



# EXXONMOBIL BATON ROUGE REFINERY BLAST, US (2016)

## **Team**

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# INTRODUCTION

- **On November 22, 2016, a serious industrial accident occurred at the ExxonMobil Refinery in Baton Rouge, Louisiana, when an isobutane release and subsequent fire severely injured four workers in the sulfuric acid alkylation unit.**
- **The incident unfolded during the removal of an inoperable gearbox from a plug valve, leading to the unintended release of flammable isobutane and a rapid ignition that trapped workers in a vapor cloud.**
- **This accident highlighted significant safety issues, including equipment design flaws, long-standing reliability problems, and a lack of proper procedures and training for maintenance tasks.**
- **The incident underscores the critical need for improved process safety management and enhanced equipment design to prevent similar catastrophic events in the future.**





# COMPANY'S BACKGROUND

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**ExxonMobil Corporation, commonly referred to as ExxonMobil, is one of the largest publicly traded international oil and gas companies headquartered in the United States. It operates in various sectors of the energy industry, including the exploration, production, refining, and distribution of oil, natural gas, and petrochemicals.**

Here's an overview of what ExxonMobil does:

## **Refinery:**

The Refinery manufactures about 300 products and grades of products, including motor gasoline, diesel, aviation gasoline, lubricating oils, waxes, petroleum coke, liquefied petroleum gas and chemical feedstock.

## **Chemical plant:**

The Chemical Plant manufactures products to produce end products such as isopropyl alcohol, rubber liner for tires, adhesives.

## **Plastics plant:**

The Plastics Plant produces low-density polyethylene for plastic films, molding, adhesives, automotive hoses, belts, seals and bumpers, roofing sheets, non-woven products and more.

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### **Polyolefins plant:**

The Polyolefins Plant produces high density polyethylene (HDPE) and polypropylene (PP) for end products such as milk containers, recyclable food containers, carpet backing, diapers, surgical/hospital gowns, lightweight auto parts and more.

### **Aviation and lubricants plant:**

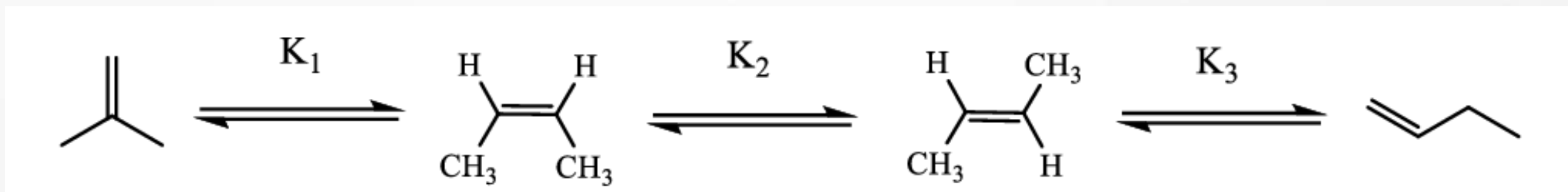
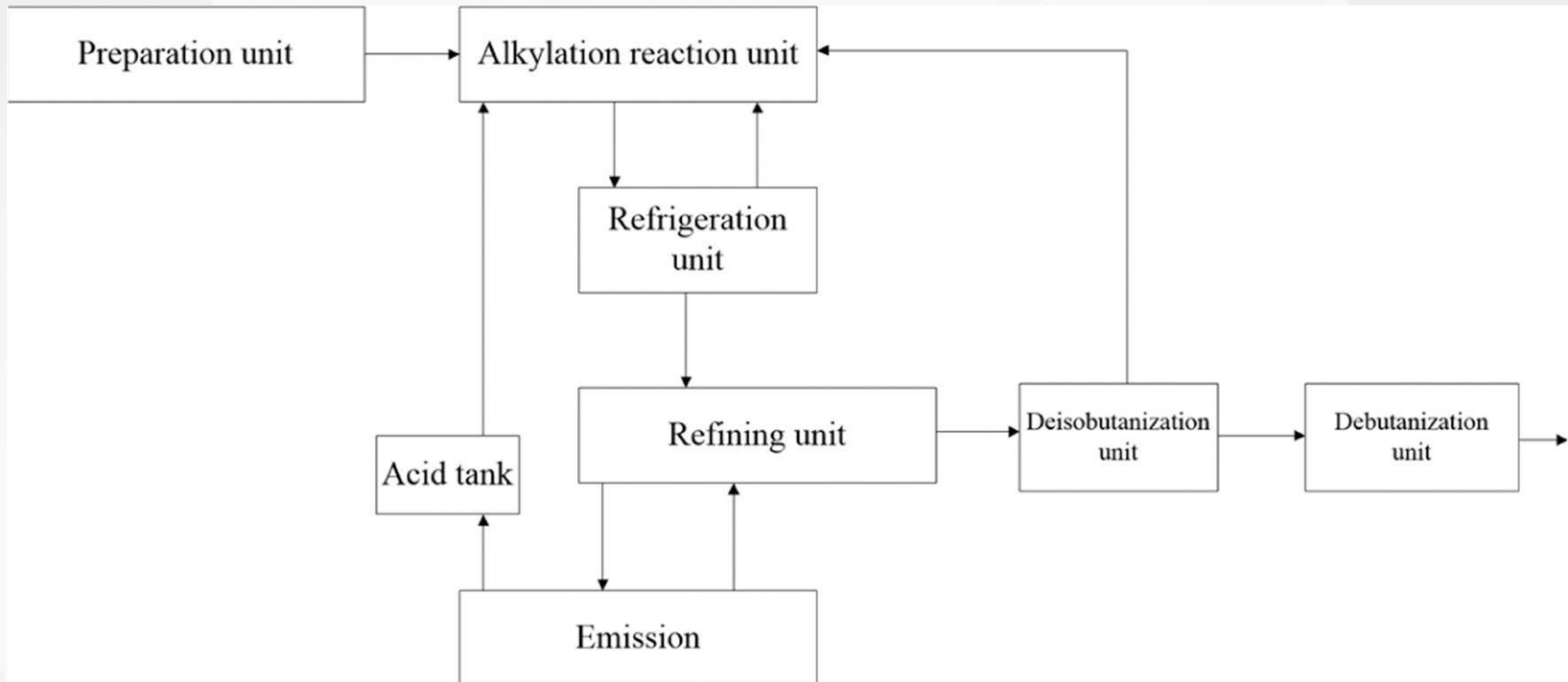
The modern blending, packaging, and warehouse operation provides engine oils, industrial lubricants, aviation piston and process oils to many ExxonMobil customers throughout the world.

### **Marketing and Distribution:**

The company markets fuels, lubricants, and other petroleum products through a vast network of service stations, distributors, and branded retailers, including Exxon, Mobil, and Esso brands.

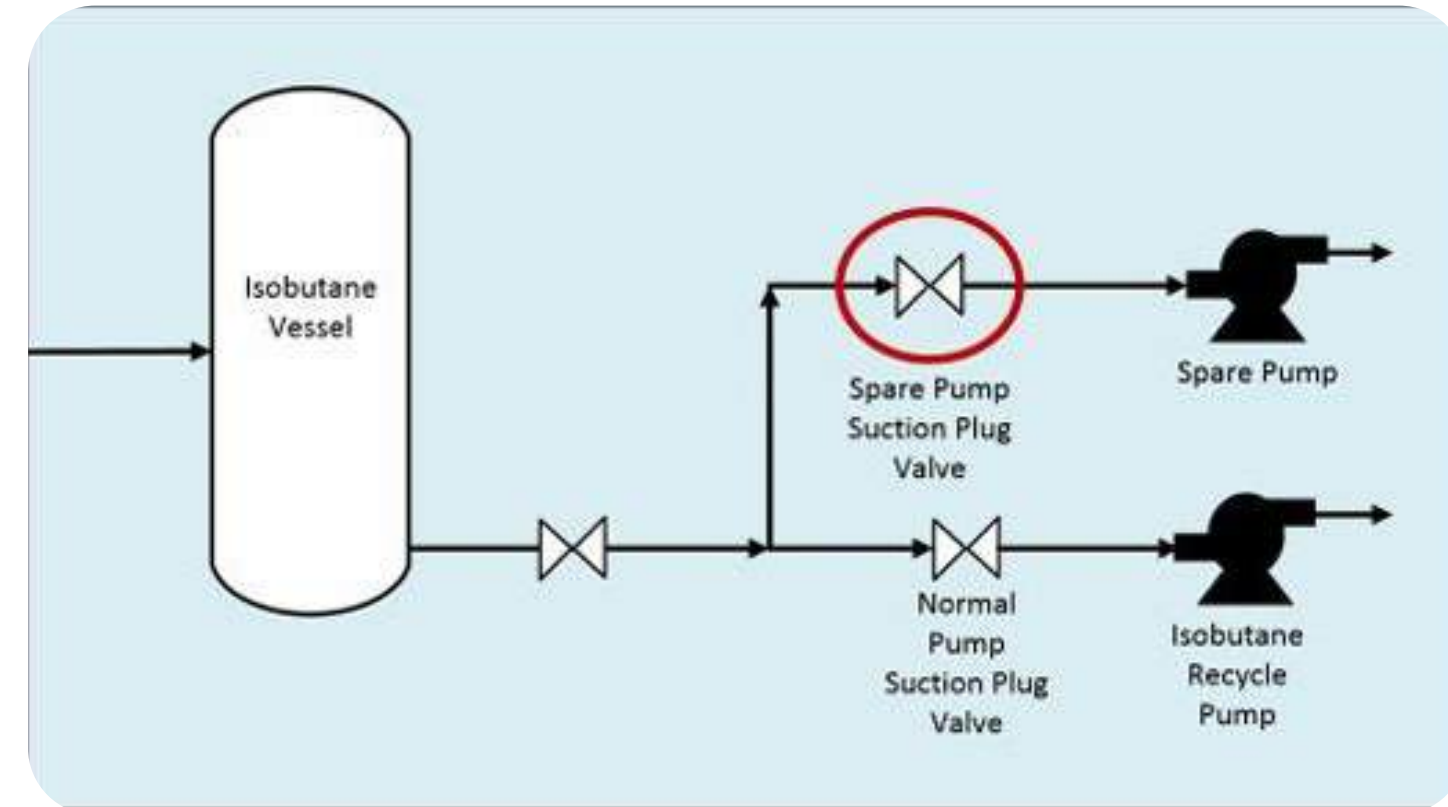
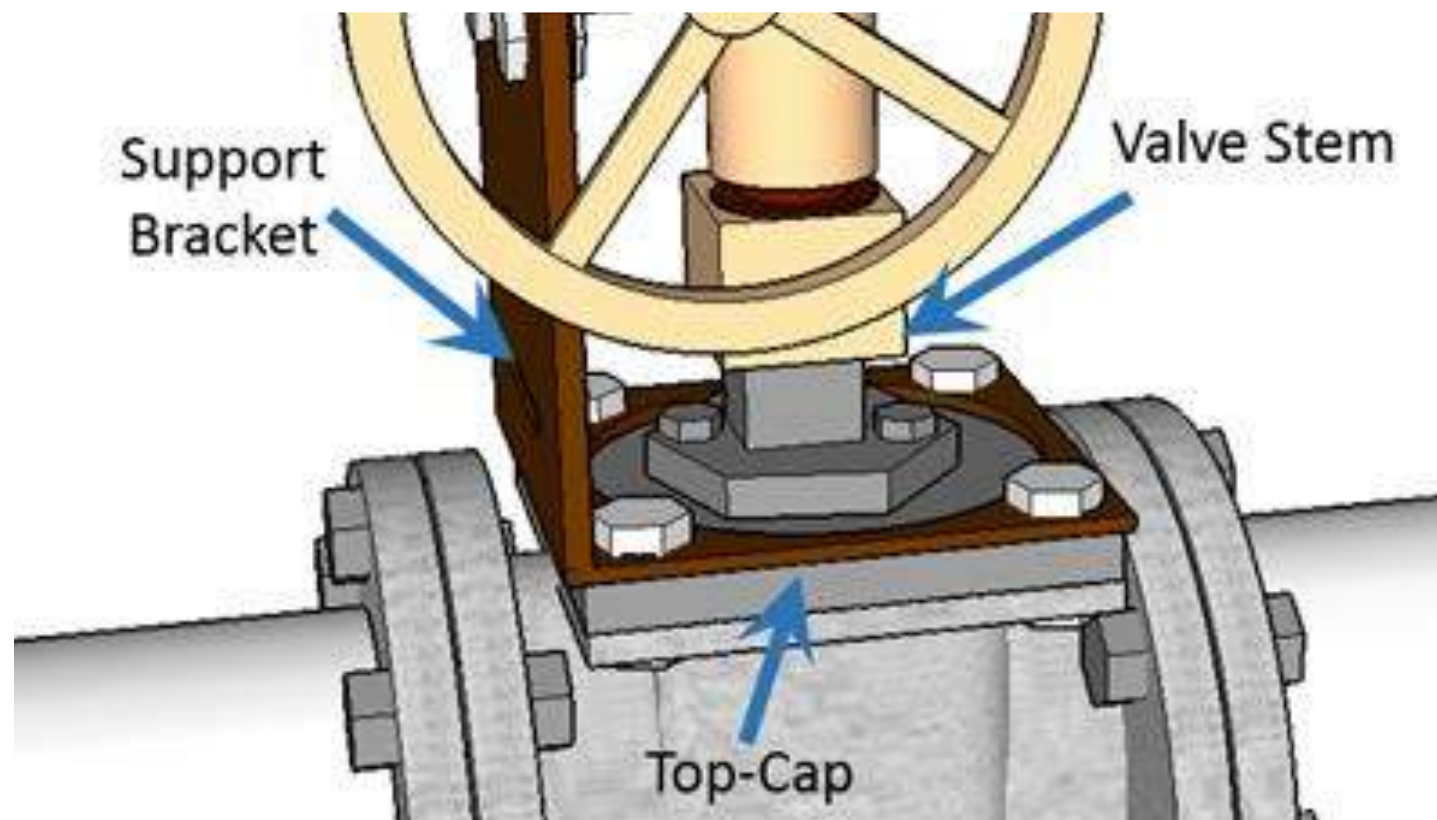


# REACTION INVOLVED



# INCIDENT DESCRIPTION

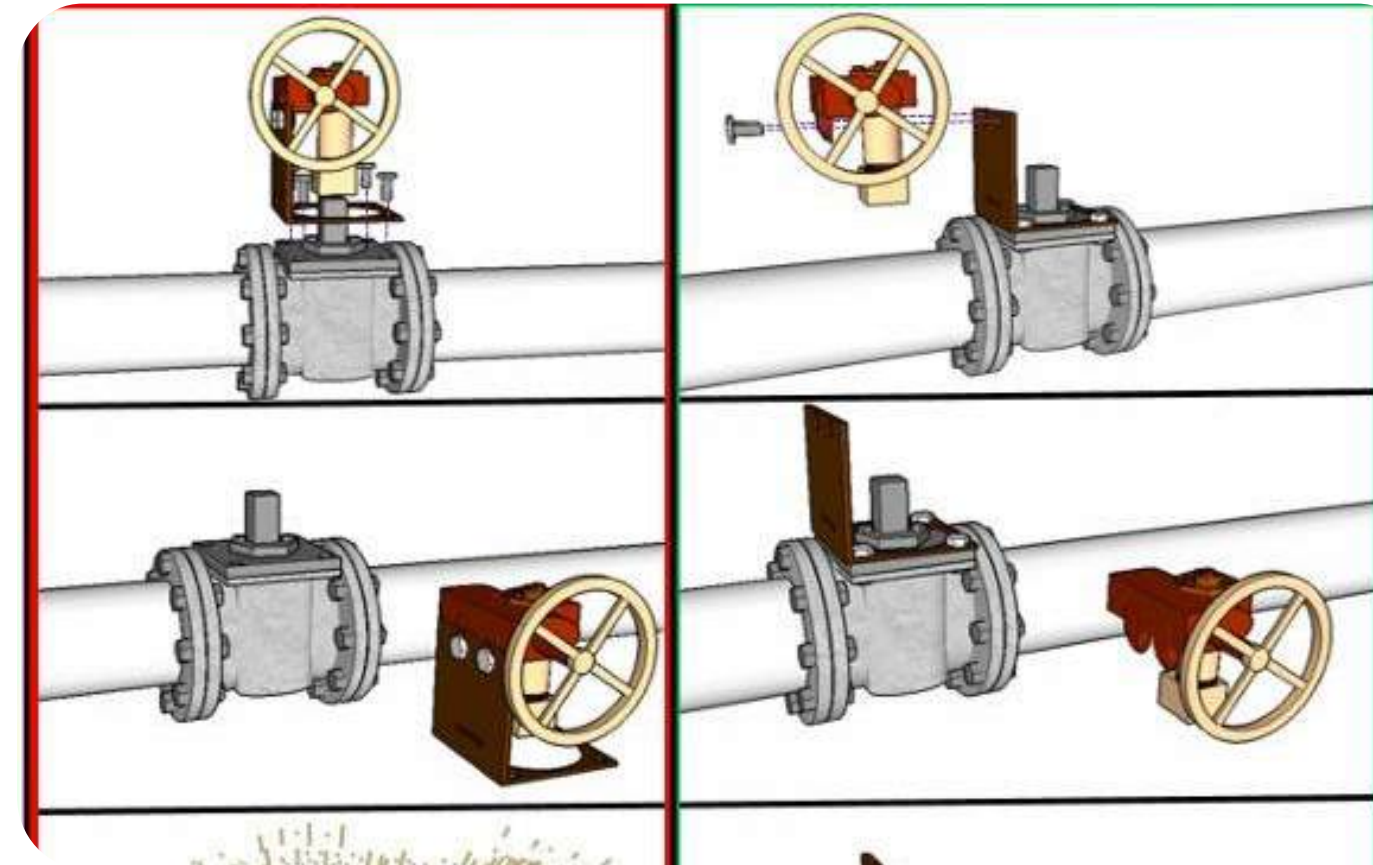
- On the afternoon of November 22, 2016, two Baton Rouge refinery alkylation unit operators were preparing isobutane equipment for maintenance.
- As part of this preparation, the operators needed to adjust valves to put a spare isobutane pump into service.
- To switch the pumps, the operators needed to open the inlet (suction) plug valve to the spare pump.
- The refinery used a type of valve known as a quarter-turn plug valve for many applications in the alkylation unit, including the inlet valves to these isobutane pumps.



- One of the operators removed the gearbox assembly so he could turn the valve stem with a pipe wrench to open the valve.
- Removing a malfunctioning gearbox from a plug valve is an accepted practice for alkylation unit operators.
- To remove the gearbox, the operator removed the four vertical bolts that connected the gearbox support bracket to the valve body.
- These four bolts, however, also secured the top-cap – a pressure-retaining component – to the valve body.
- The two horizontal bolts that could safely remove the gearbox from the support bracket remained in place.



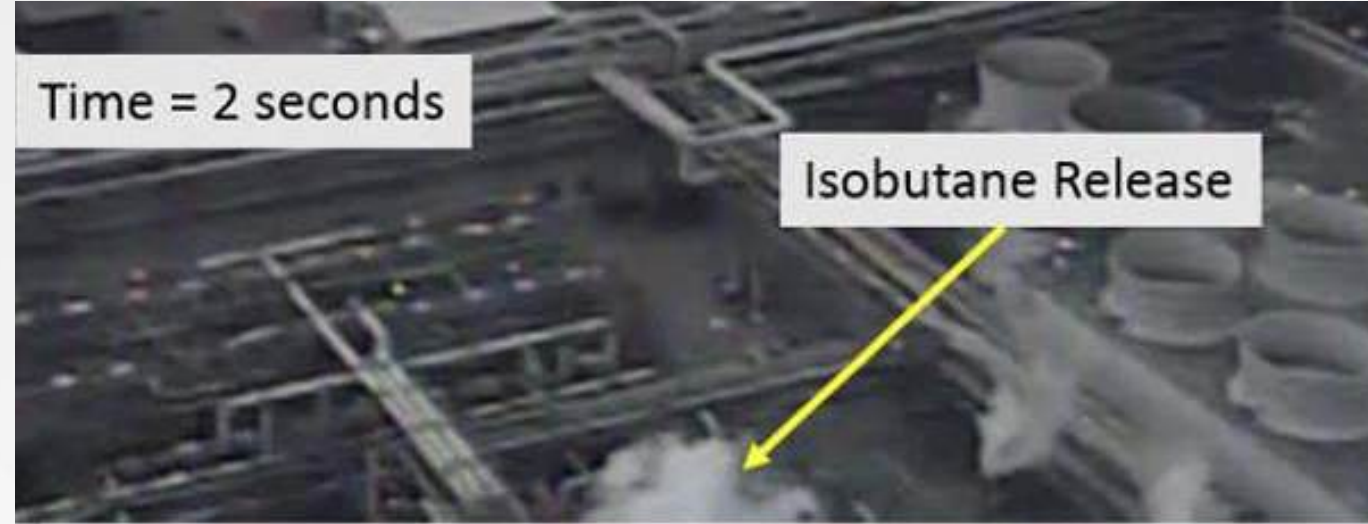
- **One of the operators then opened the valve by rotating the valve stem with a pipe wrench.**
- **With the four bolts removed from the top-cap, critical valve components were no longer held together. When the operator turned the valve stem, the plug valve loosened and came apart.**
- **Pressurized isobutane<sup>14</sup> escaped from the valve body, forming a flammable white vapor cloud. Following the release, the operators shouted to others in the area, warning them of the immediate danger and ordering them to evacuate.**
- **One of the operators alerted the board operator of the emergency by radio and told him to shut down the unit.**



- **ExxonMobil estimated that 2,000 pounds of isobutane released into the atmosphere.**
  - **Based on surveillance video, an energized welding machine located roughly 70 feet away likely ignited the vapor cloud.**
  - **The resulting fire seriously injured one ExxonMobil employee and three contractors working in the vicinity of the release.**
  - **15 Emergency responders isolated the release and extinguished the fire about 25 minutes after the initial ignition.**
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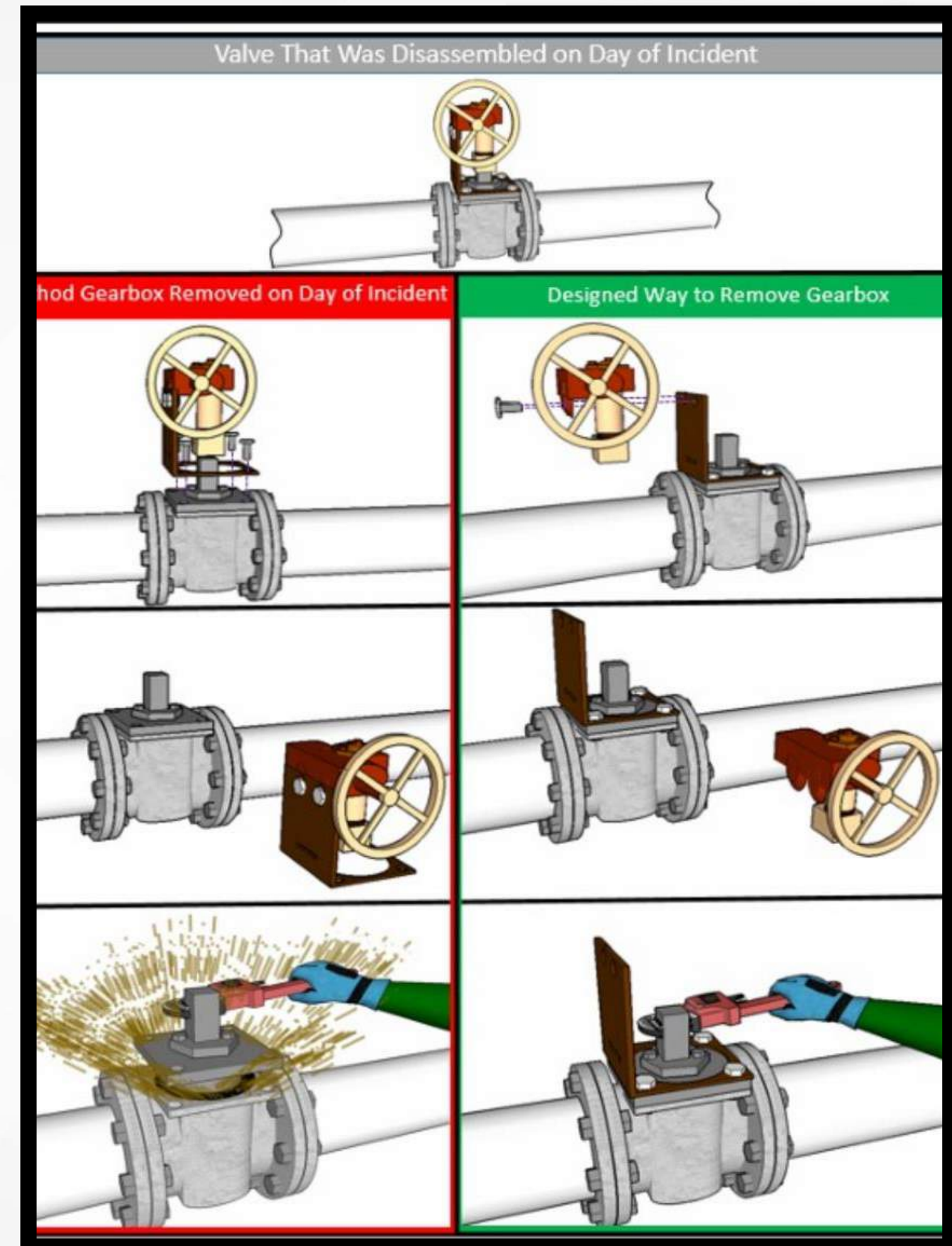
# TIMELINE





# PLUG VALVE DESIGN

- Gearbox support brackets on 15 plug valves located in the Baton Rouge refinery's alkylation unit were attached using the same four vertical bolts that secure the pressure retaining top-cap to the valve body.
- This gearbox (a 30-plus year-old design), however, could be removed by taking off the two horizontal bolts without disturbing the critical top-cap bolts.
- The gearbox involved in the incident conformed to this part of the standard because it could be removed without removing any pressure-retaining parts.
- The operator could have removed the two horizontal bolts that connect the support bracket directly to the gearbox, rather than the four vertical bolts that secure the support bracket to the pressure-retaining top-cap.
- But the operator did not remove these two horizontal bolts; instead, he removed the four vertical bolts, which he believed to be the correct bolts to remove.



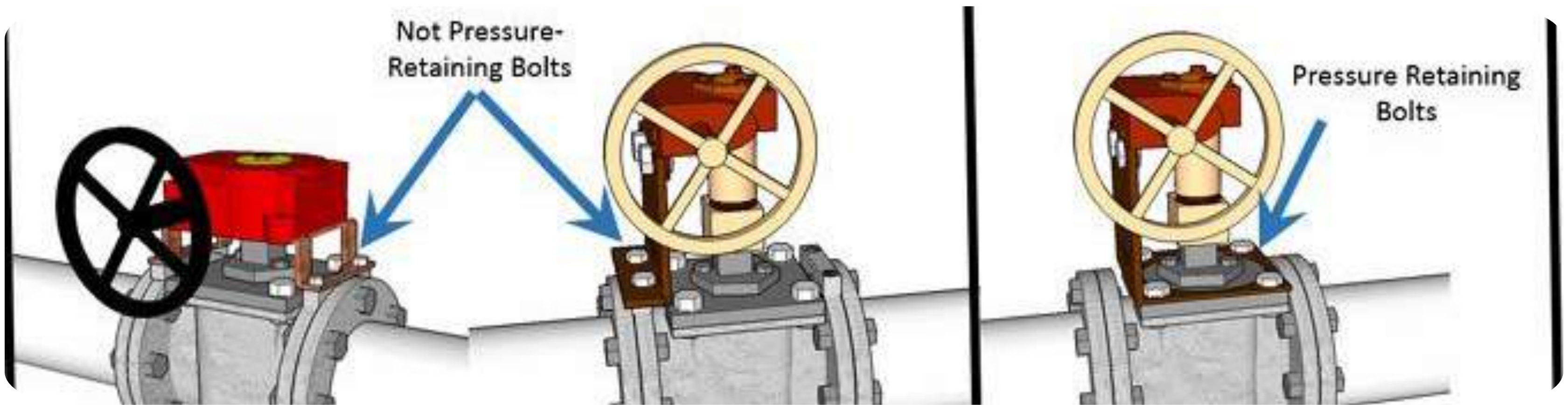


# PLUG VALVE DESIGN

- **The plug valve manufacturer (Durco) updated the plug valve design in 1984 so that the gearbox support bracket could be attached to the valve using different bolt connections than those that secure the pressure-retaining top-cap to the valve body.**
- **Approximately 97 percent of the plug valves located in the Baton Rouge refinery's alkylation unit are the more recent Durco plug valve design, which secures the gearbox assembly to the valve body flanges.**
- **With this improved design, the gearbox support bracket is unlikely to connect to the pressure-retaining top-cap, which can help prevent future incidents.**







- The newer plug valve more broadly used in the alkylation unit is a better design. The redesign addressed the potential to have a chemical release when removing the gearbox assembly. The valve designers provided four additional connection points to secure the gearbox support brackets and these attachment locations are not pressure-retaining components. (Figure 9). With the newer and improved valve design, if a worker completely removes the gearbox and its support bracket(s), a chemical release cannot occur.
- The location of the bolts on the newer valve design may have also contributed to the operator removing pressure-retaining bolts. On the newer design, the bolts connecting the support bracket to the valve are vertical, and are usually removed in order to remove the gearbox and handwheel.
- For the less common, older valve design, the vertical bolts were the pressure-retaining bolts and should not be removed; instead, the horizontal bolts should be removed to disassemble the gearbox and handwheel safely. It could appear as though these critical vertical bolts had to be removed to take the inoperable gearbox off the valve. Although other bolts allowed for gearbox removal without touching the critical pressure-retaining bolts, this design can lead to potentially catastrophic consequences.

# **INCIDENT ANALYSIS**

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- **Failure to identify and address the older model plug valve design and gearbox reliability issues.**
- **Lack of a human factors evaluation to identify the older model plug valves' design and reliability issues as well as the potential hazards associated with operating and maintaining these valves.**
- **No written procedures detailing the steps needed to remove different models of gearboxes from plug valves to manually open or close the valve safely.**
- **Not training workers to safely remove the various plug valve gearbox models in the alkylation unit and the hazards associated with this type of work.**
- **An organizational culture that accepted operators removing malfunctioning plug valve gearboxes despite the lack of detailed procedures and training for safe removal.**

# **POST-INCIDENT ACTIONS**

- **Refinery personnel surveyed the alkylation unit to identify susceptible plug valves. The survey identified 15 plug valves in the alkylation unit with gearbox support brackets attached to pressure-retaining components.**
- **Prior to plug valve modifications, refinery personnel installed warning signs on the susceptible valves to alert workers that bolts were used to secure the support brackets to pressure-retaining components.**
- **To address the potential hazard, refinery personnel established a mitigation strategy**
- **ExxonMobil communicated incident learnings to its other sites and made a presentation on the incident to the petroleum refining industry at an**







# **SUMMARY OF KEY LESSONS:**

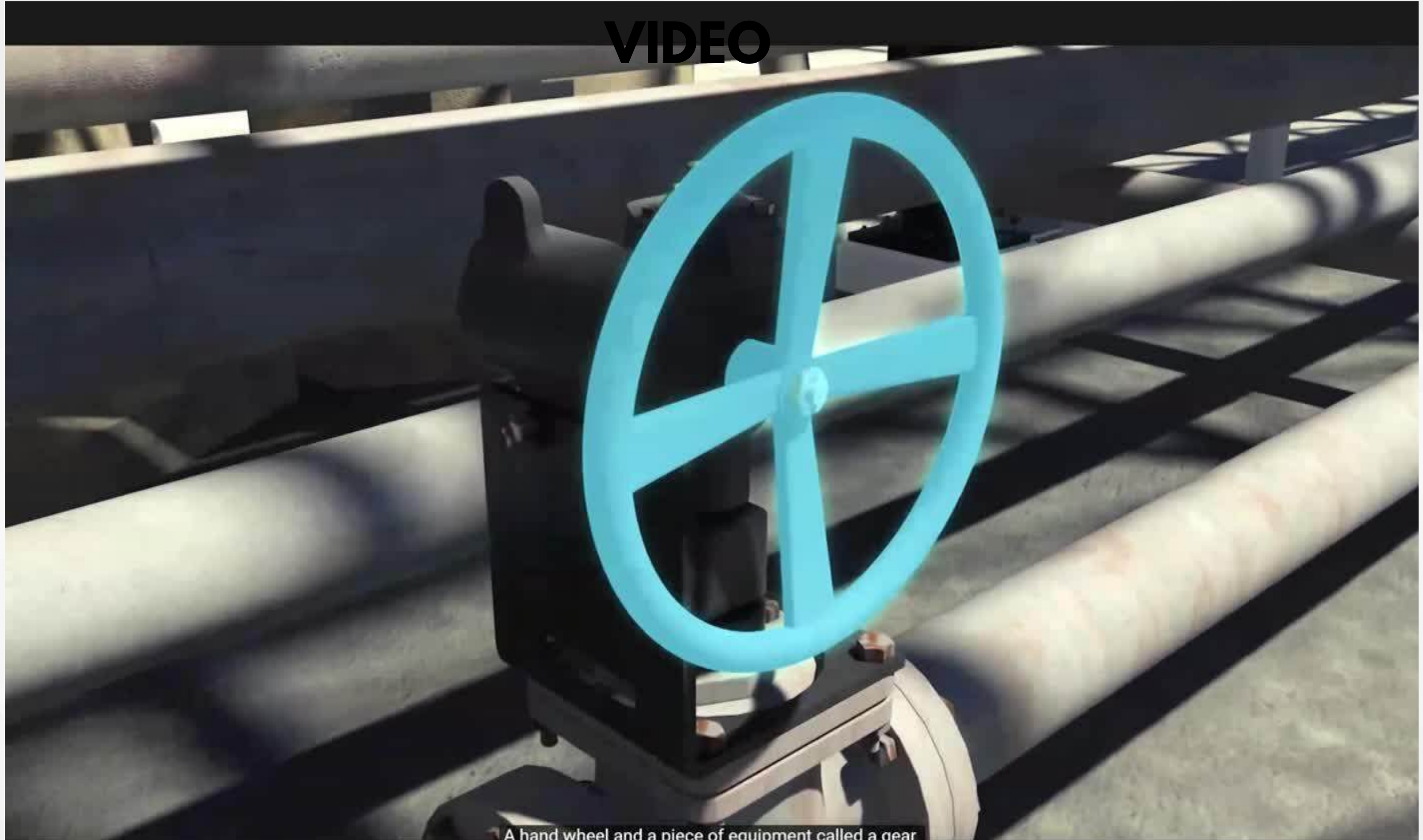
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## **COMPANIES SHOULD:**

- **Evaluate human factors associated with equipment design and apply the hierarchy of controls to mitigate identified hazards.**
- **Establish detailed and accurate written procedures and provide training to ensure workers can perform all anticipated job tasks safely.**
- **Establish procedures specific to removing malfunctioning gearboxes from plug valves. It is especially important when different types of equipment or configurations exist which could cause confusion.**
- **Provide training to ensure workers can perform all anticipated job tasks safely.**

# INCIDENT VIDEO



A hand wheel and a piece of equipment called a gear box were connected to the valve by a support bracket.

**THANK YOU**