SafeARC™ Arc Flash Protection System

Installation, Operation & Maintenance

Version 1.0 ● February 2019

The Engineered Arc Flash Hazard Elimination System

A Hudson McKay Group Company

SafeARC Pty Ltd
ABN 32 111 407 660
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Hazard Warnings

The following important highlighted information appears throughout this document to warn of potential hazards or to call attention to information that clarifies a procedure.

DANGER

Indicates a high risk activity or situation which if not avoided will result in death or serious injury.

WARNING

Indicates a high risk activity which failure to follow the instruction may result in death or serious injury.

CAUTION

Indicates that failure to follow this instruction may result in minor to moderate injuries

ATTENTION

Is use to inform of practices not related to personal injury

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Safety Notices

Engineered Solution

WARNING

SafeARC™ is an application specific engineered solution. The Arc Flash protection provided relates only to the assessed installation by a Professional Engineer.

Contact Hudson McKay Group for further information.

The Arc Flash Risk Reduction of the SafeARC™ module is dependent on the following critical components:

- Source Impedance;
- Transformer Rating;
- Transformer Impedance;
- Impedance of MCC Supply Cable;
- Number and Size of Interrupter Modules.

Modification of any of the above may result in increasing the Arc Flash Category. You must consult a Professional Engineer to determine the risk reduction factor provided by the SafeARC™ module.

For Further Information

If you have difficulty understanding the information contain within, contact Hudson McKay Group for further information.

When requesting information from the Hudson McKay, include the complete data appearing on the equipment nameplate, serial number, rated current, arc flash category, number of interrupters, and size of interrupters. The nameplate is located on the front top section of the SafeARC™ module.

Related Publications

Each SafeARC™ Arc Flash Protection System has the following associated documentation:

- Installed Location Unique Arc Flash Assessment;
- Module General Arrangement Drawings;
- Flange General Arrangement Drawings;
- Connection Bus Bar Pattern Drawing; and
- Auxiliary Wiring Connection Diagram.

Receiving, Handling and Storage

Receiving

Equipment Packages

Every package leaving the factory is plainly marked with the case number, requisition number, and customer's order number. If the equipment has been split for shipment, the section numbers of the equipment enclosed in each shipping package are identified.

ATTENTION

To avoid the loss of any parts when unpacking, the contents of each package should be carefully checked against the packing list before discarding the packing material.

The contents of each shipping package are listed on the Master Packing List

Inspecting for Damage

All equipment leaving the factory is carefully inspected and packed by personnel experienced in the proper handling and packing of electrical equipment. Upon receipt of any equipment, immediately perform a visual inspection to ascertain if any damage has been sustained in shipping or if there are any loose parts.

Be sure to inspect all devices mounted or packed inside the cooling control cubicle to see if any have been dislodged or damaged.

Filing a Claim

If any damage is evident, or indication of rough handling is visible, file a claim for damage at once with the transportation company and notify PACE immediately.

Information on damaged parts, part number, case number, requisition number, etc., and photographs should accompany the claim

Handling

ATTENTION

It is preferable to leave the SafeARC™ shipping skids in place until it reaches its final location.

1 – Crane Lifting Lugs.
2 – 2 – Control Cabinet;
3 – MCC Power Connections;
4 – Trf Power Connections;
5 – Shipping\Mounting Plinth;
6 – Heat Exchanger;

Figure 1 - Equipment Handling Points

Lifting

DANGER

Do not stand under SafeARC™ Module while it is being moved. Serious injury or death may occur if the cables, lifting sling or lifting device fail.

The SafeARC™ Module is best handled by lifting with a long tong forklift using the plinth shown in Figure 1, Item 5.

Forklifts

If crane facilities are not available the SafeARC™ Module may be lifted and/or moved into position via the Shipping Skids, Figure 1, Item, by using a "long tines" fork lift.

> **WARNING**
>
> Do not attempt to lift or move the SafeARC™ Module unless the forklift tines are spread to the maximum internal width of the Shipping Skid and forklift tines are under both cross members. Equipment may tip over causing equipment damage and Serious injury.

When using a forklift proceed as follows:

1. Expand the forklift tines to the maximum internal width of the Shipping Skid, Figure 1, Item 3;
2. Carefully insert tines of the forklift until they are sufficiently passed the front and rear cross members. It is recommended that the forklift tines be 100mm pass the rear cross member, Figure 1, Item 4;
3. Gently raise the SafeARC™ Module 50mm of the ground, tilt slight towards the Forklift and check stability;
4. Once stability is confirmed raise the SafeARC™ Module to the desired height while maintaining stability by tilting slight towards the forklift;
5. Travel with the SafeARC™ Module on the Forklift tines should be limited to less than 5km\hr;
6. When the SafeARC™ Module is in its final position on the mounting plinth, (supplied by PACE or others),slightly raise the SafeARC™ Module and remove the lower portion of the shipping skid by undoing the four (4) bolts;
7. Carefully lower the SafeARC™ Module on the plinth and secure in place via bolts placed in the plinth and the four (4) holes created by removing the lower half of the shipping skid.

Crane

A spreader bar should be used to prevent damage and preserve the external appearance of the SafeARC™ Module.

Utilise two equal length cables or slings and an overhead crane, each with a minimum load rating of twice the weight of the SafeARC™ Module. Estimated weights for SafeARC™ Module appear on the name plate.

Example: SafeARC™ Module Weight = 1500kg. The crane and two lift cables or slings must have a minimum load capacity of 3000kg.

Connect cables or slings via shackles to the two lifting points.

> **ATTENTION**
>
> Gently lower the SafeARC™ Module onto a level site location. If the SafeARC™ Module is roughly handled, it is possible to damage internal components or the transport skid.

Jacks

Jacks may be used in place of forklifts to raise and lower the SafeARC™ Module is in its final position on the mounting plinth.

> **CAUTION**
>
> Do not place Jacks in any location other than on the cross members of the Shipping Skid. Doing so may result in serious damage to the SafeARC™ Module enclosure.

For Jacks:

1. lace a jack under the front and rear corners of the Shipping Skid cross member, four (4) in total
2. Raise the SafeARC™ Module evenly and just enough to remove the lower portion of the shipping skid by undoing the four (4) bolts;
3. Carefully lower the SafeARC™ Module on the plinth and secure in place via bolts placed in the plinth and the four (4) holes created by removing the lower half of the shipping skid

Storage

If it necessary to store the SafeARC™ Module for any length of time:

1. Leave the protective packing in place to help prevent inadvertent damage;
2. Move the SafeARC™ Module to a flat location for storage.

Background

The Arc Flash\Blast Problem

Arc Flash\Blast is a recognised electrical safety hazard. Arc flash\blast is an electrical plasma explosion which is capable of causing death and/or severely injuring persons within the blast exposure area.

There is no escaping and arc flash\blast if you are in the exposure area. Within 200 milliseconds the explosion will expel outwards from the source:

- Extreme Temperatures;
- Molten Metal;
- Toxic Gases; and
- A High Pressure Blast Wave

The human injuries from such may include:

- The heat causes 2nd degree burns on exposed skin;
- The heat ignites non-arc rated clothing causing severe 3rd degree burns;
- Inhaling of the molten metal and the toxic plasma plume may cause lung damage;
- The sound generated exceed levels which may damage human ears;
- The pressure wave from a high fault current blast may cause internal and chest injury similar to a bomb blast.

Your facility may not have experienced and arc flash\blast event, however, the likelihood of an arc flash/blast event occurring without appropriate risk control measures is very likely.

Risk Management Hierarchy of Controls

Embedded in the Australian occupational health and safety acts, codes of practice and standards is a requirement to implement risk management systems in accordance with ISO 31000.

The core principle is so far as reasonably possible to eliminate and/or control the hazard using the hierarchy of controls. The use of PPE, while important in the protection against arc flash, should be regarded as the last line of defence.

With evolving electrical safety technologies, it is possible to minimise the consequence of and lower the likelihood of an arc flash/blast.

The SafeARC® mitigation system acts to minimise the consequence, i.e. the likelihood of burns, on the occurrence of an arc flash/blast should one occur.

What are the Severity Factors and How to Limit Them

The severity factors involved in an arc flash\blast incident are:

- Energy – how intense will the explosion be?
- Time – how long will it go for?
- Distance – how close will I be to the explosion?

The proven most effective means to reduce the severity of an arc flash\blast event is to reduce the energy level and remove it as quickly as possible.

The SafeARC® arc flash mitigation system achieves both measures by limiting fault current, reducing the incident energy to below 1.2 calories\cm^2, the 2nd degree burn limit, and interrupting the fault within 3 to 10 milliseconds.

SafeARC™ Mitigation System at Work

The solution is a simple but elegant engineered, fault current limiting parallel high speed fuse assembly installed on the secondary (415V) side of the supply transformer.

Figure 2 – Typical Installations

The assembly carries nominal load currents up to 4000A, but responds extremely quickly to fault currents, as low as 40% of the maximum bolted fault level, thereby interrupting the fault within half cycle and more typically between 4msec and 10msec.

This approach as two main advantages for electrical systems:

- Limits the prospective fault current typically between 30% and 40% of the prospective maximum bolted fault level preventing catastrophic equipment failure;

- Limits incident energy from the supply to less than 1.2 cal\cm^2 the 2nd degree burn limit.

Tests have also shown that even with incident energy increasing by 300%, the SafeARC™ semiconductor fuse assembly operating in its current limiting range, is unaffected and limits incident energy below the 2nd degree burn level.

Benefits Achieved By Installing SafeARC™ Are

1. System uniquely protects at the source of the energy lowering the prospective fault current to 30-40% of the maximum available
   = Safer installation for all and protects assets from catastrophic damage due to high fault currents;
2. Protects personnel from severe burns by reducing the arc flash/blast incident energy to less than 1.2 cal\cm^2
   = Safer Work Environment;
3. Enables personnel to perform fault finding and switching operations with arc rated PPE of less than 4 cal\cm^2 and possibly less than 1.2 cal\cm^2.
   = More wearable and comfortable PPE;
4. Low capital cost compared to MCC replacement.
   = Efficient cost benefit & use of scarce capital;
5. Can be retrofitted to most installations within 24 hours.
   = Low or no loss production capacity;
6. If there is and arc flash event, you will be up and running again within hours, not days or months.
   = No Loss of Life and Low loss of production;
7. System has been rigorously tested at an internationally recognized TUV facility and field tested over 5 years by one of world's largest Tier 1 mining companies.
   = Guaranteed to work under the certified conditions.

Verification of Claimed Performance

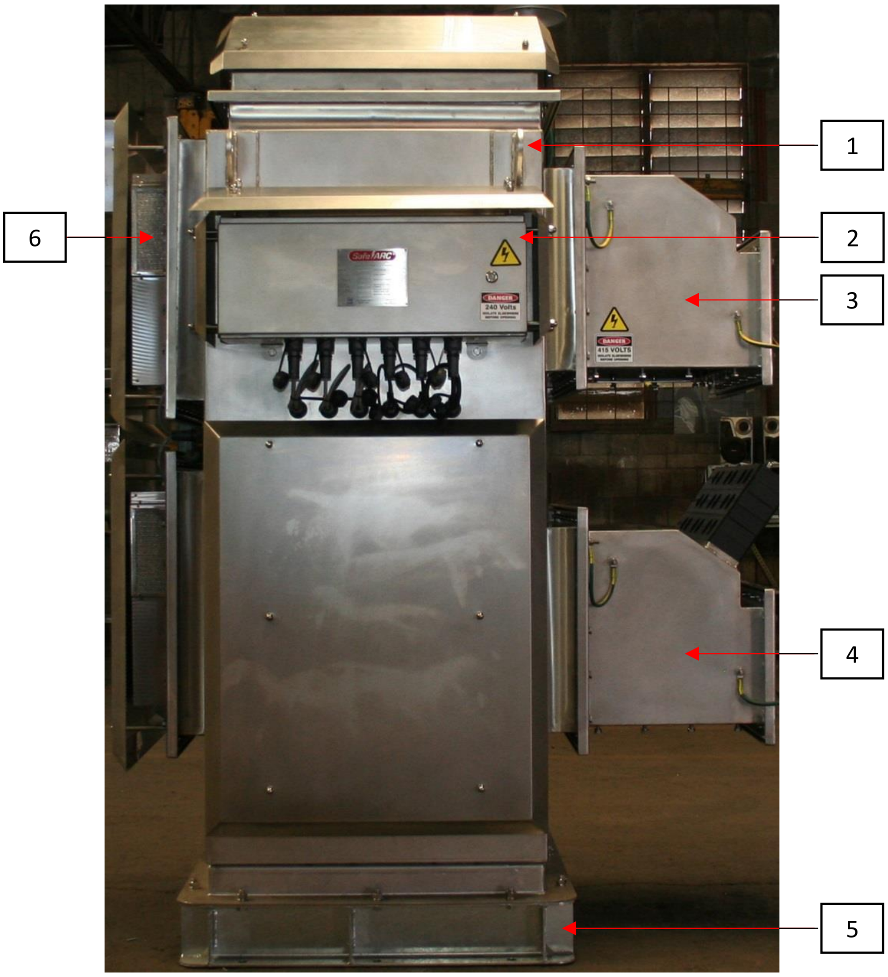
The SafeARC™ arc flash mitigation system has been engineered using well known concepts and modelled in various power system analysis software's conforming to IEEE1584 and NFPA70E.

Rigorous testing was also performed by the TUV/NATA certified test center located in Melbourne Victoria Australia to type test to IEC standards and validate the claimed performance. Independent reports are available for customer verification.

Description

General

This section contains a description of the SafeARC™ Arc Flash Protection System. Figure 3 is a front view of a typical Cable In/Cable Out SafeARC™ Module with two (2) heat exchanger units..



1 – Crane Lifting Frame;
2 – Control Cabinet;
3 – MCC Power Connections;
4 – Trf Power Connections;
5 – Shipping\Mounting Plinth;
6 – Heat Exchanger;

Figure 3 - Front View of SafeARC Module, Cable In/Cable Out

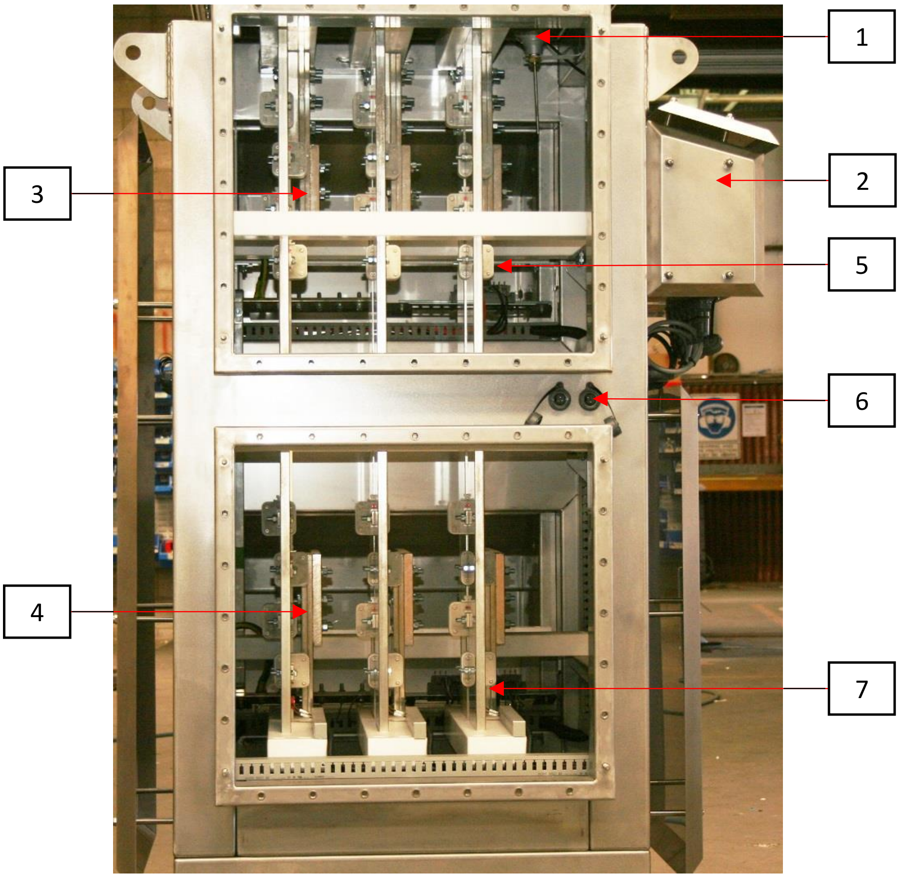
Figure 4 also shows in more detail a cross sectional view of a typical SafeARC™ Module with two (2) heat exchanger units.

Summary Description

The SafeARC™ Arc Flash Protection System is a free-standing metal clad assembly containing the main power circuit, protective semi-conductor fuses and the auxiliary power and control system for the cooling heat exchangers.

The system is nominally connected to the power transformer low voltage terminals via flexible cables of suitable load current carrying size via the upper cable connection and brass gland plate assembly, Figure 3, Item 3. The MCC or load supply and control cables are normally connected through the lower cable connection and brass gland plate assembly, Figure 4, Item 4.

Note when external powered is supplied for control system this can be modified to suit the installation requirements



1 – Temperature Control PT100;
2 – Heat Radiation Shields;
3 – Input Busbar Section;
4 – Output Busbar Section;
5 - High Speed Fuse
6 – Heat Ex – Supply Sockets;
7 – Fuse Blown Mircoswitch;

Figure 4 – Cross-sectional View of SafeARC Module, Heat Exchangers Removed

COMPARTMENTS

General

The SafeARC™ assembly consists of two compartments. The main power flow compartment and the heat exchanger control system compartment.

Power Flow Compartment

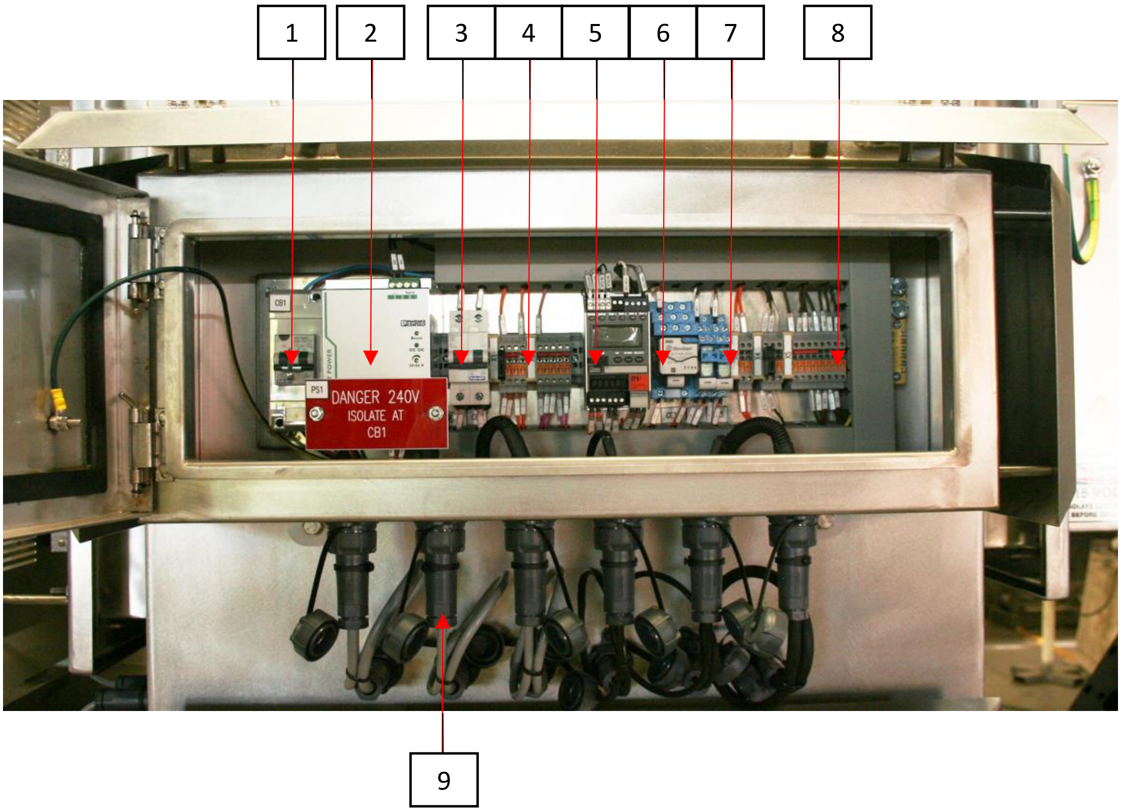
The power flow compartment is the main active compartment of the SafeARC™ Arc Flash Protection System. This compartment contains the busbar and the semi-conductors fuses. Reviewing Figure 4 it can be seen that the incoming line supply is connected to Figure 4 Item 4, the riser bus bar then distributes power to the top of the interrupter assembly to facilitate even power flow through the parallel interrupter paths. On the loads side of the bus the cables are then connected to cable connection bus Figure 4 Item 7.

Control System Compartment

The control system compartment contains the control components required to regulate the internal temperature of the main assembly to within a few degrees of the external ambient temperature by switching the heat exchanger fans on and off as required.

FUSE COOLING HEAT EXCHANGE SYSTEM

The heat exchanger control system components are detailed in the relevant schematic and layout drawings supplied with the SafeARC™ module. Generally, Figure 5 shows the layout and position of these components.



1 – Supply Vac RCD\Isolator;
2 –Vac\48Vdc Power Supply;
3 – 48Vdc Isolator;
4 – 48Vdc Distribution Terminals
5 – Temperature Controller;
6 – Heat Exchanger Control Relay;
7 – Heat Ex Fan Failure Alarm;
8 – Alarm and Status Terminals;
9 – Power & Control Cables

Figure 5 – Heat Exchanger Control System

INSTALLATION

PREPARATION

General

⚠ DANGER

Before performing installation activities ensure that the high voltage energy source has been identified and positively isolated

PERSONNEL COMPETENCIES REQUIRED

Isolation

High Voltage Qualified Electrician\Isolator to carry out switching and isolation.

Installation

Qualified Supervisor - Electrician assisted by electrician or trades assistant

INSTALLATION PROCEDURE

Steps Involved

Step	Process
1	Unpack the SafeARC® module and inspect for damage.
2	Remove the fuse access covers (heat exchangers) and inspect the busbar connections and ensure that the correct number of fuses are installed as per the name plate for the intended installation.
3	Replace the fuse access covers
4	1. Install suitable concrete foundations and earthing for a fixed installation; or 2. Construct a suitable plinth for a relocatable skid installation.
5	Locate the SafeARC® module in the correct location and secure using the holes in the supplied plinth or the SafeARC® itself.
6	Remove the Gland Plates and prepare for the required cable installation.
7	Remove the terminal box front covers.
8	Fit the Gland Plate and associated Cable Glands to the SafeARC® module
9	Install the lower terminal box Control and Instrument Cables, terminate and test.
10	Install the lower and upper terminal box earth cables
11	Install the lower terminal box power cables. Commencing from the rear cable location working from the rear to the front of the box on all phases simultaneously and testing the joints and connections as you go.
12	Install the upper terminal box power cables. Commencing from the rear cable location working from the rear to the front of the box on all phases simultaneously and testing the joints and connections as you go.
13	Carry out all pre-energisation tests detailed in Appendix – C Installation Typical Inspection and Test Plan and the additional site-specific requirements before energizing the Transformer
14	After energization ensure the heat exchanger controls are functioning correctly.

Preparation of Gland Plates

ATTENTION

The installation of the large CSA cables within the SafeARC® Terminal Boxes is a precise task and should be undertaken using due skill and care to avoid stress on the supply cables.

We recommend that flexible cables be utilised were ever possible for the main supply cables

The cable terminal boxes module has been designed to accept the following:

Upper Terminal Box

1. 6 x 1C 630mm^2 or smaller Power Cables Per Phase;
2. 1 x 1C 240mm^2 Earth Cable or 2 x 1C 120mm^2 Earth Cables.

Lower Terminal Box

1. 6 x 630mm^2 or smaller Power Cables Per Phase;
2. 1 x 240mm^2 Earth Cable; or 2 x 120mm^2 Earth Cables;
3. 1 x 2C+E 4mm^2 Power Cable
4. 1 x 2pr 1.5mm^2 Instrolex Cable;
5. 1 x 10C 1.5mm^2 Control Cable.

Prepare the SafeARC® Module gland plate by punching or drilling cable gland holes in the correct location for the power cables and control cable.

HMcK have supplied a gland plate template, Appendix D to assist in the preparation of the gland plates for cable installation.

ATTENTION

It is the responsibility of the Installer to select an adequate CSA and number of cables for the applicable load duty.

Ensure that only the holes required are cut in the gland plate and appropriate brass cable glands are fitted to maintain the IP rating.

Note avoid the use of blanking plates where used ensure that they maintain the IP rating of the module.

Control Cables

1. Fit correct cable gland for cable size being used;
2. Insert the control cable through the lower cable box cable gland;
3. Terminate the control cable in accordance with the appropriate schematic diagram on the terminals Figure 6 below.

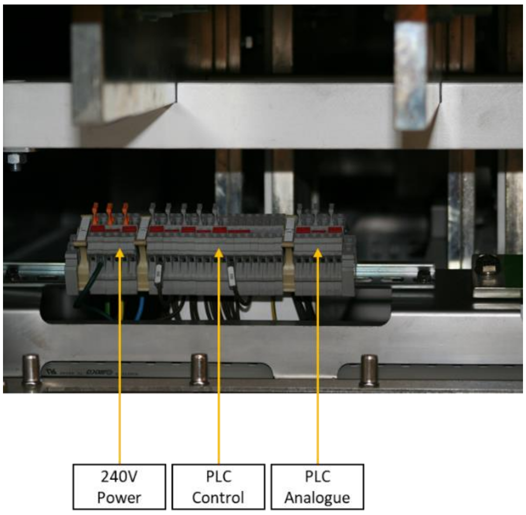


Figure 6 – Power and Control System Connections

ATTENTION

For the internally power heat exchangers the 240V power cable is not required.

Earth Cables

DANGER

The SafeARC® Module earthing system should be connected directly to the substation earthing system.

ATTENTION

SafeARC recommend that 2 x 120mm^2 earth cables be utilised in the lower and upper termination boxes.

1. Fit correct cable gland for earth cable size being used in the lower cable box;
2. Insert the earth cables through the lower cable box cable gland;
3. Terminate the earth cables on the lower earth bar, Figure 7,

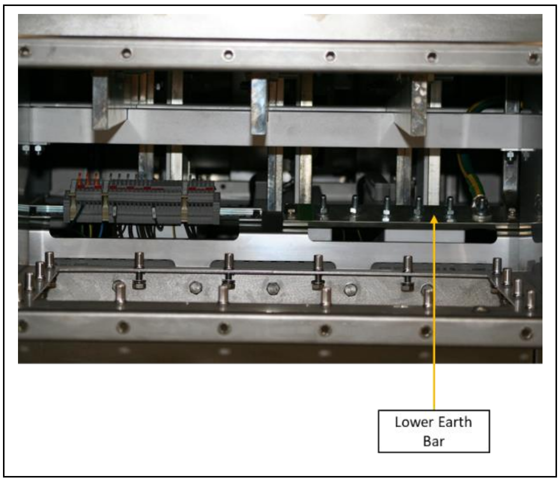


Figure 7 – Lower Earth Bar Connections

1. Fit correct cable gland for earth cable size being used in the upper cable box;
2. Insert the earth cables through the upper cable box cable gland;
3. Terminate the earth cables on the upper earth bar, Figure 8,

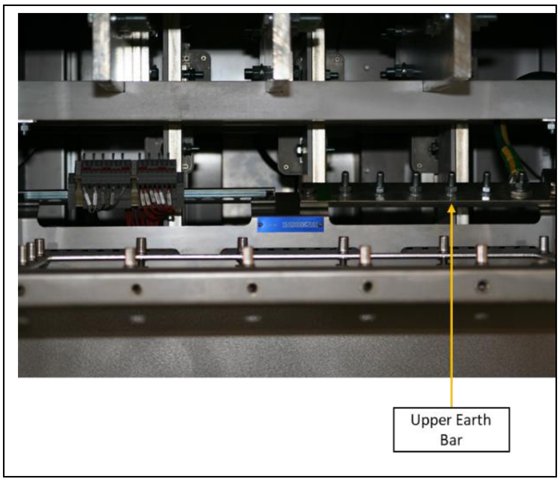


Figure 8 – Upper Earth Bar Connections

Power Cables

ATTENTION

It is the responsibility of the Installer to select an adequate CSA and number of cables for the applicable load duty.

All cables must be of sufficient size to ensure maximum energy is transferred to the MCC or Main Switchboard.

All cables must be "glanded" with suitable cable glands to ensure that the IP rating is maintained

Figure 9 – Typical 6 x 630mm^2/ Phase Installation

Figure 10 – Typical 3 x 500mm^2 / Phase Installation

1. Commencing with the lower cable termination box and layup the innermost cables firstly
2. Fit correct cable gland for cable size being used;

ATTENTION

Do not place cable lug on the cable until you have inserted it through the cable gland

3. Commencing from the most internally located cables fit the cable lugs;
4. Terminate the cables on to SafeARC® Module busbar on either side of the bar as required.
5. Ductor Test the terminations;
6. Move to the next phase and repeat Steps 1-5.
7. Move to the middle-located cable connections and repeat Steps 2-6;
8. Mover to the outer-most cable connections and repeat Steps 2-6;
9. Move to the upper cable termination box and layup the inner most cables firstly;
10. Repeat Steps 2-8 until installation is completed.

Rotation of the Arc Vent

General

The SafeARC® Module is installed with an arcing vent at the top of the module. The vent is normally facing to the right when looking at the cable termination boxes.

Should it be desired to rotate the vent the SafeARC® Module has been designed to seamlessly facilitate this procedure.

Rotation Procedure

Process

Step	Process
1	Remove the heat shield on the same side as the arc vent.
2	Remove the top four (4) spacers and tread rods and put to the side
3	Remove the heat shield on the same side as the control panel.
4	Unplug the cables from the control panel.
5	Remove the control panel and relocate it to the other side of the module.
6	Reconnect the cables to the control panel
7	Fit the heat shield below the control panel.
8	Refit the top four (4) spacers and tread rods on the other side
9	Refit the large heat shield
10	Remove the top heat shield
11	Undo the top cover and rotate 180 degrees
12	Refit the bolts in the top cover
13	Refit the top heat shield
14	Remove the top cable terminal box cover and relocate the terminal pins to the side the control box is located on.
15	Remove the bottom cable terminal box cover and relocate the terminal pins to the side the control box is located on.
16	Supply the unit with 240V on the control panel and test the operation of the control panel.
17	Replace the cable terminal box covers.

Top Cable Box Terminals

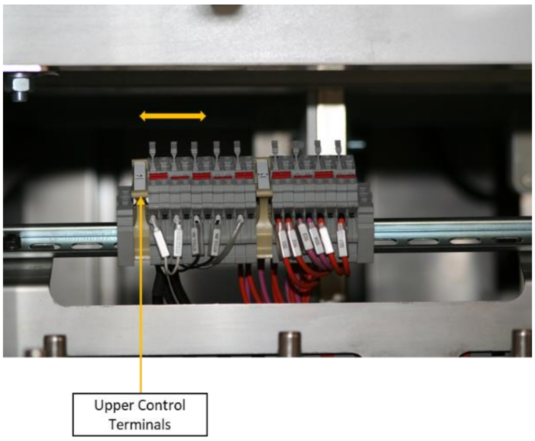


Figure 11 – Top Control Terminals

The pins shown in Figure 11 should be plugged into the terminal on the same side as the control panel.

Bottom Cable Box Terminals

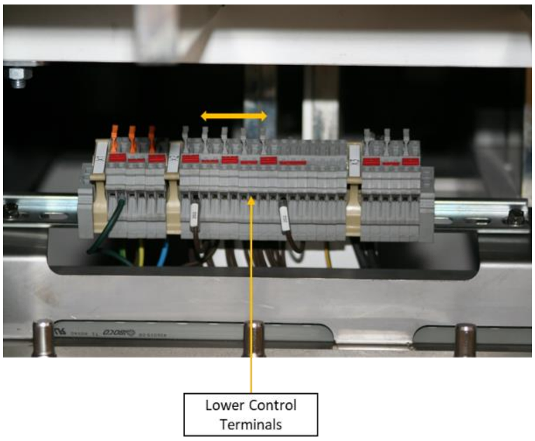


Figure 12 – Bottom Control Terminals

The pins shown in Figure 12 should be plugged into the terminal on the same side as the control panel.

SafeARC™ Technical Information

Specifications

Description

Fuses

Square body DIN43-653 stud-mount high speed fuses.

SafeARC™ Module

Type 1.1T-1.4T

Input - Transformer LV Bushing Direct Mount, Output – Cable

Type 1.1C-1.4C

Input – Cable, Output - Cable,

Physical Aspects

Dim - 895x1114x2079 (WxDxH, in mm) Tx Mounted

- 800x1200x2000 (WxDxH, in mm) Cable-In/Cable-Out

Mass - 500-1450 kg (size dependent)

Ratings

Volts: - 690Vac (IEC).

- 700Vac (UL).

Amps: - Refer Module Sizing Table for Application Voltage.

IR: - 70kA Input Bus.

200kA Output Bus.

Agency Information

Fuses

Bussmann DIN 43 653, CE, Design and tested to IEC 60269: Part 4, UL Recongnised.

SafeARC™ Module

Designed to AS\IEC 60947.1 and AS 3439.1 and tested by TUV, NATA certified test centre to AS 3439.1 for

- Short Circuit Test;
- TCC Validation;
- Dielectric Tests;
- Temperature Rise; and
- Arc Fault Containment.

Test reports available on request.

Benefits

- Low energy let-through (I^2t)
- Excellent Current Limiting Characteristics;
- Provides Low Arc Flash Incident Energy from Supply;
- Low watts loss;
- Superior cycling capability.

Features

- Automatic Internal Temperature Control;
- Temperature Analog Output;
- High-High Temperature Alarm;
- Control Power Supply Fail Alarm;
- Heat Exchanger Lock Rotor Alarm;
- Fuse Blown Alarm Each Phase;
- Rotatable Control Box Location.

Typical Module Sizing

General

The sizing of a SafeARC™ module is dependent on the following factors:

- Nominal Load Current;
- The current limiting and incident energy reduction required;
- Ambient Operating Temperature; and
- Cyclic overload considerations.

Typical recommended fuse combinations are detailed in Table 1, Table 2 and Table 3.

415V Applications

	Transformer Size	Amps @415V	No of Fuses (Phase)	Rated Current (I_N)	I_N % Safety Margin
Type 4	315 kVA	439	2	900	105%
	500 kVA	696	2	900	29%
	750 kVA	1044	3	1350	29%
Type 3	1.00 MVA	1392	4	1800	29%
	1.25 MVA	1740	5	2000	15%
	1.50 MVA	2087	6	2400	15%
	1.50 MVA	2087	7	2800	34%
Type 2	1.75 MVA	2435	7	2800	15%
	2.00 MVA	2783	7	2800	1%
	2.00 MVA	2783	8	3200	15%
Type 1	2.50 MVA	3479	8	3200	-8%
	2.50 MVA	3479	9	3600	3%
	3.00 MVA	4174	10	4000	-4%

Table 1 – Recommended SafeARC Module Size and Fuse Combination at 415Vac

480V Applications

	Transformer Size	Amps @480V	No of Fuses (Phase)	Rated Current (I_N)	I_N % Safety Margin
Type 4	315 kVA	379	1	450	19%
	500 kVA	602	2	900	50%
	750 kVA	903	3	1350	50%
Type 3	1.00 MVA	1203	3	1350	12%
	1.00 MVA	1203	4	1800	50%
	1.25 MVA	1504	5	2000	33%
	1.50 MVA	1805	6	2400	33%
	1.50 MVA	1805	7	2800	55%
Type 2	1.75 MVA	2105	6	2400	14%
	1.75 MVA	2105	7	2800	33%
	2.00 MVA	2406	7	2800	16%
	2.00 MVA	2406	8	3200	33%
Type 1B	2.50 MVA	3008	8	3200	6%
	2.50 MVA	3008	9	3600	20%
	3.00 MVA	3609	10	4000	11%

Table 2 – Recommended SafeARC Module Size and Fuse Combination at 480Vac

690V Applications

	Transformer Size	Amps @690V	No of Fuses (Phase)	Rated Current (I_N)	I_N % Safety Margin
Type 4	315 kVA	264	1	450	70%
	500 kVA	419	1	450	7%
	750 kVA	628	2	900	43%
	1.00 MVA	837	2	900	8%
	1.00 MVA	837	3	1350	61%
	1.25 MVA	1046	3	1350	29%
Type 3	1.50 MVA	1256	3	1350	7%
	1.50 MVA	1256	4	1800	43%
	1.75 MVA	1465	4	1800	23%
	1.75 MVA	1465	5	2000	37%
	2.00 MVA	1674	5	2000	19%
	2.00 MVA	1674	6	2400	43%
Type 2	2.50 MVA	2092	6	2400	15%
	2.50 MVA	2092	7	2800	34%
	3.00 MVA	2511	7	2800	12%
	3.00 MVA	2511	8	3200	27%
Type 1	4.00 MVA	3347	9	3600	8%
	4.00 MVA	3347	10	4000	20%

Table 3 – Recommended SafeARC Module Size and Fuse Combination at 690Vac

How to Select and Model Your Module

1. To select your SafeARC™ module you must first determine:
   - Transformer Size\Load Size;
   - Incident Energy Reduction Required from the Supply;
   - Maximum Demand to assess Safety Margin at the module current carrying capacity I_N.
2. Select the number of fuses based on the above tables at your rated voltage;
3. Model within your power systems software making sure you select fault current limiting fuses in the arc flash model;
4. Determine whether you wish to use transformer mounted or cable-in\cable-out module;
5. Supply the critical information to Hudson McKay so we can validate your selection.

Maintenance of Arc Flash Category Rating

The Arc Flash Risk Reduction of the SafeARC™ module is dependent on the following critical components:

- Source Impedance;
- Transformer Rating;
- Transformer Impedance;
- Impedance of MCC Supply Cable;
- Number and Size of Interrupter Modules.

Modification of any of the above may result in increasing the Arc Flash Category. You must consult a Professional Engineer to determine the risk reduction factor provided by the SafeARC™ module.

Calculating Module Current Carrying Capacity

Introduction

The rated current of a SafeARC™ module is the RMS current that the interrupters can continuously carry without degrading or exceeding the applicable temperature rise limits under well-defined and steady-state conditions.

Many conditions can affect the current carrying capability of the SafeARC™ module, and to prevent premature ageing, the following will allow the rated current selection to be on the conservative side.

Calculation of Maximum Continuous Load Current

> **ATTENTION**
>
> This part covers the basic selection criteria for the rated current of the SafeARC™ module only, and not the influence from overload and cyclic loading.

The RMS steady-state load current through the SafeARC™ module should be lower or equal to the calculated maximum permissible load current called IM

$$\boldsymbol{I_N^*} = \boldsymbol{I_F} \times \boldsymbol{K_N} \times \boldsymbol{K_t}$$

Where:

I_N	The max permissible continuous RMS load current.
I_F	Rated current of the sum of the parallel interrupters.
K_N	Number of interrupters in parallel correction factor, 0.9 < 4 interrupters, 0.8 > 4 interrupters.
K_t	Ambient temperature correction factor, refer to Figure 1. K_t = 1 @ 35°C.
*	For any periods of 10 minutes duration or more the RMS-value of the load current should not exceed this.

Temperature Correction Factor K_t

The curve in Figure 13 shows the influence of the ambient temperature on the current carrying capability of the forced cooled SafeARC™ module.

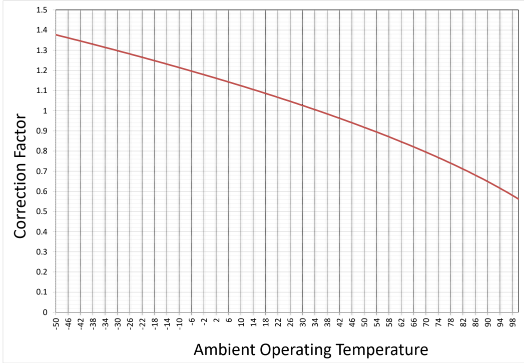


Figure 13 – Temperature Correction Factor K_t

The temperature correction factor at temperature θ can also be obtained by the following equation:

$$K_t = \sqrt{\frac{130 - \theta}{95}}$$

Forced Cooling

In many installations the SafeARC™ modules are force- cooled with a closed system, heat exchanger to achieve maximum continuous current ratings. The equation listed for temperature correction are based on test results from these models.

For naturally air ventilated or fan forced cooled modules the temperature correction factor can be found from the vendor's semi-conductor fuse guides.

Confirmation of SafeARC™ Module Continuous Current Rating

The maximum permissible steady-state load current I_N of a SafeARC™ module can be checked empirically by making simple voltage measurements under actual operating conditions after the module has been installed in its operating location and loaded at the calculated I_N value.

$$\frac{E_2}{E_1 \times (0.92 + 0.004 \times t)} \leq N$$

Where

E_1	Voltage drop across the interrupters after 5 seconds.
E_2	Voltage drop across interrupters after 2 hours.
t	Air temperature at start of test in C°.
N	Constant = 1.5

Operation at Sustained Overloads

The term "overload" is used for excess current flowing in a circuit which is electrically sound. Overload currents are usually not much greater than the normal full-load current I_N, but if allowed to persist they will eventually cause SafeARC™ module fuse operation and/or fuse fatigue.

The operation of the SafeARC™ module depends primarily on the balance between the rate of heat generated within interrupter elements and the rate of heat dissipated to external connections and surrounding atmosphere. For current values up to the continuous maximum rating of the SafeARC™ module the design generally ensures that all the heat generated is dissipated without exceeding the pre-set maximum temperatures of the element or other components.

Under conditions of sustained overloads the rate of heat generated is greater than that dissipated and this causes the temperature of the interrupters to rise. The temperature rise at the reduced sections of the interrupters (restrictions) will be higher than elsewhere and once the temperature has reached the melting point of the interrupter material, the element will break, thus isolating the circuit. The time taken for the element to break will naturally decrease with increasing values of current.

Maximum Allowable Surges and Overloads

ATTENTION

When using the published characteristics in this manual:

- The characteristics are subject to a 5% tolerance on current;
- For times below 1 s, circuit constants and the instant in the cycle of the fault occurrence affect the time/current characteristics. Minimum nominal times are published relating to symmetrical RMS currents; and
- Pre-loading at maximum current rating reduces the actual melting time.

Effects of cyclic loading or transient surges can be considered by co-ordinating the effective RMS current values and durations of the surges with the time current characteristics

Time durations fall into two categories:

- Overloads longer than one second.
- Overloads less than one second, termed impulse loads.

The following Table 4 gives general application guidelines. In the expression Imax < (% factor) x I_t, It is the melting current corresponding to the time »t« of the overload duration as read from the time/current curve of the SafeARC™ Interrupters.

Frequency of Occurrence	Overloads (> 2sec)	Impulse Loads (<1sec)
Less than one time per month	Imax < 80% x I_t	Imax < 70% x I_t
Less than twice per week	Imax < 70% x I_t	Imax < 60% x I_t
Several times per day	Imax < 60% x I_t	Imax < 0% x I_t

Table 4 – Overload/Surge Withstand Table

Cyclic Loading

Cyclic means that the load current is variable, with a repetitive cyclic nature. If the cycle contains overloads in excess of I_N it is also necessary to check the magnitude of the overload current in relation to the melting time-current characteristic of the fuse.

Cyclic loading fatigue and can be defined as regular or irregular variations of the load current, each of a sufficient size and duration large enough to change the temperature of the elements inside the fuse in such a way that the very sensitive weak spots develop which will lead to premature fuse.

In order to avoid this, empirical rules are used to ensure that there is an appropriate safety margin. Using empirical rules will cover most cyclic loading situations, but it is impossible to set up general rules for all situations.

When both empirical rule conditions are satisfied, this should ensure sufficient longevity of the interrupters subjected to the given loadings.

Empirical Rule 1

$$I_N > I_{c(RMS)} \times G$$

Where:

I_N Is the max permissible load current.
$I_{C(RMS)}$ Is the RMS value of the cyclic loading;
G Sufficient safety margin is assured by using G = 1.6.

Empirical Rule 2

Empirical Rule 1 should be followed by a check to see if the individual load pulses each expressed in (I_{pulse}, t_{pulse}) coordinates have a sufficient safety margin B in relation to I_t of the melting curve of the fuse found based upon Empirical Rule 1.

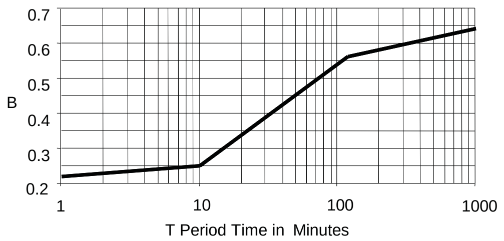


Figure 14 – Cyclic Pulse Factor B

$$I_{pulse} < I_t \times B$$

Where

I_t is the melting current of the fuse corresponding to $t=t_{pulse}$.

B found using Figure 14.

Avoiding The TCC AA Curve Characteristic

In connection with the TCC curve an AA-designation is given to part of the curve. Operation of the SafeARC™ module in this area of the curve should be avoided. Operation in this area may reduce the interrupting capacity of the fuses.

Total Clearing I^2T

The total clearing I^2t at rated voltage and at power factor of 15% are given in the electrical characteristics.

For other voltages and fault current power factors, the clearing I^2t is found by multiplying by voltage correction factor, K, given as a function of applied working voltage, Eg, (rms) and X, as a function of the fault current power factor.

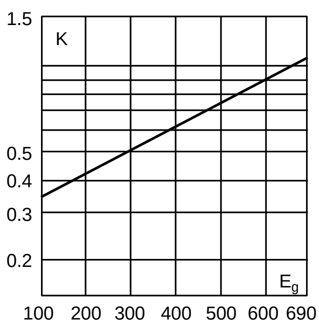


Figure 15 – I^2t Voltage Correction Factor K

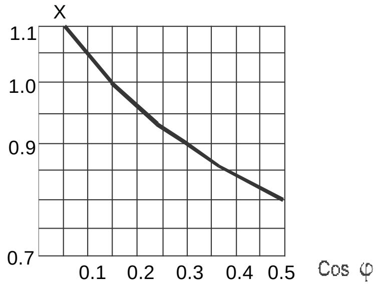


Figure 16 – I^2t Power Factor Correction Factor X

Rated Voltage Dimensioning

Voltage Rating

The voltage rating of the SafeARC™ module indicates the AC system voltage at which it is designed to operate. The SafeARC™ module is rated for the stated $AC_{(RMS)}$ voltages at 45-62Hz.

To properly protect any system, the SafeARC™ module voltage rating must be at least equal to the system voltage in question

IEC Voltage Ratings

IEC requires AC voltage tests to be performed at 110 percent of the rated voltage, with power factors between 10 and 20 percent.

This enables the SafeARC™ module to be used at rated voltage while maintaining high dielectric strength.

North America Voltage Ratings

North American Voltage rating requires that all fuses should be tested at their rated voltage only, with power factors between 15 and 20 percent.

As the SafeARC™ module has been submitted to IEC testing operation at the rated voltage is assured.

Arc Voltage

The peak arc voltage of the SafeARC™ module fuses should be lower than the peak transient voltage withstand of the installation (BIL).

When the fuse melts, the current has reached a given level during the melting time. But an arc voltage is generated due to the specially designed restrictions (necks) that are packed in sand. This forces the current to zero during the arcing time and finally isolation is established.

The curve in Figure 17, gives the peak arc voltage, U_L, which may appear across the fuse during its operation as a function of the applied working voltage, E_g, (rms) at a power factor of 15%.

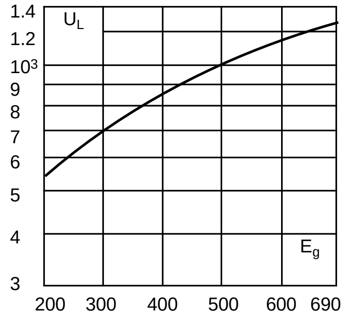


Figure 17 – Peak Arc Voltage

Power Losses

Watts loss at rated current is given in the electrical characteristics.

The curve, Figure 18, shows the power losses at load currents lower than the rated current.

The correction factor, K_p, is given as a function of the RMS load current, I_N, in % of the rated current.

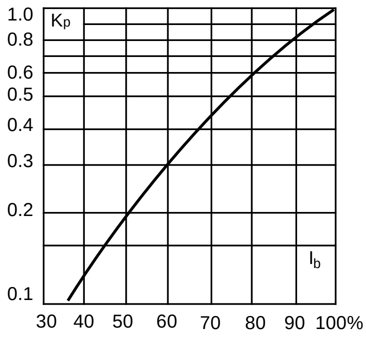


Figure 18 – Power Loss Correction Factor

EXAMPLE CALCULATIONS

Calculation, I_N

A SafeARC™ module with 8 x 500A rated square body interrupters is applied at an ambient temperature of 40C°, and wired with 6 cables per phase with a cross sectional area of 500 mm². What would be the maximum allowed steady-state RMS current I_N?

$$\boldsymbol{I_N^* = I_F \times K_N \times K_t}$$

Where

I_F = 8 x 500A = 4000A;
K_N = 0.8, for 8 interrupters;
K_t = 0.97, Figure 13 for 40C° ambient;

Therefore

$$\boldsymbol{I_N^* = 4000 \times 0.8 \times 0.97}$$
$$\boldsymbol{I_N^* = 3104\ A}$$

Allowable Overload Calculation, I_{max}

A 3200A (8x500A) SafeARC™ module has been selected and will be subjected to temporary overloads of 5000 Amps, I_{max}, of 5 seconds duration each. These overloads occur 3-5 times a day.

From the extension of the time current curve of the module, Appendix B, (8x500A), we find I_t: the melting current corresponding to the time t=5 sec of the overload duration to be: I_t=9500A.

From Table 4 – Overload/Surge Withstand Table, we find the actual limit is:

$$I_{max} < 60\% \ \times I_t$$

Therefore

$$I_{max} < 60\% \ \times 9500$$
$$I_{max} < 5700A$$

This means that temporary overloads of up to 5000A can be accepted and thus the 3200A SafeARC™ module selected and subjected to the 5000A for 5 seconds 3-5 times a day, will work correctly in this application.

Cyclic Loading

The SafeARC™ module is to be operated in a system with the following cyclic load.

3000A for 2 minutes followed by 2400A for 15 minutes, which gives I_{RMS}=2478A as RMS-value of the cyclic loading. Period time of T=17 minutes.

Using Empirical Rule 1

$$I_N > I_{c(RMS)} \times G$$

With cyclic load factor of G = 1.6.

Therefore

$$I_N > 2478 \times 1.6$$
$$I_N > 3965\text{A}$$

This rule is not satisfied under these conditions.

Using Empirical Rule 2

$$I_{pulse} < I_t \times B$$

Where I_t = 10,500A at t = 2 minutes the time current curve of the module, Appendix B, (8x500A) and B = 0.32 from Figure 14 – Cyclic Pulse Factor.

$$I_{pulse} < 10{,}500 \times 0.32$$
$$I_{pulse} < 3360A$$

In the actual case I_{pulse}=3000A, and therefore the above condition is fulfilled.

Conclusion

That a 3200A module would require its fuses to be changed periodically (every 2 years) which is the recommended process or before the average time to failure experienced in the real application.

Alternatively a 3600A or 4000A module could be employed to provide continuous service for a maximum of 10 years.

The trade-off however could be higher resultant Incident Energy and therefore arc flash risk.

INTERRUPTER REPLACEMENT

INTRODUCTION

General

DANGER

Risk of Electric Shock, This equipment must be completely de-energised before performing these activities ensure that the high voltage and low voltage energy sources has been identified and positively isolated.

Failure to do so may result in death or serious injury.

This procedure is for the replacement of the SafeARC™ Module fuses.

Maintaining Interrupter Reliability

Load sharing across the parallel fuses is essential to prevent premature rupture. Load sharing will only be achieved through attention to detail during installation, e.g. flat & clean contact surfaces, correctly torqued connection bolts.

Fuse life is a function of load cycling, thermal cycling and operating temperature. The rupture of a single fuse will stress the remaining fuses connected in parallel. It is important that all fuses associated with that phase are changed out.

Similarly, if all the fuses on a single-phase rupture, the transformer will attempt to support the load on the remaining two phases which will stress these fuses. In this case all fuses on all phases MUST be replaced.

Installation of "used" fuses should only be considered as a last resort

Using the Correct Fuse Size

CAUTION

Installing the incorrect number and size of fuses may negate the Arc Flash category rating resulting in serious injury should an event occur.

Fuse sizes and the number of fuses have been carefully selected to provide security against unintended rupture and limiting fault current and reducing fault clearing times. The electrician must not substitute fuses without consultation with a professional engineer.

TOOLS REQUIRED

The following tools are required to replace the interrupters:

1. High voltage barricade and stands;
2. Short section of portable scaffold (no wheels) one deck. Bracing and rope to tie off where necessary for stability. (Required to provide a stable work platform over the 415V cable trays).
3. Battery powered rattle gun c/w 19mm impact socket;
4. 16mm & 17mm open ended/ring spanners;
5. 1/2" drive ratchet handle c/w 16mm & 17mm sockets;
6. 1/2" drive torque wrench capable of 50Nm;
7. "Never Seize" (for external bolts of fuse cover plate only).
8. Tarp or cover to cover area under scaffold;
9. Clean rags to wipe over worked areas;
10. Permanent marker pen to label fuses.

Personnel Competencies Required

Isolation

High Voltage Qualified Electrician\Isolator to carry out switching and isolation.

Interrupter Replacement

Qualified Supervisor - Electrician assisted by electrician or trades assistant

Isolation Requirements

HV Isolation

CAUTION

HV Isolation to be performed by HV qualified Electrician.

1. Isolate and earth the HV Circuit Breaker or Fuse Switch supplying the HV side of the transformer that the SafeARC™ Module is connect to in accordance with site procedures.

LV Isolation

CAUTION

Isolation of all incomer MCB is required to prevent back feed of electrical energy to the SafeARC™ Module.

2. Isolate all incomer MCB's connected to the transformer. Caution: there maybe more than one MCB in accordance with site procedures.

Procedure

To replace the interrupters reference the procedure below. Note it takes approximately 3 hours to change the interrupters.

Preparation

1. Position High voltage stands and barricades around High voltage work area.
2. Sign onto high voltage work permit and lock onto lock box
3. Erect portable scaffold (no wheels) over cables and cable tray, stabilize with bracing and insert platform deck.
4. Place tarp under scaffold and over incomers to catch and dropped items eg fuse rupture micro switch retention springs.
5. Utilize rattle gun to remove external bolts from fuse cover plate, the 16/17mm spanners will be required to remove the nuts on the locating studs.
6. Unplug heat exchangers;
7. Remove heat shields;
8. Remove fuse cover plate (Two people are required to remove this plate!).

Interrupters

1. Begin with the right hand phase (one phase at a time)
2. Grip the blown fuse indicators from each side and wriggle free
3. Loosen the front bolt enough for the fuse to move (requires 16/17mm spanners and sockets)
4. Loosen the rear bolt till 20mm of thread exposed
5. Lift fuse out (top of set up and bottom down)
6. The bottom fuse will require the removal of the bolts completely
7. Mark each fuse removed with the date of removal
8. Inspect the contact surfaces of the busbar for any pitting or distortion, rectify if required
9. Starting with the bottom fuse, fit the blown fuse indicator, mark fuse with the date installed and finger tighten bolts
10. Fit the remaining date marked phase fuses into place and finger tighten
11. Torque each bolt on the fuses to 50Nm and witness mark each bolt once bolts are at correct tension
12. Check the blown fuse indicators for correct positioning (red plunger shouldn't be visible when correctly installed). Test integrity of blown fuse indication at the terminal strip in the bottom of the module;

13. Repeat steps 2. to 12. for the middle phase
14. Repeat steps 2. to 12. for the left hand phase (most difficult).

Final Completion

1. Check for any loose items or materials inside enclosure, remove if necessary;
2. Carry out doctor testing of fuse joints;
3. Thoroughly inspect for any phase to earth and phase to phase fault paths;
4. Check seal around fuse cover plate is in good order, refit cover plate and apply small amount of never seize to external bolts;
5. Plug in heat exchangers;
6. Fit Heat Shields’
7. Check area; pick up all tools and rubbish. Remove locks, sign off permit and remove barricading.

Testing and Inspection

During initial installation of the SafeARC™ Module and after fuse replacement the following minimum tests should be carried out:

1. General Visual Inspection;
2. Ductor Testing of all joints made during installation;
3. Insulation Testing;
4. Heat Exchanger Testing.

A typical procedure and test record sheet is contained in Appendix C.

POST SAFEARC™ MODULE OPERATION EVENT

If a short circuit event triggers the SafeARC™ Module to operate perform the following steps;

1. Verify all 3 phases of the SafeARC™ Module have been interrupted and isolated;
2. Isolate the downstream low voltage supply main isolator/s;
3. Isolate the upstream high voltage supply;
4. Verify that the short circuit condition has been cleared and rectified;
5. Replace all SafeARC™ Module Interrupters in accordance with the procedure contained within;
6. Re -energise the system.

Maintenance

General

The SafeARC™ Module sized correctly will have very low maintenance requirements. Routine Maintenance will be essentially limited to the Heat Exchange Unit.

6 Monthly

- Inspect heat exchanger external cooling fan operation and replace as required.

2 Yearly

- Inspect heat exchanger external cooling fan operation and replace as required.
- Inspect heat exchanger internal cooling fan operation and replace as required.
- Replace fuse interrupters if the installation experiences high cyclic loads or high ambient temperatures.

4 Yearly

- Replace fuse interrupters;
- Ductor test all joints.

Trouble Shooting

The following chart is a simple trouble shooting checklist only. If the suggested solution does not succeed, or if the information is insufficient to solve the problem please contact HUDSON MCKAY.

	Problem	Possible Cause	Solution
1	Interrupters failing in expectantly	Overload/Cyclic Loading	Measure and confirm that the nominal current does not exceed the interrupter nominal installed rating
		High Internal Temperatures	Ensure that the Heat Exchanger is operating correctly
2	High Internal Temperatures	Current requirements exceed nominal rating	Refer to Item 1
		Heat Exchanger Failure	Check that 240Vac is present; Check that 48Vdc is present; Check that the Moore SPA 2 Temperature Controller is Functional; Check that the control relay is functional; Check that heat exchangers are plugged in.
3	240Vac not present	Blown Internal Supply Fuse	Isolate unit and replace 240Vac supply fuse.
4	Heat Exchanger Not Operating Correctly	Failure of Cooling Fans	Check operation of External Fans and replace if necessary; Check operation of Internal Fans and replace if necessary; Check operation of RTD connected to Moore SPA 2 Temperature Controller.
5	Interrupter indicates failed when fuses are ok	Fuse Blow Indication Micro-switch Failed	Replace micro-switches

APPENDIX – A

ELECTRICAL CHARACTERISTICS

	SafeARC™ Electrical Characteristics @ 415Vac							
	Transformer Size	Amps @415V	No of Fuses (Phase)	Rated Current (I_N)	I_N % Safety Margin	I^2t (A^2S) Pre-arc	I^2t (A^2S) Clearing at 415V	Watts Loss
Type 4	315 kVA	439	2	900	105%	35280	150822	570
	500 kVA	696	2	900	29%	35280	239400	570
	750 kVA	1044	3	1350	29%	79380	538650	855
Type 3	1.00 MVA	1392	4	1800	29%	141120	957600	1140
	1.25 MVA	1740	5	2000	15%	220500	1496250	1425
	1.50 MVA	2087	6	2400	15%	317520	2154600	1710
	1.50 MVA	2087	7	2800	34%	432180	2932650	1995
Type 2	1.75 MVA	2435	7	2800	15%	432180	2932650	1995
	2.00 MVA	2783	7	2800	1%	432180	2932650	1995
	2.00 MVA	2783	8	3200	15%	564480	3830400	2280
Type 1	2.50 MVA	3479	8	3200	-8%	564480	3830400	2280
	2.50 MVA	3479	9	3600	3%	714420	4847850	2565
	3.00 MVA	4174	10	4000	-4%	882000	5985000	2850

I^2t calculated from publish data, test results indicate this is conservative.
Interrupting rating 200kA (estimated 300kA) RMS Symmetrical
I_N Safety Margin is at rated transformer current
Watts Loss is the heat generated in the fuse body and disapated by the heat changers

	SafeARC™ Electrical Characteristics @ 480Vac							
	Transformer Size	Amps @480V	No of Fuses (Phase)	Rated Current (I_N)	I_N % Safety Margin	I^2t (A^2S) Pre-arc	I^2t (A^2S) Clearing at 480V	Watts Loss
Type 4	315 kVA	379	1	450	19%	9800	46550	285
	500 kVA	602	2	900	50%	39200	266000	570
	750 kVA	903	3	1350	50%	88200	598500	855
Type 3	1.00 MVA	1203	3	1350	12%	88200	598500	855
	1.00 MVA	1203	4	1800	50%	156800	1064000	1140
	1.25 MVA	1504	5	2000	33%	245000	1662500	1425
	1.50 MVA	1805	6	2400	33%	352800	2394000	1710
	1.50 MVA	1805	7	2800	55%	480200	3258500	1995
Type 2	1.75 MVA	2105	6	2400	14%	352800	2394000	1710
	1.75 MVA	2105	7	2800	33%	480200	3258500	1995
	2.00 MVA	2406	7	2800	16%	480200	3258500	1995
	2.00 MVA	2406	8	3200	33%	627200	4256000	2280
Type 1	2.50 MVA	3008	8	3200	6%	627200	4256000	2280
	2.50 MVA	3008	9	3600	20%	793800	5386500	2565
	3.00 MVA	3609	10	4000	11%	980000	6650000	2850

I^2t calculated from publish data, test results indicate this is conservative.
Interrupting rating 200kA (estimated 300kA) RMS Symmetrical
I_N Safety Margin is at rated transformer current
Watts Loss is the heat generated in the fuse body and disapated by the heat changers

	SafeARC™ Electrical Characteristics @ 690Vac							
	Transformer Size	Amps @690V	No of Fuses (Phase)	Rated Current (I_N)	I_N % Safety Margin	I^2t (A^2S) Pre-arc	I^2t (A^2S) Clearing at 690V	Watts Loss
Type 4	315 kVA	264	1	450	70%	15400	114950	285
	500 kVA	419	1	450	7%	15400	104500	285
	750 kVA	628	2	900	43%	61600	418000	570
	1.00 MVA	837	2	900	8%	61600	418000	570
	1.00 MVA	837	3	1350	61%	138600	940500	855
	1.25 MVA	1046	3	1350	29%	138600	940500	855
Type 3	1.50 MVA	1256	3	1350	7%	138600	940500	855
	1.50 MVA	1256	4	1800	43%	246400	1672000	1140
	1.75 MVA	1465	4	1800	23%	246400	1672000	1140
	1.75 MVA	1465	5	2000	37%	385000	2612500	1425
	2.00 MVA	1674	5	2000	19%	385000	2612500	1425
	2.00 MVA	1674	6	2400	43%	554400	3762000	1710
Type 2	2.50 MVA	2092	6	2400	15%	554400	3762000	1710
	2.50 MVA	2092	7	2800	34%	754600	5120500	1995
	3.00 MVA	2511	7	2800	12%	754600	5120500	1995
	3.00 MVA	2511	8	3200	27%	985600	6688000	2280
Type 1	4.00 MVA	3347	9	3600	8%	1247400	8464500	2565
	4.00 MVA	3347	10	4000	20%	1540000	10450000	2850

I^2t calculated from publish data, test results indicate this is conservative.
Interrupting rating 200kA (estimated 300kA) RMS Symmetrical
I_N Safety Margin is at rated transformer current
Watts Loss is the heat generated in the fuse body and disapated by the heat changers

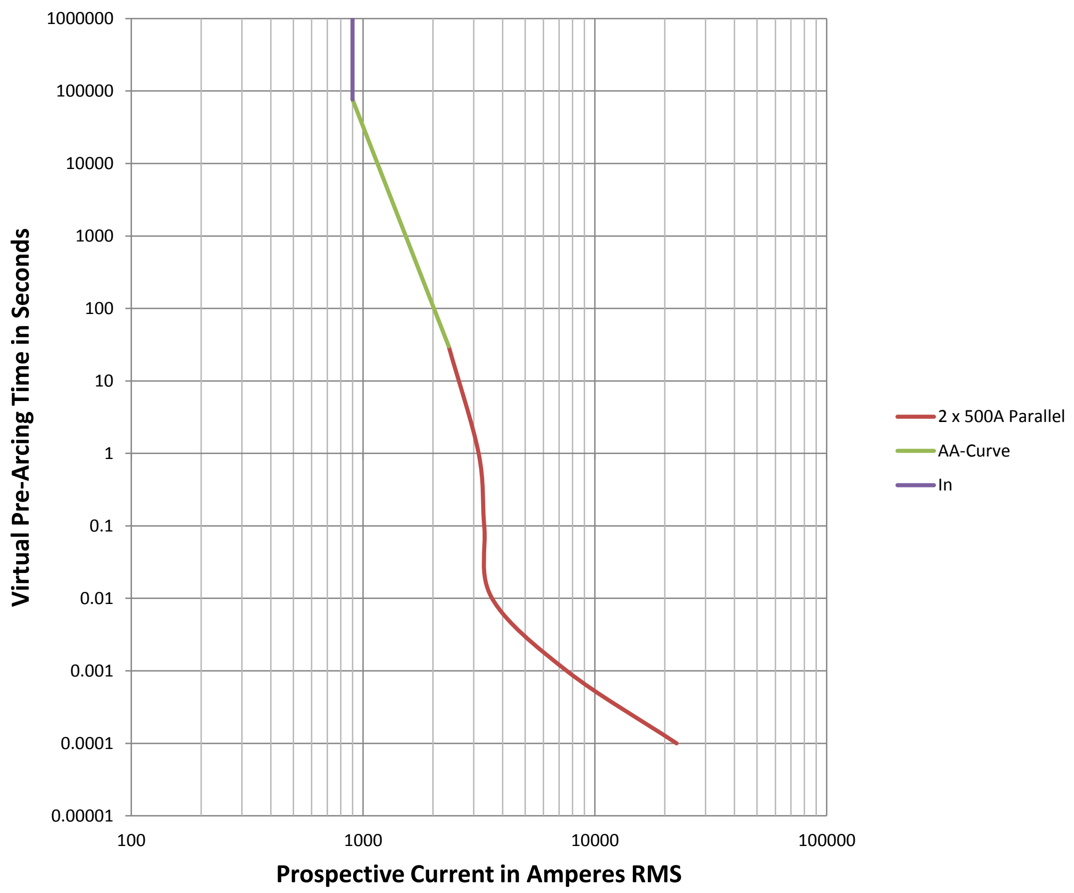
APPENDIX – B

TIME CURRENT CURVES

Semi-Conductor Fuse Parallel Interrupter Specifications

Nominal Voltage	690Vac	**Our Ref**	10BNEPRD001440TS007R0
Interrupter Size	500A	**Interrupting Capacity**	200kA RMS Symmetrical
No	2	**Watts Loss**	95 Watts/Interrupter @ Rated Current
Nominal SafeARC Current Rating	900A	**Ambient Temperature**	35 deg C

SafeARC™ Module - 2 x 500A Interrupters

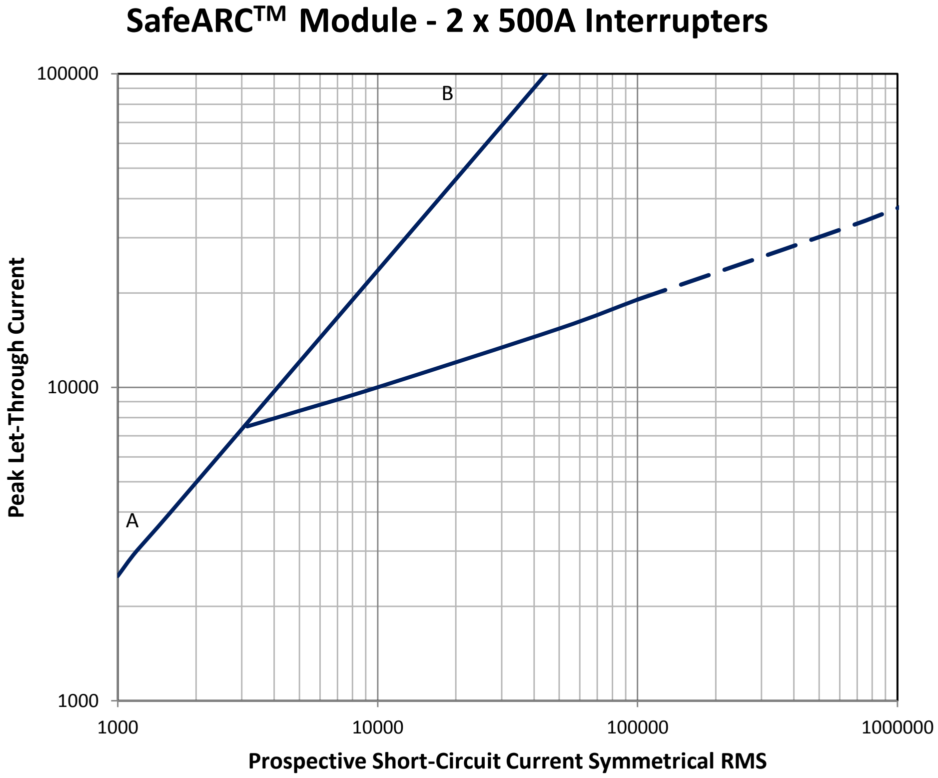


Pre-Arcing - Time Current Characteristic Curve	Approved:	BSG	Figure	1 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. AA-Curve is indicated by a constant gradient line in order to be able to draw the complete curve;
2. Operation above the AA-Curve is not recommended even though the actual melting curve may provide a higher value;
3. Actual operating characteristics of the SafeARC™ Module are dependent on the ambient temperature, cooling employed, cyclic loading profiles and overload durations.

SafeARC™ Module - 2 x 500A Interrupters



Peak Let - Through - Cut-Off Current Characteristic Curve	Approved:	BSG	Figure	2 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Maximum interrupting capacity 200kA RMS symmetrical.

Current	Time
900	1000000
900	114750
2340	30
3150	1
3330	0.1
3600	0.01
7560	0.001
22500	0.0001

Pre-Arcing - Time Current Curve Characteristic Data Points	Approved:	BSG	Figure	3 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

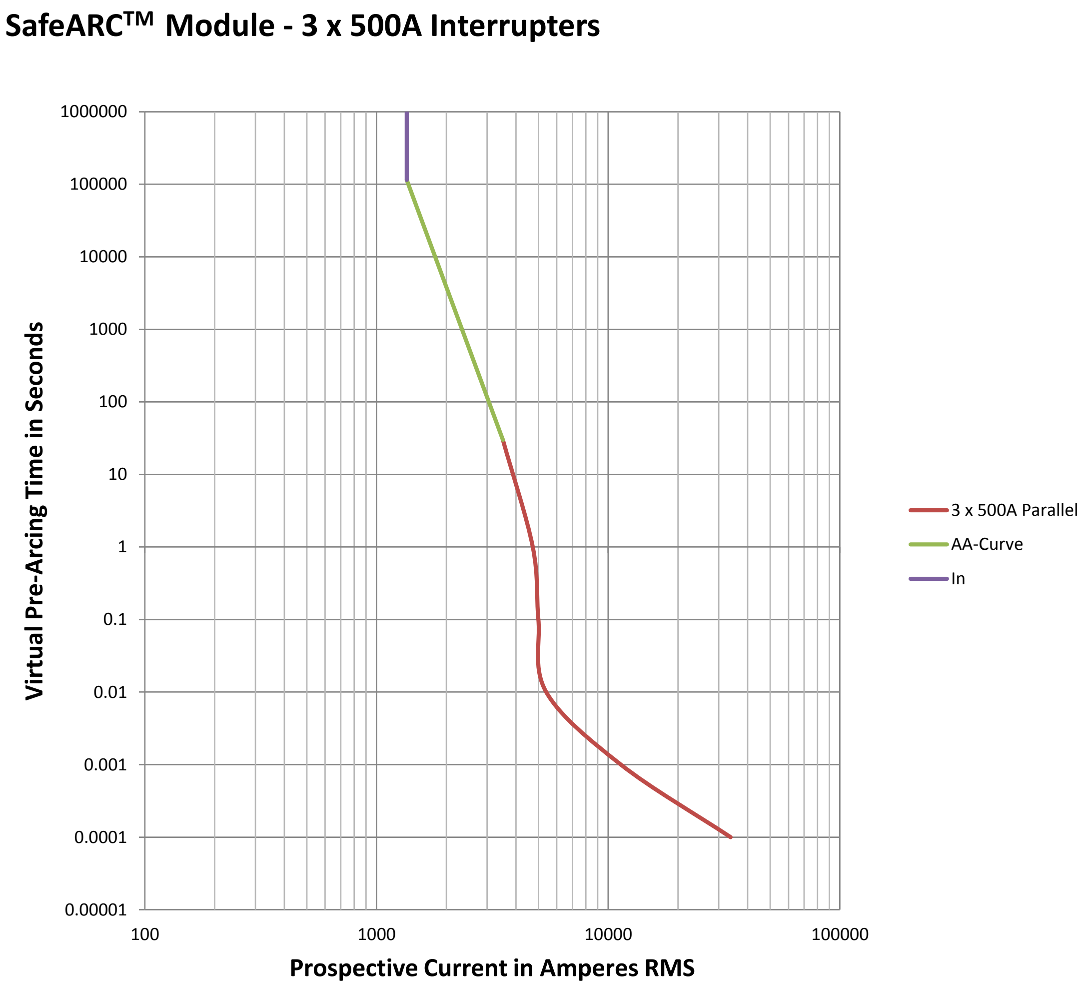
Notes

1. Data points above for entry in to SKM PowerTools Device Library.

Safe ARC
Arc Flash Protection System

Hudson McKay

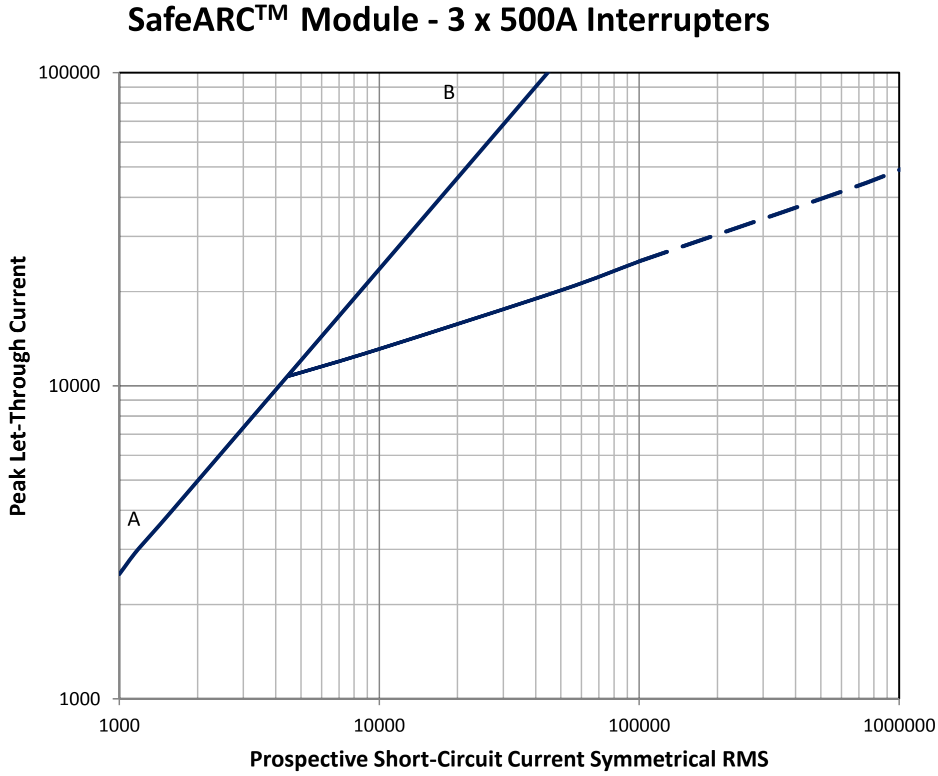
Semi-Conductor Fuse Parallel Interrupter Specifications			
Nominal Voltage	690Vac	**Our Ref**	10BNEPRD001440TS006R0
Interrupter Size	500A	**Interrupting Capacity**	200kA RMS Symmetrical
No	3	**Watts Loss**	95 Watts/Interrupter @ Rated Current
Nominal SafeARC Current Rating	1350A	**Ambient Temperature**	35 deg C



Pre-Arcing - Time Current Characteristic Curve	Approved:	BSG	Figure	1 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. AA-Curve is indicated by a constant gradient line in order to be able to draw the complete curve;
2. Operation above the AA-Curve is not recommended even though the actual melting curve may provide a higher value;
3. Actual operating characteristics of the SafeARC™ Module are dependent on the ambient temperature, cooling employed, cyclic loading profiles and overload durations.



Peak Let - Through - Cut-Off Current Characteristic Curve	Approved:	BSG	Figure	2 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Maximum interrupting capacity 200kA RMS symmetrical.

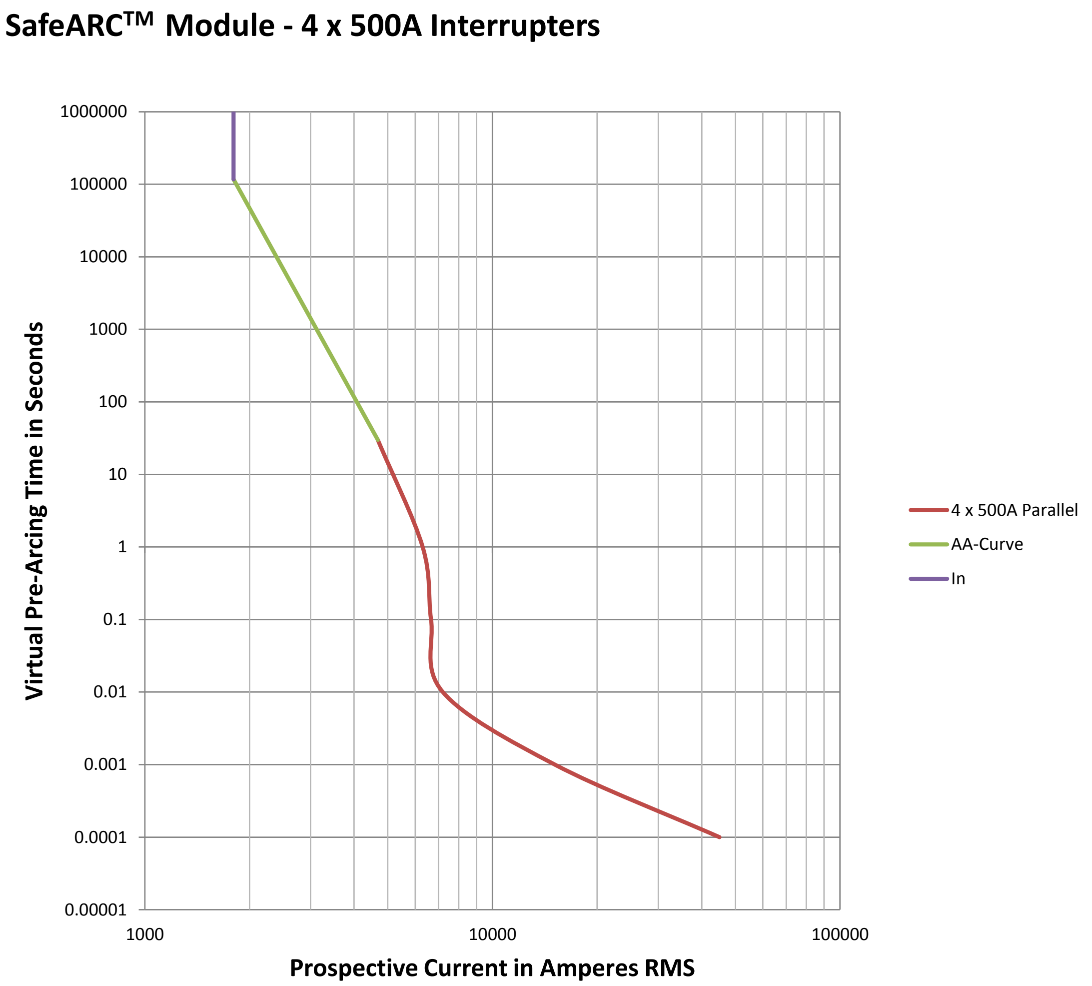
Current	Time
1350	1000000
1350	114750
3510	30
4725	1
4995	0.1
5400	0.01
11340	0.001
33750	0.0001

Pre-Arcing - Time Current Curve Characteristic Data Points	Approved:	BSG	Figure	3 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Data points above for entry in to SKM PowerTools Device Library.

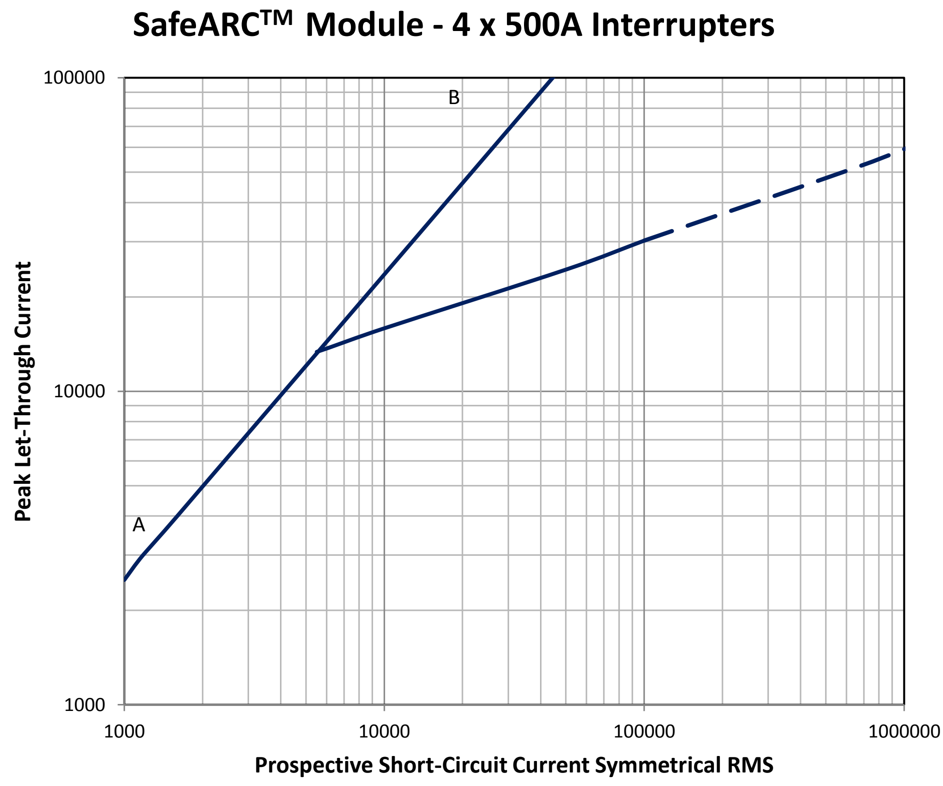
Semi-Conductor Fuse Parallel Interrupter Specifications			
Nominal Voltage	690Vac	**Our Ref**	10BNEPRD001440TS005R0
Interrupter Size	500A	**Interrupting Capacity**	200kA RMS Symmetrical
No	4	**Watts Loss**	95 Watts/Interrupter @ Rated Current
Nominal SafeARC Current Rating	1800A	**Ambient Temperature**	35 deg C



Pre-Arcing - Time Current Characteristic Curve	Approved:	BSG	Figure	1 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. AA-Curve is indicated by a constant gradient line in order to be able to draw the complete curve;
2. Operation above the AA-Curve is not recommended even though the actual melting curve may provide a higher value;
3. Actual operating characteristics of the SafeARC™ Module are dependent on the ambient temperature, cooling employed, cyclic loading profiles and overload durations.



Peak Let - Through - Cut-Off Current Characteristic Curve	Approved:	BSG	Figure	2 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Maximum interrupting capacity 200kA RMS symmetrical.

Current	Time
1800	1000000
1800	117000
4680	30
6300	1
6660	0.1
7200	0.01
15120	0.001
45000	0.0001

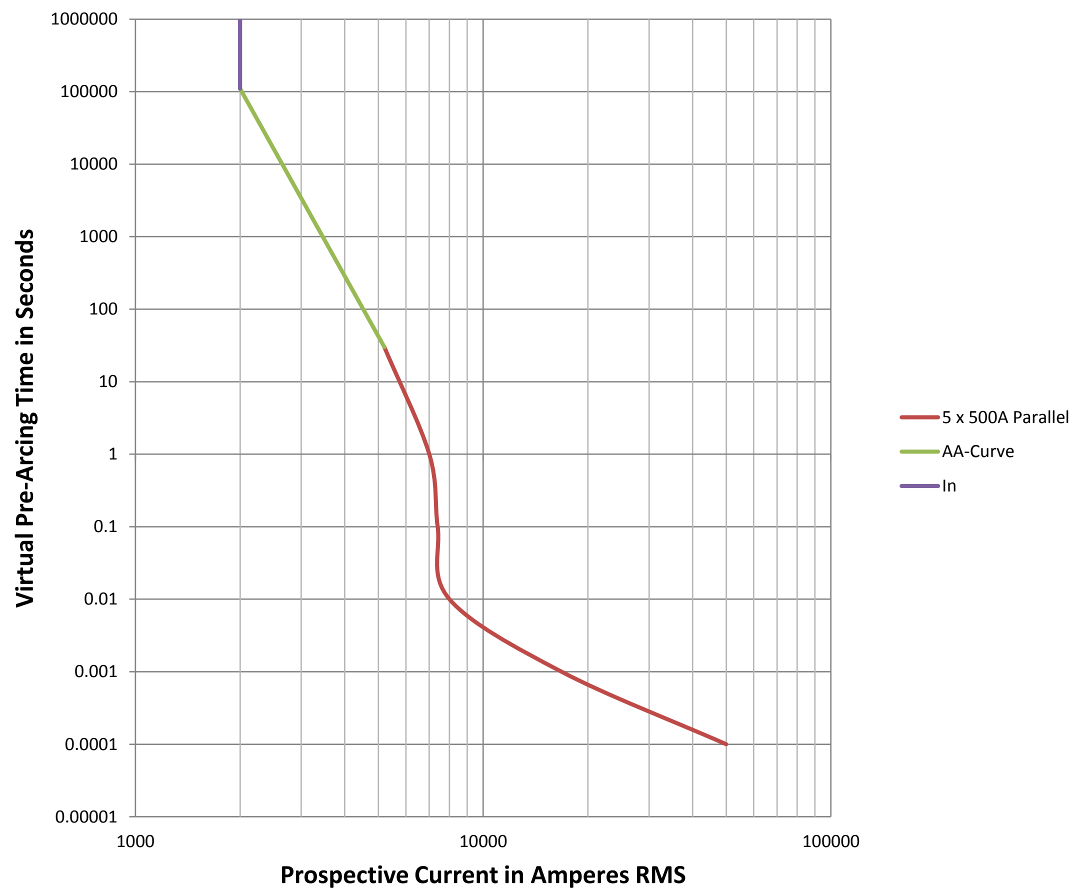
Pre-Arcing - Time Current Curve Characteristic Data Points	Approved:	BSG	Figure	3 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Data points above for entry in to SKM PowerTools Device Library.

Semi-Conductor Fuse Parallel Interrupter Specifications			
Nominal Voltage	690Vac	**Our Ref**	10BNEPRD001440TS004R0
Interrupter Size	500A	**Interrupting Capacity**	200kA RMS Symmetrical
No	5	**Watts Loss**	95 Watts/Interrupter @ Rated Current
Nominal SafeARC Current Rating	2000A	**Ambient Temperature**	35 deg C

SafeARC™ Module - 5 x 500A Interrupters

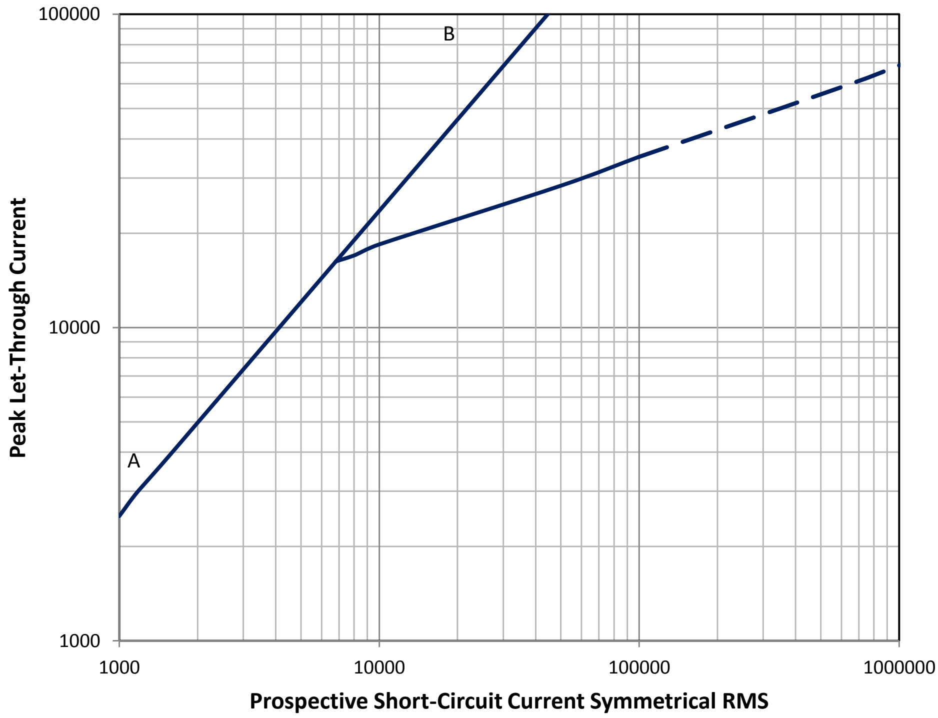


Pre-Arcing - Time Current Characteristic Curve	Approved:	BSG	Figure	1 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. AA-Curve is indicated by a constant gradient line in order to be able to draw the complete curve;
2. Operation above the AA-Curve is not recommended even though the actual melting curve may provide a higher value;
3. Actual operating characteristics of the SafeARC™ Module are dependent on the ambient temperature, cooling employed, cyclic loading profiles and overload durations.

SafeARC™ Module - 5 x 500A Interrupters



Peak Let - Through - Cut-Off Current Characteristic Curve	Approved:	BSG	Figure	2 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Maximum interrupting capacity 200kA RMS symmetrical.

Current	Time
2000	1000000
2000	110000
5200	30
7000	1
7400	0.1
8000	0.01
16800	0.001
50000	0.0001

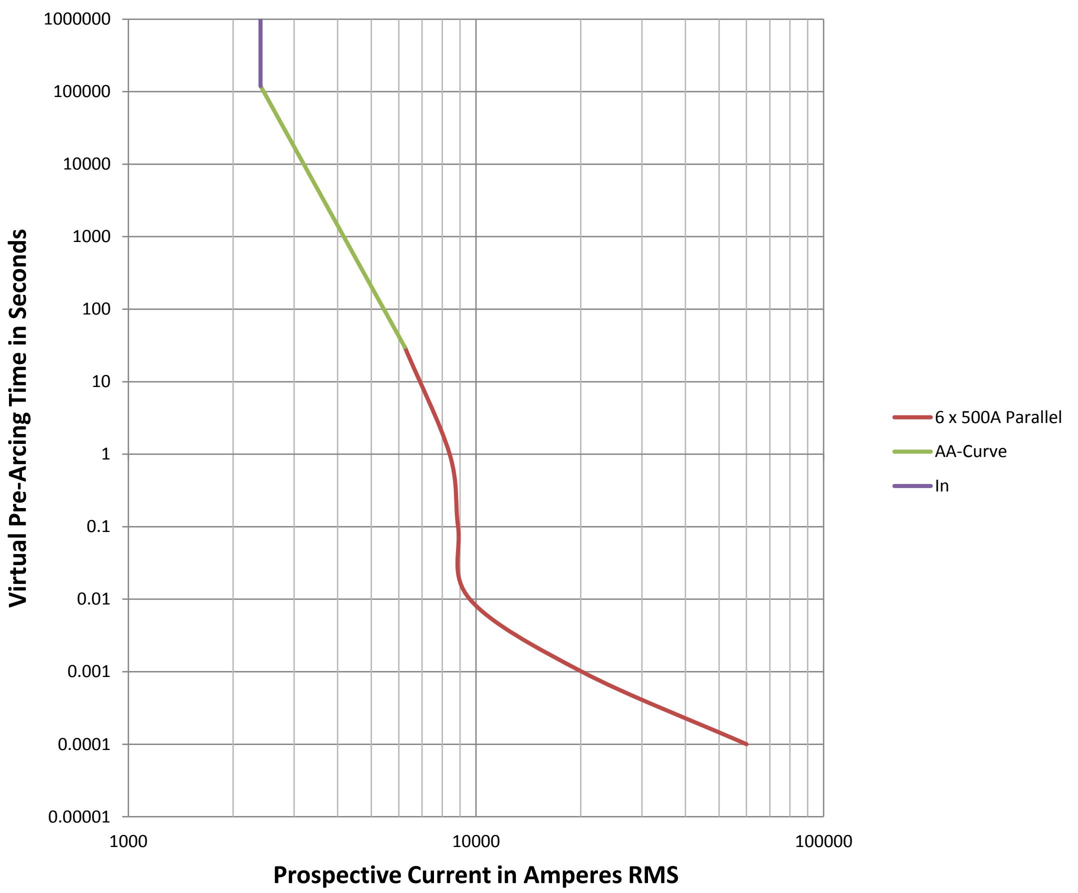
Pre-Arcing - Time Current Curve Characteristic Data Points	Approved:	BSG	Figure	3 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Data points above for entry in to SKM PowerTools Device Library.

Semi-Conductor Fuse Parallel Interrupter Specifications			
Nominal Voltage	690Vac	**Our Ref**	10BNEPRD001440TS003R0
Interrupter Size	500A	**Interrupting Capacity**	200kA RMS Symmetrical
No	6	**Watts Loss**	95 Watts/Interrupter @ Rated Current
Nominal SafeARC Current Rating	2400A	**Ambient Temperature**	35 deg C

SafeARC™ Module - 6 x 500A Interrupters



Pre-Arcing - Time Current Characteristic Curve	Approved:	BSG	Figure	1 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. AA-Curve is indicated by a constant gradient line in order to be able to draw the complete curve;
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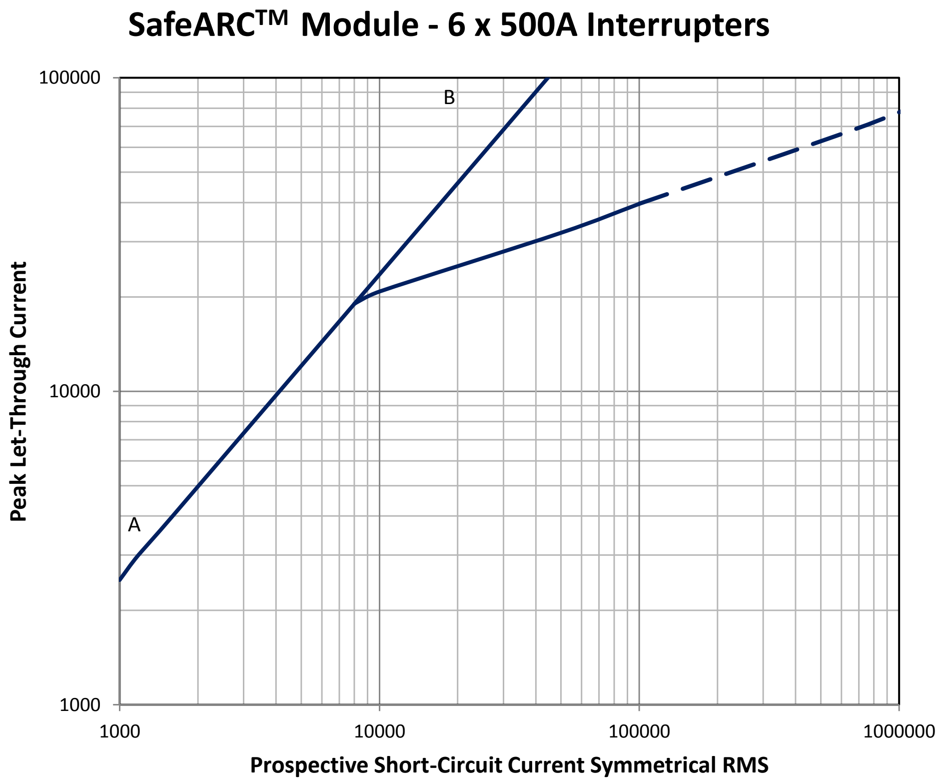
3. Actual operating characteristics of the SafeARC™ Module are dependent on the ambient temperature, cooling employed, cyclic loading profiles and overload durations.



Peak Let - Through - Cut-Off Current Characteristic Curve	Approved:	BSG	Figure	2 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Maximum interrupting capacity 200kA RMS symmetrical.

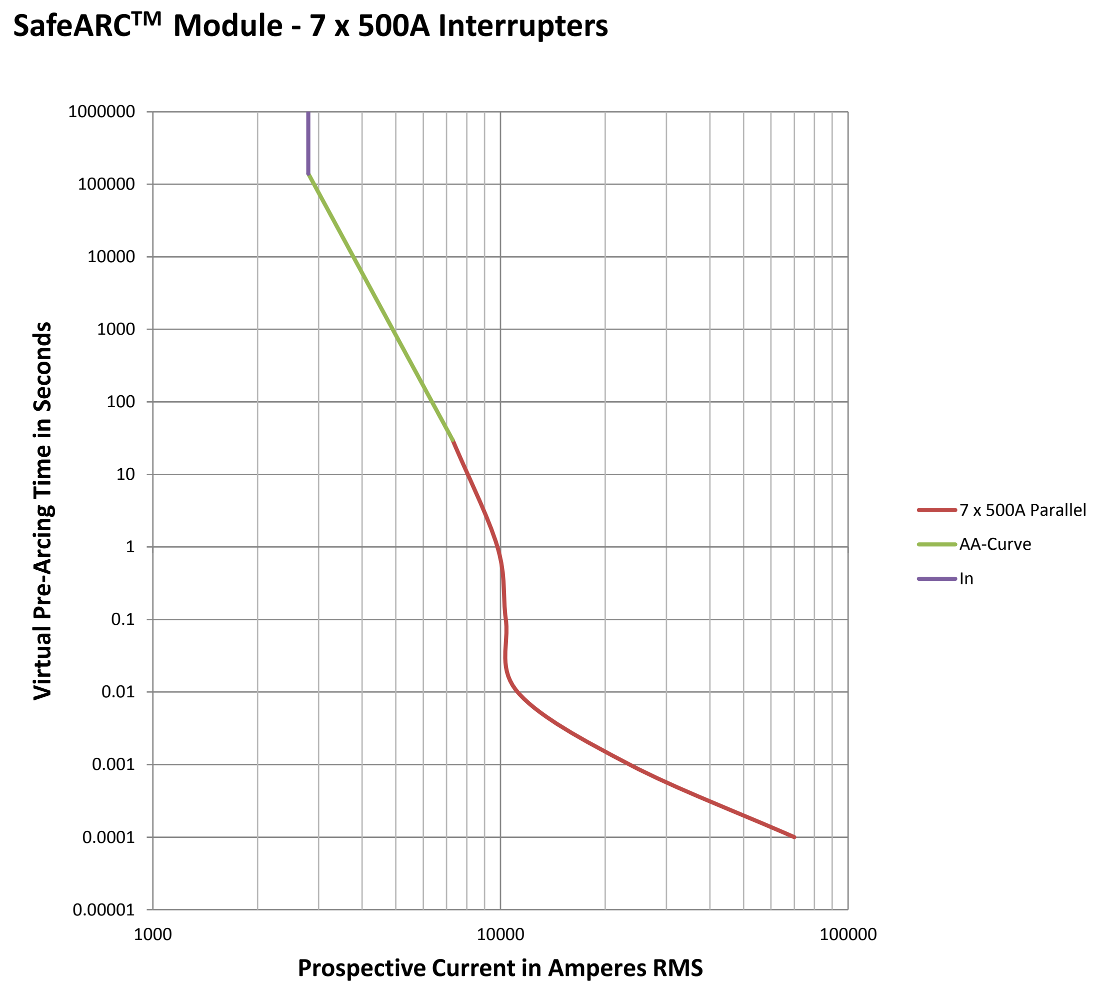
Current	Time
2400	1000000
2400	120000
6240	30
8400	1
8880	0.1
9600	0.01
20160	0.001
60000	0.0001

Pre-Arcing - Time Current Curve Characteristic Data Points	Approved:	BSG	Figure	3 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Data points above for entry in to SKM PowerTools Device Library.

Semi-Conductor Fuse Parallel Interrupter Specifications			
Nominal Voltage	690Vac	**Our Ref**	10BNEPRD001440TS002R0
Interrupter Size	500A	**Interrupting Capacity**	200kA RMS Symmetrical
No	7	**Watts Loss**	95 Watts/Interrupter @ Rated Current
Nominal SafeARC Current Rating	2800A	**Ambient Temperature**	35 deg C

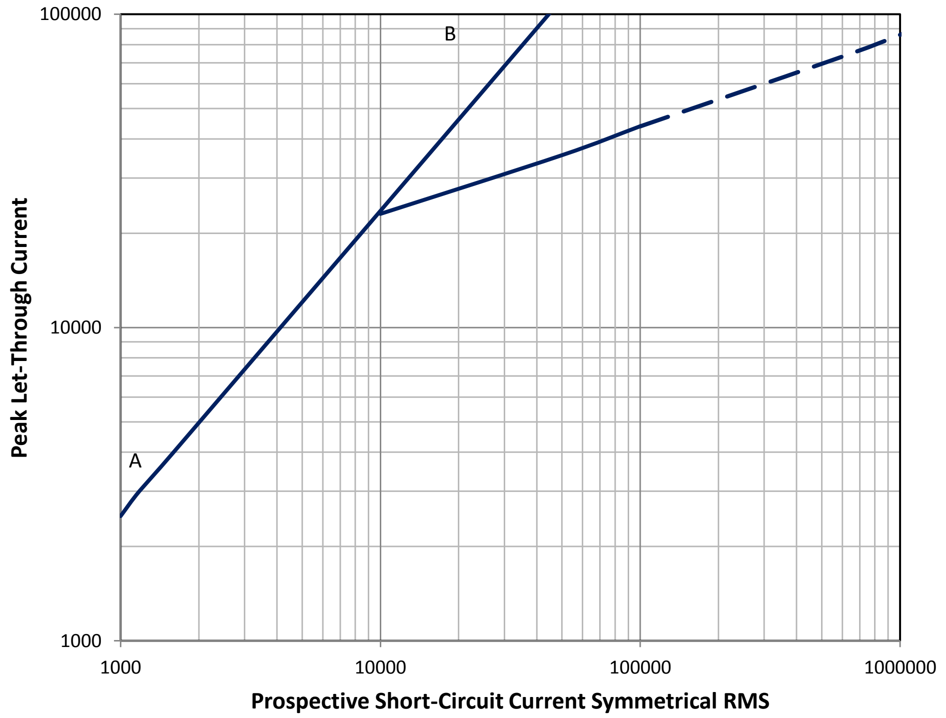


Pre-Arcing - Time Current Characteristic Curve	Approved:	BSG	Figure	1 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. AA-Curve is indicated by a constant gradient line in order to be able to draw the complete curve;
2. Operation above the AA-Curve is not recommended even though the actual melting curve may provide a higher value;
3. Actual operating characteristics of the SafeARC™ Module are dependent on the ambient temperature, cooling employed, cyclic loading profiles and overload durations.

SafeARC™ Module - 7 x 500A Interrupters



Peak Let - Through - Cut-Off Current Characteristic Curve	Approved:	BSG	Figure	2 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Maximum interrupting capacity 200kA RMS symmetrical.

Current	Time
2800	1000000
2800	140000
7280	30
9800	1
10360	0.1
11200	0.01
23520	0.001
70000	0.0001

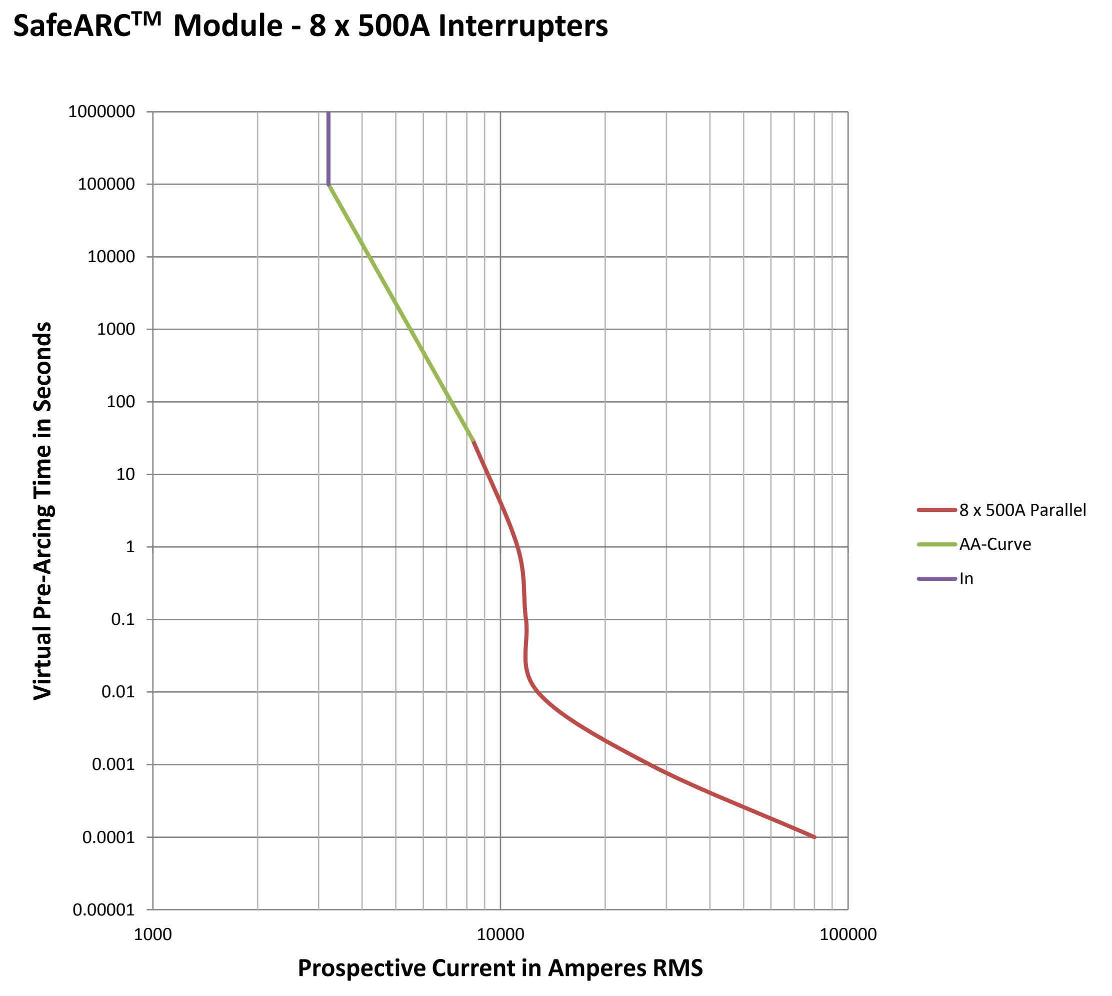
Pre-Arcing - Time Current Curve Characteristic Data Points	Approved:	BSG	Figure	3 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Data points above for entry in to SKM PowerTools Device Library.

Semi-Conductor Fuse Parallel Interrupter Specifications

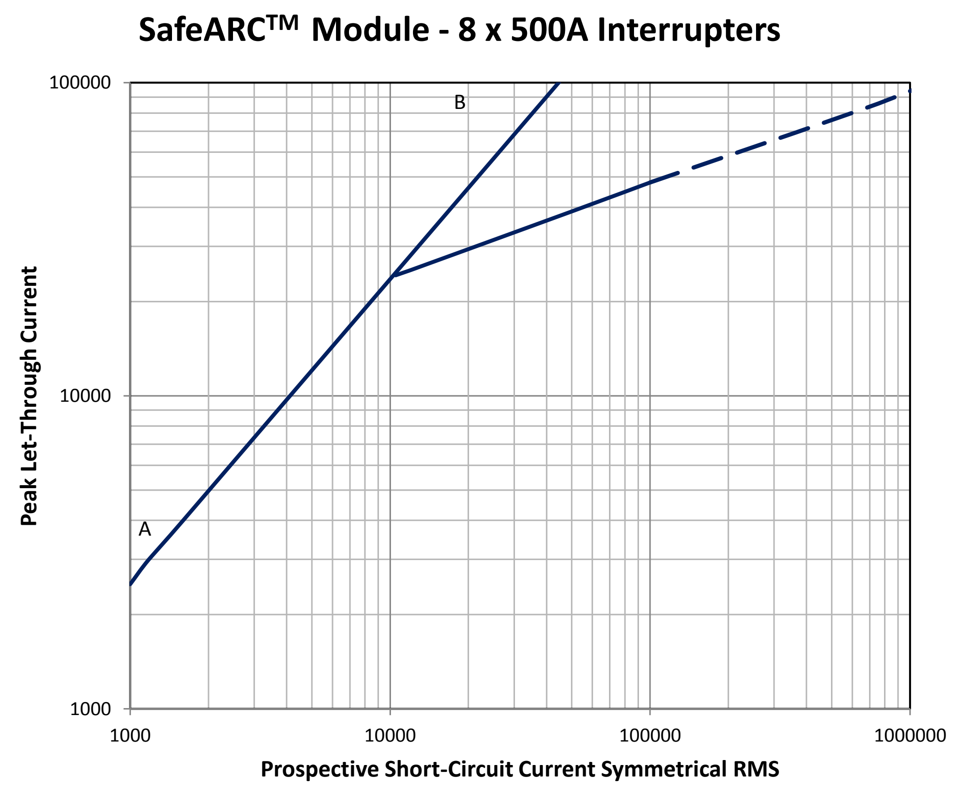
Nominal Voltage	690Vac	**Our Ref**	10BNEPRD001440TS001R0
Interrupter Size	500A	**Interrupting Capacity**	200kA RMS Symmetrical
No	8	**Watts Loss**	95 Watts/Interrupter @ Rated Current
Nominal SafeARC Current Rating	3200A	**Ambient Temperature**	35 deg C



Pre-Arcing - Time Current Characteristic Curve	Approved:	BSG	Figure	1 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. AA-Curve is indicated by a constant gradient line in order to be able to draw the complete curve;
2. Operation above the AA-Curve is not recommended even though the actual melting curve may provide a higher value;
3. Actual operating characteristics of the SafeARC™ Module are dependent on the ambient temperature, cooling employed, cyclic loading profiles and overload durations.



Peak Let - Through - Cut-Off Current Characteristic Curve	Approved:	BSG	Figure	2 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Maximum interrupting capacity 200kA RMS symmetrical.

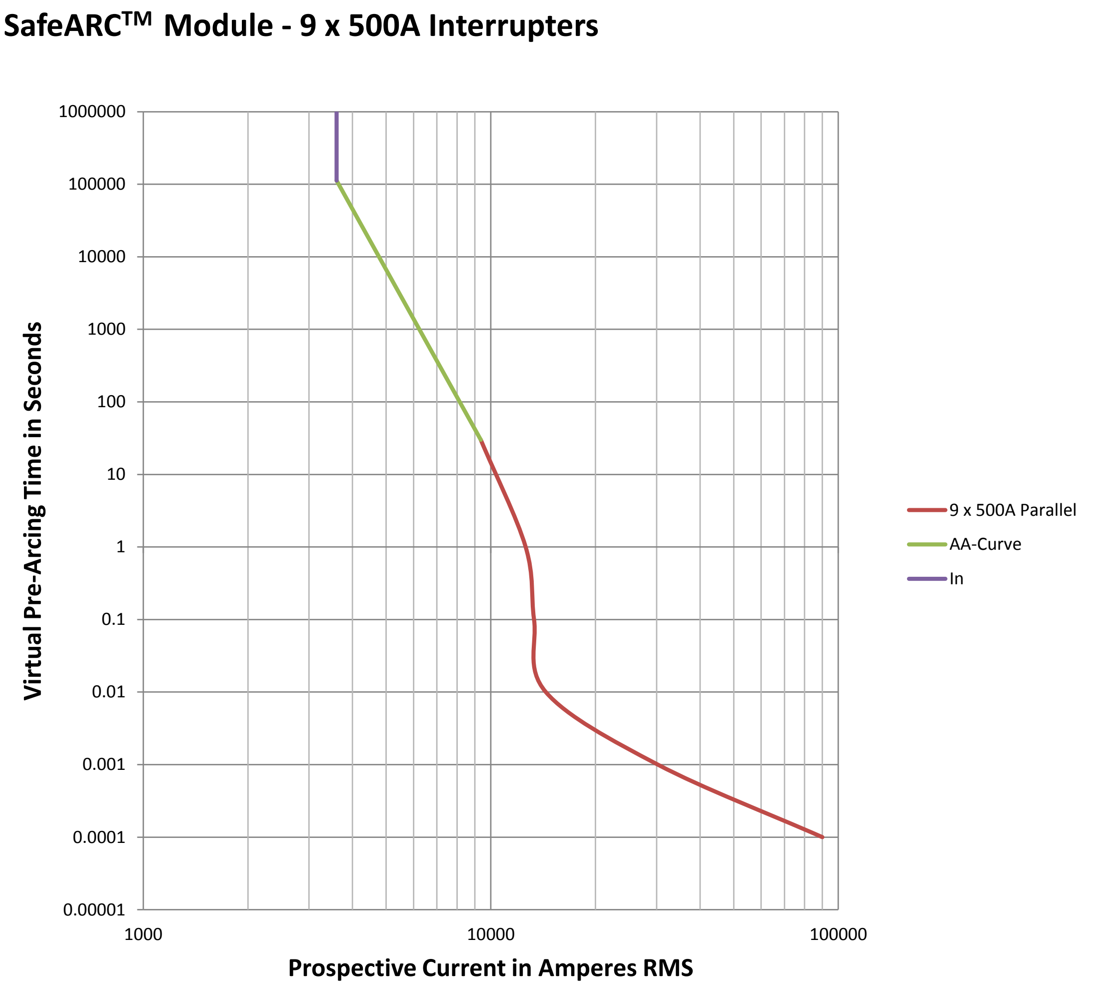
Current	Time
3200	1000000
3200	100000
8320	30
11200	1
11840	0.1
12800	0.01
26880	0.001
80000	0.0001

Pre-Arcing - Time Current Curve Characteristic Data Points	Approved:	BSG	Figure	3 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Data points above for entry in to SKM PowerTools Device Library.

Semi-Conductor Fuse Parallel Interrupter Specifications			
Nominal Voltage	690Vac	**Our Ref**	10BNEPRD001440TS011R0
Interrupter Size	500A	**Interrupting Capacity**	200kA RMS Symmetrical
No	9	**Watts Loss**	95 Watts/Interrupter @ Rated Current
Nominal SafeARC Current Rating	3600A	**Ambient Temperature**	35 deg C

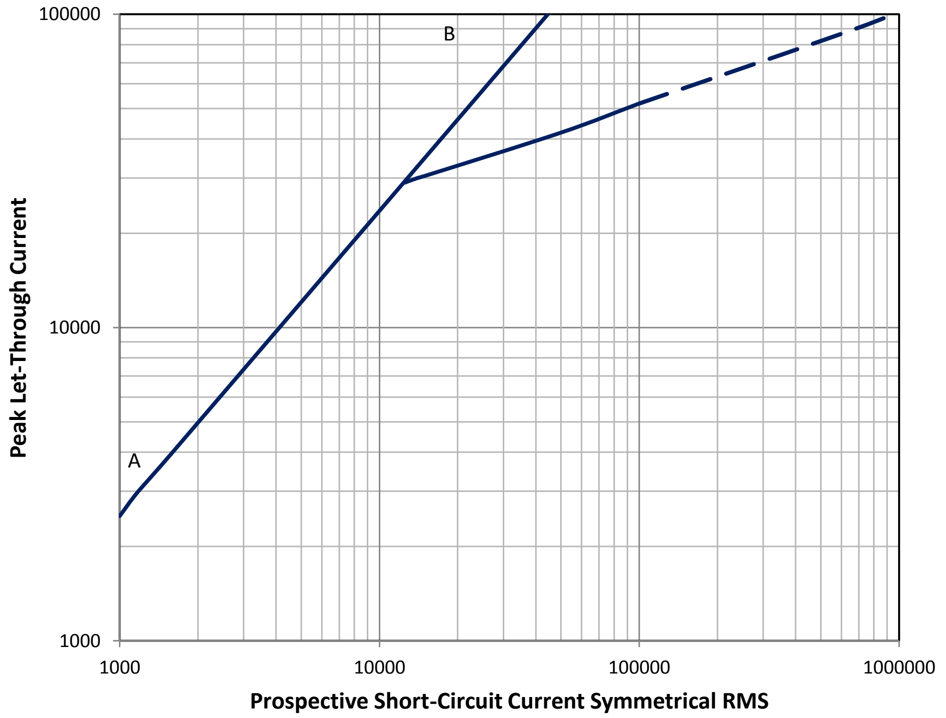


Pre-Arcing - Time Current Characteristic Curve	Approved:	BSG	Figure	1 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. AA-Curve is indicated by a constant gradient line in order to be able to draw the complete curve;
2. Operation above the AA-Curve is not recommended even though the actual melting curve may provide a higher value;
3. Actual operating characteristics of the SafeARC™ Module are dependent on the ambient temperature, cooling employed, cyclic loading profiles and overload durations.

SafeARC™ Module - 9 x 500A Interrupters



Peak Let - Through - Cut-Off Current Characteristic Curve	Approved:	BSG	Figure	2 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Maximum interrupting capacity 200kA RMS symmetrical.

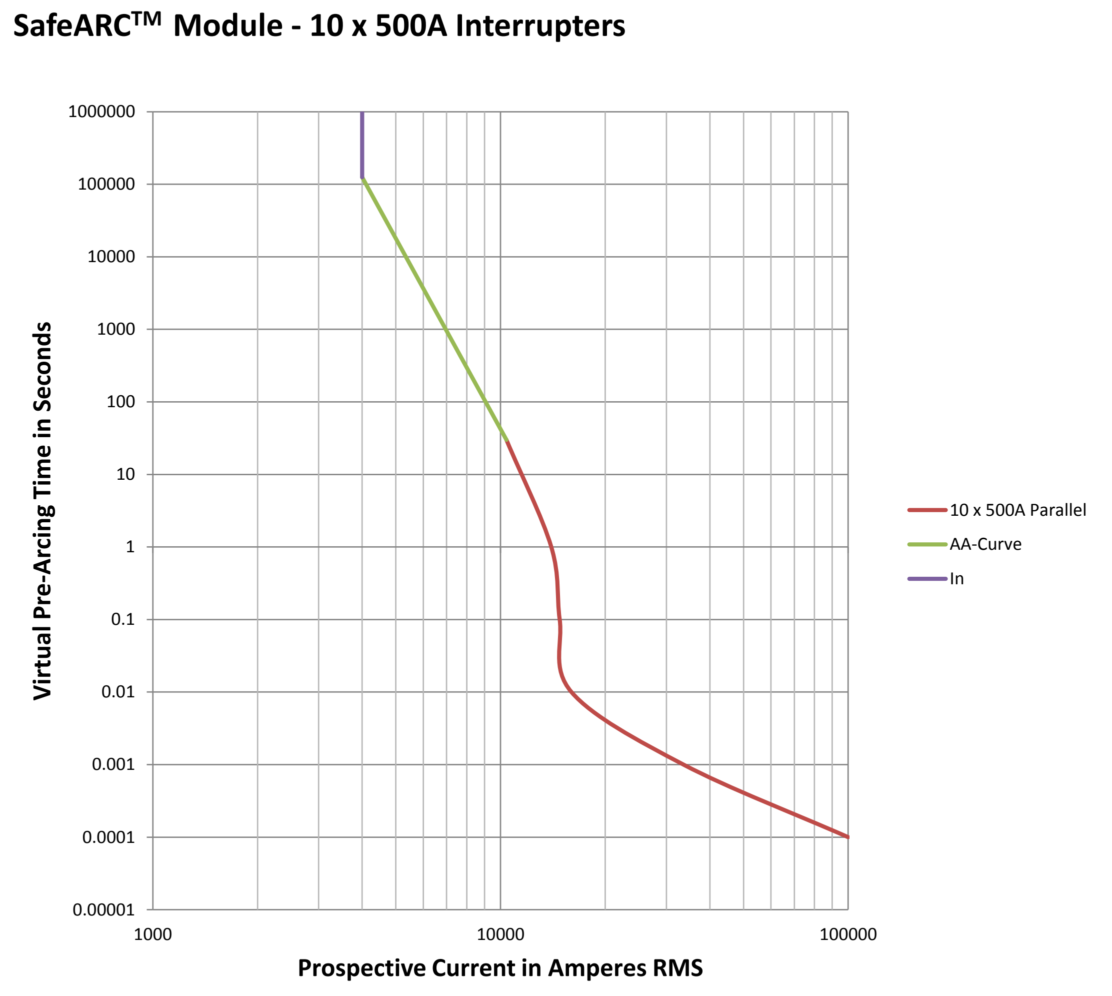
Current	Time
3600	1000000
3600	112500
9360	30
12600	1
13320	0.1
14400	0.01
30240	0.001
90000	0.0001

Pre-Arcing - Time Current Curve Characteristic Data Points	Approved:	BSG	Figure	3 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Data points above for entry in to SKM PowerTools Device Library.

Semi-Conductor Fuse Parallel Interrupter Specifications			
Nominal Voltage	690Vac	**Our Ref**	10BNEPRD001440TS012R0
Interrupter Size	500A	**Interrupting Capacity**	200kA RMS Symmetrical
No	10	**Watts Loss**	95 Watts/Interrupter @ Rated Current
Nominal SafeARC Current Rating	4000A	**Ambient Temperature**	35 deg C

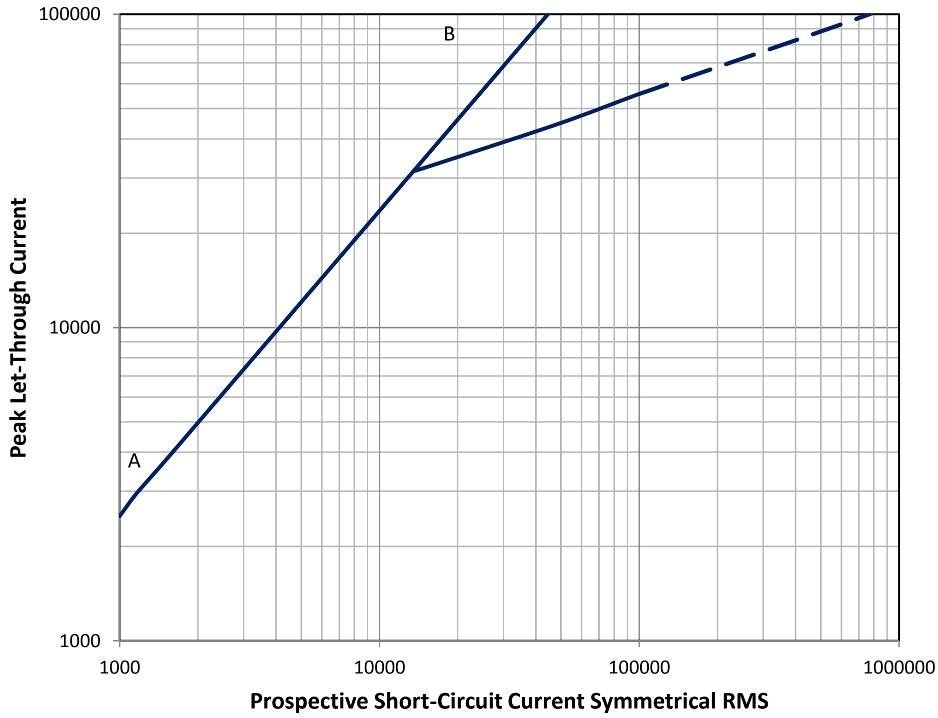


Pre-Arcing - Time Current Characteristic Curve	Approved:	BSG	Figure	1 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. AA-Curve is indicated by a constant gradient line in order to be able to draw the complete curve;
2. Operation above the AA-Curve is not recommended even though the actual melting curve may provide a higher value;
3. Actual operating characteristics of the SafeARC™ Module are dependent on the ambient temperature, cooling employed, cyclic loading profiles and overload durations.

SafeARC™ Module - 10 x 500A Interrupters



Peak Let - Through - Cut-Off Current Characteristic Curve	Approved:	BSG	Figure	2 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Maximum interrupting capacity 200kA RMS symmetrical.

Current	Time
4000	1000000
4000	125000
10400	30
14000	1
14800	0.1
16000	0.01
33600	0.001
100000	0.0001

Pre-Arcing - Time Current Curve Characteristic Data Points	Approved:	BSG	Figure	3 of 3
	Rev Date:	04/2011	Pub Date:	04/2011

Notes

1. Data points above for entry in to SKM PowerTools Device Library.

APPENDIX – C

INSTALLATION TYPICAL INSPECTION AND TEST PLAN

Client: ______________________________ Test Date: ______________________________

Test Site: ______________________________ Tester: ______________________________

Signature: ______________________________

SafeARC Serial No:		Fuses per Phase:	
Type Number:		Fuse size:	
Colour:		System Voltage:	

INSPECTION PROCESS

SAFETY REQUIREMENTS & PRE TEST CHECKS

No equipment is to be energised for this test - ensure isolations are in place and locks / tags applied.
Check that the area to be inspected is safe prior to commencing the checks.
Refer to the safety management plan and commissioning risk assessments for specific safety requirements.
Ensure all required group and personal JSA's have been completed and signed off by Project Supervisor.
Maintain positive radio contact with designated contact area.

TEST REQUIREMENTS

The test voltage used shall be 500V for equipment rated up to 1kV. Minimum acceptable resistance values:

- *LV Cables and Busbars - 25 MΩ*
- *Machines and Transformers - 25 MΩ*

Resistance values between 1MΩ and the minimum values above shall be reported to the engineer and accepted at his discretion. Values less than 1MΩ will not be accepted.

TEST PROCEDURE

Sensitive Ohmmeter (Ductor) has to be used for measurements of joints resistance. Probes of the Ductor should be applied on both ends of the joint (as close to the joint as possible without touching the same part of the joint with both probes).

Metric Course		PC 8.8		PC 10.9	
Diam.	**Pitch mm**	**Torque Nm**	**Bolt Tension kN**	**Torque Nm**	**Bolt Tension kN**
M8	1.25	22.0	13.80	32.0	19.80
M10	1.50	44.0	21.90	63.0	31.30
M12	1.75	77.0	31.80	109.0	45.50
M14	2.00	122.0	43.40	174.0	62.10
M16	2.00	190.0	59.20	270.0	84.50

Client: ________________________________ Test Date:____

Test Site: ________________________________ Tester: ____

Signature: ____

INSTALLATION AND EQUIPMENT CHECKS				
No	**DESCRIPTION**	•		
		OK	**N/A**	**Def**
1. GENERAL				
1.1	Ensure that all vendor FAT documentation is available			
1.2	Visually inspect equipment for external damage and surface finish			
1.3	Check for equipment levels and alignment and ensure all fixings and mounting points are correct and secure			
1.4	Check equipment (tag) identification label is fitted and correct			
1.5	Check equipment earthing is correct, confirm all doors, escutcheons and gland plates are connected to earth			
1.6	Check operation of doors, handles and locking mechanisms and confirm integrity of door seals/gaskets			
2. CABLING				
2.1	Check that all internal wiring is consistent with the design drawings and that all terminations are tight			
2.2	Check cable terminations to ensure all lugs/pins are crimped correctly and terminals are clean and dust free			
3. BUSBARS				
3.1	Check that all terminations are tight and where torque settings are required, ensure that correct values have been obtained and the connection has been marked to indicate completion			
4. HEAT EXCHANGE CONTROL CIRCUIT				
4.1	Check the 240VAC RCBO			
4.2	Check the power supply powers up			
4.3	Check 48VDC CB			
4.4	Check MOORE SPA2 relay powers up			
4.5	Check fused links			
5. TESTING				
5.1	Complete insulation resistance tests and record results in following table			
5.2	Complete ductor continuity tests across busbar joints and record results in the following table			
5.3	Ensure that all outer panels are correctly re-fitted and doors locked			
5.4	Check all drawings marked up to ‘as-built’ status			
5.5	Check PSU voltage settings after energisation			
5.6	Check MORRE SPA2 settings after energisation			
5.7	Check Heat Exchanger operation			
5.8	Abnormalities and defects included on punch list			

Client: ______________________________ Test Date:______________________________

Test Site: ______________________________ Tester: ______________________________

Signature: ______________________________

HEAT EXCHANGER SETTINGS AND TEST RESULTS		
MOORE SPA2 SETTINGS		
High Alarm [°C]	Dead Band [°C]	High High Alarm [°C]
Analogue output 0% - 4mA [°C]	Analogue output 100% - 20mA [°C]	
Time Delay [s]		
Supply DC voltage [Volts]		
HEAT EXCHANGE CIRCUIT TEST		
TEST PROCEDURE		
Supply the heat exchanger circuit (disconnect main bus bars from the control circuit). Cause the rise of temperature measured by RTD. Observe the temperature rise and time delay. After the set trip temperature is attained, and after the trip time elapses, heat exchanger should turn on. Remove the source of heat from the RTD. Wait until the temperature falls below the low setting (dead band). Heat exchanger should turn off.		
TEST RESULTS AND NOTES		

Client: ______________________________ Test Date: ______________________________

Test Site: ______________________________ Tester: ______________________________

Signature: ______________________________

TEST RESULTS			
INSULATION RESISTANCE TESTS			
Test Point	**Test Voltage**	**Test Duration**	**Test Results**
R to B	500 VDC	Seconds	MΩ
R to W	500 VDC	Seconds	MΩ
W to B	500 VDC	Seconds	MΩ
R\W\B to E	500 VDC	Seconds	MΩ
N to E (no MEN connected)	500 VDC	Seconds	MΩ
R\W\B to N	500 VDC	Seconds	MΩ

BUSBAR FROM THE TRANSFORMER TO SafeARC (TRANSFORMER END)- DUCTOR TEST				
Test Points	**Red Phase**	**White Phase**	**Blue Phase**	**Neutral**
Number of Bolts				
Resistance Direction ‘A’	μΩ	μΩ	μΩ	μΩ
Resistance Direction ‘B’	μΩ	μΩ	μΩ	μΩ
Average Resistance of phase	μΩ	μΩ	μΩ	μΩ

BUSBAR INPUT FROM THE TRANSFORMER TO SafeARC (SafeARC END)- DUCTOR TEST				
Test Points	**Red Phase**	**White Phase**	**Blue Phase**	**Neutral**
Number of Bolts				
Resistance Direction ‘A’	μΩ	μΩ	μΩ	μΩ
Resistance Direction ‘B’	μΩ	μΩ	μΩ	μΩ
Average Resistance of phase	μΩ	μΩ	μΩ	μΩ

CABLE OUTPUTFROM THE SafeARC TO SWITCHBOARD (SafeARC END)- DUCTOR TEST				
Test Points	**Red Phase**	**White Phase**	**Blue Phase**	**Neutral**
Number of Bolts				
Resistance Direction ‘A’	μΩ	μΩ	μΩ	μΩ
Resistance Direction ‘B’	μΩ	μΩ	μΩ	μΩ
Average Resistance of phase	μΩ	μΩ	μΩ	μΩ

Client: ________________________________

Test Site: ________________________________

Test Date: ________________________________

Tester: ________________________________

Signature:

____

TEST RESULTS						
Fuse Number	**Red Phase**		**White Phase**		**Blue Phase**	
	A	B	A	B	A	B
1	µΩ	µΩ	µΩ	µΩ	µΩ	µΩ
2	µΩ	µΩ	µΩ	µΩ	µΩ	µΩ
3	µΩ	µΩ	µΩ	µΩ	µΩ	µΩ
4	µΩ	µΩ	µΩ	µΩ	µΩ	µΩ
5	µΩ	µΩ	µΩ	µΩ	µΩ	µΩ
6	µΩ	µΩ	µΩ	µΩ	µΩ	µΩ
7	µΩ	µΩ	µΩ	µΩ	µΩ	µΩ
8	µΩ	µΩ	µΩ	µΩ	µΩ	µΩ
Average	µΩ	µΩ	µΩ	µΩ	µΩ	µΩ

TEST RESULTS		
Link Number	**Neutral Phase**	
	A	B
1	µΩ	µΩ
2	µΩ	µΩ
3	µΩ	µΩ
4	µΩ	µΩ
5	µΩ	µΩ
6	µΩ	µΩ
7	µΩ	µΩ
8	µΩ	µΩ
Average	µΩ	µΩ

Re-test of Failures (If Any)		
Item #	Pass / Fail	Comments

Client: ________________________________ Test Date: ________________________________

Test Site: ________________________________ Tester: ________________________________

Signature: ________________________________

TEST EQUIPMENT DETAILS				
Type	**Manufacturer**	**Model**	**Serial No**	**Calibration Details**

COMMENTS & NOTES
Test Conditions =

Client: ______________________________ Test Date:______________________________

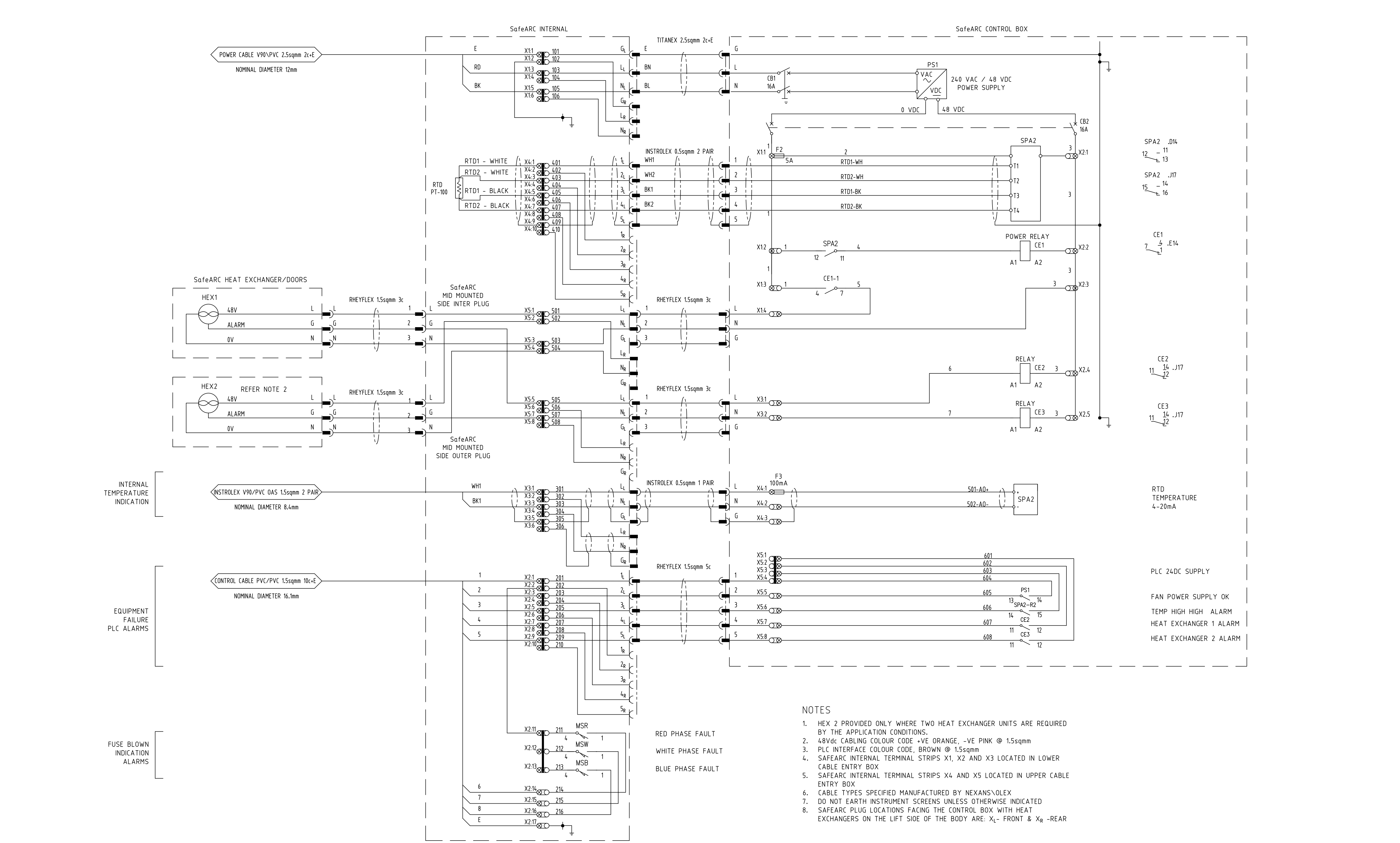
Test Site: ______________________________ Tester: ______________________________

Signature: ______________________________

Photos

Appendix – D

Electrical Diagrams – External Powered Cooling System



NOTES

1. HEX 2 PROVIDED ONLY WHERE TWO HEAT EXCHANGER UNITS ARE REQUIRED BY THE APPLICATION CONDITIONS.
2. 48Vdc CABLING COLOUR CODE +VE ORANGE, -VE PINK @ 1.5sqmm
3. PLC INTERFACE COLOUR CODE, BROWN @ 1.5sqmm
4. SAFEARC INTERNAL TERMINAL STRIPS X1, X2 AND X3 LOCATED IN LOWER CABLE ENTRY BOX
5. SAFEARC INTERNAL TERMINAL STRIPS X4 AND X5 LOCATED IN UPPER CABLE ENTRY BOX
6. CABLE TYPES SPECIFIED MANUFACTURED BY NEXANS\OLEX
7. DO NOT EARTH INSTRUMENT SCREENS UNLESS OTHERWISE INDICATED
8. SAFEARC PLUG LOCATIONS FACING THE CONTROL BOX WITH HEAT EXCHANGERS ON THE LIFT SIDE OF THE BODY ARE: X_L - FRONT & X_R -REAR

REV	DRAWN	DATE	DESCRIPTION	CHECKED	APPROVED
-	-	-	-	-	-

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EMAIL ADMIN@HUDSONMCKAY.COM.AU

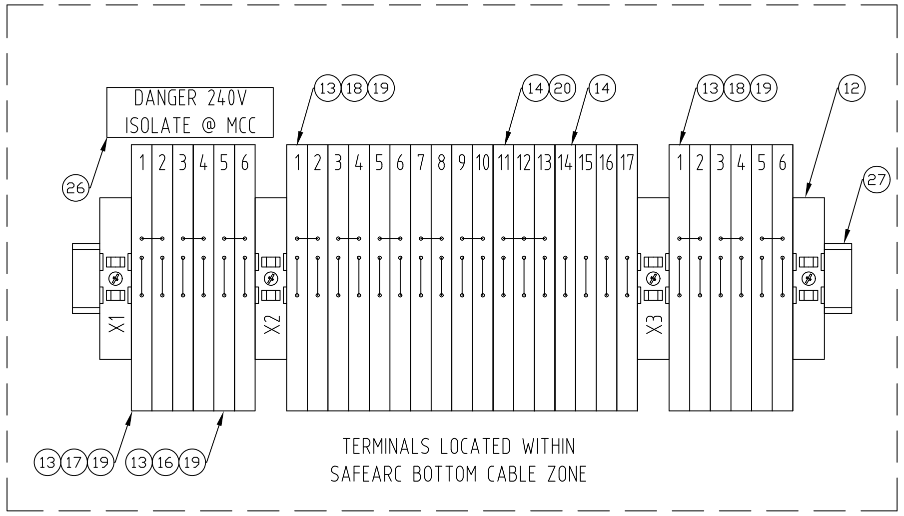
Safe ARC™

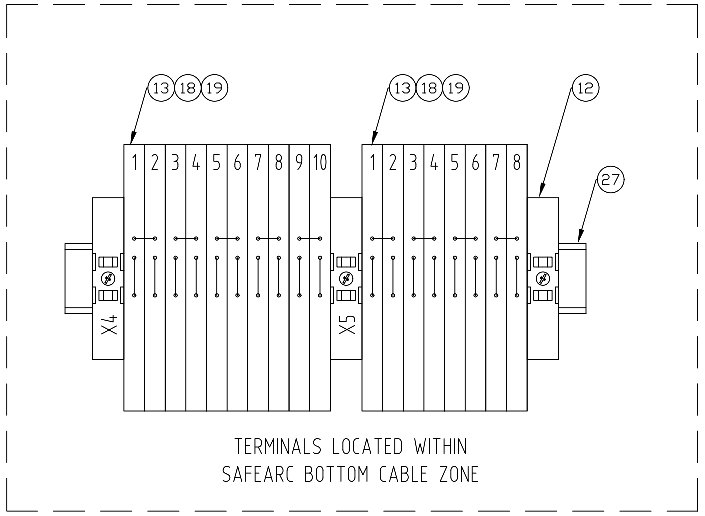
GENERAL TOLERANCES
0.5mm ± LINEAR
0.1mm ± DIAMETERS

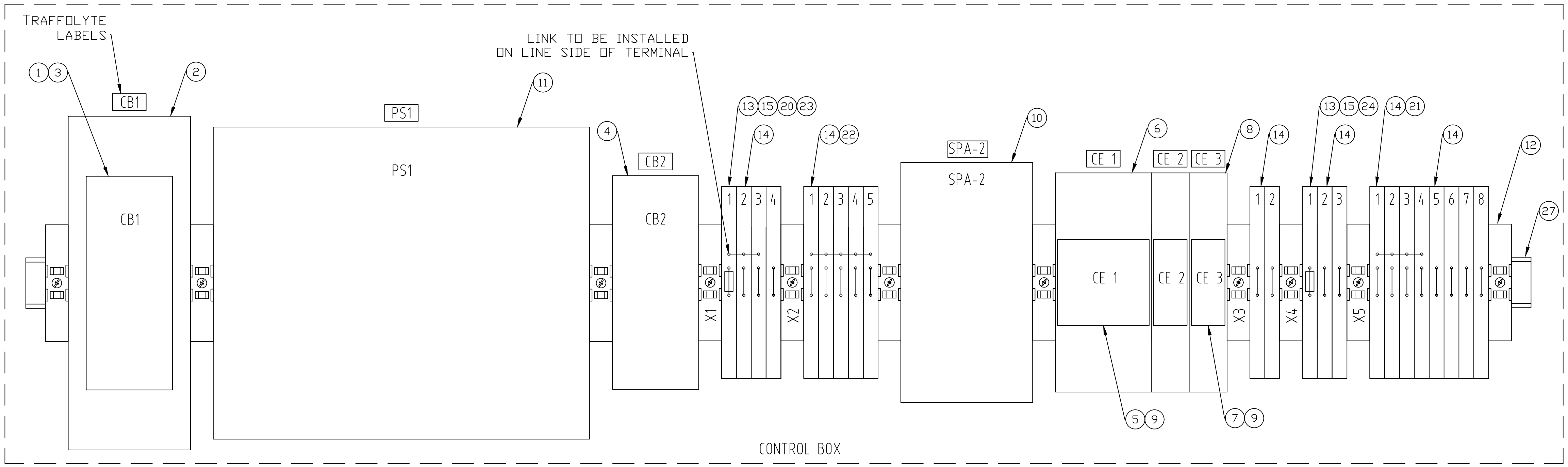
ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.

MATERIAL			SCALE NTS	A3 — FOR CONSTRUCTION
WEIGHT (kg)		DO NOT SCALE	CLIENT DWG No.	
DESIGNER	BSG	02/06/2015	PRODUCT	SafeARC TYPE 1C.1
DRAWN	-	-	DESCRIPTION	CABLE IN-CABLE OUT CONTROL SCHEMATIC 48VDC
CHECKED	-	-		
APPROVED	BSG	06/06/2015	DWG No.	SAC1C-E-9001 — REV 1

ITEM	QTY	BRAND	PART No	DESCRIPTION
1	1	TERASAKI	DSRCB1630	10kA 30mA 2POLE CB (16A RCD MCB/RCD 10KA 1PN 16A 30MA)
2	1	TERASAKI	DTPC2	POLE COVER 2P DIN-T
3	1	TERASAKI	DTLLAB	2 POLE LOCK DIN LH (DINT LOOG 3-6MM 2 POLE DSRCB)
4	1	TERASAKI	DTCB6216D	6ka 2 POLE 16A CB (MCB 6KA 2P 16A D CURVE DIN)
5	1	FINDER	62.33 48 VDC	RLY BKTMT/PLGIN 3CO 16A/7A 48VDC POWER RELAY
6	1	FINDER	92.03	MOUNTING BASE - DIN RAIL (SKT FOR 62.32/33 DINMT SCTERM)
7	2	FINDER	40.52.48 VDC	MINIATURE 48VDC PCB RELAY
8	2	FINDER	95.05.	MOUNTING BASE - DIN RAIL (SKT FOR 40.52 DINMT SCTERM)
9	3	FINDER	99.02.9.060	LED & DIODE MODULE
10	1	MOORE INDUSTRIES	SPA2/TPRG/2PRG/U/(DIN)	PROGRAMMABLE RTD ALARM UNIT-SPA2
11	1	PHOENIX CONTACT	PS/ 1AC/48DC/10	POWER SUPPLY QUINT/48VDC/10A
12	18	PHOENIX CONTACT	E/NS 35 N	END CLAMP, WIDTH; 9.5 mm, COLOUR: GREY
13	42	PHOENIX CONTACT	UT 4-TG	UNIVERSAL TERMINAL BLOCK, SCREW CONECTION
14	27	PHOENIX CONTACT	UT 4-MT	UNIVERSAL DISCONECT TERMINAL BLOCK, SCREW CONECTION
15	2	PHOENIX CONTACT	PFU 5X20	FUSE PLUG, NOMINAL CURRENT: 6.3A
16	2	PHOENIX CONTACT	P-FIX	FEED THROUGH CONNECTOR FOR UT-4-TG TERMINAL
17	2	PHOENIX CONTACT	P-DI	ORANGE ISOLATING PLUG FOR UT-4-TG TERMINAL
18	17	PHOENIX CONTACT	P-DI GY	GRAY ISOLATING PLUG FOR UT-4-TG TERMINAL
19	20	PHOENIX CONTACT	FBS 2-6	PLUG-IN BRIDGE, 2 POSITION
20	2	PHOENIX CONTACT	FBS 3-6	PLUG-IN BRIDGE, 3 POSITION
21	1	PHOENIX CONTACT	FBS 4-6	PLUG-IN BRIDGE, 4 POSITION
22	1	PHOENIX CONTACT	FBS 5-6	PLUG-IN BRIDGE, 5 POSITION
23	1	BUSSMANN	S500-5-R	5A GLASS FUSE 20x5mm
24	1	BUSSMANN	S500-100-R	100mA GLASS FUSE 20x5mm
25	1	MOORE INDUSTRIES	SPA2/TPRG/2PRG/U/(DIN)	PROGRAMMABLE RTD ALARM UNIT-SPA2
26	1	ALLISON'S PLAQUES		ACRYLIC DANGER LABEL, 60x15mm, 2 HOLES-RED PANEL/WHITE ENGRAVING
27	1	GENERIC		PERFORATED DIN RAIL







NOTES

LABELS:
LABEL COMPONENTS AS SHOWN

240V POWER CIRCUIT:
240Vac POWER SUPPLY SOURED FROM EXTERNAL SUPPLY POINT.

48VDC POWER CIRCUIT:
DC OUTPUT OF POWER SUPPLY SHOULD BE WIRED TO A 16A 2 POLE CIRCUIT BREAKER.
POWER TO THE FAN UNITS WILL BE CONTROLLED BY THE SPA2 RELAY.

RTD
RTD SENSOR (ITEM 21) LOCATED BEHIND EQUIPMENT PLATE IN THE EXPLOSIVE VENT, CABLE TO BE RUN THOUGH EQUIPMENT PLATE TO RTD SENSOR BRACKET.

REV	DRAWN	DATE	DESCRIPTION	CHECKED	APPROVED

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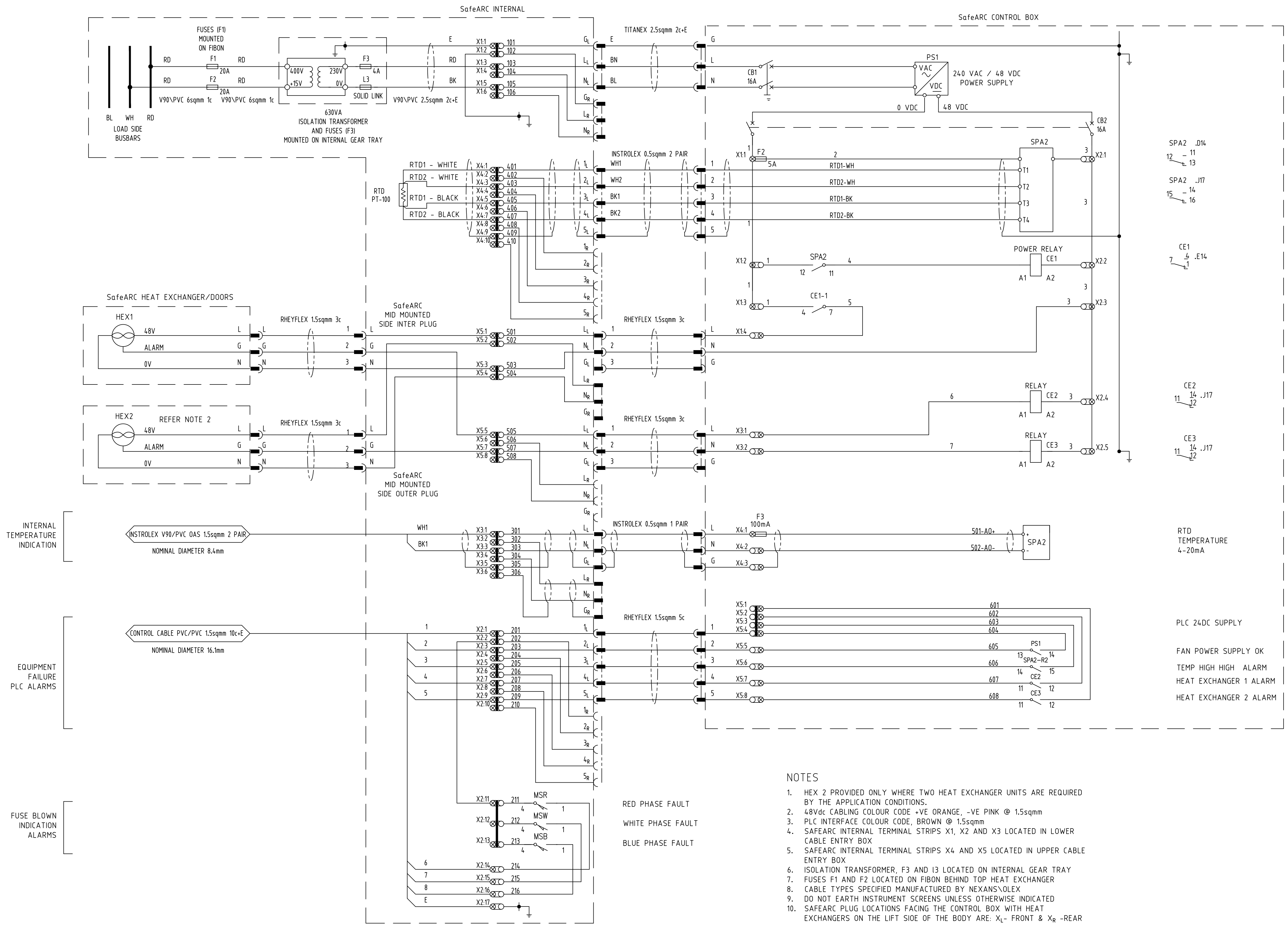
GENERAL TOLERANCES
0.5mm ± LINEAR
0.1mm ± DIAMETERS

ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.

MATERIAL			SCALE NTS	A3 — FOR CONSTRUCTION
WEIGHT (kg)		DO NOT SCALE	CLIENT DWG No.	
DESIGNER	BSG	04/06/2015	PRODUCT	SafeARC TYPE 1C.1
DRAWN	-	-	DESCRIPTION	TERMINAL ARRANGEMENT COOLING SYSTEM SH 1 OF 2
CHECKED	-	-		
APPROVED	BSG	06/06/2015	DWG No.	SAC-E-9002 — REV 1

APPENDIX – E

ELECTRICAL DIAGRAMS – INTERNALLY POWERED COOLING SYSTEM



NOTES

1. HEX 2 PROVIDED ONLY WHERE TWO HEAT EXCHANGER UNITS ARE REQUIRED BY THE APPLICATION CONDITIONS.
2. 48Vdc CABLING COLOUR CODE +VE ORANGE, -VE PINK @ 1.5sqmm
3. PLC INTERFACE COLOUR CODE, BROWN @ 1.5sqmm
4. SAFEARC INTERNAL TERMINAL STRIPS X1, X2 AND X3 LOCATED IN LOWER CABLE ENTRY BOX
5. SAFEARC INTERNAL TERMINAL STRIPS X4 AND X5 LOCATED IN UPPER CABLE ENTRY BOX
6. ISOLATION TRANSFORMER, F3 AND I3 LOCATED ON INTERNAL GEAR TRAY
7. FUSES F1 AND F2 LOCATED ON FIBON BEHIND TOP HEAT EXCHANGER
8. CABLE TYPES SPECIFIED MANUFACTURED BY NEXANS\OLEX
9. DO NOT EARTH INSTRUMENT SCREENS UNLESS OTHERWISE INDICATED
10. SAFEARC PLUG LOCATIONS FACING THE CONTROL BOX WITH HEAT EXCHANGERS ON THE LIFT SIDE OF THE BODY ARE: X_L - FRONT & X_R -REAR

REV	DRAWN	DATE	DESCRIPTION	CHECKED	APPROVED
-	-	-	-	-	-

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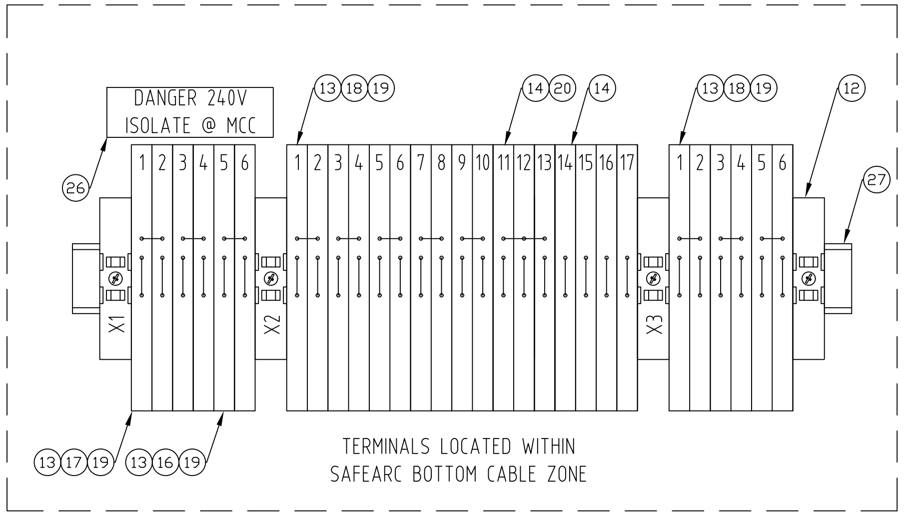
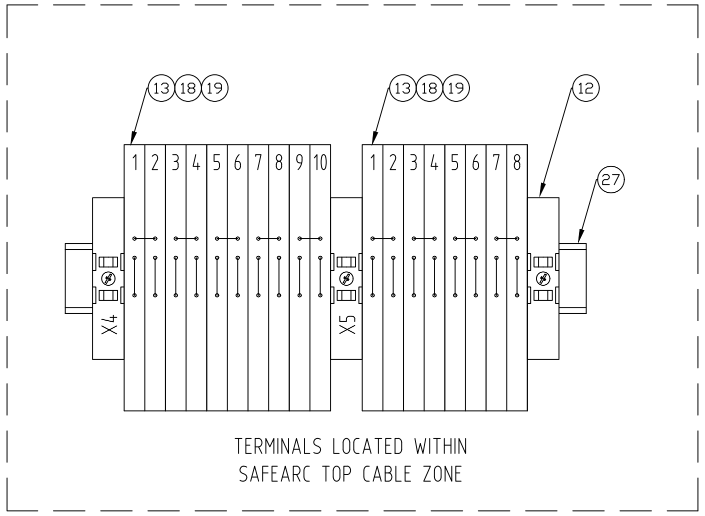
GENERAL TOLERANCES
0.5mm ± LINEAR
0.1mm ± DIAMETERS

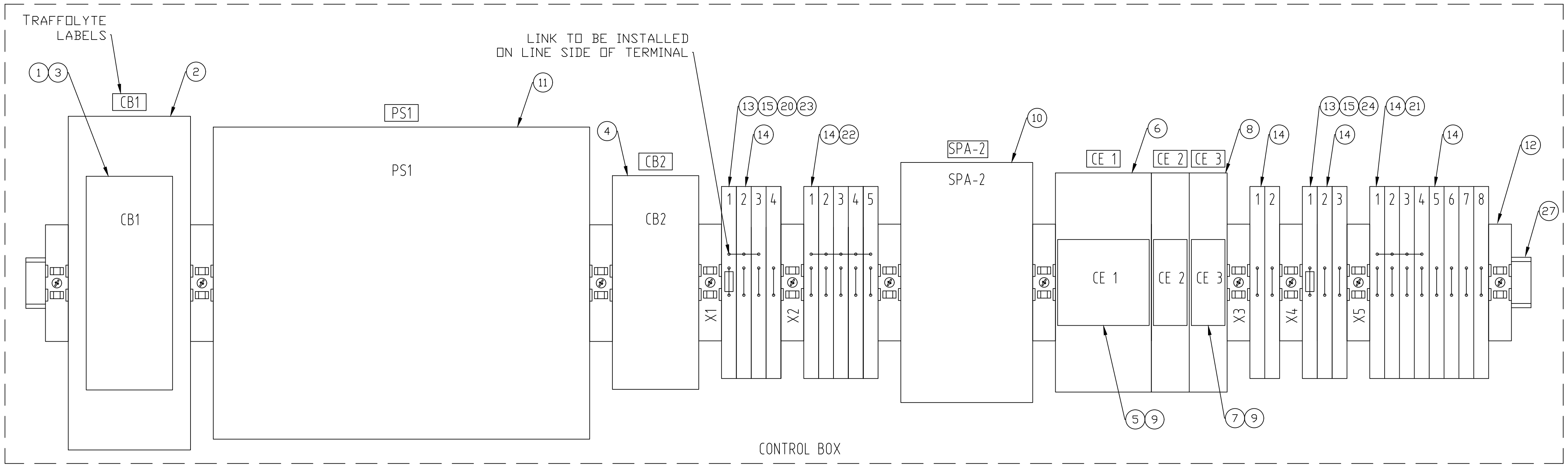
ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.

MATERIAL			SCALE NTS	A3 — FOR CONSTRUCTION
WEIGHT (kg)		DO NOT SCALE	CLIENT DWG No.	
DESIGNER	BSG	02/06/2015	PRODUCT	SafeARC TYPE 1C.1 - HiX
DRAWN	-	-	DESCRIPTION	CABLE IN-CABLE OUT CONTROL SCHEMATIC 48VDC
CHECKED	-	-		
APPROVED	BSG	06/06/2015	DWG No.	SAC1C-E-9001 — REV 1

ITEM	QTY	BRAND	PART No	DESCRIPTION
1	1	TERASAKI	DSRCB1630	10kA 30mA 2POLE CB (16A RCD MCB/RCD 10KA 1PN 16A 30MA)
2	1	TERASAKI	DTPC2	POLE COVER 2P DIN-T
3	1	TERASAKI	DTLLAB	2 POLE LOCK DIN LH (DINT LDOG 3-6MM 2 POLE DSRCB)
4	1	TERASAKI	DTCB6216D	6ka 2 POLE 16A CB (MCB 6KA 2P 16A D CURVE DIN)
5	1	FINDER	62.33 48 VDC	RLY BKTMT/PLGIN 3CO 16A/7A 48VDC POWER RELAY
6	1	FINDER	92.03	MOUNTING BASE - DIN RAIL (SKT FOR 62.32/33 DINMT SCTERM)
7	2	FINDER	40.52.48 VDC	MINIATURE 48VDC PCB RELAY
8	2	FINDER	95.05.	MOUNTING BASE - DIN RAIL (SKT FOR 40.52 DINMT SCTERM)
9	3	FINDER	99.02.9.060	LED & DIODE MODULE
10	1	MOORE INDUSTRIES	SPA2/TPRG/2PRG/U/(DIN)	PROGRAMMABLE RTD ALARM UNIT-SPA2
11	1	PHOENIX CONTACT	PS/ 1AC/48DC/10	POWER SUPPLY QUINT/48VDC/10A
12	18	PHOENIX CONTACT	E/NS 35 N	END CLAMP, WIDTH; 9.5 mm, COLOUR: GREY
13	42	PHOENIX CONTACT	UT 4-TG	UNIVERSAL TERMINAL BLOCK, SCREW CONECTION
14	27	PHOENIX CONTACT	UT 4-MT	UNIVERSAL DISCONECT TERMINAL BLOCK, SCREW CONECTION
15	2	PHOENIX CONTACT	PFU 5X20	FUSE PLUG, NOMINAL CURRENT: 6.3A
16	2	PHOENIX CONTACT	P-FIX	FEED THROUGH CONNECTOR FOR UT-4-TG TERMINAL
17	2	PHOENIX CONTACT	P-DI	ORANGE ISOLATING PLUG FOR UT-4-TG TERMINAL
18	17	PHOENIX CONTACT	P-DI GY	GRAY ISOLATING PLUG FOR UT-4-TG TERMINAL
19	20	PHOENIX CONTACT	FBS 2-6	PLUG-IN BRIDGE, 2 POSITION
20	2	PHOENIX CONTACT	FBS 3-6	PLUG-IN BRIDGE, 3 POSITION
21	1	PHOENIX CONTACT	FBS 4-6	PLUG-IN BRIDGE, 4 POSITION
22	1	PHOENIX CONTACT	FBS 5-6	PLUG-IN BRIDGE, 5 POSITION
23	1	BUSSMANN	S500-5-R	5A GLASS FUSE 20x5mm
24	1	BUSSMANN	S500-100-R	100mA GLASS FUSE 20x5mm
25	1	MOORE INDUSTRIES	SPA2/TPRG/2PRG/U/(DIN)	PROGRAMMABLE RTD ALARM UNIT-SPA2
26	1	ALLISON'S PLAQUES		ACRYLIC DANGER LABEL, 60x15mm, 2 HOLES-RED PANEL/WHITE ENGRAVING
27		GENERIC		PERFORATED DIN RAIL
28	3	NHP	NV32FW	32A CLIP-IN FUSE HOLDER (BLACK)
29	1	NHP	NV32FWW	32A CLIP-IN FUSE HOLDER (WHITE)
30	2	NHP	NNS20	20A HRC FUSE LINK
31	1	NHP	32CLK	BS SOLID LINK
32	1	NHP	NNS04	4A HRC FUSE LINK







NOTES

LABELS:
LABEL COMPONENTS AS SHOWN

415V/240V POWER CIRCUIT:
FAULT CURRENT LIMIT PROVIDED 20A FUSE & 32A FUSE HOLDERS (ITEMS 1 & 2) TO BE ATTACHED TO LOAD SIDE OF BUS.
ACTIVE AND NEUTRAL SUPPLY CABLE NEEDS DOUBLE INSULATED 6MM² PVC/PVC FROM FUSE TO BARS, AND FROM FUSE TO CIRCUIT BREAKER.

48VDC POWER CIRCUIT:
DC OUTPUT OF POWER SUPPLY SHOULD BE WIRED TO A 16A 2 POLE CIRCUIT BREAKER.
POWER TO THE FAN UNITS WILL BE CONTROLLED BY THE SPA2 RELAY.

RTD
RTD SENSOR (ITEM 21) LOCATED BEHIND EQUIPMENT PLATE IN THE EXPLOSIVE VENT, CABLE TO BE RUN THOUGH EQUIPMENT PLATE TO RTD SENSOR BRACKET.

REV	DRAWN	DATE	DESCRIPTION	CHECKED	APPROVED

Hudson McKay
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EMAIL ADMIN@HUDSONMCKAY.COM.AU

GENERAL TOLERANCES
0.5mm ± LINEAR
0.1mm ± DIAMETERS

ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.

MATERIAL		
WEIGHT (kg)		DO NOT SCALE
DESIGNER	BSG	04/06/2015
DRAWN	-	-
CHECKED	-	-
APPROVED	BSG	06/06/2015

SCALE NTS | A3 | FOR CONSTRUCTION

CLIENT DWG No.

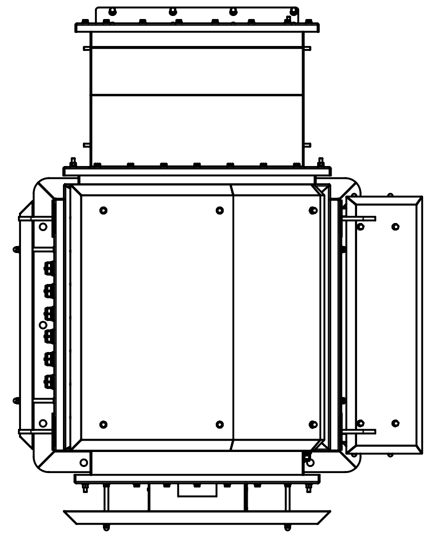
PRODUCT: SafeARC TYPE 1C.1 - HiX

DESCRIPTION: TERMINAL ARRANGEMENT COOLING SYSTEM SH 1 OF 1

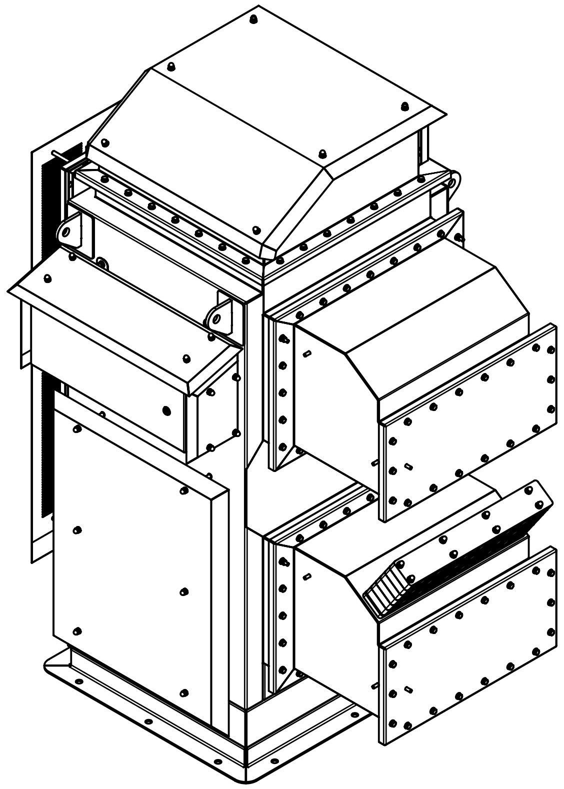
DWG No. SAC-E-9002 | REV 1

APPENDIX – F

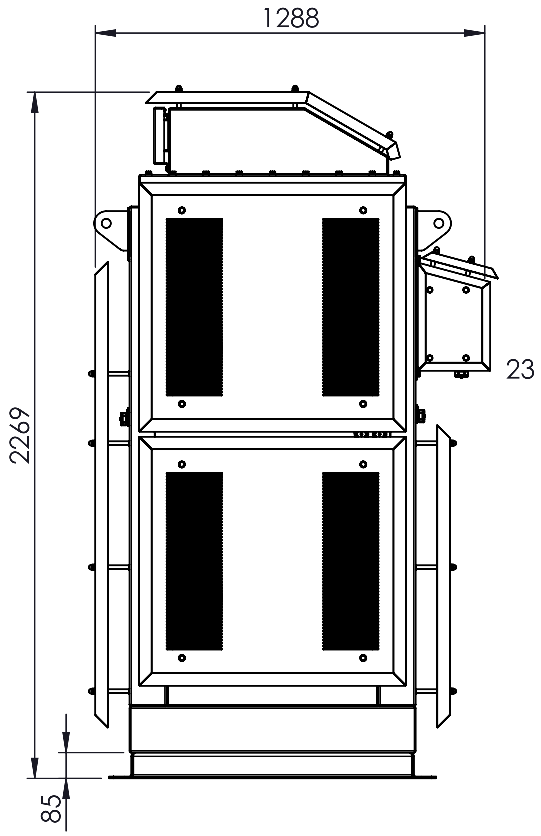
GENERAL ARRANGEMENT DIAGRAM



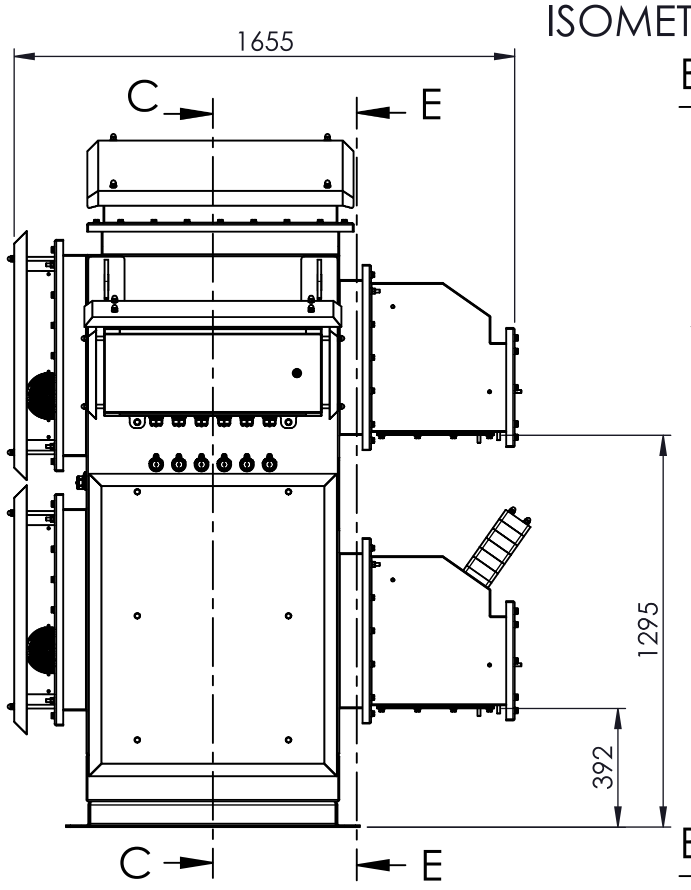
TOP VIEW



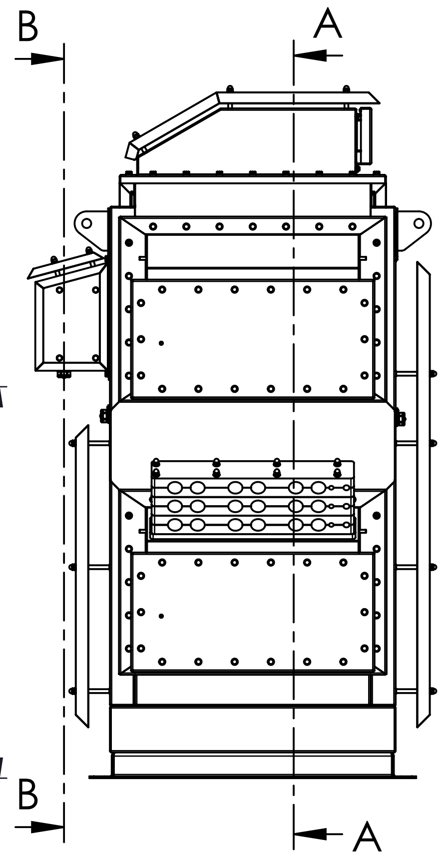
ISOMETRIC VIEW



FRONT VIEW



R.H. VIEW



REAR VIEW

REV	DRAWN	DATE	DESCRIPTION	CHECKED	APPRV'D
A	S.A.	15/07/2015	ISSUED FOR CONSTRUCTION	B.G.	B.G.

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CLIENT:

SafeARC®
SafeARC Pty Ltd
www.SafeARC.com.au

THIRD ANGLE PROJECTION

DO NOT SCALE

ALL DIMENSIONS IN MILLIMETERS UNLESS NOTED OTHERWISE.

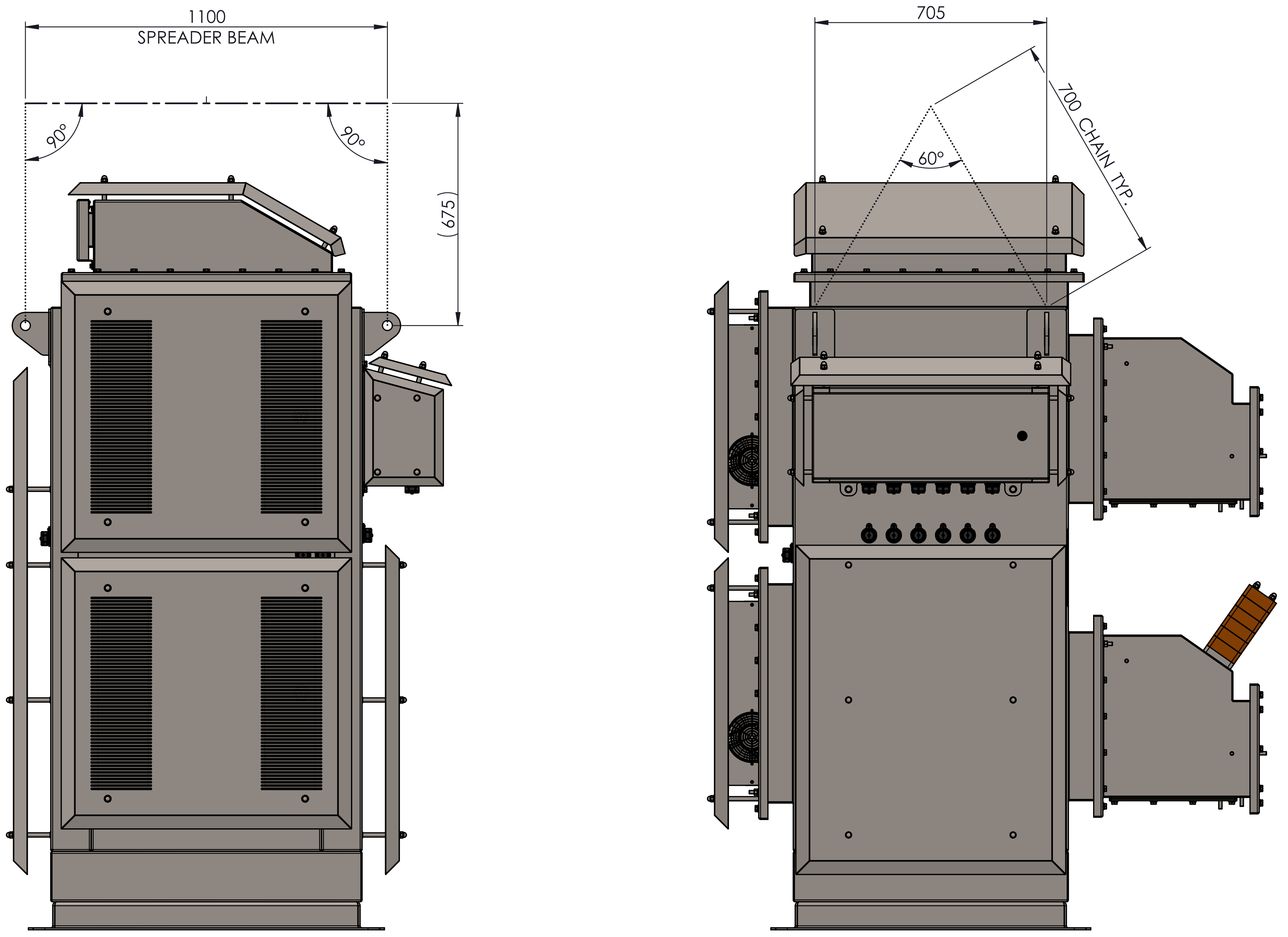
GENERAL TOLERANCES
LINEAR ± 0.5mm
DIAMETERS ± 0.1mm

MATERIAL: AS NOTED
WEIGHT (kg): 1729.47

DRAWN	S.A.	15/07/2015
CHECKED	B.G.	16/07/2015
APPROVED	B.G.	17/07/2015
RPEQ CPEng	B.G.	17/07/2015

SCALE: 1:25 A3
AS BUILT
SHEET: 1 OF 4
PROJECT No:
PRODUCT: SafeARC SAC
DESCRIPTION: ENCLOSURE GENERAL ARRANGEMENT
PART / DWG No: SAC2-5000
REV. A

SAC2-5000



LIFTING DETAILS

REV	DRAWN	DATE	DESCRIPTION	CHECKED	APRV'D
A	S.A.	15/07/2015	ISSUED FOR CONSTRUCTION	B.G.	B.G.

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CLIENT:

SafeARC®
SafeARC Pty Ltd
www.SafeARC.com.au

THIRD ANGLE PROJECTION

DO NOT SCALE

ALL DIMENSIONS IN MILLIMETERS UNLESS NOTED OTHERWISE.

GENERAL TOLERANCES
LINEAR ± 0.5mm
DIAMETERS ± 0.1mm

MATERIAL	AS NOTED	
WEIGHT (kg):	1729.47	
DRAWN	S.A.	15/07/2015
CHECKED	B.G.	16/07/2015
APPROVED	B.G.	17/07/2015
RPEQ CPEng		

SCALE 1:15 | A3 | **AS-BUILT**

SHEET 4 OF 4 | PROJECT No:

PRODUCT: SafeARC SAC

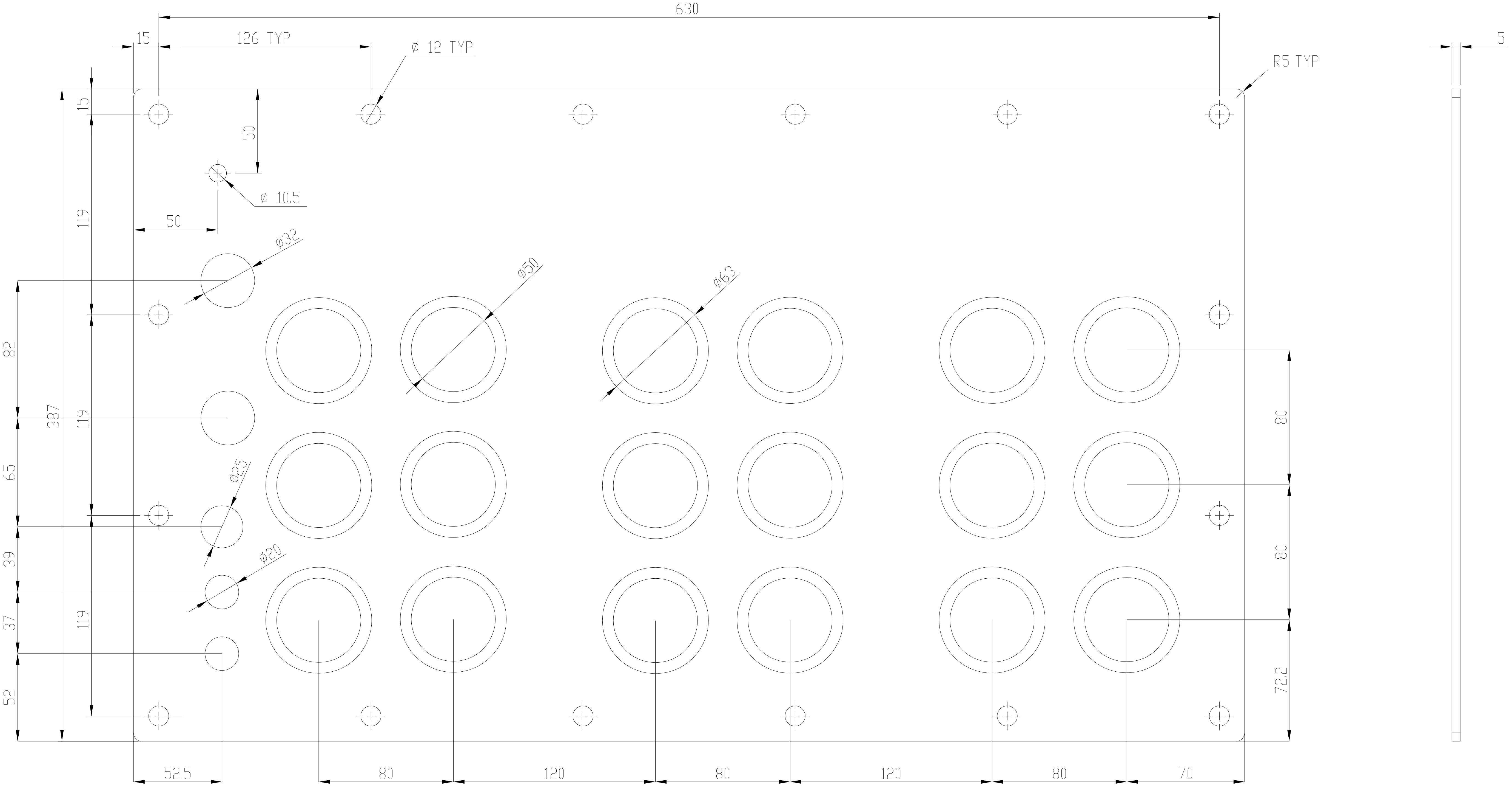
DESCRIPTION: ENCLOSURE GENERAL ARRANGEMENT

PART / DWG No: **SAC2-5000** | REV. **A**

SAC2-5000

APPENDIX – G

GENERAL ARRANGEMENT GLAND PLATE



GLAND PLATE - FRONT VIEW

R.H. VIEW

FOR CONSTRUCTION

REV	DRAWN	DATE	DESCRIPTION	CHECKED	APRV'D
	S.A.	15/07/2015	ISSUED FOR CONSTRUCTION	B.G.	B.G.
A					

Hudson McKay

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www.HudsonMcKay.com.au

CLIENT:

SafeARC Pty Ltd
www.SafeARC.com.au

THIRD ANGLE PROJECTION

DO NOT SCALE

ALL DIMENSIONS IN MILLIMETERS UNLESS NOTED OTHERWISE.

GENERAL TOLERANCES
LINEAR ± 0.5mm
DIAMETERS ± 0.1mm

MATERIAL	BRASS 5	
WEIGHT (kg)	11	
DRAWN	S.A.	15/07/2015
CHECKED	B.G.	16/07/2015
APPROVED	B.G.	17/07/2015
RPEQ CPEng		

SCALE	1:2.5 A3
SHEET	2 OF 2
PROJECT No:	SAC-4001
PRODUCT	SafeARC SAC Type ALL
DESCRIPTION	GLAND PLATE - CABLE IN-OUT
PART / DWG No:	
REV	A

SAC-4001