKA thermometers fulfil the requirements of DIN 16195 „Requirements and testing of industrial glass thermometers". Scale intervals and error limits are defined in relation to the casing size and the display range. For example, a 291 HBZ thermometer, typical for heating applications, with a display range of 0 to 120 °C, has a scale interval of 2 °C and an error limit of 1 °C.

Quick Details

Place of Origin: Zhejiang, China (Mainland)	Brand Name: LETIN,SKYTHERMO or OEM	Model Number: LT-093-03
Usage: Industrial	Theory: Glass Thermometer	Accuracy: 1.0
Temperature range: -30~600C	Product name: v-shape glass thermometer	Material: metal case, glass rod
Upper body size: 200mm	stem length: 63mm or custom-made	scale: C or F or both
Application: industrial, boat, marine	Certificates: ISO9001:2008	Standard: ROHS /CE
Establish: 2001	Location: Yuyao,near Ningbo	

Packaging & Delivery

Packaging Details:	white box+carton. OEM is available for v-shape glass thermometer
Delivery Detail:	usually within 30 days



Product Details

Basic Info.

Model NO.: JH-TM-J
Accuracy: 1°C
Display: Dial
Temperature Range: -50-400c
Color: Black White and Yellow
Material of Case: Stainless Steel,Aluminum
Standard: Celsius/Fahrenheit
Usage: Industrial
Material: Mercury
Length of Probe: 110mm or Customized
Thread Type: M20X1.5,G1/2" or Customized
Export Markets: Global

Additional Info.

Trademark: JH
Standard: CE, RoHS
HS Code: 9025800000
Packing: Carton
Origin: Shanghai
Production Capacity: 10000PCS/M

ATLANTIS®

Specifications

Type	Type L--rigid 90° angle stem, available for SB & RG series Type S--rigid straight stem, available for SB & RG & SG series
Case material	SB series--V-shaped aluminum completely polished, gold-colored anodized RG series--Cylinder-shaped steel, chromium anodized SG series--Rectangular-shaped aluminum, silver-colored painted
Case size	SB series--110mmL x 35mmW；150mmL x 35mmW；200mmL x 35mmW RG series--120mmL x 19mmΦ；140mm x 19mmΦ SG series--110mmL x 32mmW；145mm x 32mmW
Lens	Clear glass
Scale plate	SB series--scale painted on the V-shaped case RG & SG series--Aluminum, black markings on white background single scale ℃ or ℉；dual scale ℃ and ℉ only available for SB series
Measuring principle	Mercury filled in glass tube Organic liquid available made-to-order, only for range below 200℃
Wetted parts material	Brass, chromium anodized for RG & SG series Stainless steel available made-to-order
Connection	1/2"PF (BSP) / NPT standard, other size available made-to-order
Stem length (including length of thread)	SB series--30；40；50；63；75；100；160；200 mm RG series--50；60；95；110；125 mm SG series--30；70；80；110 mm Other length available by order
Accuracy	±1 scale division
Range	SB series — -60+40；-30+50；0+60；0+100；0+120；0+160；0+200；0+300；0+400；0+500；0+600 ℃ RG series —-10+100；0+100；0-200；0+300；0+500；0+600 SG series — 0+100；0-200；0+600 Other range available by order

Lampiran 8.

Installation, Operation and Maintenance Guide,

York RecipPak Liquid Chiller

LAMPIRAN INI HANYA BERISI BAGIAN POKOK

(Untuk Melihat Lampiran Secara Lengkap Terdapat Pada Buku Skripsi)

YORK®

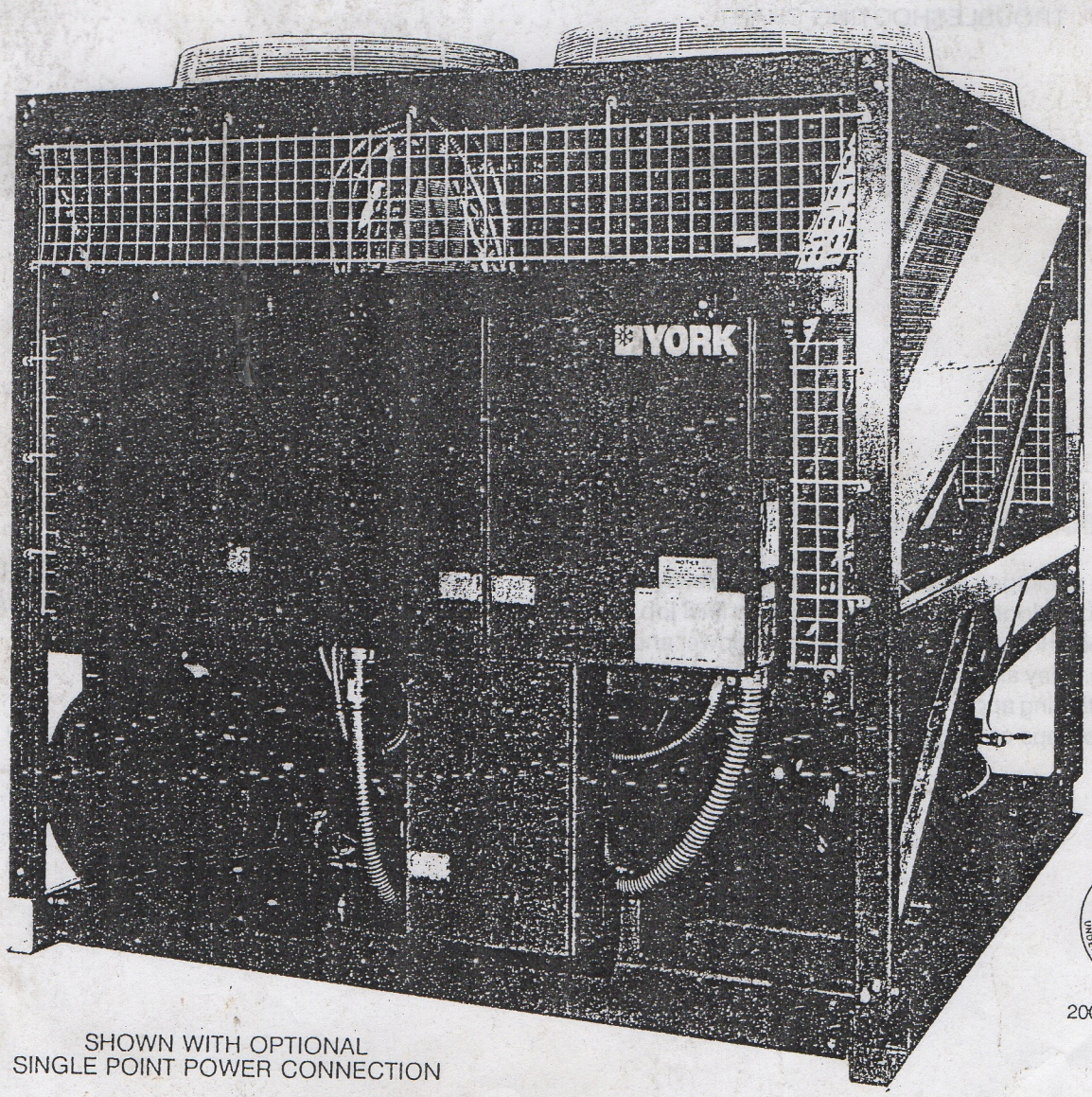
RecipPak LIQUID CHILLERS
AIR COOLED — RECIPROCATING HERMETIC

INSTALLATION, OPERATION, MAINT. | Supersedes: 150.60-NM1 (790) | 192 | FORM 150.60-NM2

60 HZ MODELS
YCAZ88MR6, YCAJ44MR6, YCAJ44ST6, YCAJ54NS6, YCAJ55ST8, YCAJ65ST8, YCAJ66XT8

50 HERTZ MODELS
YCAJ44MR7, YCAJ55MR7, YCAJ55ST7, YCAJ65NS7 YCAJ66ST9, YCAJ76ST9, YCAJ77XT9

STYLE B*

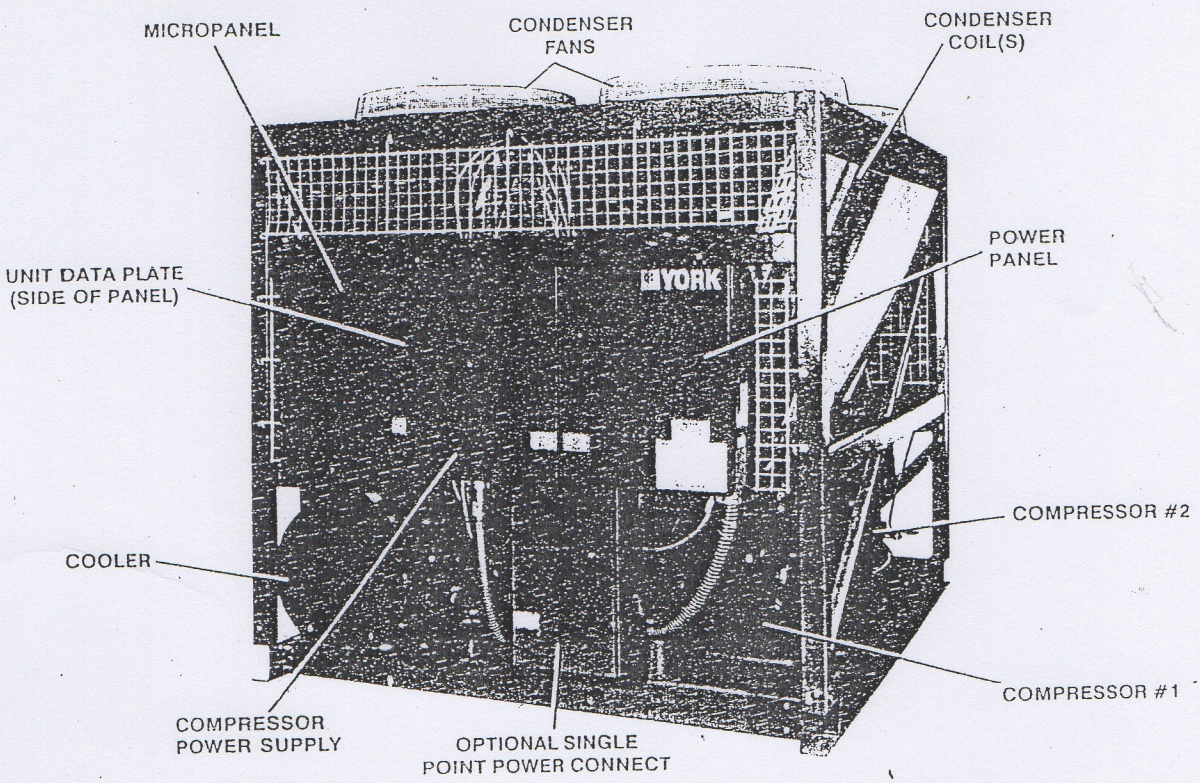


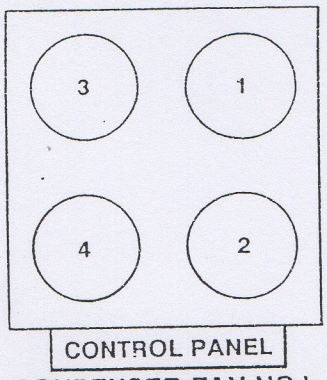
SHOWN WITH OPTIONAL
SINGLE POINT POWER CONNECTION

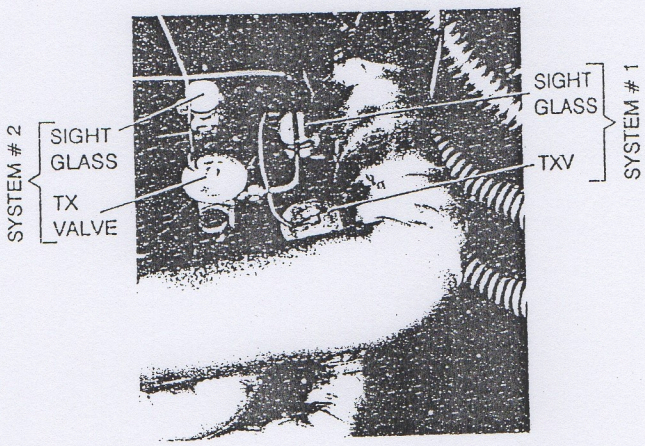
LISTED UNDER UNDERWRITERS' LABORATORIES, INC. REEXAMINATION SERVICE UL

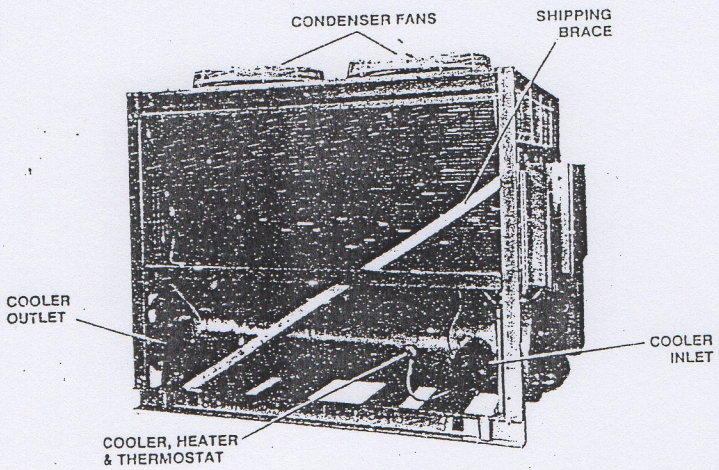
200, 230, 460-3-60

*With EPROM 031-01096C000 VER 0.0 (Standard, Brine & Metric Models, Combined)









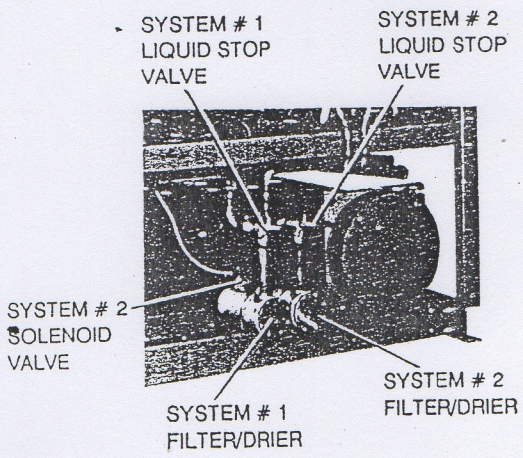
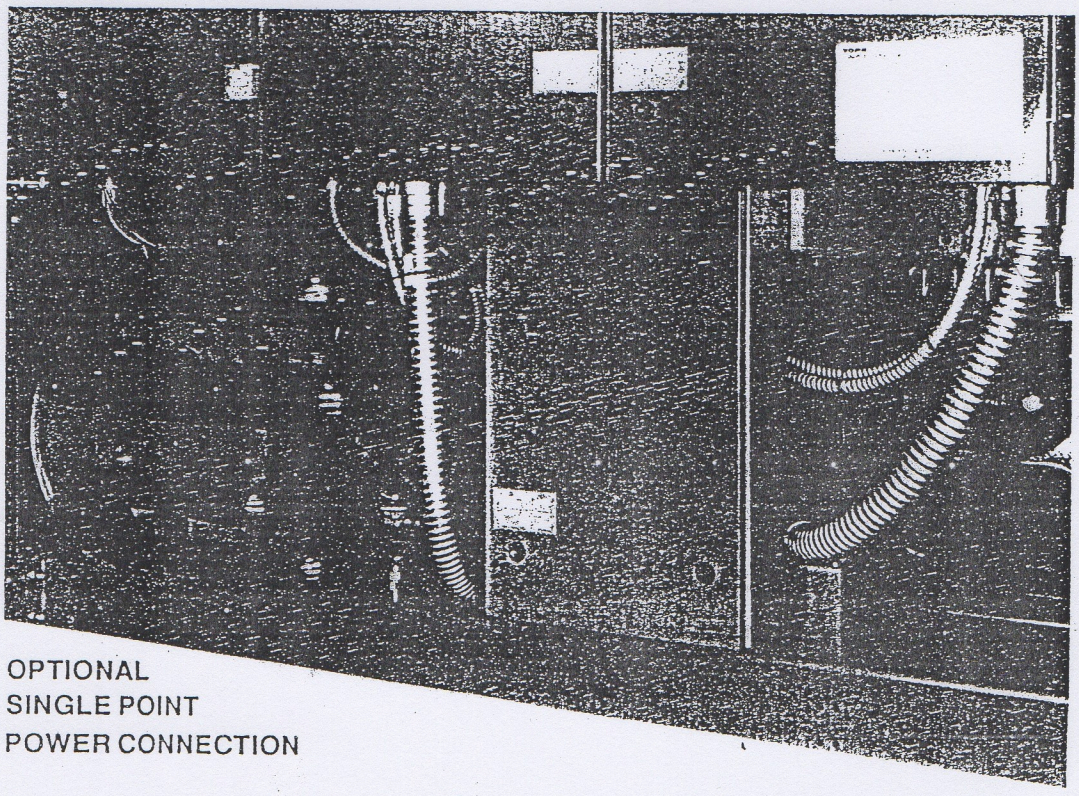
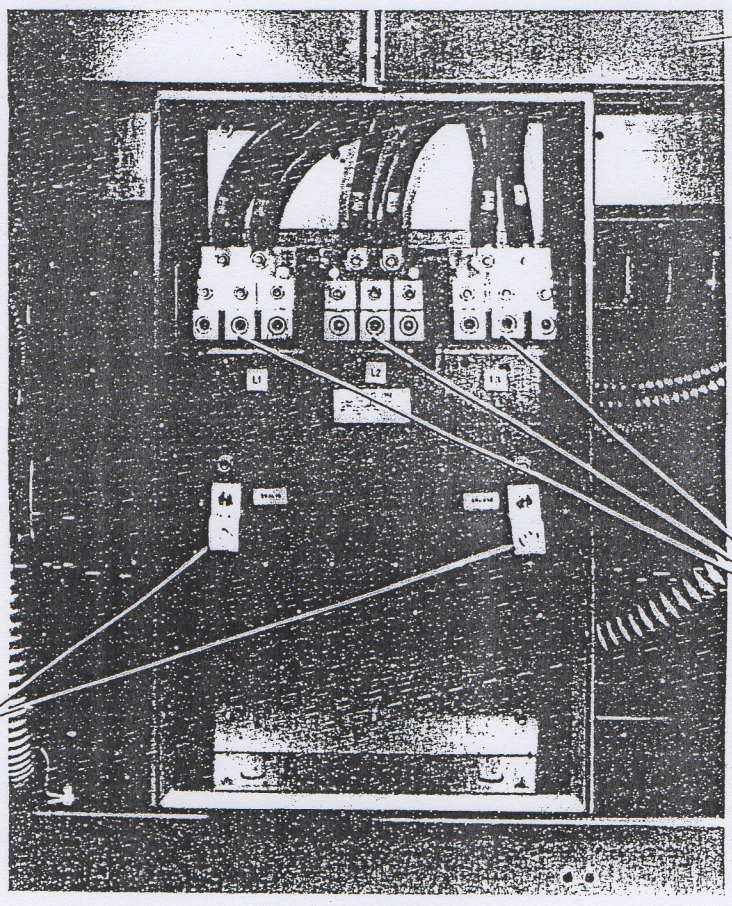


FIG. 1 – UNIT COMPONENTS

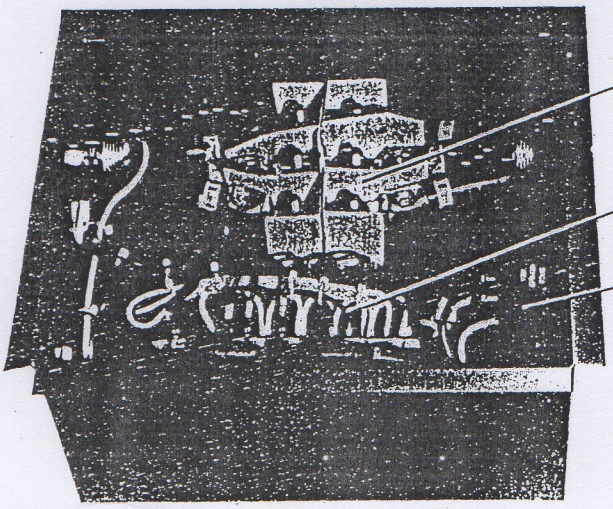


OPTIONAL
SINGLE POINT
POWER CONNECTION

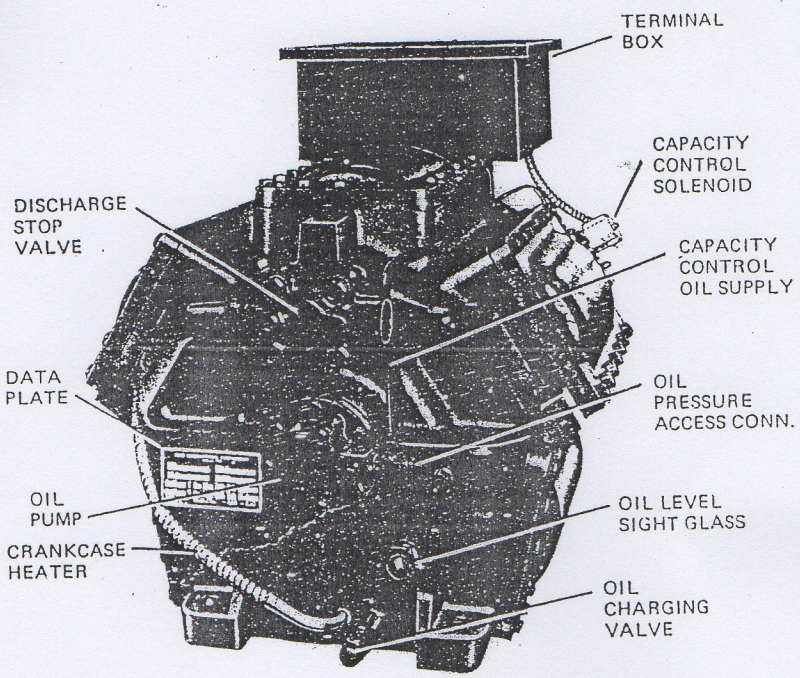


INTERIOR VIEW

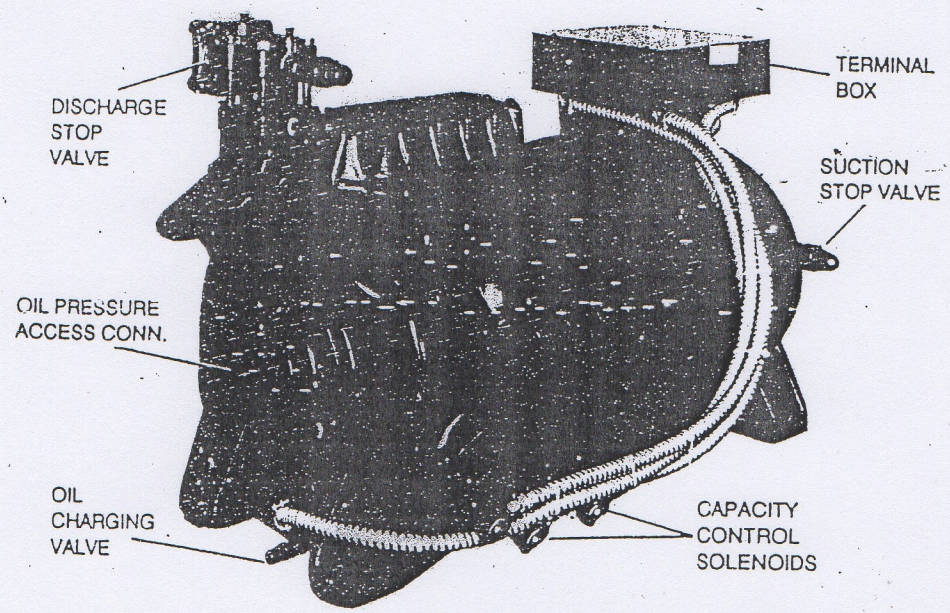
FIG. 1 – UNIT COMPONENTS - CONTINUED



COMPRESSOR
TERMINAL BOX



6 CYLINDER
MODEL Z COMPRESSOR



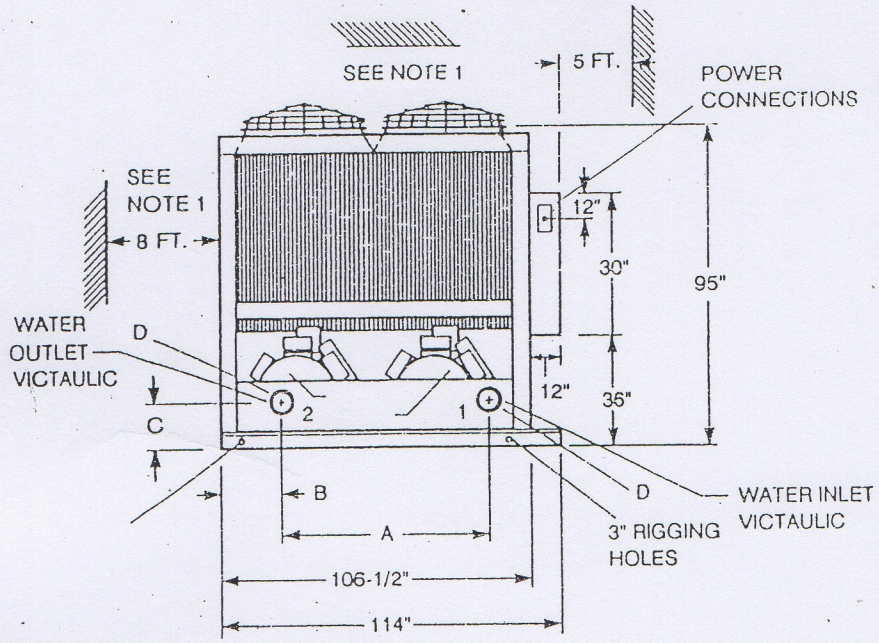
6 CYLINDER
MODEL J "F" COMPRESSOR

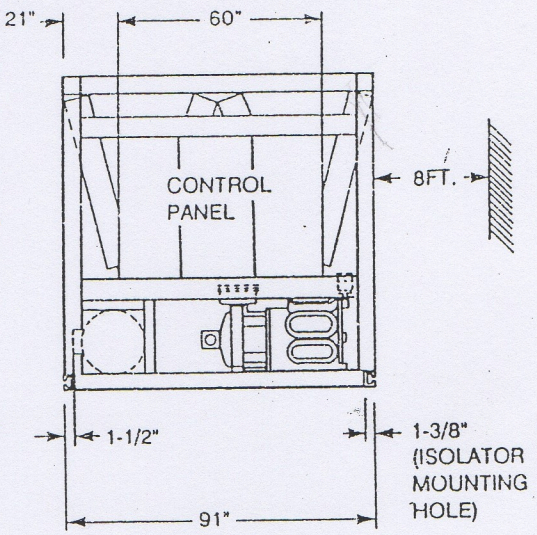
FIG. 1A – COMPRESSOR COMPONENTS

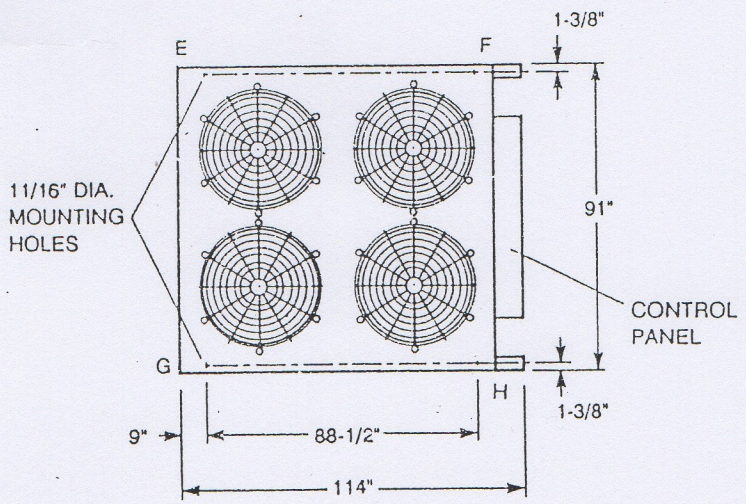
PHYSICAL DATA

MODEL YCA			60 HZ 50 HZ	Z88MR6 J44MR7	J44MR6 J55MR7	J44ST6 J55ST7	J54NS6 J65NS7	J55ST8 J66ST9	J65ST8 J76ST9	J66XT8 J77XT9
NOMINAL TONS			60 HZ	92.4	104.1	111.5	114.9	131.0	138.8	149.6
			50 HZ	92.1	105.4	112.8	[illegible]	130.3	[illegible]	[illegible]
NO. OF REFRIG. CIRCUITS				2	2	2	2	2	2	2
COMPRESSOR MODEL & MOTOR HORSEPOWER	60 HZ	Sys. 1		Z6W2A-1E (65 HP)	JS43F-M (60 HP)	JS43F-M (60 HP)	JS44F-P (80 HP)	JS44F-P (80 HP)	JS63F-Q (90 HP)	JS63F-Q (90 HP)
		Sys. 2		Z6WIA-1E (65 HP)	JS43F-M (60 HP)	JS43F-M (60 HP)	JS43F-M (60 HP)	JS44F-P (80 HP)	JS44F-P (80 HP)	JS63F-Q (90 HP)
	50 HZ	Sys. 1		JS43F-M (60 HP)	JS44F-P (80 HP)	JS44F-P (80 HP)	JS63F-Q (90 HP)	JS63F-Q (90 HP)	JS64F-S (115 HP)	JS64F-S (115 HP)
		Sys. 2		JS43F-M (60 HP)	JS44F-P (80 HP)	JS44F-P (80 HP)	JS44F-P (80 HP)	JS63F-Q (90 HP)	JS63F-Q (90 HP)	JS64F-S (115 HP)
UNIT CAPACITY CONTROL			60 HZ	5 Steps	5 Steps	5 Steps	5 Steps	5 Steps	6 Steps	7 Steps
			50 HZ	5 Steps	5 Steps	5 Steps	6 Steps	7 Steps	7 Steps	7 Steps
CONDENSER—DWP 450 PSIG NO. OF FANS (36" Dia.Direct Drive)				[illegible]	4	4	4	4	4	4
HP/KW Each	60 HZ (1140 RPM)			3/2.4	3/2.4	3/2.4	3/2.4	5/3.8	5/3.8	5/3.8
	50 HZ (950 RPM)			3/2.2	3/2.2	3/2.2	3/2.2	5/4.1	5/4.1	5/4.1
CFM Total			60 HZ	62,200	62,200	60,000	61,100	71,600	71,600	71,600
			50 HZ	61,700	61,700	58,600	60,100	71,100	71,100	71,100
COOLER—DUAL CIRCUITED DWP—235 PSIG REF. SIDE, 150 PSIG WATER SIDE DIA. x LENGTH				14" x 8'	14" x 8'	16" x 8'	14" x 8'	16" x 8'	16" x 8'	20" x 8'
WATER VOLUME (Gals.)				36	36	39	33	39	39	54
GPM			MIN.	120	120	150	120	150	150	250
			MAX.	580	580	640	580	640	640	803
SHIPPING WEIGHT (LBS.)	Alum. Fins		60 HZ	7,500	8,500	9,000	8,800	9,500	9,700	10,300
			50 HZ	8,500	8,650	9,150	9,075	9,900	10,050	10,650
	Copper Fins		60 HZ	8,500	9,500	10,300	9,950	10,800	11,000	11,600
			50 HZ	9,500	9,650	10,450	10,225	11,200	11,350	11,950
OPERATING WEIGHT (LBS.)	Alum. Fins	Sys. 1		7,800	8,800	9,350	9,075	9,850	10,050	10,750
		Sys. 2		8,800	8,950	9,500	9,350	10,250	10,400	11,100
	Copper Fins	Sys. 1		8,800	9,800	10,650	10,225	11,150	11,350	12,050
		Sys. 2		9,800	9,950	10,800	10,500	11,550	11,700	12,400
REFRIG. CHARGE (LBS. R-22)		Sys. 1		71	78	84	89	97	109	114
		Sys. 2		71	78	84	89	97	97	114

DIMENSIONS







MODEL YCA	A	B	C	D
Z88MR6	85	10-3/4	16	6
J44MR6	85	10-3/4	16	6
J44ST6	83	11-3/4	17	8
J5NS6	85	10-3/4	16	6
J55ST8	83	11-3/4	17	8
J65ST8	85	10-3/4	17	8
J66XT8	83	11-3/4	18-1/2	8
J44MR7	85	10-3/4	16	6
J55MR7	85	10-3/4	16	6
J55ST7	85	10-3/4	17	8
J65NS7	85	10-3/4	16	6
J66ST9	85	10-3/4	17	8
J76ST9	85	10-3/4	17	8
J77XT9	83	11-3/4	18-1/2	8

NOTES:

1. Clearances — Recommended YORK clearances to prevent condenser air recirculation and faulty operation of units are as follows:
   Side to wall 8'-0"* Rear to wall 8"-0"* Control End to wall 5'-0"* Top 50'-0" Distance between adjacent units 12'-0"
   * No more than one wall can be higher than the top of the unit.
   The area within the clearances shown above and area under the unit must be kept clear of all obstructions that would impede free air flow to the unit. In installations where winter operation is intended and snow accumulations are expected, additional unit height must be provided to insure full air flow.
2. VIBRATION ISOLATORS (not shown) will increase overall height of unit by approx. 7".

TROUBLESHOOTING CHART

PROBLEM	CAUSE	SOLUTION
No display on panel Unit will not operate	1. No 115VAC to 2T. 2. No 24VAC to Power Supply Board. 3. 2T defective, no 24VAC output. 4. No +12V output from Power Supply Board.	1. Checking wiring and fuses (1 FU and 2 FU). Check emergency stop contacts 5 to 1. 2. Check wiring 2T to Power Supply Board. 3. Replace 2T. 4. Replace Power Supply Board or isolate excessive load on the board.
	Contact YORK Service Before Replacing Circuit Boards!	
"NO RUN PERM"	1. No flow. 2. Flow switch installed improperly. 3. Defective flow switch. 4. Remote cycling device open. 5. "System" switch in the OFF postion.	1. Check chilled liquid flow. 2. Check that flow switch is installed according to manufacturer's Instructions. 3. Replace flow switch. 4. Check cycling devices coonnected to terminals 13 & 14 of the TB3 Terminal Block. 5. Place switches to the ON position.
"MOTOR CURRENT' FAULT Motor Contactor may or may not Energize	CONTACTOR DOES NOT ENERGIZE 1. External high pressure switch tripped. 2. External motor protector tripped. 3. Defective relay output board.	1. Check external high pressure switch, fan operation, and discharge pressure stored in memory. Air flow from fans must be up. 2. Check for defective External motor protector, wiring and motor problems. Assure the motor protector is not tripped due to external high pressure switch. 3. Replace relay output board.
	CONTACTOR ENERGIZES 1. Improper system high voltage. 2. Defective contactor contacts and contactor. 3. Faulty high voltage wiring. 4. High motor current stored in memory. 5. Defective current transformer (CT).	1. Check system high voltage supply. 2. Check contacts and contactor. 3. Check wiring. 4. Loose calibration resistors in J9 (SYS 1) or J10 (SYS 2) of power supply board. 5. CT resistance 42-44Ω.
	Contact YORK Service Before Replacing Circuit Boards or C.T.'s!	
"LOW OIL PRESS" FAULT	1. Low oil charge. 2. Too much refrigerant-in oil, particularly on start-up. 3. Liquid Line Solenoid Valve (LLSV) not operating. 4. Suction Press. Transducer or wiring defective. 5. Oil Press. Transducer or wiring defective.	1. Oil level should be visable in either sight glass at all times. Add YORK "C" oil if necessary. 2. Check crankcase oil heater operation. (350 Watt heater should be "ON" when unit is "OFF". Measure heater current. (Should be min. 2 amps.) 3. Check wiring and LLSV. 4. Compare display to a guage (SYS OFF). Replace defective component. 5. Compare suction and oil gauges to display. Replace defective component.

PROBLEM	CAUSE	SOLUTION
"Low Suction" Fault	1. Improper Suction Pressure Cut-out adjustment. 2. Low refrig. charge. 3. Fouled filter drier. 4. Thermal expansion valve adjustment/failure. 5. Reduced flow of chilled liquid through cooler. 6. Defective suction press. transducer. 7. Fouled compressor suction strainer. 8. Faulty wiring to transducer.	1. Adjust per recommended settings and restart unit. 2. Repair leak/add refrigerant. 3. Change drier core. 4. Adjust compressor suction superheat to 11°F (6.1°C) or replace power element (or valve). (5) Check GPM (See OPERATING LIMITATIONS) Check operation of pump. Clean pump strainer, purge chilled liquid system of air. 6. Replace transducer. 7. Remove and clean strainer. 8. Check wiring.
"High Dsch" Fault Cuts out on High Discharge Pressure as sensed by Microprocessor via high discharge pressure transducer. *NOTE: If external H.P. Cut-out Switch opens, a "Motor Current" Fault will result.*	1. Condenser fans not operating or rotating backwards. 2. Too much refrigerant. 3. Air in Refrigerant System. 4. Defective discharge pressure transducer. 5. Assure Programmable H.P. Cut-out is correctly set. 6. Assure OAT sensor is reading properly.	1. Check fans, fuses, and contactors. 2. Remove refrigerant. 3. Evacuate and recharge. 4. Replace discharge pressure transducer. 5. Adjust per recommended settings and restart unit. 6. Place a thermometer next to the sensor and compare reading to the display. Operation should not suffer if thermometer is ± 10°F.
"Chiller Fault: High Ambient Temp" Cuts out on high ambient temperature. (Max. = 130°F will restart automatically if temperature drops below 128°F)	1. Temperature sensed incorrectly by thermistor. 2. Fans rotating backwards. 3. Air flow to unit restricted (or being re-circulated). 4. High ambient cut-out set too low.	1. Verify actual ambeint temperature at probe ± 10°F with a thermometer placed next to the OAT sensor. 2. Air flow must be up. Correct fan rotation. 3. Check installation clearances. (See Page 9). 4. Reprogram cut-out.
"Chiller Fault: Low Ambient Temp" Cuts out on low ambient temperature. (25°F min. for std. adjustable for low ambient unit) *NOTE: Operation below 25°F requires low ambient accessory.*	1. Temperature of outside air is below cut-out setting. 2. Temperature sensed incorrectly by thermistor. 3. Check low ambient temperature Cut-out setting on the display.	1. No problem exists. 2. Verify actual ambient temperature immediately at probe with thermometer. 3. Adjust if necessary. *NOTE: For occassional operation below 0°F set the cut-out at 0°F. The chiller is then allowed to operate regardless of temperature. A low ambient kit must be installed.*

PROBLEM	CAUSE	SOLUTION
"Chiller Fault: Low Water Temp" Low water temperature shutdown.	1. RWT Control ONLY: Control range is too small and does not match actual ΔT across evaporator under full load conditions. 2. Check LWT cut-out point on panel. 3. Defective LWT or RWT sensor. (Assure the sensor is properly installed in the bottom of the well with a generous amount of heat conductive compound. *NOTE: It is not unusual to find up to a ±1°F difference between the display and a thermometer located in water piping.*	1. Flow is lower than design. Increase flow or increase the control range to match actual evaporator ΔT. 2. Adjust if necessary, and restart unit. (See Page 36). 3. Check according to following table (use digital volt meter)* Repalce if necessary. TEMP. VOLTAGE (DC) 20.0°F 1.65 22.0°F 1.71 25.0°F 1.82 27.0°F 1.88 30.0°F 1.99 33.0°F 2.09 36.0°F 2.22 38.0°F 2.28 41.0°F 2.37 43.0°F 2.43 46.0°F 2.54 48.0°F 2.60 50.0°F 2.67 53.0°F 2.77 55.0°F 2.83 57.0°F 2.89 59.0°F 2.95 61.0°F 3.02 63.0°F 3.08 65.0°F 3.14 67.0°F 3.20 70.0°F 3.28 * Check voltage on Microprocessor Board. LWT: J11-7 to J11-1 RWT: J11-8 to J11-1
Low Compressor Oil Level (Particularly on start-up)	1. Low oil charge. 2. Excessive flood back of liquid refrigerant.	1. Oil level should be visable in either sight glass at all times. Add YORK "C" oil if necessary. 2. Adjust Thermal Expansion Valve (TXV) or replace power element. Check TXV bulb location. Should be located on suction line at least 8"-10" from nearest elbow. Bulb should be at 4 o'clock or 8 o'clock position, have good contact with suction line and be well insulated.
Crankcase Heater won't Energize (Should energize anytime unit is "OFF") (Min. current draw = 2 amps)	1. Open in 115 VAC wiring to heater. 2. Defective heater. 3. Auxilliary contacts of compressor contactor defective.	1. Check wiring. 2. Replace heater. 3. Replace contactor.