SCOTTISH
FIRE AND RESCUE SERVICE
Working together for a safer Scotland

Fire Investigation Report

The Glasgow School of Art

15 June 2018

Working together for a safer Scotland

News Pictures
/ Alamy Stock Photo

CONTENTS

1. FIRE INVESTIGATION REPORT

Report of Fire at:

Premises:	Glasgow School of Art, The Mackintosh Building, 167 Renfrew Street, Glasgow				
Post Code:	G3 6RQ				
Occupier:	Glasgow School of Art				
Day of Call:	Friday	Date of Call:	15/06/18	Time of Call:	23:19
Incident No:	30394181	No. of Calls:	84	Grid Reference:	258493, 665940
Appliances first Mobilised	Three Rescue Pumps (RPs) and One Aerial Appliance (AA) from Cowcaddens and Maryhill Fire Stations				
Incident Commander (First Attendance):	Watch Commander (WC) (**redacted**), Cowcaddens Fire Station				
Other Appliances attending:	See Appendix A				
Incident Commander (Overall):	Deputy Chief Officer (DCO) (**redacted**) Scottish Fire and Rescue Service, Headquarters				
Method of Extinguishing fire:	Five AA water towers, three ground monitors, six main jets, six Breathing Apparatus (BA) wearers, and one High Volume Pump (HVP)				

Other Services Attending and Contact Details

Police Scotland Lead Officers:	Detective Inspector (DI) (**redacted**) and Detective Constable (DC) (**redacted**), CID, Police Scotland (PS).
Police:	As Above.
Ambulance Service:	Special Operations Response Team (SORT) attended; details unknown.
Doctor / Police Surgeon:	N/A
Police Photographer:	N/A
Forensic Scientist:	N/A
Procurator Fiscal Contact:	N/A
Gas:	Scottish Gas Networks (SGN) attended; details unknown.
Electricity:	Scottish Power Energy Networks attended; details unknown.
Others:	Scottish Water attended details unknown. Glasgow City Council Building Control Glasgow. Reigart Contracts, Specialist Contractors, Coatbridge.

This report has been compiled by the undernoted officer who has been duly authorised in writing by the Chief Officer or his/her Deputy or Assistant Chief Officer to carry out the functions and exercise the powers as detailed within Section 29 of the Fire (Scotland) Act 2005.

Reporting Officer:	Peter Allardice		
Role:	Watch Commander (WC)	Service:	28yrs
Address:	Scottish Fire and Resue Service Headquarters Westburn Drive Cambuslang Glasgow G72 7NA		
FI Attendance Details:	WC's P. Allardice and (**redacted**) attended the scene at approximately 23:50hrs on Friday the 15th June 2018. They liaised with the Incident Commander (IC) at the scene. Firefighting operations were escalating at this time with significant Scottish Fire and Rescue Service (SFRS) resources on scene firefighting until 11:59hrs, 18th June 2018. Further SFRS resources were engaged in dealing with isolated pockets of fire and taking external and internal building temperature readings utilising a Thermal Image Camera (TIC) until the building was handed over to Glasgow School of Art (GSA) Management team on the 25th June 2018. Group Commander (GC) D. Dourley, Head of Fire Investigation, attended the scene on Monday 18th June 2018 to ensure the SFRS fire investigation was prioritised as the firefighting operations were scaled back. Police Scotland had been tasked with leading the operational multi-agency meetings and GC Dourley attended these on the 18th and 19th June to convey the fire investigation requirements and ensure arrangements were in place to allow the investigation to be progressed.		

Supporting Appendices

To support the readers understanding of the content of this report, seven appendices are provided. These are -

- Appendix A details the SFRS resources that attended the incident.
- Appendix B can be referenced to provide an overview of SFRS terminology used throughout the report and provides a short summary of how incidents are managed by SFRS.
- Appendix C provides detailed and referenced plans of the Mackintosh Building.
- Appendix D contains witness statements (**redacted**).
- Appendix E contains the list of premises type deemed as "High Risk" premises within the SFRS Fire Safety Enforcement (Protection) Framework.
- Appendix F References
- Appendix G Abbreviations

2. EXECUTIVE SUMMARY

On the 15th June 2018, the Glasgow School of Art (GSA) Mackintosh Building, 167 Renfrew Street, Glasgow, suffered a significant and catastrophic fire incident. The Scottish Fire and Rescue Service (SFRS) deployed extensive firefighting resources from across Scotland to deal with the incident. At its peak during the early hours of the 16th June 2018, the incident had in attendance 17 Rescue Pumps (RPs), 5 Aerial Appliances (AAs), other specialist appliances and over 100 personnel. Firefighting operations continued for 10 days with the last RP leaving the scene on 25th June 2018.

Specialist SFRS Fire Investigation Officers (FIOs) were deployed as part of the response on the evening of the fire, and what followed has led to the largest, most complex, resource intensive fire investigation undertaken and led by SFRS. The investigation started on the night of the fire and continued through to 30th September 2021. The physical excavation of the building and production of this report has taken SFRS over 172 weeks to complete.

The Mackintosh Building was subject to an extensive refurbishment programme, following the previous fire experienced on 23rd May 2014, and had been partially restored when fire broke out. As such the building was in a vulnerable condition and at higher risk from fire, due to the nature of ongoing restoration and construction works.

Post fire, the integrity of the building was severely compromised, requiring complex engineering works to stabilise and make safe the remaining structure. These extensive works led to a delay in being able to access the fire damaged building to enable FIOs to undertake the physical aspects of the fire investigation.

From a very early stage of the investigation, FIOs worked closely with Police Scotland (PS) and other partners to start the process of information gathering, whilst stabilisation work was undertaken. SFRS chaired multi-agency meetings with key stakeholders involved in the Mackintosh restoration to nurture working relationships, develop common aspirations and encourage the swift exchange of information to inform the investigation. Effective working with key stakeholders ensured that information requested by SFRS was quickly shared between the partners. All stakeholders were committed to the common goal of understanding the acts and omissions that led up to the event, ensuring an open and honest exchange of information could take place. As a result of these arrangements, a vast amount of evidence was made available to SFRS FIOs for review, that served to support and inform the investigative process.

In terms of the remaining structure of the Mackintosh Building, the SFRS fire investigation aspiration was to gain access to the building when it was safe to do so. FIOs developed an outline strategy with the key stakeholders, detailing "areas of interest" in order of priority. These "areas of interest" were designed to prioritise recovery of evidence that would support possible identification of the origin and cause of the fire.

Detailed discussion between SFRS and the GSA resulted in a viable plan, to support the fire investigation strategy, being agreed. Sufficient finance was sourced by the GSA, and an engineer and a specialist contractor were formally appointed to undertake the necessary stabilisation works to support the SFRS fire investigation strategy.

The first phase of works commissioned (Phase 1) focused on gaining access to the initial "area of interest" at the east end of the building on level 2 at the security guards desk area. This area was known to contain the Fire Warning System (FWS) control panel and, the Closed-Circuit Television (CCTV) hard drive for the site. These items could, depending on their condition, be key items of evidence with potential to provide detailed information to support the investigation. Phase 1 commenced on 15th October 2018 and was completed, with the excavation and recovery of items, on 5th November 2018.

Any subsequent phases of stabilisation works would be undertaken based on the evidence gained from the items recovered during Phase 1 excavation. Unfortunately, the outcomes of the analysis of these items did not provide sufficient information to support an origin and cause.

Over the following months plans to undertake further stabilisation and excavation works were discussed and agreed. The fire investigation strategy detailed the next "areas of interest". These were:

- Phase 2 – this required the examination of the fire debris contained in the central corridor on level 2.

- Phase 3 – as access to other areas became possible, it was evident that parts of the electrical systems remained intact. Phase 3 focused on the remaining electrical distribution system and a forensic examination of the remaining fire debris across all other areas within the building.

Work on Phase 2 commenced on 15th October 2019, following completion of stabilisation work within the "areas of interest". A series of comprehensive risk assessments and control measures ensured that these areas were safe for FIOs to enter.

From the 15th October 2019 through to the 3rd June 2021, FIOs maintained a near continuous presence alongside the onsite contractors. A short but forced break in continuity was necessary due to the escalation of the Covid 19 pandemic. The Covid restrictions in place at the site prevented SFRS attendance from 23rd March 2020 through to 1st July 2020. By maintaining continuity at the site where possible, SFRS ensured that excavation works being undertaken by the contractors were sympathetic to the investigation and aligned with the investigative strategy. As excavation works progressed across Phase 2 and 3, all debris removed from the site was extensively sifted for any items of interest that may support the investigation.

FIOs are experienced, trained to Skills for Justice – Level 5 Certificate in Fire Investigation (or equivalent) and meet the requirements contained in the "Code of Practice for Fire Investigators of Fires and Explosions for the Criminal Justice System in the UK". As such, the scientific method is applied to all investigations. Hypotheses are tested against the known evidence and only where evidence supports one or more hypotheses can this be presented as a possible origin and cause conclusion. Where there is insufficient evidence to support any of the origin and cause hypotheses, a fire investigation report may be recorded as undetermined.

Three broad hypotheses were formed. These were:

- Wilful Fire Raising,
- Fault or Failure of Electrical Appliances or Distribution Systems, and
- Accidental Ignition (not electrical)

These broad hypotheses were further subdivided to focus on specific origin and cause possibilities based on the known physical evidence observed at the fire scene, and the circumstantial evidence during the days prior to the fire incident. The detail of these are considered later in this report.

The damage to the internal structure was such that almost all the combustible materials had been consumed in the fire. All timber roof structures had been completely consumed. Remaining materials, including non-combustible stonework, concrete, brick, steel and other metals suffered various degrees of fire and heat damage. The large timber joists that held up floors forming the levels within the building no longer existed. Surface finishes to walls and ceilings that were once timber clad, or lath and plaster, had all been consumed in the fire. On the walls, only bare stone and brickwork remained. The resulting fire debris from all the combustible material within the building had settled on level 2, forming a formidable and dense layer of compact material up to four metres high in some areas.

Physical features, that fire investigators use to help determine the area of origin in buildings that suffer less catastrophic damage, were not present for FIOs to observe due to the extensive internal damage. Any physical evidence was significantly damaged or consumed in the fire. Due to the damage observed within the building, witness testimonies, CCTV and photographic footage was utilised to indicate a possible area of origin and a cause.

Despite an unprecedented and extended investigative process, sufficient evidence to support any credible origin and cause hypothesis has not been recovered from the scene or evidenced in witness testimonies or eyewitness accounts. Therefore, the origin and cause of the fire incident at the Mackintosh Building on the 15th June 2018 has been recorded as "undetermined".

Should further information be presented that may alter this conclusion, this will be considered, and the findings contained within this fire investigation report may be subject to a comprehensive review.

3. INTRODUCTION

This report has been prepared following the fire incident at the Mackintosh Building, 167 Renfrew Street, Glasgow, on the evening of the 15th June 2018.

The report is the product of an unprecedented and protracted fire investigation process, led and undertaken by the SFRS from the evening of the fire through to 30th September 2021.

The investigation has focused on identification of the most likely origin and cause of the fire. It has been a long, difficult and challenging investigation. Application of a robust fire investigation strategy has ensured that all known aspects surrounding the incident have been considered and form part of this comprehensive report.

Collection and analysis of data and information (evidence) that features within this report has facilitated the development of a number of credible hypotheses. The testing of these hypotheses against the available or known evidence enables the FIO to propose the most likely origin and cause.

Where the evidence collected from an investigative process does not support a most likely origin or cause hypothesis, the investigation may be declared as undetermined based on the evidence available at the time of publishing the report.

Legislation and SFRS Powers to Investigate

It should be emphasised that this fire investigation report focuses on the most likely origin and cause of the fire. It does not consider the general fire precautions or fire safety management within the premises before the fire occurred. The SFRS are not the enforcing authority for general fire precautions on construction sites.

The Fire (Scotland) Act 2005 (FSA) and The Fire Safety (Scotland) Regulations 2006, provide the legislative framework for "relevant premises" in Scotland. A "relevant premises" is generally any premises other than domestic premises, with offshore installations, construction sites and facilities, borehole installations and armed forces crown property being the main exceptions.

The enforcing authority for the majority of "relevant premises" is the responsibility of the SFRS. However, premises such as sportsgrounds are enforced by the local authority, licensed nuclear facilities are enforced by the Office for Nuclear Regulation and Construction Sites are enforced by the Health and Safety Executive (HSE).

All relevant premises fall within the scope of the FSA and the associated regulations. The FSA details an employer's responsibilities to ensure the safety of employees as far as is reasonably practicable in respect of harm caused by fire in the workplace. It also details Duty Holder responsibilities to ensure fire risks are identified and appropriate fire precautions are in place to reduce the likelihood of harm from fire to individuals resorting to the premises.

In this case, the Mackintosh Building is a "relevant premises" under the FSA, but as a Construction Site, responsibility for enforcement rests with the Health and Safety Executive as detailed in the FSA Section 61(9)(za)(iv) and referenced in the HSE guide HSG 168 (P60 section 344 to 357).

The FSA also details the powers of authorised personnel to enter premises in which there has been a fire for the purposes of investigating what caused the fire and why it progressed as it did. Section 29 of the FSA has been applied to enable authorised SFRS personnel to undertake a robust scene examination, the findings of which are detailed later in this report.

All SFRS Fire Investigation Officers (FIOs) are authorised under the FSA to undertake fire scene investigation on behalf of the Chief Officer of the SFRS. Each FIO has undertaken the Skills for Justice Level 5 (SFJL5) Certificate in Fire Investigation (or equivalent) and has a wide range of Fire Service experience supported by a programmed Continuous Professional Development (CPD) pathway.

A team of two FIOs attend all significant investigations, and a lead FIO is appointed to manage the investigation.

All SFRS fire scene investigations are undertaken using the "scientific approach". This approach is recognised across the fire investigation sector as the most appropriate method to ensure an evidence led, methodical and systematic fire scene investigation takes place. The "scientific approach" underpins the SFJL5 course and can be referenced in publications by both the National Fire Protection Association (NFPA), specifically NFPA 921, or Kirks Fire Investigation. The methodology of this approach supports all SFRS led fire investigations and was applied to the strategy for the Mackintosh Building.

Local SFRS Fire Safety Engagement with the GSA

Following the previous fire incident at the Mackintosh Building on the 23rd May 2014 (the 2014 fire), the premises was designated as a building site and did not reopen as an operational education facility. SFRS have recorded two engagements relating to the Mackintosh Building since the 2014 fire.

The first recorded engagement was on 20th February 2015. This informal engagement involved locally based SFRS Fire Safety Enforcement Officers (FSEOs), GSA staff and contractors, with discussion focused on automatic fire detection.

A second engagement was recorded as taking place on 23rd May 2018. However, this visit took place at the GSA Reid Building (opposite the Mackintosh Building). It was recorded against the Mackintosh Building as there was, at that time, no Unique Premises Reference Number (UPRN) for the Reid Building. SFRS have no further record of fire safety related meetings or engagements in relation to the Mackintosh Building prior to the 2018 fire incident.

The SFRS Fire Safety Enforcement (Protection) Framework details the premises types that SFRS prioritises as part of its responsibilities as an "Enforcing Authority". The Mackintosh Building (during normal operation) is a "relevant premises" under the FSA however, as the Mackintosh Building does not present a high life risk occupancy, it has never been subject to a formal Fire Safety Enforcement Audit (FSEA).

Premises deemed as presenting a high life risk, form part of the annual workload for SFRS Protection Officers. The majority of premises that are considered as "high risk" are those that offer sleeping accommodation, such as care homes, hospitals, hotels and prisons.

A full list of premises deemed as "high risk" can be referenced in Annex E.

4. BACKGROUND

The Mackintosh Building is situated in the City of Glasgow, on Renfrew Street, which is north of and parallel to, Sauchiehall Street. The building has been used as a functioning art school for over 100 years and is renowned for its historical importance as one of Charles Rennie Mackintosh's' finest architectural examples.

The GSA is Scotland's only public self-governing art school offering university level programmes and research in architecture, fine art and design.

The building was in the process of being fully refurbished following the 2014 fire. That fire significantly damaged much of the west side of the building, destroying most of the library area, several art studios and office accommodation. Firefighting tactics successfully arrested the spread of the fire, resulting in fire damage to the west side of the building only. The need to rebuild and repair the fire damaged areas led to the decision to fully refurbish the entire building to ensure it remained a robust, functioning and inspirational working art school, fit for the 21st Century.

Refurbishment work commenced during the summer of 2016 with many contractors and restoration experts involved in the complex, detailed restoration project.

5. DESCRIPTION OF THE PRIMARY PREMISES INVOLVED

MACKINTOSH BUILDING

East Elevation Dalhousie Street | North Elevation Renfrew Street | West Elevation Scott Street

Figure 1 – Glasgow School of Art Elevations

The Mackintosh Buildings' north elevation is on Renfrew Street, the east elevation is on Dalhousie Street, the west elevation is on Scott Street and the south elevation faces towards Sauchiehall Street. The building is approximately 74 metres long and 23 metres wide. It is located on a sloping site and is 17 metres high from ground on the north elevation, increasing to 25 metres from ground on the south elevation. The building consists of ten levels which include mezzanine levels. The south elevation has two adjoining properties that are detailed later in this report.

It was built in two stages; construction of the east side of the building commenced in May 1898 and was completed in December 1899. The west side was built between 1907 and 1909. Honeyman and Keppie were the architectural firm commissioned to construct the building from a Charles Rennie Mackintosh design.

The building construction is traditional in nature, using stone, steel, timber, concrete and slate with detailed stonework, tower elements and extensive glazing in the large window apertures. The east side featured timber flooring construction throughout with steel members supporting this. The west side, built a number of years later, featured more use of steel and concrete for creating the levels although timber remained the main material for floor construction. A detailed breakdown of the construction is given on the following page.

External Walls	Sandstone blockwork.
Roofs	Combination of roofing including timber pitched roof with covering of slate, glazed pitched roof and lead sheet roofing.
Windows	A mixture of timber, metal and lead framed windows and rooflights. Mostly single glazed with the exception of the rooflights and the main studio windows at levels 2, 4 and 6. The rooflights and windows are slimline double glazing.
Doors	Timber exterior doors, interior doors were mostly timber with decorative glazed panels.
Internal Walls	Lath and plaster. Timber cladding to either full or half wall in corridors. Timber stud and plasterboard walls between some studios on second floor.
Ceilings	Lath and plaster A mix of lime plaster on lath (chestnut split timber or metal), plaster "on the hard" and gypsum plasterboard.
Levels	Timber, steel supports (Rolled Steel Joists), some reinforced concrete.
Voids	Multiple hidden voids throughout. There are also vertical and horizontal ducts for the largely redundant original air handling system. These are used throughout the building to carry services such as pipework and electrical cabling.
Other	Temporary construction materials present such as timber and plasterboard partitions, temporary fire doors, scaffolding (internally and externally)

Description and uses of each level

The building consists of 10 different levels which include basements and Mezzanine (M) levels.

Level 1	Used for storage/plant and extends only in west side of building.
Level 2	Range of studios and offices. On the north elevation, the studios have rooflights forming glazed roofs which look out just below pavement level. On the south elevation, the studios have pitched roofs with rooflight windows installed.
Level 3 (M)	Offices.
Level 4	Offices, administration and studios.
Level 5 (M)	Offices.
Level 6	Studios, Directors' offices and library.
Level 7 (M)	Library balcony
Level 8	Offices and storage.
Level 9	Studios, Professors' studios and offices, hen run and loggia
Level 10 (M)	Storage.

Contents of the Building at Time of Fire

The restoration project addressed the renovation and restoration needs of the entire Mackintosh Building. All levels were subject to major removal, replacement, renewal and upgrading works. Restoration was at an advanced stage, however major structural work remained on going across most of the site.

Contents within the building were typical of a building site and a building under major renovation. Building materials, particularly timber is known to have been located throughout all levels of the building. In addition, there were materials to form structures, contractor scaffolding, major plant machinery, temporary electrical infrastructure, contractors' tools, wood treatment products and small quantities of surface finish products.

The building also housed the main contractor's office and several smaller office areas to manage the construction works. These office areas contained typical office furniture, desktop and laptop computers, plans and paperwork, portable electrical appliances, convector heaters, desk fans, some small tools and catering facilities.

Kay Roxby / Alamy Stock Photo

6. DESCRIPTION OF THE SECONDARY PREMISES INVOLVED

Two further adjoining properties were involved in the incident as shown below in Figure 2 "Overview":

- Both adjoining properties were located to the rear (south) of the Mackintosh Building with the main access points located on Sauchiehall Street.
- Both properties suffered smoke, heat and fire damage.
- Jumpin Jaks Nightclub, 294 Sauchiehall Street (southeast) suffered smoke and heat damage with minimal internal fire damage. Further damage was arrested by the actions of SFRS firefighting crews.
- The O2 ABC, 300 Sauchiehall Street (southwest) suffered major fire damage and structural collapse despite extensive internal and external firefighting by SFRS crews. In addition, several smaller properties on Sauchiehall Street, within the same block, were also directly affected.

A further property, the GSAs' Reid Building (opposite the Mackintosh Buildings' main entrance on Renfrew Street), was also damaged. This building's south elevation was subjected to radiated heat from the Mackintosh Building fire. Boundary cooling tactics applied by SFRS crews prevented any fire spread to the Reid Building, although the external cladding did suffer significant heat damage.

Although not directly involved or damaged by fire, properties in the surrounding area were evacuated as a precautionary measure to mitigate the risk to the public. Evacuations extended to residential properties in the Garnethill area as well as commercial premises on Scott Street and Sauchiehall Street. Due to continuing safety concerns, and potential collapse of the remaining fire damaged building, premises on Dalhousie Street, Scott Street and Sauchiehall Street remained inaccessible to members of the public, in the days, weeks and months following the fire.

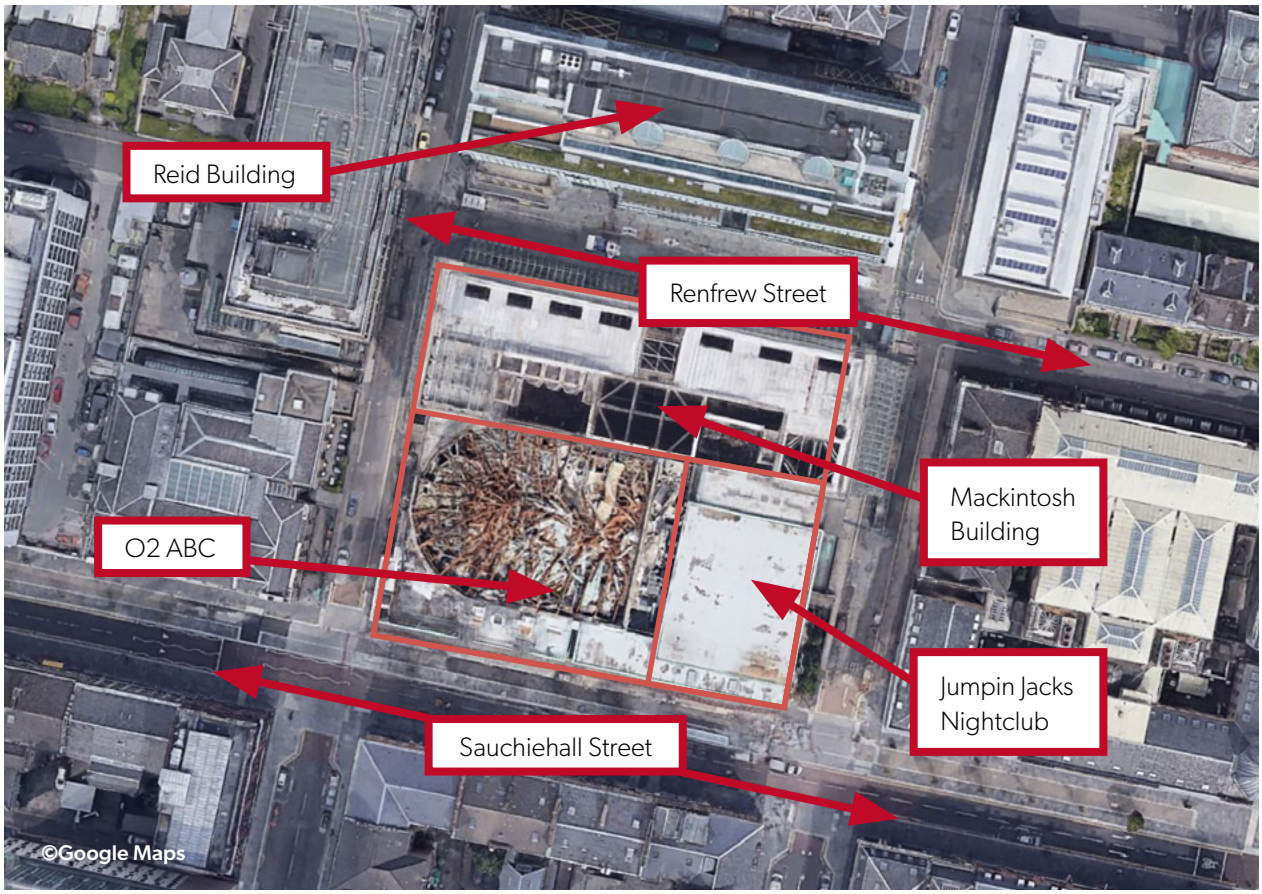


Figure 2 – Overview

7. MACKINTOSH BUILDING PREVIOUS FIRE HISTORY

The Mackintosh Building suffered extensive damage when in use as an art school during the 2014 fire. The subsequent fire investigation report identified the origin and cause within Studio 19 on level 2 in the west side of the building. A mixture of flammable gases generated by artwork within the studio ignited when it came in to contact with an ignition source within a projector unit.

The fire developed and spread quickly, causing extensive damage to the west side of the Mackintosh Building. The full fire investigation report is available online and can be viewed here – The 2014 fire report.

There is no evidence of any further fire events reported within the Mackintosh Building since the 2014 fire, and there is no evidence of any fire situation during the restoration project prior to the evening of the 15th June 2018.

John Peter Photography / Alamy Stock Photo

8. THE RESTORATION

Following the 2014 fire, operation as a working art school ceased and the building was closed for investigation work, making safe and cleaning.

Later that year, the GSA committed to a full restoration of the entire building with intent to bring it back to life as a robust, functioning and inspirational working art school. The overarching intent was to deliver an exemplary restoration of the Mackintosh Building. This would be achieved through meticulous and detailed conservation, traditional craftsmanship and construction skills whilst taking cognisance of new technology, design innovation and functionality.

The Mackintosh Restoration Project team was appointed on 31st March 2015 and a main contractor was appointed on 28th June 2016 to undertake the restoration work. Physical on-site work commenced in the summer of 2016 and was scheduled to complete in May 2019.

The restoration was expected to cost in the region of £48 million and involved the refurbishment of all internal and external aspects of the structure. This required detailed research, planning, modelling and the sourcing of expert tradespersons capable of applying their unique skillsets to meet the meticulous attention to detail required to retain the qualities of the original Mackintosh design.

The west side of the building was extensively damaged during the 2014 fire and required major refurbishment to all the fire damaged areas. The east side had not been subject to direct burning but required extensive post fire cleaning.

The restoration project considered all elements of structure, finishes and textiles and opted for a full, comprehensive refurbishment as the best option to ensure the building could continue to operate as a functioning art school in to the 21st Century.

The main contractor formally started work on site on the 4th July 2016.

The refurbishment work was close to the halfway stage when fire took hold on the evening of 15th June 2018. Much of the restoration work in the west side was at an advanced stage, particularly the library area which had been painstakingly restored following almost complete destruction in the 2014 fire.

Throughout the rest of the building, surface finishes of paint, stain and varnish were being applied, flooring was being laid, plumbing, heating and electrical systems were being installed, roofing work, stonework and data wiring were all at an advanced stage. Building materials, plant, scaffolding and temporary site electrics were in place in rooms and corridors throughout the site.

Externally, scaffolding was in place on the Dalhousie Street, Renfrew Street and Scott Street elevations, with further scaffolding on parts of the south elevation. The site had plywood hoarding at street level, approximately 2 metres high. This obscured any view into the building site and the building itself from passers-by. Safety netting that extended up the full height of the scaffolding, also served to obscure the external elevations of the building.

In general terms, during building construction and restoration, buildings can become more vulnerable to fire as passive and active fire precautions are impacted by construction activities. In terms of passive fire safety measures, compartmentation and separation, normally inherent in the building design, are compromised as building works are undertaken. Passive features prevent fire spread by providing physical barriers between rooms and floors. A lack of passive fire safety measures within any building promotes unchecked smoke, heat and fire spread.

In terms of active measures, FWS are often scheduled to be replaced or decommissioned for the period of planned construction works. Likewise, any suppression systems or smoke, heat and ventilation systems are also unlikely to be active during the construction phase.

Verbal evidence from site and security staff, along with physical and photographic evidence, confirmed that a FWS was fitted throughout the site, consisting of a fire alarm panel, break glass call points, sounders, and detection units (smoke and carbon monoxide). This should have provided early warning in case of fire in unoccupied areas. It is unclear if the system met the requirements of British Standard (BS)5839 or if any testing or maintenance procedures were in place.

In June 2018, the renovation works that were being undertaken within the Mackintosh Building served to increase the building's vulnerability to fire. This has been evidenced in video footage and photographs taken on the days leading up to the fire. The video footage

was taken as part of a BBC programme commissioned to document the restoration. The photographs were taken by GSA and the main contractor to document the intricate detail of restoration works and the craftsmanship throughout the project. Both the video footage and the photographs have served as a record that captures how the impact of the construction works significantly compromised the passive fire safety measures of the building. The normally inherent passive fire safety measures of separation and compartmentation were compromised by openings in walls, floors, open duct work, open voids, partially completed stud/partition work and the fitting of temporary door sets.

The building had been subject to extensive construction work for almost two years. Electrical, plumbing, heating and data services were in the process of being installed throughout the building.

Large quantities of combustible materials had been either fitted or were stored throughout the building waiting to be installed.

Despite doors to rooms and cross corridor doors being in position, the doors that were in place, whether original or temporary, would be unlikely to be capable of demonstrating fire resistance in the same way as a modern "rated" British Standard (BS476) fire door set would. Some of the original doors remained in their original locations, with some temporary doors fitted where original doors had been removed for refurbishment.

Passive fire safety measures were compromised across the entire building due to the nature and extent of the refurbishment work being carried out. This level of vulnerability during construction is not uncommon, however it does significantly increase the risk of fire spread where the fabric of a building has been compromised.

Active fire safety measures should have been subject to a through programme of scheduled maintenance and testing. It was confirmed by the main contractor that onsite records for testing and maintenance of the FWS were only retained on site and were consumed in the fire.

The Mackintosh Building has an additional inherent design feature that further compromised the passive fire safety measures and contributed further to the increased risk - ventilation ducts. The original Mackintosh designed ventilation system featured ducts throughout the entire building. The network of ventilation ducts varied in construction type, but have been observed as being brick, metal or timber lined. The legacy ventilation system was referenced in the 2014 fire report as a major contributor to rapid spread of fire.

As a result of the refurbishment work undertaken prior to the 2018 fire, the original ventilation system played an even greater role in supporting smoke, heat and fire spread. Many of the ventilation ducts were exposed and unprotected to allow services to be channelled throughout the building (electricity/data/heating/plumbing). The ducts had no effective passive fire stopping measures or cavity barriers although, fire dampers had been fitted to some areas but were not operational. The remainder of the ducts were scheduled to be fitted with fire cavity barriers/fire stopping measures upon completion of the installation of services. At the time of the fire, these active fire safety measures were not commissioned or fitted, providing a route for fire and fire gases to rapidly spread both horizontally and vertically. The well-ventilated ducts most likely served to provide a chimney effect, entraining an endless supply of fresh air to the fire as it developed and spread across the entire building.

DAYS PRIOR TO THE FIRE

During the week commencing Monday 11th June 2018, work was continuing as normal with a wide range of activities being undertaken. The library on the west side of the building was having finishing coats of paint and stain applied and was very close to completion. Elsewhere in the building, doors were being stripped of old paint and renovated, floors were being laid and sanded, roofing and masonry work was being carried out, electrics were being installed and ceilings were being plastered. New pumps for the fire suppression system had been put in place on level 1 but had not yet been installed.

It was normal practice during working hours on site, to isolate the smoke detection part of the FWS. Arrangements to manually do this at the fire alarm panel rested with on-site security staff. This process of isolation was undertaken at the start of every weekday to enable on site works to continue uninterrupted, preventing unnecessary false alarms. The smoke detection would then be restored to full coverage at the end of the working day.

DAY OF THE FIRE

On the day of the fire, a BBC film crew visited the site between 09:00hrs to 12:00hrs to record additional footage of the restoration. They focused filming on the almost completed library at the west end of the building. The GSA had been celebrating the 150th anniversary of the birth of Charles Rennie Mackintosh and Friday 15th June marked Graduation Day for the students at the GSA. Graduation Day celebrations had been held across the campus; however, no events were held in the Mackintosh Building.

It was a reasonable summers day with no rain, light winds, clear visibility and temperatures in the mid-teens.

There was limited work activity undertaken on site that day. The subcontractors on site were working throughout the building on:

- **Flooring surfaces** – floors were being laid, and floors that had been laid were in the process of being sanded and having surface finishes applied.
- **Roof** – the building was watertight in most areas with exposed or unfinished sections covered where necessary. Of note, lead work on the flashings and soffits on the pitched roof of Studio 8 on level 2 is known to have been undertaken on the morning of the fire.
- **Electrical supplies** – the newly wired electrical system was largely redundant awaiting commission. The temporary site electrics and the new supply to the electrically operated lift were the known energised supplies on the day of the fire. The lift contractor had attended on the day of the fire to rectify a fault on the reduced voltage side of the lift control panel.
- **Stonework** – some minor work on the external sandstone had taken place on the morning of the fire. This work was carried out at the north/west end of the building.
- **Doors** – many of the original doors were not in place as they had been removed to be refurbished back to their original condition. Hinges, handles and other ironmongery were also removed to be restored. Door frames and standards that formed part of the full door set were also subject to refurbishment. Whilst this work was being undertaken (often involving weeks or months of work) temporary doors were fitted throughout the site to maintain compartmentation.

During the day, contractor numbers on site fluctuated as people came and went. In total, 101 different people were recorded as having visited the site to undertake work activity between 07:00 and 17:00hrs. Evidence gathered from sub-contractors' statements and the site managers, cross referenced with the site entry/exit information, indicates that the last sub-contractor left the site at around 17:00hrs.

The site managers carried out several "walk rounds" of the site each day. The last walk round by a site manager on the day of the fire was carried out at approximately 15:00hrs. Once the walk round was complete and the last sub-contractor had left, the responsibility for the site was passed to security staff at 17:00hrs. The security guard then did a further walk round of the site himself, closing all doors and windows as he progressed around his route. He also armed the Scaffolding Movement Alarm System (SMAS). This was a small alerting system controlled from a room on level 6. If activated, it sounded a local alarm that was audible at the security guards' desk at level 2 to alert them of any movement detected on the scaffolding. An external strobe also provided an actuation alert indicator.

On return to the security guard desk area, he stated that he set the FWS to bring all smoke detection units back "online".

The site manager left the site just after 17:00hrs.

There was no facility for off-site data collection for the CCTV system or the FWS. The SMAS was remotely monitored but did not have data storage. There is no evidence of actuation on the evening of the fire.

The CCTV and the FWS were monitored from the security office on level 2 at the Dalhousie Street entrance (the main site entrance during the restoration). The CCTV hard drive was at this location as was the FWS control panel.

The day shift security guard handed over to the nightshift security guard at 18:20hrs.

There is no evidence to indicate anything unusual or untoward in or around the building earlier that day or during the evening although, it has been evidenced in statements that a number of faults were ongoing with the SMAS and the FWS. There is no record of the faults in either system (these were lost in the fire), so the nature of the faults remains unclear. There was no indication of activity on CCTV, the FWS did not sound, the SMAS did not activate and there was no new fault tone or localised signal from any of these systems.

A review of photographic and film footage evidence captured earlier in the day by the BBC shows the site was generally well kept and tidy. Witness testimonies verify this and consistently state that at the end of a working day, small tools were locked away in tool chests or removed from the site by contractors. Larger tools and machinery were left within rooms. The review of this evidence also confirms that building materials were neatly kept within areas throughout the building ready for application as construction work progressed. The Festoon 110v lighting and extension leads was also evident in the footage.

The 110volt system was fed from various transformers located across the site, and the lighting system remained energised at night for safety purposes.

NIGHT OF THE FIRE

The nightshift security guard completed his first, full walk round of the site at approximately 18:45hrs, checking that the external doors were locked and that internal doors were closed.

The nightshift and dayshift security guards had two further exchanges that evening. The first was at approximately 20:00hrs when the dayshift security guard returned for a personal item from the security desk, used the site toilet (adjacent to the security guards' desk) then left shortly afterwards.

The second exchange was at approximately 21:00 -21:30hrs when he returned, this time to collect a piece of building memorabilia for a friend, picking the item up from the security desk. Neither security guard noted anything unusual or had any cause for concern.

The first possible indication of fire in the vicinity was noticed 1 hour and 34 minutes prior to the first 999 call. This was detailed in a statement from a member of the public walking along Renfrew Street at approximately 21:45hrs. As he walked from east to west, he detected a smell of "burned material", but attributed it to the ongoing renovation works or a residual fire smell. He did not notice anything unusual as he passed by the east end of the building and made his way towards Charing Cross.

The first indications of unusual activity noticed by the nightshift security guard, were a series of noises at approximately 23:10hrs. His first instinct was that an intruder may have been on the external scaffolding as he described the noise as resembling something falling off the scaffolding. He proceeded the short distance from his desk to the Dalhousie Street entrance to visually check the scaffolding. After a short time, having observed no activity, he returned to his desk, only to hear further noises a minute or two later. This time, he thought the noise originated from inside the building and he proceeded to the south-east stairwell to investigate. When he reached the level 4 landing, he observed fire and sparks in what he described as "a crawl space" or a "duct". He immediately retreated and called 999 at 23:19hrs leaving the building as he did so. A short time later he contacted the dayshift security guard by telephone call to inform him of the fire. The day shift security guard stated that he was standing at a bus stop in Bath Street waiting on a bus to take him home, but he would make his way back to the site.

Around this timeframe (approximately 23:21hrs) a second member of the public, walking north up Dalhousie Street, observed a glow in a window aperture on the east elevation and took this photograph with a mobile telephone. In the photograph shown below in Figure 3, the glow of fire can be observed, as well as smoke issuing from the top of the building.

At approximately 23:22hrs, CCTV footage taken from the Reid Building, opposite the Mackintosh Building on Renfrew Street, shows further external signs of fire. Light wisps of smoke at streetlight level, can be observed, but no fire is visible on the front elevation of the Mackintosh Building.

The first SFRS crews are recorded on the CCTV footage arriving at 23:25hrs. A further photograph taken by a member of the public at approximately 23:25hrs captures fire venting from the roof at the east end of the building. This is shown in Figure 9 later in this report.

At approximately 02:12hrs, further CCTV footage captured by a camera covering the rear carpark of the Sports Complex Building of St Aloysius College (Dalhousie Street, North of the Mackintosh Building) shows a lone figure emerging from an access point at the southeast corner of the carpark. The figure appears to watch the attending SFRS crews. After 78 minutes the figure leaves the carpark area. There is no footage linking this individual to other areas prior 02:12hrs or following their departure from the carpark area. This individual was not traced by Police Scotland and there are no further enquiries progressing in this respect.

Figure 3 – Dalhousie Street east elevation

9. SFRS SEQUENCE OF EVENTS:

On receipt of the 999-call on 15th June 2018 at 23:19hrs (made by the nightshift security guard), SFRS Johnstone Operations Control (JOC) mobilised the Pre-Determined Attendance (PDA) of three Rescue Pumps and an Aerial Appliance to the GSA, Mackintosh Building, 167 Renfrew Street, Glasgow. This initial call was followed by many repeat calls from 23:20hrs onwards confirming that this was a building alight.

The first RPs from Cowcaddens arrived at 23:25hrs with WC (**redacted**) as the initial IC. His initial action was to speak with the persons at the location and gather as much information as possible. At 23:29hrs a further RP from Maryhill arrived and liaised with the IC.

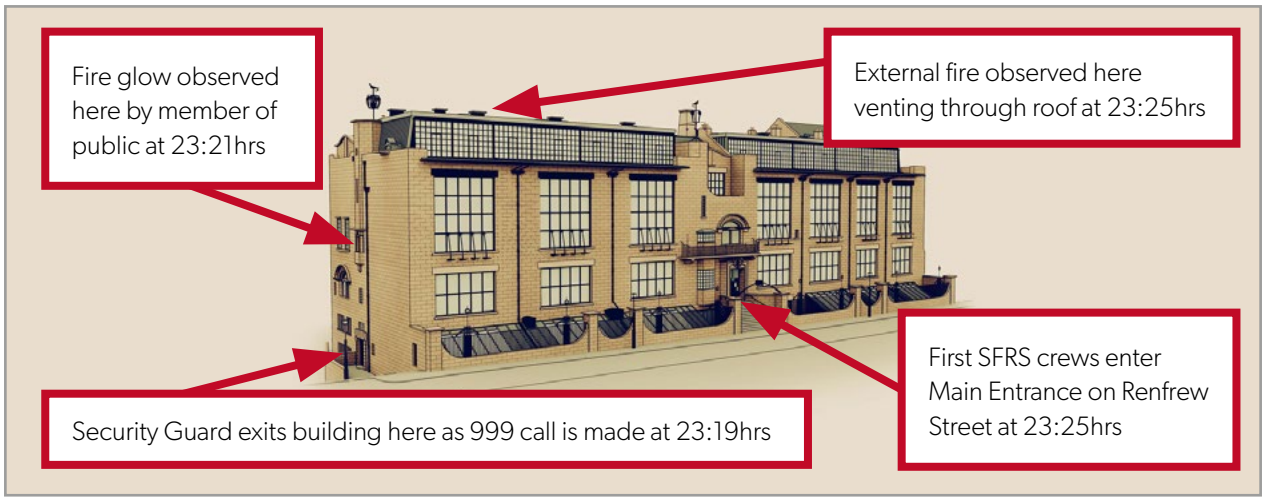


Figure 4 – Key points

Once the initial Dynamic Risk Assessment had been completed, the IC committed a BA Team equipped with a main jet through the main entrance accessed from Renfrew Street on the north elevation. At this point there was smoke in the vicinity but no visual confirmation of fire within the building observed by SFRS crews.

The BA team proceeded through the entrance hall and turned left towards the east end of the building where they opened a set of double doors giving access to the level four corridor that runs towards the Dalhousie Street (east end) of the building. On opening these doors, the BA team observed a well-developed fire that was located directly above them. Fire was visible along the entire length of the east corridor in an area now known to be just below level 6 and above. Simultaneously, the IC noticed that fire was now visible externally and venting though the roof as he viewed the building from the junction of Renfrew and Dalhousie Street. He instructed that the BA teams be withdrawn and sent an "Assistance" message escalating SFRS resources to a Level 3 response, requesting attendance of nine RPs, an Aerial Appliance (AA), Command Support Unit (CSU) and the attendance of a Fire Investigation Unit (FIU).

On 16th June 2018 at 00:04 hrs, Station Commander (SC) (**redacted**), who had assumed the role of IC, passed a further "Assistance" message to JOC requesting a Level 4 response, stating that "approximately 50% of the building is now well alight from the basement to the roof". Further information passed included that the incident had been sectorised, BA crews had been withdrawn, and that two water towers and three main jets were in use.

A further message was passed to JOC at 00:07hrs, asking Scottish Water to attend to increase water pressure, as problems with pressure from hydrants was being reported from frontline firefighting crews.

At 00:12hrs Area Commander (AC) (**redacted**) assumed the role of IC. At 00:12hrs a further "Assistance" message was passed to JOC for a Level 5 response requesting attendance of 17 RPs, 5 AAs, 1 CSU and 1 FIU.

Further messages were passed to JOC at 00:18hrs and 00:34hrs respectively, requesting that Scottish Power attend to isolate the building, and Scottish Water attend to increase water supply pressure.

Firefighting operations were predominantly external with internal operations at the Renfrew Street main entrance only. The fire was described as spreading uncontrolled throughout the east of the building, both vertically and horizontally, moving from east to west.

Figure 5 – Northeast corner

Figure 6 – Northwest corner

The Fire Investigation Unit from Yorkhill attended at 23:50hrs and observed a very well-developed fire visible through openings at most levels involving the east side of the building (Figure 5 above).

The FI team remained in attendance for approximately three hours. During this time, the FI team observed the fire rapidly spreading from east to west to involve the whole of the Mackintosh Building.

At 01:44hrs, DCO (**redacted**) assumed the role of IC. An "Informative" message was sent to JOC stating that PS were evacuating commercial properties on Sauchiehall Street and domestic properties on Dalhousie Street due to significant risk of collapse of the scaffolding enclosing the building and collapse of the Mackintosh Building itself (Figure 6 above).

Firefighting operations continued and the incident was sectorised to support incident management. Resources from the West Service Delivery Area, and the wider SFRS were brought in to support fireground operations and, backfill fire cover in the Glasgow area, as further appliances and personnel were deployed to the scene.

At 02:57hrs, a further "informative" message was passed to JOC stating four sectors were in operation. Three sectors were carrying out external firefighting operations utilising multiple RPs supplying water to aerial appliance water towers and main jets. The fourth sector had SFRS crews' firefighting at the O2 ABC building, carrying out limited internal firefighting operations, utilising six BA wearers and two main jets. Further information stated that fire had broken through the roof of the O2 ABC building.

At 03:23hrs, JOC were informed that all BA wearers had been withdrawn from O2 ABC due to deteriorating conditions within the building, and external firefighting only was now in operation.

At 04:41hrs, a further "informative" message from the IC was sent to JOC stating that firefighting teams were continuing to experience water supply issues, and that a High-Volume Pump (HVP) was in the process of establishing an open-source water supply from the River Clyde. At this point, firefighting operations were scaled back to a Level 3 response.

At 05:54hrs a further "informative" message from the IC was sent to JOC stating that hose for the HVP had been laid and was in the process of being charged. A multi-agency meeting had been held and a total of 27 residents had been evacuated from properties in the immediate area.

Firefighting operations continued throughout the day with pockets of fire being attacked and crews damping down fire debris across the Mackintosh and O2 ABC buildings. Cordons had been extended to Sauchiehall Street with evacuations taking place on Dalhousie Street and Scott Street (Figure 7 on the following page.

North Elevation, east end
Dalhousie Street/Renfrew Street corner

North Elevation, west end
Renfrew Street Scott Street corner

O2 ABC, looking south
Scott Street/Sauchiehall Street corner

Figure 7 – fire damage

At 20:11hrs a further "informative" message was sent from the IC to JOC, stating that all gas supplies had been isolated to all buildings in Sauchiehall Street that had been involved in the fire.

Further "informative" messages were sent the following days to JOC, requesting further operational resources for crew rotation. The messages also served to inform JOC of the equipment in use in the different sectors of the fire ground and the overarching tactical mode.

During 17th June SFRS resources consisting of RPs and AAs, continued working to extinguish pockets of fire and checking for hotspots using TIC equipment.

At 11:59hrs on Monday the 18th June 2018 a "Stop" message was sent to JOC by the IC indicating that no further resources, other than those in attendance, would be required to conclude the operational phase of the incident. At this point SFRS, having had primacy during the operational firefighting phase, provided a detailed incident handover to the GSA, effectively giving site control to the GSA.

On the 20th June, following consultation with the GSA and building engineers, Glasgow City Council Building Control applied a Dangerous Buildings Notice to the site due to the potential for partial or full building collapse.

SFRS Operations to damp down and extinguish isolated pockets of fire, continued through to the 25th of June 2018 until 15:41hrs when the SFRS completed operations at the scene and the last RP left the incident.

10. FIRE INVESTIGATION TIMELINE

Two SFRS FIOs from the Fire Investigation Unit at Yorkhill were part of the PDA on the evening of the fire. WC's P. Allardice and **(redacted)** attended at approximately 23:50hrs and remained on site until 02:41hrs. The attending FIOs observed the initial stages and quickly realised that accessing the scene would not be possible due to the magnitude of the fire, and the impact of fire on the structure and its stability.

It was also recognised at this point, that any physical excavation activity would be an unprecedented, technically formidable and time-consuming task due to the quantity of debris and the condition of the structure. It was clear that the extent of fire damage was far greater than the 2014 fire, with the entire building suffering catastrophic damage.

During the early hours of Saturday morning through to Monday 18th June, FIOs were unable to access the site due to ongoing firefighting operations and the dangerous state of the building.

At this stage the FIOs focused on locus protection, made observations and started to gather statements from attending SFRS crews and eyewitnesses who were available.

On Monday 18th June, FI GC D. Dourley attended a Police Scotland (PS) led multi-agency meeting on site. At the meeting GC D. Dourley was satisfied that the PS strategy in place protected the locus for any subsequent fire investigation activity that may take place pending completion of firefighting operations.

GC D. Dourley formally appointed the initial attending FIOs as the lead team for the investigation with WC P. Allardice identified as the lead FIO. GC D. Dourley and the lead FIO drafted a fire investigation strategy that was put in place as soon as firefighting operations concluded.

On the 20th June, Glasgow City Council Building Control applied a Dangerous Buildings Notice on the entire building and the immediate surrounding area. This action prevented any intrusive fire investigation activity at the fire scene, but rightly served to safeguard members of the public from potential full or partial collapse of the remaining fire damaged structure. Regardless of this, firefighting operations continued through to the 25th June.

Due to the inability to safely access the fire scene, the fire investigation strategy was reviewed to plan the excavation over a longer term. Extensive discussions between SFRS, the GSA, PS, the HSE and Glasgow City Council started the process of achieving this.

Whilst the discussions and actions took place to make the building safe to enable examination of the fire scene, the investigation was progressed in other ways. FI teams worked closely with PS, to take initial witness testimonies from SFRS crews, GSA staff, security staff, contractors, site managers and members of the public. PS supported activity to extensively review the locally available CCTV footage from the surrounding properties.

On the 26th June SFRS chaired and facilitated the first GSA Fire Investigation Partnership (FIP) meeting. This was the first of a number of multi-agency meetings with key stakeholders to facilitate information sharing.

During this meeting it was clarified that SFRS would be the lead organisation for the multi-agency investigation.

Attendance at this meeting included representation from:

- GSA
- PS
- HSE
- Appointed private investigators

On the 29th June 2018, the SFRS Communications team released a media piece to the public for a "request for information". Members of the public were asked to submit any information to SFRS that related to the fire incident (including photographic or video evidence), that could potentially assist the investigation.

The FIP meetings outlined the fire investigation strategy, detailed the investigation "Phases" and prioritised the sharing of information between the partners to support the SFRS fire investigation.

A further 18 meetings were held between June 2018 and June 2019. The meetings generated workstreams and enabled continuous information sharing between the partners, enabling SFRS to request and access detailed plans, photographs, registers, certificates

and other documentation detailing the building, construction work and activities within the building.

The SFRS "request for information" resulted in SFRS and PS reviewing 76 pieces of information provided by members of the public, alongside extensively analysed local CCTV footage from the surrounding properties.

Based on the information from early witness testimonies, the public response and the information sharing within the group, the fire investigation strategy was reviewed to adopt an approach where evidence recovery would be prioritised in order of information gain.

In terms of undertaking physical fire scene excavations, it was clear that conventional excavation by SFRS, using hand tools, would not be possible given the nature and the volume of debris. The extent of damage to the remaining structure indicated that building stability was also a concern. A collaborative approach would be necessary with a specialist contractor using heavy lifting equipment to secure, and ultimately clear the fire scene of debris.

This approach, working alongside a contractor to finance and support the physical excavation, was agreed and progressed with GSA partners. The SFRS fire investigation strategy identified and prioritised the known "areas of interest" to ensure a sympathetic excavation approach was undertaken in these locations.

The initial area of interest formed the Phase 1 investigation and excavation works, focusing on recovery of two potential pieces of evidence located at the east end of the building on level 2, at the security guards desk area. This area was known to contain the FWS control panel and, the CCTV hard drive for the site. These items could, depending on their condition, have been key items of evidence with potential to provide detailed information to support the investigation. The SMAS recording system, although audibly monitored from this area, had its control mechanism on level 6. There is no evidence to suggest the SMAS actuated on the night of the fire. Recovery of the SMAS control mechanism was therefore not a priority, but it would be considered for analysis if recovered during later phases of work if it survived the fire.

Phase 1 commenced on 15th October 2018 and was completed, with the excavation and recovery of items, on 5th November 2018.

Subsequent investigation "Phases" and stabilisation works would be undertaken based on the evidence gained from the items recovered during Phase 1 activities. The outcomes of the analysis of these items did not provide sufficient information to support an origin and cause, therefore further "Phases" of work were planned for.

Over the following months, plans to undertake further investigative "phases" of work, were discussed and agreed. Extensive and complex engineering was required to ensure safety and stabilisation of the structure for the investigation to progress. Concurrently, the fire investigation strategy was reviewed to detail the next priority "areas of interest". These were

- **Phase 2** – examination of the fire debris contained in the central corridor on level 2.
- **Phase 3** – focused on the electrical distribution system and a forensic examination of the remaining fire debris across all other areas within the building.

Work on Phase 2 commenced on 15th October 2019, following completion of stabilisation work within the "areas of interest". A series of comprehensive risk assessments and control measures ensured that these areas were safe for FIOs to enter.

From the 15th October 2019 through to the 3rd June 2021, FIOs maintained a near continuous presence onsite on a Monday to Friday basis (except during COVID 19 restrictions 23rd March 2020 - 1st July 2020), to ensure excavation works being undertaken alongside the contractor aligned with the investigation strategy, were appropriately co-ordinated, and prioritised the requirement for evidence preservation. As excavation works progressed across Phase 2 and 3, all debris removed from the site was extensively sifted for any items of interest that may support the investigation. SFRS did not recover any items identifiable as the SMAS control mechanism. It was not capable of recording data and is deemed to have been destroyed by fire.

11. FIRE INVESTIGATION FINDINGS

Initial External Observations

The external view of the building indicated that there had been an intense internal fire. This resulted in the failure of approximately 97% of the windows, severe spalling of the sandstone outer façade, warping of steel beams and severe fire and heat damage to the scaffolding structure that encased the building. The entire roof structure had perished with only stone, brick and distorted steel structural members remaining (Figure 8).

Figure 8 – South Elevations

Initial Internal Observations

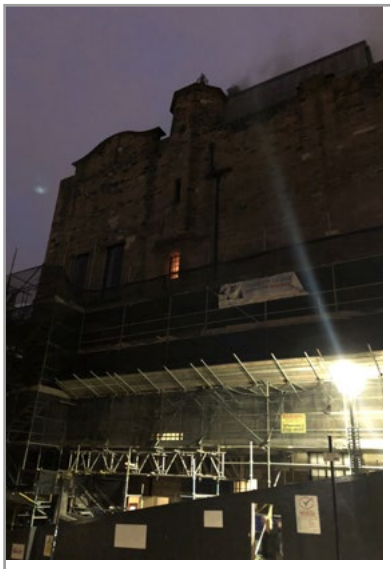
Internal observations were limited due to the unstable nature of the remaining structure. By viewing through window apertures and doorways, hundreds of tons of debris could be observed, and this remained consistent across the entire site from the lowest level upwards. Timber flooring and ceilings had been consumed by fire. Remaining exposed steelwork was warped and twisted, hardly any timber remained, and walls were stripped to brickwork as surface finishes had been consumed in the intense heat.

12. DEVELOPMENT OF FIRE

The initial area of fire is considered likely to have been on the east side on or above level 4. This is supported by the nightshift security guards' statement and by observations from SFRS crews who initially entered the building at level 4. The initial location of a developed fire above level 4 is also supported by photographic evidence in Figure 9 below, which shows a fire burning within a level 6 room, visible through a window opening on the east elevation. These two photographs were taken by a passer-by from street level at Dalhousie Street. This area of known fire is further supported by the initial SFRS ICs account where he witnessed fire venting from the roof high on the east side above Renfrew Street.

Photographs taken by FIOs and time-lapse video footage taken from the rooftop of GSA offices south of the Mackintosh Building, also document a well-developed fire in the east wing during the initial stages of firefighting operations.

As the fire developed further, it spread to involve all levels in the east side and progressed through the central area to the west of the building. Later, it would spread to the adjoining O2 ABC building, which also suffered catastrophic fire damage. The remaining adjoining building, Jumpin Jaks nightclub suffered minor fire, heat and smoke damage.



Photograph
taken at 23:21hrs

Photograph
taken at 23:25hrs

Figure 9 – Northeast Corner

Major contributory factors for the fire spreading in a rapid and uncontrolled way, are attributed to the compromised compartmentation and separation and, open brick and timber lined ducts running vertically and horizontally throughout the building.

The construction, layout, and high fire loading allowed the fire to spread unchecked from the area of origin in all directions. The availability of horizontal and vertical routes via rooms, corridors, voids, and ducts, led to 50% of the building being well alight within thirty-eight minutes of SFRS arrival. An unlimited air supply fed through the duct system, coupled with failing windows served to intensify the fire, promoting uncontrolled fire growth and rapid development.

CCTV and video footage taken from surrounding premises captures the fire development from east to west, involving the whole building before spreading to the adjoining O2 ABC building.

13. DETAILED OBSERVATIONS

Following stabilisation work, initial access to the site was gained on 15th October 2018 during Phase 1 excavations. This was limited to the east end of the building for a specific forensic search of a particular "area of interest" (detailed below), with access gained to the remainder of the building over the following 12-18 months during Phases 2 and 3.

Detailed observations noted the following:

Level 1	Severe fire damage to the central plant rooms with water and smoke damage to remaining rooms off the corridor.
Level 2	Severe fire damage to central corridor and all rooms located off this location. Concrete slab for floor remaining.
Level 3 (M)	Severe fire damage to the whole level.
Level 4	Severe fire damage to the whole level. Smaller sections of concrete slab forming floors remain at west end of building, with another section remaining forming floor of Studio 18.
Level 5 (M)	Severe fire damage to the whole level.
Level 6	Severe fire damage to the whole level. Smaller sections of concrete slab forming floor of central corridor floor remaining at west end of building.
Level 7 (M)	Severe fire damage to the whole level.
Level 8	Severe fire damage to the whole level. Partial sections of concrete slab that formed the central corridor floor remaining at west end of building.
Level 9	Severe fire damage to the whole level.
Level 10 (M)	Severe fire damage to the whole level.

DETAILED EXTERNAL OBSERVATIONS

Further external observations were limited due to the unstable nature of the remaining structure and detailed examination was only possible after considerable stabilisation work had taken place. This stabilisation included a complete replacement and enhancement of the scaffolding and a complex structural reinforcement metal box system secured to the building by specialist contractors.

Prior to the investigation commencing, and while carrying out remedial structural work, the specialist contractor had to clear loose blockwork from the top sections of all the walls both exterior and interior. Due to location and difficulty in safe removal, sections of sandstone were dropped internally into the building.

All the external metal scaffolding which surrounded the four sides of the building had been severely fire and heat damaged due to the severity of the fire. Remaining exposed steelwork forming lintels across the large openings facing Renfrew Street were observed to be warped, twisted, and cracked.

A large majority of the exterior sandstone block work on three sides of the building (north, east and west elevations) was observed to have suffered severe spalling to both the exterior and internal surfaces. This is attributed to intense heat from the internal fire, heat, fire and smoke escaping from window apertures, and the scaffolding planks providing a combustible material for fire to impinge across the external facades.

The south elevation was constructed of brick with sandstone lintels. The cover was of a wet dash render and severe spalling was observed to a greater degree in the east side of the building, and above three openings which formed part of the ventilation system. These openings which would have been accessible from the existing scaffolding led into a wooden formed duct which ran the length of the building and was being utilised to run services in. This duct was later established to be the area on fire when SFRS crews entered the building.

DETAILED INTERNAL OBSERVATIONS

Identification of Areas of Interest

Through close partnership working, information sharing and the application of a methodical approach, the following areas of interest underpinned the evidence led strategy designed to recover priority pieces of evidence. It was anticipated that the FWS control panel and the CCTV hard drive could be recovered from the security guards' desk area (on level 2) for analysis and perhaps, provide data to inform the investigation. This formed the first of five "areas of interest" to be excavated during phases of excavation, which were prioritised to provide optimum evidence recovery benefit:

1. Security Guards Desk level 2 – Phase 1 excavation
2. Central Corridor level 2 – Phase 2 excavation
3. Electrical Central plant room level 2 – Phase 3 excavation
4. Plenum at between levels 1 and 2 – Phase 3 excavation
5. Lift shaft – Phase 3 excavation

The remainder of the building was forensically excavated on completion of the five areas of interest.

Access Route via Main Contractor Office level 2

This area was the route to the first "area of interest" to be excavated as part of Phase 1 excavation work. On the 15th October 2018, work commenced to create a safe forensic path through the main contractor office on level 2 towards the security guards' desk area. The excavation was limited to creating a safe 1-metre-wide passageway with minimum excavation towards the known location of the desk, with the objective to recover the FWS control panel and the CCTV hard drive (Figure 10).

Figure 10 – Main contractor office level 2

Entry into the corridor on level 2 at the east end of the building was achieved on the 30th October 2018 (Figure 11).

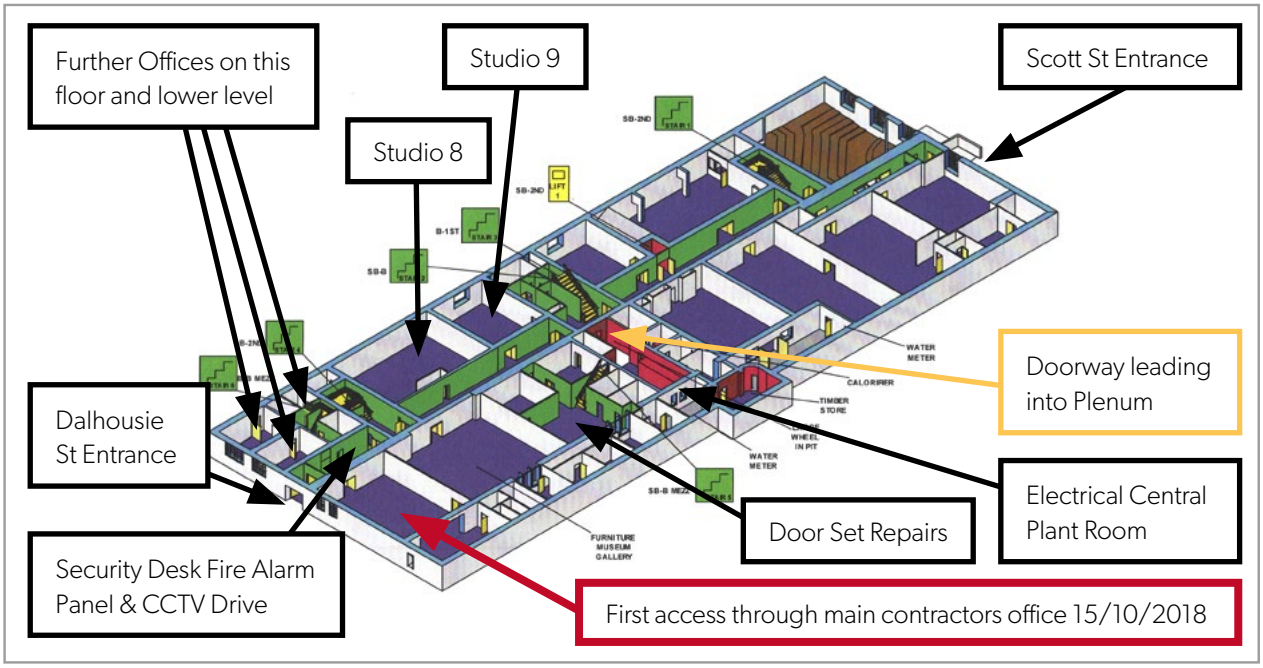


Figure 11 – Level 2

1. SECURITY GUARD DESK CENTRAL CORRIDOR

On the 1st November 2018, the excavation progressed into the level 2 corridor area (see Figure 11) where the severely damaged remains of the security guards' desk were uncovered at approximately 14:00hrs.

At 14:45hrs, the external housing of the FWS control panel was located below approximately one and a half metres of fire debris behind the location of the remains of the desk. The housing was located adjacent to the right-hand side of the corridor wall when facing west and 3 metres from the doorway leading to the main contractor office (Figure 12).

Location of FWS control panel

FWS control panel prior to impounding

Figure 12 – FWS recovered

The exterior of the metal housing (measuring about 500mm x 500mm x 180mm) was observed to have suffered severe fire and heat damage. The housing was photographed prior to being removed and impounded at 16:30hrs and sent for forensic data retrieval (Figure 12).

On 5th November 2018 at 14:47hrs, the exterior metal housing of the CCTV hard drive (measuring about 300mm x 300mm x 60mm) was located and observed to have suffered severe fire and heat damage. The housing was photographed prior to being removed and impounded at 16:30hrs and sent for forensic data retrieval (Figure 13).

Figure 13 – Location and condition of CCTV Hard drive

A data recovery company tasked with forensic data retrieval was appointed by Travelers Insurance. An excerpt of their report is provided in Figure 14 below:

(REDACTED) (DATA RECOVERY COMPANY) REPORT

Media Examined

1 CCTV DVR

1 Fire Alarm Panel

Summary of Findings

Our Professional Data Recovery Engineers have found the following issues with the media that was examined:

Extreme Fire Damage

CCTV DVR – We found within the device the area that resembled a Hard Drive, or where the Hard Drive should be. However, the intensity of the fire has clearly melted this so it is now actually part of the chassis of the DVR, unfortunately leaving us nothing to be able to recover from.

Fire Panel – we found a large panel within that looked like to be the motherboard. Upon attempting to access it, it began disintegrating as we touched it and there was no discernible electronics or chips that would suggest there was any chance of recovery of any information.

Definitions

Extreme Fire Damage

This damage is caused directly by the flames or could occur due to smoke and other corrosive substances emitted by the fire. The damage is so widespread and severe that not even a partial recovery is possible.

Conclusion

Due to the severity of the damage, unfortunately we were unable to recover any data on this occasion.

Figure 14

Both recovered items failed to provide any information that would support further development of origin or cause hypothesis.

2. CENTRAL CORRIDOR LEVEL 2

On the 15th October 2019, Phase 2 commenced with simultaneous work starting from both ends of the building to gain access to the Central Corridor. Access was via two entry points, one at the east end where the main contractor office was located, and the other at the west end, at the Scott Street entrance (see Figure 11 above).

Large quantities (several hundred tons) of fire debris were observed in the remains of both areas. Significant time, effort and resourcefulness was required to create safe systems of work to ensure safe access for FIOs (Figure 15 below).

Figure 15 – Central Corridor level 2

The fire investigation strategy was reviewed to ensure that FIOs and the onsite contractor could clear safe forensic pathways, whilst carefully analysing and removing potential evidence from the areas concerned. The formation of pathways was undertaken using hand tools only. No mechanical machinery was utilised at these locations to clear forensic pathways. Once safe forensic pathways were established, further fire debris was subject to analysis prior to being removed from the building by the contractor using conveyor belt systems located at both ends of the building, depositing the debris in demountable large volume skips.

As the process of excavation was undertaken by hand this process was not completed until the end of November 2019.

The analysis of debris being removed concluded that the debris consisted of ash, smaller pieces of timber, mortar, sandstone and building bricks. Other items amongst the debris included pipework, cabling, radiators, fire extinguishers, tool chests and other unidentifiable metal work.

Items of interest relevant to the investigation, and salvageable artefacts of importance to the GSA, were carefully removed from the debris and set aside for further analysis. Some items were noted in the debris as having been located on the upper levels of the building prior to the fire such as air vent duct work from the level 6 service plenum, shown in Figure 16 below. Some masonry and sandstone in the debris was identified as having been deliberately dislodged from the higher elevations during the stabilisation works prior to the excavation.

During the process of debris analysis and removal, examination took place of the corridor floor and ventilation openings. Observations of the central spine walls, that run the length of the building on both sides of the corridor, revealed that all the wooden floor joist pockets forming the missing floors had sustained severe fire damage consuming any remaining wooden structure contained within.

No unexpected items and no pieces of evidence were recovered from this area, despite meticulous sifting of the debris by FIOs as it was removed by the onsite contractor.

No recovered items of interest offered any information to support origin and cause.

Figure 16 – Metal duct work installed in level 6 plenum, found on level 2

3. ELECTRICAL CENTRAL PLANT ROOM

On the 2nd December 2019 Phase 3 commenced with access to the electrical central plant room located at level 2. Observations within the plant room confirmed that newly installed distribution systems for hard wired electrics throughout the building had not been energised or commissioned prior to the fire and remained in a partially complete state, undamaged by fire (Figure 17 below).

An energised three-phase distribution board was located to the righthand side of the new equipment. The three-phase lift supply, the supply to the temporary distribution board located in the plenum below level 2 (which supplied the temporary site electrical system) and the mains powered office supply originated from here. There was no evidence to suggest that the electrical equipment in this area should be considered as a possible origin or cause, due to no fire damage being observed or noted.

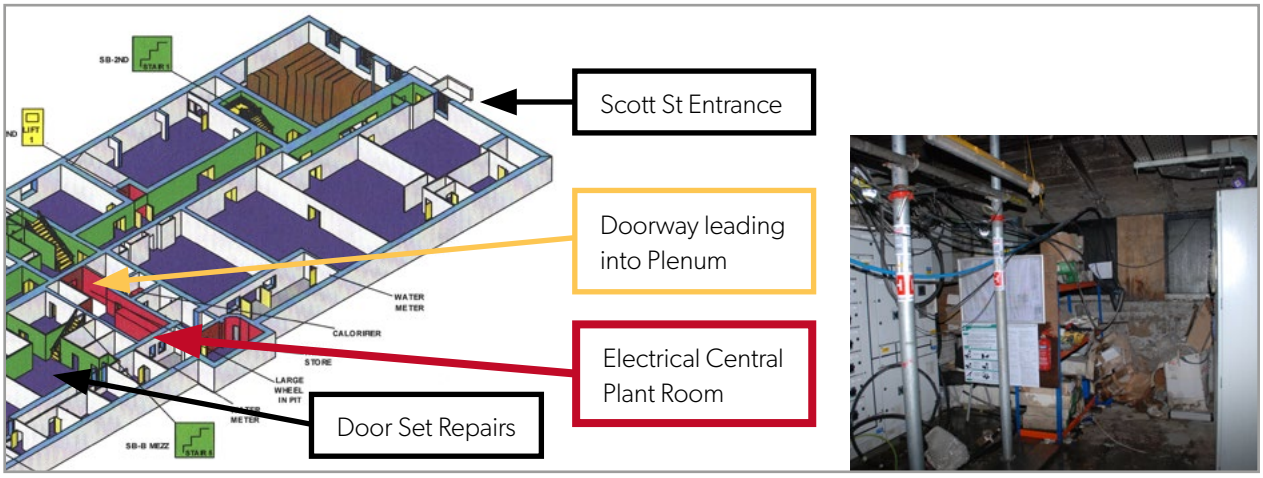


Figure 17 – Level 2 location (and photograph) of Electrical Central Plant Room

4. PLENUM AT LEVEL 1 AND 2 (SITUATED BETWEEN LEVEL 1 AND 2, BELOW CENTRAL CORRIDOR ONLY)

On the 29th November 2019, limited access was gained to the plenum under the guidance of the structural engineer, to establish the stability of the concrete walls and ceiling. The plenum runs the full length of the building under level 2 floor level. It is approximately 1.8 metres high and 2.5 metres wide. The inspection covered both east and west elevations of the plenum after entering by a doorway located in the middle of the building

It was observed that the plenum had been utilised to route most of the electro-mechanical services for the building, including air conditioning ducts and fans, and a vast array of electrical and data wiring. Most of the wiring was observed to be secured to metal trays fastened at ceiling level. The majority of the plenum appeared to be undamaged by fire, with fire damage noted adjacent to vertical ducts which ran from numerous locations along the length of the plenum (Figure 18).

Plenum looking east

Plenum looking west

Figure 18 – Plenum below level 2

On the 2nd December 2019 full access to the plenum was gained, with a full investigation of the plenum commencing the following day. The investigation and clearance of the plenum, started at a duct positioned on the north wall, righthand side (leading west) on entry to the plenum.

The work in examining the duct initially commenced from level 2. A large section of bricks forming the front face of a vertical duct had been removed to enable electrical cabling to be installed to the upper floors from the electrical mechanical plant room via the plenum level and the duct. The cabling running through ducts and voids was a mixture of newly installed supplies, which had not yet been energised and, energised supplies. The energised supplies included -

- The newly installed three-phase lift supply.
- The 110volt temporary site electrics and mains powered temporary site supplies fed from a small distribution board in the plenum. This distribution board was not damaged by fire.

The debris at the base of the vertical duct was observed to consist of a large quantity of bricks, ash, mortar, and general dust particles. This fire debris material was consistent with that observed when the final examination of the lower section of the duct was carried out within the plenum later that day.

The electrical cabling within the vertical duct, and further cabling secured to the horizontal metal trays, was observed to have sustained severe fire and heat damage at the duct and plenum intersection. The cabling rising within the vertical duct was also observed to have suffered severe fire and heat damage. Within the base of the duct, it was observed that cables had melted and fused together the remaining copper conductors, preventing further tracing of the cables. It is likely that some of the lighter construction cables had been completely consumed during the fire.

A further two vertical ducts located on the north wall and to the left of the plenum entry point (leading east) were excavated 4th December 2019. The base of the vertical ducts were observed to contain general fire debris including bricks, mortar, wood ash and fine dust. No large pieces of wood were observed or located within the ducts. On removal of the fire debris from the base of the ducts, it was quickly apparent that the cable had sustained severe fire damage within the ducts. The damage observed to the cables within the ducts was attributed to involvement in fire, as opposed to being the cause of fire. No evidence of faulty cabling was observed. Cables were also observed as having been mechanically damaged and broken, rendering the tracing of wiring impossible.

The remainder of the vertical ducts located on the north wall and to the left of the plenum entry point (leading East), were excavated from the 4th to the 7th December 2019. The ducts were observed to contain general fire debris including bricks, mortar, wood ash and general fine dust. No large pieces of wood were observed or located within the ducts. Electrical cabling entering the ducts had sustained severe fire damage, with the remaining cable forming a tangled section within the fire debris located at the bottom of the duct (Figure 19).

Figure 19 – Cables exiting vertical ducts into level 2 Plenum

Several energised electrical supply cables were noted to be in use in a number of the vertical ducts. These supply cables served the lift, 110volt temporary site electrics and mains powered temporary site supplies. The mains powered cables supplied the contractors' offices located in the east of the building (levels 2 and 3), and an electrical control switch for a floor sander located on level 6 (Figure 20).

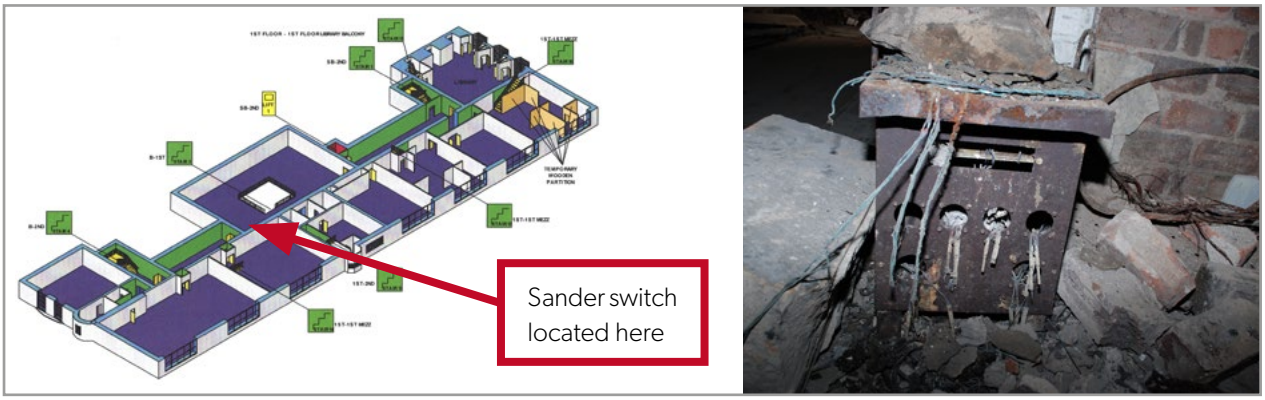


Figure 20 – Location of floor sander switch and the remains of one of nine 110volt site transformers

All the electrical supply cables were examined, after removal of the associated fire debris. All the cables had sustained severe fire damage, leaving the denuded and heat affected central copper conductors only. Having been dislodged and broken during the fire, it was impossible to ascertain where the cables led to, if they had or had not been energised prior to the fire or, what they were intended to supply. No evidence of origin or cause was provided by the remains of the cables.

5. LIFT SHAFT

On the 22nd March 2020, initial observations and photographs of the lift shaft were obtained from a scaffolding tower erected adjacent to it, allowing access to the lift shaft at each level. Initial observations within the lift shaft showed severe fire and heat damage to an internal scaffolding tower erected within the lift shaft.

Severe fire and heat damage was observed to the vertical metal framework attached to the east wall of the shaft which would carry the lift car to the numerous floors.

Located at the top of the shaft was the severely damaged lifting mechanism attached to steel framework. At the rear south/east corner a severely fire damaged armoured cable running the entire length of the shaft was observed (Figure 21).

The electrical supply cable was noted to be continuous from the bottom to the top of the lift shaft.

Due to the location of the lift shaft (midway along the west side of the building), both the wiring within the lift shaft and the supply cable termination at level 9 for the lift supply are not considered further as areas of origin or cause.

Figure 21 – Top of lift mechanism, west side

14. PANDEMIC IMPACT 2020

Due to Covid restrictions and the escalation of the Pandemic across the UK, activity at the site was temporarily suspended on the 23rd March 2020.

The physical investigation work recommenced at the site on the 1st July 2020, when Covid restrictions were revised by the Scottish Government.

There were no other significant findings to inform the investigation beyond the 1st July 2020. The physical aspects of the investigation continued and Phase 3 excavations at the Mackintosh Building concluded on 3rd June 2021.

15. HYPOTHESES

Due to the severity of the fire, amount of damage to the building and the volume of fire debris within the remaining structure, the fire investigation excavation was particularly challenging, with FIOs operating under considerable constraints and limiting factors. The work carried out by the specialist contractor was essential to stabilise the structure and preserve the scene to enable an investigation to proceed in a safe environment. Although this delayed the initial investigation and limited access, the investigation was successfully completed in a comprehensive and professional manner.

The severity of the fire had resulted in much of the structural timber being consumed by fire which led to the roof and all subsequent levels, and materials on these levels, collapsing to level 2. Consequently, the most likely room of origin no longer exists, therefore evidence in respect of the origin and cause was most likely destroyed by fire and not available for FIOs to observe or document. The impact and severity of the fire on the building and its contents restricted the likelihood of a precise area of origin being competently identified. Witness information from both the on-duty security guard and, from the initial attending SFRS crews suggest that the fire in the minutes after discovery was already well developed between the fourth and sixth levels within the east end of the building. The evidence available to FIOs supports this however, due to the renovation work underway, voids, and the horizontal and vertical ducts within the building, it cannot be competently declared as the only possible place of origin.

Several possible hypotheses were considered:

Wilful fire raising

The investigation considered four theories that could support a deliberate act of wilful fire raising.

1. At the time of discovery of the fire it was established that only the security guard was authorised to be within the main building. The investigation concluded that there is no evidence to suggest that the night shift, or day shift security guards had any involvement in the outbreak of fire. To the contrary, both gave statements that demonstrated a thorough understanding of their fire safety responsibilities. Both security guards carried out mitigating actions on the day/evening of the fire, routinely checking the building and closing fire doors to maintain compartmentation.

   Therefore, it is considered highly unlikely that the only known persons in the building at the discovery of fire had engaged in an act of wilful fire raising.

2. The investigation concluded that even if the SMAS was operating normally throughout the evening, coverage of the entire scaffolding structure was not provided. This suggests that a person, or persons, could access the building via the scaffolding structure, undetected. Once in the building or on the exterior scaffolding they would have full access to combustible materials and an unknown ignition source to engage in wilful fire setting activity.
   As previously documented, CCTV footage taken from the Sports Complex Building of St Aloysius College, captured a lone figure in the carpark approximately three hours after discovery of the fire. The motives of this individual were unclear; however, they were never traced by Police Scotland and there are no further enquiries progressing in this respect.
   The timeframe concerning this individual does not coincide with the outbreak of fire, however, involvement earlier in wilful fire-raising activity cannot be fully discounted, albeit there is no evidence to support such a scenario.

3. During the Graduation Day, a Board member of the GSA had received numerous social media messages that were aggressive, abusive and threatening in nature. The motives of this individual were unclear however, the individual was traced by PS and there are no further enquiries progressing in this respect.
   Therefore, this theory can be discounted.

4. Although not completely lock-fast, the night shift security guard stated that, to his knowledge, he was alone in the building. As previously stated, the site had a CCTV system and a SMAS fitted externally to the scaffolding. When the SMAS was operating properly, an audible tone would alert the on-duty security guard to the presence of movement externally on, the scaffolding structure. They would then interrogate the CCTV prior to an external investigation. It is not known if the scaffolding movement alarm system was functioning properly on the evening of the fire however, it was reported that problems existed with reliability, and coverage did not extend to the entire scaffolding structure.

Therefore, it cannot be discounted that person(s) unknown entered the site confines undetected and engaged in wilful fire-raising activity.

Due to the extensive fire damage to much of the building, there is no evidence to enable the investigation to determine a fire origin. Additionally, there is no indication of multiple seats of fire to further support a wilful fire-raising theory. The review of evidence includes the physical excavation of fire debris, remaining structure observations, photographic and CCTV material and information provided by the attending SFRS crews, security staff and members of the public in the vicinity.

Concurrent PS investigations do not indicate that any other individuals had been within the building or on the scaffolding prior to the discovery of fire. The SFRS investigation found no evidence to suggest the cause of the fire was due to a deliberate act, however the possibility must remain that wilful fire-raising activity could have been undertaken by persons unknown. Therefore, wilful fire-raising cannot be fully discounted as a possible, cause of the fire.

Fault or Failure of Electrical Appliances or Distribution System

The investigation considered seven theories that could support an electrical source as the cause of ignition.

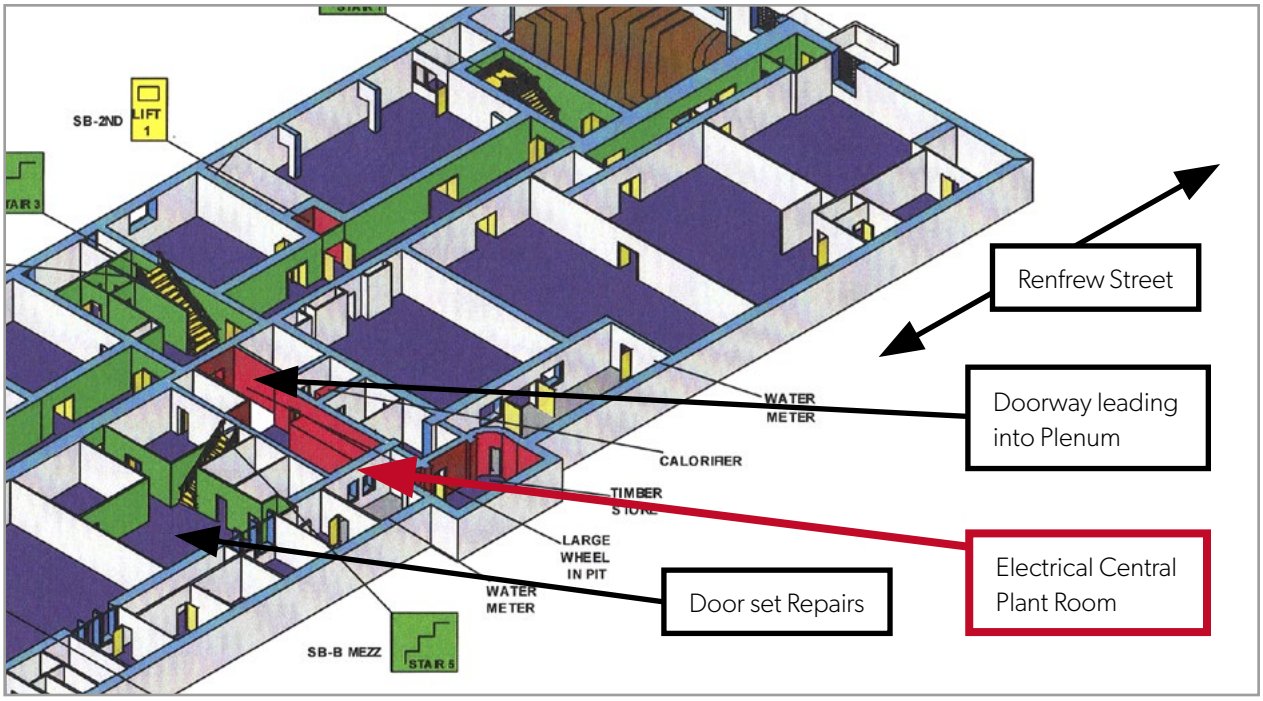


Figure 22 – Central plantroom level 2

New Three Phase Supply

1. A new, yet to be commissioned distribution panel, that would supply power and lighting circuits throughout the completed building was fitted within the plant room at level 2. It was located below the main bridge/staircase leading from Renfrew Street to the main entrance. This modern, three phase electrical panel and distribution system would, in due course, have supplied all levels and rooms within the completed building. Due to its location (low level and on the north elevation), and the passive protection around the plant room (concrete ceiling and brick walls), the plant room suffered very light damage during the fire. There was no fire damage observed to the non-energised three-phase distribution panel either internally or externally.

   Detailed examination of the new distribution panel concluded that the distribution system and the network of cables originating had not yet been energised.
   Therefore, this can be discounted as an origin and cause.

Temporary Site Supplies

1. Within the plantroom located to the right of the new distribution panel, was a smaller energised distribution board. This 12 way three-phase distribution board supplied power to a further energised distribution board in the plenum below level 2, and the recently energised lift supply cable. There was no fire damage observed to any of these three-phase distribution boards either internally or externally. Some circuit breakers were observed to be in the "off" position suggesting that they had been de-energised prior to the fire or de-energised due to fault conditions occurring as the fire developed. All the cables from this distribution board were intact within the plant room and throughout the plenum (other than damage sustained at vertical ducts due to fire debris drop down).
As the temporary site supply cables were energised throughout the building, fault or failure within the distribution network cannot be discounted as a possible cause, although there is no supporting evidence observed within the remaining electrical distribution equipment to indicate an area of origin.

   In addition to the site transformer supplies (see no.3 below), the circuits from this board also fed power to computers, lighting, portable heaters, printers and other equipment in the site office areas. Based on the witness account from the security guard, whose desk was adjacent to these office areas, there was no indication of fire originating from that location. Witness accounts from SFRS staff, confirm this with no sign of fire in this area immediately after arrival of SFRS resources, with all witness accounts indicating the fire to be above the level 2 area. This is supported by CCTV footage taken from the Reid Building CCTV cameras with no visible fire at street level or below.
Based on the available evidence, it remains possible that the energised mains powered distribution system supplying the office areas on level 2 could have suffered a fault condition in an unknown location, possibly a connecting duct or void. It is considered unlikely that any of the electrical equipment or appliances contained within the office areas at the east end of level 2 were the ignition source of the fire.

2. Transformers – Power for the construction site was delivered via a 110volt distribution system. This system was fed from the temporary three-phase distribution board (in the plenum below level 2), via steel wire armoured (SWA) cables, terminating at 110volt transformers on various levels and at various locations throughout the building. In total there were nine transformers positioned around the site. All 110volt transformers were energised up to and during the fire. This is evidenced in witness accounts by the security guard, and the first SFRS crews entering the building, stating that festoon lighting was powered on and lighting the site prior to failure. It is certain that transformers on all levels at the east side of the Mackintosh Building were energised, offering a viable ignition source. However, due to extensive fire damage, inspection of the remains of the transformers, supply cables and 110volt trailing leads and festoon lighting has provided no evidence that would indicate a fault condition or mechanical damage.
Despite a lack of available supporting evidence, the SWA supply cables, transformers, and 110volt trailing leads and festoon lighting that were confirmed as energised cannot be discounted as a potential ignition source.

3. As noted previously, the plenum between level 1 and 2 was a primary service route and contained electrical and data cabling. Some areas of direct burning were observed, but this has been attributed to fire debris "drop down", where burning debris from above has ignited small sections of cable(s). These areas aligned with breaks in the floor structure and the vertical ventilation ducts. The plenum formed the service run for the energised temporary electrical supplies, however there was no evidence observed to support a fault or failure of these cables within this area.
Therefore, ignition due to a fault within a cable in the plenum between level 1 and 2 is considered as a highly unlikely area of origin or cause.

4. A further high-level plenum, located between level 5 and level 6, was also used as a "services" route and contained electrical and data cabling. The first observations of fire are recorded as being above level 4 but below level 6. Due to the concealed nature of the plenum, the ignition sources within it and the combustible lining (timber) and materials

within, this area would support an origin area with ample ignition sources available (energised electrical supplies and lighting).
No further evidence is available to support this theory however it remains a possibility that the plenum between level 5 and 6 on the east side of the building was a possible area of origin and cause.

5. There is no evidence or information suggesting problems with power tools chargers, or that any mechanical damage to lithium-ion battery units had occurred prior to the fire.
   Due to the severe fire damage to the building, subsequent collapse of the internal floors, displacement of tool chests and loose electrical tools and batteries, evidence to support origin and cause relating to a fault in power tools or associated equipment has not been available or observed during the investigation.
   Contractors normally removed tools from the site to prevent loss or theft and to use them at other contracts. It was not widespread practice to leave batteries on charge whilst not engaged in work activity at the site.
   Despite the lack of evidence, ignition through a fault in a battery charger or a thermal runaway event within a lithium-Ion battery cell, cannot be discounted as a possible ignition source.
6. No other defects were identified in the remaining electrical distribution system in other areas of the building and no "switched-on" portable electrical appliances, or tools were identified within the fire debris. Battery charging was not known to take place on site with contractors preferring to secure tools or take them off site at the end of the working day. It should be noted that the extent of the damage severely restricted detailed analysis of electrical equipment and electrical items. Additionally, the intensity of the fire may have destroyed key pieces of evidence including equipment, portable appliances or sections of cable.
   Taking these factors in to account, ignition by electrical transformers, portable appliances or a fault in a cable cannot be fully discounted, as mains voltage supplies and 110volt equipment were known to be present throughout the building and energised in the area where fire was first observed.

Accidental Ignition (not electrical)

The investigation considered five theories that could support an accidental ignition.

1. Accidental ignition by smokers' materials (cigarette, match, lighter, pipe) was considered. A carelessly discarded cigarette (or similar) externally (on or around the scaffolding) or within the building itself could offer a viable ignition source. The site had a strict no smoking policy in place. There is no verbal evidence to suggest that this was not adhered to, although some cigarette ends have been observed in the electrical central plant room area next to the electrical distribution boards. It is not known if these were left pre, or post, fire. The act of a sub-contractor carelessly discarding a cigarette end in the afternoon does not match the elapsed time to the discovery of fire. The night shift security guard was a smoker but did not smoke within the building and there was no evidence to support origin of fire at a low level where the security guard was located. There is also no evidence that the fire originated externally. Based on this evidence, it is unlikely that a carelessly discarded cigarette (or similar) by someone inside or outside the building was an ignition source.
   Based on the available evidence, accidental ignition by smokers' materials is considered unlikely as an ignition source, however it cannot be fully ruled out.

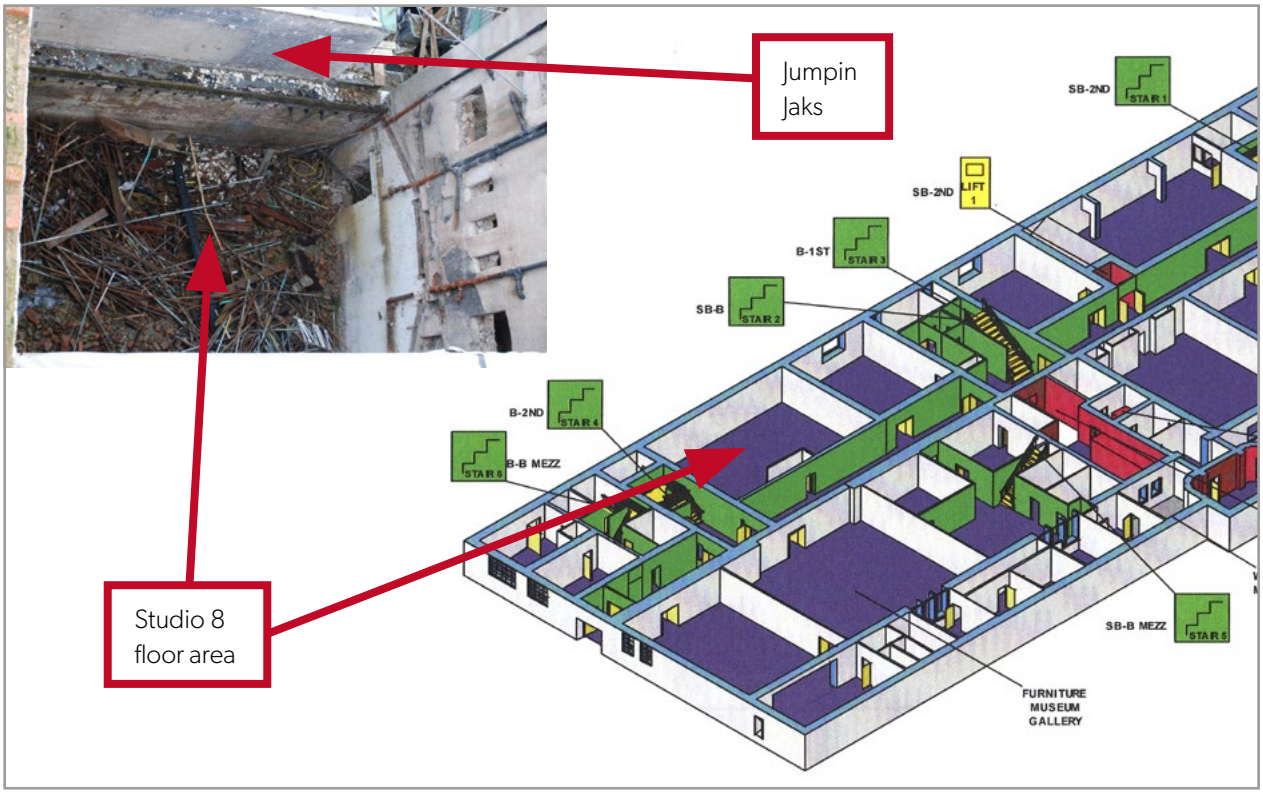


Figure 23 –View from above Studio 8, and location plan on level 2

2. Hot works were undertaken by a roofing sub-contractor on the day of the fire on the roof of Studio 8 at level 2 (Figure 23).

   Hot work is the term given to a process involving a flame or heat source. The hot work undertaken on 15th June had not been appropriately authorised using the safe system of work put in place by the main contractor to reduce fire risk. Evidence in respect of the hot works undertaken originated from a statement provided by the sub-contractor who undertook the work. It was necessary to use a small roofing blow torch to install lead flashing as part of the rainwater gutter system to the exterior south facing wall of Studio 8. The hot work activity finished at around 11:30hrs. Other roofing work was completed at 12:15hrs and the sub-contractor left the site after clearing up at 14:00hrs. The excessive elapsed timeframe from completion of work to discovery of fire (approximately 11hrs) indicates that this was unlikely to be the source of ignition. Furthermore, checks were made one hour after completion of the work by the sub-contractor himself. The area was again checked by one of the site managers at around 15:00hrs followed by the security guards' walk round at 17:00hrs and 18:45hrs.

   On the 13th October 2020, during Studio 8 excavations, a total of six cylinders were located within the fire debris. The cylinders recovered comprised of two small acetylene cylinders, two small oxygen cylinders, one propane cylinder and a small handheld plumbers blow torch cylinder. All were observed to be damaged by fire and corroded. Excerpts from statements stated that all these cylinders were empty at this location.

   The location of Studio 8 shown in Figure 23 and 24, was external to the main building and at a low level on the south facing elevation. There were no voids linking Studio 8 to the main building, making it highly unlikely for fire to spread unobserved from this location. Despite the Studio 8 roof, and the rear elevation being obscured by the adjoining buildings (Jumpin Jaks Nightclub and the O2 ABC), had fire started here, smoke and flames would have been visible much earlier in the day from surrounding buildings. Studio 8 is also close to the location of the security guards' desk. The security guard did not encounter signs of fire until he reached level 4 as he ascended the staircase to investigate noises that he heard around 23:10hrs.

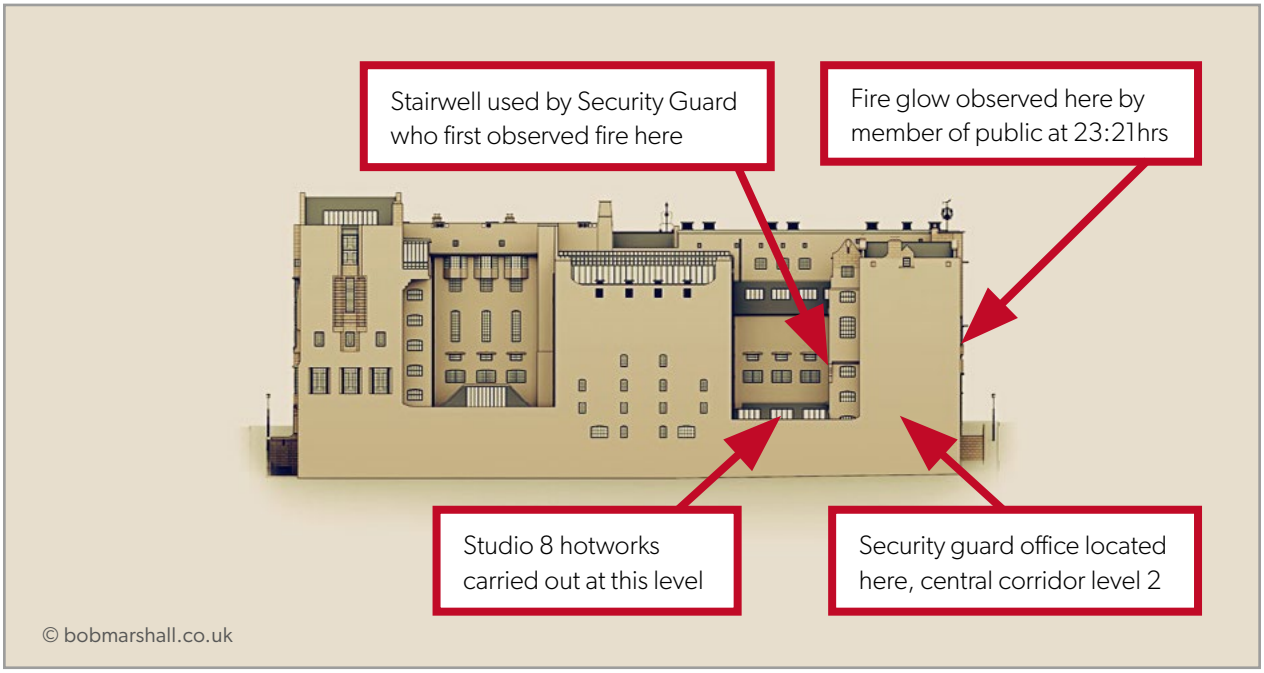


Figure 24 – Rear, South facing elevation

There is no evidence to suggest that hot works were undertaken anywhere else in the building on the day of the fire.

These factors suggest that the hot works known to have been undertaken in Studio 8 are unlikely to indicate this as the area of origin and cause of the fire.

3. Floor sanding was known to have taken place on the days leading up to the fire, at level 8 on the east side of the building at the location shown in Figure 25. Accidental ignition through chemical reaction inducing spontaneous combustion has been considered, as has electrical fault within the floor sander itself.

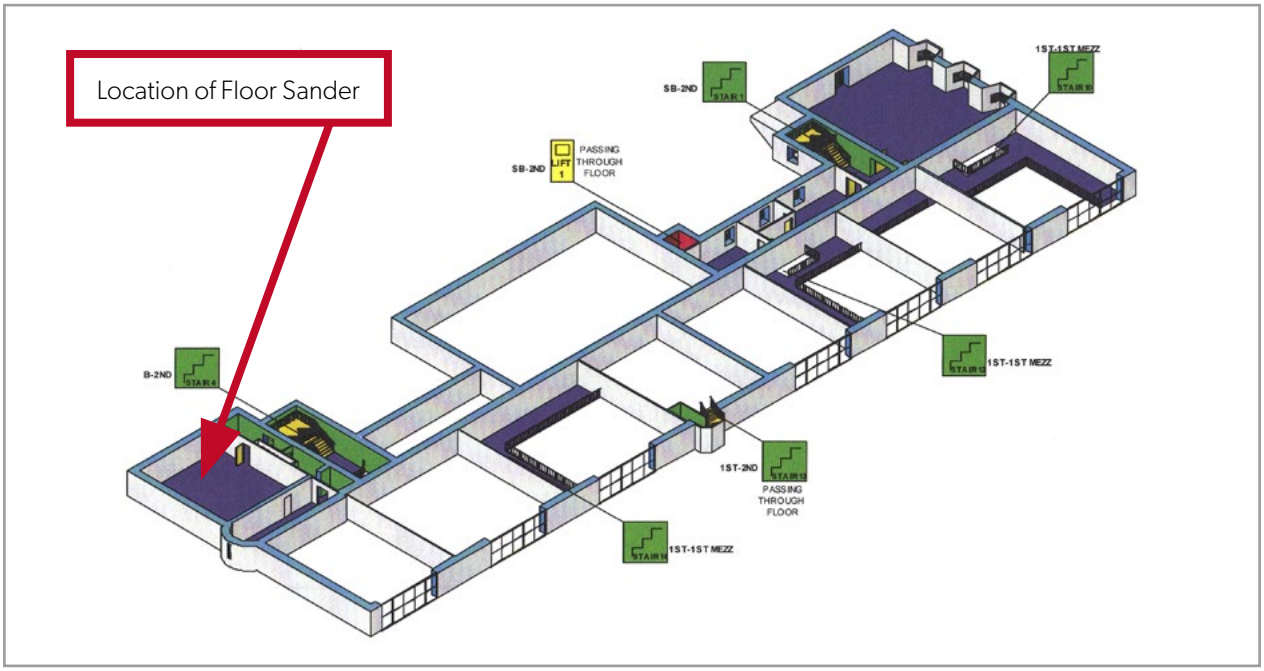


Figure 25 – Location of Floor Sander level 8, east side

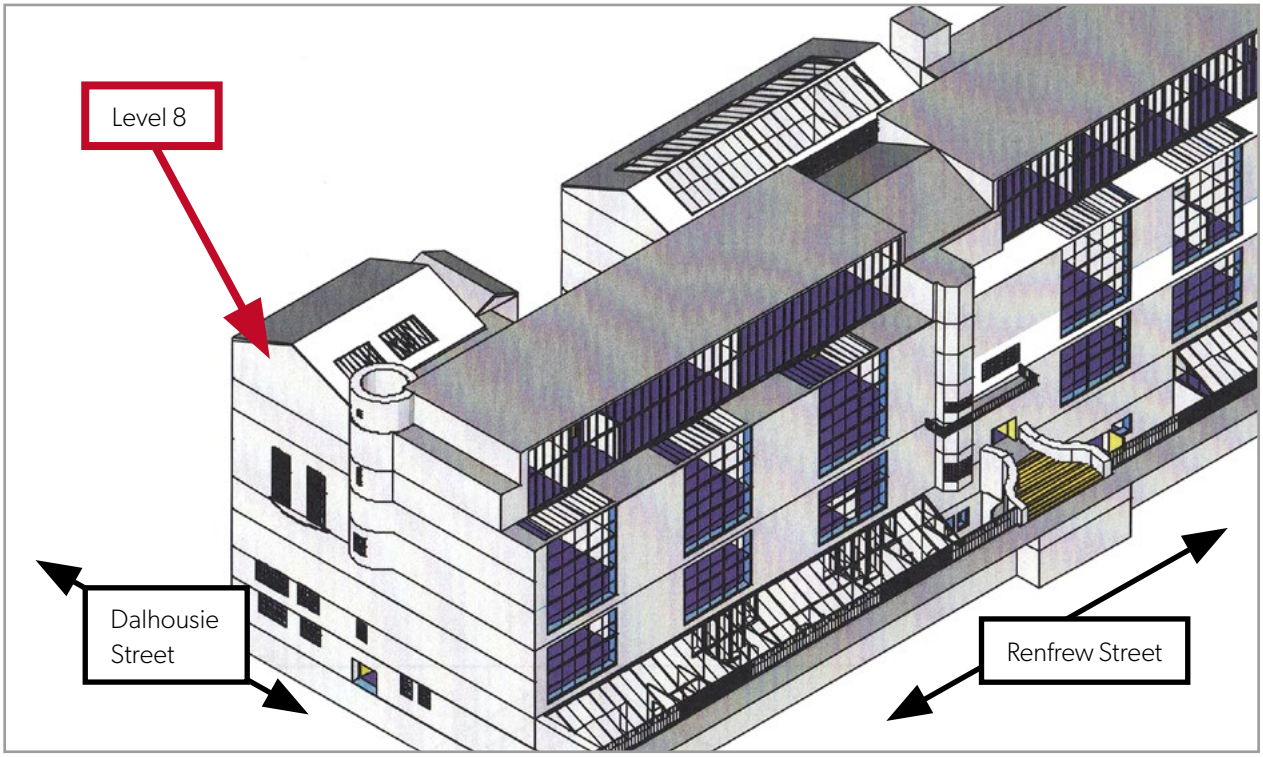


Figure 26 – Level 8, high level and prominent on the skyline from a southerly location

The sander was located within the fire debris at level 2, but extensive damage prevented any detailed analysis. The surface finish of the floor being sanded and the resulting sanded material within the sander containment bag is unknown. If the sanded material within the sander collection bag came in to contact with a heat source (such as the sander motor) there may have been enough energy to ignite the material. Furthermore, a spark from a floor nail entering the bag during operation could have sustained a slow smouldering fire within.

A further, although unlikely possibility is – if sanded material contained traces of an oil-based floor stain or finish, the resulting wood dust and oil mix may have self-heated and ignited. SFRS have been unable to test any of these theories due to the damage to the sander and the unknown properties of the materials.

Witness evidence suggests that the fire was initially observed at level 6, which is 2 levels lower than the known location of the floor sander on level 8. In support of this, had the floor sander ignited at level 8 (the topmost level in this area), it is highly likely that, due to its prominent high-level position, smoke or fire would have been seen from passers-by in the surrounding area, and the fire would have vented through the roof at an earlier stage. Additionally, extensive floor sanding had taken place across the site during the previous months with no reports of near miss incidents of a similar nature.

Although an unlikely origin and cause, a mechanism of ignition relating to the floor sander cannot be fully discounted.

4. The original door sets were in the process of being removed from their locations for refurbishment. Much of this work was done on site at in a room facing on to Renfrew Street, level 2 on the east side of the building.

   The doors had their ironmongery removed, old paint stripped, sanded, repainted then stored for refit. The paint stripping process was undertaken using a water-based stripping product **(redacted)** that was applied using a brush to break down the layers of paint. The length of time for the product to strip paint varied from minutes to several hours, depending on the properties of the paint being removed. Hinges, handles and other ironmongery

Michael McGurk / Alamy Stock Photo

were also stripped using the same product and sanded with steel wool, sandpaper and emery cloth. The resulting paint/stripper waste solution was removed by hand tools and scraped into waste bins prior to removal from the site. There is a possibility that the water-based stripper, steel wool and the unknown properties of the decades of paint layers that were removed somehow reacted to form a self-heating mixture.

This possibility was considered as unlikely origin and cause, due to the location the process was undertaken in, the known high-water content and witness testimonies referring to the outbreak of fire at a higher level - not in the area where the doors were stored, or where the process was undertaken.

Water based paint stripper was stored elsewhere in the building, but as it is water based it is not likely to be an origin, cause or contributory factor. As such it is not considered any further in this report.

5. About a week prior to the fire, Studio 58 at level 9 on the west side, was being used by contractors to apply small samples of oil-based artists paint to surface finishes. In the months prior to the fire, similar paint had been applied in Studios 19 and 21. The application of an oil-based paint can present a risk of spontaneous combustion when the oil element dries and a chemical reaction generates heat within the application material. It is understood that the paint applied in Studio 58 was likely applied with cotton rags. The used rags were immediately disposed of and not kept on site.

   Based on evidence provided, timeframes involved, and the location of Studio 58, this theory of spontaneous combustion can be discounted.

16. SUMMARY AND CONCLUSION

Due to the extensive damage throughout the entire site, post fire indicators were not available to support the investigation by indication of a possible origin or cause area. Directional indicators did not exist on the remaining structure as surface finishes had either spalled or been consumed in the fire, window lintel blackening, although visible, was present on multiple apertures as the fire progressed through the building.

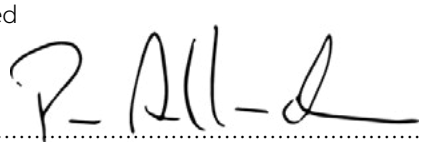
To competently determine the origin and cause of this fire, the hypotheses offered above have been tested against the evidence available to the FIO.

Despite a sustained, comprehensive investigation and excavation process, carried out over a three-year period, SFRS where unable to identify any evidence that would competently test and support the hypotheses.

Having, considered the available evidence and the possible origin and cause hypotheses, in the absence of any further information, I conclude that the cause of the fire to be recorded as Undetermined.

Should further information be presented, this will be considered, and the conclusion of this report may be subject to a comprehensive review.

Signed



.....

Name – Peter Allardice

Role – Watch Commander Fire Investigation

Position – Lead Fire Investigation Officer

17. RECOMMENDATIONS

The SFRS strongly suggest that lessons learned from the Mackintosh Building fire in 2018 should be carefully considered by key stakeholders involved in future construction projects.

When construction work is underway, there is little doubt that buildings are at greater risk of significant damage should a fire start. The following recommendations are offered to limit or mitigate the damage caused by fire whilst a building is under construction.

- Management teams responsible for delivery of construction or renovation projects, should ensure that, during the early planning stages of the project, they fully consider the risk of fire. Project management teams should appoint competent persons with the appropriate skills, knowledge, qualifications and experience to ensure the existing regime of Health and Safety legislation and regulations are appropriately applied. To support early risk identification, robust fire risk assessment principles should be considered and adopted during the design, plan and build stages, utilising existing fire safety guidance, legislation and regulations where appropriate. When construction work commences, a comprehensive Fire Risk Assessment (FRA), undertaken by a competent person, should identify suitable and sufficient control measures are implemented to mitigate the fire risks. The FRA should be continuously reviewed, and control measures should be periodically evaluated. Any new, emerging or changing hazards and risks should be addressed through the FRA process, and any further mitigating actions and/or control measures identified should be implemented as soon as practicable.
- Specific fire safety training should be delivered to all construction site staff and those with site responsibility (such as security guards and Fire Marshals). This should be enhanced as the building vulnerability changes in relation to works being carried out. Robust checking and monitoring of site activity should be undertaken to ensure risks are identified at an early stage and control measures or safe systems of work can be applied to mitigate the risk. This should include any procedures necessary during opening up (start of day) or closing down (end of day) such as reinstatement of FWS. This includes electronic means of isolation and reinstating of detectors or detection zones and placement/removal of any dust covers or similar devices from detection units.
- When buildings under construction reach a vulnerable condition (combustible materials, open voids, ignition sources), consideration should be given to provision of a comprehensive FWS where and when appropriate. The system must be carefully maintained and appropriately managed by a competent person so that it remains capable of providing early warning of fire, particularly during unoccupied periods. In particular circumstances, consideration should not only be given to protection of life, but also to protection of property at significant risk or of national importance.
- Passive and active fire safety measures to protect a building should, where practicable, be introduced as soon as possible during the construction phase, to provide compartmentation and separation, and reduce fire growth. Early installation of suitable fire safety measures will assist in checking a developing fire within a specified area or area of risk. It is recognised that this will be a challenging recommendation to achieve, however the fire in the Mackintosh Building demonstrates how unchecked fire spread can impact on a large area in a very short timeframe.
- Consideration should be given to creating improved relationships and information exchange between Enforcing Authorities (EAs) through a new forum. By ensuring a robust information exchange between SFRS and other EA partners, SFRS can consider what action is required in response to the change in risk in terms of operational response, crew familiarisation and securing operational intelligence.


BLUE LAGOON
NY SLICE
NY SLICE

18. APPENDIX A

Appliances Attending Up To Stop Message

Time Mobilised	Appliance & Type	Station	Time Leave Incident
23:20	Rescue Pump	Cowcaddens Fire Station	07:29
23:20	Rescue Pump	Cowcaddens Fire Station	06:28
23:20	Rescue Pump	Maryhill Fire Station	07:00
23:20	Aerial Rescue Pump	Maryhill Fire Station	03:49
23:22	Response Car	SFRS Officer	11:34
23:29	Aerial Rescue Pump	Springburn Fire Station	10:28
23:29	Aerial Rescue Pump	Polmadie Fire Station	06:59
23:31	Rescue Pump	Milngavie Fire Station	10:00
23:31	Rescue Pump	Yorkhill Fire Station	06:57
23:31	Fire Investigation Unit	Yorkhill Fire Station	02:41
23:31	Rescue Pump	Springburn Fire Station	06:55
23:31	Forward Control Unit	Milngavie Fire Station	10:00
23:31	Rescue Pump	Polmadie Fire Station	06:47
23:31	Rescue Pump	Polmadie Fire Station	06:41
23:31	Rescue Pump	Polmadie Fire Station	07:15
23:31	Rescue Pump	Govan Fire Station	07:22
23:33	Response Car	SFRS Officer	09:38
23:35	Response Car	SFRS Officer	09:15
23:36	Rescue Pump	Easterhouse Fire Station	07:49
23:39	Response Car	SFRS Officer	07:33
23:40	Response Car	SFRS Officer	08:18
23:41	Response Car	SFRS Transport Manager	07:01
23:42	Aerial Rescue Pump	Coatbridge Fire Station	15:31
23:42	Response Car	SFRS Officer	09:11
23:42	Response Car	SFRS Officer	09:54
23:46	Response Car	SFRS Officer	07:58
23:48	Response Car	SFRS Officer	09:37
23:52	Response Car	SFRS Officer	10:28
23:53	Response Car	SFRS Officer	13:01

Time Mobilised	Appliance & Type	Station	Time Leave Incident
23:55	Response Car	SFRS Officer	09:09
00:14, 16/06/18	Rescue Pump	Clydebank Fire Station	08:06
00:14	Rescue Pump	Cumbernauld Fire Station	08:40
00:14	Rescue Pump	Coatbridge Fire Station	08:24
00:14	Rescue Pump	Pollok Fire Station	08:07
00:14	Rescue Pump	Govan Fire Station	06:51
00:14	Rescue Pump	Knightswood Fire Station	02:35
00:20	Response Car	SFRS Officer	08:43
00:20	Response Car	SFRS Officer	07:40
00:57	Response Car	SFRS Officer	13:00
01:10	Response Car	SFRS Officer	17:26
01:10	Response Car	SFRS Officer	18:16
01:24	Response Car	SFRS Officer	12:53
01:28	Prime Mover	Renfrew Fire Station	02:45
01:49	Rescue Pump	Bellshill Fire Station	08:03
01:49	Forward Control Unit	Bellshill Fire Station	15:48
02:01	Rescue Pump	Knightswood Fire Station	08:02
02:34	Rescue Pump	Clydebank Fire Station	09:56
02:34	Rescue Pump	Bishopbriggs Fire Station	06:48
02:34	Rescue Pump	East Kilbride Fire Station	06:37
02:34	Rescue Pump	Whitburn Fire Station	08:47
02:34	Rescue Pump	Paisley Fire Station	07:48
03:09	Response Car	SFRS Officer	11:07
03:59	Incident Support Unit	Kilsyth Fire Station	06:31
06:46	Rescue Pump	Dumbarton Fire Station	11:30
06:46	Rescue Pump	Castlemilk Fire Station	10:30
06:47	Rescue Pump	Ayr Fire Station	11:40
06:48	Rescue Pump	Dreghorn Fire Station	16:38
06:48	Rescue Pump	Hamilton Fire Station	10:42

Time Mobilised	Appliance & Type	Station	Time Leave Incident
07:24	Response Car	SFRS Officer	14:08
08:24	Response Car	SFRS Officer	16:07
08:35	Aerial Rescue Pump	Greenock Fire Station	11:36
08:38	Forward Control Unit	Dreghorn Fire Station	16:38
08:38	Rescue Pump	Bellshill Fire Station	14:47
08:42	Aerial Rescue Pump	Motherwell Fire Station	09:51
08:55	Rescue Pump	Port Glasgow Fire Station	13:16
08:58	Rescue Pump	Pollok Fire Station	15:49
09:01	Rescue Pump	Easterhouse Fire Station	12:34
09:02	Rescue Pump	Calton Fire Station	15:26
09:05	Rescue Pump	Calton Fire Station	15:13
10:38	Fire Investigation Unit	Yorkhill Fire Station	15:54
11:42	Response Car	SFRS Officer	21:58
12:06	Response Car	SFRS Officer	21:16
12:48	Response Car	SFRS Officer	22:03
13:33	Aerial Rescue Pump	Clydebank Fire Station	23:22
13:35	Rescue Pump	Cumbernauld Fire Station	23:52
13:40	Rescue Pump	Milngavie Fire Station	19:31
13:40	Forward Control Unit	Milngavie Fire Station	19:31
13:42	Rescue Pump	Govan Fire Station	19:13
13:45	Rescue Pump	Castlemilk Fire Station	19:33
13:52	Rescue Pump	Maryhill Fire Station	20:07
13:53	Rescue Pump	Knightswood Fire Station	19:56
14:18	Rescue Pump	Hamilton Fire Station	19:09
14:34	Rescue Pump	Springburn Fire Station	19:48
14:35	Aerial Rescue Pump	Motherwell Fire Station	00:01, 17/06/18
15:06	Response Car	SFRS Officer	22:24, 16/06/18
18:30	Rescue Pump	Cowcaddens Fire Station	23:30
18:32	Rescue Pump	Pollok Fire Station	23:21

Time Mobilised	Appliance & Type	Station	Time Leave Incident
18:37	Rescue Pump	East Kilbride Fire Station	20:36
18:37	Rescue Pump	Calton Fire Station	23:10
18:38	Rescue Pump	Port Glasgow Fire Station	00:21, 17/06/18
18:38	Rescue Pump	Bellshill Fire Station	00:34
18:38	Forward Control Unit	Bellshill Fire Station	00:37
18:38	Rescue Pump	Kilmarnock Fire Station	23:52, 16/06/18
19:41	Response Car	SFRS Officer	07:02, 17/06/18
19:45	Fire Investigation Unit	Yorkhill Fire Station	21:40, 16/06/18
20:50	Response Car	SFRS Officer	23:08
20:51	Response Car	SFRS Officer	05:19, 17/06/18
20:52	Response Car	SFRS Officer	04:42
20:55	Response Car	SFRS Officer	04:30
22:07	Response Car	SFRS Officer	04:43
22:12	Aerial Rescue Pump	Coatbridge Fire Station	04:16
22:13	Rescue Pump	Castlemilk Fire Station	04:05
22:17	Rescue Pump	Knightswood Fire Station	03:20
22:18	Rescue Pump	Ardrossan Fire Station	04:00
22:27	Rescue Pump	Easterhouse Fire Station	03:24
22:46	Aerial Rescue Pump	Greenock Fire Station	03:13
22:46	Rescue Pump	Johnstone Fire Station	03:33
22:53	Aerial Rescue Pump	Paisley Fire Station	04:03
23:24	Rescue Pump	Dreghorn Fire Station	05:33
23:24	Forward Control Unit	Dreghorn Fire Station	21:13, 18/06/18
23:46	Incident Support Unit	Kilsyth Fire Station	01:03
02:35, 17/10/18	Aerial Rescue Pump	Clydesmill Fire Station	07:23
02:40	Rescue Pump	Polmadie Fire Station	07:23
02:42	Rescue Pump	Kilwinning Fire Station	07:22
02:45	Rescue Pump	Springburn Fire Station	07:17
02:54	Rescue Pump	Govan Fire Station	06:33

Time Mobilised	Appliance & Type	Station	Time Leave Incident
03:13	Rescue Pump	Hamilton Fire Station	08:03
03:16	Response Car	SFRS Officer	09:10
03:28	Response Car	SFRS Officer	10:36
03:28	Rescue Pump	Cowcaddens Fire Station	07:38
03:28	Response Car	SFRS Officer	09:29
03:38	Response Car	SFRS Officer	08:45
04:31	Rescue Pump	Milngavie Fire Station	12:15
06:34	Aerial Rescue Pump	Motherwell Fire Station	11:35
06:40	Rescue Pump	Castlemilk Fire Station	11:53
06:41	Rescue Pump	Knightswood Fire Station	11:46
06:42	Rescue Pump	Paisley Fire Station	11:38
06:44	Rescue Pump	Coatbridge Fire Station	10:04
06:45	Rescue Pump	Calton Fire Station	11:23
06:48	Rescue Pump	Maryhill Fire Station	11:27
06:53	Rescue Pump	Pollok Fire Station	11:11
06.59	Response Car	SFRS Officer	15:09
07:29	Response Car	SFRS Officer	13:36
09:25	Response Car	SFRS Officer	15:16
10:05	Response Car	SFRS Officer	18:55
10:29	Rescue Pump	Hamilton Fire Station	15:40
10:30	Rescue Pump	Dreghorn Fire Station	16:08
10:40	Aerial Rescue Pump	Coatbridge Fire Station	15:56
10:45	Rescue Pump	Cowcaddens Fire Station	15:35
10:47	Rescue Pump	Easterhouse Fire Station	15:30
10:49	Rescue Pump	Polmadie Fire Station	15:48
10:53	Aerial Rescue Pump	Springburn Fire Station	15:22
10:56	Rescue Pump	Cumbernauld Fire Station	15:39
12:05	Fire Investigation Unit	Yorkhill Fire Station	15:49
12:13	Response Car	SFRS Officer	21:05

Time Mobilised	Appliance & Type	Station	Time Leave Incident
13:11	Response Car	SFRS Officer	23:45
13:39	Response Car	SFRS Officer	22:52
14:02	Rescue Pump	Greenock Fire Station	19:27
14:22	Rescue Pump	Paisley Fire Station	19:34
14:26	Rescue Pump	Bellshill Fire Station	19:49
14:34	Rescue Pump	Knightswood Fire Station	20:03
14:37	Rescue Pump	Pollok Fire Station	19:29
14:39	Aerial Rescue Pump	Motherwell Fire Station	19:24
14:39	Rescue Pump	Calton Fire Station	19:46
14:49	Rescue Pump	Maryhill Fire Station	19:26
18:38	Rescue Pump	Hamilton Fire Station	00:21, 18/06/18
18:40	Aerial Rescue Pump	Clydebank Fire Station	00:15
18:42	Rescue Pump	Dreghorn Fire Station	00:46
18:43	Rescue Pump	Cumbernauld Fire Station	00:00
18:51	Rescue Pump	Castlemilk Fire Station	23:55, 17/06/18
18:56	Aerial Rescue Pump	Paisley Fire Station	23:58
18:58	Aerial Rescue Pump	Springburn Fire Station	00:01, 19/06/19
19:06	Rescue Pump	Cowcaddens Fire Station	00:01
19:19	Response Car	SFRS Officer	04:21
20:48	Response Car	SFRS Officer	04:25
21:34	Response Car	SFRS Officer	04:36
22:52	Aerial Rescue Pump	Greenock Fire Station	04:33
23:04	Rescue Pump	Knightswood Fire Station	04:30
23:06	Rescue Pump	Kilmarnock Fire Station	04:18
23:08	Rescue Pump	Milngavie Fire Station	04:51
23:08	Forward Control Unit	Milngavie Fire Station	04:53
23:10	Rescue Pump	Motherwell Fire Station	04:17
23:16	Rescue Pump	Calton Fire Station	05:02
23:18	Aerial Rescue Pump	Maryhill Fire Station	04:20

Time Mobilised	Appliance & Type	Station	Time Leave Incident
23:24	Rescue Pump	Pollok Fire Station	04:17
03:28, 18/06/18	Response Car	SFRS Officer	10:53
03:35	Rescue Pump	Castlemilk Fire Station	09:07
03:38	Aerial Rescue Pump	Polmadie Fire Station	06:41
03:39	Response Car	SFRS Officer	13:24
03:41	Rescue Pump	Paisley Fire Station	06:42
03:42	Response Car	SFRS Officer	12:42
03:45	Aerial Rescue Pump	Coatbridge Fire Station	09:19
03:46	Rescue Pump	Bellshill Fire Station	09:36
03:46	Rescue Pump	Easterhouse Fire Station	09:07
03:53	Rescue Pump	Cowcaddens Fire Station	10:25
04:30	Rescue Pump	Clydebank Fire Station	08:49
04:38	Response Car	SFRS Officer	07:59
08:11	Rescue Pump	Polmadie Fire Station	14:28
08:16	Aerial Rescue Pump	Clydesmill Fire Station	13:58
08:19	Response Car	SFRS Officer	17:19
08:19	Rescue Pump	Calton Fire Station	13:29
08:20	Rescue Pump	Maryhill Fire Station	13:49
08:22	Response Car	SFRS Officer	17:21
08:23	Rescue Pump	Milngavie Fire Station	14:11
08:47	Response Car	SFRS Officer	15:25
09:54	Fire Investigation Unit	Yorkhill Fire Station	17:09
11:10	Response Car	SFRS Officer	13:10

APPENDIX B

Fire Service Terminology and Incident Management

The SFRS **Incident Command System (ICS)** is the system employed to ensure an incident ground is appropriately resourced, and spans of control are manageable for **Incident Commanders (IC)** tasked with responsibility for firefighter and public safety.

The role of an IC is proportional to the scale of the incident. A **Crew Commander (CC)** may be the IC at a small incident, such as a fire in a refuse container. A **Watch Commander (WC)** may be the IC at a house fire.

For the more complex and escalating incidents, **Command Officers (CO)** are allocated to incidents to support or take charge of incidents. The number and role of officer allocated relates to the SFRS resources deployed, incident type and scale.

At a developing incident, the role of IC increases from WC to the middle manager roles of **Station Commander (SC)**, followed by **Group Commander (GC)**.

On occasions where the incident escalates further, senior officers above the middle manager roles will assume the role of IC. These senior roles include **Area Commanders (AC)** and **Deputy Assistant Chief Officers (DACO)**.

Beyond these roles, **Principal Officers** will assume the role of the IC for the most demanding, resource intensive, large-scale incidents. Principal Officers include the roles of **Assistant Chief Officer (ACO), Deputy Chief Officer (DCO)** and **Chief Officer (CO)** – the highest role of Operational Commander in the SFRS.

An incident is resourced by SFRS appliances and Command Officers using pre-determined categories from levels one to five, with five being the highest. A Level one incident ranges from a one to a four **Rescue Pump (RP)** attendance, a level two incident will result in six RPs attending. Each level response from Level two onwards, increases the attendance by an additional three RPs, along with specialist resources and Command Officers as required.

Specialist resources include **Aerial Appliances (AA)** such as a **Turntable Ladder (TL), Aerial Ladder Platform (ALP), Environmental Protection Unit (EPU)** and **Command Support Units (CSU).**

A **Dynamic Risk Assessment (DRA)**, is undertaken by the IC to determine the hazards and risks present and to declare a tactical mode indicating that a DRA has been completed.

Tactical modes are:

- **"Offensive"** where firefighting operations have SFRS personnel in an area where risk of injury exists
- **"Defensive"** where firefighting operations do not present any risk to SFRS personnel and control measures are appropriate

Following the initial DRA and tactical mode declaration, an **Analytical Risk Assessment (ARA)** will follow as soon as is practicable to ensure hazards and risks are appropriately recorded and control measures identified can be implemented where required.

As the scale of an incident increases, the resources required will likely increase too. During escalation, the IC will change as resources increase, with the most senior fire officer on the incident ground assuming responsibility for the entire incident. The most senior officer may not always take charge of an incident by assuming the role of IC, but for large scale incidents the most senior officer in attendance will, most likely, assume the IC role.

To provide appropriate control at an incident and manage the spans of control, **physical and functional sectors** can be introduced to devolve responsibility for operations in certain areas. An example would be a single storey detached building with four elevations may have four operational sectors, one on each elevation. Operational sectors are normally identified by numbering e.g.; Sector 3. A functional sector may support these operational sectors through providing BA resources or hose, fuel or any other additional equipment. Functional Sectors are named by the function that they serve e.g. BA Sector.

To ensure safe operations whilst using **Breathing Apparatus (BA)**, appropriate and recognised control measures are used. Stage I (one) is used to apply control procedures to meet the demands of small or limited incidents and Stage II (two) is used to apply control procedures which meet the demands of larger and more complex incidents.

Stage II introduces additional control measures to monitor the safety of breathing apparatus BA wearers and was implemented in this instance due to the large number of BA wearers being deployed to various locations within the building.

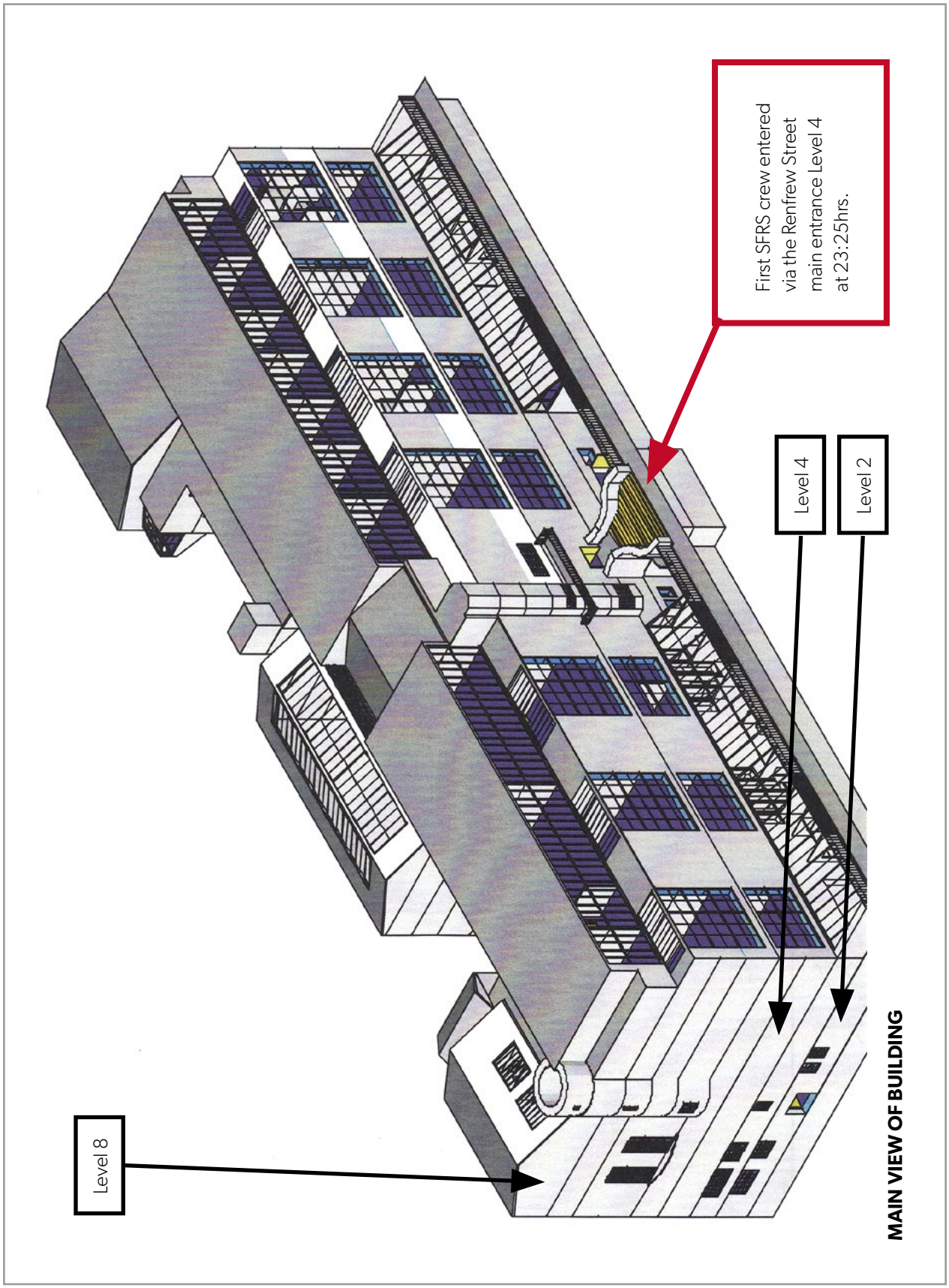
An IC is required to update **SFRS Operations Control** (OC) using a suite of messages. These are used to ensure that messages and clear, concise and contain the information required to make decisions regarding strategic issues remote from an incident.

This may include large-scale evacuation from the surrounding area, media management, longer term impact beyond an operational phase, updating senior managers, or briefing a multi-agency Gold Command forum.

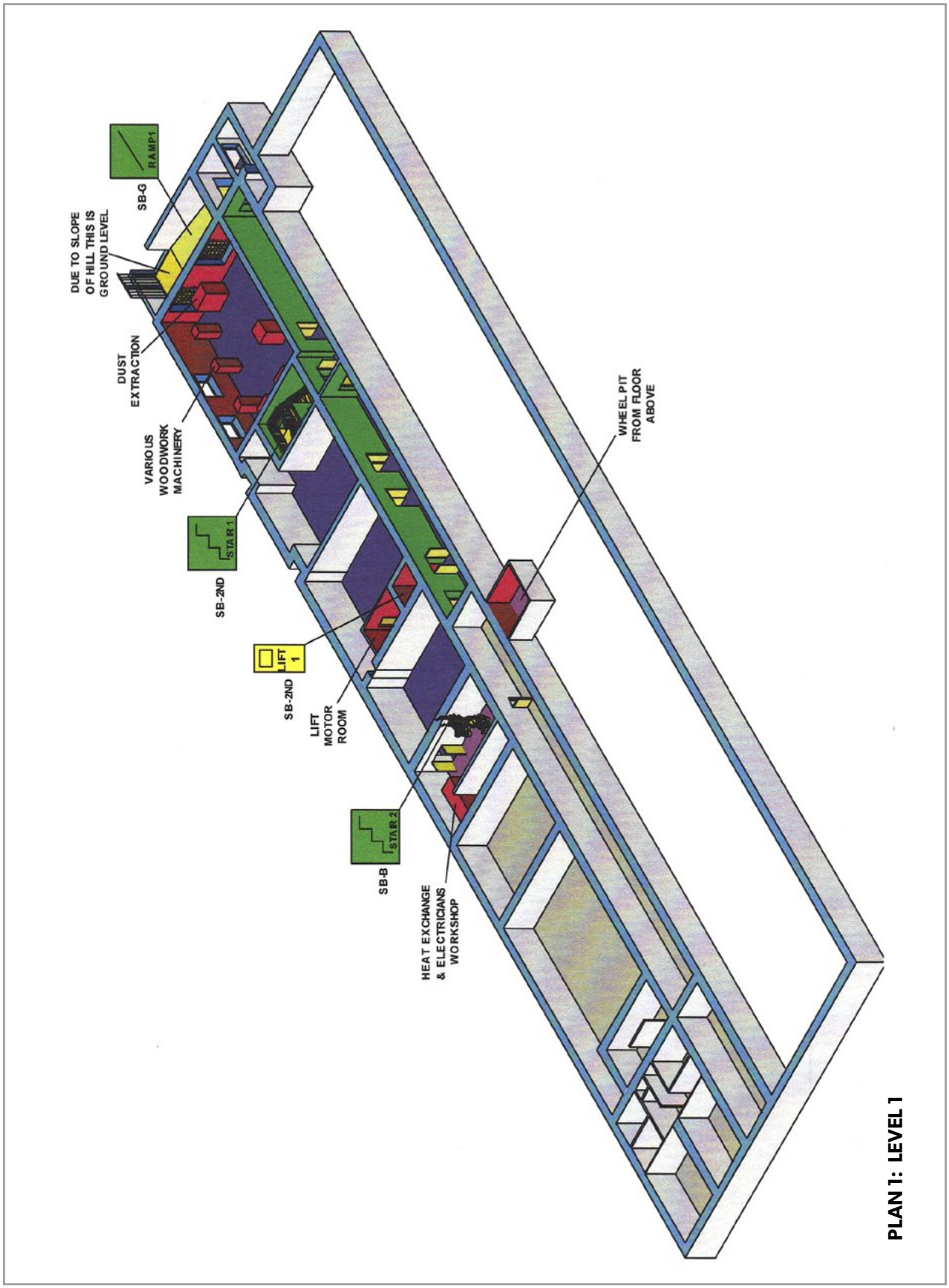
These messages take the following forms:

- **INFORMATIVE** – message – detailing the incident information and activity
- **ASSISTANCE** – message – requesting SFRS or partner agency resources
- **FIRE SURROUNDED** – message – used to communicate the fire is not going to spread further
- **STOP** – message – communicating that no further SFRS resources are required

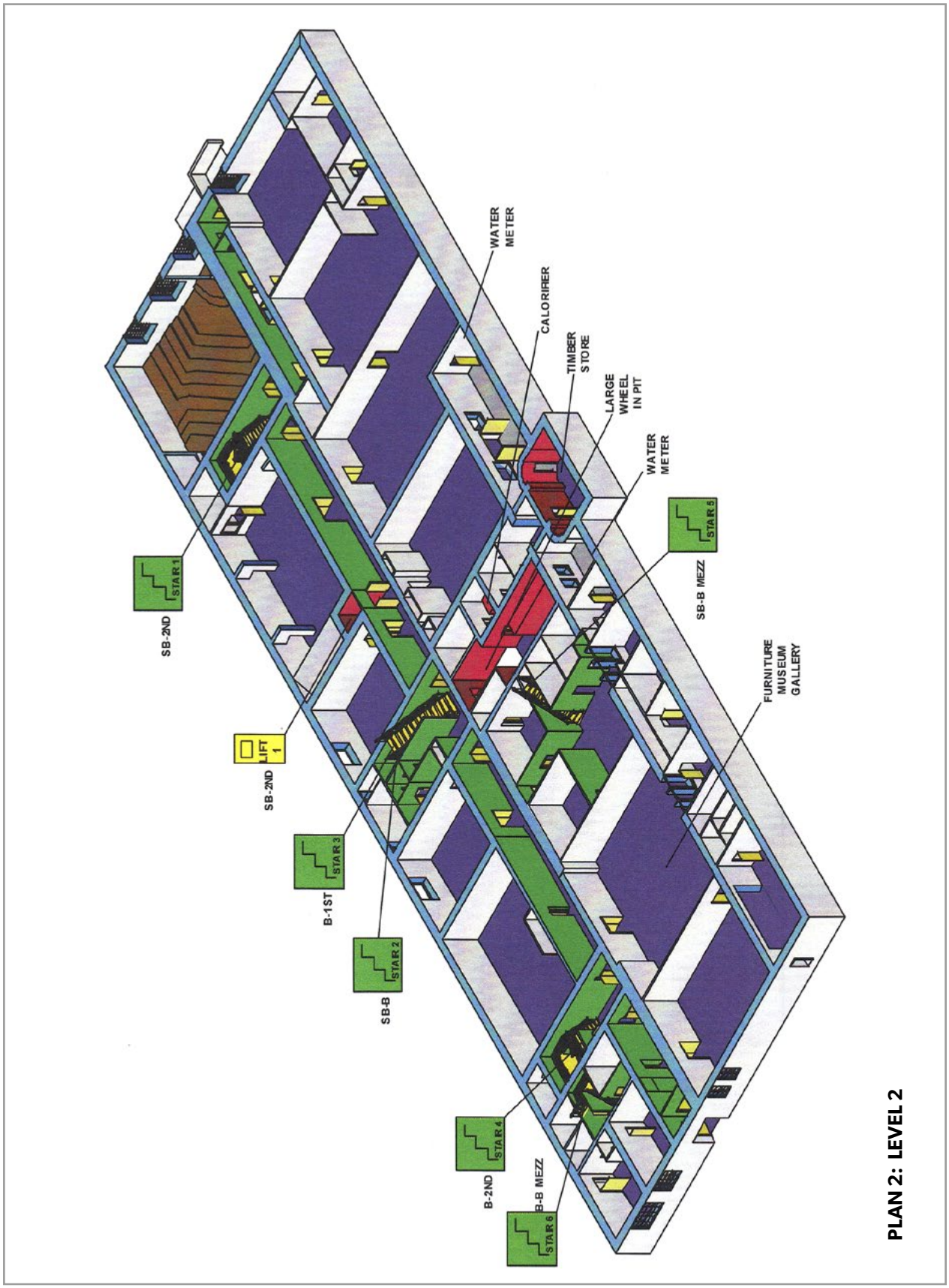
APPENDIX C.1


First SFRS crew entered via the Renfrew Street main entrance Level 4 at 23:25hrs.
Level 4
Level 2
Level 8
MAIN VIEW OF BUILDING

APPENDIX C.2

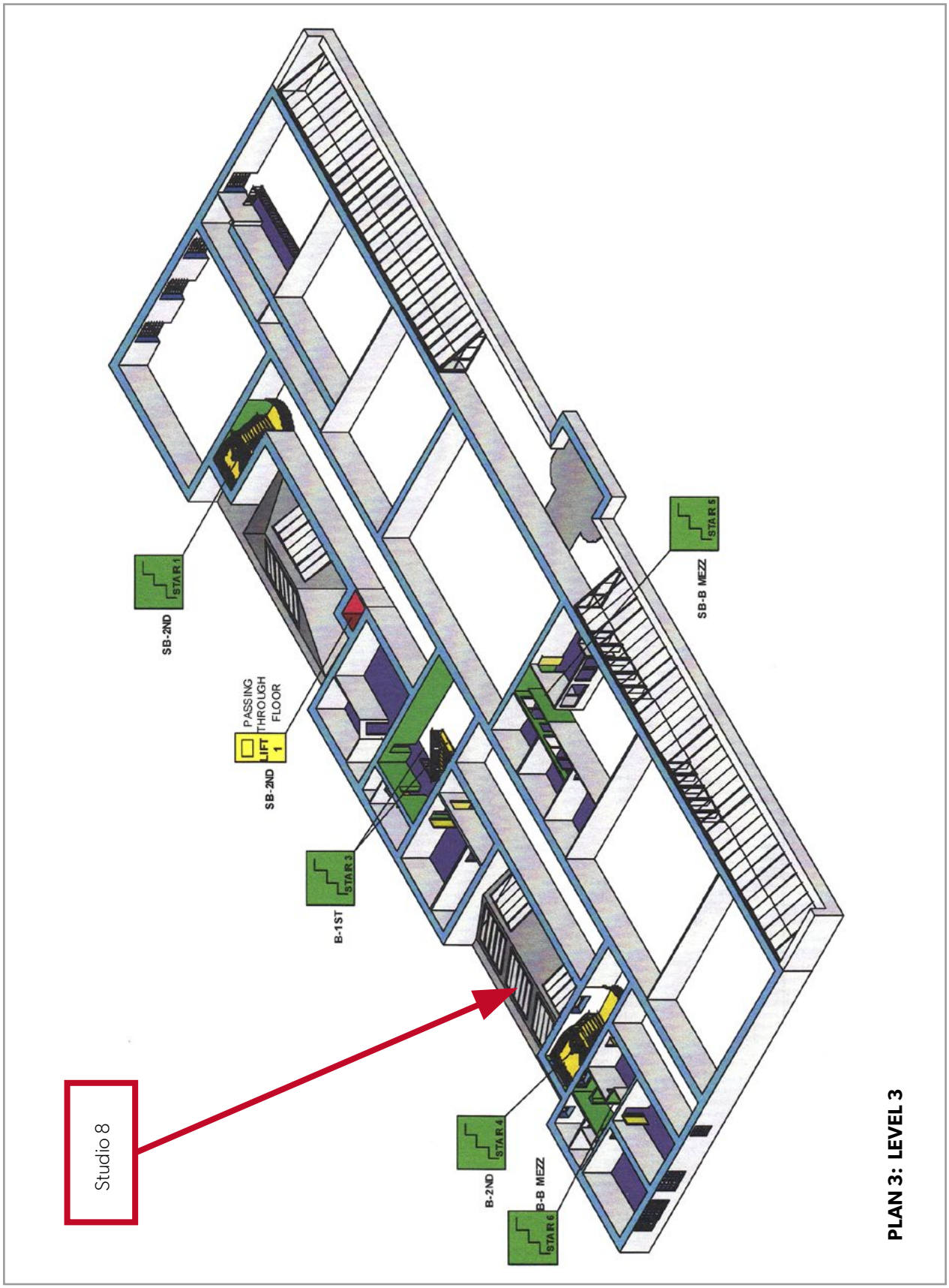

RAMP 1
SB-G
DUE TO SLOPE OF HILL THIS IS GROUND LEVEL
DUST EXTRACTION
VARIOUS WOODWORK MACHINERY
STAIR 1
SB-2ND
LIFT 1
SB-2ND
LIFT MOTOR ROOM
WHEEL PIT FROM FLOOR ABOVE
STAIR 2
SB-B
HEAT EXCHANGE & ELECTRICIANS WORKSHOP
PLAN 1: LEVEL 1

APPENDIX C.3



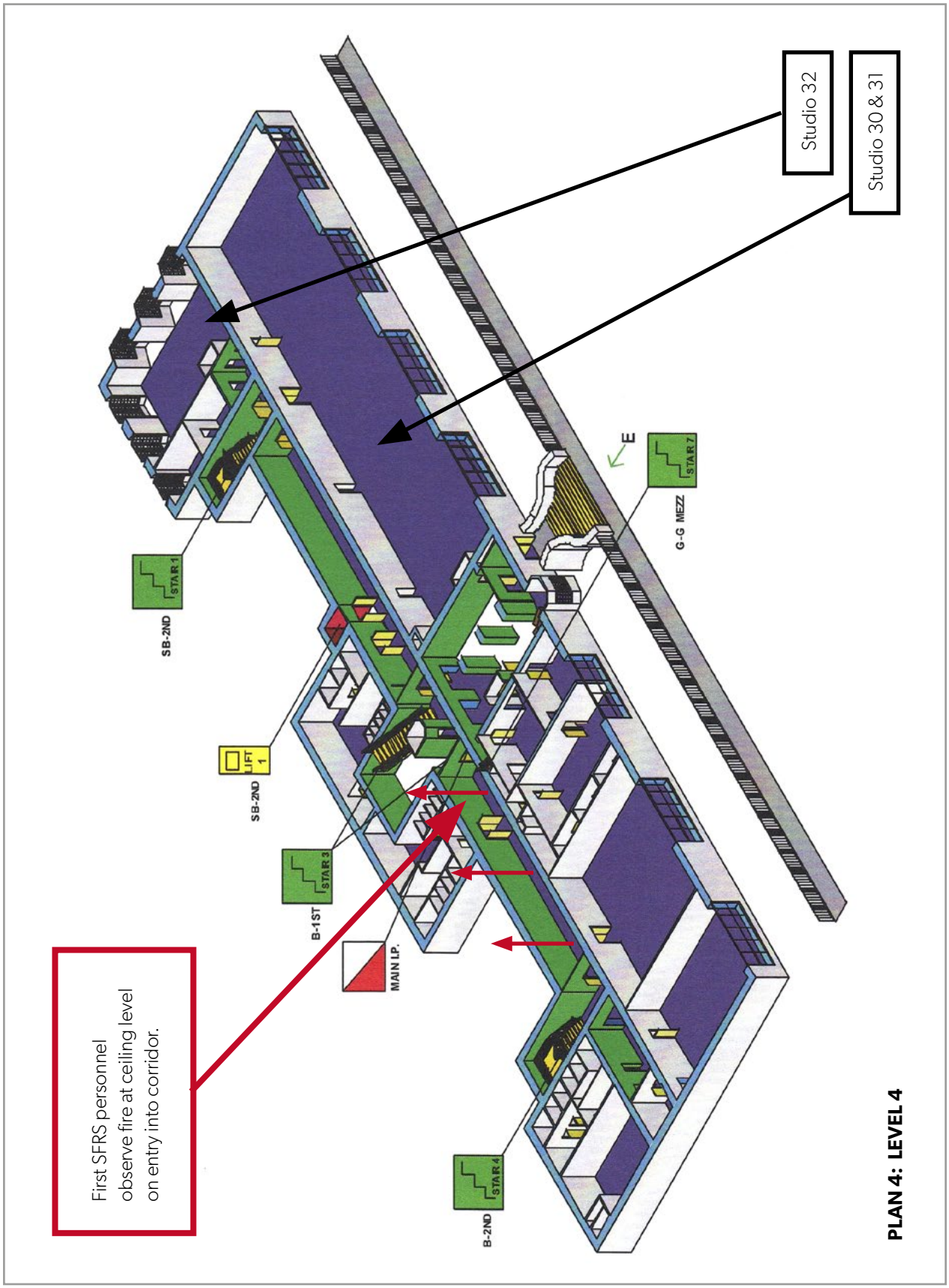
PLAN 2: LEVEL 2

APPENDIX C.4

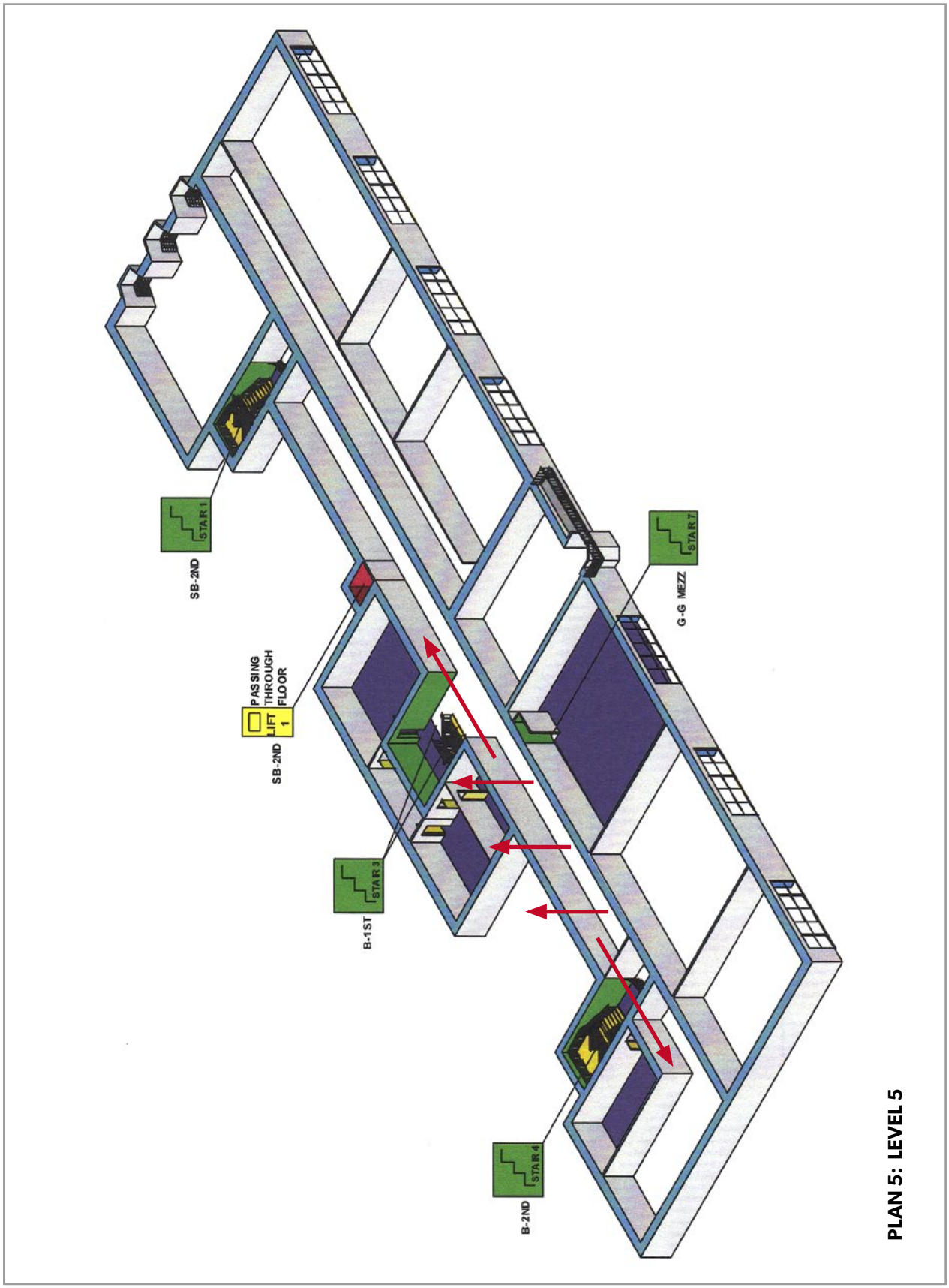


PLAN 3: LEVEL 3

APPENDIX C.5

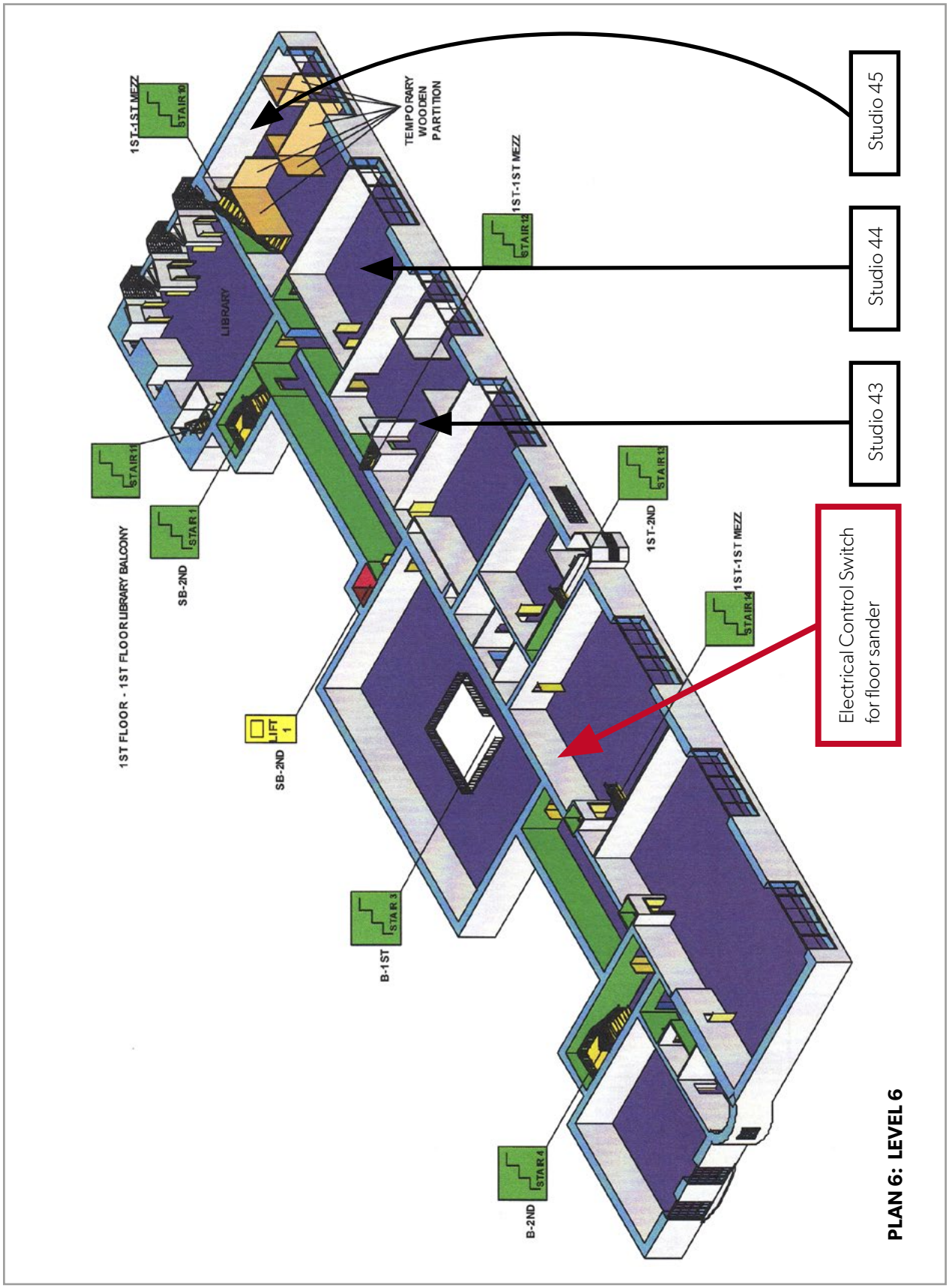

Studio 32
Studio 30 & 31
First SFRS personnel observe fire at ceiling level on entry into corridor.
STAR 1
SB-2ND
LIFT 1
SB-2ND
STAR 3
B-1ST
MAIN LP.
STAR 4
B-2ND
E
STAR 7
G-G MEZZ
PLAN 4: LEVEL 4

APPENDIX C.6



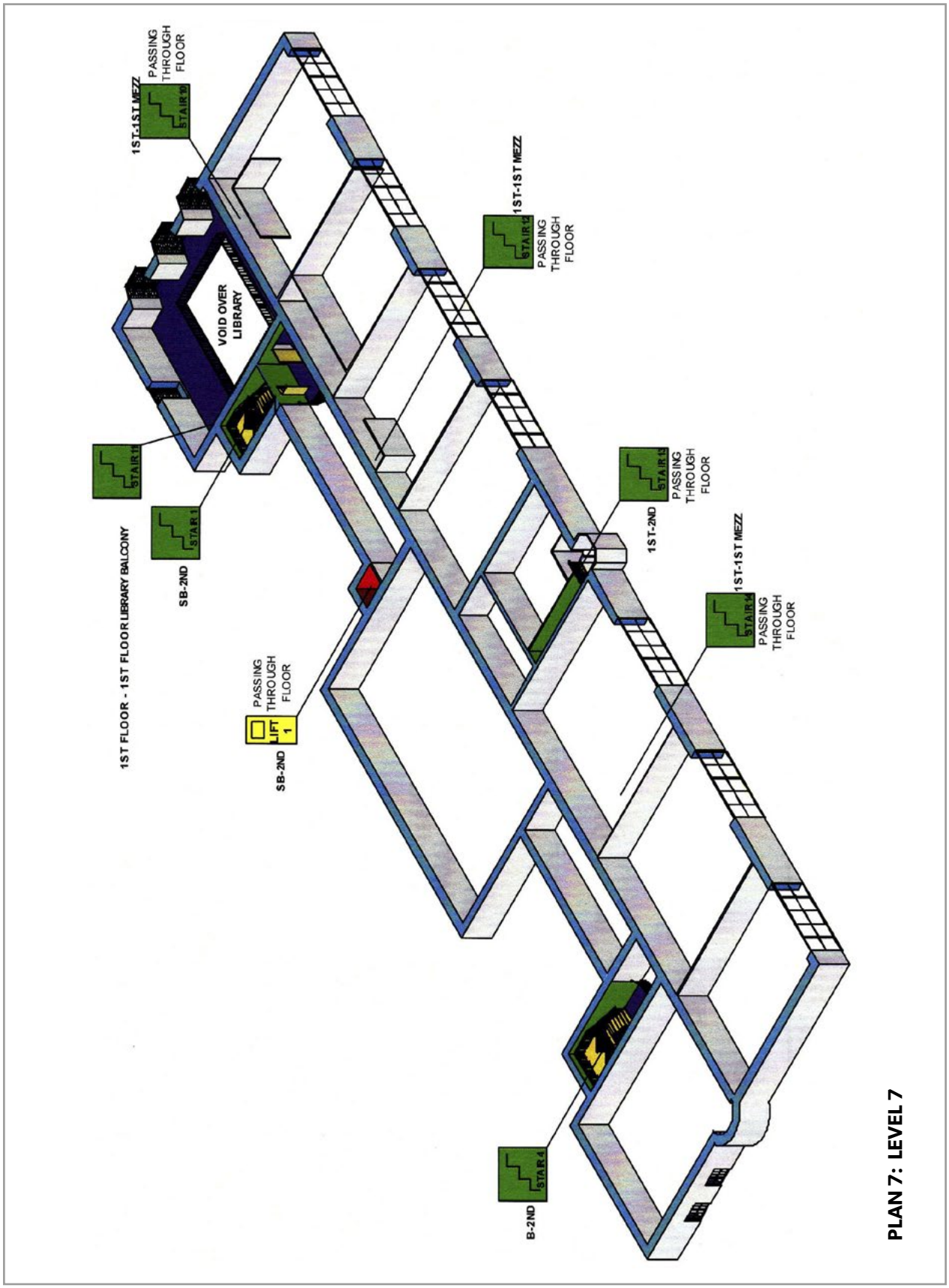
PLAN 5: LEVEL 5

APPENDIX C.7



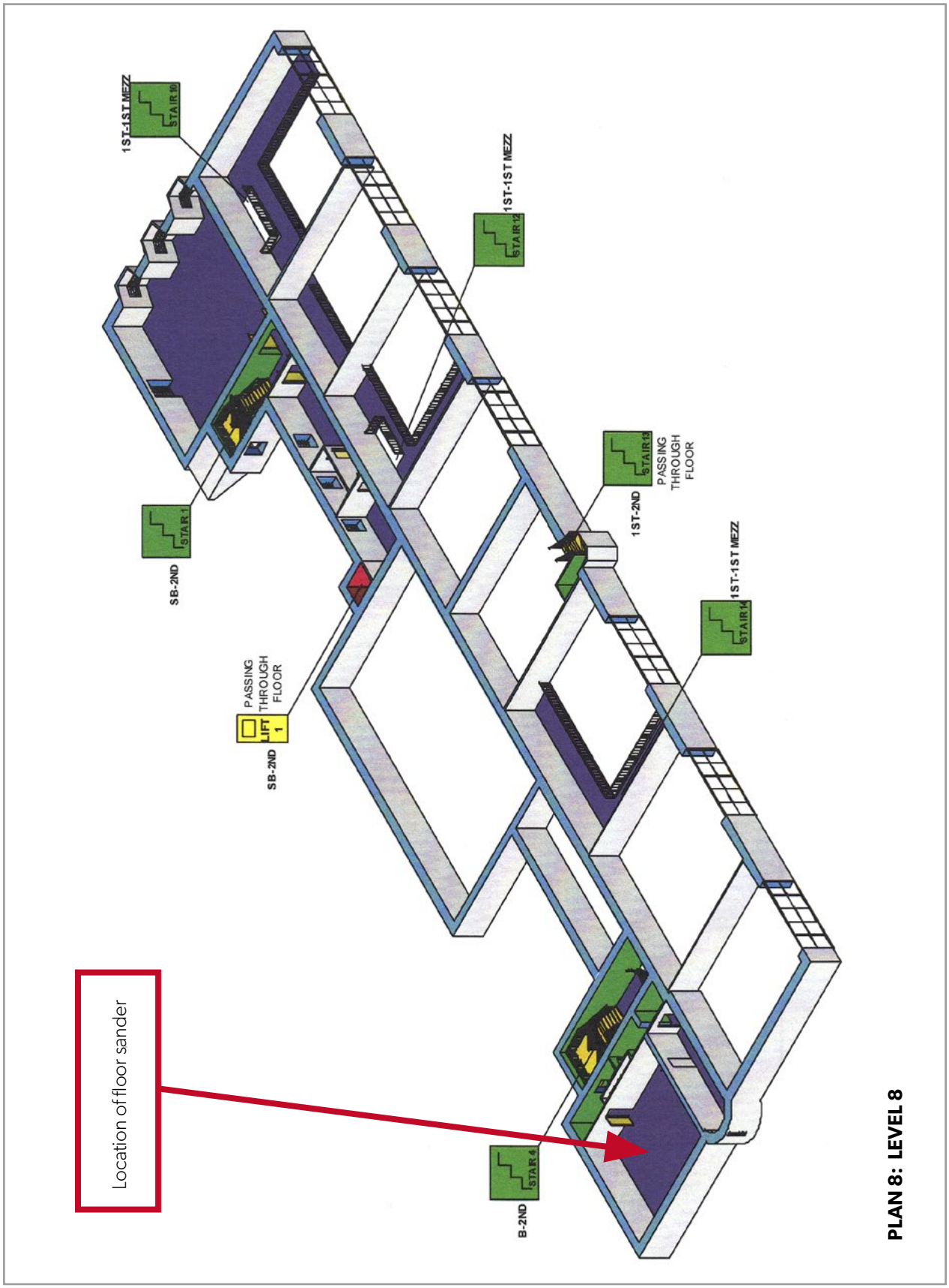
PLAN 6: LEVEL 6

APPENDIX C.8



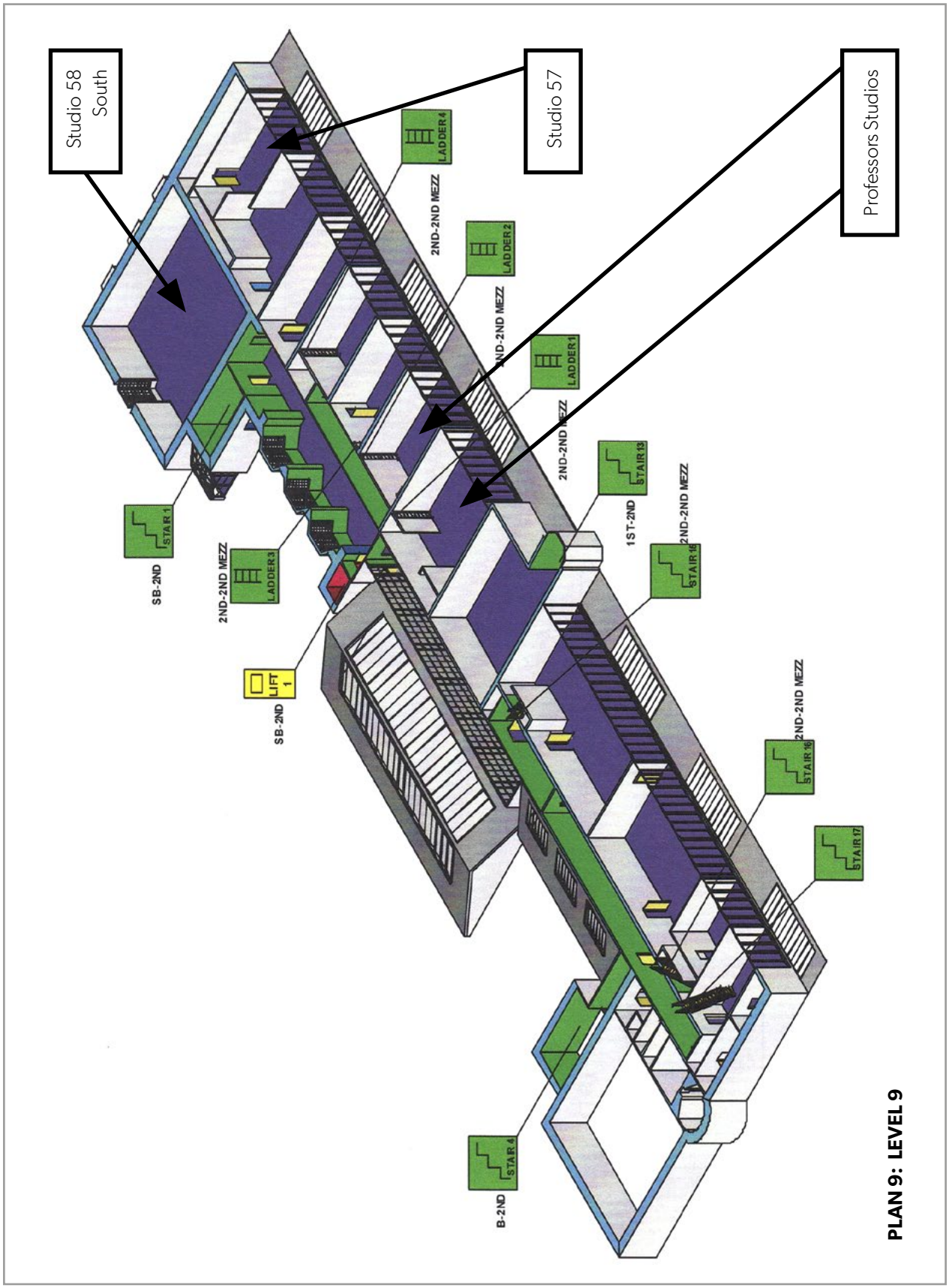
PLAN 7: LEVEL 7

APPENDIX C.9



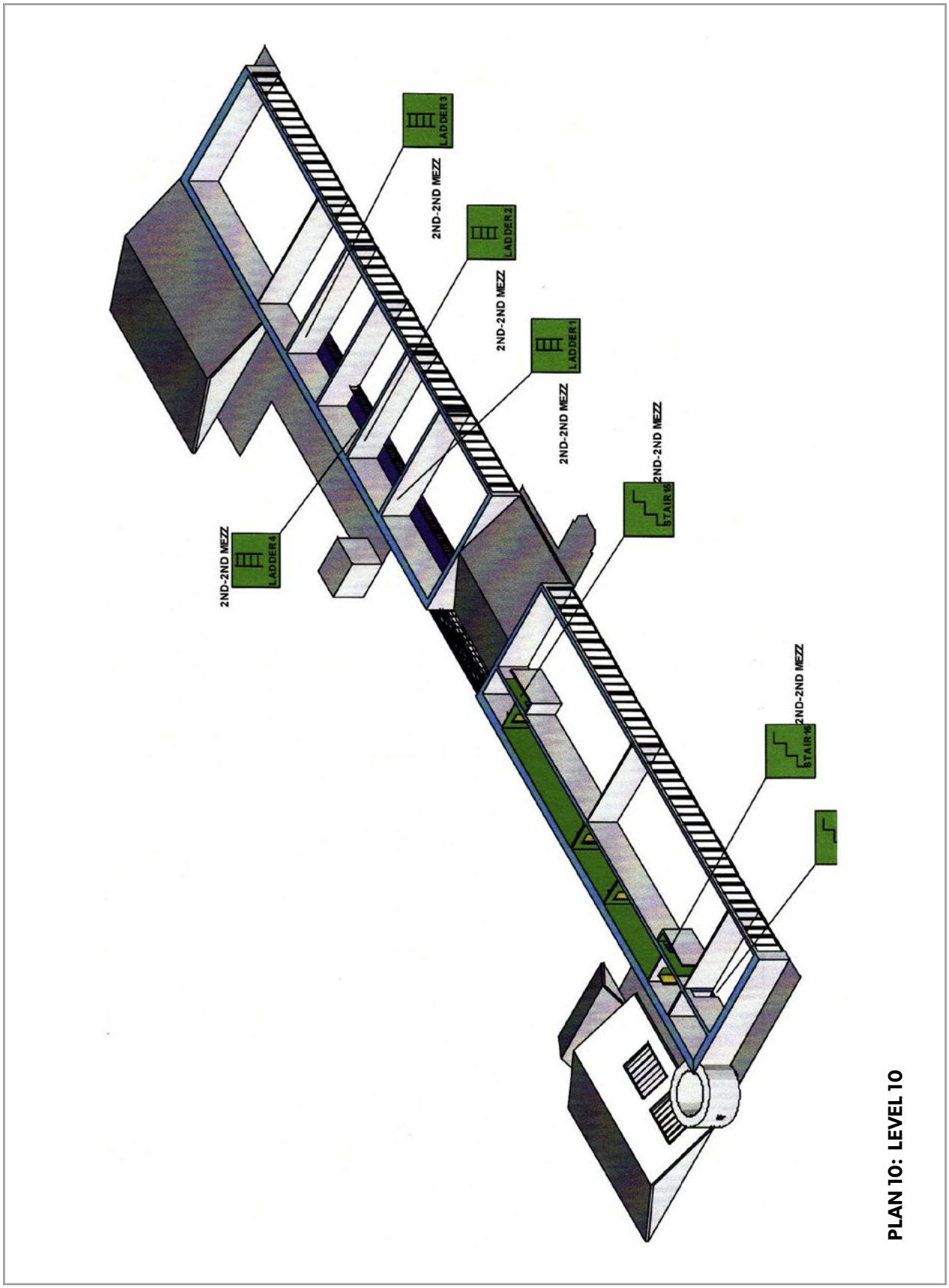
PLAN 8: LEVEL 8

APPENDIX C.10



PLAN 9: LEVEL 9

APPENDIX C.11



PLAN 10: LEVEL 10

APPENDIX C.12

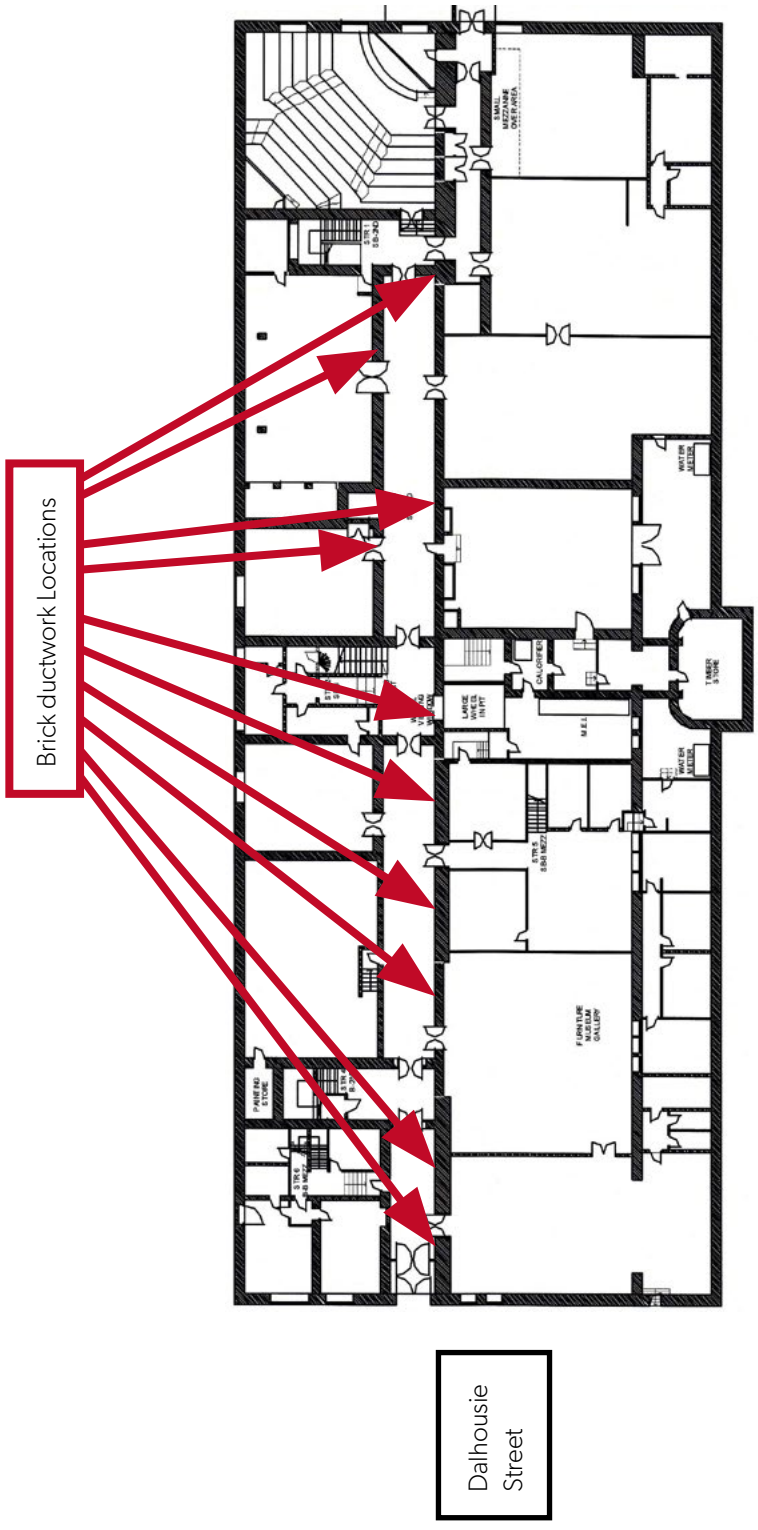


DIAGRAM 1

Diagram showing some of the brick duct locations within the building

APPENDIX C.13

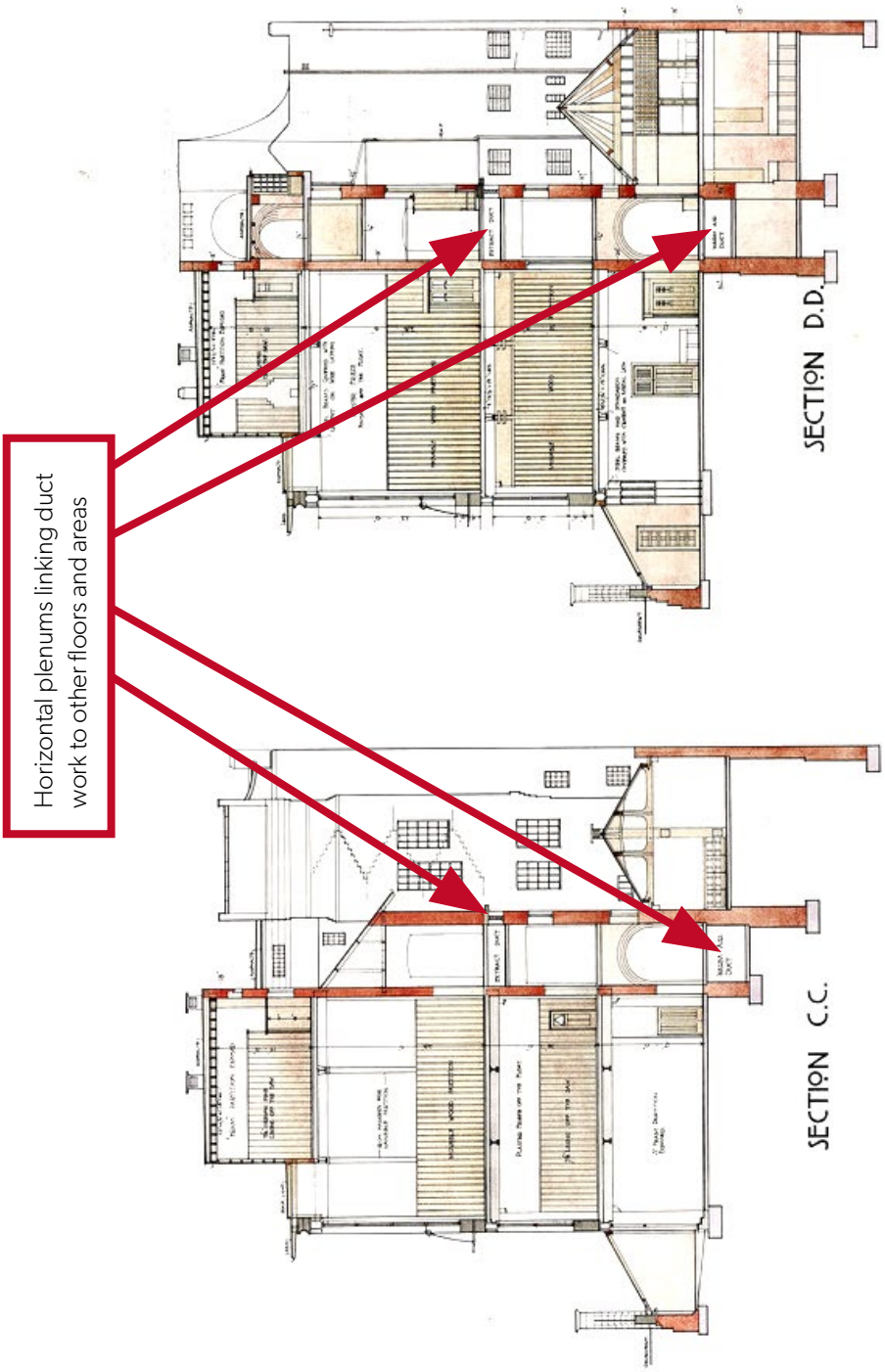


DIAGRAM 2

Diagram showing the horizontal service plenums at level 1-2 and level 6. These linked to horizontal ducts

APPENDIX D

Witness Statements

The following statements are taken word for word from statements given.

The text matches exactly what Police Scotland recorded during interviews with witnesses.

(Redacted)

APPENDIX E

High Risk Premises Descriptor

The SFRS Fire Safety Enforcement (Protection) Framework provides a strategic methodology for the identification and targeting of higher risk premises allowing effective deployment of limited Fire Safety Enforcement resources.

- Care Homes, Hospitals and Prisons are audited annually.
- Newly registered Care Homes within 7 working days of becoming operational.
- Hotels and Hostels which have a medium risk rating and Management Compliance Level (MCL) 3 or above.
- All significant sleeping risks not previously audited.
- All previously audited premises which have a High or Very High risk rating and MCL3 or above.
- HMO premises in line with the HMO auditing Policy.
- Post fire audits.
- Stage 3 UFAS.

APPENDIX F

References

Photographs contained within this report are courtesy of the Scottish Fire and Rescue Service, Glasgow School of Art, PASSER BY Three-dimensional plan drawings of each level courtesy of Scottish Fire and Rescue Service and the Glasgow School of Art.

Map views courtesy of Google Maps

APPENDIX G

Abbreviations

AA	AERIAL APPLIANCE
AC	AREA COMMANDER
BA	BREATHING APPARATUS
BBC	BRITISH BROADCASTING CORPORATION
BS	BRITISH STANDARD
CC	CREW COMMANDER
CCTV	CLOSED CIRCUIT TELEVISION
CID	CRIMINAL INVESTIGATION DEPARTMENT
CO	CHIEF OFFER
CPD	CONTINUOUS PROFESSIONAL/ PERSONAL DEVELOPMENT
CSO	COMMAND SUPPORT OFFICER
CSU	COMMAND SUPPORT UNIT
DACO	DEPUTY ASSISTANT CHIEF OFFICER
DC	DETECTIVE CONSTABLE
DI	DETECTIVE INSPECTOR
EA	ENFORCING AUTHORITY
FF	FIREFIGHTER
FIO	FIRE INVESTIGATION OFFICER
FIP	FIRE INVESTGATION PARTNERSHIP
FIU	FIRE INVESTIGATION UNIT
FSA	FIRE (SCOTLAND) ACT
FSEA	FIRE SAFETY ENFORCEMENT AUDIT
FSEO	FIRE SAFETY ENFORCEMENT OFFICER

FWS	FIRE WARNING SYSTEM
GC	GROUP COMMANDER
GSA	GLASGOW SCHOOL OF ART
HSE	HEALTH AND SAFETY EXECUTIVE
HVP	HIGH VOLUME PUMP
IC	INCIDENT COMMANDER
JOC	JOHNSTONE OPERATIONS CONTROL
LSO	LOCAL SENIOR OFFICER
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
PDA	PRE-DETERMINED ATTENDANCE
PS	POLICE SCOTLAND
RP	RESCUE PUMP
SAS	SCOTTISH AMBULANCE SERVICE
SC	STATION COMMANDER
SFJL	SKILLS FOR JUSTICE LEVEL
SFRS	SCOTTISH FIRE AND RESCUE SERVICE
SGN	SCOTTISH GAS NETWORKS
SMAS	SCAFFOLDING MOVEMENT ALARM SYSTEM
SORT	SPECIAL OPERATIONS RESPONSE TEAM
UPRN	UNIQUE PREMISES REFERENCE NUMBER
WC	WATCH COMMANDER

Michael McGurk
/ Alamy Stock Photo

SCOTTISH
FIRE AND RESCUE SERVICE
Working together for a safer Scotland

firescotland.gov.uk

Fire Investigation Report

The Glasgow School of Art, 15 June 2018

Version 1.0 January 2022