Fire & Rescue NSW

IN34/14

Barangaroo
29 Hickson Road
Sydney NSW 2000

Incident date
Wednesday, 12 Mar 2014

Investigator
Senior Firefighter [redacted]

Document ID: Doc ID

FIRE INVESTIGATION SYNOPSIS

Fire Investigation & Research Unit
Community Safety Directorate

BUILT ENVIRONMENT

Building

Construction Site

Occupants / activity

Construction Workers

Fire / incident description

Fire involving large quantity of combustible timber ply formwork on three levels; ground, basement one and basement two.
The fire area on all levels measuring approximately eighty metres by sixty metres, numerous ventilation gaps between the form work showing flames two to three metres in height and large volumes of smoke issuing from shielded areas of formwork.
An eighty six metre crane fixed in place and surrounded by timber ply formwork showed flames approximately two metres in height coming from vent gaps around the base.

INTERVIEWS

Fire & Rescue NSW-[redacted] City Of Sydney B Platoon

Upon arrival received numerous 000 calls. Heavy black smoke issuing from site.
Initial arrival set up two lines of 38mm hose for fire attack in sectors Alpha and Bravo.
Site mostly locked up, entry tools utilised to gain access.
Flames issuing two to three metres in height. Flames appeared to be coming from formwork.
Received information from site management (Lend Lease) that concrete had been poured six to seven days ago. Huge pour in two sections and concrete still very green[1].
Formwork was on fire and we were told that it was set alight by workers using acetylene welders. We asked if any persons remained on site and were informed all workers had been evacuated and no injuries had been reported.
The metal supports and formwork encasing the concrete had by this stage been destroyed by fire and the concrete is supporting itself. Concern is whether it can continue to support itself.
It was obvious that the entire form structure was involved in fire. We began fire attack in the accessible areas.
Heavy smoke began to come from the base of the crane. Flame then began to come up from the base of the crane like a chimney.
We're in defensive operations in all four sectors due to concerns about the integrity of the green concrete, if the concrete pour had taken place thirty or forty days ago things might be different.
We're getting temperatures at the moment of 1100 degrees using the thermal imaging camera. The readings are from the fire floor in close proximity to the legs of the crane base.

[1]Definition: Concrete that has set but not hardened

Have met with structural engineers regarding the crane and the concrete, the general opinion is that the concrete is green; it's unknown and unlikely that the crane will fall. If it does fall it will impact a large area.
If the heat has affected high tensile steel bolts securing the crane legs the result could be a rapid collapse.
The crane is ninety metres in height, if a single leg comes away from its anchors it may twist and buckle and come down. Due to this we have established a one hundred and fifty metre radius collapse zone.
The fire is shielded in areas and it's unsafe for offensive operations.

NSW Police Force- [redacted] **Sydney City Local Area Command**

Three statements from construction workers shared with FRNSW. Full statements available in FRNSW TRIM folder IN34/14.

Owner or occupant – Site Manager [redacted] **Lend-Lease**

Police are interviewing three construction workers.
Construction workers were carrying out hot work in the area were the fire started.
Crane Engineers are from the company called CMS Surveyors.
Formwork supplied by Dalma Corp project manager is [redacted] contact [redacted]
Column formwork supplied by Consystex, contact person is [redacted] [redacted]

Witness- [redacted] **Steelfix Courtley Rio (from Police Witness Statement)**
*Excerpts from full statement:

[redacted]

Witness- [redacted] **Steelfix Courtley Rio (from Police Witness Statement)**
*Excerpts from full statement:

[redacted]

[redacted]

Witness- [redacted] **Welder Zanx Welding (from Police Witness Statement)**
*Excerpts from full statement:

[redacted]

[redacted]

PHYSICAL INDICATORS

External

Large area approximately eighty metres by sixty metres surface formwork charred black and completely destroyed in some areas. Supporting aluminium framing props partially melted and deformed from heat. Black soot marks on the trellis metal frame at crane base.

Internal

Basement level one showed severe fire damage to timber formwork throughout the area which was visible from ground level.
The main fire area was badly damaged and inaccessible.

Photo 84 showing fire damage to formwork at ground level. Area inaccessible.

The formwork on Basement level one was mostly burnt through at ceiling level and partially destroyed at ground level with the remaining timber showing deep charring.

Photo 22 showing Basement level one: Damage at ceiling height.

Basement level one showed large areas of exposed concrete with soot deposits and displaying chipping and pitting damage from spalling[1].

Photo 16 showing Basement level one: Soot deposits to concrete and spalling.

[1]NFPA 921 Guide for Fire and Explosion Investigations 2014 Edition 3.3.163 pg 18

The aluminium reinforcement props on the outer limits of the area involved in fire on basement level one showed signs of being exposed to extreme heat.
The concrete above the supporting props showed a dark brown deposit of soot.
The timber formwork in this area showed signs of deep char.
The upper ends of the aluminium supports were deformed and melted indicating that the material was exposed to temperatures of around 660ºC[1].
At the outer limits of the fire damage area were aluminium support props which showed signs of clean burn[2] which occurs when soot has failed to deposit because of high surface temperatures.
The visible fire damage to the aluminium support props indicates that hot fire gases were burning in conjunction with the combustible materials and producing temperatures in excess of 600ºC

Photo 45 showing basement level one aluminium support props.

[1] DeHaan, J. Kirk's Fire Investigation 7th Edition 2012 Chapter 7 pg 295
[2] NFPA 921 Guide for Fire & Explosion Investigations 2014 Edition 3.3.30 pg 14

CAUSE AND ORIGIN

Area of origin

The area of origin appears to be at the Southern most end of the site perimeter. This area was being prepared for concrete pour. The area of most damage appears to be the first basement level.

The damage to the combustible materials on ground level is less severe than the damage to the basement level below. Looking at ground level in isolation, the area of greatest damage identifies the southernmost column as the area of origin. At this area of origin I observed an electric grinder with a metal cut off wheel attached, also a number of fire extinguishers lying on the ground and a garden hose with water still running.

Consistent with the witness statements, my observations and further inspection of the steel reinforcement indicates that the southernmost column was the one being worked on by steel fixers. The steel reinforcement showed signs of oxy acetylene cuts in sequence.

The polystyrene product formwork surrounding the steel reinforcement at this column was completely destroyed.

Photo 73 showing an example of the polystyrene product used to form the concrete columns. This picture is taken from a separate area of the Barangaroo site. It is confirmed by Lend Lease staff as being the same as the product used in the fire involved area.

The destruction of the combined formwork where the concrete column base extends to the first basement level indicates the area of most damage to be the southernmost column beginning at the first basement level floor. This is my observation from approximately six metres away. The area was inaccessible at the time of investigation and no excavation had been carried out to allow further investigation.

Layout of combustible materials

The fire involved area contained a large volume of combustible materials. The main fuel load being the formwork materials used to prepare the area for the next concrete pour.

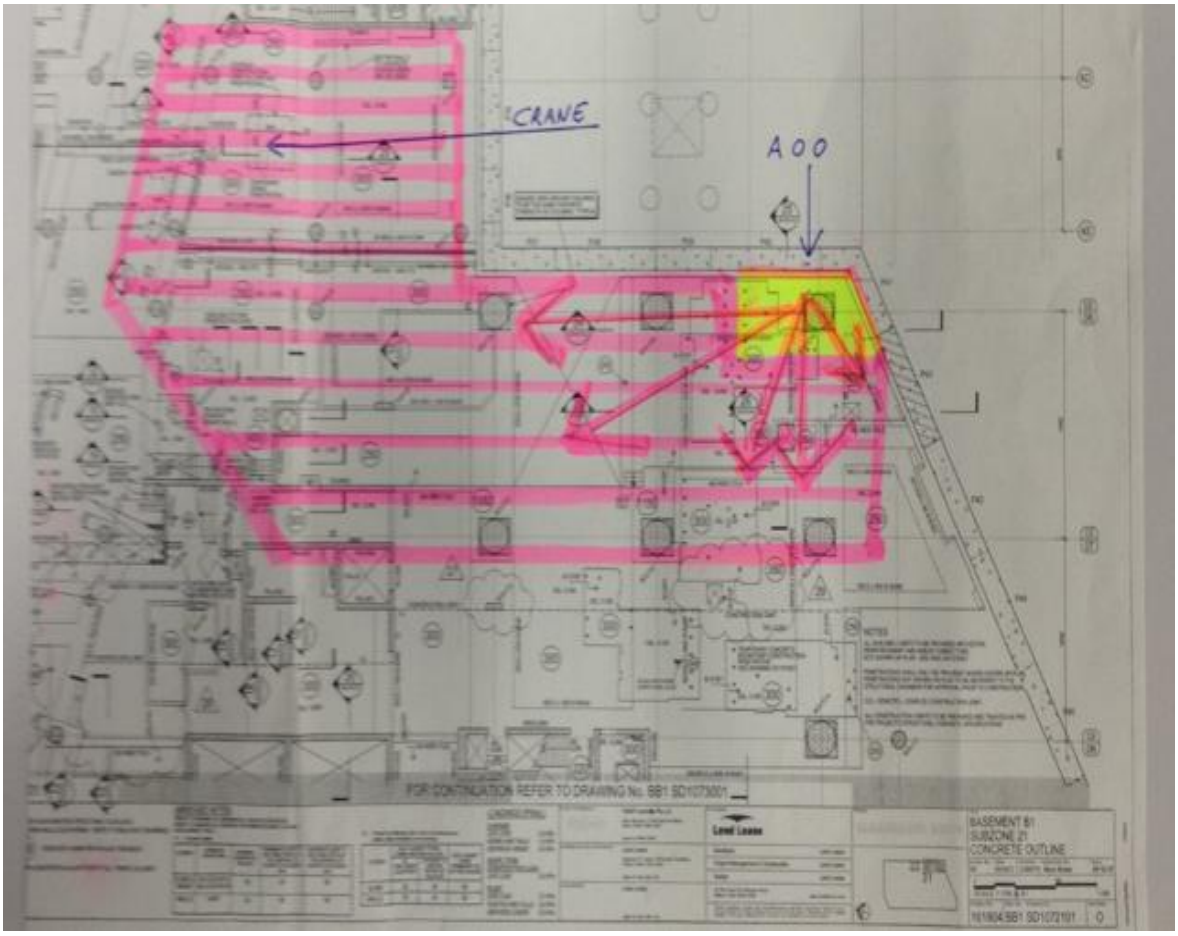


Photo of building plan basement one showing fire involved area and area of origin.

The formwork consisted of the following products:

CHH H2 (TERMITE) TREATED LVL PLYWOOD
CHH H2 (TERMITE) TREATED LVL I JOIST
CHH Woodproducts (Big River Timbers) supplied by Dalma Formwork

AU + S EXPANDED POLYSTYRENE FOAM (EPS)
Australian Urethane and Styrene PTY LTD supplied by Consystex

RAMSET FOMOFILL (FMFLG500, FMFLG750)
ITW Ramset Australia supplied by Dalma Formwork

Photo showing timber plywood formwork sheet.

Photo showing timber formwork beam.

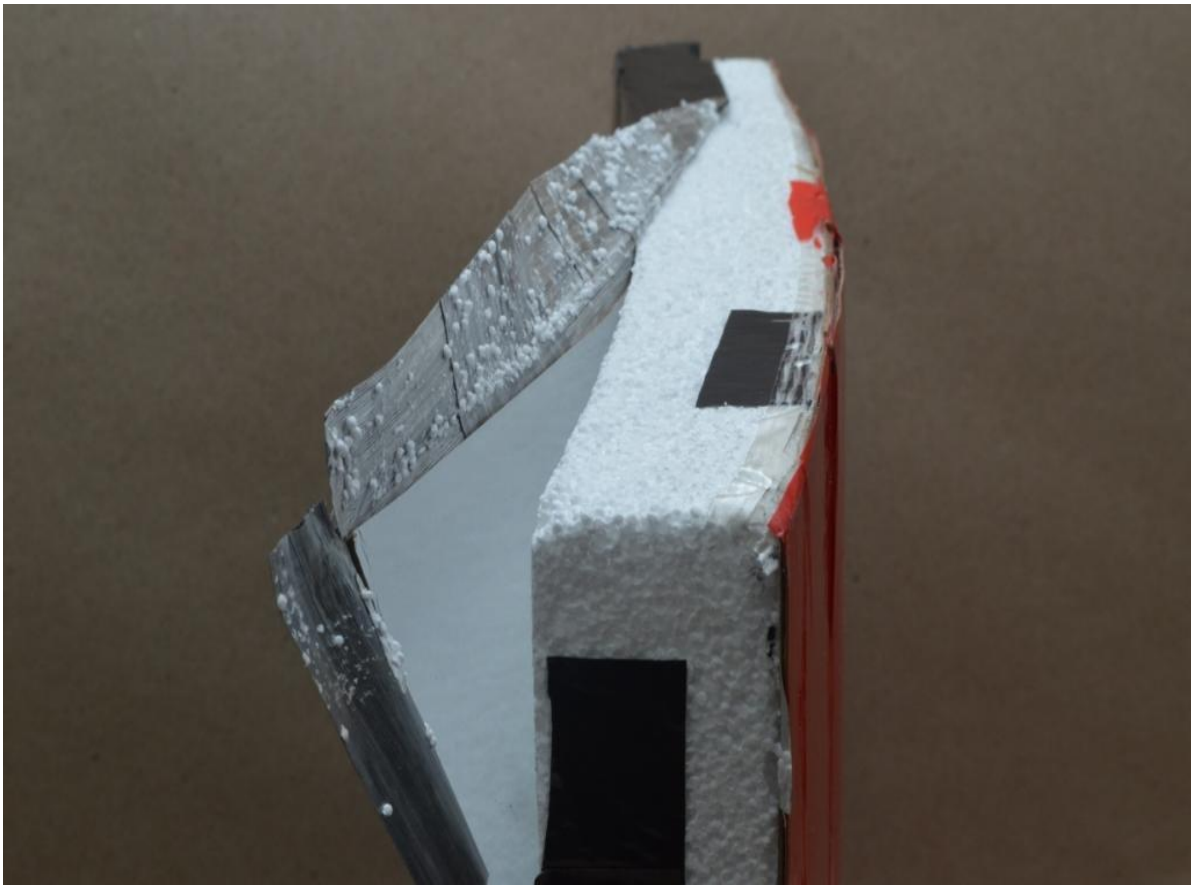
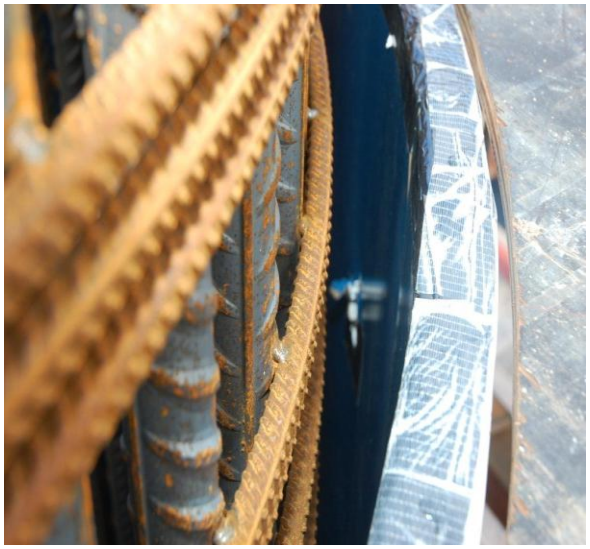


Photo showing expanded polystyrene foam formwork product.



Photos showing the expanded polystyrene foam formwork in use at Barangaroo.

Product Image showing RAMSET FOMOFILL (FMFLG500, FMFLG750)

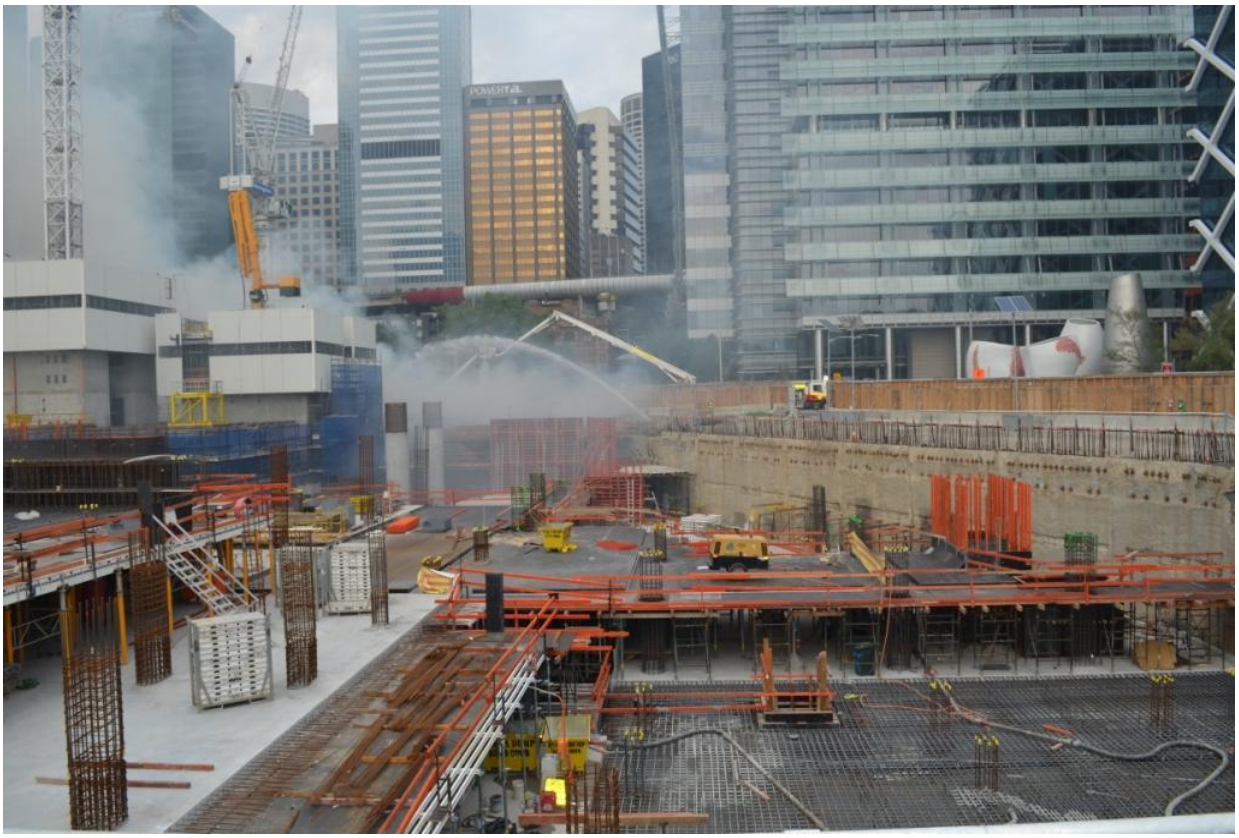


Photo 21 showing the placement and layout of formwork at a separate area of the Barangaroo site. Firefighting operations visible in background.

Analysis of combustible materials

CHH H2 (TERMITE) TREATED LVL PLYWOOD AND BEAM
As per MSDS information supplied by CHH and Big River:

Flammability

-The boards are flammable but difficult to ignite.
-Avoid sources of radiant heat and flame, and avoid sparks and sources of ignition in all electrical equipment including dust extraction equipment.
-People must not smoke in storage or work areas.

Fire/Explosion Hazard

Early fire hazard properties as determined in accordance with AS1530 pt3
-Ignitability Index 14
-Spread of Flame Index 8
-Heat Evolved Index 8-10
-Smoke Developed Index 2-3

AU + S EXPANDED POLYSTYRENE FOAM (EPS)
As per MSDS information supplied by Consystex and Australian Urethane and Styrene PTY LTD:

Flammability

-Combustible. Air/Dust mixtures are flammable.

Hazards

-The product contains a combustible thermoplastic, which will melt and drip when ignited.

Melting Point

80ºC

Other Information

-General purpose flame retarded rigid polystyrene foam.

RAMSET FOMOFILL (FMFLG500, FMFLG750)
As per MSDS information supplied by ITW Ramset Australia**:**

Flammability

-Extremely flammable.

Fire/Explosion Hazard

-Liquid and vapour are highly flammable.
-Severe fire hazard when exposed to heat or flame.
-Vapour forms an explosive mixture with air.
-Severe explosion hazard, in the form of vapour, when exposed to flame or spark.

Fire Incompatibility

- Avoid contamination with oxidising agents i.e. nitrates, oxidising acids, chlorine bleaches, pool chlorine etc. as ignition may result.

Timeline

1300 Steel Fixers commence work on steel column
1350 Steel Fixers stop work and leave site for lunch
1355 Approximate time the alarm was raised by Contractor [redacted]
1400 FRNSW turnout
1410 FRNSW on scene
1403 First FRNSW message: “Confirmed Fire – Ground level”
1408 FRNSW message: “Large volume of smoke from basement area”

Presence of gas

In his police statement [redacted] stated that at 1100 he noticed a strong smell of methane gas. [redacted] further elaborated that he knew it was methane because it has a distinctive smell, like rotten eggs.

In his police statement [redacted] stated that he could smell gas at about 0800.

No '000' calls were placed on the day of the fire regarding a gas leak at the Barangaroo location.

No gas readings were collected using a gas detector by FRNSW on that day.

FRNSW carried out atmospheric monitoring at the site during firefighting operations.

To my knowledge there was no collection of a gas reading which identified the presence of methane gas at the Barangaroo site on the day of the fire.

Methane gas is the chief component of natural gas which is a mixture of gases lighter than air, in its natural state Methane is an odourless, colourless gas. Commercial natural gas has an odorant added to it.

To my knowledge there was no report of a leaking gas main on the day of the fire.

The presence of gas may have contributed to the fire situation, however the area is well ventilated and methane or natural gas being lighter than air may have dissipated if it had been in small doses i.e. not a leaking or ruptured gas main.

[redacted] made reference to the smell of rotten eggs which is an odour associated with Hydrogen Sulphide gas (H2S).

FRNSW monitored the area during firefighting operations using several gas detectors which are set up to collect H2S readings; none were reported during the fire.

To my knowledge there was no collection of a gas reading which identified the presence of H2S at the Barangaroo site on the day of the fire.

Competent ignition source

Definition: An ignition source that has sufficient energy and is capable of transferring that energy to the fuel long enough to raise the fuel to its ignition temperature.[1]

Work being carried out by steel fixers around 1300 involved using a four and a half inch electric grinder with a metal cut off wheel (observed at the scene). According to witness statements the work at this location involved cutting metal reinforcement rods.

Incandescent particles have been observed up to 5 metres from a handheld grinder being used on a steel reinforcing bar. Such sparks reportedly have a starting temperature of 1600ºC to 2130ºC. (DeHaan 2012)[2].

Work being carried out by steel fixers around 1300 also involved using an Oxy-Acetylene torch to cut the metal reinforcement rods. The Oxy-Acetylene torch cuts metal by bringing it to its kindling temperature which coincides with ignition temperature (NFPA 921 2014)[3]. Depending on its composition steel typically melts between 1100ºC and 1650ºC.

[1] 921 Guide for Fire & Explosion Investigations 2014 Edition 3.3.116 pg 15
[2] DeHaan, J. Kirk's Fire Investigation 7th Edition 2012. Chapter 6 pg 199
[3] NFPA 921 Guide for Fire & Explosion Investigations 2014 Edition 3.3.116 pg 17

A welder was working near the area of origin and switched his welder off around the same time the steel fixers shut down the oxy-acetylene and went to lunch. The welding equipment has not been inspected by me and the welding temperatures for work carried out are not known to me

Point of origin

The process in forming the concrete at the Barangaroo site involves liberal application of the Ramset Fomofill product in order to seal the gaps between the form panels and tubes thereby preventing wet concrete from spilling during the pour.

It is my understanding that this method of formwork results in a high quality finish to the concrete once cured. This was observed by inspection of completed concrete work in other areas of the site.

Understanding of the process used in forming the concrete columns in conjunction with analyses of the witness statements and inspection of the visible damage indicates a likely point of origin to be the top of the existing formed concrete on the southernmost concrete column.

Cause (opinion)

A competent ignition source exists in the area of origin at the time of the fire starting and the alarm being raised.

In my opinion three ignition sources exist as a hypothesis. Either the heat produced by the welding work, a spark produced by the angle grinder or hot metal cut off by the oxy-acetylene torch had sufficient energy to transfer energy to the fuel long enough to raise the fuel to its ignition temperature.

The fuel located in the area of origin consisted of several combustible materials, in particular the Ramset Fomofill product which is highly flammable. The combustible materials which were in the area of origin are all capable of being ignited by the hypothesized ignition source.

It is my opinion that carrying out hot work[1] in proximity to the volume and configuration of combustible material at the point of origin has resulted in an accidental fire.

[1]defined as the undertaking of a process that may generate significant heat or sparks.

[redacted]
Senior Firefighter
Fire Investigation & Research Unit

