Root Cause Analysis

of
North West Community Campus
Dumfries

For
Scottish Futures Trust

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glm

Quality Information

Prepared for:

Martin Blencowe - Procurement Review Director
Scottish Futures Trust,
11-15 Thistle Street,
Edinburgh,
EH2 1DF

Prepared by:

Ian McKee
Managing Director
BSc(Hons) FRICS FCABE

Direct *44 (0)131 225 4235

Checked by:

Aythan Lewes
Director
BSc(Hons) MRICS

Direct *44 (0)131 225 4235

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Contents

Executive Summary

Background

1. Following the collapse of a ceiling during the construction phase in July 2018, and other incidents whilst in use, the North West Community Campus in Dumfries was closed for seven months to rectify a significant number of defects.

2. GLM has been commissioned to carry out a root cause analysis (see Section 1 for a definition) into three incidents:

    - the collapse of the staff room ceiling prior to handover,
    - once possession (as defined in the Beneficial Access supplementary agreement) was taken a sliding door which came from its runner, and
    - a Promethean smart screen which struck a child.

3. This exercise addresses two questions:

    - Why did the failures occur?
    - What lessons can be learned for future projects?

    The intention is that this report feeds in to a wider lessons-learnt exercise. It is intended to assist in making any appropriate changes felt necessary to avoid a repeat of the circumstances which led to these three defects at North West Community Campus.

Root Cause Analysis

Ceiling Mounted Services

4. The design concept was that the services (sprinkler pipework, radiant panels and pipework, light fittings and electric conduit etc) would be visible below the ceiling. The ceiling had to be connected to the roof structure above it. The services had to be connected through or via the ceiling back to structure. There was no explicit design for how to take the weight of the services directly back to the structure. The services were instead fixed to the ceiling. The ceiling's fixings to structure therefore carried the load of both the ceiling and the services, which was too much for them and it collapsed.

5. The services subcontractor and ceiling subcontractor, the two parties responsible for the Point of Cause of this failure, declined to speak to us. The sprinkler subcontractor did speak to us, which gave us part of the picture. Despite this, we cannot definitively pinpoint a root cause as we do not have enough detail to answer the first of the root cause "why" questions – "why did the subcontractors deliver an incorrect installation". Without having more detail we cannot comment on the reasons for their actions and must therefore look at the next level up. It would be logical to ask:

    - Why did the services subcontractors not fix the sprinklers back to structure?
    - Why was there no system to carry the load of the services past the ceiling to structure?
    - Why does there appear to have been no design to transfer the loads?

Either:

- This was to be designed by the subcontractor but was not, or
- it was to be designed by the design team but was not, or
- there was a design, but it was not communicated.

6. From this point a range of causal factors arise:

    - Why was this not raised by the installers?
    - Why was this omission not noticed by the Tier 1 contractor?
    - Why was this omission not noticed by the Design Team?
    - Why was this omission not noticed by the Hub SW team?
    - Why was this omission not noticed by the Authority (Dumfries and Galloway Council) team/Clerks of Works?

7. The answers to the above are multifaceted and specific to each team but raise questions at every level.

8. There were two contracts: the "DBDA" between the Dumfries & Galloway Council and Hub South West; and the "D&B Subcontract" between Hub SW and Graham Construction Limited. Hub SW were responsible for the correct design and construction of the works to meet the Authority's Construction Requirements, Hub's proposals, and "good industry practice" as defined in the DBDA. Under the D&B Subcontract Grahams were the Design and Build (D&B) contractor, with contractual responsibility to Hub SW for the design and construction of the works to meet hub's Employer's Requirements, Graham's Contractor's Proposals, and "good industry practice" as defined the D & B Sub-contract.

9. Graham's design process, and that of their subcontracted Design Team and specialist subcontractors, did not fully design a specific detail for transferring the loads of the services back to structure. The design of the non-structural builderworks in connection with services (which the supports for ceiling mounted services were considered as) was the responsibility of the mechanical and electrical subcontractor, JBE. They developed some, but not all, details which were approved by their own designers. From what we can tell Grahams' Structural Engineer had no role in the approval of the design.

10. With no completed explicit design, those tasked with checking had nothing to check against. Grahams did not implement a robust Quality Management process on site, and so missed the fact the detail that was being built did not meet the requirements of the Contractor's Proposals in the contract. Those overseeing the work by Hub SW and Dumfries and Galloway also failed to spot this.

11. In common with many projects procured using a D&B procurement route, the Design Team's role did not include a continuous supervisory role and so they only inspected at intervals. Those inspections evidently did not pick up the lack of support for the services. We believe they were dislocated from the detail design of the ceilings and services supports.

12. We have no evidence that Hub SW checked Graham's Quality Plan after start on site. If they had they'd have noticed it was not developed as it was meant to be. We do have evidence of some tracking of quality Key Performance Indicators (KPIs) by them, and interrogation of other details, but nothing around the ceilings, sliding doors or Promethean screen. The distinction between managing a quality assurance system and actually managing quality is a key point arising from our review. Does tracking KPIs actually deliver quality? In the case of the services supports it did not.

13. Despite Hub SW's Employer's Representative having powers under the contract to inspect and to order the opening up of works to check any concerns, we found no evidence of this happening where the ceiling services supports are concerned, despite the detail being built being at odds with the subcontractor's generic detail in the Contractor's Proposals. We believe Hub SW expected Graham's own quality oversight would deliver quality, which is not unreasonable given their size and ISO:9001 qualification. However, it must be questioned how Hub SW maintained this belief without checking Graham's Quality Plan.

14. The Authority employed Clerks of Works who sent reports to Hub SW's Employer's Representative (ER) and to Grahams. These reports were not used effectively. The ER relied on Grahams to track issues raised, and they were reported and tracked as KPIs. Grahams were relied upon to close them out.

15. Under the DBDA contract the Authority's Representative also has the power to inspect, to open up, and to audit the quality assurance of both Hub SW and Grahams. We did not see any evidence that these activities occurred where the three defects are concerned. The Authority established a quality-oversight set-up whereby Clerks of Works monitored works and were meant to report to Project Managers who had the delegated powers of the Authority Representative. This set-up did not spot the key failings which occurred, or if they were, they were not attended to. From our interviews with many of the key people we do not believe that the Authority Representative team fully understood their role in the delivery of the quality of the works.

Sliding Door

16. The failure of the sliding door would appear to be one of design and specification, caused by insufficient thought having been put into how the doors would be stopped where two doors met in the middle of the opening. There was no door jamb, so nothing for the leading edge to hit, and so one of the stoppers which came with the system was omitted as it had nothing to meet. The stopper on the top rail alone took the full force of the door and failed.

Promethean Screen

17. For this issue there is complication around the Point of Cause due to the failure occurring when the school had taken possession as defined in the Beneficial Access supplementary agreement. First-hand reports conflict. The first purported cause is that the screen is so easy to move that a child should not have been allowed to play with it, is contradicted by testimony that two "fully-grown men" could not repeat the feat. The second is that the frame was damaged after installation by either Grahams or another party. This is supported by photographs, but it is not apparent how this would cause the system to malfunction. That 'security' grub screws were missing has also been suggested as a cause, though this is rejected by the manufacturer and installer. Even if this were the reason, it's unclear who might have removed them. We cannot conclude a root cause.

Overall conclusions

18. Grahams did not develop and issue key details to ensure the correct fixing back to structure of the ceiling mounted services. The sprinkler contractor's generic fixing details were not achieved. The

subcontractors had no defined way of correctly executing the works and were allowed to choose and implement a technical solution which did not work. With no design there was nothing for those auditing the works to compare against. We believe this to be the root cause of the ceiling failure.

19. Graham's Quality Management Plan was not developed after financial close as is required by the contract. The Quality Management system implemented was not therefore comprehensive. Hub SW did not develop their own Quality Plan as is required in the DBDA contract. Hub SW did not note the lack of Graham's Quality Plan, and the Authority did not note the lack of Hub SW's Quality Plan.

20. The contractor's IT systems were difficult to access and interrogate. This lack of transparency impacted those who were tasked with auditing it (Grahams, Hub SW, Dumfries & Galloway), and the contractor's own team in delivering it.

21. As in many Design and Build procurement processes the Design Team had no continuous independent supervisory role or obligation to sign off that works were in accordance with their design. We suspect their disconnection from the project contributed to the failings which occurred.

22. Hub SW did not interrogate Graham's quality control, despite having the contractual powers and ability to do so. Lack of distinction between operating a Quality Assurance system, and actual delivery of quality, along with reliance on the contractor self-auditing, impacted the effectiveness of their role. There is confusion over who was to deliver quality: is it Hub SW who are contracted to Dumfries and Galloway, or Grahams, who are contracted to Hub SW? We believe every level thought it had passed that obligation down the line until ultimately it is left to the subcontractors on the ground.

23. The Authority set up a team structure that could not make best use of their powers under the contract where quality oversight was concerned. The only technical role in the system for overseeing Grahams were the Clerks of Works, who were restricted in carrying out their role by the lack of transparency of Graham's systems and the lack of completeness of design to use as a baseline to compare against. Their effectiveness was reduced due to the Dumfries and Galloway Council team structure. We emphasise the distinction between those with technical construction backgrounds – architects, engineers, building surveyors – and those trained to manage such as Quantity Surveyors and Project Managers. To deliver the quality oversight roles set out in the contract requires individuals with the right skills.

24. There was lack of clarity between the roles of Hub's Employer's Representative and the Authority's Representative as to who was responsible for delivery and oversight of quality on the project. This contributed to the Clerks of Works not being used effectively as they were not clear who was leading this aspect, and Hub stepping back from their role due to the presence of Clerks of Works.

25. In the design process technical design documentation was only presented by Hub SW to the Authority when the contract was signed (at Financial Close), with no obligation for the Authority to review it for technical compliance. At this point design was developed to the old RIBA Stage E level where not all details are complete. Following Financial Close no other review was undertaken by anyone outside the contractor's team. No tracking of changes which might impact on the design quality were mandated from this point until completion, nor were there checks that any remaining critical details were developed. Flexibility in the detail of design may be necessary to enable D&B to deliver the desired commercial outcomes, but it must be questioned whether the resulting lack of oversight was appropriate.

26. Design proposals were not sufficiently developed at Financial Close to present a comprehensive baseline for comparison against during the works. Key details were not developed after this point providing no baseline to compare the works against, making quality assurance very difficult to

deliver. It was then left to the contractor to satisfy themselves as to the robustness of the design and the works.

27. When it comes to these three elements, all of which had the potential to impact the health and safety of users, we do not consider that a sufficient process was in place to deliver the quality of design and construction required, or to provide appropriate oversight. In such matters effective oversight outside the contractor's team must be in place.

Recommendations

28. In summary our recommendations (for full details see section 9) regarding critical health and safety aspect of the works are:

- All key supports for services must be explicitly designed and approved by the Tier 1 contractor's full Design Team. A process must be in place so that this happens as and where required after Financial Close.
- Drawings should be available for those auditing or using them to check quality prior to each works package/element commencing. Works should not progress if this is not the case.
- A Quality Management Plan for design and construction must be developed and implemented by the Contractor in line with the requirements of the contract and their ISO:9001 qualification.
- We believe Design Teams should confirm that the works accord with their design as they progress and at completion.
- All design must be the responsibility of either the Design Team or specialist subcontractor.
- Key hold points (defined in section 9) should be signed off throughout the project.
- A Quality Management Plan must be developed and implemented by HubCo. The respective Quality Plans must then be audited as intended in the contracts.
- It must be clarified that the Authority Representative and Employer's Representative are actively involved in oversight of quality in the DBDA and D&B Subcontract respectively. In the wider team any confusion as to who is responsible for oversight and auditing of the Tier 1 Contractor's design and works quality must be removed.
- The Authority Representative and Employer's Representative must have the capacity and expertise to use the quality assurance powers they have in the contract. It should be clear who the Clerk of Works report to and remove any confusion of reporting lines.
- The Clerks of Works role should be formalised in the project and correctly resourced given their critical role. The Authority should have a documented plan for exercising their contractual powers for quality oversight.

1. Purpose and Scope of the Exercise

Purpose of the Exercise

1.1. As the North West Community Campus (NWCC) was nearing Practical Completion the staff room ceiling collapsed together with the undermounted services. This led to an investigation of the fixing of all ceilings and ceiling mounted services (sprinkler pipework, radiant panels and pipework, light fittings and electric conduit etc). Remedial works were carried out to attend to the shortcomings in the installation identified, delaying handover. The school opened on the 21st of August 2018 without Practical Completion being issued, but under an agreed 'beneficial access' arrangement defined in a supplemental agreement. Shortly after beneficial access a sliding door became detached and fell from its runner. Following this a Promethean "smart" screen fell from its bracket, striking a child. As a result the facility was closed and a full review carried out.

1.2. Scottish Futures Trust (SFT) commissioned GLM to undertake a root cause analysis of the circumstances which led to the three specific defects described above at North West Community Campus. It addresses two questions:

- Why did they occur?
- What lessons can be learned for future projects?

1.3. A root cause analysis can be defined as "a process for identifying the basic or causal factors that underlie variation in performance". Systematic analysis of the events leading to the Point of Cause (PoC – sometimes referred to as the "sentinel event"). The PoC is identified, those symptoms and the causes of the symptoms are identified. The root cause(s) are then those which, if removed, would have meant the variation did not occur. Those causes which contribute are termed 'causal factors'. A typical analytical technique is the "five whys", where to fully understand likely causes, "why" is asked repeatedly to get to the real root cause.

1.4. This analysis covers the processes, procedures, events, actions and decisions which led to the three specific issues arising on the project.

1.5. We were required to carry out a thorough review of the quality assurance processes of the Authority (DGC), Hub SW and the contractors involved on this project.

Scope of the Exercise

1.6. To enquire into and report on the following matters:

1. The root cause and causal factors behind the collapse of the ceiling mounted services in the staff room.
2. The root cause and causal factors behind the sliding door falling from its runner.
3. The root cause and causal factors behind the Promethean "smart" screen coming off its mounting.

Methodology

1.7. As set out in Appendix A, we collected data through interviews and documents requested from the key parties. Much of the additional work revealed other individuals, or other documents material to the exercise. Appendix B contains the Request For Information register showing what was

requested and what was received. Appendix C lists those interviews that were carried out. An iterative process was followed until we considered we had gathered all that was likely to be made available. We have not spoken to everyone we asked to see as some parties declined to speak to us. We have not had all documents requested. A schedule of requests for information and of interviews are included in the Appendices.

2. Development and Construction Responsibilities

Procurement and Contract

2.1. The NWCC was delivered through the Hub programme, whereby regional Hub Companies (HubCos) work in partnership with local authorities to deliver community infrastructure investment. The HubCos provide continuity of procurement ability between various authorities. One of the many reported benefits of this system is to give support to the authorities, as retaining skilled in-house resource is difficult with the variable volume of procurement in any one authority area over a given timeframe. HubCos provide expertise and experience in public procurement to support the public sector.

2.2. HubCos are by nature delivery vehicles, with little resource themselves, and so, pass-through risk and obligations to their supply chains. For this reason, the contract between the HubCo and the Authority, and the HubCo and their delivery partner(s) (usually the "Tier 1 contractors") are 'back-to-back', so all rights and obligations are passed directly through with little remaining for Hub themselves to deliver directly.

2.3. There are different models of procurement between authorities and HubCos. The two models relevant to this exercise are Design Build Finance Maintain (DBFM – used for revenue funded projects) and Design & Build Development Agreement (DBDA – used for capital funded projects). NWCC was developed using the DBDA model. The contracts are standard templates used across the Hub programme and amended for each project. We understand this was the case for the NWCC.

2.4. Although the basic form of procurement, Design & Build (D&B), remains the same between DBDA and DBFM, the obligations of the HubCo and their delivery partners differ depending on the funding model being used. There are some important differences:

- Under DBFM the 'hard' facilities management of the completed building is the responsibility of a stand-alone DBFM Company. Under DBDA the Authority retains the facilities management obligation.

- There are external funders in a DBFM contract, whereas the public sector is the funder under DBDA contract.

- There is no mandated requirement for an Independent Tester under the DBDA contract, whereas there is a requirement for this role under DBFM.

2.5. In the case of NWCC, as in all Hub procurement, there are two contracts – that between the Authority and the HubCo, and that between HubCo and the delivery partner or contractor.

2.6. Both DBDA and DBFM are essentially D&B forms of procurement. The D&B contractor employs the designers and subcontractors. The term within HubCo procurement for this main point of deliver is the "Tier 1 contractor" of which there is a restricted number associated with each HubCo at any one time.

2.7. At pre-contract stage the Authority's Construction Requirements (ACRs) are developed alongside the Contractor's Proposals (CPs), otherwise referred to as "HubCo proposals" (hCs) as they are to an extent one and the same. The Contractor's Proposals are then subject to "market testing" whereby the design is put to competitive tender between subcontractors. A stage 2 project cost submission is then made and HubCo enter a period of negotiation with the Authority and their advisors. Once the costs are agreed "Financial Close" is reached and the project proceeds to site.

2.8. From this point the contracts are administered until completion by HubCo. The CPs, hCs and ACRs (all defined above) form the basis of the contracts and are used as the tests as to whether works are designed and constructed correctly. The contracts include mechanisms similar to other standard form contracts for change and for monitoring of quality. It should be noted that the intention of the procurement route is that responsibility for the design and construction of the finished building meeting the Authority's Construction Requirements (ACRs) and HubCo's proposals is with HubCo, and by extension via a "back-to-back" contractual arrangement as set out above, to the Tier 1 contractor.

Roles and Responsibilities

2.9. The parties to the two contracts at NWCC were as follows:

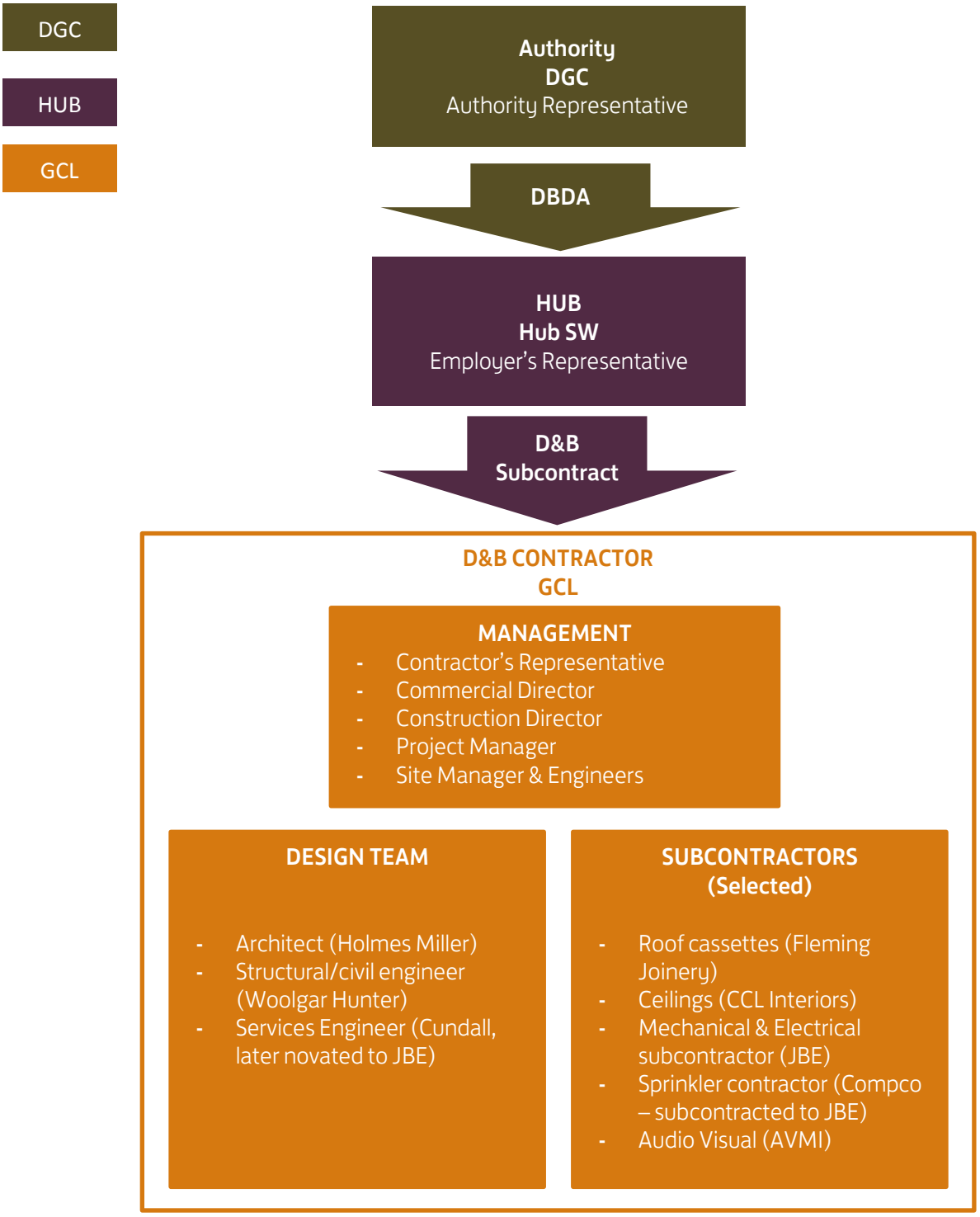
- The Authority – Dumfries and Galloway Council (DGC)
- HubCo – hub South West Scotland Limited (Hub SW)
- The Tier 1 Contractor - John Graham Construction Limited (GCL)

2.10. The Authority have a Representative named in the DBDA contract. Hub, as Employer in the D&B Subcontract, have a named Employer's Representative. The Contractor must name key staff within the contract, including their own "Representative". HubCo refer to themselves as the 'contract administrator'.

2.11. Other key team members to the project are as follows (limited to those relevant to this exercise):

- The DGC Authority team:
    - Senior Responsible Officer
    - Authority Representative
    - Senior Project Manager
    - Project Manager for NWCC
    - Clerks of Works (CoW)
- Hub SW team
    - Director
    - Construction Manager /Contract Administrator (Employer's Representative)
- GCL Tier 1 contractor
    - Contractor's Representative
    - Construction Director
    - Commercial Director
    - Contracts Manager
    - Project Manager
    - Site Manager
- GCL's Design Team
    - Architect (Holmes Miller)
    - Structural & Civil engineer (Woolgar Hunter)
    - Mechanical and Electrical engineer (Cundall – novated to JBE)

- GCL's subcontractor team (specific to the three issues in the scope of this report):
    - Roof cassettes (Fleming Joinery)
    - Ceilings (CCL Interiors)
    - Mechanical & Electrical subcontractor (JBE)
    - Sprinkler contractor (Compco – subcontracted to JBE)
    - Ironmongery, Internal Timber Doors & Screens (Williams Ironmongery (Glasgow) Ltd)
    - Audio Visual (AVMI)


DGC
HUB
GCL
Authority
DGC
Authority Representative
DBDA
HUB
Hub SW
Employer's Representative
D&B
Subcontract
D&B CONTRACTOR
GCL
MANAGEMENT
- Contractor's Representative
- Commercial Director
- Construction Director
- Project Manager
- Site Manager & Engineers
DESIGN TEAM
- Architect (Holmes Miller)
- Structural/civil engineer (Woolgar Hunter)
- Services Engineer (Cundall, later novated to JBE)
SUBCONTRACTORS (Selected)
- Roof cassettes (Fleming Joinery)
- Ceilings (CCL Interiors)
- Mechanical & Electrical subcontractor (JBE)
- Sprinkler contractor (Compco – subcontracted to JBE)
- Audio Visual (AVMI)

3. Background

Dumfries Learning Town and Schools for the Future

3.1. A broad initiative called Dumfries Learning Town (DLT) was established in 2014 to bring all education provision together across Dumfries. Phase 1 of this initiative sought to reduce the number of locations, refurbish some buildings and to create a new facility – the North West Community Campus (NWCC) being one.

3.2. The delivery of the projects comprising Phase 1 was driven by the Scottish Schools for the Future (SSF) team at Dumfries and Galloway Council, which was part of Education Services.

3.3. The projects in Phase 1 – St Joseph's, The Bridge and NWCC – were delivered around the same time as other projects in the region. Adjacent projects are important to this exercise as a benchmark where design and team members were the same as NWCC. Where projects were executed under a Design Build Finance Maintain (DBFM) model, rather than the Design Build Development Agreement (DBDA) model used at NWCC, but similar issues have not arisen, raises important questions .

3.4. We are informed that the DGC team who delivered DLT were employed immediately before this programme and all systems were set up for it, albeit with support from Hub SW and other public sector teams. Few existing processes were taken from existing DGC teams/departments.

4. Contract

4.1. The following section sets out our observations of relevant parts of the contracts we have reviewed.

The DBDA contract

4.2. The entire contract sits under the Territory Partnering Agreement (TPA) for the South West Territory. The Territory Partnering Agreement includes other documents, some of which are referenced later.

4.3. The contract is primarily balanced to place all commercial risk, as well as responsibility to deliver against the ACRs and CPs, with HubCo and by extension with the Tier 1 contractor. Clause 5.1 of the contract states *"Subject to, and in accordance with, the provisions of this Agreement, HubCo shall perform its duties under this Agreement at its own cost and risk without recourse to the Authority except as otherwise expressly provided in this Agreement."*

4.4. Clause 5.2 states that:

"hubco shall at its own cost be solely responsible for procuring that the Works are at all times performed:-

5.2.1 in compliance with all Law and Consents (including without limitation the giving of notices and the obtaining of any such Consents) and so as not to prejudice the renewal of any such Consents;

5.2.2 in a manner that is not likely to be injurious to health or to cause damage to property;

5.2.3 in a manner consistent with the Quality Plans;

5.2.4 NOT USED;

5.2.5 in a manner consistent with the Authority discharging its statutory duties and other functions undertaken by it as the same may be notified to hubco from time to time; and

5.2.6 in so far as not in conflict with an express obligation of hubco under this Agreement, or where in relation to a matter there is no express obligation or standard imposed on hubco under this Agreement, in accordance with Good Industry Practice."

4.5. Clause12.1 states that "*HubCo shall carry out the Works:*

12.1.1 so as to procure satisfaction of the Authority's Construction Requirements

12.1.2 in accordance with Hubco's Proposals ; and

12.1.3 in accordance with this Agreement.

4.6. It should be noted that the Proposals at this point consist of little more than Building Warrant Submission (RIBA Stage 4, but more accurately the old Stage E) level documents which must set out how the design meets the building regulations but do not fully detail the works. The ACR's are high level outline requirements mostly focussed on operational needs.

4.7. 12.3 states that *"HubCo warrants it has used, and will continue to use, the degree of skill and care in the design of the Facilities that would be reasonably expected of competent professional designer experienced in carrying out design activities of a similar nature, scope and complexity of those*

comprised in the Works."

4.8. 12.5 states that *"The Authority confirms that, as at the date of this Agreement, it has reviewed Hubco's Proposal and subject to any qualifications and/or comments notified by the Authority to Hubco in writing and set out in Table B of Appendix 1 of Schedule Part 7 such proposals satisfy the Authority's requirements in respect of Operational Functionality, so far as can reasonably be determined given the level of detail of Design Data which has been disclosed to the Authority."* Operational Functionality is defined as *"a) the following matters as shown on the 1 :500 scale proposed site plan/ departmental adjacencies drawing:*

i. the points of access to and within the Site and the Facilities; and
ii. the relationship between one or more buildings that comprise the Facilities; and

b) the following matters as shown on the 1 :200 scale:
i. the adjacencies between different departments; and
ii. the adjacencies between rooms within departments.

(c) the quantity, description and areas (in square metres) of those rooms and spaces shown on the Schedules of Accommodation;

(d) the location and relationship of equipment, furniture, fittings and user terminals as shown on the 1 :50 loaded room plans (following development and review through the Reviewable Design Data process) in respect of:

i. all fixed and loose furniture positions; and
ii. location of all small power and lighting etc positions; and
iii. internal room elevations; and
iv. reflected ceiling layouts,

4.9. 12.6 notes that HubCo must complete the design as above (at Financial Close it is not at a point where all design is complete), and then outlines the Reviewable Design Data (RDD) process. Reviewable Design Data, as in many D&B contracts, is managed via an A B C system of reviews and comments. In this case RDD was defined in the contract part 5 Section 5. The items listed relate only to operational aspects – room data sheets and finishes. There is a list called "Outstanding design drawings as identified in Appendix 02A", but this document does not list any technical matters. We understand the Authority may request any information they want in this schedule.

4.10. 12.6.3 states that HubCo will allow the AR to view any Design Data on request.

4.11. Section 13. establishes the AR's rights, and 13.3 sets out the right to inspect, as well as to open up and the apportionment of the cost of this depending on what is found. The mechanism is that if nothing is found then the Authority/employer (Hub) pays – depending on who instructed the opening up; if defective work is found, then the D&B contractor pays.

4.12. 16.16 sets out that the as-built specification must be issued to the Authority as soon as it is available after Practical Completion. This is the only point after Financial Close that HubCo are required to share anything other than the limited RDD data with the Authority.

4.13. Clause 20 deals with Quality Assurance, setting out that HubCo must establish and maintain a Quality Management system for Design and Construction. Quality Management through the design phase and construction is managed through processes set out in the Quality Plans (Design and Construction) – otherwise known as the Quality Management Process (QMP). This is a document developed by GCL and forms part of the contract. Further commentary on the QMP can

be found below.

4.14. 20.10 states that *"hubco shall maintain a quality management system which shall:-*

20.10.1 ensure the effective operation of the quality systems described in this Clause 20 (Quality Assurance);

20.10.2 cause an audit of the quality systems at regular intervals and the findings of such audit will be reported to the Authority's Representative;

20.10.3 require review of all quality systems at intervals agreed with the Authority's Representative to ensure their continued suitability and effectiveness

20.10.4 require liaison with the Authority's Representative on all matters relating to quality management; and

20.10.5 require production of reports and their delivery to hubco."

4.15. 20.11 provides that *"The Authority's Representative may carry out audits of Hubco's quality management system (including all relevant Quality Plans and any quality manuals and procedures) to establish that Hubco is complying with Clauses 20.1 and 20.3."* Further, *"Hubco shall procure that the Authority's Representative shall have an equivalent right in respect of the Contractor's quality management services. Hubco shall co-operate and shall procure that any Sub-Contractor co-operates with the Authority's Representative including providing him with all information and documentation which he reasonably requires in connection with his rights under this Clause."*

The Design & Build Subcontract

4.16. This contract is between Hub SW and GCL as Tier 1 contractor.

4.17. It acts as a pass-through of the obligations of Hub for the design and construction of the works. It is structured almost identically to the DBDA contract.

4.18. The contract sets out the role of hub's Employer's Representative. The powers and functions of this role are similar to those of the Authority Representative in that they can inspect, request opening up, and audit the Quality Plans. The Opening Up clause contains the same mechanism whereby if nothing is found then the Employer (Hub) bears the cost.

4.19. The contract places the same level of design ownership on to Hub as the Authority takes in the DBDA, effectively removing any obligation on Hub to interrogate the technical quality of the design. Hub only confirm that, at Financial Close, that it meets the requirements of Operational Functionality. In simple terms, the only party who confirms the design is correct is the D&B Contractor.

4.20. Interestingly clause 16 sets out that the Authority Representative signs the Practical Completion certificate for the D&B Subcontract, placing significant focus on their opinion of completeness.

The Design Team Appointments

4.21. The design team appointments are in a different structure to the DBDA and D&B Subcontract.

4.22. The Architect's appointment confirms them as the Lead consultant, a role which requires them to coordinate the efforts of the rest of the Design Team and *"generally ensuring that those involved in the Project or the part or parts of the Project for which the Consultant is responsible are all organised and act in a properly co-ordinated and integrated manner."*

4.23. Clause 3.17 of the Architect's appointment states: *"Where the Client* [DGC] *instructs and/or authorises detailed designs and/or specifications to be drawn up by others the Consultant may be required to review such designs and/or specifications but unless specifically agreed between the parties as a term or condition of such instruction/authorisation the Consultant shall not be vicariously liable for any errors, defects and/or deficiencies in such detailed designs and/or specifications. The Consultant shall only be liable in such circumstances for:-*

3.17 .1 failing to exercise the requisite standard of skill and care required by clause 4.1 in checking that the detailed designs and/or specifications satisfy the Client's Design Brief;

3.17.2 failing to exercise the requisite standard of skill and care required by clause 4.1 in checking that the detailed designs and/or specifications are compatible with and are properly co-ordinated and integrated with the designs and specifications for the part or parts of the Project for which the Consultant is responsible; and/or

3.17.3 failing to exercise the requisite standard of skill and care required by clause 4.1 in advising or warning the Client of any errors, defects and/or deficiencies in the detailed designs and/or specifications which were or ought reasonably to have been apparent to a consultant reviewing the designs and specifications from the perspective of satisfying the Client's Design Brief and ensuring compatibility, co-ordination and/or integration of such designs and/or specifications with the designs and specifications for the other elements of the Project and/or the part or parts of the Project for which the Consultant is responsible."

4.24. Clause 4.1 stating: *"The Consultant warrants that it has used, and will continue to use, the degree of skill and care that would reasonably be expected of a competent professional architect experienced in carrying out design activities of a similar nature, scope and complexity to those comprised in the Works in:*

4.1.1 the design of the Facilities; and

4.1.2 the performance of the Services.

4.2 states: *"Without prejudice to clause 4.1, the Consultant further warrants and undertakes to the Client that;*

4.2.1 its final design and all materials and goods specified therein will correspond as to description, quality and condition with the requirements of the Building Contract; and

4.2.2 its final design will at practical completion or its equivalent under the Building Contract, as the case may be, comply with all relevant legislation and ***Good Industry Practice."***

4.25. The design responsibility matrix in the contract confirms the following:

- The Architect is the Design Leader.
- The coordination and setting out of the builderworks in connection lies with the M&E subcontractor, **with input from the Tier 1 contractor, Architect, Structural Civil Engineer and Services Engineer**.

- “Builders work – structurally significant” lies with the Services Engineer. “Builders work – structurally significant details” lies with the M&E Subcontractor. “Builders work – non-structurally significant” lies with the M&E Subcontractor.

- Patrices [sic], noggins etc are the responsibility of the Architect with input from the services engineer.

- Doors and frame as well as sliding folding partitions are the responsibility of the Architect.

- Ironmongery is for the architect to input into, but no-one is marked as responsible.

5. Chronology

5.1. Pre-contract

Event	Date
Outline business cases for DLT published.	December 2013
GCL bid for all 6 Dumfries Learning Town projects to Stage 1	2014
North West Campus Stage 1 Submission	7th August 2015
First issue of NWCC ACRs – version 2.3 issued 15th August 2016. v2 dated 8 August 2016.	18th September 2015
West Campus Stage 1 Approval letter	26th January 2016
First issue of the Quality Management Plan	3rd May 2016
Stage 2 submission – initial issue.	10th June 2016
Project Management Plan (GCL) issued.	23rd August 2016
Financial Close/contract signed	25th August 2016

5.2. Post Contract

Event	Date
NWCC Start on site	19th September 2016
Change of SFTF Senior PM	October 2017
Original completion date	11th June 2018
Sprinkler pipe and ceiling failure in staff room	22nd July 2018
Adjusted completion date once extension of time granted (not achieved)	23rd July 2018
Children start in school	21st August 2018
Sliding door falls from its runner. The school is closed over the weekend and reopened on the 28th of August.	24th August 2018
A Promethean smart screen comes free of its' rise and fall mounting and strikes a child. Following this the Authority close the school to allow investigation and remedial works.	7th September 2018

6. Remit Item 1: Collapse of Services fixed to Staff Room Ceiling

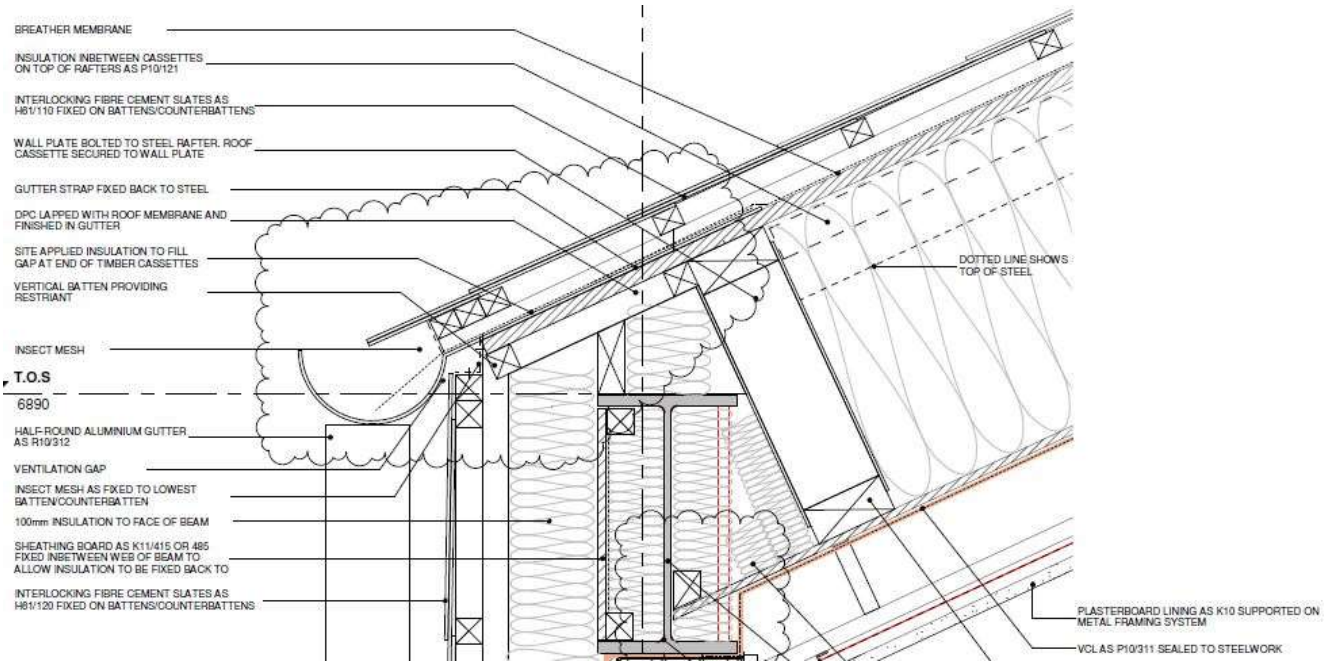
In this section we describe and analyse the broader structures of the delivery and oversight of quality on the project. Many of these issues apply to Remit Items 2 and 3 but we will not repeat them in each case.

Background

6.1. The first-floor ceilings in areas such as the staff room follow the pitched roof above. The roof structure was formed of timber cassettes – pre-fabricated units made of timber "I" beams and 'eco-joist' prefabricated lightweight trusses formed of timber flanges and metal webs. The cassettes span between steel "I" section rafters. The cassettes have a plywood top sheet on which the waterproofing is fixed. On the underside a 9mm OSB 'liner' is fixed to keep the insulation filling the cassette from falling out.

6.2. Beneath this cassette are the ceilings, of which there are essentially two types: metal frame (MF) ceilings with steel 'hangers' fixed to the cassette which in turn hold up 'top-hat' rails to which the plasterboards are fixed; or plasterboard on timber battens.

6.3. Beneath the ceilings are the services, made up of sprinklers, radiant panels (radiators fixed to the ceilings rather than the walls), electrical conduit and lighting distribution and fittings, as well as other cables. Extracts from the contractor's design documents are in the appendices to illustrate the construction, and we include one below for reference.



Extract from Holmes Miller drawing 3462 AA(2)100 Rev A issued 31st October 2016 showing roof section.

Point of Cause

6.4. As identified by GCL incident report Rev C *"the sprinkler pipes had not been directly fixed to the roof structure in accordance with the sub-contractor (COMPCO) sprinkler design and details". "Further inspection of the sprinkler installation confirmed that this was also the case for all areas where there*

was an MF ceiling make-up at first floor level".

6.5. We have no reason, from review of documentation and interviews with other members of the team, to doubt this statement.

6.6. It should be noted that following the "further inspections" by the Authority and others, other incidences of inadequate mounting of mechanical and electrical installations through the ceiling back to structure were discovered. We understand all these incidences have been attended to under a separate exercise and the facility is occupied and functioning. It should be noted that the heating installation will have imposed significantly greater loads on the ceiling than the sprinklers.

6.7. The first 'Why' must be: **why did the mechanical and electrical subcontractors (JBE and Compco) not fix back to structure**?

Subcontractor's own management

6.8. Compco stated that the detail they used on a nearby similar project carried out for the same Authority, with both GCL and JBE, involved threaded steel rod fixed back to the structure. The ceilings were then installed around the rod, leaving it protruding and ready for fixing of the sprinkler pipework and heads. This would satisfy the requirements of their standard detail ensuring pipework was fixed back to structure. Others have confirmed this was the case.

6.9. Compco stated that at NWCC the detail was changed to ply pattressing behind the ceiling installed by others. Compco indicated this was to reduce the number of visits and reduce the time taken to install. GCL refute any suggestion that the design change was made by them.

6.10. Compco stated that all design decisions for fixings were taken by contractors: GCL, JBE or themselves. What is clear is that with no explicit design from the Design Team, the subcontractors decided how to proceed. Commentary on Design Management is made later in the report.

6.11. Compco were employed by JBE, so their immediate oversight was by JBE. Despite repeated requests we have not been able to speak to JBE so questions over their level of oversight, checking and testing cannot be answered. We also cannot ask about the other systems installed by them on the ceilings. During the research phase of this exercise, it was reported to us that JBE had entered administration. This may be why we were unable to interview them.

6.12. CCL interiors, the ceiling subcontractor, also failed to make themselves available for interview.

6.13. The one other subcontractor we did speak to was Fleming Joinery who built and installed the roof cassettes. Their account of the quality control, design management and site management illustrates a high level of focus on quality and coordination on their part and by GCL. It should be noted that the design and installation of the roof cassettes played no part in the failure of the sprinkler installation, and it is important to note that some subcontract works packages were executed correctly.

6.14. It may well be that the sprinkler installation fault lies primarily with Compco. It is reasonable to ask why they departed from their own standard detail. They were informed that the fixing detail had changed yet carried on regardless. Our observations are that no structure was in place to carry the load directly from the sprinklers to the roof cassettes. There was ply pattressing fitted above the plasterboard to provide a fixing for the service installations. But this would not have provided structural support (indeed, it probably made it worse by adding more load to the ceiling) and may have misled Compco to think they were fixing into something more solid than plasterboard. It may

be that other M&E subcontractors were fixing in to the ceilings without issue. It is reasonable to conclude that Compco may have assumed that the ply provided for them to fix to was in turn fixed back to structure, so meeting their standard detail. However, they clearly proceeded.

6.15. It should be noted that other plant, notably radiant panels (radiators at high level) were also fixed to the ceiling and likely placed an even greater load than the sprinklers. Much of the discussion around the failure initially focussed on the sprinklers, but from our observations the same vagueness around builderworks in connection with services and the 'strategy' to transfer the loads to the structure applies to all other ceiling mounted services. As far as we can see, contractually JBE were responsible for all services installations as well as all builderworks in connection. This applies to both design and construction with the exception of "structurally significant" elements, which were the responsibility of the services engineer, who were novated to JBE.

6.16. As we cannot obtain conclusive first-hand evidence of the failings at subcontractor level, we must look at the next level of oversight: GCL.

Main Contractor's Oversight

6.17. GCL employed a team of at least five to manage site activities – a Project Manager, one or more Site Managers, and site engineers. This team was overseen by a Contracts Manager, who in turn was overseen by a Construction Director. We have been told by several sources that GCL's Project Manager did not start on the project until several months after site commencement.

6.18. GCL issued a Quality Plan for Design and Construction at Stage 2 of the Hub development process, (pre-Financial Close). This document was issued on the 3rd May 2016. There are 25 items in the QMP, with one line only for M&E services. GCL have confirmed that this was never updated despite the Stage 2 document lacking sufficient detail to enable it to be used to manage quality.

6.19. There are two types of Quality Plan required by the contract: one for Design and one for Construction. They may be in one document, which was the case at NWCC. The Design Quality Plan would state how the design is to be completed and changes managed.

6.20. The Construction Quality Plan required additional detail being developed to provide a system to check the installation and workmanship of every element specific to the project. As far as we know this was not done. GCL confirmed to us that the QMP was not updated after the initial issue.

6.21. The developed Quality Plan should then inform development and use of Inspection Test Plan (ITP) check sheets to review works and confirm compliance with the completed design.

6.22. We have seen no evidence that quality assurance checks were carried out on the ceiling or services installations by GCL's site management team. A photographic record was taken showing the installation of the roof, ceiling and ceiling mounted services. We have seen some of the photographs taken.

Design Management

6.23. GCL were employed by Hub SW as a Design & Build (D&B) contractor and the form of contract used, the D&B Subcontract, placed with them the responsibility to design the works to meet hub's Employer's Requirements, which were a direct pass-down of the Authority Construction Requirements (ACRs) . GCL therefore employed a Design Team including Architects and Engineers.

6.24. The Authority Construction Requirements (ACRs) were developed alongside the Contractor's Proposals (CPs). ACRs were developed by the Authority and were non-technical end user

requirements setting out the operational needs of the building. The CPs were then market tested (priced competitively by subcontractors) prior to Financial Close. From the Design Team's feedback, and our own analysis, the information at this time was to RIBA Stage E level, so not sufficient to build from.

6.25. The Project then proceeded to Financial Close, during which the works scope was confirmed along with cost and programme. The contract was signed on 25th August 2016.

6.26. To enable the works to be properly constructed and completed in accordance with all relevant legislation and good industry practice it is reasonable to expect that from this point on the works would be fully designed, a process which would run concurrently with the works, but the design of each element concluded before it is executed on site.

6.27. From our review of the documents no explicit, project-specific design was provided to confirm how the services were to connect back to structure when installed on the face of the MF ceiling. As noted above, despite it being a structural element, complicated by the services distribution strategy and the requirement to transfer loads past the MF ceiling system, this was ultimately the responsibility of the M&E subcontractor. A performance specification for the builderworks was provided by the services engineer pre-Financial Close. This provided a baseline for the technical design to be compared against.

6.28. Our understanding is that it would have been simple and straightforward to provide the missing structural supports.

6.29. We understand from interviews that the structural engineer was only responsible for designing builderworks in connection with services for "significant equipment" such as boilers or Air Handling Units (AHUs). This conflicts with the design responsibility matrix (see extract below).

	Element	Participant	Delivery Partner	Cost Consultant	Tier 1 Contractor	Architect	Structural & Civil Engineer	Services Consultant	Principal Designer	BREEAM Co-ordinator	Fire Engineer	Transportation Consultant	Landscape Architect	Acoustician	Environmental Consultant	Build Subcontractor	M&E Subcontractor	Air Leakage Consultant
4.222	Carry out fine tuning and adjustment of the systems for 12 months from practical completion including environmental testing and monitoring.	o															x	
	Production Drawings																	
4.223	Sketch							x										
4.224	Sketch schematic							x										
4.225	Detailed schematic							x										
4.226	Detailed design							x										
4.227	Coordinated working																x	
4.228	Installation																x	
4.229	Manufacturer																x	
4.230	Record																x	
4.231	Builders work - structurally significant							x										
4.232	Builders work - structurally significant details																x	
4.233	Builders work - non structurally significant																x	

Extract from responsibility matrix in Holmes Miller appointment document.

6.30. The technical submission by JBE shows plywood pattressing above the MF ceiling in locations which we believe match the location of service runs. We have seen no drawings showing the detail of the pattressing, thickness of ply, fixing, or any commentary regarding the ability of the ceiling to take these additional loads.

6.31. From our observations the subcontractor design review process had a clear structure and was actively managed by GCL's Design Manager. However, from the audit trail we have seen it appears that the builderworks submission from JBE was only reviewed by the services engineer, and not the structural engineer or architect. If they had reviewed it, they may have noticed that the proposal was incapable of supporting the weight of the services.

6.32. We have reviewed a document from the ceiling manufacturer Knauf dated 2nd August 2018 following an inspection of the installation. The report states: *"THIS SPECIFICATION IS FOR CEILING SELF-WEIGHT ONLY."* The obvious conclusion from this is that the ceiling could never have taken the service loads applied to it. The Knauf report confirms centres of the supports are correct, though we have received testimony that the fixings were not reliably fixed in to the structure in the cassettes with many just fixed to the OSB liner.

6.33. There appears to be no requirement for the Design Team to confirm that the works as executed meet their design, and their site presence was only 'as required' by GCL. From our reviews of GCL's reports, the Design Team were on site regularly.

6.34. The 'Whys' regarding Design Management are therefore as follows:

- Why was there no design of the connection of the ceiling services to structure?
- Why did the subcontractor not question this?
- Why did the main contractor's quality assurance not question this?
- Why did the design team not question this?
- Why did Hub SW not question this?
- Why did the Authority not question this?

6.35. There appears to have been no requirement for design review following Financial Close (other than fairly superficial elements included in RDD), meaning the works move from the old RIBA Stage E Design to construction and hand over with no further Authority or Hub involvement. There is half a sentence in the DBDA contract regarding this: in clause 12.6 it states: ***"Hubco shall develop and finalise the design and specification of the Works*** *and the Authority shall review the Reviewable Design Data in accordance with Schedule Part 7 (Review Procedure) and the provisions of this Clause 12.6:".* The contract does not state how or when this will be done or the controls for concluding that this finalisation of design is correct or acceptable. It could have been that a well - developed QMP would include for finalisation of the design, and if the QMP had then been audited as intended, such a process would have been in place. Sadly this did not happen.

6.36. Points to note in response to the 'Whys' are as follows:

- The Subcontractor reporting lines in to GCL were extended, with Compco reporting to JBE, JBE in to GCL.
- The concept design itself lacks buildability, requiring two trades working side by side with significant coordination to complete it successfully in every instance. This is complicated by JBE being a designer of one element – the builderworks transferring loads from the services (designed by the consulting services engineer), past the ceiling (specified by the Architect) to the roof cassettes (designed by the consulting structural engineer and the roof cassette subcontractor).

- GCL's failure to develop their Quality Plan gave no formal structure for completing design or checking construction.

- Design leadership was confused, with the traditional lead role of the architect as design manager taken by GCL's design managers. This could be seen as contradicting the design responsibility matrix, but design team leadership is different to design leadership, which focusses on driving the concept, rather than coordinating the team. Some builderworks design lay with JBE (services subcontractor) and some with Woolgar Hunter (structural engineer). JBE's incomplete builderworks design appears to have gone completely unnoticed, despite going through a design review.

- According to Compco's verbal evidence (for which we have no documentary back-up), a conscious design change to a system that would never have worked was instructed by GCL and implemented by JBE. Again, design leadership was by GCL, not the design team. The design review cut the architect and structural engineer out of review of this decision. It would be reasonable to expect that a competent designer would not have allowed this to happen.

- Specialist technical resource was lacking at Hub SW and Authority level to enable them to use the powers they have under the contract to interrogate the design and works quality management – this is commented on further below.

Main Contractor Works Quality Monitoring

6.37. No development of GCL's Quality Management Plan led to sporadic application of an Inspection Test Plan (ITP). Given the lack of a plan it is hardly surprising that correct practice did not follow. We made numerous requests to see the ITP for the ceilings and ceiling mounted services but none have been provided beyond a photographic record. We must conclude that none were carried out. This alone is a significant failing by GCL.

6.38. That JBE were in control of a significant portion of the works should have been a risk noted by GCL and managed appropriately. Several interviewees have noted that they were left to run their own works with little control or oversight by GCL. The lack of ITP for the services installations could be seen as evidence to support this dynamic. Any element in isolation of those around it is more likely to lead to lack of control at interfaces – an obvious one being the builderworks supporting JBE's installations. A lack of documentation from the site phase has left these matters difficult to interrogate.

6.39. Some builderworks designs by JBE have been made available to us. As noted above, they set out ply pattressing above the plasterboard for the fixing of various services installations. These documents are incomplete. We cannot confirm exactly what was presented to the Design Team for review. During several interviews we were assured that all Contractor Designed Portions (CDP) and subcontractor developed design information was reviewed by the Design Team. This begs the question as to how deficient design information was allowed to proceed.

6.40. A tangential query is around the services engineer Cundall's novation to JBE. This meant that GCL had no-one at their level able to review design developed by their subcontractor and led to a situation where the subcontractor checked their own proposals.

6.41. We have seen evidence of daily meetings between GCL and their subcontractors, which could be seen to contradict the point above regarding GCL's lack of oversight of JBE. From interviews it seems some efforts were in place to oversee subcontractor works.

6.42. It should be noted that it is not possible to effectively check contractor's work without design documents setting out what is to be built to compare against. As set out above key pieces of design had not been developed. No plan was developed as to how checking would be carried out of the ceilings and M&E as there was no specific ITP. From corroborated interview evidence, the site management team were unable to keep up with the scale and pace of the work being undertaken. We understand that for some parts of the subcontractor team GCL's site management were unable to get the required transparency to properly audit the quality of the works.

6.43. It is evident that GCL were not on top of the quality management of the design and construction of the ceiling mounted services. The subsequent failure of the ceiling in the staff room is a direct result of that.

6.44. It is important to note that the contracts transfer responsibility for correct design and execution of the works from DGC to Hub SW, and then from Hub SW to GCL. GCL are an ISO:9001 qualified organisation. The other parties – Hub SW and DGC – had an overseeing role only. However the intention of the contracts is that the roles of Hub SW and DGC, which are not identical, did have a place in the oversight of the project, as well as powers to do something about issues identified with GCL's performance. The next question must be why did they not pick up the, not insignificant, failings identified above?

Hub SW

6.45. Hub SW describe themselves as acting as the contract administrator in the delivery by the Tier 1 contractor, via Hub, to the Authority. There are two contracts – the DBDA between the Authority (DGC) and Hub, and the D&B Subcontract between Hub and the Tier 1 contractor (GCL). Hub SW are the Employer in the D&B Subcontract.

6.46. The benefits of the Hub system are reported to be many. A key element is that they provide consistency of technical advice to local authorities whose own procurement and technical teams may fluctuate.

6.47. We are informed that Hub SW advised on the initial set-up of the SSF team at DGC. Hub SW then provided resource to assist the Authority's involvement in the design phase prior to financial close, for cost management, and then as Contract Administrator during the works.

6.48. We do not consider Hub SW's involvement prior to financial close material to this exercise, though we have been given a description of their activities with the Authority. Subsequently we do not comment on this phase of the project.

6.49. The detail of their role is set out in the Project Development Partnering Services (PDPS) document issued in 2012 which forms part of the Territory Partnering Agreement to which the DBDA contract is subject. This establishes the role of the Construction Manager, who was Hub SW's main day to day representative after Financial Close and fulfilled the duties of Employer's Representative as set out in the D&B Subcontract.

6.50. Key extracts from the PDPS document relevant to this exercise are as follows:

Design Management (section 11.1)

"During this stage design management controls are implemented to provide effective control of the process and ensure that Project deliverables are achieved. HubCo carefully manages the process which is controlled through the following:

- *A formal RDD process;*
- *A formal change control process;*
- *The role of the Hubco Construction Manager in monitoring progress;*
- *The continuation of the Tier 1 Contractor's Design Manager on site;*
- *Ensure progress with design is reviewed at the monthly progress meetings; and*
- *Continuation of the Consultation and Engagement plan.*
- *A standard suite of controls are monitored by Hubco and include;*
    - *a design finalisation programme;*
    - *a design deliverables schedule;*
    - *an information requirements schedule; and*
    - *Design review sign off sheets (for compliance, quality and health and safety)."*

We have not seen a design finalisation programme. We have not seen design review sign off sheets.

Regarding Quality Control during the works, section 11.4 states the following:

- *"Hubco's Construction Manager and its Tier 1 Contractor ensure that benchmarks are established as each trade starts work. This consists of an area of the works being completed to a specified stage and accepted and signed off as the standard to be achieved for that area of the Works. It is then the responsibility of the Tier 1 Contractor's site manager to monitor the subcontractors operations to ensure compliance with the agreed quality procedures.*
- *Hubco's Construction Manager and its Tier 1 Contractor ensure that during the preparation of Method Statements the quality control activities required to achieve the specified quality are identified.*
- *The Tier 1 Contractor agrees with Hubco's Construction Manager, the Relevant Participant(s) and its subcontractors the procedures by which work is inspected so that any non-conformance with the specification is identified at the earliest possible opportunity. Key subcontractors provide their project specific quality plan(s) for the Tier 1 Contractor's approval. This is reviewed by the PM and other appropriate team members and only approved when it complies with the project quality requirements.*
- *Hubco's Construction Manager and its Tier 1 Contractor ensure that each of the key subcontractors produces a detailed inspection plan for their scope of work."*

The lack of ITP documentation, and the lack of reporting of same, suggests that the HubCo Construction Manager did not carry out the above. If they did their actions were not noticed, or their objections were not acted on.

6.51. From corroborated interview evidence we believe that Hub's role involved checking of quality at a very high, perhaps superficial, level. Monthly reports and meeting minutes reference quality, but

only track non compliances as KPIs, with no commentary on the reason for them or the conclusion of them. From interview evidence it seems these matters were left to be cleared up between the CoWs and GCL, though we have no documents to confirm this.

6.52. The example above regarding threaded rod being used on a nearby project to support the ceiling mounted services is suggestive of a detachment from the technical detail. Two almost identical projects both run by Hub SW (though Hub SW state that there were different ERs) and a significant design change from one to the other, yet no flag appears to have been raised. As this change was allowed to proceed and ultimately failed it is self-evident that Hub SW's oversight was not sufficient to catch this significant contractor shortcoming. Hub SW reject the idea they were detached from the technical detail, and point to opening up which was instructed on other projects in the DLT Phase 1 works.

6.53. From interview evidence given by almost every party, we are led to believe that the ER, being on site less frequently than the DGC team, lost the authority this role needs to be effective. We understand this role was left out of communication loop and that DGC did this from a sense of frustration at the disconnectedness of Hub. We cannot confirm if this was the case, but the importance of the Contract Administrator (in this case the ER) to the successful delivery of any contract is beyond question. If the situation described was allowed to develop, an atmosphere of lack of control would not have helped keep focus on the correct delivery of the project.

6.54. The DBDA required Hub SW to have their own QMP. We have not seen such a document. The DBDA allows the Authority to audit Hub's QMP, but we have seen no evidence this occurred. We have seen no evidence of auditing of GCL's QMP by Hub's ER. The entire project appears to have run without any party noticing the absence of two key quality assurance documents.

6.55. From our analysis of all the evidence provided, Hub's ER was mostly a management function. The role does have an obligation to *"ensure the effective operation of the quality systems"*, but this is not the same as checking quality. Nowhere in the Hub SW Project Development and Partnering Services document or in the D&B Subcontract is Hub expected to review design – this is left to the Tier 1 contractor. This is not unusual in D&B procurement where design responsibility must remain with the D&B contractor. However, in a project of this size and importance it would seem reasonable to have some form of design audit in place for key details which could impact the health and safety of the completed works. With no capacity or requirement for Hub to carry out this role, who was reviewing the D&B contractor's proposals? If the answer is no-one, then in light of the events at NWCC, the questions should be asked as to whether this was correct.

6.56. There was no Independent Tester support to Hub and the Authority as there would be in a DBFM, so there was no mandated technical resource at this level with a contractual role. The Authority Representative and hub's Employer's Representative were left with the technical oversight roles the contract sets out and had to choose how to resource them. We understand that the decision to have no independent technical resource was made by the Authority. We're informed DGC relied upon Hub SW's advice in making this decision, though Hub SW refute this.

6.57. Hub SW relied on their Construction Manager, who was qualified as an Architect, to deliver the oversight roles set out in the contract. It should be noted that the Hub SW Construction Manager role specification does not mandate that this role is fulfilled by someone with a technical consultancy qualification, such as an architect. It should also be noted that despite the qualifications of the individual the failings of GCL occurred anyway.

6.58. The Authority believed their project managers could do a similar job to an Independent Tester, which is curious given the non-technical professional backgrounds of the Project Managers. The Project Manager's Job Description does not mention technical oversight or any of the duties of the

AR. The qualifications of the individuals involved would not qualify them to inspect construction work.

6.59. The Authority note that Hub SW have the contractual responsibility to deliver the design and construction of the works to meet the ACRs and hPs. Hub SW note that GCL have the contractual responsibility to deliver the design and construction of the works to meet the ACRs and CPs. GCL then passed these obligations on again to designers and subcontractors. It must be asked just how much of their responsibilities Hub SW should be able to pass through. Is it right that, as is apparently the case, Hub SW had no responsibility for delivery? It may be that shortcomings at Hub level are due to the common or conflicting beliefs around what each entity in Hub delivery is there to do, rather than errors by individuals.

6.60. The Authority had more power in the contract than Hub SW, and arguably more to lose should things go wrong. The Authority Representative has many of the traditional Contract Administrator powers under the contract. The AR was to sign the Practical Completion for both the DBDA and D&B Subcontract. This seems to be an unsatisfactory arrangement, effectively duplicating the contract administrator's role but without the technical expertise to do so in the Authority team above Clerk of Works level.

The Authority

6.61. The Authority's role in management of quality is to set the Authority Construction Requirements (ACRs), establish the checks and balances, and then provide resource to run those checks and balances which remain with them.

6.62. It should be noted that the procurement route places the responsibility to design and build the works safely, and in compliance with all statutory requirements and to meet the ACRs and hPs with HubCo and subsequently the D&B Contractor.

6.63. The Authority do however have a key role in establishing the framework for delivery, in carrying out the duties of the Authority Representative under the contract, and in agreeing any other quality assurance resources, such as independent technical advisors, inspectors, or Clerks of Works (CoW). As in all construction projects, the ultimate client sets the tone and the standard.

6.64. In the case of the Authority's team for NWCC, there were two Clerks of Works for four projects, four project managers (PMs, one dedicated to each project), a senior project manager (sometimes two) and the named Authority Representative (AR) under the contract, who was senior to the Senior Project Managers (SPM). It should be noted that employing Clerks of Works is not mandated by the DBDA standard template contract, though there are technical oversight duties for the Authority which would have to be resourced somehow.

6.65. We understand that satisfying Quality Management as far as the Authority's role went was to be carried out by the CoWs as observers only, with the PMs, SPMs and AR executing the duties of the Authority Representative. The named AR delegated some of their powers to the SPMs and PMs. As noted above, the SPMs and PMs we have spoken to were not qualified to provide technical quality oversight of construction works. This left the CoWs as the only technical members of the team outside of GCL's control and so theirs was the only role qualified to identify incorrect construction on behalf of the Authority.

6.66. Under the contract the AR has powers to check the quality of works, including opening-up and audit of quality management plans and procedures. It should be noted that opening up which does not find defective work has potential cost and programme implications for the Authority.

6.67. We understand that recruitment of CoWs was difficult for many reasons. We're informed that the remuneration was low for such a significant role in the delivery of this project. That they were responsible for four projects, spending up to two days a week at NWCC, is surprising when traditionally a CoW on a project of this scale would be expected to be on site full time.

6.68. Without completed design documents to check against (as noted above), the CoWs could not carry out a key part of their role – namely checking works against the design. From what we have seen of their reports, they were left making observations regarding workmanship against their own understanding of best practice. Access to documents was via Viewpoint 4 Projects and Observations, Non-conformance Records (NCRs) and snags were tracked using BIM Field. The CoWs noted they did not have reliable access to these systems and so their observations were direct to GCL and relied on them to upload and manage.

6.69. The CoW's themselves state their role had no impact and they had no authority. They believed they could not order opening up, so were clearly unaware that their project manager colleagues were authorised to do so. Their reports were not sent to their colleagues, the PMs who had AR powers, though they were uploaded to a shared server. This is despite the Organogram for the DGC team showing them reporting into the SPM. They did send their reports to GCL who had no contractual obligation to act on them and copied in the Hub ER. Considering the CoWs were the only technical members of the DGC team, this key level of oversight was denuded of its impact.

6.70. Traditionally the Clerk of Works has a "disapproving role" only and, in a traditional contract is paid by the Employer but works under the direction of the Architect/Contract Administrator. In this case the overlap of the contract administrator role between the Authority and the Hub ER, and the confused reporting lines, meant that no-one with technical expertise was giving direction to the Clerk of Works or reviewing their reports. From our observations no-one seemed to drive through action on the back of the issues they raised.

6.71. The Project Managers were tasked with the implementation of the AR's powers for technical oversight as well as the managerial roles for which they are qualified. We question whether Project Managers with no technical or design background (as opposed to Architects, Engineers or Building Surveyors) are appropriate to carry out this role on their own. From interviews it was unclear whether the PM's role of technical oversight had been communicated. Delivery of AR duties is not mentioned in the Role Description for the PMs that we have reviewed. There was no Authority Project Execution Plan setting out how they would use their powers.

6.72. We have no evidence of the AR powers to audit the quality management process of Hub SW and GCL being used. If they were, it is inconceivable that the issues we have noted around lack of ITP documents and the lack of structural fixings through the ceilings would have occurred. Whether the PMs knew their full powers or understood their role is unclear.

6.73. In respect of the three defects we reviewed, the Authority's technical oversight of the works did not use the powers available to them under the contract. To have failed to use them, and to have allowed a disconnect between the technically qualified CoWs and those with the power to act on their observations (the PMs), meant then this key level of quality review outside the Tier 1 contractor was ineffective. We note that during the period that all three defects occurred the NWCC was at all times under the control of Hub SW and GCL under the "Construction Phase" as defined in the DBDA contract.

7. Remit Item 2: Sliding Door

Point of Cause

7.1. Whilst under Beneficial Access, a sliding door, used to conceal coats and bags on the ground floor, came off its track and fell. GCL's incident report states that "It was... concluded that the stop channels / buffers were either not installed, or not installed appropriately, to stop the door in its operation."

7.2. As noted above, GCL did not run their Quality Plan as intended. No documents regarding the Quality checking of the installation of the door have been provided.

7.3. We have been informed that the top rail stopper was never installed and that a bolt or similar was used. We do not have sufficient information to corroborate either claim.

7.4. The responsibility matrix in the Architect's appointment has them giving 'input' to the ironmongery specification but lists no-one as having 'Primary Responsibility'. The design information we have demonstrates that the Architect specified the doors and the opening, but not the ironmongery. We have seen the ironmongery schedule from the supplier which was lodged as a subcontractor design proposal. We have seen the audit trail of the ironmongery through GCL's own design review process and individual components are scheduled. The submission was given approval. From this we conclude that the ironmongery was never 'designed' as such, but the design team did review and approve it.

7.5. Our own observations are that the system specified has three stoppers – top rail, bottom rail and in the middle of the door leading edge. The system is rated for doors up to 180kg. In the design documents the door is stated as weighing around 160kg. The middle stopper indicated on the supplier's data sheets for the system was omitted from the ironmongery schedule, leaving the stopper on the top rail to stop the door. When we spoke to the manufacturer, they stated that stoppers may be omitted, though they do not advise it.

7.6. The sliding door arrangement has two doors whose rails overlap slightly in the middle of the opening. There is no jamb at this point, so nothing for the leading edges of the doors to stop against. This leaves the stoppers in the top rails to arrest the movement of what are heavy doors. A reasonable conclusion is that the top stopper was not sufficient to stop the door on its own and so failed.

Analysis of Causes

7.7. The door did not stop when it came to the end of the rail. Why?

7.8. The mechanism to stop it was insufficient to resist the force. Why?

7.9. The system was either:

A) incorrectly installed.

B) incorrectly specified, or

C) the product failed – in which case this should be put down as an unfortunate accident.

7.10. For A), why did GCL Quality system not catch this? Because it was not fully in operation. Further analysis of this point is the same as that in the previous section regarding the GCL QMP system,

design team oversight, Hub SW oversight and Authority oversight.

7.11. For B), why was it incorrectly specified? That there was no structure for the doors to stop against in the middle of the run was the responsibility of the Architect. It may be possible for ironmongery to halt the doors at this point, but the system chosen is highly unlikely to achieve this. As stated in the manufacturer's literature *"independent door stops must be fitted to act against the edge of the door(s) and not against any fitment, unless the fitment has been specifically designed for the purpose... The ideal position for a door stop is at midheight of the door, for doors up to approximately 4m high. Taller doors and heavy bottom rolling installations should have door stops fitted at top and bottom of door."* With no jamb, there is nothing for a stop to act on. Why was the interaction of the walls and doors and ironmongery not understood?

7.12. By the Design Team only reviewing the ironmongery they have not taken ownership of this element, and so the ironmongery supplier acted as designer. This was not a formally designated CDP element. The ironmongery does not function in isolation – it must interact with the door, the frame and in this case the floor and soffit of the opening. It is for this reason the Architect would usually "own" the specification.

7.13. A D&B procurement route removes the Design Team from the heart of the project, making the contactor the designer and risking the Design Team losing ownership. The commercial imperative may drive the selection of components without checking by the designers. The contractual responsibility for the design sits with the contractor but may not be fully passed to the Design Team in the same way it is passed from Hub to the contractor. By passing the design responsibility piecemeal to the Design Team gaps may appear, leading to contractor selections not being fully checked. This may not be the root cause in this instance, but it is a notable risk of this form of procurement and checks should be in place to ensure it does not happen.

7.14. This issue raises the question of design ownership, and of the closeness of the Design Team to the works. Although this is a Design and Build contract, there is still an obligation to correctly design the works including full design of key junctions. Full development and explicit design of the ironmongery, (as with the builderworks supporting the ceiling mounted services), was absent. It appears there was insufficient clarity regarding the ownership of design within GCL's team. This is an example of a grey area around Contractor Designed Portions (CDPs) whereby no formal transfer of design responsibility was established, but the contractor/supplier proposals are not adopted by the Design Team, leaving a gap in responsibility.

7.15. It is worth noting the Architect's role here as Design Leader, but not as Design Manager. The Design Manager was a Tier 1 contractor role, leaving someone with no design role to determine the routes for design information within the consultant designer and subcontractor design teams. On the whole this management seems to have worked but in the case of the sliding door and the ceiling mounted services this coordination allowed incorrect design development to occur, leading to Remit Items 1 and 2.

8. Remit Item 3: Promethean Screen

Point of Cause

8.1. Following granting of Beneficial Access and the NWCC starting to function, a Promethean smart screen on a rise and fall mechanism became loose and struck a 4-year-old child.

8.2. Due to the many parties involved, the presence of the end user and other associated groups, there is inevitable contradiction in the first-hand accounts of what happened.

8.3. The most common candidate for the failure is the lack of the 'anti-theft' bolts in the frame, although this is contested by the manufacturer and supplier. The supplier and installer was AVMI, whose report suggests that the frame had been tampered with following installation. Other statements suggest that there was a lack of training of staff, or that a child should not have been allowed to operate the rise and fall mechanism.

8.4. Due to the lack of corroboration around the Point of Cause we cannot determine the root cause.

Causal Factors

8.5. Having reviewed the reports from GCL and the specialist subcontractor we understand the following to be Causal Factors:

- The screens were chosen by the Authority in liaison with AVMI. Any discussion on fitness for purpose therefore lies with the Authority and AVMI, not the Tier 1 contractor. AVMI note that they no-longer specify this type of screen for use in this situation.

- The installation was carried out by AVMI as a subcontractor of GCL. Any workmanship issues or quality control issues around installation therefore lie with GCL and any commentary regarding their oversight would echo that made above regarding lack of QMP and ITP.

- Any alteration of the units which may have led to the frame malfunctioning may lie with GCL carrying out works post-handover, or with DGC staff should any maintenance or adjustment been carried out.

- We understand that training of the teaching staff was not carried out prior to giving possession due to the rushed nature of the handover. If staff were not trained in how to use the rise and fall mechanism, it is reasonable that incorrect use followed. Following this reasoning does beg the question as to why any installation in a school accessible to children should be capable of failing in an unsafe way when in normal use.

9. Conclusions

9.1. Graham Construction Limited (GCL) did not issue key details to ensure the correct fixing back to structure of the ceiling mounted services. Although the sprinkler contractor provided generic fixing details these were not sufficient to build from. GCL should have issued documents indicating the details fixing back the services to the structure. From all our enquiries it appears they did not do so.

9.2. This led to the subcontractors having no defined way of correctly executing the works and nothing for those auditing the works to compare against. Regardless how, this void of design information allowed a design decision to be made by the contractors, leading to an installation which ultimately failed. This is, as far as we can tell, the root cause of the ceiling failure.

9.3. GCL's Quality Management Plan was not developed after financial close as is required by the contract. Hub SW did not have a Quality Plan. Neither the AR nor Hub's ER audited the entity below them, so no-one noticed the lack of these documents.

9.4. The contractor's quality assurance and IT systems were difficult to access, making interrogation of their quality management system very difficult. This clearly would have impacted on those who were tasked with auditing it, and arguably even their own team in delivering it.

9.5. As is typical in much Design and Build procurement the Design Team had only a limited independent professional role. The risk of Design and Build is that the design team can be dislocated from the project and do not fully take ownership of the design. In the matter of the ceiling mounted services this may have been the case here. In the case of the sliding door it almost certainly was the case, since the ironmongery proposal must not have been considered in the overall functioning of the door.

9.6. The Design Team have no obligation to sign off that works are in accordance with their design, so a critical check present in other forms of procurement is missing; if they did have to sign off on the works, they would be less likely to become distant from the delivery of their design.

9.7. Hub SW did not interrogate GCL's quality control, despite having the contractual powers and an obligation to do so. Despite quality being on the agenda at every Progress Meeting Hub's ER did not interrogate to check actual delivery of quality of the ceilings and service connections. The distinction between running a quality management system and delivering quality is key. Responsibility for delivering quality cannot be passed on, yet the overriding impression is that each level thought it had done so.

9.8. The Authority set up a team structure that could not make best use of their powers under the contract where quality oversight is concerned. The only technical role in the system (across both Hub SW and DGC) for overseeing GCL were the Clerks of Works. A higher level of input by them would have been needed to catch these defects. The lack of transparency of GCL's process, and the incomplete nature of the design, meant that the Clerks of Works were restricted in their ability to do their job. We do not consider that the Clerk of Works' reporting lines were set out with sufficient clarity. The Clerk of Works issued reports to GCL/Hub SW and not the Project Managers who as the Authority Representative had the power to act on their observations. Tracking of their observations was by GCL, rather than the Authority.

9.9. Within the procurement process the design documentation was only available for inspection when the contract was signed (at Financial Close). At this point not all the details were completed. Further work remained to be done to develop the design to a point where it could be built from. Following Financial Close no further review was undertaken by anyone outside the contractor's team as none was mandated. No tracking of changes which might impact on the design quality were mandated

from this point until completion.

9.10. This meant that the design proposals were not sufficiently developed at Financial Close to present a comprehensive baseline for comparison against during the works, and no more detailed design was to be passed to those outside Graham's team after this. Although we understand the commercial reasons for the contractor being able to determine their own way of executing the works, this makes quality checking – e.g. of key details like builderworks in connection with ceiling mounted services, or the sliding door fixings – very difficult. It was left to the contractor to satisfy themselves as to their robustness.

9.11. It is not clear if anyone with the appropriate technical skills was championing quality at Hub SW or Authority level. The distinction between technical qualifications giving the ability to oversee the technical execution of works, and management functions within construction must be understood. The role specifications for the Hub ER and the Authority PMs do not mention the oversight of quality, so it is not surprising they did not consider doing so to be part of their job.

9.12. If the ceiling had failed at a different time it could have caused serious injury or worse. However, it is worth noting that the contractual intent of the procurement route, from the Authority's perspective, has worked. The cost liability has remained with Hub SW and the Tier 1 contractor. That said, in common with the conclusions of other similar reports, what remains with the Authority is the legal obligation for health and safety and the disruption of their new facilities not being available.

9.13. When it comes to critical elements which impact the health and safety of users we do not consider that a sufficient process was in place to assure the quality of the work. In such matters the contractor should not be left to mark his own homework.

9.14. These conclusions must all be considered against an industry-wide backdrop of reducing construction training, skills, resourcing, and funding impacting the prioritisation, execution, and delivery of quality.

10. Recommendations

None of these recommendations should be implemented in such a way to as to reduce the liability of the Design & Build contractor or to increase that of the Authority/Employer.

1. The Tier 1 project team should fully design the support systems for significant items and must be seen to do so by the Authority before each package is built. This will require design work after Financial Close, and so a plan must be in place to manage this. There must be a design to check against for those who have the powers to do so. No work element should proceed until its design is complete.

2. All the design drawings should be available to the Authority's quality oversight team in a readily manageable form.

3. The Contractor must develop their Quality Plans for Design and Construction as required in the D&B Subcontract. The Contractor's Quality Management Plan should be audited by Hub's Employers Representative. HubCo's Quality Management Plan should be audited by the Authority Representative. These powers exist in the contracts and should be properly exercised.

4. We believe Design Teams should confirm that the works accord with their design as they progress and at completion.

5. All design should be either the responsibility of the Design Team or formally designated as a Contractor Designed Portion. All contractor design must be approved by the relevant members of the Design Team.

6. The Tier 1 contractor, designers and subcontractors should sign off the project at key points before proceeding. For example: completion of substructure; wind and weathertight; close-up of ceilings and walls; completion of second fix. The Hub Employer's Representative should have a role in this.

7. Someone outside of the Tier 1 contractor's team must champion quality. The responsibility for delivery of quality, as opposed to merely running processes, should more clearly be placed with Hub's Employer's Representative.

8. Hub's Employer's Representative and Authority Representative need to have sufficient level of expertise and capacity so that when they come to exercise their powers under the contract, they are suitably skilled and able to utilise them.

9. It should be made clear who is to lead the Authority's on-site quality team, e.g. the Clerks of Works. Reporting lines should be established at the out-set. Technical roles to enable the ER and AR to exercise their contractual roles for technical oversight should be funded and resourced appropriately. The Authority must have a documented plan for exercising their powers under the contract.

10. Quality KPIs must be much more focussed on factors which affect the health and safety of the finished works. Performance against quality KPIs should be interrogated. Non-conformances must be closed out by those who raised them.

11. Authority Clerks of Works should have formal roles within the project. Their relationship to Hub's Employer's Representative and Authority Representative must be formalised and all members of the Authority team must have an understanding of how this is to work to oversee quality. If they are to be the sole technical resource on the Authority team, this should be clear. Ultimately, they should feed in to the decision to sign Practical Completion.

Appendix A – Accepted Scope of this Exercise

Introduction

This methodology has been established to set out the steps proposed to enact a Root Cause Analysis into construction quality failures regarding the work at North West Community Campus in Dumfries.

We are informed that as the building was nearing operation the staff room ceiling collapsed, leading to investigation of the fixing of all ceilings and ceiling void services and subsequent remedial works. This was followed by a door becoming detached and hitting a pupil. The school was closed, and all doors were taken off and re-fixed. Following this a display screen fell from its bracket, injuring a child. At this point the facility was closed and a full review carried out. Further issues have since been identified of varying levels of significance.

Scottish Futures Trust now require a Root Cause Analysis of the issues which have occurred and to establish the lessons arising from them.

Outline Methodology

Root Cause Analysis stems from the Toyota Production System (TPS) and has been further developed by Lean and SixSigma thinking. There are many variants, though all share several fundamental steps:

1. Definition of the problem. This must involve clarification of the problem to get to the area, or “Point of Cause” (POC).
2. Gather data and evidence, classifying it along a timeline of events to the final failure or crisis. For every behaviour, condition, action and inaction, specify in the "timeline" what should have been done when it differs from what was done.
3. Ask "why" and identify the causes associated with each sequential step towards the defined problem or event. "Why" is taken to mean "What were the factors that directly resulted in the effect?"
4. Classify causes into two categories: causal factors that relate to an event in the sequence; and root causes that interrupted that step of the sequence chain when eliminated.
5. Identify all other harmful factors that have equal or better claim to be called "root causes". If there are multiple root causes, which is often the case, reveal those clearly for later optimum selection.
6. Identify corrective action(s) that will, with certainty, prevent recurrence of each harmful effect and related outcomes or factors. Check that each corrective action would, if implemented before the event, have reduced or prevented specific harmful effects.

Further steps would then typically focus on implementation of the solutions and monitoring to confirm that the root causes are being attended to. This final step is outside the scope of our exercise.

GLM have implemented much of the TPS philosophy in the running of the company and are therefore conversant in the method of working and continuous improvement through rigorous analysis of performance. It is this approach we will employ in the North West Community Campus exercise.

Detailed Methodology

GLM’s team will be comprised of Ian McKee, Aythan Lewes and Liam Ireland. CVs for the team are included elsewhere. Ian will lead the team while Aythan and Liam will manage data collection and report drafting.

1. Definition of the Problem

Initial briefing, determining Terms of Reference for the exercise, and common definitions will be essential to a successful conclusion. Our position as independent from the project team is intrinsic to the value we bring and will require an initial period of familiarisation with the project members, processes, history and systems. We would start with a briefing session with the client and end user team at which the background to the issue will be outlined, and the background explained. During this session key sources of information, key personnel, constraints and opportunities will be explored.

A written detailed brief for the exercise will be issued following this meeting, along with outline timelines for the process. It should be noted we will be dependent on other parties, but we will notify of any potential deviations from the timeline as we proceed.

2. Data gathering

From the briefing meeting we will then proceed to gather all data about the issues raised. We expect this to consist of three main sources:

- A survey of the building, seeing the installation and areas affected first hand. As Building Surveyors we are used to being 'hands-on' with the issue in question and would expect to be able to inspect the installations ourselves.
- Review of documents. We expect to be given access to all documents material to the issues and anticipate that the Common Data Environment used for the project would be accessible. We will also need access to all documents produced as a result of the defects and any interim investigations, remedial measures and other external reviews. During the document review a Request For Information (RFI) Register will be established, which will list any documents noted as missing from the record that are required for us to complete our exercise.
- Interviews with key personnel. Despite the ability for enormous amounts of data generated during modern projects to be recorded, there will inevitably be parts of the background which the people involved have that's not written down. Further interrogation of the issues may also be required.

The RFI schedule will be expanded to include all queries raised with the various stakeholders and responses tracked.

Research will be required, such as speaking to industry experts, product suppliers and manufacturers. We will work with these external sources as required in this phase of the exercise.

3. Analysis

A schedule of defects will be established, and their source, impact and type identified.

A network diagram review will be carried out regarding those processes and activities relating to the defects. We will check the activities carried out against the process set out by the project team. Where no process was documented by the team prior to starting work we will establish the network diagram for the process which was implemented. We will then carry out analysis of any gaps to establish any differences between what should have happened and what then did happen. It may be necessary to go to other Public Procurement exercises to establish best practice.

A timeline of events leading to the defects will be established. This will be baselined against the network diagrams for the relevant processes, showing when each step occurred. This timeline will be driven by the document review and the interviews.

Following the basis of Root Cause Analysis in TPS, the fundamental review of issues raised will be carried out initially using the 5 Whys process to identify causes and check back through the network diagrams to

identify contributing factors. These causes will then be classified as either causal or root causes. From these root causes lessons will be drawn as to what led to the failures and what changes may address these causes.

An inherent challenge in this exercise is that by following the 5 Whys may take us into contractual or governance issues beyond the immediate project and technical failures. It is for this reason that establishing the Terms of Reference at the outset is so important.

4. Reporting

We expect with an exercise of this type a draft report presented to the client for review prior to issue of final report will be necessary. We intend to present in person to the client team, following which the report will be amended with any agreed alterations and issued as a final version to the client.

As the focus is of the exercise is to identify lessons learnt, it will then be key to hold a Lessons Learnt exercise. We do not expect to lead this as our involvement in the project will encompass only two months, whereas the wider team's broader involvement makes their input essential to conclude the review of what went wrong and what changes should be enacted in response. We have included for attending a Lessons Learnt session to present the findings of our exercise which can then be discussed with the team to feed into the wider exercise.

The draft report will be issued electronically, while the final report will be issued electronically and in two bound hardcopy versions to the client.

5. Outcome

Throughout this process a dialogue with the client, end user and HubSW team will be required. We expect that there will be one point of contact identified in both client and Hub teams and that further liaison by us will not be required.

The SFT have asked that this exercise address two questions regarding the defects:

1. Why did they occur?
2. What lessons can be learned for future projects.

The root cause analysis will answer the "Why".

The lessons learned will be identified in our exercise and presented at the final meeting. To take this on and gain value from the exercise the HubSW team must then take these lessons, identify changes to the systems and processes required to attend to the points raised and then monitor

Appendix B – Request for Information Register

GLM Chartered Building Surveyors. Architects. Project and Construction Managers. Tel: 0131 225 4235 Email: enquiries@weareglm.com

REQUEST FOR INFORMATION SCHEDULE

03 May 2019

Project: E3352 - North West Community Campus
To: SFT/HubSW/Dumfries & Galloway PAS
From: GLM

URGENT	1
REQUIRED	2
COMPLETE	3

ITEM NO.	DESCRIPTION	DATE RE - QUESTED	DATE RE-QUIRED	REQUEST STATUS	PROVIDER	DATE RECEIVED	COMMENTS
1	Project Execution Plan	15/11/2018	23/11/2018	3	HubSW	21/11/18	Dated 29/06/2016. Initial issue for Construction Phase. Is there one for Pre-contract phase?
2	Project organogram	15/11/2018	23/11/2018	3	HubSW	21/11/18	Includes Client, Hub and GCL team.
3	Project directory	15/11/2018	23/11/2018	3	HubSW	21/11/18	Includes Client, Hub and GCL team.
4	Stage 2 document set - all documents which established the project at Financial Close.	15/11/2018	23/11/2018	3	HubSW	21/11/18	Require confirmation that all documents have been sent. Is there a master schedule?
5	Contractor's Quality Management Plans for Design and construction - last issue	15/11/2018	23/11/2018	1	GCL		
6	Contractor's Quality Assurance documentation from the site phase. Limited information held on site.	15/11/2018	23/11/2018	1	GCL		No documents relating to the ceiling mounted services on the first floor.
7	HubSW completion checklist as referenced in our meeting.	15/11/2018	23/11/2018	3	HubSW	12/12/18	
8	Scope of Services for the Clerks of Works.	15/11/2018	23/11/2018	3	DGC	21/11/18	
9	Clerk of Works reports	15/11/2018	23/11/2018	3	DGC	14/01/19	
10	Design documents relating to the roof deck.	15/11/2018	23/11/2018	3	GCL	21/11/18	Contractor Proposals received. Issued For Construction set received. Specialist sub as builts required.
11	Design documents relating to the ceilings.	15/11/2018	23/11/2018	3	GCL	21/11/18	Contractor Proposals received. Issued For Construction set recieved. Specialist sub as builts required.
12	Design documents relating to all ceiling mounted mechanical services, particularly fixings.	15/11/2018	23/11/2018	3	GCL	21/11/18	Contractor Proposals received. Issued For Construction set required. Specialist sub as builts required.
13	Design documents relating to the sliding door which came off its runner.	15/11/2018	23/11/2018	3	GCL	16/04/19	Manufacturer's information within Incident Report. Ironmongery subcontractor submission issued.
14	Design documents relating to the Promethean screen and fixings.	15/11/2018	23/11/2018	3	GCL		Some documents present on 4P but not project specific.
15	Design documents relating to all patricing/grounds in plasterboard walls.	15/11/2018	23/11/2018	3	GCL	05/12/18	Confirmation via O&Ms as to what was built required.
16	Graham's incident report in to the sprinkler failure.	15/11/2018	23/11/2018	3	GCL	08/01/19	
17	Grahams' incident report in to the sliding door failure.	15/11/2018	23/11/2018	3	GCL	08/01/19	
18	Graham's incident report in to the Promethean screen failure.	15/11/2018	23/11/2018	3	GCL	08/01/19	
19	Building Control Completion Certificate.	15/11/2018	23/11/2018	3	HubSW	16/01/19	
20	Design Team meeting minutes between Financial Close and start on site.	15/11/2018	23/11/2018	3	GCL	17/01/19	
21	Design team inspection records throughout the site phase relating to the ceilings, sliding doors, and Promethean Screen installation.	15/11/2018	23/11/2018	3	GCL	13/12/18	
22	Supplemental agreement put in place in July.	15/11/2018	23/11/2018	3	HubSW	05/12/18	
23	Progress reports and minutes of project meetings from December 2017 to July 2018.	15/11/2018	23/11/2018	3	HubSW	05/12/18	
24	Graham team directory, including subcontractors.	15/11/2018	23/11/2018	1	GCL		
25	Graham team organogram.	15/11/2018	23/11/2018	3	GCL	08/01/19	
26	Contracts for Dalbeattie project for comparison purposes.	15/11/2018	23/11/2018	3	HubSW	05/12/18	
27	Roles and responsibilities matrix, if not present in the above.	15/11/2018	23/11/2018	1	HubSW		
28	As-built document set including ceilings, partition walls, roof deck, sliding door running gear, Promethean Screen and mounting.	15/11/2018	23/11/2018	3	GCL		
29	Complete RDD tracker for the project.	15/11/2018	23/11/2018	3	HubSW	05/12/18	
30	Contractor's digital QA records on BIM360 or Viewpoint or similar.	15/11/2018	23/11/2018	1	GCL		BIM field access provided. No QA records present.
31	Initial SER Certificate	27/11/2018	04/12/2018	3	GCL	08/12/19	
32	PEP for pre-construction phase	27/11/2018	04/12/2018	3	HubSW	05/12/18	
33	Specialist subcontractor approved proposals for the roof deck cassettes.	27/11/2018	04/12/2018	3	GCL	05/12/18	Not clear that these documents are approved, but present on Graham's Viewpoint.
~~34~~	~~Access to Buzzsaw~~	~~27/11/2018~~	~~04/12/2018~~	~~3~~	GCL		~~Was not used on the project.~~
35	Technical Action Tracker completed through the project.	27/11/2018	04/12/2018	3	HubSW	05/12/18	
36	Project Management Plan as referred to in Graham Quality Plan (design and Construction) CI14-PQP-01	27/11/2018	04/12/2018	3	GCL		Does not exist.

GLM Chartered Building Surveyors. Architects. Project and Construction Managers. Tel: 0131 225 4235 Email: enquiries@weareglm.com

REQUEST FOR INFORMATION SCHEDULE

03 May 2019

Project: E3352 - North West Community Campus
To: SFT/HubSW/Dumfries & Galloway PAS
From: GLM

URGENT	1
REQUIRED	2
COMPLETE	3

ITEM NO.	DESCRIPTION	DATE RE - QUESTED	DATE RE-QUIRED	REQUEST STATUS	PROVIDER	DATE RECEIVED	COMMENTS
37	Completed Inspection and Test Schedule - template in Graham Quality Plan (design and Construction) CI14-PQP-01	27/11/2018	04/12/2018	1	GCL		
38	Specialist Subcontractor as-built for roof cassettes.	27/11/2018	04/12/2018	1	GCL		
39	Specialist Subcontractor as-built for ceiling linings.	27/11/2018	04/12/2018	1	GCL		
40	Specialist Subcontractor as-built for ceiling mounted services.	27/11/2018	04/12/2018	1	GCL		Sprinkler BWICs present. Others not present.
41	Approved RCPs and RDD status A.	17/12/2018	24/12/2018	1	GCL		
~~42~~	~~D&G Project Control documents - PEP, Org Chart etc~~	~~10/01/2019~~	~~17/01/2019~~	~~3~~	~~DGC~~		~~Does not exist~~
43	Daily meeting minutes from Graeme Mitchell.	25/01/2019	01/02/2019	3	GCL	19/03/19	
44	Photos of sliding door failure.	25/01/2019	01/02/2019	3	GCL	08/04/19	
45	Reports of pull-tests for ceiling into OSB	25/01/2019	01/02/2019	2	GCL		
46	Photographs from Graeme Mitchell of the first floor ceiling and services being installed.	25/01/2019	01/02/2019	3	GCL	14/02/19	
47	CM job role specification	28/04/2019	12/05/2019	3	HubSW	19/04/19	
48	Builderworks subcontractor design submission and audit trail.	15/04/2019	29/04/2019	3	GCL	16/04/19	
49	Roof Cassette subcontractor design submission and audit trail.	15/04/2019	29/04/2019	3	GCL	16/04/19	
50	Ironmongery subcontractor design submission and audit trail.	15/04/2019	29/04/2019	3	GCL	16/04/19	
51	Authority incident reports for the Sliding Screen and Promethean Board failure	03/04/2019	17/04/2019	3	DGC	10/04/19	
52	HSE report for the Promethean Screen incident	03/04/2019	17/04/2019	3	DGC	10/04/19	
53	Matrix/scheme of delegation which defines the levels of authority for various decisions and processes within the Council delivery team	03/04/2019	17/04/2019	3	DGC	10/04/19	
54	hubSW method statements	03/04/2019	17/04/2019	3	HubSW	05/04/19	

Appendix C – List of Interviewees

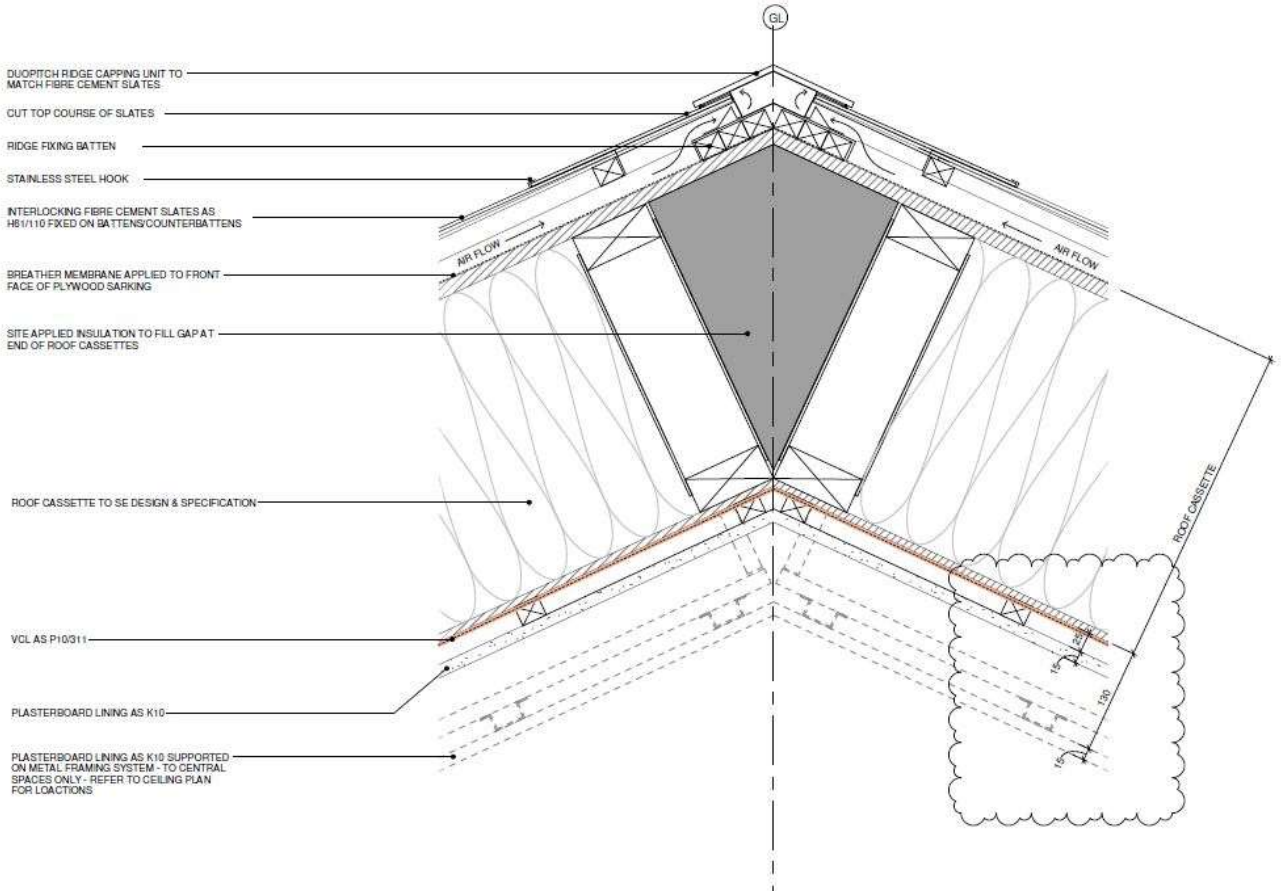
List of Interviewees

Interviewees listed by role only

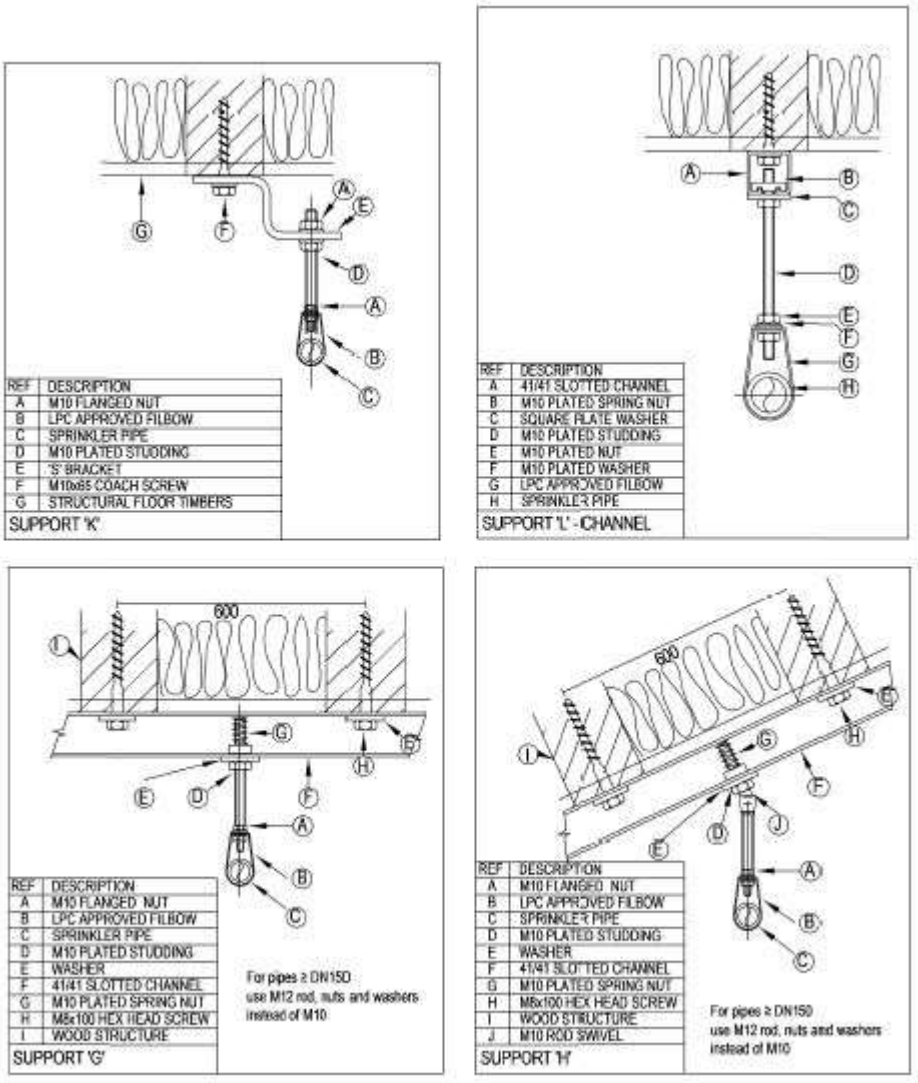
Role	Date of Interview
Hub SW Chief Executive and Project Director	07/11/2018
GCL Commercial Director	09/11/2018
Property and Architectural Services Manager	12/11/2018
DGC Senior Project Manager 1 & Project Manager	28/11/2018
Hub SW Construction Manager	30/11/2018
GCL Design Manager and Design Team (Architect, Structural and Civil Engineer, Services Engineer)	04/12/2018
Hub SW Territory Programme Director	09/01/2019
Roof cassette specialist subcontractor	17/01/2019
GCL Project Manager and Site Manager	23/01/2019
DGC Clerks of Works	05/03/2019
DGC Senior Responsible Officer	05/03/2019
DGC (Authority Representative)	12/03/2019
DGC Senior Project Manager 2	27/03/2019
GCL Contracts Manager & Contract Planner	09/04/2019

Follow-up phone calls held on an ad-hoc basis

Appendix D – Illustrative Images

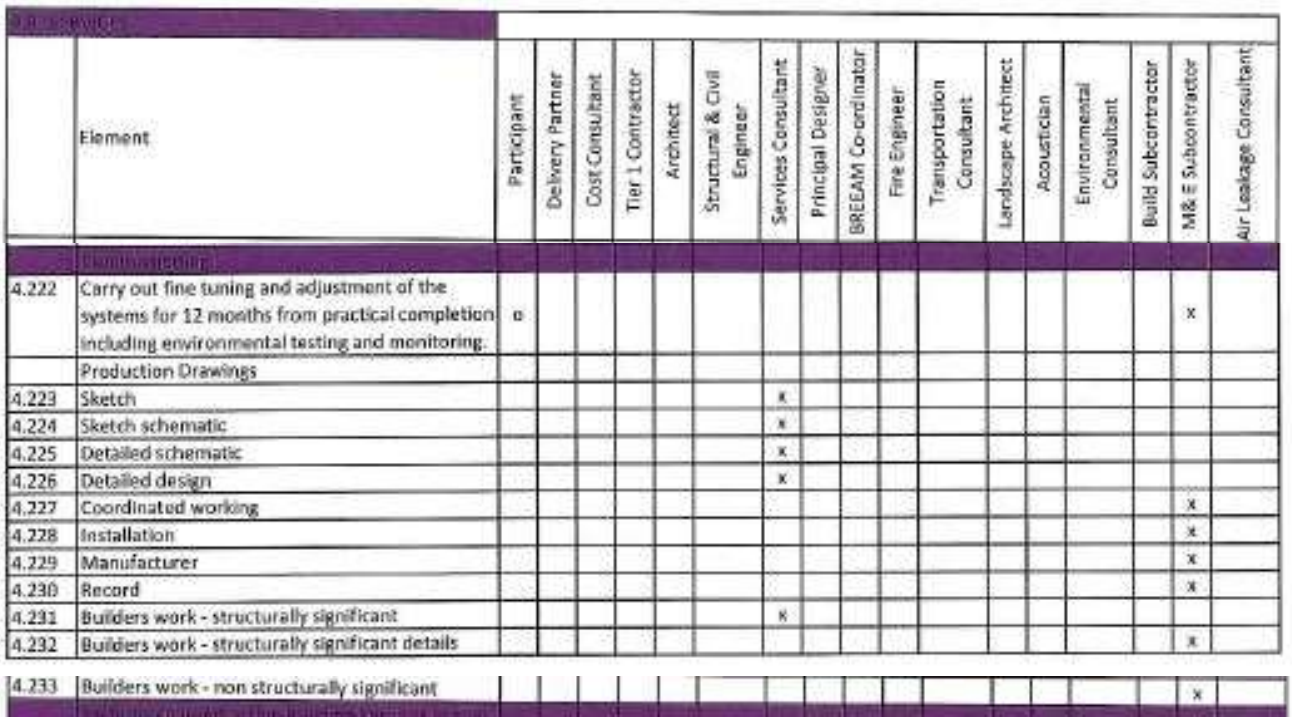


Extract from Holmes Miller drawing 3462 AA(2)104 C



Extract from Compco As Built drawing N6087-01-02 showing Builderworks generic details.

Photograph of ceiling install showing underside of cassette, MF ceiling rails and plywood pattressing.



	Element	Participant	Delivery Partner	Cost Consultant	Tier 1 Contractor	Architect	Structural & Civil Engineer	Services Consultant	Principal Designer	BREEAM Co-ordinator	Fire Engineer	Transportation Consultant	Landscape Architect	Acoustician	Environmental Consultant	Build Subcontractor	M&E Subcontractor	Air Leakage Consultant
4.222	Carry out fine tuning and adjustment of the systems for 12 months from practical completion including environmental testing and monitoring.	o															x	
	Production Drawings																	
4.223	Sketch							x										
4.224	Sketch schematic							x										
4.225	Detailed schematic							x										
4.226	Detailed design							x										
4.227	Coordinated working																x	
4.228	Installation																x	
4.229	Manufacturer																x	
4.230	Record																x	
4.231	Builders work - structurally significant							x										
4.232	Builders work - structurally significant details																x	
4.233	Builders work - non structurally significant																x	

Extract from Holmes Miller appointment document showing responsibility matrix for Builderworks in connection with services.

Photograph following the sliding door failure

Photograph showing the overlapping top rails and missing stopper.

Photograph showing the Promethean Screen bracket after the screen has fallen.