The Coode Island Fire Incident and its Consequences

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The Coode Island Fire Incident and its Consequences

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1. Introduction

- A fire at a suburban chemical storage facility almost led to a catastrophic incident in the City of Melbourne, Australia.

- Just after 2pm on an August day in 1991, firefighters from multiple fire stations were called to Coode Island after an initially inaccurate report of a shipping container being ablaze.
1. Introduction

• A 600,000 litre chemical storage tank full of acrylonitrile exploded at 2.15 p.m., and the fire that followed the explosion lasted for two days.

• The facility is located only a few kilometres from Melbourne’s Central Business District (CBD) and even closer to residential areas.
1. Introduction

• A number of official inquiries were conducted following the incident

• Recommendations:
  – Changes to the monitoring of the safety standards and the corresponding legislation
  – Relocation of hazardous material storage away from residential areas
1. Introduction

• Despite the years passing since the incident it is still debated vehemently in Australia as a number of successive state governments failed to implement the recommendation of moving the facility.
1. Introduction

- The objective of this paper is to:
  a. provide a brief overview of the incident;
  b. discuss the post-incident investigations;
  c. list the key lessons to be learned; and
  d. discuss the concept of multi-agency response to major incidents.
2. Background

- Coode Island, is located 4 km west of Melbourne’s CBD.
- It is part of the Port of Melbourne.
- It is occupied by container storage, rail yards, and a number of chemical storage facilities.
2. Background

Coode Island Facility

Residential Areas

Approx. 4 km

Melbourne CBD
2. Background

• The chemical storage terminal comprised 44 tanks with a total capacity of 45,000$\text{m}^3$ / 54,000 tonnes.

• Chemicals stored included:
  – Acrylonitrile (vinyl cyanide)
  – Phenol
  – Methyl ethyl ketone
  – Butanol
  – Benzene
3. The Incident

- On August 21, 1991, a 600,000 litre chemical storage tank full of acrylonitrile exploded at 2.17 p.m.
3. The Incident

• What happened:
  – Rising up into the air of tank no:80 which contained acrylonitrile (vinyl cyanide) monomer.
  – The discharging of its contents into the tank bund.
  – The crashing down of the tank and associated pipework and pump, onto the main fire-fighting water and foam lines of the plant adjacent to the office building.
3. The Incident

• What happened:
  – Shortly after, tank no:81, which contained molten phenol and was located in the same bund, rose into the air and landed near to benzene tank no:79.
  – A very large fire ensued in the tank bund area in a relatively short period of time.
3. The Incident

• What happened:
  – A number of other tanks became involved and either blew off their lids or collapsed in place.
  – The truck-fill stand and two trucks previously loading benzene quickly became involved as did the nearby drum-filling area.
3. The Incident

• What happened:
  – The incident was substantially over later in the day but flared up again the following day following inability to extinguish a residual flange fire emanating from methyl ethyl ketone (MEK) tank no:69.
3. The Incident

• What happened:
  – The propagation was found to be:
    • due to passage of fire through the interconnecting vapour recovery system pipework; and
    • through the fire-fighting foam network which connected tanks together.
3. The Incident

• The Cause *(speculatively)*:
  – An explosion in the vapour space of acrylonitrile tank no: 80 following a strike of ‘St Elmo’s Fire’ entering through the pressure/vacuum relief valve (PV-valve) at the top of the tank.
3. The Incident
3. The Incident

• Incident Timeline:
  – 21 August, 1991
    • First explosion: 2.17 pm
    • Fire controlled: 5.30 pm
  – 22 August, 1991
    • Second explosion: 11.30 am, (caused by a ruptured pipeline)
    • Fire spread to four other storage tanks
    • Fully extinguished by late afternoon
3. The Incident

• Some phenomena observed:
  – Tanks rising vs lids popping
    • Some tanks which were on fire rising into the air and others remaining in-place and popping their lids.
    • Design intent is for tanks to pop their lids.
    • The cause for tanks to rise was found to be a consequence in some cases, of wall-to-roof welds being stronger than wall-to-floor welds.
3. The Incident

- Fourteen tanks were totally destroyed and 18 others were damaged.
- Approximately 10 million litres of chemicals was burnt.
3. The Incident

- The fire created a toxic cloud over nearby residential suburbs, which was fortunately dispersed by high winds.
- The wind direction was favourable that it blew the smoke away from the CBD and densely populated residential areas.
3. The Incident
3. The Incident

• Before, after and today:
4. Fire Brigade Intervention

- 1\textsuperscript{st} Alarm: 14.17 pm
- Word back and 5\textsuperscript{th} alarm: 14.23 pm
- Fire brigade dispatched
- Total of 40 trucks and 130 firemen arrive at the scene
4. Fire Brigade Intervention

• First 90 minutes very little progress was made
• Lack of foam hampered fire fighting attempts
• After 3 hours fire was under control
• Emergency response during Day 1
  – Local residents were evacuated to the nearby Western Oval, and four ships in the port were also evacuated.
4. Fire Brigade Intervention

• Emergency response during Day 1
  – Several areas in Melbourne were closed, and police redirected the traffic, as a black cloud drifted over.
  – Residents in other areas were advised to stay indoors and to close windows and doors.
4. Fire Brigade Intervention

• Emergency response during Day 1
  – By 5 p.m. office workers in the city were advised to stay inside and turn off air-conditioners, as the cloud drifted southeast.
4. Fire Brigade Intervention

• Emergency response during Day 1
  – By 11 p.m. the Environmental Protection Agency had determined that the cloud contained acrylonitrile, phenol, butanol, methyl ethyl ketone, and cyclohexane
Next morning a new explosion occurred at 11.30 am

Despite efforts, new ignitions followed
4. Fire Brigade Intervention

- Eventually fire vehicles with fire retardant chemicals (foam) were brought in.
• After 4 hours the fire was fully extinguished
4. Fire Brigade Intervention
5. The Consequences

- Melbourne was very lucky that the Coode Island incident did not further develop to become a disaster.

- The initial response by the Government was to announce a two-stage inquiry.
5. The Consequences

• The two key findings of the inquiry were that:
  1. Coode Island's storage systems failed international safety standards
  2. There had been about 400 breaches of regulations after years of poor scrutiny

• The inquiry recommended that:
  – the hazardous chemical storage facility should be moved to West Point Wilson.
5. The Consequences

[Map showing current and proposed locations]
5. The Consequences

- For the next facility the Coode Island Review panel recommended:
  a. remote impounding basins to collect and contain spills;
  b. sufficient spacing between tanks to minimise incident escalation or knock-on effects;
5. The Consequences

• For the next facility the Coode Island Review panel recommended:
  c. appropriate separation between different grouped tanks of chemical products;
  d. provision of immediate road access around every area for fire fighting, spill recovery and other emergencies;
5. The Consequences

• For the next facility the Coode Island Review panel recommended:
  
  e. tank layouts no more than two deep from an access road so that firefighters can direct foam or water at any tank;
  
  f. a one-way ring road around the site;
  
  g. **automatic systems in place** to detect leaks and operate fire fighting equipment on all tanks and in ship-to-shore transfer of chemicals.
5. The Consequences

• Much progress has been made in the management of safety not only at the fire site but at all others storing dangerous goods:
  – fire fighting systems have been upgraded;
  – tanks nitrogen-blanketed;
  – discharges incinerated before entering the atmosphere; and
  – impervious synthetic clay mats installed beneath storage tanks to reduce ground pollution.
5. The Consequences

• Following the inquiry the public was assured by the government that the regulations and processes controlling the handling, storage and disposal of hazardous and toxic materials would be improved and strictly enforced.
5. The Consequences

• In 2000 the Major Hazard Facilities (MHF) Regulations were adopted with the objective:
  – To provide for safe operation of major hazard facilities in order to reduce the likelihood of a major incident (MI) occurring and to reduce the consequences to health and safety and damage to property

• Focus of MHF Regulations is high consequence (catastrophic) but low frequency incidents
5. The Consequences

- Specific parts of the MHF Regulations included:
  - Safety management system
  - Hazard identification
  - Safety assessment
  - Control measures
  - Emergency planning
  - Review of risk controls
  - Consultation – Health and Safety Representatives, employees, community
5. The Consequences

• Multi-agency response:
  – Coode Island incident required only a low level evacuation by major incident standards.
  – If the wind changed direction, the outcomes may have been significantly worse and may have resulted in a mass evacuation of many 10's of thousands of people.
5. The Consequences

• Multi-agency response:
  – Looking back, the evidence shows that the authorities may have not been well prepared for an effective mass evacuation.
  – It became obvious that the agencies needed to have a sound knowledge of the principles of mass evacuation and how to apply this knowledge in a multi-agency response.
5. The Consequences

• Exercise Labyrinth:
  – The Coode Island incident highlighted the need for a well co-ordinated multi-agency response to major incidents.
  – Following various discussions it was decided to organise and test a multi-agency response.
  – That led to the Exercise Labyrinth.
5. The Consequences

• Exercise Labyrinth
  – In 2003 Exercise Labyrinth was designed and conducted
  – This was a 200 hour, continuous, real-time multi-agency exercise involving Hazmat & Urban Search and Rescue activities
  – This exercise was the largest of its type conducted by an emergency service organisation within Australasia
Exercise Labyrinth

- The exercise saw over 1000 emergency personnel participate with observers from Australia and all parts of the world.
- It involved responses and management of incident scenarios including building collapses, industrial disasters, etc.
5. The Consequences

• Exercise Labyrinth
  – The objective was to test the application of a comprehensive approach to emergency management in relation to:
    • preparedness;
    • prevention;
    • response and recovery; and
    • the ability for agencies to work and train together.
  – The exercise proved to be a major success.
6. Conclusions

• The Coode Island incident was among a series of incidents which changed the Major Hazard Facility safety outlook in the State of Victoria.
• “Lady Luck” was on the side of the City of Melbourne and its residents.
• There were many lessons to be learned and we would like to think some lessons were learned.
6. Conclusions

- Coode Island Incident led to improvement of conditions within many facilities.

- New regulations were introduced which no doubt have benefited the industry and the community.
6. Conclusions

- One of the key recommendations of the post-incident inquiry was to move the high risk chemical storage facilities to a remote area.
- However, this is yet to happen 23 years after the incident.
- The terminals may be safer but they are still “too close for comfort”.

[Image of an aerial view with a yellow line indicating a distance of less than 1km]
6. Conclusions

• Food for thought:
  – There were no fatalities during the Coode Island incident.
  – In 2006, The Herald Sun newspaper reported that:
    • Up to 15 firefighters who battled the 1991 Coode Island chemical disaster are suffering from cancer including lung disease.
    • Four more have taken their own lives in what has been described as a 15-year time bomb.
6. References

- The references adopted in preparation of this presentation included but was not limited to the following:
  - Melbourne Metropolitan Fire Brigade Post Incident reports and video footage.
  - “A Discussion of Coode Island Fires”, Ian F Thomas.
Thank you......
What is St Elmo’s Fire?

• St. Elmo's fire is an electrical weather phenomenon in which luminous plasma is created by a coronal discharge originating from a grounded object in an atmospheric electric field.

• The electric field around the object in question causes ionization of the air molecules, producing a faint glow easily visible in low-light conditions.

• Approximately 1,000 - 30,000 volts per centimeter is required to induce St. Elmo's fire.