LFI: Uncontrolled Combustion in Boiler

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"This means something
but I can't remember what!"

Uncontrolled Combustion in Boiler

1. What went wrong?
2. What is the worst that can happen?
3. Why did it happen?
4. What can we do tpo prevent it from happening?

What went wrong?

The Boilers

- Generates 44 bar steam by vaporising water using heat energy released from the combustion of various fuels - Heavy Fuel Oil (HFO), Light fuel Oil (LFO), LNG (Lean natural gas) and flash gas.
- Boilers 1 and 2 both contain 2 burners which can be fired independently, with any of the available fuels.

What went wrong?

On 21 July 2017 during the start up of boiler 2

Several failed attempts (14) to ignite the fuel occurred.

Eventually ignition of fuel occured and a flame was established and boiler was running

Excessive black smoke observed around boiler; smoke coming from gun ports; high temperatures on the boiler

Boiler was tripped (fuel stopped firing) but there was still a fire in the furnace

Fire eventually stopped on its own after complete burning of the fuel

What went wrong?

On 23 July during the start up of boiler 2

Several failed attempts (15) to ignite the fuel occurred

Burner guns are changed with clean ones

Boiler 1 is successfully started up using one burner

Flame scanner on Burner 2 of the boiler sees flame even though there is no fuel being fired on that burner

Uncontrolled fire occured in the furnace

Boiler is shutdown and fire eventually stops on its own after complete burning of fuel.

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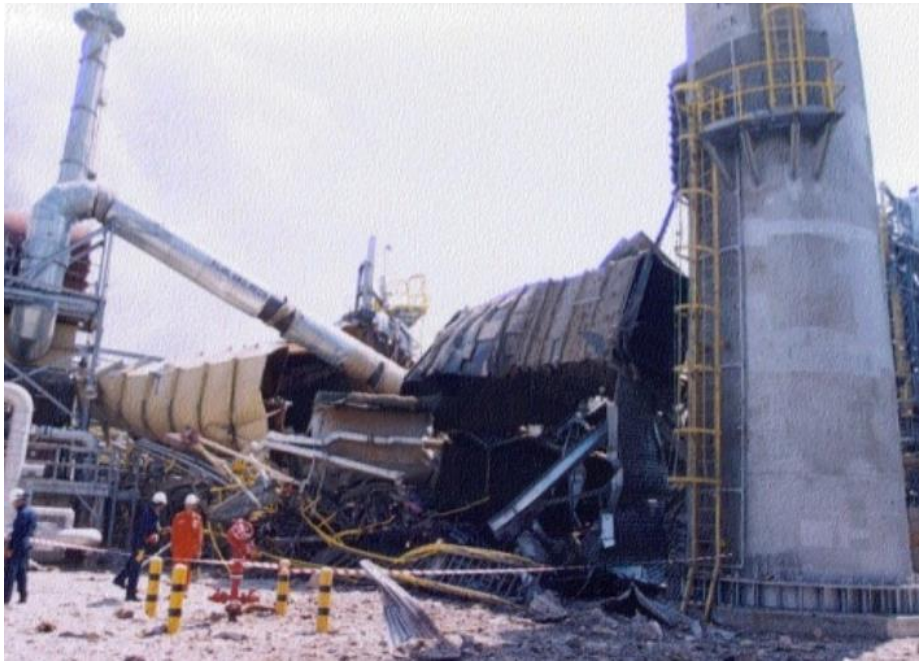
What is the worst that can happen?

- **Boiler explosion occurred during start-up at Exxon Mobil Singapore.**
- **2 Process Controllers died in the incident.**



What is the worst that can happen?

- **EXPLOSION DUE TO FUEL RICH MIXTURE**
  - HIGH CONCENTRATIONS OF UNBURNT FUEL CAN BUILD UP AND WHEN IT IGNITES CAN DO SO IN A RAPID AND EXPLOSIVE WAY

- **MATERIAL DAMAGE TO BOILER CAN OCCUR**
  - IMPROPER WARM UP CAN CAUSE DAMAGE TO VARIOUS MATERIALS OF THE BOILER (DUE TO THERMAL EXPANSION)
  - TYPICAL WARM UP IS 55°C PER HOUR. DURING INCIDENT WARM UP RATE WAS 1470°C/H

Why did it happen?

DIRECT CAUSE

- Accumulation of unburnt HFO and LFO in the boiler.
- No atomisation of fuel oil due to blockages in burner gun.
- Burners are shutdown on HFO which cools down and blocks guns.

Why did it happen?

ROOT CAUSES

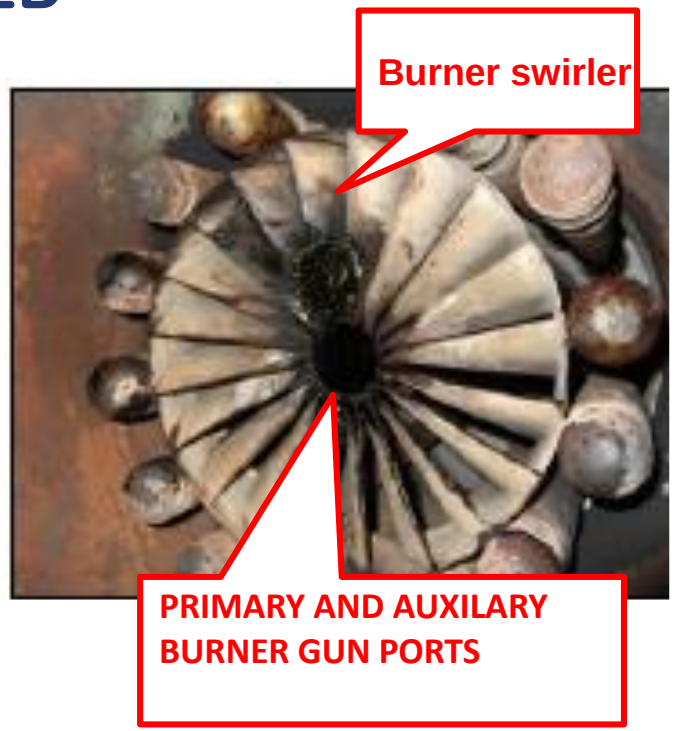
- **Relevant documents were not in controlled status or available.**
  - Unofficial start-up guideline is used which is not in controlled status.
  - Training module not in controlled status.
  - No maintenance checklist.

Why did it happen?

ROOT CAUSES

- **INTEGRITY OF FUEL MANAGEMENT SYSTEM AND BURNER ASSEMBLY COMPROMISED**

- Modifications made on boiler refractory during construction, led to changes that impacted other parts of the burner – the need for an MOC was not recognised.
- Burner swirler was damaged as a result.
- Only one burner gun port can be used properly.
- Wrong burner gun with incorrect length was used as 3 different boilers operate on site.



Preventing it from happening?

I. **Get start-up procedure and training manual in controlled status.**
   - Most incidents happen during start-up and shutdown!

II. **Reviw and update boiler maintenance manuals and drawings.**
   - Making sure all the parts are correct and labelled properly.

Thank You…

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