# DAVID LUKE BOWEN DB133872 SGEE4006

*by* Luke Bowen

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# HNC Electrical and Electronic Engineering
# HNC Project
# SGEE 4006

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*Good extensive list of figures*

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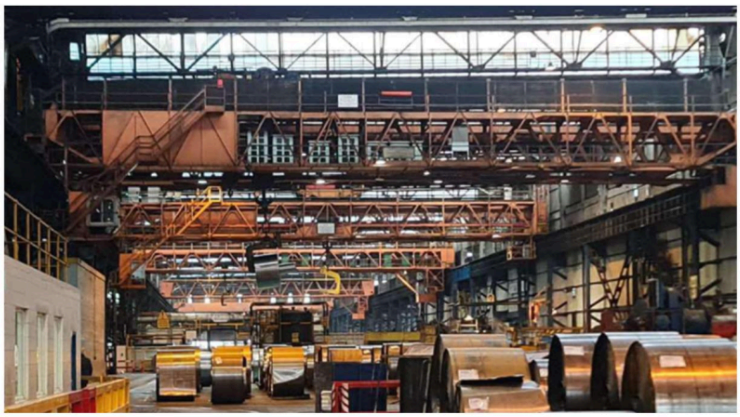
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*Good use of tables*

## Introduction

Tata Steel is a major steel producer with operations spanning raw steelmaking to finished products. Trostre Steelworks in Llanelli, South Wales is a tinplate manufacturing facility producing approximately 400,000 tonnes per year of packaging steels.

Within such industrial plants, high level overhead gantry cranes play a vital role in handling material for processing and shipment. Gantry cranes (a type of bridge crane) are used to lift and transport heavy loads such as steel coils and raw materials across the facility with precision. Their ability to lift and position steel coils efficiently makes them indispensable, directly supporting high productivity and safe operations. (bettercrane.com) *Correct citation*



*Good supporting image*

*Figure 2 - Gantry cranes*

Having the current circuit breaker within the cab poses safety and maintenance challenges (See project justification). In the interest of operator safety, regulatory compliance, and ease of maintenance, Tata Steel initiated a project to replace and relocate the breaker of the crane cab to a safer location. This report documents that project from initial research and specification through planning, implementation and final testing process.

**Importance of Main Breakers in Crane Systems**

Main breakers play a critical role in overhead crane systems by providing a primary means of electrical isolation and protection. In high current environments such as this example of gantry cranes operating at 240V DC and 800A, the main breaker ensures that the entire electrical system can be safely disconnected during maintenance, emergencies, or in the event of a fault. Without a properly functioning main breaker, maintenance personnel and operators would be exposed to the risk of uncontrolled electrical faults, which could result in equipment damage, serious injury from arc flash incidents and fires. Additionally, the breaker protects against electrocution and the crane's control circuits and motors by interrupting overcurrent or short circuit conditions before failures occur. (motors and control, 2021) *Correct citation* *Good argument for project with a H&S focus*

**Eaton Cutler-Hammer 800A magnet disconnect circuit breaker**

Cutler-Hammer (now part of Eaton) breakers of this class are built for heavy industrial applications such as DC crane controls, mill motors, and large battery or photovoltaic systems. They serve as main disconnects to isolate power and protect equipment like DC hoist motors and magnet systems. This indicates it can safely break very large DC fault currents, an essential requirement in crane power systems. The breaker uses a thermal magnetic trip mechanism – a thermal element for overload protection and a magnetic element for instantaneous short circuit protection. The Eaton breaker's contact design uses magnetic repulsion forces to rapidly separate contacts under fault conditions, quickly elongating and extinguishing the DC arc. The "manual/electrical magnet" indicates this breaker can be operated manually (via a lever) and may also have electrical operating accessories – for instance, an undervoltage release or trip coil to trip the breaker remotely and a mechanism to enable remote closing. (Eaton, 2021) *Good information* *Correct citation*

These features are crucial for the project's goal of cab remote control: with the appropriate accessories, the breaker can be opened or closed from the CAB by energising a coil via a button, instead of the operator physically handling the switch. *Good point*

## Specification

**Project Objective**

The purpose of this project is to improve the safety, reliability and operational efficiency of an aging DC breaker system located within a high level gantry crane at the Tata Steel's Trostre site. The existing breaker presents significant operational and safety risks due to its location within the crane operator's cab and its deteriorated condition. The system currently requires the crane operator to physically operate the breaker from inside the cab, exposing them to high-voltage equipment and increasing the likelihood of injury or arc flash incidents.

A new control interface will be developed allowing the operator to energise and isolate the crane via low voltage remote controls, eliminating the need for direct manual interaction with higher voltage switches. This includes installing appropriate control wiring, safe isolation, interlocking mechanisms, and safety features to allow the crane's electrical system to be isolated remotely in compliance with safety and electrical standards, this will eliminate the need for the operator to be near potentially dangerous equipment.

*Good points*

The upgraded system must meet the following requirements:

**Replacement breaker:** must be rated for DC operation at 240V, capable of safely interrupting high direct current loads and be suitable for use in a high current industrial environment.

**Relocation of breaker:** Relocate the main breaker to a position that is accessible for maintenance and compliant with relevant crane safety guidance.

**Safer operation:** Ensure the operator can safely energise or isolate the crane without direct exposure to the higher voltage circuit. Provide clear visual and operational feedback to the operator regarding breaker status.

**Timeframe:** Be completed within the established timeframe of 4 months whilst working with operators and staff to minimise crane downtime.

**Budget constraints:** The total project was planned and executed within a strict budget of approximately £10,000, covering materials, labour, equipment hire, and system upgrade. Maintain or improve the performance of the existing power distribution setup, ensuring adequate protection for crane components.

**H&S and electrical standards:** Comply with all health and safety regulations, including the Electricity at Work Regulations and IET Wiring Regulations.

**Electrical specification:** The gantry cranes operate on a 800A 230DC supply with 110v AC for the control circuits.

**Testing:** All components will be carefully integrated into the crane's existing radio and cab system. Post installation testing will be carried out to ensure full functionality, safety, and compliance with electrical standards. Documented test results proving the functionality of the new configuration and training for operators on the changes.

**Sustainability:** Must consider sustainability issues that the project incorporates such as refurbishing and reusing materials to saves resources.

**Environmental impact:** Must consider environmental issues may be involved during this project such chemicals that have an effect on the environment or if the efficiency of crane operation be improved.

**Project justification**

The existing main breaker on the gantry crane is an original piece of equipment installed during the 1950s, making it over 70 years old. Despite continued operation, the breaker's age, exposure to harsh industrial environments, and lack of modern safety features present significant risks. A nearly identical breaker on another crane recently experienced and electrical fault, resulting in arc flash and a small electrical fire, highlighting the urgency of replacing these outdated units as part of a broader site electrical overhaul. Currently before use of the crane the operator of the crane MUST activate it manually in the CAB by pulling a handle which will latch the outdated breaker.



*Figure 4 - Operator activating old breaker (1)*




*Figure 3 - Operator activating old breaker (2)*

*Good evidence of old system*

Internal inspection of the breaker reveals signs of carbon tracking, corrosion, and wear to contact assemblies—all clear indicators of mechanical and electrical fatigue. Its continued use not only threatens operational reliability but also poses a serious safety hazard due to potential arc faults. Modern circuit protection standards, fault energy management, and operator safety considerations are no longer met by this legacy unit.

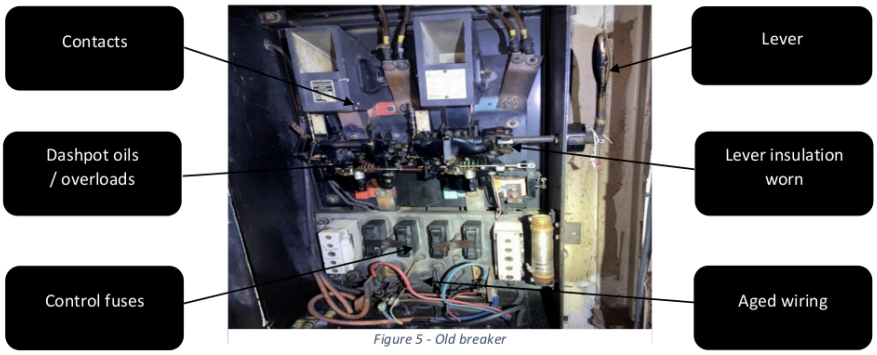



*Figure 5 - Old breaker*

## Planning

**Time constraints**

The project timeline plan for a 4 month project has structured into key phases:

**Planning phase:** the team will create a proposal, conduct site assessments, carry out planning of required safety procedures, finalise the project scope, carry out project presentation and coordinate with staff to schedule downtime and prepare materials.
**Replacement phase:** the old breaker will be safely removed, and the new system will be installed.
**Completion phase:** which involves the test plan being carried out, completion of documentation and a project debrief to ensure all objectives have been met for commissioning before the crane is returned to full operation.

These stages were broken down and shown in the following Gannt chart.




*Good plan with good explanations*

*Figure 6 - Gantt chart plan*

***Environmental and Sustainability Considerations***

Refurbishing a newer type breaker taken from an old crane on site helped reduce material waste and avoided the environmental impact of manufacturing a new unit. This approach supported sustainability goals while also saving costs. Additionally, as this breaker type is already in use on site, spare parts are available in store, ensuring quicker repairs and reduced downtime without the need for new resources during emergencies and breakdowns.

Test plan for outcomes of project

After installation, a comprehensive test plan was executed to verify that the new system met all design requirements and that the crane was safe to return to service. The testing was divided into three main criteria which includes inspections, electrical tests, and functional tests, with results recorded for each test.

| Test | Expected result |
|---|---|
| Continuity | No open circuits. Low ohms reading. |
| Polarity | Positive and negative connections not swapped. Polarity confirmed. |
| Insulation Resistance | All readings should be >200 MΩ (500v). |
| Mechanical Inspection | Every bolt, crimp lug, and gland to be to standard. |
| Test in Locked off Position | Start button disabled, nothing should happen. |
| Operation of Controls when Breaker is open | Nothing should happen. |
| Control Circuit ON | Control relay in the main panel picked up and latch and coil to energise when start button is pressed. Confirmed operation of craned panels in control. |
| Control Circuit OFF | Relay to drop out and energise when stop button pressed. |
| Mains No-Load Closing | Breaker to close and power to the crane panels. LED ON illuminated. |
| Check transfer switch Interlock check 1 | Crane should be controlled via CAB whilst set to CAB and then the same via radio. |
| Mains No-Load E/stop | Trip immediately, cutting power. LED OFF illuminated. |
| Hoist Motor Test | Renewed operation of hoist motor for CAB and radio. |
| Long Travel Motor | Renewed operation of long travel motor for CAB and radio. |
| Cross Travel Motor | Renewed operation of cross travel motor for CAB and radio. |
| Emergency Stop During Operation | Breaker should deenergise. |
| Prove Transfer Relay Interlock check 2 | Operate CAB whilst switch set to radio, volt relay (VR) to drop out and then the same for radio whilst set to CAB. |
| MR Timer | MR timer set to drop out after 30 seconds after no operation of radio control. |
| Simulating a Fault | Secondary current induced into the breaker's trip unit should simulate an overload and require manual reset. |

*Table 1 – Recommended tests*

H & S requirements

Moving the breaker out of the cab addresses the risk of an arc flash or electrical fault occurring next to the operator. It also aligns with industrial standards that recommend the main disconnect be located on the crane's foot walk (with a means for operation from cab and remote).

An emergency stop function will be implemented via the Stop pushbutton to immediately deenergise the crane's supply in an emergency. All electrical work will follow the Electricity at Work Regulations and BS7671 wiring standards, ensuring proper insulation, segregation, and earthing of the new cables and panels.

A detailed risk assessment and method statement (RAMS) was produced. Hazards such as working at height, heavy lifting, high voltage DC exposure, and arc flash were identified with controls including harnesses and fall arrest for height work, Lock-Out Tag-Out procedures during electrical work, arc flash PPE for make/break operations, and barricading the area below during installation.

## Solutions considered

**Solution #1**
**Install a Terasaki Air Circuit Breaker (ACB)**

This involves purchasing a modern low voltage air circuit breaker such as a Terasaki TemPower2 ACB, of equivalent current rating to replace the old Cutler-Hammer unit. A picture including parts and functions was including in the appendix.



*Good image*

*Figure 7 -Terasaki ACB Type AGR-21B series (Terasaki Electric Co., Ltd. n.d.)*

*Correct citation*

The AGR-21B series supports 230V DC applications and is available in ratings from 600 amps to 1.6k amps. While it requires a new custom housing, the panel cut-outs remain consistent across all models, simplifying the switchboard design process. This Installation is similar to the primary solution, involving cable connections and a stop/start button. However, it also demands additional auxiliary supplies to power the spring charging motor and a separate supply for the maintained tripping coil, adding complexity to the overall system integration.

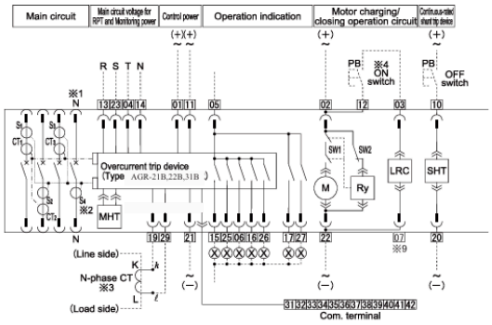



*Figure 8 - AGR-21B series circuits 1 (Terasaki Electric Co., Ltd. n.d.)*

This schematic illustrates the control and protection circuit for the Terasaki ACB AGR-21B series. It shows the integration of main circuit inputs, overcurrent trip detection, and motor

driven closing and tripping mechanisms via auxiliary relays and pushbuttons. This setup ensures both manual and electrical operation, with built in safety interlocks and control logic to allow safe switching and monitoring of the breaker state.

**Cost**

The ACB device itself and integration was estimated at £50k with a new 800A ACB and modifications for additional auxiliary supplies to power the spring charging motor and a separate supply for the maintained tripping coil.

**Feasibility & Downtime**

The Terasaki ACB replacement is achievable within the 4 month project window. It would require engineering the mounting of the ACB housing and additional supplies to spring charging motor and tripping coil. The ACB on existing DC system would not change the operation of the crane, it would still operate and function on the existing DC motors and resistive controllers.

**Reliability & Maintenance**

Replacing the old breaker with a Terasaki ACB would improve reliability of the main disconnect. However, the rest of the DC system (motors, controls) would remain, meaning ongoing maintenance of DC motors (brushes, commutators) and the old control circuits would still be required. It solves the immediate breaker issue but no other age related issues such as parts can be difficult to source. ACBs are slightly more difficult to unrack for maintenance compared to the existing system, as they often require additional safety precautions and require unracking to fully isolate and remove the unit from its housing.

**Evaluation**

*Good explanation and argument for a solution*

Solution 1 was a viable option, but carries a high cost relative to budget.

(additional data sheets included in appendix). (Terasaki Electric Co., Ltd. n.d.)

*Evaluation involves a variety of criteria not just cost and a table method is best suited.*

## Solution #2

**New AC Powered Crane Infrastructure**

This ambitious option would include a full conversion of the crane's electrical system from DC to AC. It would involve a new crane entirely or replacing the DC motors with AC motors (for hoist, long travel, cross travel), installing Variable Frequency Drive (VFD) controllers (inverters) for each motion, and feeding the crane with standard 415 V AC power through an isolator or ACB. The existing 800A DC breaker and DC rectifier system would be entirely removed.

*Still a good option in the long term*

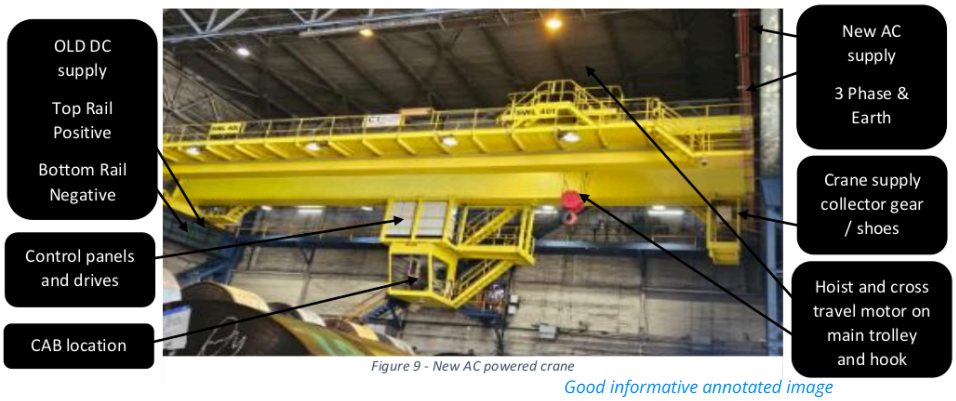



*Figure 9 - New AC powered crane*

*Good informative annotated image*

This would not only solve the current problem of the breaker but also solve a wider host of problems. This crane is over 70 years old with a lot of original equipment which is coming to the end of its life. Infrastructure for AC supplied crane has been done in another area where another crane was condemned.

Schneider Electric Altivar Process ATV930 variable frequency drive (VFD) includes a 3 phase output with full variable frequency (0 to 500 Hz typical) for wide speed control range suitable for this project. This industrial drive is part of Schneider's current ATV900 series, which is designed for heavy-duty applications like conveyors, cranes, and mills. (se.com)



*Good explanation and argument*

*Figure 10 - Schneider Electric Altivar Process ATV930 VFD (se.com)*

Schneider's Altivar Process ATV930 is explicitly targeted at high demand hoisting applications. It provides the robust performance and safety features required for overhead and gantry cranes, a high overload margin for lifting heavy loads, precise motor control to prevent unpredictable movement, and reliable braking and safety functions for handling suspended loads. (Automation Distribution. n.d.)

(See appendix for datasheets).

**Cost**

Although it is now cheaper to purchase a new AC crane than a new DC powered crane as they are more common, this solution was estimated to cost around 1 million pounds.

**Feasibility & Downtime**

This is a major project that could exceed the timeframe. Swapping motors on a large crane, installing new control panels, and commissioning the system could take many more months of complete crane downtime, the plant operations rely on the full operation of the crane as it is based in the stores has no replacement. Also, the complexity and need for specialist engineering would be required.

**Reliability & Maintenance**

A new AC system would dramatically improve energy efficiency – studies show converting overhead crane controls from DC to AC can reduce power consumption by nearly 50% due to more efficient motors and drives. (konecranes.com)

It would also eliminate the issue of obsolete DC parts, modern AC drives have widely available components, and the crane could benefit from new safety features such as easier addition of anti-sway. (konecranes.com)
This would also require training for electricians and the drivers would require training for the new system.

*Good explanation*

**Evaluation**

To install a new infrastructure on this scale would be expected to cost up to 1 million pounds, due to budget constraints the only viable solution is replacing the DC breaker for another.

*Both solutions should be evaluated using a table for comparison*

*There should be a better reason for the chosen solution*

## Final solution and implementation

**Scope of work**
This project will be carried out in TATA Steel Trostre and involves the replacement of an 800A Eaton Cutler Hammer electrical/manual magnet disconnect breaker on a 240v dc high level gantry crane and also the installation of a control circuit for the protective device to be electrically operated as well as manually.

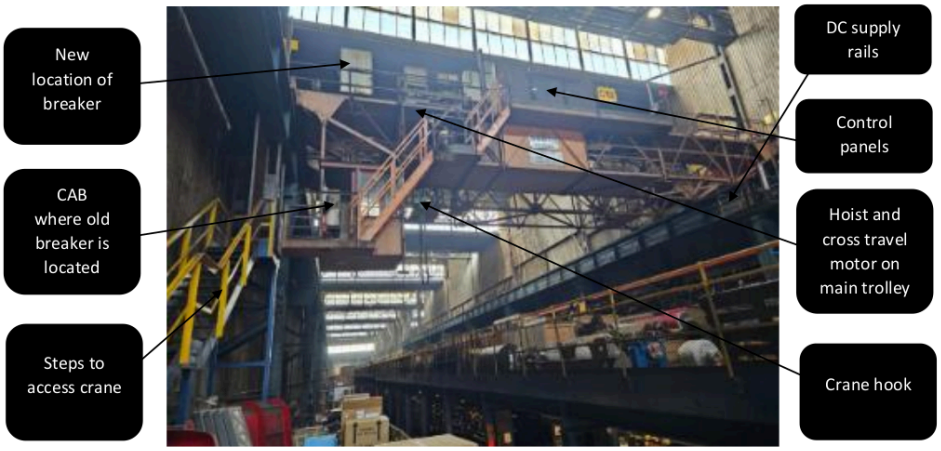



*Figure 11 - Subject crane*

*Good annotated image*

To complete the project the following tasks are required to be carried out:

**Prepare new breaker:** Refurbish and test Eaton Cutler-Hammer 800A magnet disconnect circuit breaker

**Main Breaker Replacement**: Hire mobile crane to remove existing main breaker in CAB and replace with a new electrical/manual disconnect breaker onto the top platform.

**New supply to breaker:** Install new supply to breaker from crane long travel collector gear (shoes/rails).

**Replace cables to facilitate relocation:** New supply required to supply control panels, interface panel (which manages communication between control equipment for radio and cab operations) and inverter panel (to supply inverter and transformer panel to regulate the crane's power conversion needs).




*Good diagram*

*Figure 12 – New cable installation required*

**Start/Stop Button:** Installation of a start/E-stop button and indication lights to provide a user-friendly and efficient control and safety mechanism for the crane operator to control the main disconnect electrically.

**Relays:** Install relays to facilitate safe switching between power sources and control modes. This includes a main line relay to open and close the breaker remotely via radio control and a transfer relay to prevent simultaneous operation from both radio and cab control circuits.

**Testing:** All components will be carefully integrated into the crane's existing radio and cab system. Post installation testing will be carried out to ensure full functionality, safety, and compliance with electrical standards. Documented test results proving the functionality of the new configuration and training for operators on the changes.

**Improve safety:** Improved compliance with safety standards having the main disconnect on the bridge platform and still accessible for emergency shutdown.

**Environmental protection & sustainability:** Further investigate what effects this project has on the environment, considering energy efficiency, waste management and what benefits this instalment can improve future sustainability for the company.

*Scope of work is explained clearly here*

**Main Breaker Replacement**

The breaker unit was previously removed from a condemned crane on site and kept in the stores for future use. This was booked out and a copy of the invoice included in figure 38 in the appendix. During refurbishment, all internal fuses, connections, and contact assemblies were thoroughly inspected, cleaned, and serviced to ensure functionality and reliability. The gland plate was repainted for improved corrosion protection and durability and new holes drilled with correct glands used for corresponding cables and redundant holes covered. Overload protection devices were tested on a known dc source at ground level and verified to ensure correct ratings and safe operational compliance, the results were recorded in the testing sequence, confirming the suitability for ongoing service.

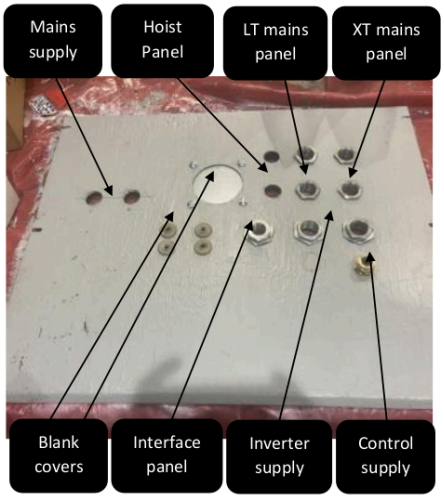



*Figure 13 - Refurbishing gland plate*

*Good explanation and evidence*

**Mobile crane hire**

On the scheduled day, the area below the gantry crane was cordoned off and the mobile crane was brought in to lift the new breaker panel, which was assembled on the ground before being hoisted up to the top platform. The mobile crane lifted the heavy breaker enclosure which was rigged and hoisted under supervision of a lifting team with professional signalling and radio communication used between the ground team and the personnel on the crane's platform. Once positioned aligning the new panel's mounting holes with the pre-drilled holes on the crane structure, it was bolted to the crane's structural beams. Mechanical implementation also included installing new cable trays and cleats along the crane girder to support the new cables that connect the breaker to the existing control panels.



*Figure 14 – Breaker in new location*

## Main breaker installation

**New supply:** A new electrical supply to be installed to feed the main breaker, supplied from the long travel collector gear. Current carrying capacity of 95mm² copper cable is 300A which is suitable for the supply of this crane.

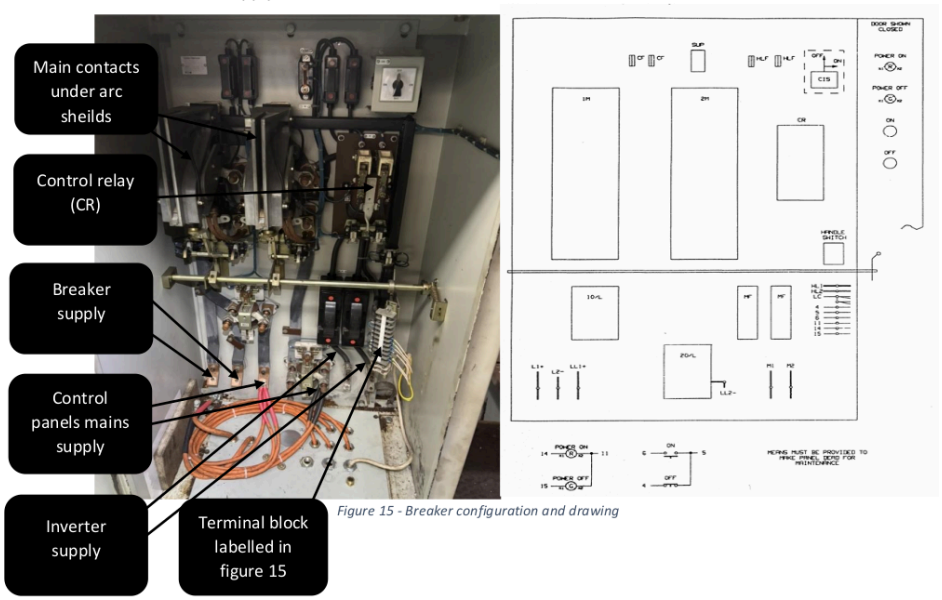
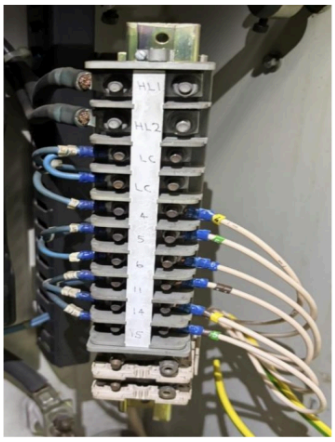



*Figure 15 - Breaker configuration and drawing*

**The following will be supplied from the main breaker:**

**Hoist Panel**: Install new supply hoist contactor panel to control the crane's lifting operations. The 160A hoist motor will require a 70 mm² copper cable, which can safely carry the current.
**Long Travel Panel**: Install new supply to long travel contactor panel to control the crane's longitudinal movement. The 113A long travel motor requires a 35mm² copper cable.
**Cross Travel Panel**: Install new supply to cross travel contactor panel to control the crane's lateral movement. For the 24A cross travel motor a cable for 30A is required under standard installation conditions, however this was upgraded to 35mm² also.
**Load control (LC):** 110V is to supply the auxiliaries in contactor panels. Required to supply interface panel to manage communication between control equipment for radio and cab operations shown in figure 15.
**Inverter Panel**: New supply required a 10mm² supply the inverter and transformer panel to regulate the crane's power conversion needs (230V DC – 415/110AC) in order to supply control equipment and lighting.

See appendix for further images, schematics and additional information of crane control panels, inverter panel and interface panel.




Heating and lighting supply (HL1-HL2)

Load control supply (LC)

Stop start button (4,5,6)

LED indication for stop start (11,14,15)

*Good image evidence*

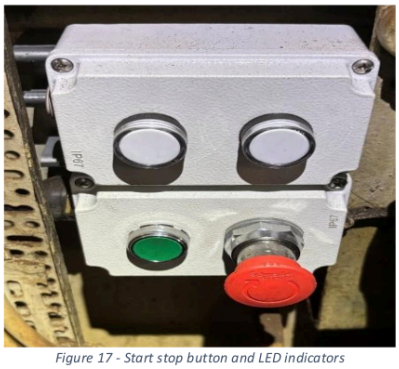
*Figure 16 - Breaker terminal block*

*16*

Figure 15 shows a labelled terminal block used for interfacing control and auxiliary circuits within the crane system. Terminals 4, 5, and 6 are allocated to the stop/start button circuit, allowing the operator to control breaker activation remotely, while terminals 11, 14, and 15 are used for the LED indication in this circuit for visual feedback of the breaker status shown below. Terminals HL1 and HL2 supply power for the heating and lighting systems. All connections are crimped and colour coded for clear identification and help with maintenance and fault finding.

**Start/Stop Button**

Installation of a start/E-stop button and indicate on lights to provide a user friendly and efficient control and safety mechanism for the crane operator.

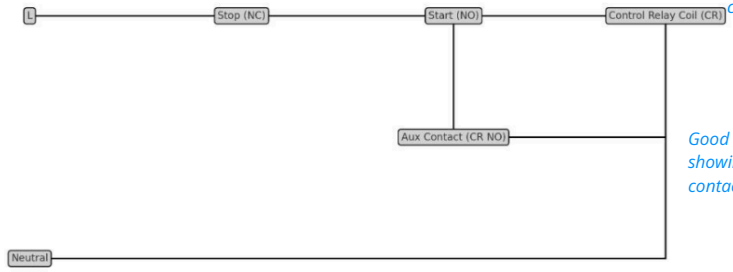


*Good explanation and image*

*Figure 17 - Start stop button and LED indicators*

This circuit uses a 110V AC control supply to operate a control relay (CR) through a 3 wire start stop circuit. The stop button is a normally closed (NC) contact that ensures power is interrupted immediately when pressed. The start button is normally open (NO), and when pressed energises the relay coil. Once energised an auxiliary normally open contact on the relay closes, forming a holding circuit that keeps the relay active even after the start button is released. The circuit is isolated only when the stop button is pressed.

*Good explanation of the retaining contact*




*Good diagram showing retaining contact function*

*Figure 18 - 3 wire stop/start control circuit*

**Relays**

Installation of the stop/start button with relays to facilitate the switching of the breaker via the CAB or radio remote control electrically.




*Figure 20 - Schneider Electric TeSys D LC1D Contactor (se.com)*




*Figure 19 - Schneider Electric TeSys Pneumatic Timer (se.com)*

*Good supporting images*

The installation incorporates two Schneider Electric TeSys D LC1D contactor relays to facilitate radio remote or CAB opening and closing of the main breaker.

**Transfer Relay:** TR is a normally closed contact in CAB circuit, positioned between terminal 6 and the overload contact (O/L) as per the provided schematic in figure 20. Its function is to act as a safety interlock, via a switch transferring control from CAB operation (closed) to radio remote control (open), preventing simultaneous operation.

**Main Line Relay:** MR contact will supply power to the radio control interface relays so that it can activate the crane remotely as well as the start button. This relay is integrated with a Schneider Electric TeSys pneumatic timer, connected between 5 and 6, configured to 1 or 2 second delay on. MR timer contact is activated to close which will pick up CR (control coil) closing relay which will close 1M and 2M (main closing coils) to manet control which will put power to all main and control circuits.

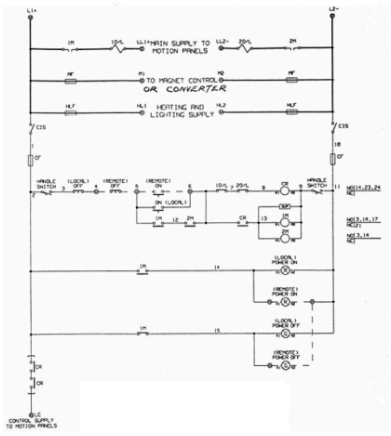



*Figure 21 - Breaker schematics*

*Good explanation and cct diagram*

These relays will be found in the interface panel shown in figure 30.

**Estimated costs**

The table outlines the detailed costs for the project.

| REQUIRED ITEM | COST |
|---|---|
| 800A MAIN BREAKER | REFURBISHED |
| RELAYS | £150 |
| STOP/START BUTTONS | £90 |
| CABLES | £4000 |
| MISC PARTS | £200 |
| MOBILE CRANE HIRE | £500 |
| LABOUR | £5000 |
| **TOTAL BUDGET** | £9940 |

*Figure 22 - Total cost predictions*

*Good cost breakdown and under budget*

The total estimated cost of the project is £9,940, well within the allocated budget constraint of £10,000. The detailed cost breakdown provided above covers all essential materials, labour, and equipment needed to complete the breaker upgrade and associated control installations.

**Environmental protection & sustainability**

**Sustainability:** The project incorporates sustainability by refurbishing and reusing an existing breaker on site instead of scrapping it, which saves resources and avoids waste. Additionally, the new installation is designed for requiring fewer replacements over the crane's remaining life (minimizing future waste).

**Environmental:** All old cabling and equipment removed from the cab will be recycled or disposed of properly through Tata Steel's waste management system such as copper cables were recycled and the oil from the old breaker removed following environmental regulations. Additionally the new crane also does no longer require oil for the overloads.

The project also considered energy efficiency, while the crane will remain DC powered the improved controls will allow the operator to disconnect power when the crane is idle for long periods via the stop button, potentially saving energy that would otherwise be wasted.

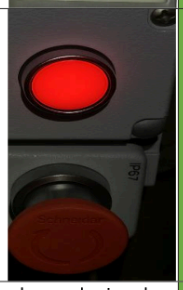
*These are good points considering the industry relevance*

## Testing and results

After installation, a comprehensive test plan was executed to verify that the new system met all design requirements and that the crane was safe to return to service. The testing was divided into inspections, electrical tests, and functional tests, with results recorded for each.

| Test | Expected result | | Pass | Fail |
|---|---|---|---|---|
| Inspect and Prove New Breaker with Known DC Source | Breaker opens and closes smoothly, trips reliably, resets without issue, and shows no signs of mechanical wear or failure. |  | | |
| Continuity | No open circuits. Suitable ohms readings throughout installation. |  | | |

| | | |
|---|---|---|
| Polarity checks | Positive and negative connections are not swapped. Correct polarity confirmed through installation.   | |
| Insulation Resistance | All (P-N, P-E, N-E) readings are >200 MΩ (500v).   | |
| Mechanical Inspection | Every bolt, crimp lug, and gland checked and secure. | |
| Visual checks (includes signage and labels) | All signage in place and no clear evidence of issues. | |
| Test in Locked off Position | Start button disabled, nothing happens. | |
| Operation of Controls when Breaker is open | CAB and radio controls offline but breaker can now be activated via start button and radio.   | |
| Check transfer switch<br><br>Interlock check 1 | Crane controlled via CAB whilst set to CAB and then used in radio when set to radio.  | |
| | | |

| | | |
|---|---|---|
| Control Circuit ON | Control relay in the main panel picked up and coil energised when start button is pressed. Confirmed operation of crane panels in control ONLY.  | |
| Control Circuit OFF | Relay dropped out and deenergises when stop button pressed. | |
| Mains No-Load Closing | Breaker closed and now mains power to the crane panels.   | |
| Mains No-Load E/stop | Tripped immediately, cutting power. LED OFF illuminated.  | |
| Hoist Operation | Renewed operation of hoist motor taken through speeds via cab and radio. Brake OK. | |
| Long Travel Operation | Renewed operation of long travel motor taken through speeds via cab and radio. Brakes OK. | |
| Cross Travel Operation | Renewed operation of cross travel motor taken through speeds via cab and radio. | |
| Emergency Stop During Operation | All power cuts, breaker to deenergise and motors to stop. Red LED illuminated again. | |

| | | | |
|---|---|---|---|
| Prove Transfer Relay<br><br>Interlock check 2 | CAB controls operated whilst switch set to radio, volt relay drops out. Radio controls operated whilst switch set to CAB, volt relay drops out. |  | |
| MR Timer | MR timer drops out after 30 seconds of no operation of radio control. Needs to be restarted to use radio controls again. |  | |
| Simulating a Fault | Secondary current induced via megger tester into the breaker's trip unit to simulate an overload, O/Ls tripped and require manual reset. |  | |

*Table 2 - Test table procedure*

*Very good table of results for this system*

The testing carried assessed both the electrical and mechanical condition of the refurbished breaker and control system. After installation initial electrical tests proved continuity and polarity of all components showing suitable resistance values, secure connections, correct polarity and voltages. Insulation resistance tests exceeded the required 200 MΩ, confirming insulation quality and eliminating short circuit risks to the associated circuits and steel structure.

Operational checks demonstrated that the breaker reliably opens, closes, trips, and resets, operating under simulated conditions. Control system was verified, confirming that the start/stop button energises and deenergises the breaker as designed. Safety interlocks, notably the Transfer Relay (TR), correctly transferred control between CAB and radio, preventing simultaneous activation and ensuring safe operation. Additionally, the Main Line Relay (MR) and timer system correctly switched control back to the CAB after 30 seconds of inactivity from the radio control, confirming reliability and operational safety.

The testing also included appropriate functional testing such as load free breaker energising, emergency stops during operation, and correct motor and brake function checks for hoist, long travel, and cross travel controls via both CAB and radio.

Overall, all tests passed successfully, confirming that the refurbished breaker and new control system meet operational safety standards and performance expectations.

## Conclusion & Recommendations

*Good explanation*

This project successfully replaced and relocated the main 800 A DC disconnect breaker on the gantry crane, within the planned budget and with only a slight schedule over run of 2 weeks in total.

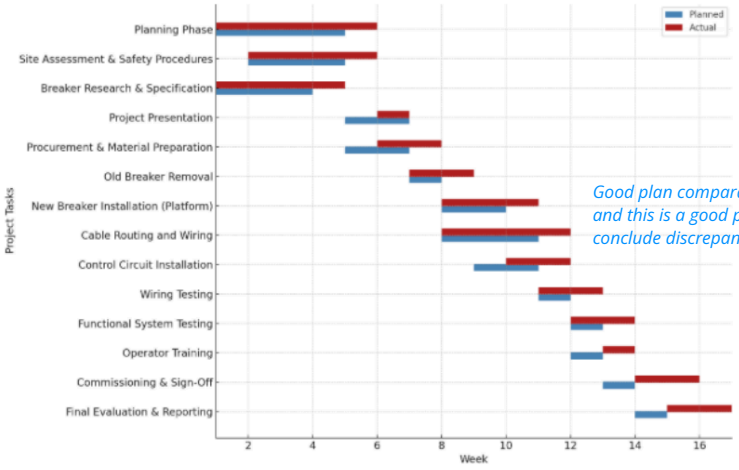



*Figure 23 - Gantt chart comparison*

*Good plan comparative timeline and this is a good place to conclude discrepancies*

The delay was primarily due to waiting for the breaker to be located and retrieved from TATA stores and further compounded by operator training beginning a week later than originally planned due to the limited availability of crane operators.

The total project was planned and executed within a strict budget of approximately £10,000, covering materials, labour, equipment hires, and system refurbishment. The total cost concluded to be £9,940 just being delivered under budget.

The new system improves operator safety as the crane operator no longer has dangerous equipment in the CAB and can also disconnect power via low voltage controls, reducing exposure to electrical hazards. The implementation of the Start/Stop control circuit helped allow this remote switching and its functionality was proven during testing.

The project had positive aspects from an environmental standpoint, by opting to refurbish the breaker rather than purchase new, scrapping a large piece of electrical equipment was avoided and the associated waste. Copper cables that were removed from the old installation were recycled. All new materials are designed to run for many years without needing major replacement, thereby reducing future waste. The energy efficiency of the crane is essentially unchanged in this project.

However, as a recommendation, Tata Steel could consider the DC to AC conversion in the future to realise significant energy savings (up to 50% reduction in power usage is possible with modern drives) konecranes.com. This would further align with sustainability goals by cutting electricity consumption and maintenance needs (eliminating brush replacements on DC motors). *Good recommendation*

All HSE regulations were followed during the project. No accidents or incidents occurred. Professional conduct was maintained, with daily safety briefings. The crane's documentation was updated to comply with the Lifting Operations and Lifting Equipment Regulations (LOLER) and Provision and Use of Work Equipment Regulations (PUWER).

In conclusion, the project achieved its aims of improving safety and operations of the Trostre gantry crane. The crane is now better equipped to serve Tata Steel's operations.

*Good conclusion and recommendation*

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*Good number of ref sources*

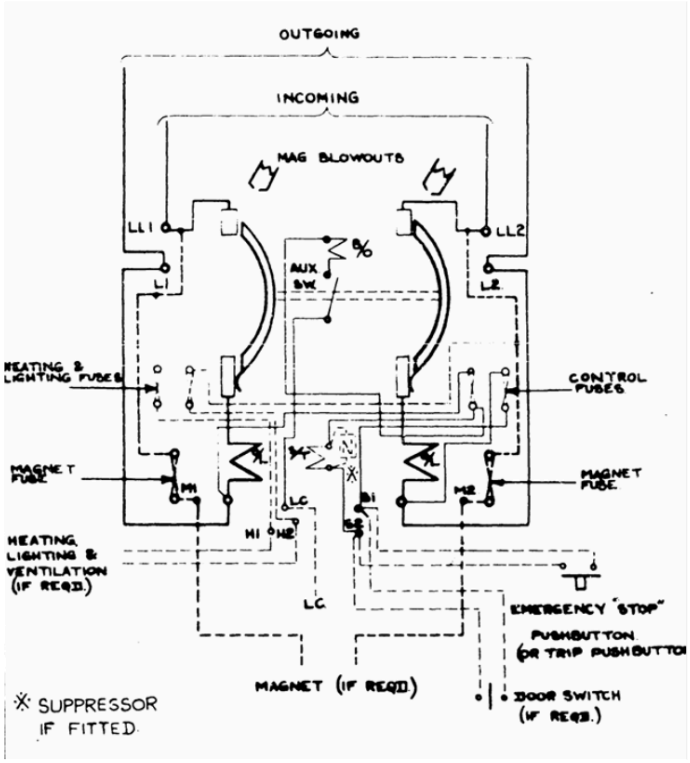



*Figure 24 - Old DC breaker drawings*

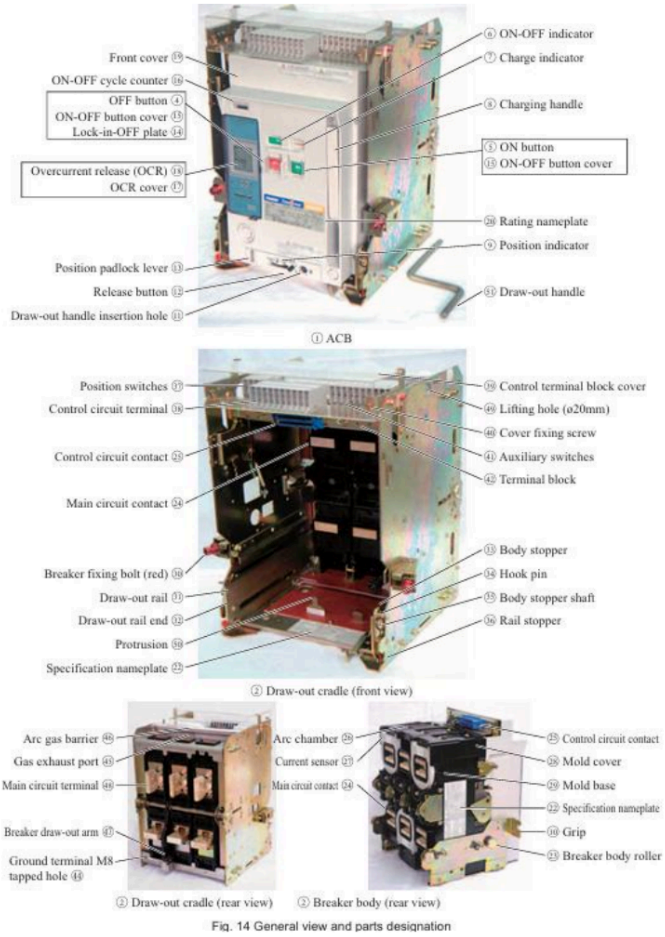



Fig. 14 General view and parts designation

*Figure 25 - Terasaki ACB Parts and Functions (Terasaki Electric Co., Ltd. n.d.)*

*Good diagrams*

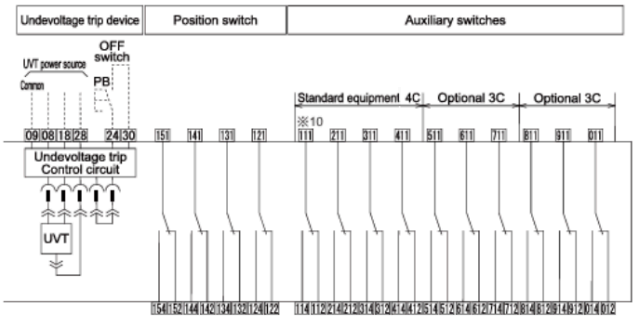



*Figure 26 - AGR-21B series circuits 2 (Terasaki Electric Co., Ltd. n.d.)*

| Rated voltage (V) | Permissible charging/closing voltage range | Ratings of operation power supply | | | |
|---|---|---|---|---|---|
| | | Peak motor starting current (A) | Steady-state motor current (A) | Peak making current (A) | Latch release coil (LRC) resistance (ohm) * |
| AC100 | 85 - 110 | 7 | 1.1 | 0.29 | 300-380 |
| AC110 | 94 - 121 | 7 | 1.1 | 0.25 | 350-440 |
| AC120 | 102 - 132 | 7 | 1.1 | 0.22 | 440-540 |
| AC200 | 170 - 220 | 4 | 0.7 | 0.15 | 1130-1390 |
| AC220 | 187 - 242 | 4 | 0.7 | 0.13 | 1410-1740 |
| AC240 | 204 - 264 | 4 | 0.7 | 0.11 | 1710-2090 |
| DC24 | 18 - 26 | 14 | 4 | 1.04 | 20-26 |
| DC48 | 36 - 53 | 10 | 1.6 | 0.51 | 85-105 |
| DC100 | 75 - 110 | 6 | 0.8 | 0.25 | 350-440 |
| DC110 | 82 - 121 | 6 | 0.8 | 0.22 | 440-540 |
| DC125 | 93 - 138 | 6 | 0.8 | 0.21 | 540-680 |
| DC200 | 150 - 220 | 4 | 0.5 | 0.13 | 1410-1740 |
| DC220 | 165 - 242 | 4 | 0.5 | 0.12 | 1710-2090 |

* Ambient temperature: 20°C

*Figure 27 - Ratings of operation power supply(Terasaki Electric Co., Ltd. n.d.)*

| Rated voltage (V) | Permissible voltage range (V) | Peak exciting current (max.) (A) | Coil resistance (ohm) * | Max. contact parting time (ms) |
|---|---|---|---|---|
| AC100 | 70-110 | 0.29 | 300-380 | 50 |
| AC110 | 77-121 | 0.25 | 350-440 | |
| AC120 | 84-132 | 0.22 | 440-540 | |
| AC200 | 140-220 | 0.15 | 1130-1390 | |
| AC220 | 154-242 | 0.13 | 1410-1740 | |
| AC240 | 168-264 | 0.11 | 1710-2090 | |
| DC24 | 16.8-26.4 | 1.04 | 20-26 | |
| DC48 | 33.6-52.8 | 0.51 | 85-105 | |
| DC100 | 70-110 | 0.25 | 350-440 | |
| DC110 | 77-121 | 0.22 | 440-540 | |
| DC125 | 87.5-137.5 | 0.21 | 540-680 | |
| DC200 | 140-220 | 0.13 | 1410-1740 | |
| DC220 | 154-242 | 0.12 | 1710-2090 | |

* Ambient temperature: 20°C

*Figure 28 - Ratings of trip device (Terasaki Electric Co., Ltd. n.d.)*

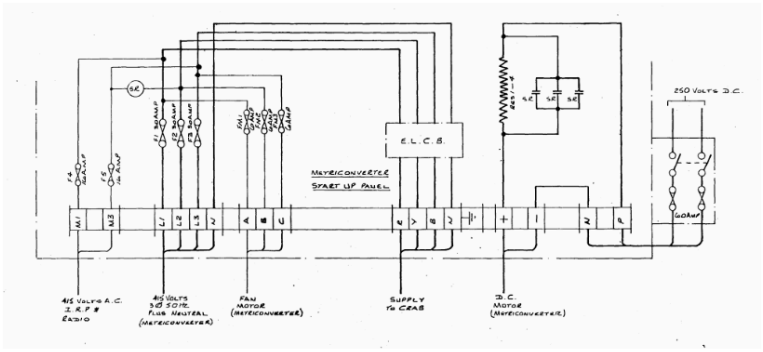



*Figure 29 - Rotary inverter set schematic*

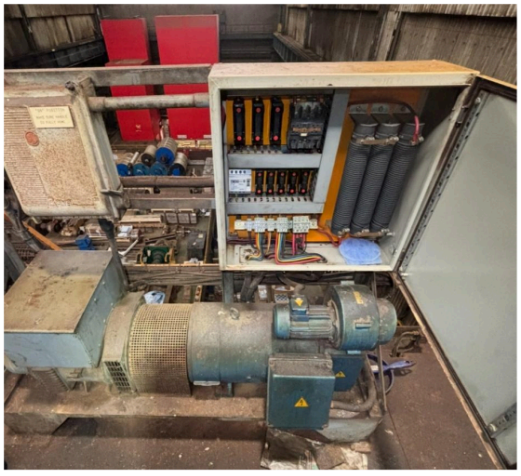


*Figure 30 – Rotary inverter set*

*Good supporting image*

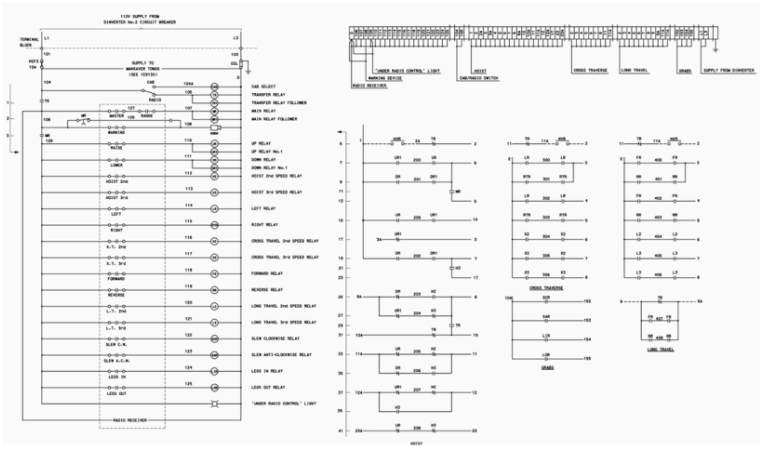


*Figure 32 - Interface panel schematic*



*Figure 31 - Interface panel*

*Good evidence*

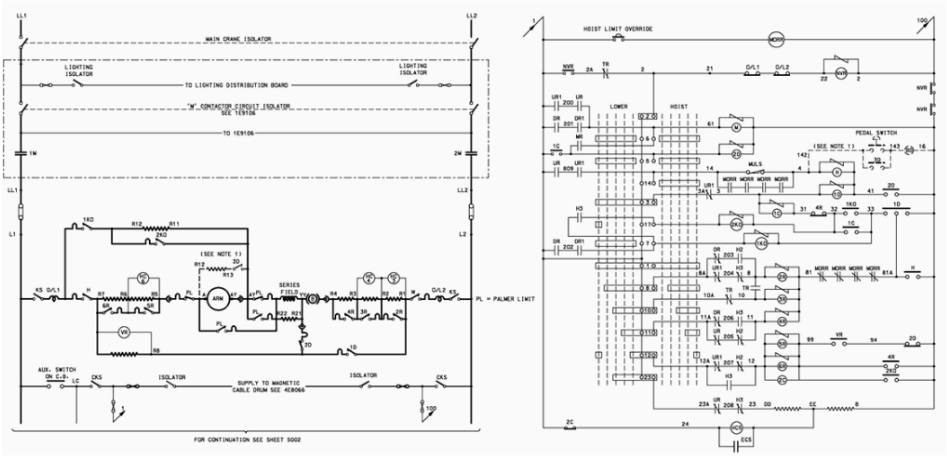



*Figure 34 - Hoisting schematics*

HOISTING

NOTCH 1

2D OPENS. REMOVING DYNAMIC BRAKING LOOP. M AND H CLOSE. CONNECTING THE MOTOR THROUGH RESISTANCES R1 – R4 AND R5 – R6 (R7). THE MOTOR DEVELOPS HALF FULL LOAD TORQUE. ON HEAVY LOADS THE MOTOR WILL NOT START. THIS NOTCH IS PROVIDED FOR TAKING UP SLACK AND FOR CREEPING SPEEDS ON LIGHT HOOK. ENOUGH CURRENT TO OPERATE A SERIES BRAKE IS PASSED ON THIS NOTCH.

NOTCH 2

2R CLOSES CUTTING OUT R1 – R2. THE MOTOR DEVELOPS ONE AND A HALF TIMES FULL LOAD TORQUE. ON FULL LOAD THE MOTOR WILL RUN UP TO FULL SPEED. NO TIMING IS PROVIDED BETWEEN NOTCHES 1 AND 2 THUS PREVENTING THE DANGER OF ALLOWING A HEAVY LOAD TO DROP.

NOTCHES 3, 4 & 5

3R, 4R, 5R (&1) CLOSE IN SEQUENCE UNDER "1GRAN I.T.D." TIMING CUTTING OUT THE REST OF THE STARTING RESISTANCE. IF THE MASTER SWITCH IS THROWN RIGHT OVER, THE MOTOR WILL RUN UP TO FULL SPEED IN APPROXIMATELY TWO TO TWO AND A HALF SECONDS TAKING PEAKS OF ABOUT ONE AND A HALF TIMES FULL LOAD CURRENT.

CHECKING BACK

ON RETURNING FROM NOTCH 5 TO NOTCH 4, 2KO (6R) AND 5R OPEN WHILE R2 CLOSES. THE MOTOR SLOWS DOWN. IF THE MASTER SWITCH IS THROWN TO NOTCH 1, 3R, 4R, 5R (AND 6R) CLOSE IN SEQUENCE UNDER "1GRAN I.T.L." TIMING SHORTENED TO A TOTAL OF ABOUT ONE SECOND.

SWITCHING OFF

ALL CONTACTORS ARE DE-ENERGISED. 2D CLOSED COMPLETING THE DYNAMIC BRAKING CIRCUIT THROUGH R5 – R7. THIS RAPIDLY RETARDS THE MOTOR WHILE THE MECHANICAL BRAKE IS SETTING. THUS REDUCING LOAD ON THIS BRAKE.

OHLS EQUIPMENTS

GRADUATED DYNAMIC BRAKING. ON SWITCHING OFF, M, 1KO, 2KO DROP OUT, R2 CLOSES. AFTER TIME LAGS, 3R AND 4R CLOSE IN SEQUENCE. ON CLOSURE OF R4 A RELAY 1C OPENS AND 2D CLOSES, 1D OPENS. A SERIES BRAKE IS RELEASED BY THE OPENING OF 1D. WHEN CURRENT THROUGH THE DYNAMIC BRAKE CIRCUIT VIA R7 – R8 CEASES, VR DROPS OUT AND RELEASES 5R & 6R.

LOWERING

ON THE LOWERING NOTCHES THE MOTOR IS CONNECTED WITH IT'S ARMATURE IN ONE PATH AND THE SERIES FIELD AND BRAKE IN THE SECOND PATH TOGETHER WITH VARIOUS RESISTANCE SECTIONS SHOWN IN FIGS 2 & 5.

NOTCH 1

2D OPEN. M, 1D, 1KO CLOSE. 2R, 3R & 4R CLOSE. 5R CLOSES AFTER A SHORT TIME LAG (FOLLOWED BY 6R). NO DRIVING TORQUE IS DEVELOPED ON THIS NOTCH, BUT FULL LOAD WILL RUN DOWN AT ABOUT A QUARTER FULL SPEED.

NOTCH 2

5R (AND 6R) OPENS AND ALLOWS FULL LOAD TO RUN AT ABOUT ONE AND A HALF TIMES FULL SPEED.

NOTCH 3

4R OPENS AND WEAKENS MOTOR FIELD. IFTHE HAS NOT STARTED, A DRIVING DOWN TORQUE OF APPROXIMATELY FULL SPEED IS DEVELOPEDAND LIGHT HOOK WILL WILL LOWER AT ABOUT QUARTER FULL SPEED. FULL LOAD WILL BE AT ABOUT FULL SPEED.

NOTCH 4

3R OPENS. LIGHT HOOK WILL DESCEND AT ABOUT HALF FULL SPEED AND WITH FULL LOAD ON THE HOOK AT ABOUT FULL SPEED.

NOTCH 5

2R OPENS. 2KO CLOSES CUTTING OUT R11 – R12. AFTER A SHORT TIME LAG 5R CLOSES (FOLLOWED BY 6R). LIGHT HOOK WILL DESCEND AT ABOUT 1 TIMES FULL SPEED AND WITH FULL LOAD ON THE HOOK AT ONE AND THREE QUARTER TIMES FULL SPEED. THE MASTER SWITCH MAY BE THROWN TO ANY OF THE FIRST FOUR NOTCHES ON THE LOWERING SIDE AND NOTCH CONDITIONS 2, 3 OR 4 WILL BE OBTAINED IMMEDIATELY. IF THROWN DIRECTLY TO NOTCH 5, M, 1D, 1KO AND 2KO CLOSE IMMEDIATELY. THE MOTOR WILL DEVELOP ABOUT ONE AND A QUARTER TIMES FULL LOAD TORQUE. AFTER A SHORT TIME LAG 5R CLOSES (FOLLOWED BY 6R).

*Figure 33 - Hoisting and lowering operations*



*Figure 35 - Hoist panel*

*Good image*

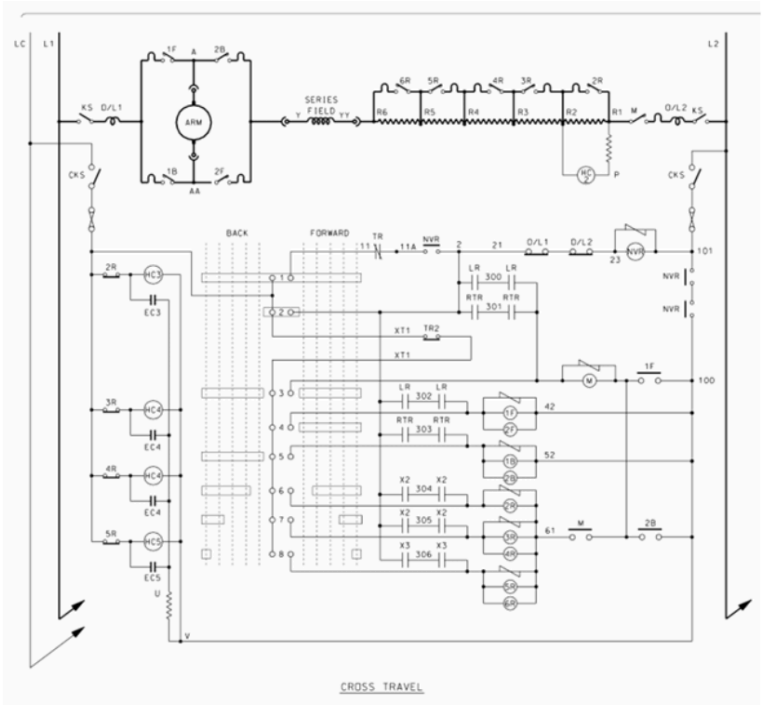



*Figure 36 - Cross travel schematic*

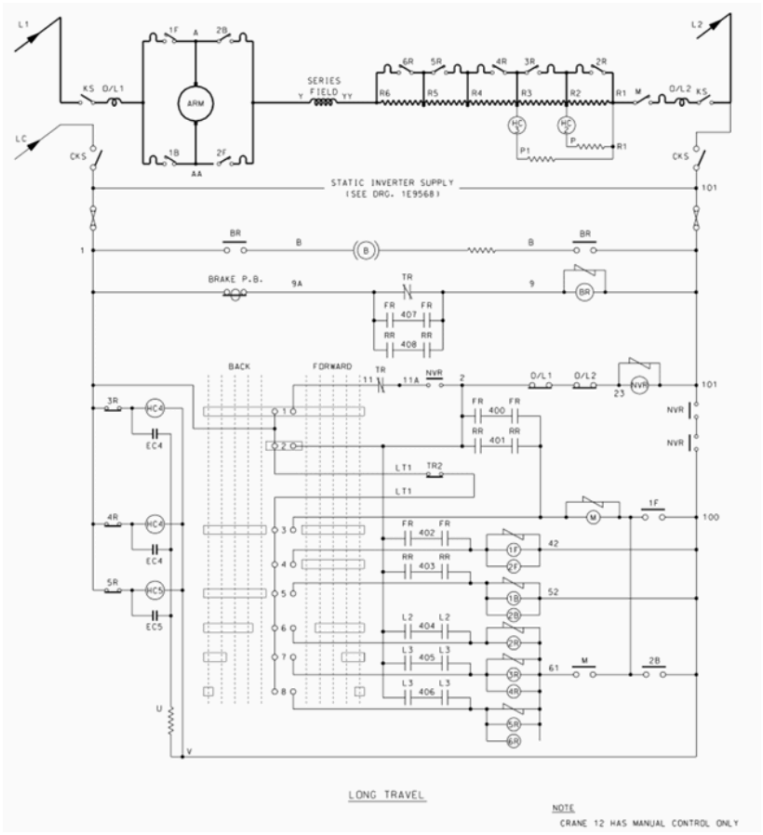
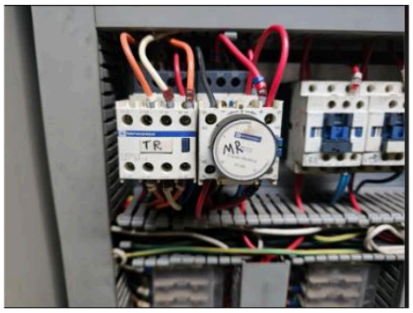



*Figure 37 - Long travel schematic*




*Good evidence*

*Figure 38 - Main line relay and transfer relay*

corus

| Article/material | Persno 1017407<br>Name DW Richards<br>Telno 2707 | Page 1<br>14.08.2024<br>14:40:48 |
|---|---|---|

Material WB792/140
Description 800A MANUAL MAGNETIC DISCONNECT SWITCH*

| | | | |
|---|---|---|---|
| Old materialnumber | B792/140 | Material Type | RESE |
| Material Group | 341642 | Key Supply article | N |
| Net weight | | | |
| Gross weight | | Weight Unit | KG |
| Volume | | Volume unit | |
| EAN/UPC | | EAN type | |
| Lab/bureau | CDT UK CENTRAL MASTER DATA TEAM | | |
| Grootte/afmeting | | | |

Descripion

800A 230V DC MANUAL MAGNETIC DISCONNECT SWITCH-ARROLL/BOOTH CRANES
CUTLER HAMMER REFERENCE- DRG NO. Y/1536/K/1,REQ.NO. BB1536Y1
230V DC 800A RATING, CONTROL CIRCUIT 230V DC

Class Class descripion

Characteristic description Characteristic value Bestelling

*Figure 39 - Breaker invoice*

# Log Sheet

| | |
|---|---|
| Log No | 1 |
| No hrs | 5 |
| Running total hrs | 5 |

**Planning phase:** The team created a proposal, conduct site assessments, carry out planning of required safety procedures.

| | |
|---|---|
| Student signature |  |
| Supervisor Signature | |
| Lecturer Signature | |

# Log Sheet

| | |
|---|---|
| Log No | 2 |
| No hrs | 5 |
| Running total hrs | 10 |

The project scope was finalised, carried out project presentation and coordinated with staff to schedule downtime with limited disruption to site.



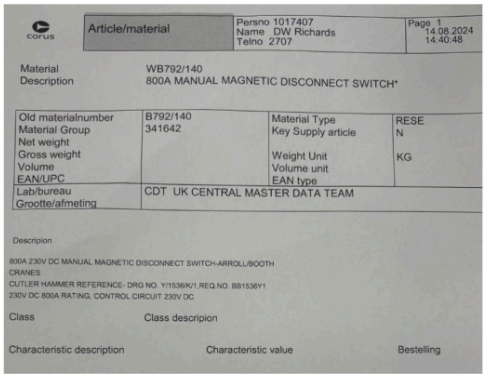

| | |
|---|---|
| Student signature |  |
| Supervisor Signature | |
| Lecturer Signature | |

# Log Sheet

| | |
|---|---|
| Log No | 3 |
| No hrs | 5 |
| Running total hrs | 15 |

PREPARE MATERIALS

The breaker unit was previously removed from a condemned crane on site and kept in the stores for future use. This was booked out and a copy of the invoice was granted.



corus | Article/material | Persno 1017407 Name DW Richards Telno 2707 | Page 1 14.08.2024 14:40:48

Material WB792/140
Description 800A MANUAL MAGNETIC DISCONNECT SWITCH*

| | | | |
|---|---|---|---|
| Old materialnumber | B792/140 | Material Type | RESE |
| Material Group | 341642 | Key Supply article | N |
| Net weight | | | |
| Gross weight | | Weight Unit | KG |
| Volume | | Volume unit | |
| EAN/UPC | | EAN type | |
| Lab/bureau | CDT UK CENTRAL MASTER DATA TEAM | | |
| Grootte/afmeting | | | |

Descripion

800A 230V DC MANUAL MAGNETIC DISCONNECT SWITCH-ARROLL/BOOTH CRANES
CUTLER HAMMER REFERENCE- DRG NO. Y/1536K/1,REQ.NO. BB1536Y1
230V DC 800A RATING, CONTROL CIRCUIT 230V DC

Class Class descripion

Characteristic description Characteristic value Bestelling

| | |
|---|---|
| Student signature |  |
| Supervisor Signature | |
| Lecturer Signature |  |

# Log Sheet

| | |
|---|---|
| Log No | 4 |
| No hrs | 5 |
| Running total hrs | 20 |

Refurbishment

During refurbishment, all internal fuses, connections, and contact assemblies were thoroughly inspected, cleaned, and serviced to ensure functionality and reliability. The gland plate was repainted for improved corrosion protection and durability and new holes drilled with correct glands used for corresponding cables and redundant holes covered.



| | |
|---|---|
| Student signature |  |
| Supervisor Signature | |
| Lecturer Signature | |

# Log Sheet

| | |
|---|---|
| Log No | 5 |
| No hrs | 5 |
| Running total hrs | 25 |

Inspect and Prove New Breaker with Known DC Source.

Breaker opens and closes smoothly, trips reliably, resets without issue, and shows no signs of mechanical wear or failure.

Overload protection devices were tested on a known dc source at ground level and verified to ensure correct ratings and safe operational compliance, the results were recorded in the testing sequence, confirming the suitability for ongoing service.

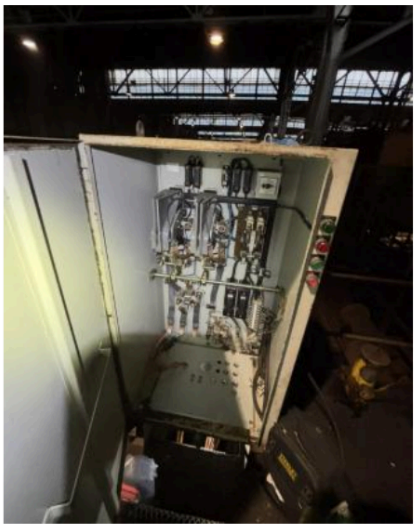



| | |
|---|---|
| Student signature |  |
| Supervisor Signature | |
| Lecturer Signature | |

# Log Sheet

| | |
|---|---|
| Log No | 6 |
| No hrs | 5 |
| Running total hrs | 30 |

On the scheduled day, the area below the gantry crane was cordoned off and the mobile crane was brought in to lift the new breaker panel, which was assembled on the ground before being hoisted up to the top platform. The mobile crane lifted the heavy breaker enclosure which was rigged and hoisted under supervision of a lifting team with professional signalling and radio communication used between the ground team and the personnel on the crane's platform. Once positioned aligning the new panel's mounting holes with the pre-drilled holes on the crane structure, it was bolted to the crane's structural beams. Mechanical implementation also included installing new cable trays and cleats along the crane girder to support the new cables that connect the breaker to the existing control panels.



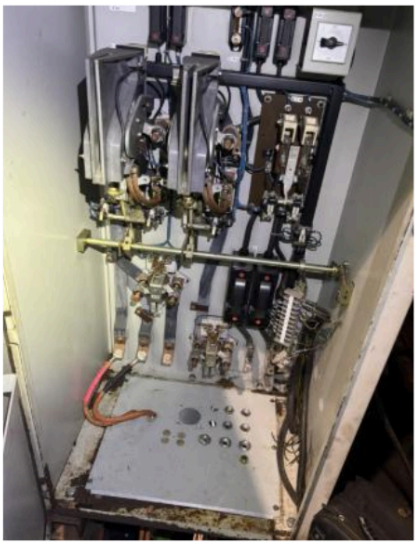
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# Log Sheet

| | |
|---|---|
| Log No | 7 |
| No hrs | 5 |
| Running total hrs | 35 |

**New supply to breaker:** Install new supply to breaker from crane long travel collector gear (shoes/rails).

**New supply:** A new electrical supply to be installed to feed the main breaker, supplied from the long travel collector gear. Current carrying capacity of 95mm² copper cable is 300A which is suitable for the supply of this crane.



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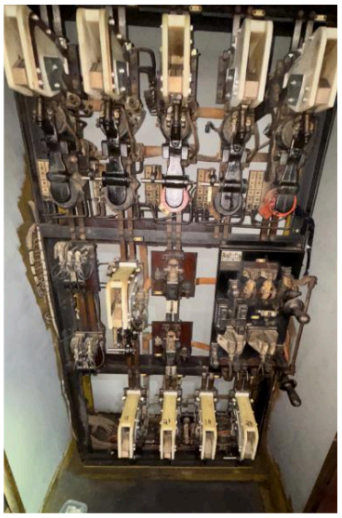
# Log Sheet

| | |
|---|---|
| Log No | 8 |
| No hrs | 5 |
| Running total hrs | 40 |

**Replace cables to facilitate relocation:** New supply required to supply control panels, interface panel (which manages communication between control equipment for radio and cab operations) and inverter panel (to supply inverter and transformer panel to regulate the crane's power conversion needs).

**The following will be supplied from the main breaker:**

**Hoist Panel**: Install new supply hoist contactor panel to control the crane's lifting operations. The 160A hoist motor will require a 70 mm² copper cable, which can safely carry the current.



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# Log Sheet

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| Log No | 9 |
| No hrs | 5 |
| Running total hrs | 45 |

**Long Travel Panel**: Install new supply to long travel contactor panel to control the crane's longitudinal movement. The 113A long travel motor requires a 35mm² copper cable.




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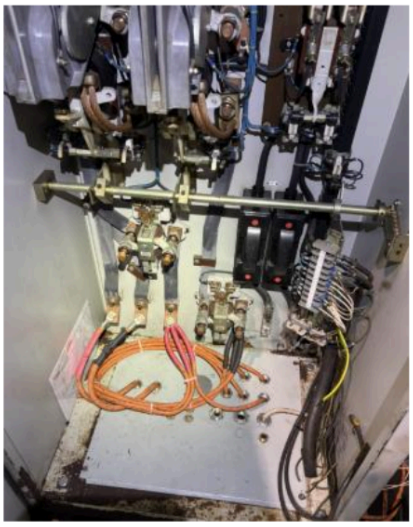
# Log Sheet

| | |
|---|---|
| Log No | 10 |
| No hrs | 5 |
| Running total hrs | 50 |

**Cross Travel Panel**: Install new supply to cross travel contactor panel to control the crane's lateral movement. For the 24A cross travel motor a cable for 30A is required under standard installation conditions, however this was upgraded to 35mm² also.

See appendix for further images, schematics and additional information of crane control panels, inverter panel.

All panels now connected.

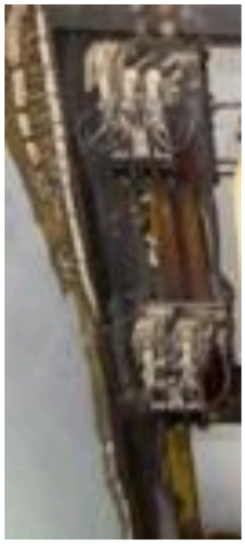


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# Log Sheet

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|---|---|
| Log No | 11 |
| No hrs | 5 |
| Running total hrs | 55 |

**Load control (LC):** 110V is to supply the auxiliaries in contactor panels. Required to supply interface panel to manage communication between control equipment for radio and cab operations shown in figure 15



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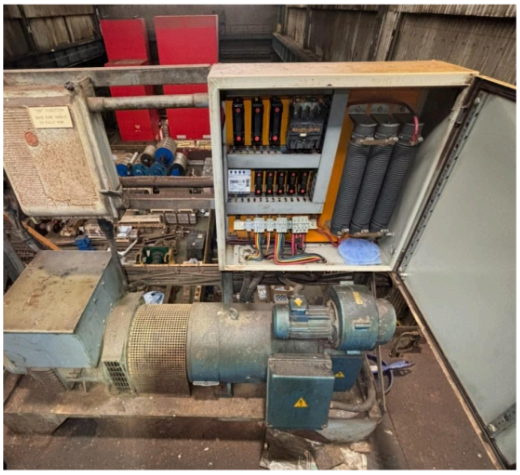
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# Log Sheet

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|---|---|
| Log No | 12 |
| No hrs | 5 |
| Running total hrs | 60 |

**Inverter Panel**: New supply required a 10mm² supply the inverter and transformer panel to regulate the crane's power conversion needs (230V DC – 415/110AC) in order to supply control equipment and lighting.

See appendix for further images, schematics and additional information of inverter panel.



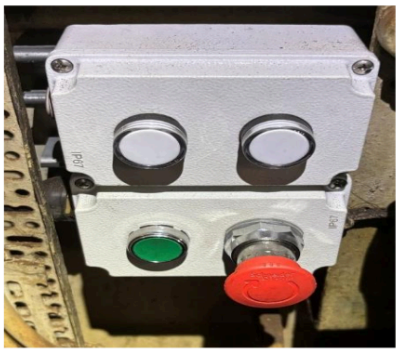
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# Log Sheet

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|---|---|
| Log No | 13 |
| No hrs | 5 |
| Running total hrs | 65 |

**Start/Stop Button:** Installation of a start/E-stop button and indication lights to provide a user-friendly and efficient control and safety mechanism for the crane operator to control the main disconnect electrically.

This circuit uses a 110V AC control supply to operate a control relay (CR) through a 3 wire start stop circuit. The stop button is a normally closed (NC) contact that ensures power is interrupted immediately when pressed. The start button is normally open (NO), and when pressed energises the relay coil. Once energised an auxiliary normally open contact on the relay closes, forming a holding circuit that keeps the relay active even after the start button is released. The circuit is isolated only when the stop button is pressed.

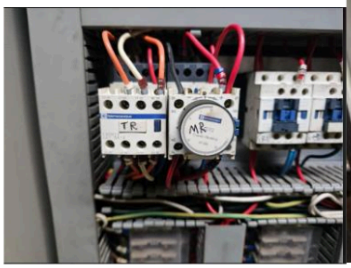


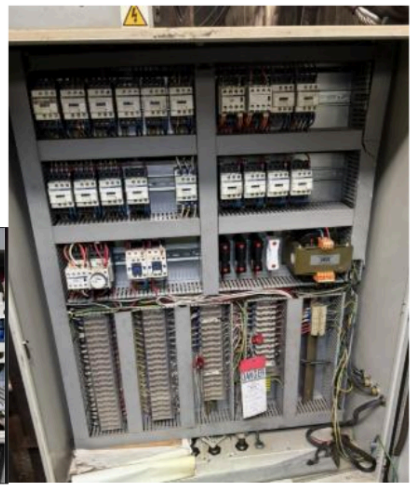
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# Log Sheet

| | |
|---|---|
| Log No | 14 |
| No hrs | 5 |
| Running total hrs | 70 |

**Relays:** Install relays to facilitate safe switching between power sources and control modes. This includes a main line relay to open and close the breaker remotely via radio control and a transfer relay to prevent simultaneous operation from both radio and cab control circuits.

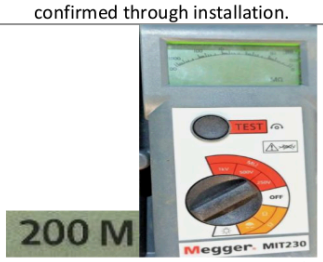


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# Log Sheet

| | |
|---|---|
| Log No | 15 |
| No hrs | 5 |
| Running total hrs | 75 |

| | |
|---|---|
| TESTING STARTS<br><br>Continuity |  <br>No open circuits. Suitable ohms readings throughout installation. |
| Polarity checks |  <br>Positive and negative connections are not swapped. Correct polarity confirmed through installation. |
| Insulation Resistance |  <br>All (P-N, P-E, N-E) readings are >200 MΩ (500v). |

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# Log Sheet

| | |
|---|---|
| Log No | 16 |
| No hrs | 5 |
| Running total hrs | 80 |

Mechanical and visual inspections

| | |
|---|---|
| Mechanical Inspection | Every bolt, crimp lug, and gland checked and secure. |
| Visual checks (includes signage and labels) | All signage in place and no clear evidence of issues. |

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# Log Sheet

| | |
|---|---|
| Log No | 17 |
| No hrs | 5 |
| Running total hrs | 85 |

| Operation of Controls when Breaker is open |
|---|
| Check transfer switch |
| Interlock check 1 |
| Control Circuit ON |
| Control Circuit OFF |
| Mains No-Load Closing |
| Mains No-Load E/stop |

FUNCTIONAL TESTING DAY 1

Including transfer switch, control circuits and mains with E stop.




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# Log Sheet

| | |
|---|---|
| Log No | 18 |
| No hrs | 5 |
| Running total hrs | 90 |

| | |
|---|---|
| Hoist Operation | Renewed operation of hoist motor taken through speeds via cab and radio. Brake OK. |
| Long Travel Operation | Renewed operation of long travel motor taken through speeds via cab and radio. Brakes OK. |
| Cross Travel Operation | Renewed operation of cross travel motor taken through speeds via cab and radio. |
| Emergency Stop During Operation | All power cuts, breaker to deenergise and motors to stop. Red LED illuminated again. |

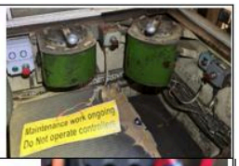
FUNCTIONAL TESTING DAY 2



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# Log Sheet

| | |
|---|---|
| Log No | 19 |
| No hrs | 5 |
| Running total hrs | 95 |

| | | |
|---|---|---|
| Prove Transfer Relay<br><br>Interlock check 2 | CAB controls operated whilst switch set to radio, volt relay drops out.<br>Radio controls operated whilst switch set to CAB, volt relay drops out. |  |
| MR Timer | MR timer drops out after 30 seconds of no operation of radio control. Needs to be restarted to use radio controls again. |  |

FUNCTIONAL TESTING DAY 3

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| Lecturer Signature | |

# Log Sheet

| | |
|---|---|
| Log No | 20 |
| No hrs | 5 |
| Running total hrs | 100 |

| | | |
|---|---|---|
| Simulating a Fault | Secondary current induced via megger tester into the breaker's trip unit to simulate an overload, O/Ls tripped and require manual reset. |  |

FINAL TESTING

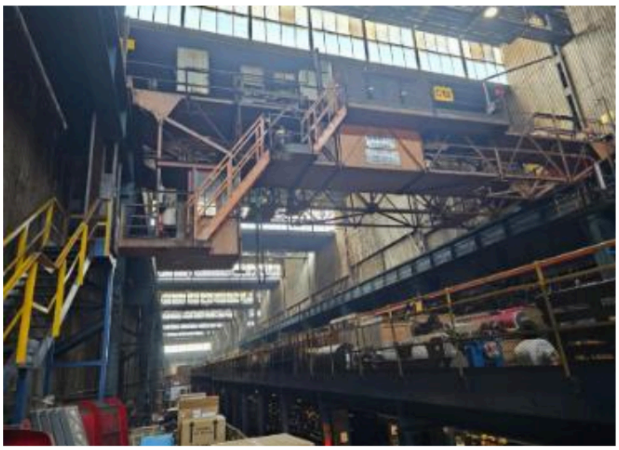
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# Log Sheet

| | |
|---|---|
| Log No | 21 |
| No hrs | 5 |
| Running total hrs | 105 |

FINAL EVALUATION AND BRIEFING

A meeting was carried out between electrical, mechanical and team leaders. It was concluded from the meeting all HSE regulations were followed during the project. No accidents or incidents occurred. Professional conduct was maintained, with daily safety briefings. The crane's documentation was updated to comply with the Lifting Operations and Lifting Equipment Regulations (LOLER) and Provision and Use of Work Equipment Regulations (PUWER) and the crane was successfully transferred back to operators.



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# DAVID LUKE BOWEN DB133872 SGEE4006

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

68/100

PAGE 1

PAGE 2

**Text Comment.** Reference list

**Text Comment.** Good table of contents

PAGE 3

**Text Comment.** Good extensive list of figures

PAGE 4

**Text Comment.** Good use of tables

PAGE 5

**Text Comment.** Correct citation

**Text Comment.** Good supporting image

PAGE 6

**Text Comment.** Correct citation

**Text Comment.** Good argument for project with a H&S focus

**Text Comment.** Good information

**Text Comment.** Correct citation

**Text Comment.** Good point

PAGE 7

**Text Comment.** Good points

**Text Comment.** Good spec with relevant details. Table method would have been more effective

PAGE 8

**Text Comment.** Good evidence of old system

**Text Comment.** Very informative annotated image

PAGE 9

**Text Comment.** Good plan with good explanations

PAGE 10

PAGE 11

PAGE 12

**Text Comment.** Good image

**Text Comment.** Correct citation

PAGE 13

**Text Comment.** Good explanation and argument for a solution

**Text Comment.** Evaluation involves a variety of criteria not just cost and a table method is best suited.

PAGE 14

**Text Comment.** Still a good option in the long term

**Text Comment.** Good informative annotated image

**Text Comment.** Good explanation and argument

**Text Comment.** Correct citation

PAGE 15

**Text Comment.** Good explanation

**Text Comment.** Both solutions should be evaluated using a table for comparison

**Text Comment.** There should be a better reason for the chosen solution

PAGE 16

**Text Comment.** Good annotated image

**Text Comment.** Good explanation

PAGE 17

**Text Comment.** Good diagram

**Text Comment.** Scope of work is explained clearly here

PAGE 18

**Text Comment.** Good explanation and evidence

**Text Comment.** Good explanation and supporting image

PAGE 19

PAGE 20

**Text Comment.** Good image evidence

**Text Comment.** 16

**Text Comment.** Good explanation and image evidence

PAGE 21

**Text Comment.** Good explanation of the retaining contact

**Text Comment.** Good diagram showing retaining contact function

**Text Comment.** Good supporting images

PAGE 22

**Text Comment.** Good explanation and cct diagram

**Text Comment.** Good cost breakdown and under budget

PAGE 23

**Text Comment.** These are good points considering the industry relevance

PAGE 24

PAGE 25

PAGE 26

**Text Comment.** Very good table of results for this system

PAGE 27

**Text Comment.** Good explanation

**Text Comment.** Good plan comparative timeline and this is a good place to conclude discrepancies

PAGE 28

**Text Comment.** Good recommendation

**Text Comment.** Good conclusion and recommendation

PAGE 29

**Text Comment.** Good number of ref sources

PAGE 30

PAGE 31

**Text Comment.** Good diagrams

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PAGE 33

**Text Comment.** Good supporting image

PAGE 34

**Text Comment.** Good evidence

PAGE 35

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**Text Comment.** Good image

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**Text Comment.** Good evidence

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GRADING FORM: CSG-RUBIC

| LUKE BOWEN | **0** |
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**RESEARCH-INFORMED LITERATURE**

Research includes many relevant points, but there should be more content to meet the requirements. However, there is relevant research for the solutions with ref sources and supporting images.
Good number of ref sources.10/20

**10/20**

**KNOWLEDGE AND UNDERSTANDING**

Good informative spec with good relevant points included. 7/10
Good solutions considered with good arguments and ref source for each.
Evaluation for chosen solution should have been more detailed and used a table method. 6/10

**13/20**

**ANALYSIS**

Table of results with evidence for the system is very good and a good explanation to support test results. 8/10
Very good conclusion with very significant points relative to the industry.
Good relevant recommendation that will probably happen in the future. 8/10

**16/20**

**PRACTICAL APPLICATION AND DEP.**

Planning uses a plan chart and a chart with plan and actual timeline comparison with explanations to support. Discrepancies have been explained. 4/5
Solutions are good arguments for practical implementation and ref source for each. There should have been a more effective evaluation. 6/10
Implementation is very detailed with plenty of evidence. 7/10

**17/25**

**SKILLS FOR PROFESSIONAL PRAC.**

A very good structured report and very well presented.

**12/15**