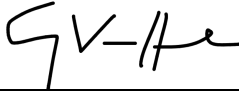



TITLE: Engineering Advice Note Reactor Buildings – Pre-cast Concrete Panels Overview AUTHOR: Aled Hughes – Project Engineer FUNCTION: Engineering	DATE: January 2023 TRAWS-EAN-23-005 QA GRADE: 3
DISTRIBUTION: Project Files Document Centre Systems Engineering Decommissioning Programme (Site) Work Control	STATION: Trawsfynydd ATTACHMENTS: Appendix A - Original PCCPP As Built Drawings Appendix B – Structural Strengthening and Repair Drawings Appendix C - PCCPP Detailed Information Spreadsheet Appendix D - Defect Panel Drawings Appendix E - Supplementary Drawings
QA STATEMENT: All work has been carried out in accordance with the relevant company quality procedures.	

Verified Gareth V Heerden – Senior Project Engineer **Date** 08/02/2023


Rob Hughes – Senior Systems Engineer

Approved  **Date** 08/02/2023
 Adrian Jones – Project Manager

Accepted  **Date** 08/02/2023

ABBREVIATIONS

PCCP – Pre-cast Concrete Panels

EAN – Engineering Advice Note

LC28 Inspections – Licence Condition 28 Inspections

1. INTRODUCTION

The site programme for entry into care and maintenance requires the construction of a new weather envelope for both reactor buildings at Trawsfynydd decommissioning site. Part of the enabling works for the weather envelope is the height reduction of both reactors. The work associated with height reduction includes, but is not limited to the following activities to be undertaken on both reactor buildings:

- Completion of inner envelope.
- Partial demolition of the existing superstructure down to the determined cutline.
- Removal of in-situ housed plant and equipment
- Removal of external pre-cast concrete cladding panels.
- Proportionate repair of the remaining structure for serviceability and durability.

This EAN summarises all relevant information related to the known configuration and identifies aspects for consideration in devising a suitable removal methodology of the external PCCP. The assets are referenced as 121 (reactor building 1) and 124 (reactor building 2) in accordance with site plan.

1.1. General Description

The Trawsfynydd Site construction period was between 1959 to 1964. Both reactor buildings are entirely separate and virtually identical with façades predominantly featuring exposed cast in-situ reinforced concrete and PCCP, the later accounting for circa 50-60% of total elevation area. Specific to elevations with PCCP, summary details common across both reactor buildings are offered as follows:

- North and south gas circulator halls: PCCP partially form the elevations to these annexes up to a flat roof height of circa 9.6m. Above the PCCP, patent glazing originally featured which has been replaced with infill cladding. PCCP support is provided by in-situ concrete columns.



Figure 1: Reactor Building 2 - South Gas Circulator Hall

- North and south main elevations: PCCP provide closure to the interspace areas on the boiler ends in combination with alternating window/louvre banks. The later elements have been overglazed during decommissioning. Panel principal support is provided by the adjacent in-situ walls.



Figure 2: Reactor Building 2 - South Elevation

- Main staircases in each quadrant: There are 4no. staircases per reactor building which feature PCCP cladding. On the west side, PCCP are present on the west elevation from second floor to main roof level. On the outer end elevation, PCCP are present from fourth to main roof level. On the east side, PCCP clad end elevations from fourth to eighth floor level.



Figure 3: Reactor Building 1 - West Elevation

- East and west elevations: These elevations to the east and west operational floors are clad with PCCP panels.
 - From ground to fifth floor level, the PCCP panels feature integrated apertures for window/louvres sets and are supported by in-situ concrete columns. These have been both overglazed during decommissioning.
 - From fifth floor to main roof level, the PCCP panels clad the charge hall with support provided by a combination of steel columns and in-situ concrete walls.



Figure 4: Reactor Building 1 - East Elevation

A significant amount of asset management and strengthening work has been undertaken on the structure to date including installation of discrete bracketry and overglazing. Details of these works are expanded upon later in this document to include reference illustrations.

2. PCCP ORIGINAL INFORMATION

2.1. PANEL TYPES

The PCCP to all elevations are similar in construction method, with variations in terms of size and support mechanisms. Existing drawings indicate that the PCCP are constructed out of reinforced concrete and are approximately 114mm thick with larger stiffening ribs to the perimeter. Larger PCCP have vertical stiffeners either centrally or at third points depending on their length. A single compartment PCCP is generally used for spans up to 3m, a double for up to 6.5m and a treble for up to 8.2m span. There are, however, single PCCP in the Gas Circulator Halls that span 7m. The height of the PCCP extends to a maximum of 1.63m (1.53m when lapped). It should be noted that the PCCP in the Gas Circulator Halls will be retained and will not be removed as part of the Height Reduction works.

The overall panel thickness, inclusive of the stiffening ribs is 305mm. The PCCP were originally cast face up in a mould onto a permanent 38mm thick wood wool formwork/insulation finish to the inside face. The first 241 mm of reinforced concrete was cast using normal aggregates and a 63.5mm

thick facing mix incorporating a local granite aggregate cast atop while the backing concrete was still green.

The two concrete mixes were designed to be of equal strength and act together structurally as one section. The concrete mix was classified as a Class B concrete mix with a mean crushing strength of 5000psi (34N/mm²) at 28 days. The facing mix was jet washed or wire brushed to give the desired uniform finish.

2.2. PCCP SUPPORTS

The PCCP all span horizontally. The ends of the PCCP were profiled to fit over concrete support corbels forming male-female connections. 22mm diameter mild steel dowels were then threaded through 50mm diameter dowel holes in the panel nibs/corbels which were then grouted to permanently hold the panels either together or to the reactor building superstructure. The hole in the lower nib of the panel terminated short of the bottom face to aid constructability at the time. It should be noted that the dowel holes were formed using asbestos cement sleeves.

The form of the reactor building supporting structure defines the PCCP support details. There are two main types which are described below.

2.2.1. IN-SITU REINFORCED CONCRETE COLUMNS AND WALLS

Reinforced concrete columns and walls have projecting male reinforced concrete corbels cast integrally with them. The female ends of the panels would then be offered externally onto the male corbel. There are variations in panel profile, so that for some panels there are two support corbels per panel whilst other panels are supported by adjacent male/female connections. Figure 5 below shows a typical in-situ corbel support detail.

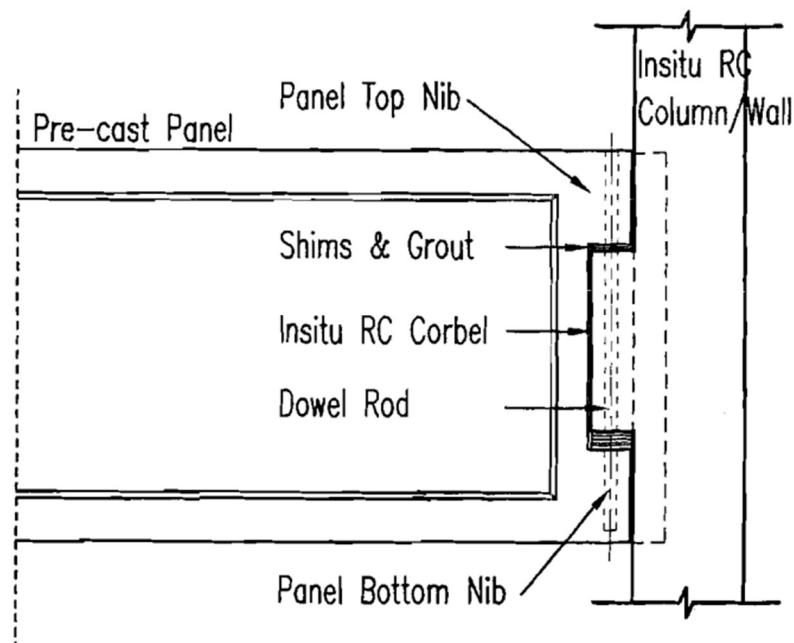


Figure 5: Typical Reinforced Concrete Support Detail

The likely sequence of PCCP erection was that the female PCCP end was placed onto the corbel, packed to level using mild steel shims, aligned to suit the dowel, dowel installed and then grouted up to form a rigid joint.

The PCCP which clad the boiler box interspaces on the north and south elevations span between in-situ corbels which are monolithic with the boiler box walls. These PCCP are longer than general PCCP and so require an intermediate lateral restraint to resist wind loads. This was provided by internal steel columns and beams which supported the interspace operational floors. The original restraints were steel straps fixed to channel support system cast into the rear of the panel horizontal stiffeners. The straps were then bolted/clamped to the outer flange of the steel columns. The midspan columns have limited capacity for which further detail can be found in EAN/12/036.

2.2.2. STRUCTURAL STEEL COLUMNS

The PCCP above charge face on the east and west elevations are directly supported off steel columns. Each horizontal line of PCCP comprises alternate male and female panels. A stiffened angle cleat is provided on the outer flange face of each steel column. A corresponding pocket has been formed in the male PCCP which fixes onto the cleat. A steel angle is cast in to form the upper bearing surface of the pocket. Figure 6 below shows a typical cleat support detail.

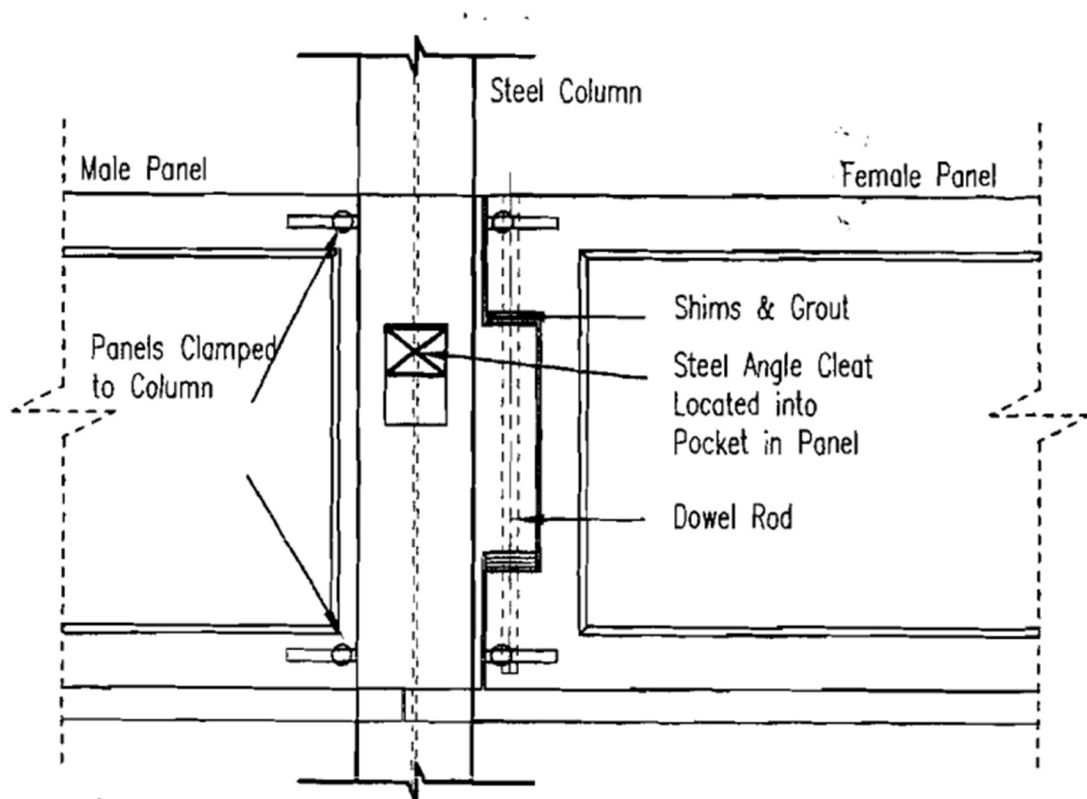


Figure 6: Typical Steel Cleat Support Detail

The male PCCP was erected and levelled on the projecting cleat and fixed laterally to the column using lindaptor connectors and a channel support system cast into the rear of the horizontal stiffener/rib. The female PCCP would then be offered up to the male PCCP and the dowel installed as previously described.

The vertical load of the male PCCP and the corresponding load of the female PCCP is thus transferred to the steel column.

2.2.3. TIE BACK AND SLAB INFILL DETAILS

All PCCP have threaded sockets that were cast near the ends of the panels for temporary pulling during the original installation of the panels. There is an additional detail which applies to courses where there is a clash between the PCCP and the downstand of the slab edge beams. To facilitate temporary pulling in this instance, a 50mm hole was created in the downstand beam. The threaded socket used for the temporary pulling was then grouted within the 50mm hole in the downstand beam to form a rigid joint. This detail applies at the following locations:

- West elevation
 - Course No 6 – bays 02-23 inclusive
 - Course No 9 – bays 07-18 inclusive (but excluding 09)
- East elevation
 - Course No 6 – bays 02-14 & 18-23 inclusive

A typical example can be seen in Figure 7 below and the full tie back detail can be seen in drawing DD/10/00/C/05474 in Appendix E. Any removal methodology will need to take account of the variations in configuration.

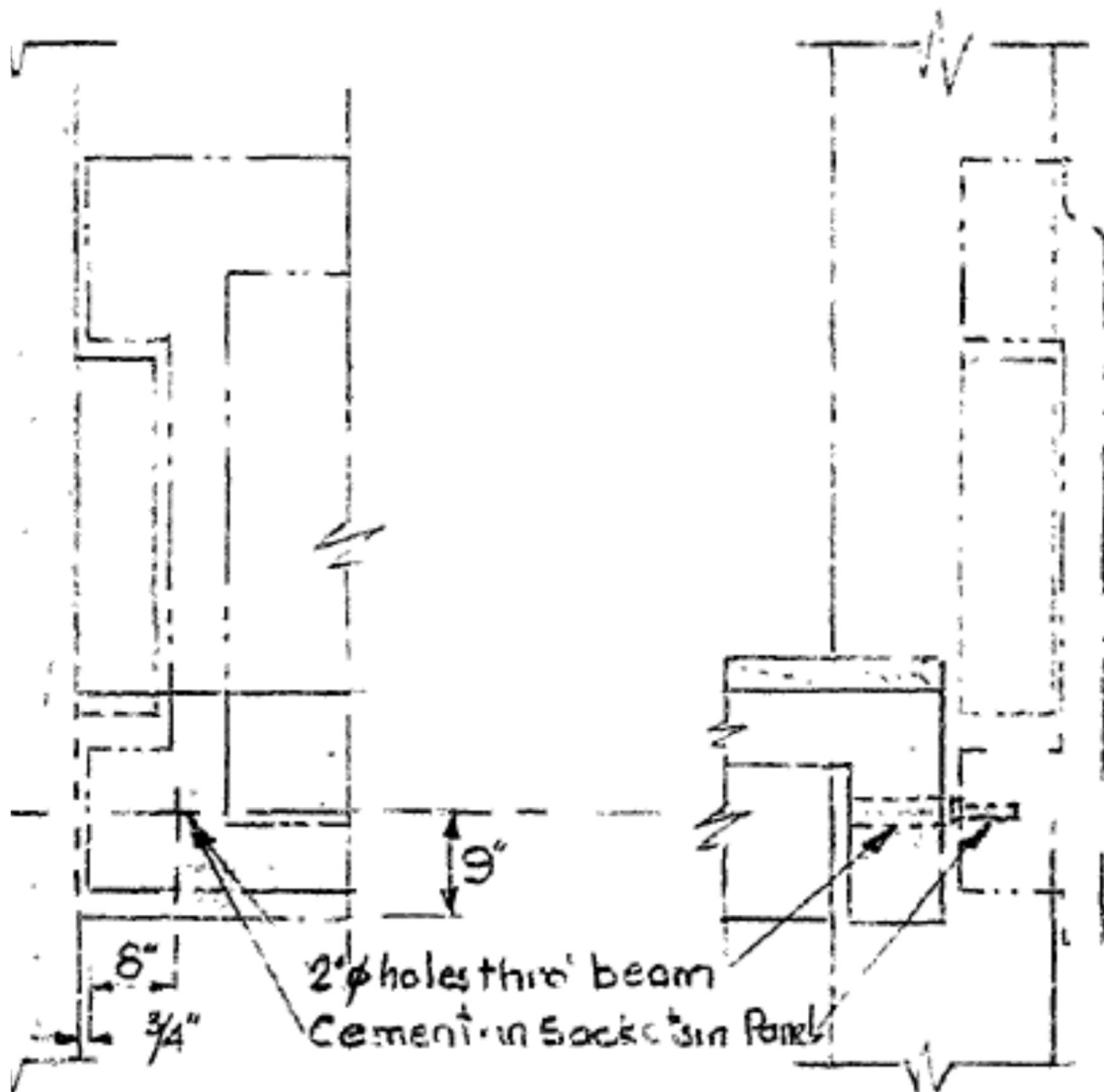


Figure 7: Typical Tie Back Detail

There are some locations where the edge slab details the PCCP being used as a composite shutter. A typical example can be seen in Figure 8 below. A comprehensive understanding of the varied load support details, connections and terminations will be critical to formulating a suitable and sufficient removal methodology. Additional details and locations can be seen in drawings DD/10/16/00/A02229 & DD/10/16/00/A02230 in Appendix E.

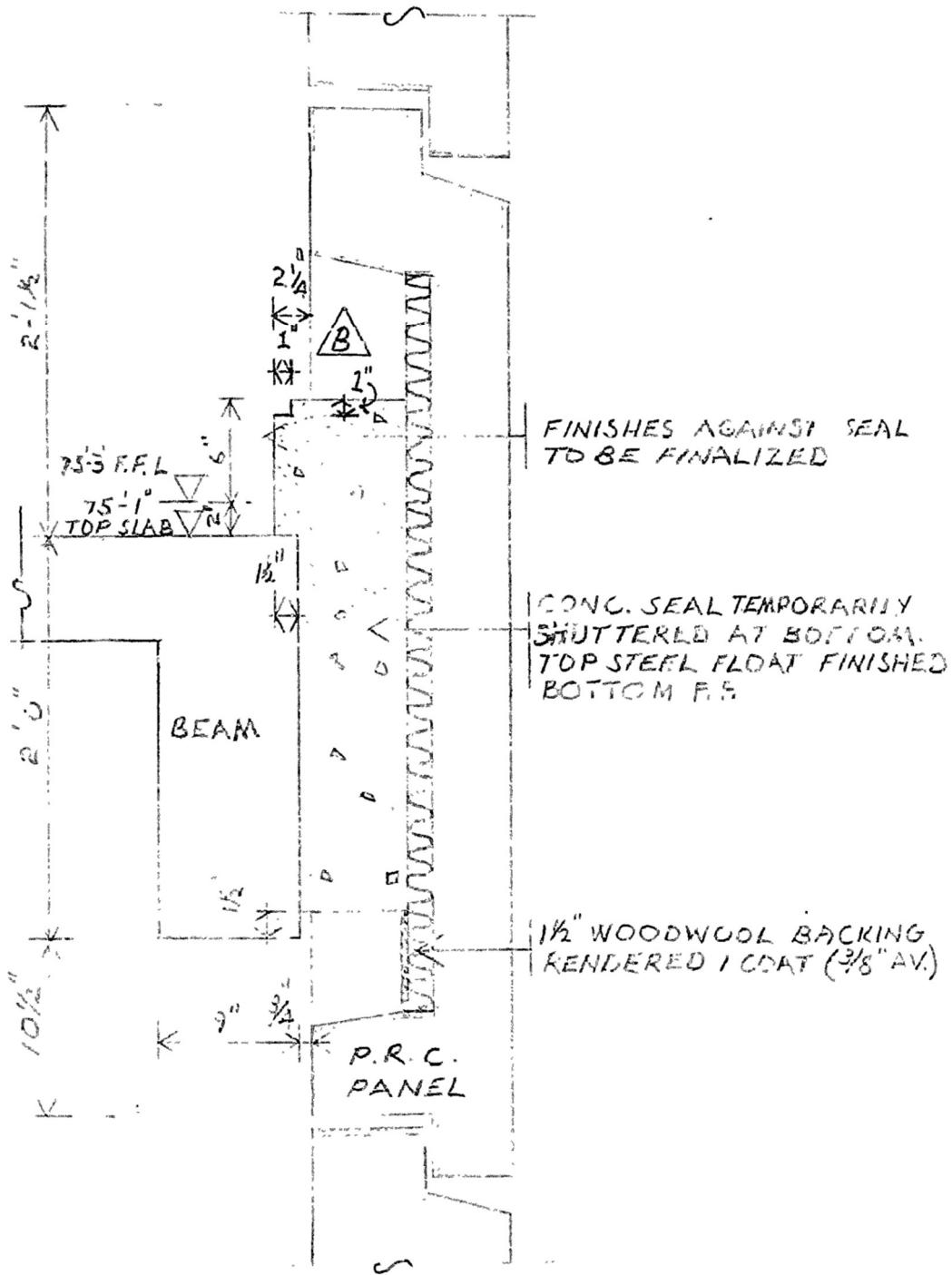


Figure 8: Example of PCCP Used as Composite Shutter

2.2.4. SUMMARY OF PCCP TYPES

Below is an illustration of all PCCP types.

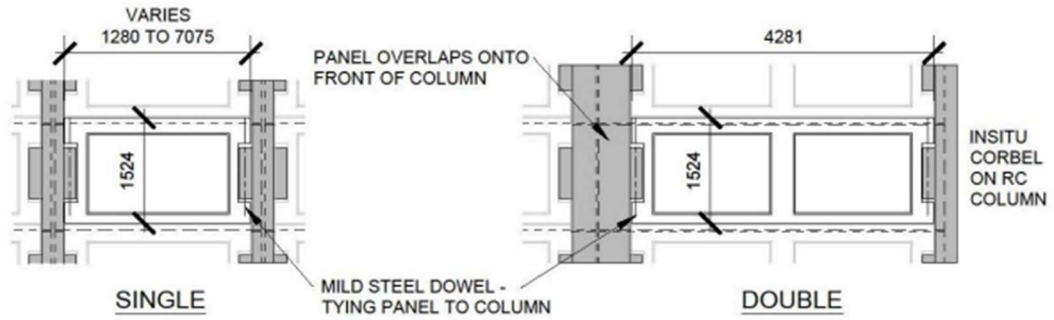
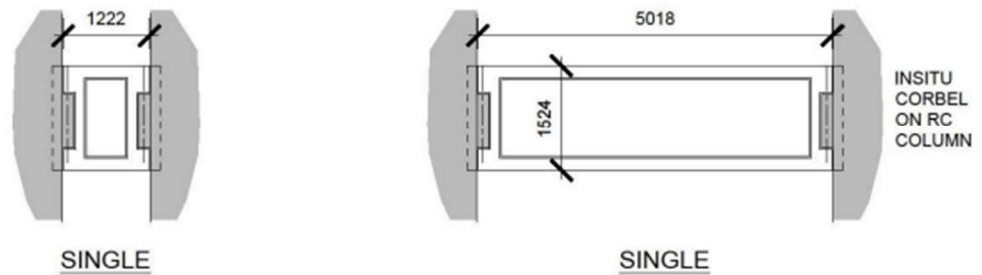
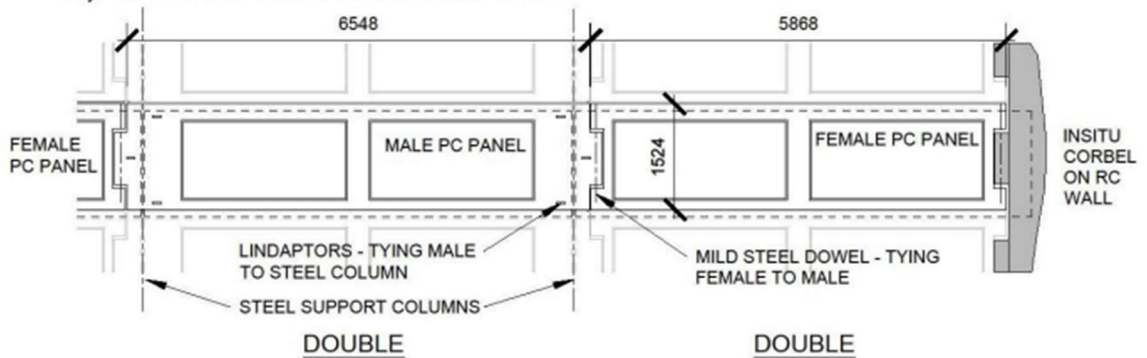
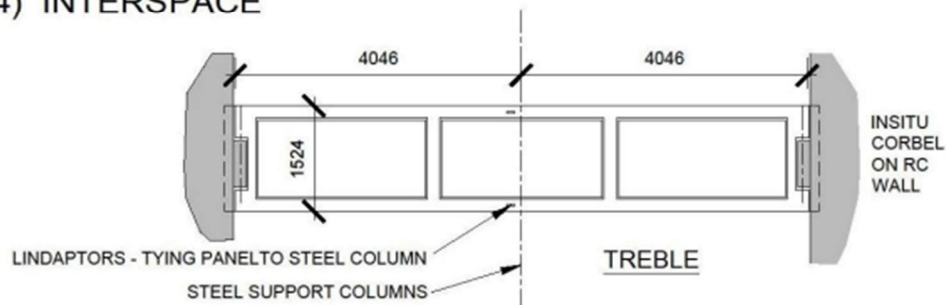
1) GENERAL PANELS

2) STAIRCASE PANELS

3) CHARGE HALL WEST/EAST

4) INTERSPACE


Figure 9: Summary of PCCP Types

It should be noted that the corbel, panel nibs and top ribs contain encased asbestos cement sleeves. Due cognisance should be given to the presence and requirement for compliant management of asbestos containing materials when formulating the panel removal methodologies and subsequent waste processing arrangements. For comprehensive details on all asbestos containing materials associated with PCCP refer to site asbestos register or relevant asbestos survey information.

3. ORIGINAL INSTALLATION OF PCCP

All PCCP consist of two lifting holes which measure 50mm in diameter formed by encased asbestos cement sleeves. At the time of construction, chain slings and lifting attachments were attached to the PCCP via the lifting apertures which facilitated lifting and positioning by crane. Each PCCP would then be fixed into their position as detailed in Section 2.2 of this document. The lifting holes were then grouted. An illustration of the lifting set up can be seen in figures 7 and 8 below. It should be noted that the below photos are from the turbine hall construction but represent a typical PCCP lift installation.



Figure 10: Typical PCCP lift set up

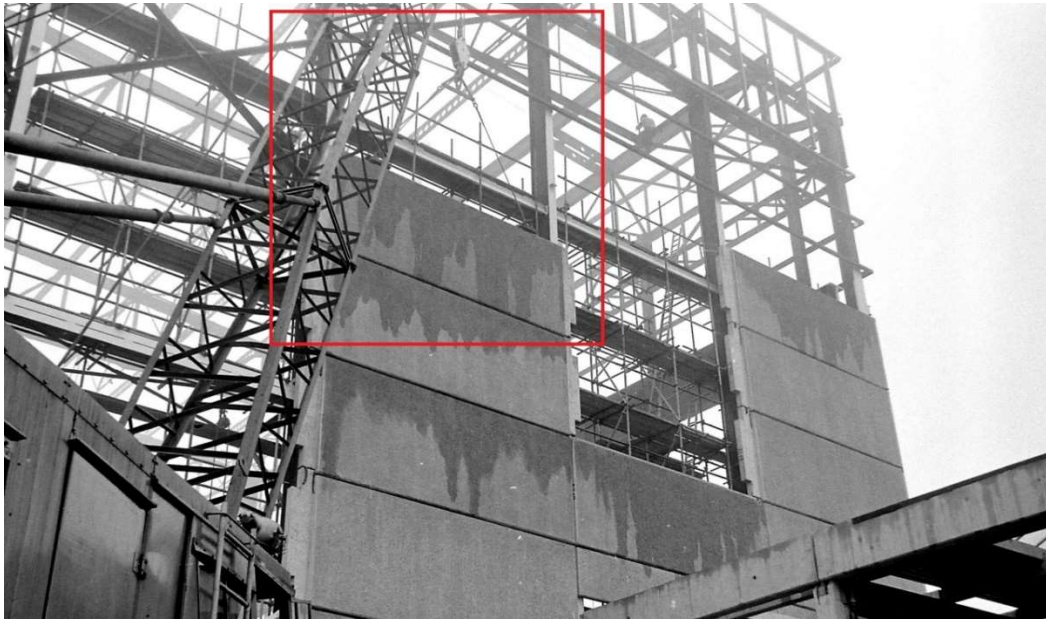


Figure 11: PCCP being lifted into position

4. SUMMARY OF HISTORICAL INVESTIGATIVE AND REPAIR WORKS

4.1. STRENGTHENING WORKS 1993

A series of documented inspections on the condition of the PCCP and external facades of the reactor buildings are available dating back to 1987. The first package of remedial work was undertaken in 1993 targeted at several PCCP and the supporting concrete corbels. A summary of the works undertaken is summarised as follows:

WEST STAIRS

- Fabricated steel brackets were fitted to PCCP which had defective supports to provide an alternative load path.
- Rolled steel angle section brackets were installed where deterioration of landing supports had been reported.
- Concrete repairs to supporting concrete corbels.
- Injection of grout around the dowels where no grout was present.
- Replacement of corroded shims with stainless steel shims with neoprene layers top and bottom.

WEST ELEVATION OF CHARGE HALL

- Fabricated steel brackets were fitted to defective PCCP and adjacent structure which provided an alternative load path.
- Concrete repairs to supporting concrete corbels.
- Injection of grout around the dowels where no grout was present.
- Replacement of corroded shims with stainless steel shims with neoprene layers top and bottom.

INTERSPACE PANELS

- Steel brackets were installed to the supporting central column.
- Concrete repairs to supporting concrete corbels.
- Injection of grout around the dowels where no grout was present.
- Replacement of corroded shims with stainless steel shims with neoprene layers top and bottom.

4.2. STRENGTHENING WORKS 2006

In July 2005, an external consultant was appointed to inspect a limited number of PCCP supports within the western staircases. The findings prompted a comprehensive follow-up inspection of all PCCP and supports later in 2005. The inspection confirmed that PCCP supports had deteriorated and a design assessment of residual strength was carried out. This resulted in recommendations for supplementary steel supports to be installed to the worst affected panels in the western staircases. The site works were completed in 2006.

4.3. X DEFECT PANEL 2010

In October 2008, an inspection of the PCCP revealed that one of the PCCP, (panel reference W-0520) located in the northwest stair core of reactor building was in a poor state of deterioration. The condition was sufficiently serious to warrant immediate action as it was judged a hazard and a risk to health and safety on the site. It was recommended that the PCCP should be removed the removal of the PCCP was carried out in March 2010.

Given the constraints of the time, extraction of the PCCP involved the removal of restraining brackets installed as part of the strengthening works discussed in Section 4.1. It was found necessary to cut some of the concrete in the panel ribs locally as there was still good adhesion of the PCCP to the parent support concrete. This was possibly due to epoxy resin adhesive that had been injected behind the restraint brackets.

The void was then infilled with a specially designed prefabricated steel frame with profiled metal sheeting. This component is still in place whilst the removed PCCP is still housed on site. Further details of the removal methodology are provided in Appendix D.

ARUP were commissioned in June 2010 to carry out an inspection of the failed PCCP. For further information into the findings of the inspection please refer to the report "0035 Inspection of 'X-Defect' Precast Panel".



Figure 12: Defect panel W-0520

4.4. STRUCTURAL INTEGRITY MANAGEMENT PLAN (SIMP) 2010

The work carried out to prepare the SIMP involved an extensive desk-top study of available information as well as detailed on-site inspection and testing of the structures. Salient aspects specific to PCCP are included here for completeness.

4.4.1 DESKTOP STUDY

External consultants were engaged in 1987 to inspect the PCCP and assess them to design codes current at that time. Further inspections were then conducted on the worst affected areas again in 1991 with deterioration detected against the established monitoring baseline. This led to the remedial works that were carried out in 1993 as discussed in Section 4.1.

External consultants were then appointed to carry out further inspections of the PCCP in September 2001. Further deterioration of PCCP was reported, of both unrepaired PCCP and target repairs conducted in 1993. Recommendations were given for a prioritised repair programme and a sustained inspection regime.

In July 2005, external consultants were appointed to inspect a limited number of PCCP supports within the western staircases which prompted a comprehensive inspection of all PCCP and supports in October 2005. The latter inspection confirmed further deterioration of the PCCP supports thus leading to the strengthening works carried out in 2006 as discussed in Section 4.2.

At the time of writing the SIMP report, the latest inspection of the PCCP was carried out in November 2008. Further deterioration was noted of PCCP supports and extremely wet conditions in the western stairs. This inspection also noted the first significant defect to a panel itself rather than the panel supports thus leading to its removal as described in Section 4.3.

4.4.2 VISUAL INSPECTION

The general visual inspection of internal faces of PCCP confirmed the findings of the various reports reviewed in the desk study, namely that the PCCP on the west elevations were generally in worse condition than elsewhere due to them being subject to the prevailing weather conditions. The PCCP panels in worst degraded condition, were those enveloping the western staircases on both reactor buildings.

It was noted that beyond 20-year deferment of Height Reduction from the time of writing the SIMP that all the PCCP on both reactors would need to be removed. Removal of the PCCP forms one of the main body of works for the Height Reduction project as its designed today.

4.4.3 RECOMMENDATIONS

The SIMP recommended that a programme of remedial works be designed and implemented. Specific to the PCCP, the most important matter to be addressed in the short term was to repair and waterproof the PCCP on the west staircases. Any other work was dependant on likely timing of Height Reduction. The additional waterproofing and strengthening works carried out in 2014-16 is discussed in Section 4.5.

4.5. STRENGTHENING WORKS 2014-16

A scheme was prepared for many smaller scale remedial works which were split over various work packages between 2014 and 2016. This Section discusses the works completed to PCCP and supporting structures.

PCCP STRUCTURAL STRENGTHENING AND REPAIRS

- **PCCP Structural Strengthening**
 - Discrete strengthening brackets have been installed internally to the PCCP which are located from ground to main roof level.
- **Seal Western Elevation PCCP Joints**
 - Sealing over the existing vertical and part horizontal sealed joints between the precast concrete panels to the Western Elevation (from Ground to Roof Level) with Dow Corning 123 strip. This includes some work to simplify the junction between the vertical and horizontal strips

EXTERNALS PHASE 1

- **Seal to Interspace PCCP**
 - Application of sealant bandage to the sides of all the Interspace PCCP on the North & South Elevations and to the top/bottom edges where new louvres were fitted.
- **Re-installation of Failed Bolts to West Stairs**
 - Several bolts supporting existing brackets were found to be defective. These needed to be replaced along with any other identified in the same brackets during testing.

EXTERNALS PHASE 2/3

- **Bottom brackets to PCCP above 3rd floor steam pipe gallery.**
 - 4 No. bottom restraint brackets were installed to concrete frame exposed to 3rd floor gallery.

BRACKETS TO INTERSPACE 2/3 BELOW CAPPING ROOF

- **Fitting of brackets to strengthen the Interspace 2/3 PCCP**
 - The Interspace PCCP were required to be better fixed to the building, both at their ends and their centre. This fixing required the installation of central brackets and end through bolts.

CIVIL WORKS TO BOILER BOXES & INTERSPACES BELOW CAPPING ROOF

- **Bracketing to Interspace PCCP**
 - The Interspace PCCP were required to be better fixed to the building, both at their ends and their centre. This fixing required the installation of central brackets and end through bolts.

INTERSPACES: WORKS ABOVE CAPPING ROOF

- **Bracketing to Interspace PCCP**
 - The Interspace PCCP were required to be better fixed to the building, both at their ends and their centre. This fixing required the installation of central brackets and end through bolts.

Full details of the works can be seen in the drawings in appendix B.

4.6. CURRENT PCCP CONDITION

To comply with Nuclear Site License Condition 28, Magnox Ltd is required to implement adequate site arrangements for the regular and systematic examination of safety related plant otherwise known as LC28 inspections.

The latest LC28 inspections were carried out in 2018. For the purpose of this EAN and future works, only class D or X defects will be discussed.

LC28 defects are classified as follows:

- **A:** No reportable defects or other challenges. Structural element (or elements within an area) satisfactory for continued use. No further action required until the next scheduled inspection.
- **B:** Defect(s) present of no structural or safety significance. Structure/element(s) suitable for continued use. No further action required before the next scheduled inspection. Defect(s) logged for future trend analysis.
- **C:** Defect(s) of structural or safety significance though it may not be clear whether remedial work is required. Further investigations may be proposed in the form of detailed inspections, design assessment, monitoring, sampling or load tests.
- **D:** Defect(s) of structural or safety significance requiring remedial measures although not immediately. Further inspections, design assessment, monitoring, sampling or load tests may be proposed, where required, to firmly establish the degradation mechanism and extent of the defect, prior to considering any appropriate repair technique.
- **E:** An adverse condition which has the potential to challenge the continued integrity or durability of the structure if not addressed.
- **F:** Structure, area or element inaccessible for inspection.
- **X:** Defect(s) of structural or safety significance considered to require urgent attention. Further investigation, design, repairs or temporary measures to be proposed as appropriate.

4.6.1. PCCP LC28 DEFECTS

REACTOR BUILDING 1

No Class D or X defects identified in 2018 LC28 report

REACTOR BUILDING 2

There is only one Class D defect identified in the 2018 LC28 report which is located on the fifth floor in interspace 8/9 room number 2080. The defect is located on a concrete corbel supporting a PCCP which has evidence of deterioration. Access to the defect area is problematic and can only be inspected from distant fifth floor slab. This defect is continually inspected. The defect ID number is 10314a/1 and its location can be seen on drawing TRA/3630/ST/46073 in Appendix E. A photo of the defect can be seen below.



Figure 13: Class D Defect – 10314a/1

4.6.2. LINDAPTOR COMMENTARY

The 2018 LC28 report includes a commentary on potential developing defects associated with the lindaptor connectors present where the PCCP is supported by a steel column. In this configuration, the top and bottom stiffeners/ribs of the PCCP feature encased channel support system which facilitate lateral restraint connection to the outer column flange by way of lindaptors. This configuration is explained in Section 2.2.2.

The current LC28 defect categorisation, for these components, is noted as Class C. The conservative narrative in the 2018 LC28 report, due to inspection constraints at the time, prompted further asset investigation and consultation with stakeholders. The findings of the follow up investigation are summarised below for completeness:

- During the campaign of works to repair the PCCP (2014-2016), extensive access provision to each internal elevation of the charge halls in both reactor buildings was provided. This afforded the opportunity to inspect and undertake repairs to the lindaptor/channel support system assembly (where needed).
- At the time, the condition was observed to be good with minor surface corrosion and no appreciable section loss.
- In a small number of cases, missing or degraded lindaptor connections were replaced. This included the replacement/addition of packing spacers given the significant column flange depth. These works were evidenced with Inspection and Test Plans specific to PCCP.
- This body of work included an assessment of connection redundancy. Specific to the right hand sides of panels E1625 and E1125, in-situ clashes were identified and these inhibited original installation of the target 3No lindaptors, typical for resisting lateral load at column positions. For these problem locations, an assessment demonstrated sufficient capacity was afforded by 2No lindaptors with additional capacity provided by the friction of the male

panel on the steel support shelf. It should also be noted in these locations, that the load was reduced due to the smaller interconnecting panel size. Further details are available in TRA/ENG/CALC/0043.



Figure 14: Lindaptor and Channel Support System Configuration (Connection to Column)



Figure 15: Example Lindaptor Repair

5. CONSIDERATIONS FOR DEMOLITION METHODOLOGY

Approximately half of the area of the external walls of the reactor buildings are clad with PCCP. Most panels are on the east and west elevations from ground level up to roof level as demonstrated in figures 3 and 4. PCCP are also present in the interspaces on the north and south elevations and on the staircases on the east and west. The gas circulator halls are also partially clad with PCCP, but it should be noted that these PCCP will not be removed as part of Height Reduction works. Information for consideration for demolition methodology can be seen below. Further detailed information (including but not limited to panel location, reference and weight) for every PCCP installed can be seen in Appendix C.

PCCP TO NORTH AND SOUTH INTERSPACES

Each PCCP is structurally independent, separated from its neighbours by windows or louvres as demonstrated in figure 2. Some PCCP have had restraint brackets installed and various nibs and corbels have had concrete repairs carried out on them to help ensure their integrity until height reduction takes place. There have been historical issues with the midspan column of the interspaces for which detailed information can be found in TRAWS/EAN/12/036. Full details of the strengthening and concrete repair works can be seen in the below noted drawings in Appendix B.

- TRA/3630/ST/24486
- TRA/3630/ST/24487

PCCP TO EAST ELEVATION – GROUND TO SECOND FLOOR PANELS

There are no PCCP at third floor level on the east elevation therefore the PCCP from ground to second floor can be removed independently of those above. It is anticipated that the PCCP will require removal from the top down. Some PCCP have had restraint brackets installed and various nibs and corbels have had concrete repairs carried out on them to help ensure their integrity until height reduction takes place. Full details of the strengthening and concrete repair works can be seen in the below noted drawings in Appendix B.

- TRA/3630/ST/24438
- TRA/3630/ST/24440
- TRA/3630/ST/24468
- TRA/3630/ST/24470

PCCP TO EAST ELEVATION – FOURTH FLOOR

These are contiguous with the PCCP to the eastern elevation of the charge hall and it is anticipated that they will be removed only after the PCCP above have been taken down. Some PCCP have had restraint brackets installed and various nibs and corbels have had concrete repairs carried out on them to help ensure their integrity until height reduction takes place. Full details of the strengthening and concrete repair works can be seen in the below noted drawings in Appendix B.

- TRA/3630/ST/24438
- TRA/3630/ST/24440
- TRA/3630/ST/24468
- TRA/3630/ST/24470

PCCP TO WEST ELEVATION – GROUND TO FOURTH FLOOR PANELS

These are contiguous with the PCCP to the western elevation of the charge hall and it is anticipated that they will be removed only after the PCCP above have been taken down. Some PCCP have had restraint brackets installed and various nibs and corbels have had concrete repairs carried out on them to help ensure their integrity until height reduction takes place. Full details of the strengthening and concrete repair works can be seen in the below noted drawings in Appendix B.

- TRA/3630/ST/24432
- TRA/3630/ST/24434
- TRA/3630/ST/24462
- TRA/3630/ST/24474

PCCP TO CHARGE HALLS

The PCCP on the west elevation are generally in worse condition than those on the east. A programme of joint waterproofing and strengthening of PCCP through the installation of restraint brackets and lindapters has been carried to the charge hall PCCP. Some nibs and corbels have also had concrete repairs carried out on them.

The charge hall PCCP interlock along their vertical edges in a male-female arrangement. The female PCCP rely entirely on the male PCCP to support their weight and provide restraint against wind loading. It is anticipated that this reliance will dictate the sequence of removal. Full details of the strengthening and concrete repair works can be seen in the below noted drawings in Appendix B.

- TRA/3630/ST/24432
- TRA/3630/ST/24434
- TRA/3630/ST/24436
- TRA/3630/ST/24442
- TRA/3630/ST/24466
- TRA/3630/ST/24472

PCCP TO EAST STAIRCASES

The east staircases have PCCP only on their short elevations. Each PCCP is structurally independent separated from its neighbours by windows. Some PCCP have had restraint brackets installed to help ensure their integrity until height reduction takes place. Full details of the strengthening and concrete repair works can be seen in the below noted drawings in Appendix B.

- TRA/3630/ST/24438
- TRA/3630/ST/24440
- TRA/3630/ST/24468
- TRA/3630/ST/24470

PCCP TO WEST STAIRCASES

The west staircases have PCCP on both their long and short elevation. Each PCCP is structurally independent, separated from its neighbours above and below by windows and from the adjacent PCCP by a structural column. All PCCP have had restraint brackets installed and various nibs and corbels have had concrete repairs carried out on them to help ensure their integrity until height reduction takes place. Full details of the strengthening and concrete repair works can be seen in the below noted drawings in Appendix B.

- TRA/3210/ST/26852 - TRA/3210/ST/26859

FURTHER CONSIDERATIONS

- Consideration should be given to the sequence of removal of the PCCP between east and west elevations. The change in internal wind pressures due to large new openings needs to be assessed along with the effect on the remaining PCCP. The effect of wind loading should be considered especially carefully for the charge hall PCCP, where removing the panels from one side before the other could result in significantly increased wind loading on the remaining panels.
- The charge hall PCCP support steelwork is propped by intermediate horizontal wind girders and by the roof structure. Therefore, it is anticipated that the PCCP will need to be removed before the restraining steelwork.
- The PCCP are supported on the main structure by a variety of fixing methods as is shown in Section 2.2, which differ primarily in respect of being fixed either to concrete or structural steel. Any removal methodology will need to take account of such variation.

- PCCP fixings are generally not accessible from the outside. Any removal methodology will need to take account of such constraints.
- It is anticipated that there will be environmental consequences due to the removal process and disposal of the PCCP arisings. For instance, there are asbestos cement sleeves in the concrete corbels supporting the PCCP. Select corridor slab termination details also feature asbestos containing materials. These details can be seen in drawings DD/10/16/00/A02229 & DD/10/16/00/A02230 in Appendix E. The PCCP are also lined internally with wood wool.
- The strengthening works previously carried out will need to be reviewed and considered as part of any removal methodology. Full details of these works can be seen in Appendix B.
- The joints between the PCCP on the external west elevation of both reactor buildings have been previously sealed with a weather proofing sealant band. This detail can be seen in drawings TRA/3630/ST/24415- TRA/3630/ST/24417 in appendix E. It is anticipated that the sealant band will need to be addressed as part of the removal methodology.
- In areas where epoxy resin adhesive has been injected behind restraint brackets that were installed as part of historical strengthening works, it is possible that some of the concrete in the panel ribs might need to be cut locally to enable the release of the PCCP.
- All restraint brackets that have been installed as part of historical strengthening works have been designed for static loading only with no considerations for dynamic loading such as those experienced from demolition work activities. Any removal methodology will need to take account of such constraints.

Appendix A - Original PCCPP As Built Drawings

Appendix B - Structural Strengthening and Repair Drawings

Appendix C - PCCPP Detailed Information Spreadsheet

Appendix D - Defect Panel Drawings

Appendix E - Supplementary Drawings