

The background of the slide is a photograph of an oil drilling site at sunset. The sky transitions from a deep blue at the top to a bright orange and red near the horizon. Several tall, dark silhouettes of drilling rigs are visible against the colorful sky. Some of the rigs have small lights on them, which appear as bright white spots. The overall scene is industrial and dramatic.

# Diesel Engine Runaway:

The unexpected danger  
on drilling sites

amot



# Introduction

- The dangers of diesel engine runaway
- Accident history shows a need for safety devices. California and Wyoming are the first to have OSHA policies.
- Other US states are not fully aware of the dangers and solutions.





## Stephen Gale Oil & Gas Safety Advocate

Educating industry professionals on diesel engine safety for over 17 years.

### **Presentations Given:**

Texas City Safety Council

ASSE (American Society of Safety Engineers) Kuwait

Qatar Safety Symposium

IADC (International Assoc. of Drilling Contractors)

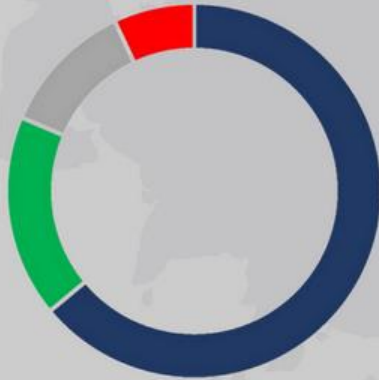


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# **O&G Operations: Risky Business**

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# OSHA Fatalities in Upstream Oil & Gas 2011 - 2015



55% Struck by  
15% Fires & Explosions  
10% Falls  
6% Chemical Exposure

**85**

Fatalities associated  
with fire & explosions  
2005 - 2015



**29**

Fatalities where  
mobile engine was  
ignition source  
2005 - 2015

Source:  
[cdc.gov/niosh](http://cdc.gov/niosh)

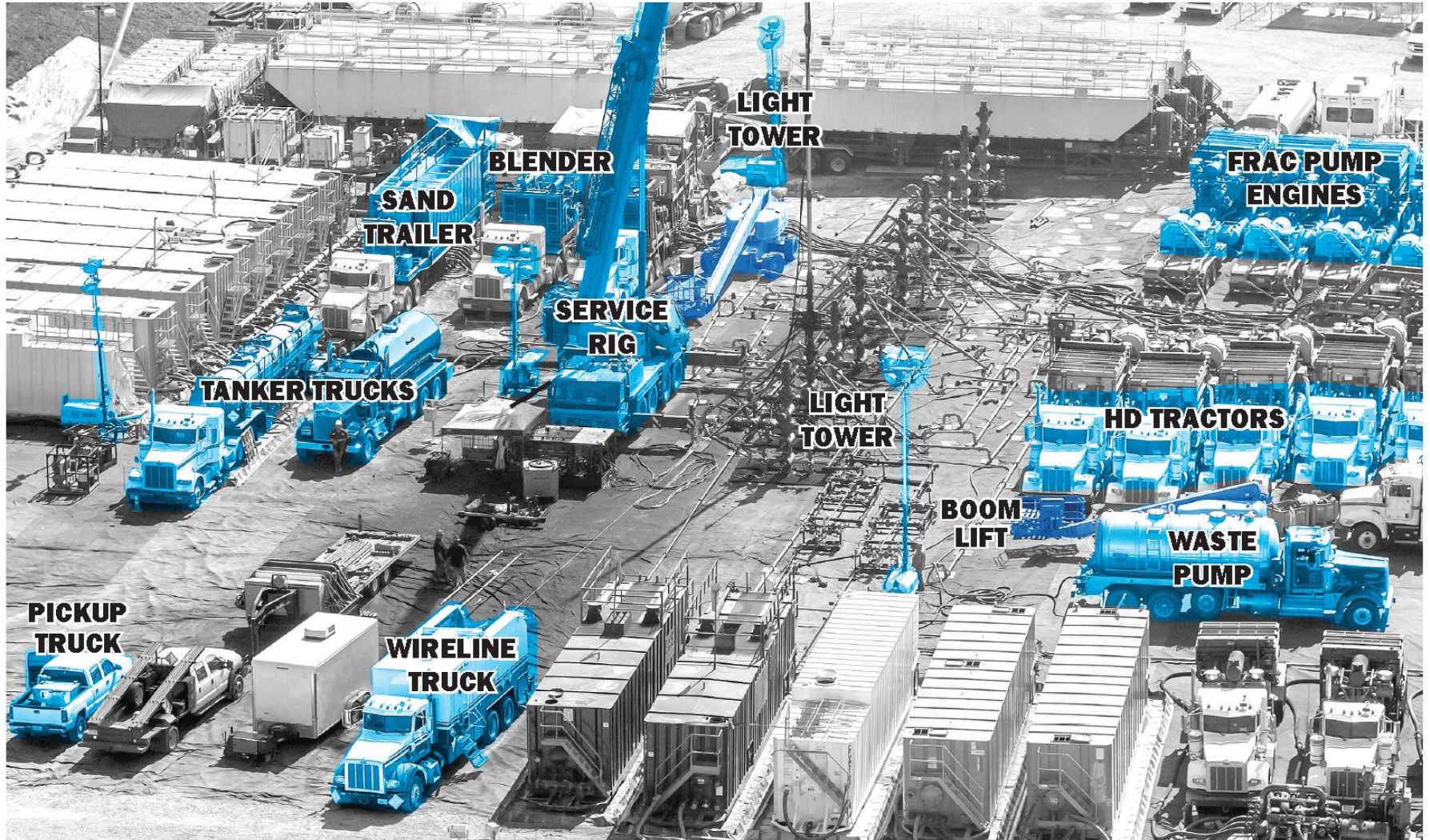


In 2014, 7 fatalities were due to combustion of vapors, gases, or fluids where the ignition source was diesel powered equipment.

Source: NIOSH FOG Report



# Typical well site



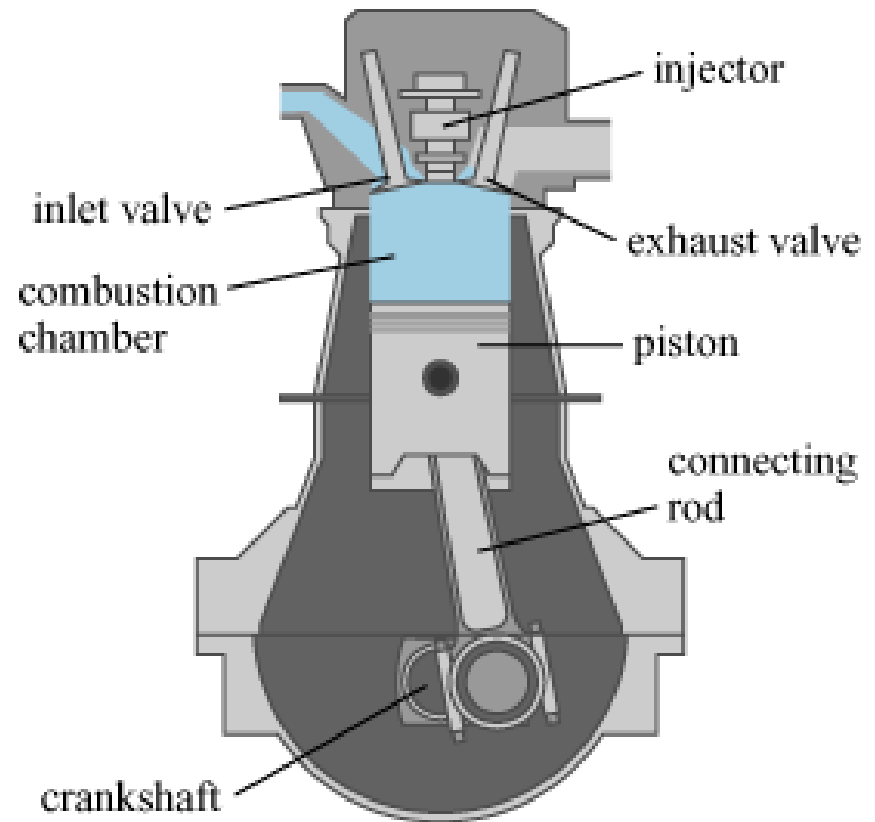
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# **Diesel Engine Runaway: How it Happens**



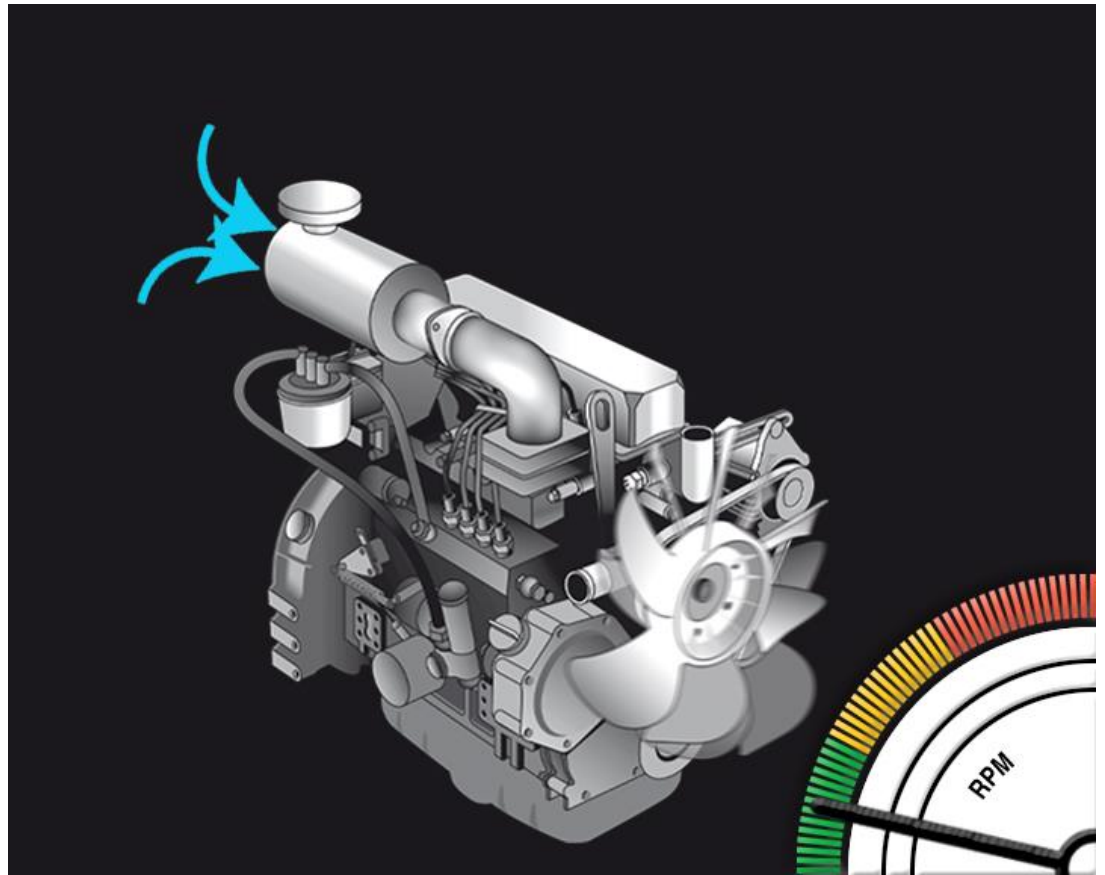
# Diesel engine principle

1. Compression Ignition –  
No spark plugs!
2. Fuel is metered to  
govern speed.
3. Methods to Shutoff  
Engine:
  - Remove Fuel Supply
  - Remove Air Supply



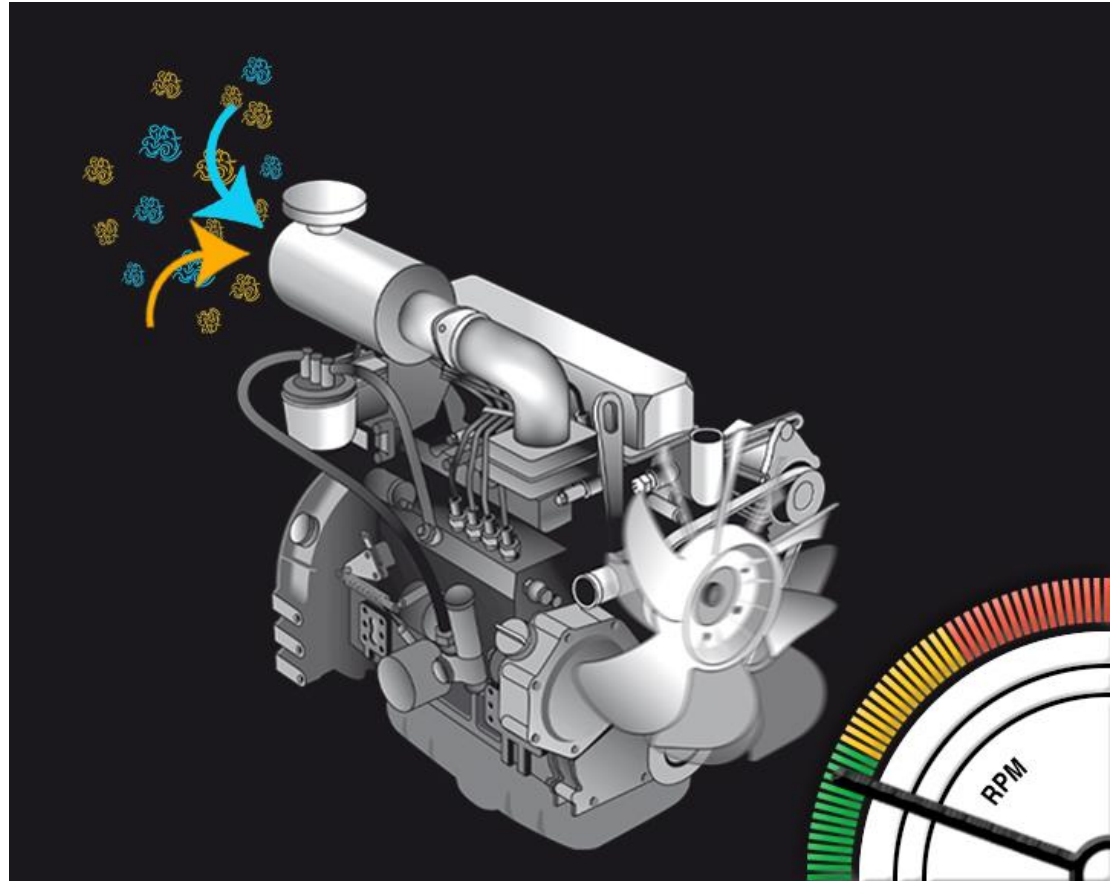
# Normal running

- Clean air is drawn in.
- Diesel fuel is injected.
- The governor maintains the speed.
- Changes in the load are controlled by the quantity of fuel injected.



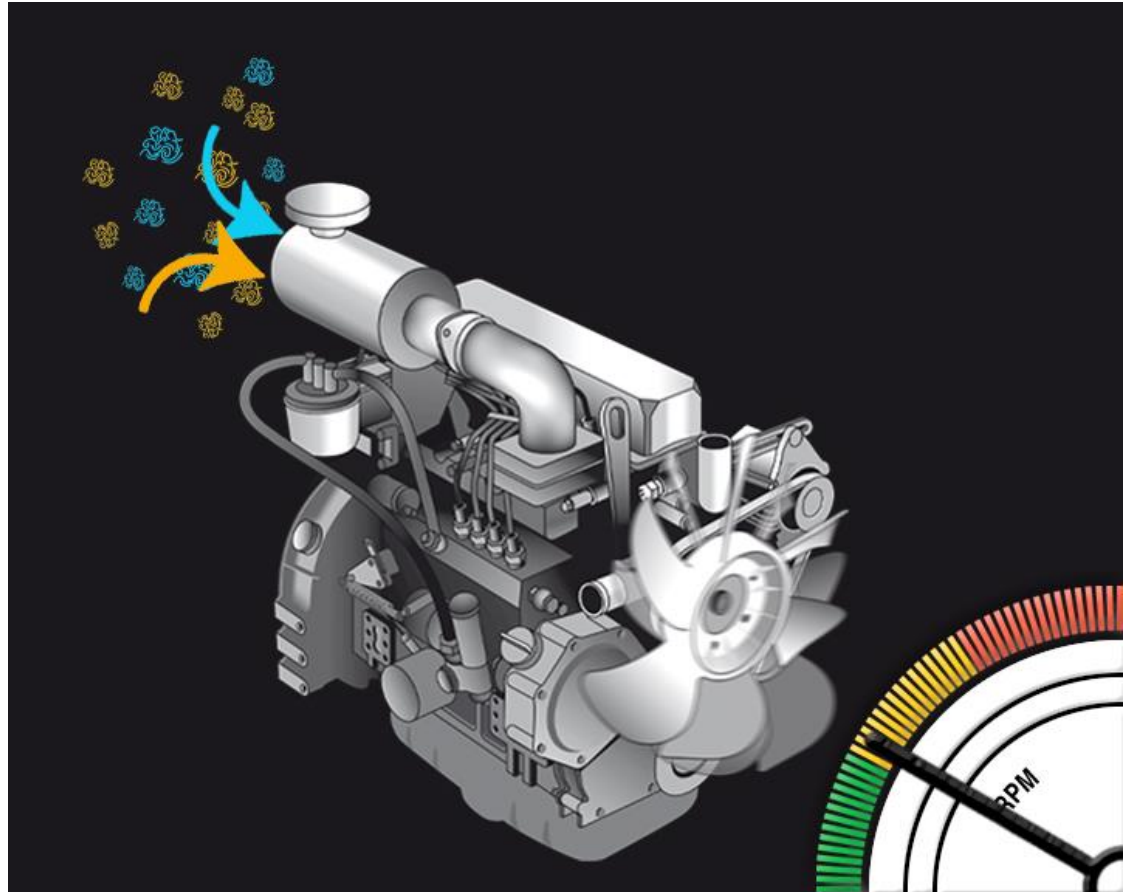
# Vapor release

If gas gets mixed with the air, then it is also consumed.



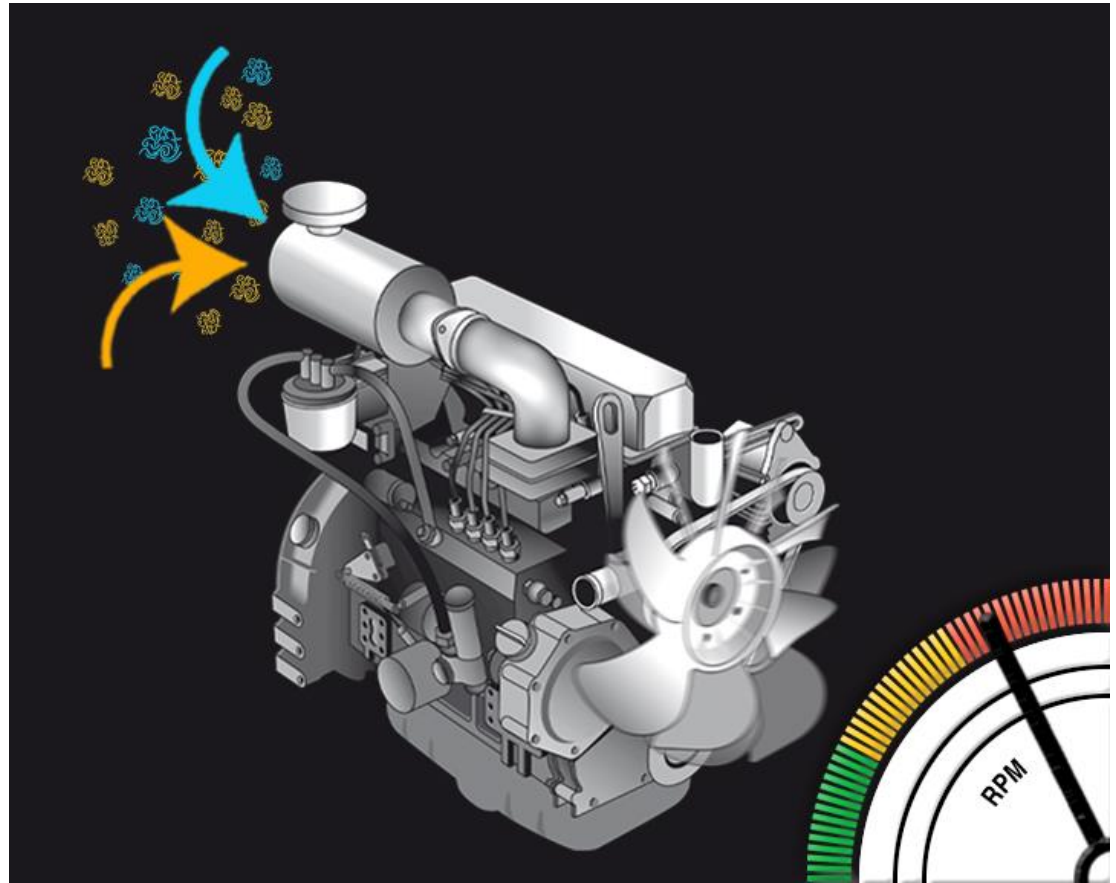
# Dual fuel running

- Engine speed increases.
- The governor responds.
- The engine operates on both fuels.



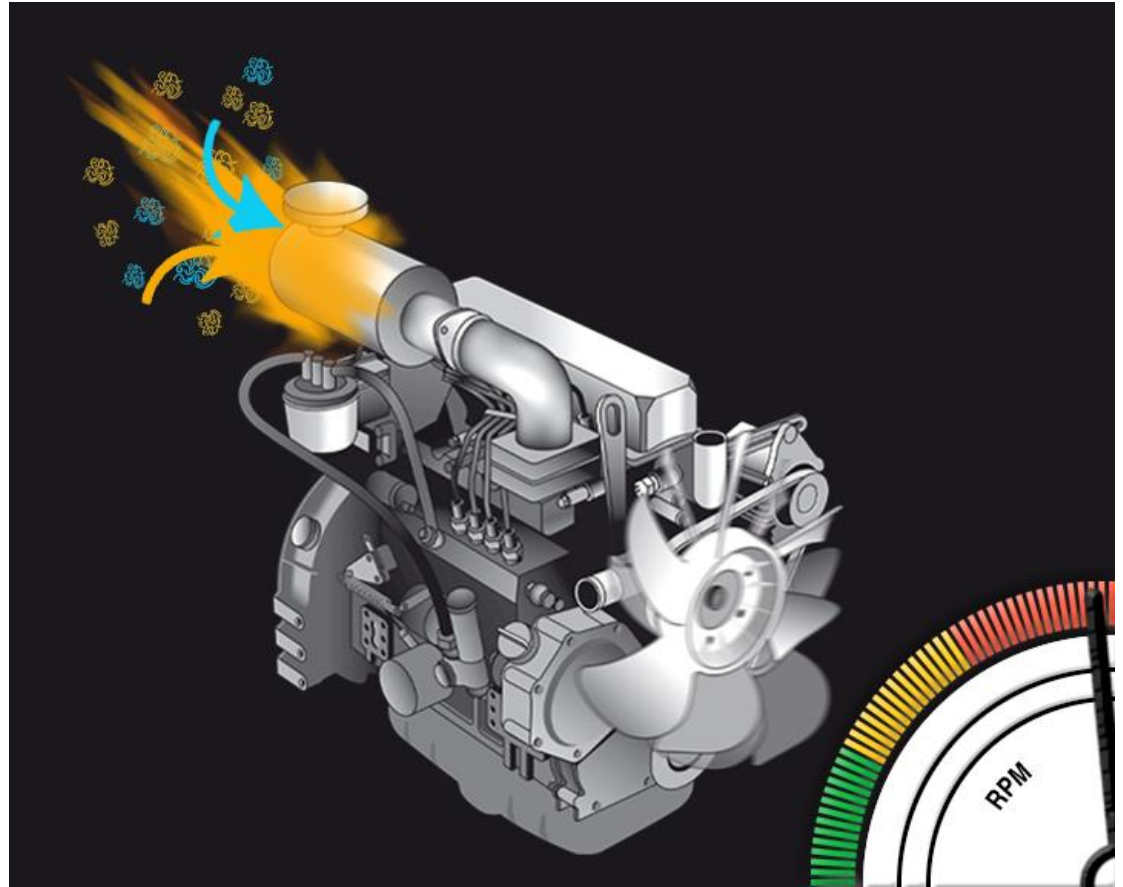
# Gas only running

- Gas rises until engine is running only on gas-exceeds the load.
- This is unstable and causes engine to accelerate.



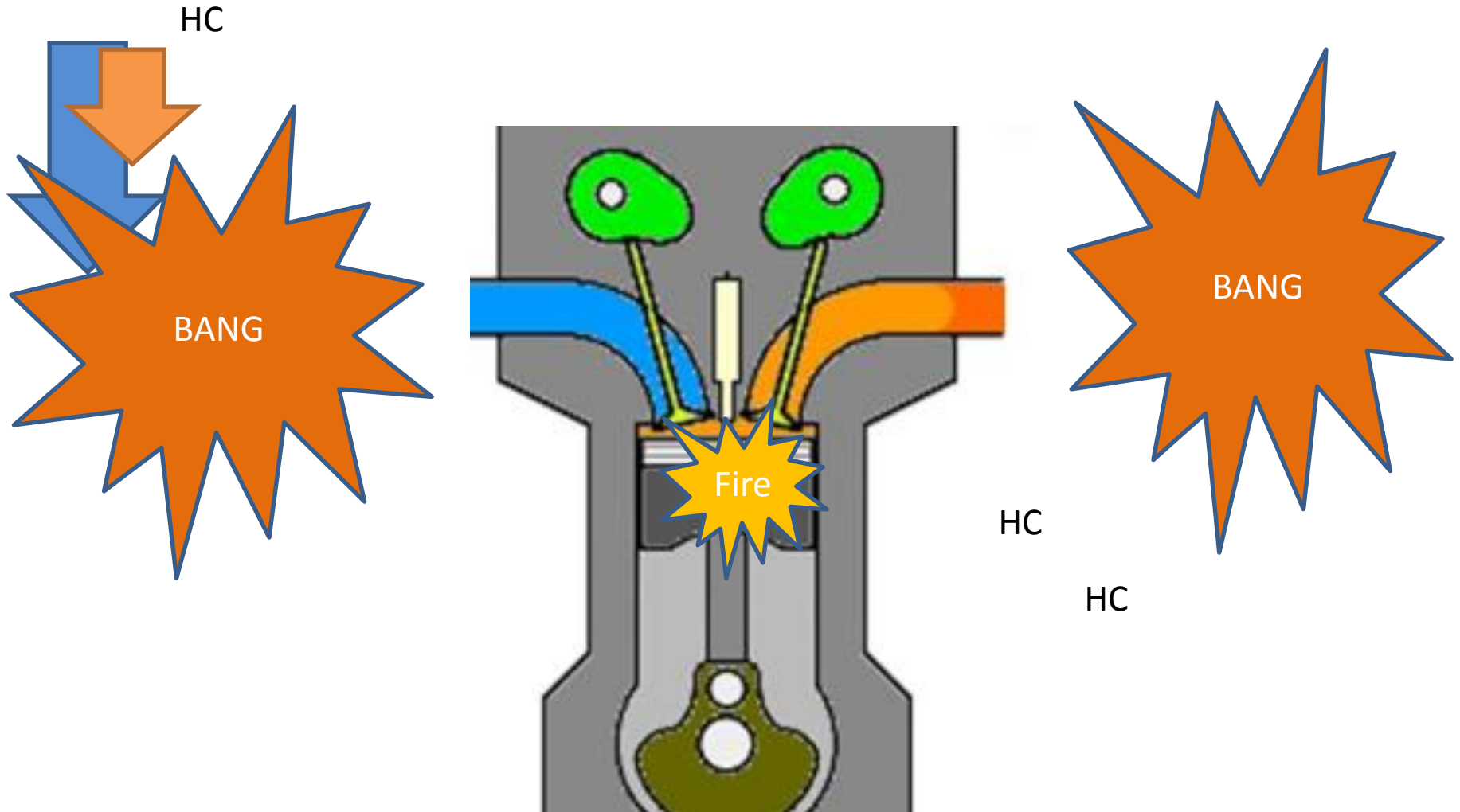
# Engine's valves bounce

- Engine continues to race.
- Valves bounce.

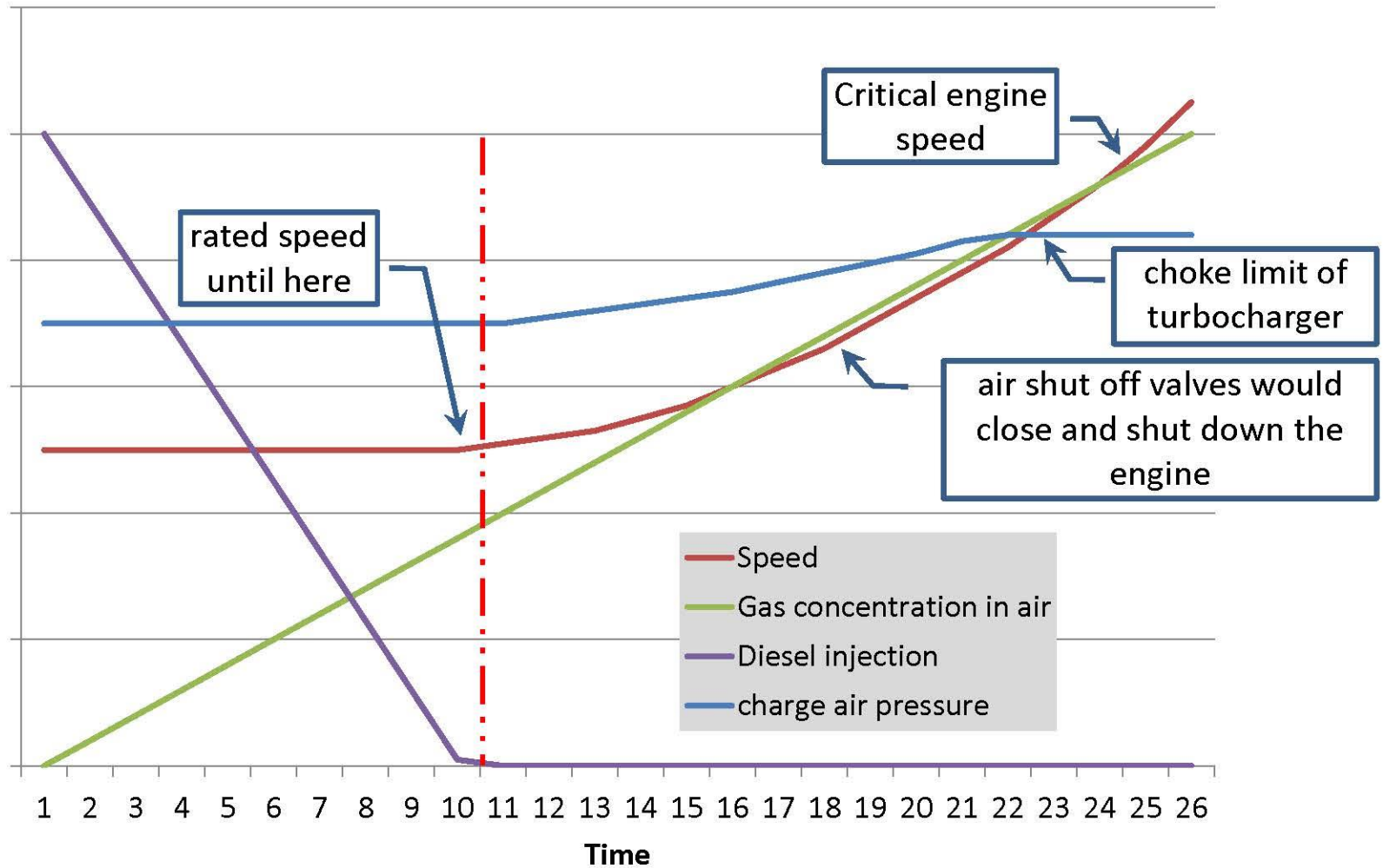




Flames pass through both manifolds creating a flash-back if any outside HC mixture is above LEL



# Engine speed behaviour in explosive atmospheres (theory and qualitative example)



# Catastrophe

The action of the flames being released through the manifolds creates an explosion.

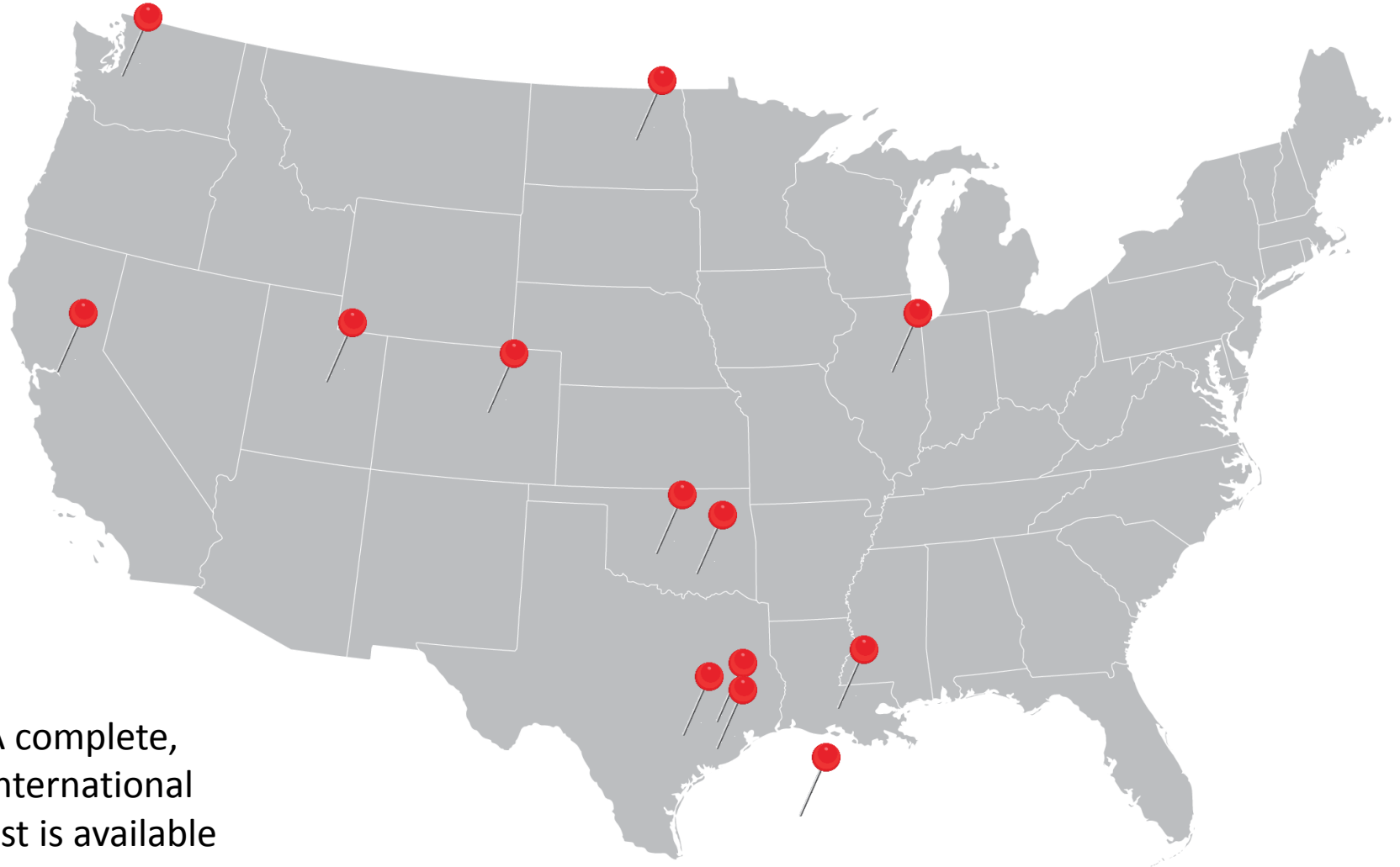


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# **Incidents and Conclusions**



# Proven U.S. Diesel Engine Runaway Accidents 2003-2012



A complete,  
international  
list is available  
upon request.

# Refinery Explosion

BP Texas City  
March 23, 2005  
Texas City, TX  
Injuries: 180  
Fatalities: 15



A vapor cloud is ignited by an idling diesel pickup truck which witnesses reported hearing rev when the vapor neared the truck.

<http://www.csb.gov>





# BP Texas City



# Refinery explosion

Calumet Refinery  
October 30, 2008  
Shreveport, LA  
Injuries: 2  
Fatalities: 0



Fire Investigator Rodney Murray said "...a small (diesel) pick-up truck was the initial heat source that ignited vapors being dispersed from tank #176," he said.

<http://www.ksla.com>



# Waste Disposal Facility

BLSR Operating, Ltd.

January 13, 2003

Rosharon, TX

Injuries: 4

Fatalities: 3



A vapor cloud is drawn into the engines of two vacuum trucks delivering waste product to the facility.

<http://www.csb.gov>



# BLSR Facility



# Oil Well Explosion

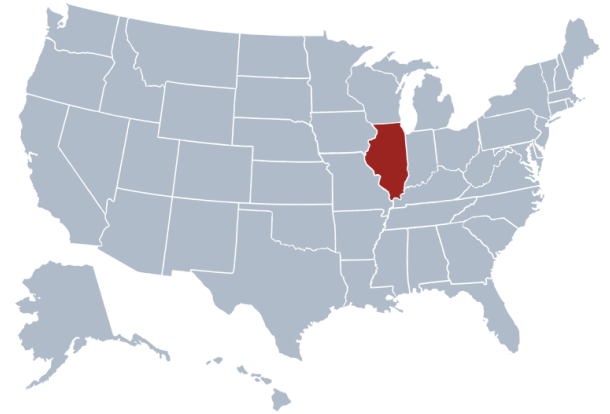
French Creek Oil Company

October 29, 2008

Carmi, IL

Injuries: 4

Fatalities: 2



A service crew was preparing to plug a well when a witness saw a gas cloud leaking from the well. The engine on a nearby pump started to rev, the crew attempted to turn off the fuel, but the engine continued to run. The pump backfired and the well exploded.

<http://www.carmitimes.com>





# Other incidents





# Impact to communities



## **Chevron Refinery Explosion**

Richmond, CA

Aug 6, 2012

5700 area residents needed  
medical treatment



## **Oil & Gas Development (2017)**

Erie, Colorado

Next to homes, baseball fields,  
town skate park

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# **Common Preventive Measures: Why They Don't Work**

# Turning off the fuel by the key

If the engine has begun to runaway, it is too late.



# Gas detection with alarms

- This is only an alert
- It does not stop the engine





# Traffic management & control rules



# Preventive measures

Turn off ignition	●	Engine is using vapor as fuel source
Gas detectors	●	Success depends on location of detector AND of personnel
Traffic rules	●	Must be followed and enforced to be effective

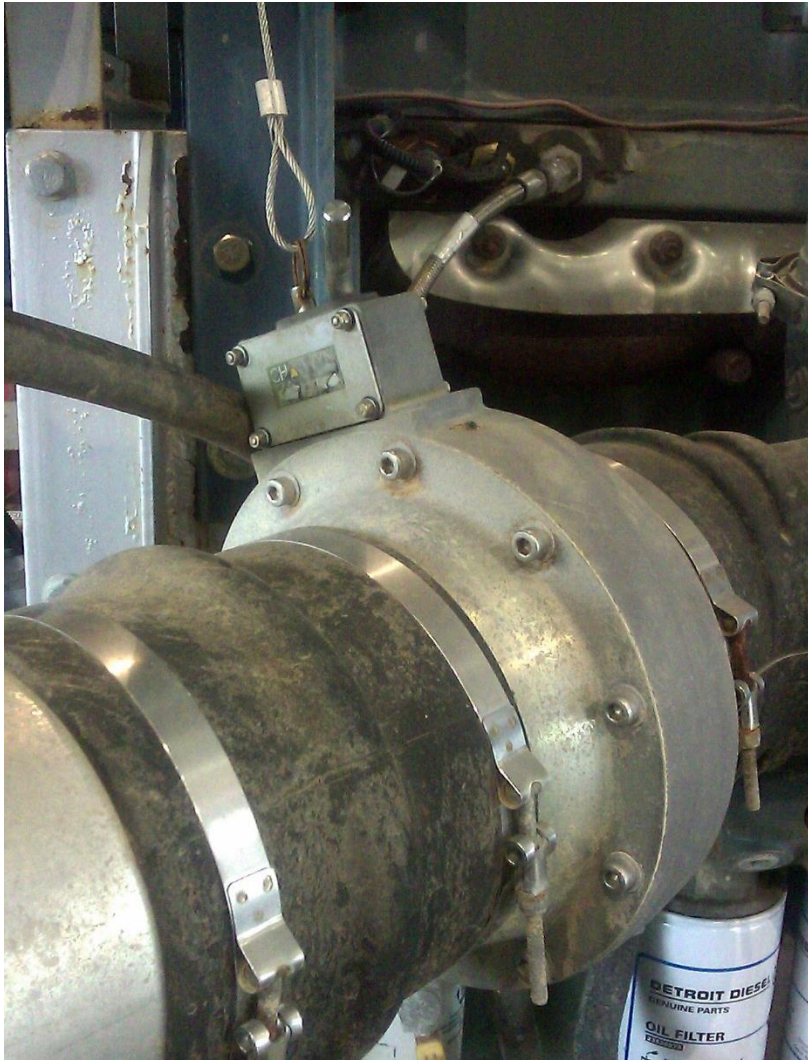
- Unsafe
- Marginally Safe
- Proven Safe



# Plastic valves



# Manual valves



# Preventive measures

Plastic slide valves	●	Not manufacturer approved; easily jammed
Remote manual valve	●	Attendant must be close enough to activate valve before runaway occurs
Automatic air intake shutoff valve	●	Proven method to cut off air supply to engine, effectively stopping runaway

● Unsafe

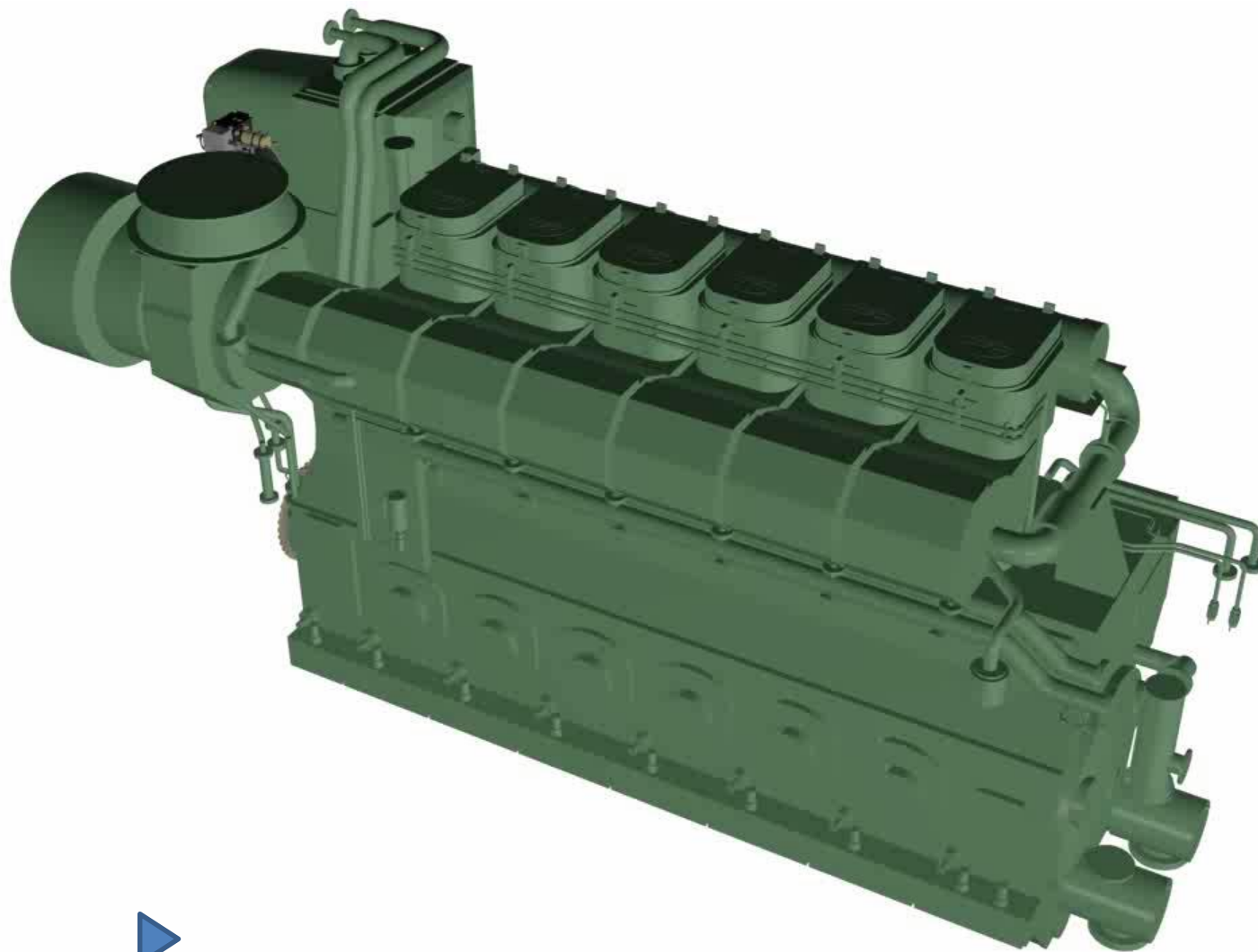
● Marginally Safe

● Proven Safe

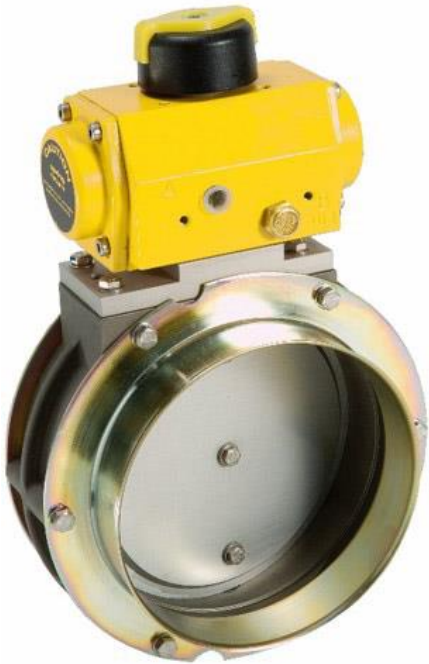
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# **Preventive Measures: What does work?**

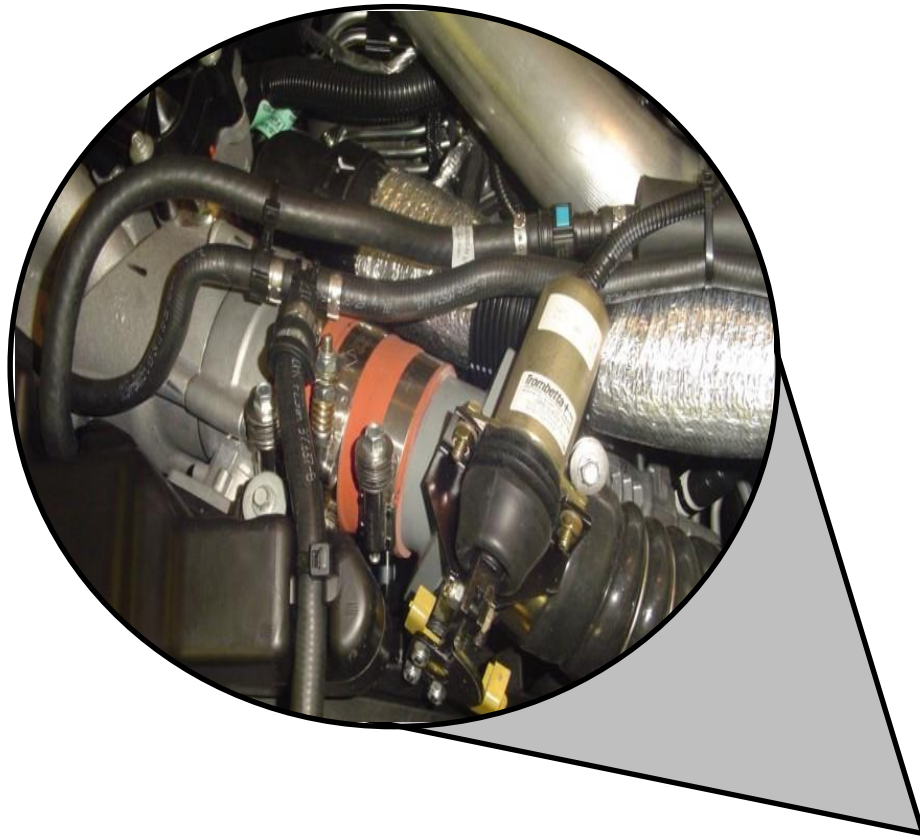
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# Air intake shutoff devices







# Pickup truck installation



# Frac truck installation





How does a shutoff valve work?



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# **North American Regulations & Industry Practices**

# OSHA Wyoming

Workforce Services Department (053)  
Oil & Gas Well Drilling (0011)  
Chapter 6 (Facilities), Section 8  
Ref. No. 053.0011.6.08302013  
<https://rules.wyo.gov/Search.aspx>

(c) Facilities and Equipment.

(ii) Emergency shut-down device(s) that will close off the combustion air shall be properly installed and identified on all diesel engines that are an integral part of the drilling rig or are operated as a stationary or mobile engine of a drilling rig within the radius of the rig anchors or within seventy five (75) feet of the well bore, whichever is greater.

## New Wyoming State OSHA Standard Diesel Engine Protection for Oil & Gas Drilling

On October 5, 2012, Wyoming State OSHA adopted a new standard to enhance safety requirements for operating at Wyoming drilling sites. The anticipated effective date of the new standard is February 2013.



### Summary of New Standard:

Chapter 6, Section 8:

(c) Facilities and Equipment.

(i) An exhaust pipe from any ground level internal combustion engine, located within seventy-five (75) feet of any well bore, process vessel, oil storage tank or other source of ignitable vapor, shall be so constructed that any emission of flame along its length or at its end is prevented.

(A) Emergency shut-down device(s) that will close off the combustion air shall be properly installed and identified on all diesel engines that are an integral part of the drilling rig or are operated as a stationary or mobile engine of a drilling rig within the radius of the rig anchors or within seventy five (75) feet of the well bore, whichever is greater.

(ii) All CBMNG drilling rigs and auxiliary equipment (mobile and vehicular engines) shall be equipped with an over rev device (automatic air intake shutoff valve) installed on the motor, and approved spark arrestors attached to exhaust.



# CalOSHA

## Petroleum Safety Orders Div 1, Chapter 4, Subchapter 14 Article 6, Section 6625.1 <https://www.dir.ca.gov/oshsb>

(a) In order to prevent diesel engine runaway as defined in Section 6505, no employer shall operate a stationary, vehicular or mobile diesel engine within 50 feet of the open well bore or other source of ignitable gas or vapor, unless the employer complies with subsection (b) through (f).

(b) The concentration of the flammable gases or vapors shall be at all times 10 percent or less of the lower explosive limit (LEL). Where concentration of the flammable gases or vapors is found to be greater than 10 percent of the LEL, the diesel engine(s) shall be shut down immediately.

(c) The air shall be continuously monitored at the well bore or at other sources of ignitable gas or vapor with an approved device to determine if a flammable atmosphere exists at concentrations greater than 10 percent of the LEL, or

(d) Where the air is not continuously monitored pursuant to subsection (c), diesel engines shall be operated under at least one of the following conditions:

(1) The diesel engine has an approved automatically actuated air intake shut-off valve that is equipped with a remote control readily accessible from the operator location or the equipment control panel where an operator is present, or

## Cal OSHA Adopts New Safety Standard

### Diesel Engine Protection for Oil & Gas Drilling and Production Facilities

On September 20, 2012, Cal OSHA adopted new standards (attached) that enhance safety requirements for operating at California well sites and production facilities. The newly adopted Cal OSHA standard will be effective beginning November 30, 2012.



**Drilling Sites**

Open Well Bore-when a well is open to the atmosphere during well drilling, workover, maintenance/repair or abandonment operations.



**Production Facilities**

Process areas and piping that contains ignitable gas or vapor in production facilities such as oil and gas production and gas treatment.

#### Summary of Revised Standard:

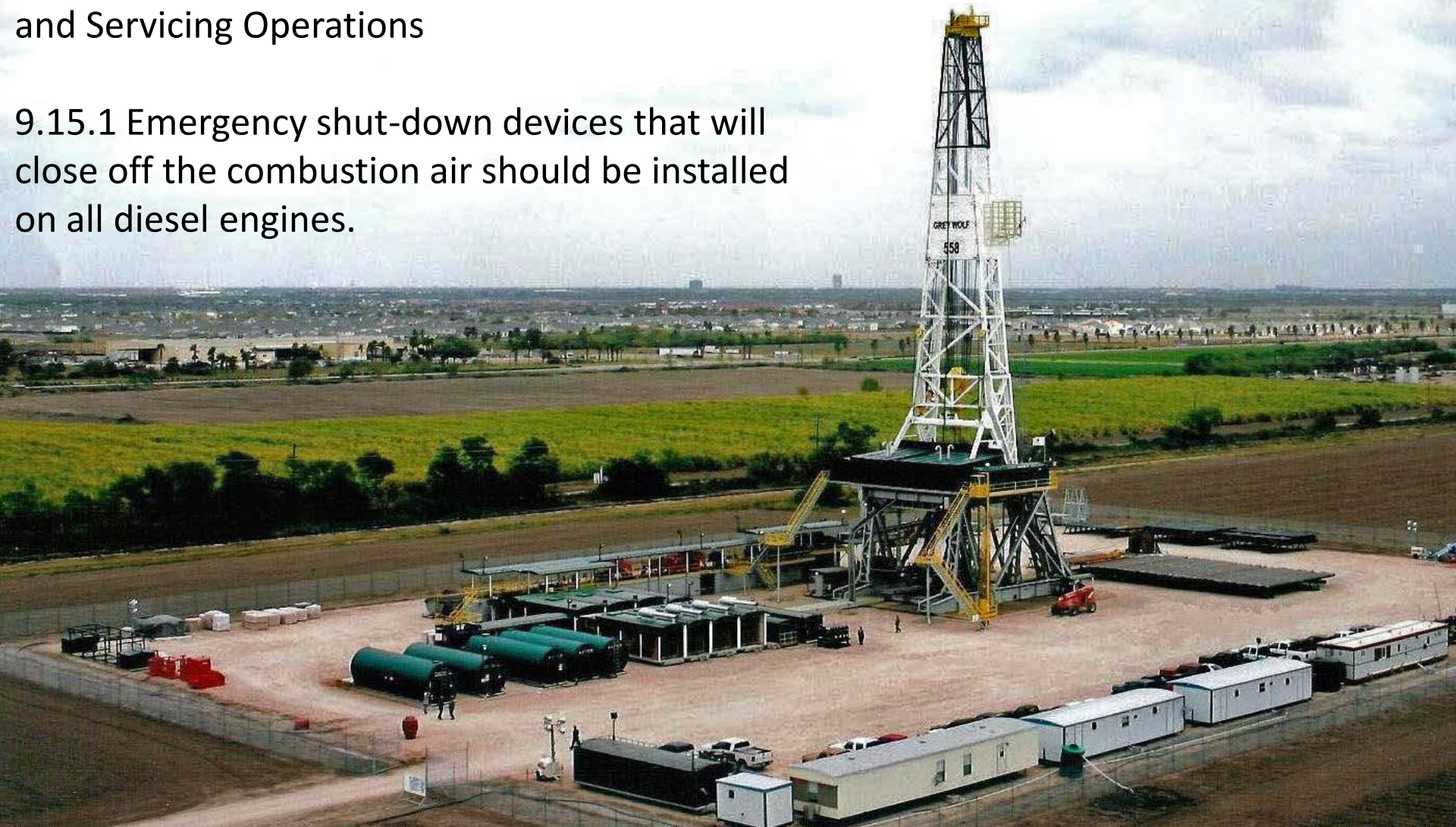
1. Defines diesel engine runaway as a hazard.
2. Identifies method of control required to shut down diesel engines in the event of a runaway.
3. Includes diesel engines that power stationary, mobile and vehicular equipment operating near the well sites and production facilities.
4. Requires installation of a manual emergency stop device on all power drilling and well servicing equipment to effectively stop a runaway.
5. Enhanced requirements at drilling sites and production facilities:
  - a. Shut down the diesel engine if the concentration of the flammable gas or vapor is greater than 10 percent of the lower explosive limit (LEL)
  - b. Continuously monitor ignitable gas or vapor
  - c. Install automatic air intake shut-off valve or equivalent within 50 feet of potential source of ignitable gas or vapor when not monitored continuously.



# All other states

API RP 54 Recommended Practice for Occupational Safety for Oil and Gas Well Drilling and Servicing Operations

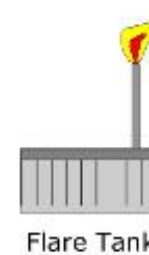
9.15.1 Emergency shut-down devices that will close off the combustion air should be installed on all diesel engines.



# Alberta, Canada: 151-71 Regulation

Minimum of 25 meters from well

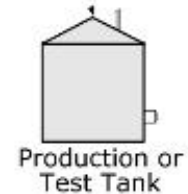
- Diesel engines without air shutoff valves
- Gasoline engines
- Other ignition sources



25 m



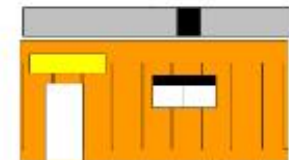
7 m



7 m



15 m



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## **7) Risk assessment and actions to reduce accidents**




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# Low event probability - but very high consequences (death, site destruction)

## Qualitative Risk

Probability of Occurrence	Consequence of Occurrence				
	Very Low	Low	Moderate	High	Very High
Very Low	Low Risk	Low Risk	Low Risk	Medium Risk	Medium Risk
Low	Low Risk	Low Risk	Medium Risk	Medium Risk	High Risk
Moderate	Low Risk	Medium Risk	Medium Risk	Medium Risk	High Risk
High	Medium Risk	Medium Risk	High Risk	High Risk	High Risk
Very High	Medium Risk	High Risk	High Risk	High Risk	High Risk

**DIESEL RUNAWAY**

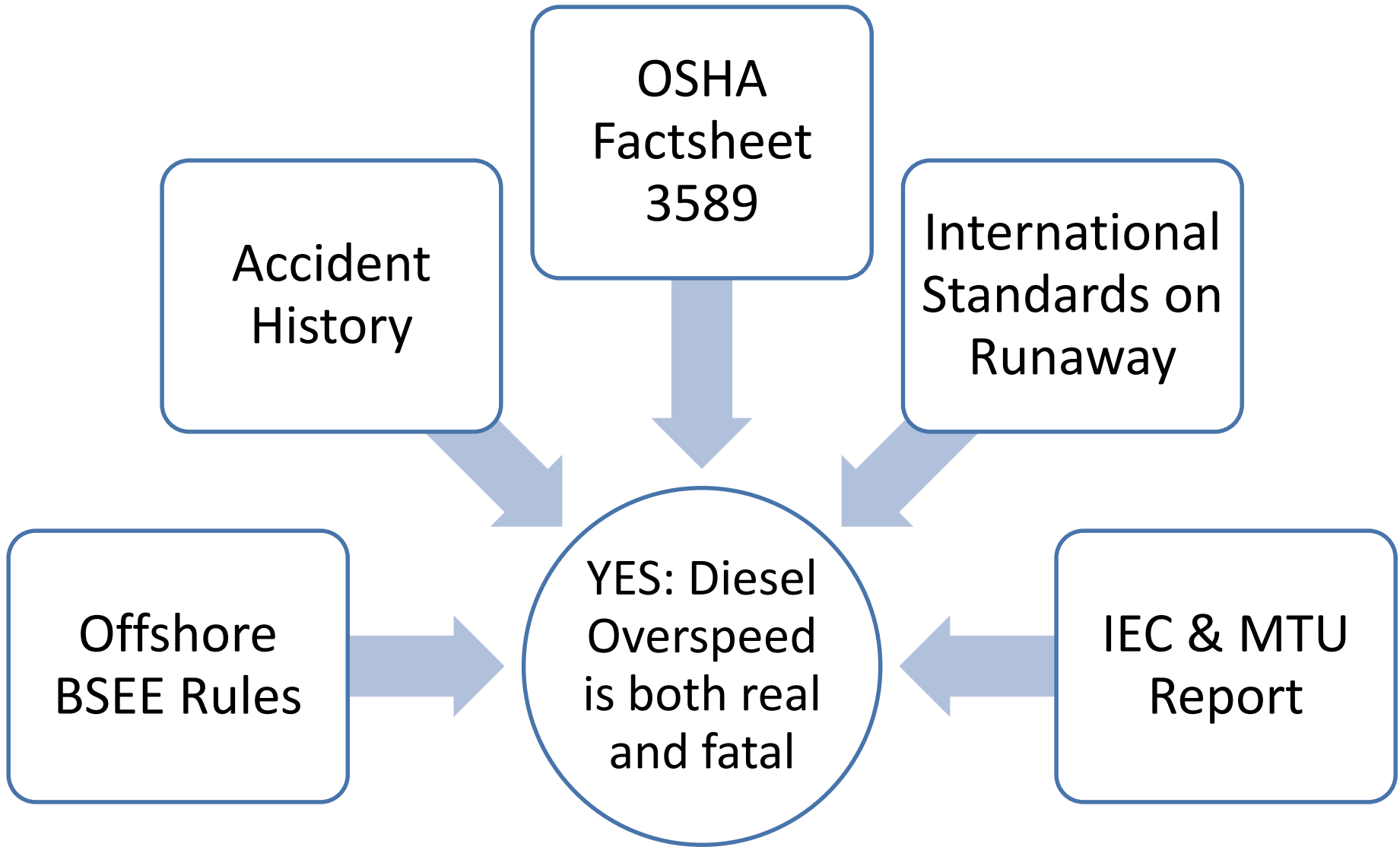
Low Risk  Medium Risk  High Risk 



# Diesel engine as ignition source

Low frequency but consequences are devastating







# In summary

- Diesel runaway occurs when an ungoverned fuel (vapor) enters the air intake system of an engine
- This creates a potential ignition source which poses a serious threat to workers on oil & gas well servicing & drilling sites
- Most reliable way to prevent runaway is by installing automatic air intake shutoff devices



# What can we do to reduce accidents?

## 1. Education & training

**OSHA<sup>®</sup> FactSheet**


### Internal Combustion Engines as Ignition Sources

Internal combustion engines present an ignition hazard when used in facilities processing flammable liquids and gases. If flammable vapors or gases are released in these facilities, an internal combustion engine could ignite the flammable materials with catastrophic consequences. Investigations by OSHA and the U.S. Chemical Safety Board (CSB) document a history of fires and explosions at workplaces (oilfields, refineries, chemical plants, and other facilities) where an internal combustion engine was identified as or suspected to be the source of ignition.<sup>1</sup>

**Understanding the Hazard**

Internal combustion engines, whether fueled by gasoline, diesel, propane, natural gas, or other fuels, can act as ignition sources. Examples include:

- Stationary engines such as compressors, generators and pumps.
- Mobile equipment or transports such as vans, trucks, forklifts, cranes, well servicing equipment, drilling rigs, excavators, portable generators and welding trucks.
- Contractor vehicles and motorized equipment.
- Emergency response vehicles such as fire engines and ambulances.
- Vehicle-mounted engines on vacuum trucks, tanker trucks and waste haulers.
- Small portable engines such as mowers, blowers, generators, compressors, welders and



*An explosion at a refinery site killed 15 and injured nearly 200; an idling diesel pickup truck was the most likely ignition point.*  
Source: U.S. Chemical Safety Board


OSHA FactSheet 3589

Oil & Gas Wellsites Hazard Alert Oil & Gas Wellsites Hazard Alert Oil

## Prevention of Fatalities from Ignition of Vapors by Mobile Engines and Auxiliary Motors

Between 2005 and 2015  
**85**  
DEATHS due to fires or explosions  
including **27** mobile engines/motors deaths

Vehicles and motorized equipment present an ignition hazard if located too close to the wellbore or other potential flammable vapor sources (e.g., flowback tanks, frac tanks, production tanks). When flammable vapors or gases are released, non-intrinsically safe engines and motors can ignite the vapors and cause explosions with catastrophic consequences. Conducting a Fire Risk Assessment to ensure safe positioning of all motorized equipment during drilling and completions, servicing, and production operations is essential to preventing fires and explosions.



**diesel trucks**      **light plants**      **motors & pumps**

# EVACUATE!

If an engine "over revs" or "runs away," you run away too

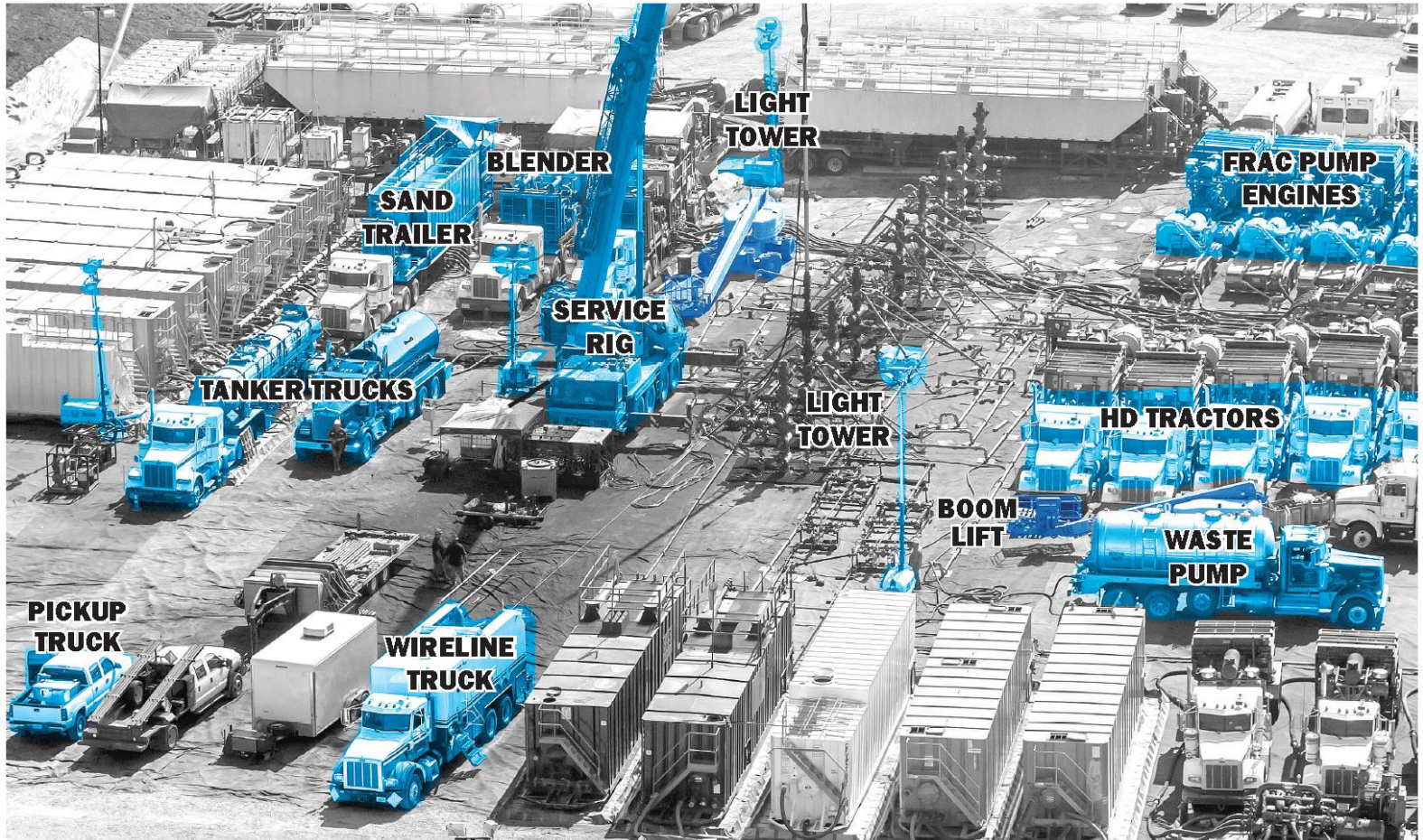
**Employers**

STEPS Network Hazard Alert





## 2. Look for shutoff valves on equipment in the field



3. Ask if there is a company policy in place

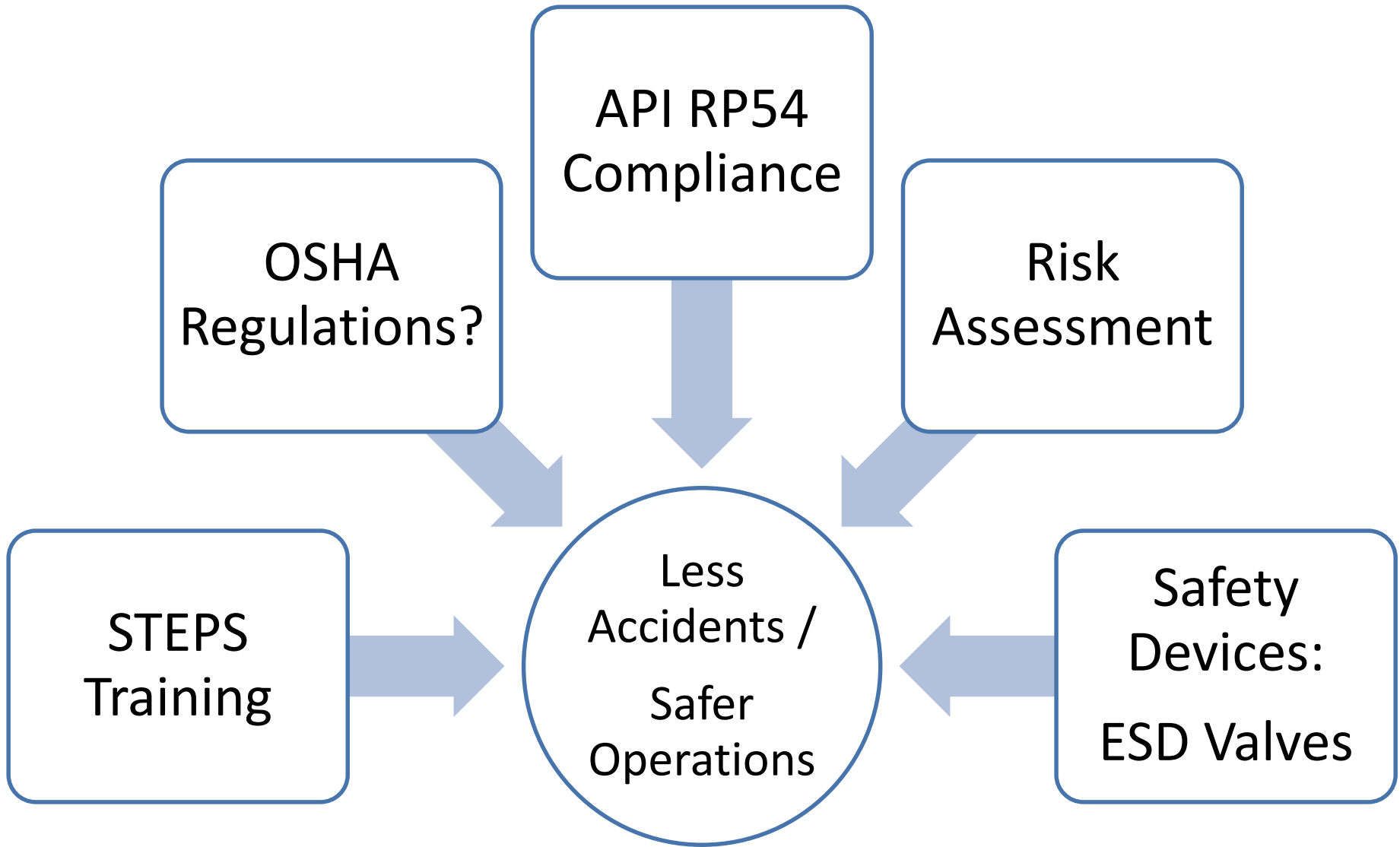


## 4. Consider proactive addition of safety devices



Air intake  
shutoff valves







The background of the slide is a photograph of an oil field at sunset. The sky transitions from a deep blue at the top to a bright orange and red near the horizon. Silhouetted against this colorful sky are several tall, lattice-structured drilling rigs and other industrial equipment. Some lights are visible on the rigs, and the overall scene is dark, with the primary light source being the setting sun.

Thank you  
Questions are welcome

Stephen Gale  
[steve.gale@amot.com](mailto:steve.gale@amot.com)