Discipline
Engineering Standard - NSW

Category
Signalling

Title
High Speed Emergency Changeover Contactor Panel

Reference Number
SPS 25 - (RIC Standard: SC 09 10 02 01 SP)

Document Control

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About This Standard

This Specification describes the general requirements for electro mechanical High Speed Emergency Change-Over Contactor Panels to be manufactured and supplied to Australian Rail Track Corporation or its contractors, for signalling power supplies.

In designated areas there are two power supplies for operating signalling system equipment. One supply is designated as the 'Normal' supply and is generally derived from the railway high voltage supply feeders. This is the main supply that is available > 99.5% of the time. The second supply is designated as the 'Emergency' supply and usually originates from the local supply authority. The Emergency Change-Over Contactor Panel (ECO panel) automatically connects an available power supply to the signalling system equipment and automatically switches to the 'Emergency' supply in the advent of the 'Normal' supply failing. This specification does not apply to electronic static switches or transfer switches.

A number of enhancements have been included in this specification to improve the switching performance of the ECO panel. This is aimed at minimizing the effects of the changeover interruption to the signalling system and equipment. The specification also requires the designer/installer to consider the signalling equipment that is going to be connected to this ECO panel to ensure that the ECO panel selected is suitable for the reliable operation of the signalling system.

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List of Amendments –

ISSUE	DATE	CLAUSE	DESCRIPTION
1.1	01/09/2004		Reformatting to ARTC Standard
1.2	14/03/2005	Disclaimer	Minor editorial change
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Contents

1. Introduction

This Specification describes the general requirements for a High Speed Emergency Change-Over Contactor Panel, rated from 25A to 250A nominal current to be manufactured and supplied to Australian Rail Track Corporation or it contractors to Australian Rail Track Corporation for signalling power supplies.

An Emergency Change-Over contactor panel “ECO panel” issued to automatically switch between ‘Normal’ supply (120V AC 50Hz) and the ‘Emergency’ supply (120V AC 50Hz), during an interruption (or fault) of the ‘Normal’ supply.

The switch over to the ‘Emergency’ supply and return to the ‘Normal’ supply must be minimized to reduce interruptions to the signalling system. As more electronics and microprocessor based signalling systems are installed there becomes a greater need to minimize power supply interruptions and ensure that signalling system is unaffected by ECO panel switchover.

Due to the mechanical limitations of the different types of contactors there is a significant difference in switch over times between 25-80A contactors and the larger 120-250A bar contactors. This specification provides guidance to which type of ECO panel should be used for an application.

This specification does not cover the requirements for electronic static switches or transfer switches, which use semiconductor devices in place of a mechanical contactor.

The example circuit diagrams included with this specification were developed after a number of prototypes were developed, tested and operated in the field.

2. Applicable Documents

2.1. ARTC Specifications

This Specification refers to the following ARTC Standard Signalling Specifications:

SPS 04 Specification – General requirements Labelling of Equipment

SCP 03 Specification – Signalling Power Systems

SCP 04 Lightning and Surge Protection Requirements

SCP 17 Computer Based Interlocking Requirements

SPS 51 Specification – Solderless Terminals Screw and Spring Clamp Terminal Blocks

SPS 02 Environmental Conditions

2.2. Australian Standards

AS/NZS 3000:2000-Electrical Installations (known as the Australian/New Zealand Wiring Rules)

AS 3947.6.1-1996 Low-voltage switchgear and control gear Part 6.1:Multiple Function equipment – Automatic transfer switching equipment.

3. Operating Performance Requirements

3.1. Traffic Densities where ECO panel is used

3.1.1 High Traffic Areas

In high traffic areas as defined in ARTC Standard Specification SCP 17 Computer Based Interlocking Requirements, the signalling system shall not be affected by the switchover of the ECO panel.

- Signals shall not be set back to stop
- Track circuits shall not drop or lock out
- Routes shall not be cancelled or require to be reset
- All microprocessor based signalling equipment shall be fully functional and unaffected.

3.1.2 Medium & Light Traffic Areas

In medium and light traffic areas as defined in ARTC Standard Specification SCP 17 Computer Based Interlocking Requirements, the signalling system should not be affected by the ECO panel switchover. If the signalling system will be affected then the design of the ECO panel installation shall ensure that this is acceptable to the owner (ARTC General Manager ISP or nominated Signalling representative) of the signalling system.

3.2. Signalling system equipment powered from ECO panel

Signalling equipment consists of signals (incandescent & LED), point machines, trainstops, track circuits, interlockings (mechanical, relay and microprocessor). Failure of the interlocking and/or the track circuits due to an ECO panel switchover can be prevented if the ECO panel has a fast enough switchover time.

The following table lists the maximum ECO panel switchover time requirements and a recommended contactor for commonly used signalling equipment on the ARTC network.

Signalling Equipment	Maximum allowable duration of switch-over time (in msecs)	Recommended ECO panel
ALSOM SSI Track Side Functional Modules Mark 2 & Mark 3 (includes: Signal modules, Points modules, Data Link modules & Long Distance terminals)	18 msec	25-80A only higher currents generally cannot use mechanical contactor
Westinghouse Signals SSI Track Side Functional Modules Mark 2 & Mark 3 (includes: Signal modules, Points modules, & Data Link modules)	35 msec	25A – 250A
Westinghouse Signals FS2500 & FS2600 Track circuit equipment	35 msec	25A – 250A
ALSTOM Pulse Track circuit equipment includes Jeumont track circuit equipment	100 msec	25A – 250A
50V filter PSUs for 50V Q relay circuits (interlocking)	100 msec	25A – 250A
Colour light Signals	250 msec	25A – 250A
Points Machines	100 msec	25A – 250A
Audio Frequency Track circuits ABB & CSEE	35 msec	25A – 250A

Note: All SSI Interlocking cubicles must be operated from an Uninterruptable Power Supply (UPS) as detailed in ARTC Standard Signalling circuits.

3.3. Design Considerations

The ECO panel will cause a brief power supply interruption in the range of 13-300 milli seconds (depending on design and construction) as it switches from the 'Normal' to the 'Emergency' power supply and back again when the 'Normal' power supply is available. The aim of the ECO panel design should be to minimize this brief power supply interruption. Testing of previously supplied ECO panels has resulted in a number of design considerations.

3.3.1 DC coils

Testing found that DC coil contactors take significantly longer to switchover from the 'Normal' supply to the 'Emergency' supply and will not meet the changeover requirements of this specification. The bridge rectifier for the DC coil has also been found to be susceptible to failure by surges.

3.3.2 Economising Resistor

An example circuit at the back of this specification shows and economising resistor,

which is connected in series with the contactor coil 15 seconds after the coil has energised. This resistor serves two functions. Firstly it reduces the operating current for the coil. Secondly when the ECO panel loses the 'Normal' supply and switches over (drops away) to the 'Emergency' there can be a significant DC (due to back emf) current fed back into the contactor coil from the output side of the ECO panel (i.e. the signalling equipment load). A feature of AC contactor coils is that they will remain energised on small DC currents. This economising resistor reduces the DC current flow in the contactor coil and allows the contactor to release quickly. It has been found that without this resistor the larger bar contactors can take up to 300 msec to drop away. The resistor value should be as high as possible while still maintaining sufficient voltage at the coil to ensure it has sufficient holding current.

An ECO panel will have a quicker change-over time (drop away) 'Normal' to 'Emergency' at no load. At load the change-over time (drop away) will depend where in the 120V AC waveform that the 'Normal' supply failed as this will influence the amount of DC current that may or may not be supplied by the signalling equipment loads.

3.3.3 Block Contactors

Block contactors due to their small physical size are quicker in operation than the bar contactors. The required changeover times in this specification are quicker than what the suggested manufacturer specifies in the data sheets.

3.3.4 Description of ECO panel operation

Please refer to example circuit drawing number 09100200-1 for ECO panel circuit configuration.

The starting position for the circuit is assumed to be that the normal supply is off and the emergency supply is on. The ECO contactor will be in the de-energised position. The normal supply voltage sensing relay, NCJR (Normal Contactor Timer Relay set for 7-sec) and NRJR (Normal Resistor Timer Relay set for 15-sec) will be de-energised.

Normal supply is switched on and must be greater than the pick up voltage of the voltage sensing relay (115V AC). The normal supply voltage-sensing relay will energise and the NCJR (7-sec timer) will begin timing. After 7 seconds the NCJR will energise which will allow the ECO coil to energise with the full supply voltage of the normal supply (the NRJR 15 sec is still de-energised but has begun timing). 15 seconds after the ECO coil energises the NRJR will energise which will effectively connect the resistor in series with the ECO coil.

If the normal supply fails then the ECO coil will de-energise and the normal supply voltage-sensing relay will de-energise. It is important that the voltage sensing relay has a quick response time so as to minimise the possibility of the ECO coil de-energising while the voltage sensing relay remains energised due to brief momentary break in the normal power supply.

The ECO AUXILARY 1 contact is used to indicate the position of the ECO contactor via the standard normal power supply indication circuit. The ECO AUXILARY 2 contact is used to protect the ECO coil and resistor from burning out if the normal power supply voltage relay remains energised but somehow the ECO coil has de-energised.

4. Construction

Suggested circuits are drawing number 09100200_1 Emergency Changeover Contactor (High Speed) 25-250A using the RMS 2V330 and drawing number 09100200_2 Emergency Changeover Contactor (High Speed) 25-250A using the PILZ S1UM in Appendix A of this specification. The circuits are for reference only and are a suggested configuration.

The ECO panel shall be designed, built, supplied, installed and operate in accordance with this specification.

5. Environmental

The ECO panel is usually installed in relay rooms, apparatus rooms or lineside location cases. The ECO panel shall meet classification D as defined in ARTC signaling specification SPS 02 Environmental Conditions. For the ECO panel the ambient temperature range for classification D is lowered to -20 - +55 C. All of the other requirements of category D classification apply to the ECO panel. The temperature operating requirement is critical when selecting the voltage sensing relay and the timer relays as these electronic devices must operate correctly over this temperature range.

The ECO panel is required to operate in an environment susceptible to surge damage on the AC ‘Normal’ and ‘Emergency’ power supplies. Surge protection is required on both of these power supplies in accordance with ARTC signaling specification SCP 04 Lightning and Surge Protection Requirements. Additional surge protection may be required to protect the internal components of the ECO panel. The ECO panel is classified as an electronic device and shall meet the requirements for Electronic Equipment in SCP 04 Lightning and Surge Protection Requirements.

6. Specific Requirements

6.1. Compliance with AS 3947.6.1-1996

The ECO panel shall comply with the following parts of AS 3947.6.1-1996 Low-voltage switchgear and control gear Part 6.1:Multiple Function equipment-Automatic transfer switching equipment.

The ECO panel is deemed for the specification to be an ATSE (Automatic transfer switching equipment) as defined in clause 2.1.2.

The ECO panel shall comply with the following requirements:

- Operation of the ECO panel is as per 2.2
- Voltage Supply deviation is -20% to +20% of 120V AC (rms)
- Frequency Supply deviation is +/-3% of 50Hz.

The ECO panel is classified as Class PC.

Rated making and breaking capacities as per 4.3.5 and Table II. The utilisation characteristic is to be AC-33B (alternating current, infrequent operations)

ECO panel Current Rating (A)	Making & Breaking Capacity (A)
80	480
120	720
200	1200
280	1680

The ARTC signalling system equipment has been assessed as motor loads with mixed loads. The incandescent loads (signal lamps) are isolated from the 120V AC supply via transformers. The ECO panel may be operated every month for testing purposes and it is estimated the ECO panel will operate 5 times per year due to failure of the normal power supply. The ECO panel current rating is assumed with a load power factor of between 1.0 and 0.7 lagging or leading. The ECO panel shall be capable is capable of carrying the rated load at the rated input voltage continuously at maximum ambient operating temperature.

The ECO panel must be capable of operating to this specification with normal and emergency supplies operating from different phases, including opposite phases. (i.e. must operate with asynchronous supplies). Any (0-360), full asynchronous supply is possible.

The ECO panel must switch both active and neutral lines.

The ECO panel is being used for a 120VAC supply, which is isolated from earth. Both the normal and alternate supplies are isolated from earth and do not have a neutral to earth MEN connection. The ECO panel shall not connect the active or neutral to earth.

The 120V AC signalling power supplies on the ARTC network may have Earth Leakage Detectors connected to monitor for earth leakage from either active or neutral to earth. These earth leakage detectors have a 15kohm input sensitivity. The ECO panel shall not have earth leakage between the active/neutral and earth, which causes the Earth Leakage detectors to trip/alarm.

ECO panel efficiency (including the power conditioner) is to be greater than 95% at the rated input voltage (for 0.7 lagging load) at maximum ambient operating temperature.

6.2. Contactors

The contactor shall be a single block or bar type and the contactor shall be break before make type. The contactor utilisation category is deemed to be AC-33B.

Selection of the contact should be dependent on the current ratings as specified in the Table 1 below. The coils are for 120V AC operation only.

Maximum Load Current at 120V AC	Contactor Type	Suggested contactor (Telemechanique part no)	Suggested Coil (Telemechanique part no)
25A	Block	LC1 D25008	110V AC 50Hz LX1D4F5
65A	Block	LC1 D65008	F5 110V AC 50Hz LX1D6F5
80A	Block	LC1 D80008	F5 110V AC 50Hz LX1D6F5
120A	Bar	CV1 GB	WB1-HA120
200A	Bar	CV1 HB	WB1-JB327
280A	Bar	CV1 JB	WB1-KB151

Table 1

The contactors are to be fitted with (2) normally open and (2) normally closed main poles. 2 normally open auxiliary contacts are to be incorporated for the operation of the ECO unit. The Block contactors are with the LA1-DN20 auxiliary contact block to provide 2 normally open auxiliary contacts. The auxiliary contacts for the bar contactors are fitted by the manufacturer.

Telemechanique contactors with the product codes listed in the above table have been found to be suitable. Other brand contactors have been tested and have been found to be slower in switchover times. Alternatives can be used if the supplier can clearly demonstrate that the ECO panel meets the requirements of this specification.

6.3. Rated Insulation of main pole contacts

Minimum Rated Insulation voltage for each main pole contact of the contactor shall be:

660V AC IEC 158-1

750V AC VDE 0110grC/IEC 947-4

6.4. Change-over times

6.4.1 25-80A ECO panels

ECO panel change-over time:

Normal to Emergency (Drop Away) ≤ 18 milli seconds

Emergency to Normal (Pickup) ≤ 18 milli seconds

6.4.2 120A-280A ECO panels

ECO panel change-over time:

Normal to Emergency (Drop Away)	≤ 35 milli seconds
Emergency to Normal (Pickup)	≤ 18 milli seconds

6.5. Relays and Bases

All relay bases used for indicating relays, timer relays and voltage sensing relays are to have clips designed to hold in the required device securely in place. All equipment shall be of front connected type.

6.5.1 Indicating Relays

All relays used in indicating circuits should be equivalent to type “Fuji” HH23PW-T or “Omron” MK3P-I.

6.5.2 Voltage Sensing Relay (VSR)

A voltage sensing relay must be provided, to force the contactor to EMERGENCY SUPPLY when the NORMAL power supply falls below 100V AC, and to prevent the contactor from switching back until normal supply voltage is restored to at least 115V AC.

The VSR must allow independent setting of the pickup and drop away voltage values and must have a release time of 100ms or faster. The quick response time is required to ensure that the ECO circuit responds quickly to a failure of the normal power supply.

The Pick-up value shall be adjusted to	115 ± 1 V AC
The Release shall be adjusted to	100 ± 1 V AC

Voltage Sensing Relays used previously are the RMS – 2V330 or PILZ S1UM. The PILZ S1UM has an inbuilt delay timer, which can be set for 7 seconds which negates the need for a separate 7-second timer.

6.5.3 Time Delay Relay

A 7-second time delay relay shall be provided to prevent the contactor from picking up to the normal position until the normal supply voltage has been restored for 7 seconds. This time delay is required to prevent the ECO panel repeatedly switching from normal to emergency and back again during normal supply disruptions (e.g. during electrical storms).

6.5.4 Economising Resistor Time Delay Relay

A 15-second time delay relay is required to switch the economising resistor into circuit.

6.6. Economising Resistor

The economising resistor is required to prevent small DC currents generated by the inductive loads (i.e. numerous isolating transformers) from holding up the AC coil and prolonging the drop away time from Normal to Emergency. It also minimizes the current required to maintain the energised coil.

a) The rated power dissipation of the economising resistor must be at least 3 times the designed and measure standing load to ensure that the resistor can handle a 3 fold increase in power dissipation if the contactor lifts away

slightly (causing the coil to draw more magnetising current).

b) The economising resistor must be mounted away from other equipment in the ECO panel enclosure and provided with sufficient air clearance above to allow for proper heat dissipation.

The resistor value required is dependent on the coil winding characteristics of the contactor. It is therefore possible that the recommended values may have to be changed to operate the contactor correctly so as to meet this specification.

For 50A-80A ECO panels a fixed 165 ohm 100 Watt resistor has been used successfully.

For the 200A-250A ECO panels a 30 ohm 400 Watt resistor has been used successfully.

Aluminium clad resistors must be mounted on a sufficient thermally rated heatsink (using heat transfer compound) to achieve the rated dissipation. Due to the high operating temperatures of the resistors it is not possible to use soldered connections as the solder can melt causing the connection to come loose. A bolted connection using high temperature rated (V105 or better) wire is required for these resistors.

6.7. Indications

The front hinged panel of the ECO panel has two indicating LED lamps to indicate availability of the 'Normal' and 'Emergency' power supplies and to indicate when the normal supply is selected. The LED lamps are to be the water clear type, which emit a green colour when lit. They must be bright enough and of a sufficient size so that they can be clearly seen in direct sunlight from a distance of 3 metres at a viewing angle of up to 30 degrees. Suggested minimum requirements would be a LED with the following characteristics: Emitted colour: green, Lens size: 10mm, Type: Clear, Intensity: 1000mcd, viewing angle: 30 degrees.

6.8. Enclosure for the ECO Panel

All equipment (except the indicating LED lamps) including the contactor, relays, timers and terminals etc shall be mounted on a metal backing plate of sufficient strength to support all of the equipment. The economising resistor may be mounted on the enclosure side wall if required but it must not obstruct access or removal of any items within the ECO panel.

All components mounted on the metal backing plate must be able to be removed and replaced without having to gain access or use tools from the rear side of the backing plate. This can be achieved by using threaded mounting holes, fixed threaded studs or some other fixing method. No loose nuts or studs are allowed on the rear of the metal backing plate.

The metal backing plate is to be attached securely to the rear panel of the enclosure using at least 4 shakeproof bolts and spacers.

The metal backing plate must be smaller than the rear panel of the enclosure and must have its corners trimmed and/or access holes cut so that access to the enclosures mounting holes is unrestricted. The ECO panel must be able to be mounted on the wall without having to remove the metal backing plate to gain access to the enclosure mounting points.

The ECO Panel shall be enclosed in a sheet metal case of Environmental Protection

Class IP 32 or better with hinged front panel. Two vents are required on the side of the enclosure where the economising resistor is mounted (preferably the left hand side). One vent is to be at the bottom of the side panel. The other vent is to be at the top of the left hand side. The vents are to be of a suitable size to provide sufficient ventilation to ensure that the maximum internal air temperature does not affect the operation or performance of the ECO panel. If natural ventilation does not provide sufficient cooling than forced cooling using electric fans or other suitable means may be required.

The hinged front panel of the enclosure is to use 2 standard T handles for opening and closing the front panel. Keys locks are not allowed.

The ECO panel must operate correctly with the ECO panel door closed. The door must not foul the free movement of the contactor.

6.9. Wiring

a) Wiring for the ECO panel shall be done with minimum of 0.7 Sq mm multi-stranded conductors in PVC insulation and be formed and secured in a neat wire loom. All terminations shall be beaded with the terminal number/name that the wire is terminated on.

b) Insulation of Wires shall be V75 or better.

c) All equipment shall be of front connected type.

d) Wire size for the power conductors shall be in accordance with AS 3000 and the rated current of the ECO panel.

e) High temperature wiring V105 or better (e.g. fiberglass insulation) shall be used for connection to economising resistor.

f) The metal backing plate, ECO enclosure and front door shall be earthed in accordance with AS3000.

6.10. Terminals and fuses

a) All conductors shall be terminated with approved pre-insulated crimp lugs or bootlace ferrules for small conductors or in the case of larger conductors, non-insulated lugs with a heat shrink sleeve applied after crimping. The heat shrink sleeve shall cover the body of the crimp lug and extend at least 15mm over the conductor insulation.

b) All main power feed through terminals and mains cable connections shall be compression clamp terminal blocks similar to the Entrelec M35/16 type. The use of bolts with unsecured nuts (as used with Klippon SAKG28) is not permissible, as access for tightening the nuts is extremely difficult.

c) All fuse holders shall be similar to “Klippon” – SAKS1 type with 4A indicating fuses. All disconnect terminals shall be similar to “Klippon” – SAKC10 type. The resistor terminals shall be similar to “Klippon” SAK6N type.

6.11. Spares to be Provided

A spare coil shall be supplied with each ECO panel. This spare coil shall be the same type as the one supplied in the ECO panel contactor.

The spare coil must be attached to the inside front panel by suitable means to ensure that they won't foul the workings of the ECO and so that they can be removed easily if required. E.g. cable tie.

6.12. Labelling

Labelling for all relays, terminals and indicating lamps shall be on Traffolyte or equivalent and permanently affixed (refer to ARTC Standard Specification SPS 04 – Labelling of Signalling Equipment).

The following labels shall be provided on the front panel of the ECO panel enclosure:

1. High Speed Emergency Change-Over Contactor Panel – xxx A 120V AC (or 415V AC)
2. Where xxx is the rated current of the unit based on the contactor used in Table 1.
3. Manufacturer's name or Identity
4. Date of Manufacture (e.g. Sept 1999)
5. Serial Number
6. Normal Supply Available (Below LED light)
7. Emergency Supply Available (Below LED light)

The following labels are required on the inside of the ECO panel enclosure to clearly label the relays, timers and economising resistor:

1. Emergency Supply Available (Relay)
2. Normal Supply VSR (Voltage Sensing Relay)
3. Load Supply Available (Relay)
4. NRJR 15 sec timer
5. NCJR 7 sec timer (if timer is not part of VSR)
6. resistor xxx Ω xx W

The 2 incoming supplies (normal & emergency) and the output of the ECO shall have the three labels listed below. The labels shall also have the A and N symbols (indicating Active and Neutral) incorporated with the labels so that the polarity of the terminals is clear.

1. 120V AC Normal Supply
2. 120V AC Emergency Supply
3. 120V AC Load Supply

A circuit diagram of the ECO panel wiring and components shall be provided with each unit. This circuit diagram is to be attached on the inside of the front panel. The circuit diagram is to be laminated to provide protection.

The circuit diagram shall also have a parts list, which lists individual part numbers and suppliers contact details (address & phone number) for all of the components, which make up the ECO panel.

Items to be included in the parts list are:

Contactor mechanism, coil for contactor, voltage sensing relay, indicating relays, timer relays, economising resistor, LED indicators and connection terminals.

The ECO panel shall also have a product information label on the inside of the enclosure, which shall at least meet part 5 of AS 3947.6.1-1996.

6.13. Programmable Logic Controller (PLC)

The suggested circuit arrangements and example circuits in this specification use discrete electronics timers and relays to control the ECO contactor and to detect the voltage levels of the incoming 'Normal' power supply.

These devices could be replaced using a small programmable logic controller (PLC) to achieve the functional requirements of this specification. If a PLC is used than the ECO panel shall operate as required by this specification.

6.14. Operation at 415V

This specification can be used for providing an ECO panel were both the 'Normal' and 'Emergency' power supplies are at 415V AC. Due to the higher potentially lethal voltages, measures must be taken to ensure accidental contact with 415V AC cannot happen. The ECO panel will be clearly labeled on the front panel and inside as 415V AC. Due to lower current requirements a 415V AC ECO panel should only need to use block contactors (25-80A). It may be desirable to operate the voltage sensing relay, timer relays and even the contactor coil from a 120V AC power supply derived from a step down transformer. All 415V AC wiring should be clearly labeled. The 415V AC ECO panel must be type approved by ARTC Corridor Manager or nominated Signalling representative.

7. Testing Requirements

7.1. Visual Inspection

Each ECO panel is to be visually inspected to ensure that it has all of the required components securely mounted and that all of the wiring is neatly loomed together. Labelling is to be checked as per the requirements of this specification. A visual check is also required that the correct circuit diagram with part numbers and suppliers details is laminated and attached to the inside of the front hinge door of the ECO panel enclosure. A check is to be made to ensure that the spare coil for the unit is also supplied.

7.2. Electrical Tests

Each ECO panel is to have the attached test report completed satisfactorily and attached to the ECO panel for delivery. The ECO panel will not be accepted for use without a completed test sheet.

TEST REPORT ECO Panel

Test Activity	Test Requirement	Pass
1. Visual inspection	All labels present, spare coil provided, circuit diagram etc	Y/N
2. Apply 120V AC to Emergency input Connect 5A load to ECO panel output Connect variable supply to normal supply Adjust supply to 105V AC initially and then slowly increase. VSR should energise. Record voltage	VSR pickup 115 ± 1V AC	p.u. voltage
3. Apply 120V AC to Emergency input Connect 5A load to ECO panel output Apply 120V AC to Normal Input Time how long before the contactor picks up and how long before economising resistor is connected in series with coil.	7 ± 1 seconds for time delay 15 ± 1 seconds for economising resistor time delay relay	times
4. Apply 120V AC to normal input. Wait until contactor has energised and the economising time delay relay has energised. Slowly reduce the Normal supply input. Record voltage that ECO de-energises	ECO drop away 100 ± 1V AC	volts
5. Monitor output of ECO panel with a chart recorder or scope. Connect 120V AC to Emergency Input. Record switch over time of contactor after 120V AC is applied to the 'Normal' power supply input. Repeat 3 times	Chart recorder printout or scope showing break before make in voltage output of ECO panel to be less than 18 msec for all ECO panel ratings.	
6. Monitor output of ECO panel with a chart recorder or scope. Connect 120V AC to Emergency Input. Connect 120V AC to Normal Input. Record switch over time of contactor after 120V AC is removed from the 'Normal' power supply input. Repeat 3 times.	Chart recorder printout or scope showing that break before make in output of ECO to be less than 10 msec for 25-80A rated ECO panel and less than 35 msec for 120-250A rated ECO.	

TEST DATE: ..... **Serial Number:** .....

Tested by: **Name:** .....

Signature: .....

Appendix A

Example Circuit Diagrams for

Emergency Changeover Contactor (High Speed)