2015 Torrance Refinery Explosion: Industry Impacts Then and Now

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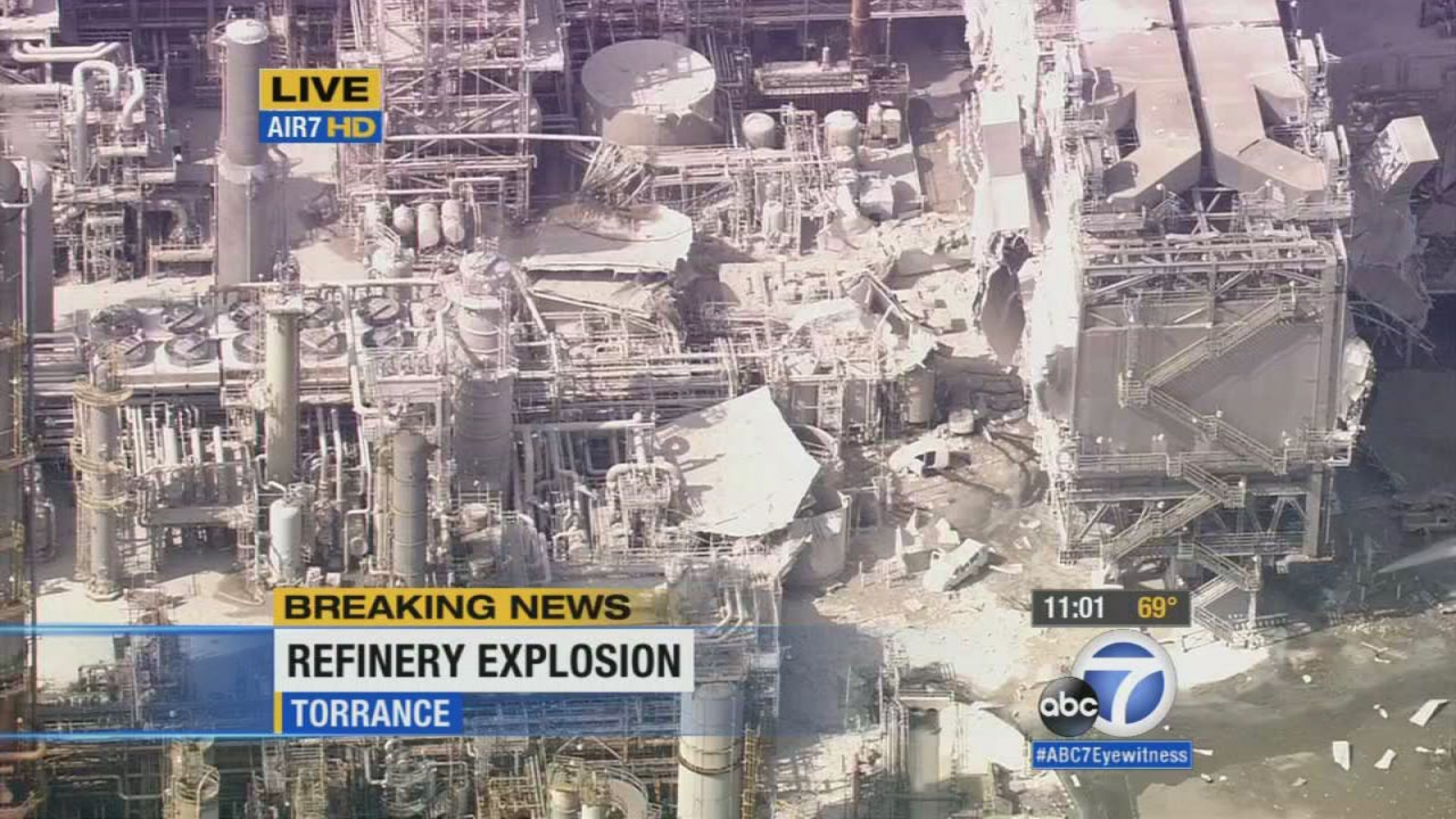
U.S. Chemical Safety Board (CSB)

TU-A4

February 27, 2024

26th California Unified Program Annual Training Conference
February 26-29, 2024


LIVE
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BREAKING NEWS
REFINERY EXPLOSION
TORRANCE
11:01 69°
abc 7
#ABC7Eyewitness

Agenda

- About the CSB
- Fluid Catalytic Cracking Overview
- Transient Operations
- 2015 Torrance, CA Incident

Break

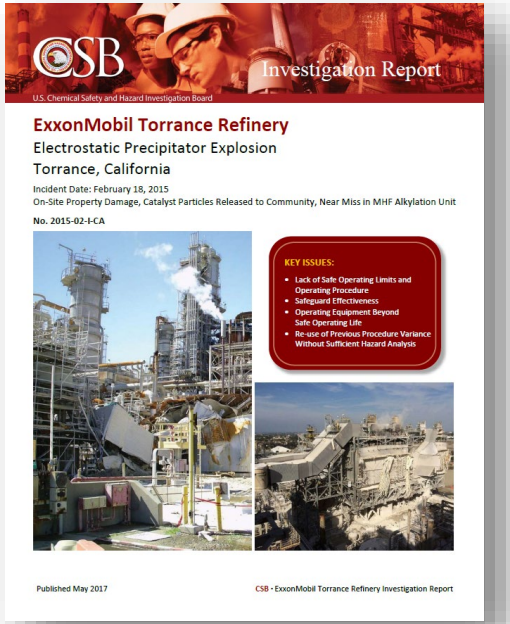
- 2018 Superior, WI Incident
- Industry Response
- Hydrogen Fluoride Near-Misses
- California PSM Reform

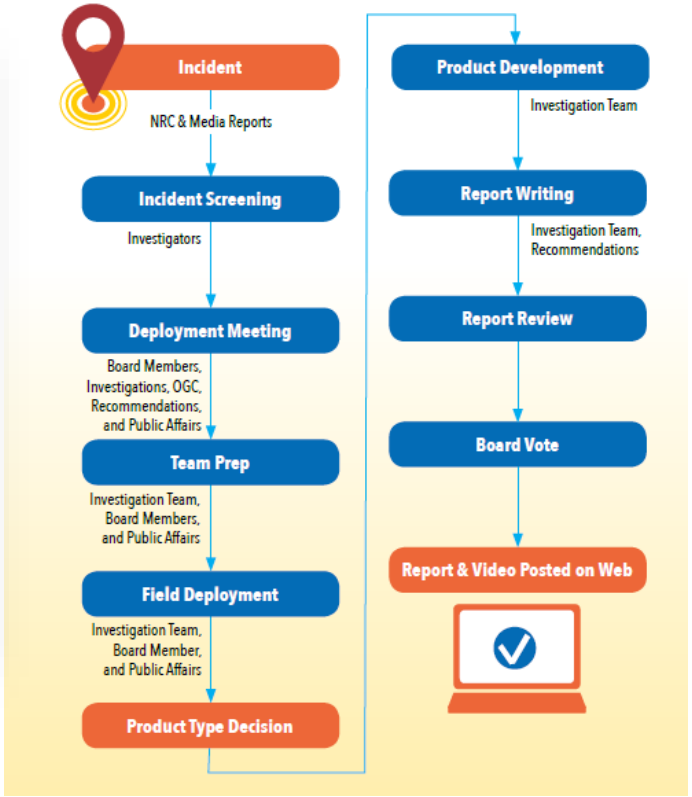
About the CSB

- Independent federal agency
- The “Board” is a group of 5 individuals nominated by the President
- From 42 U.S. Code § 7412 (6)(C)(i):
  - “The Board shall investigate…determine and report to the public in writing…the cause or probable cause of any accidental release resulting in fatality, serious injury, or significant property damages.”
- Companies are required to report incidents to the CSB (40 C.F.R. Part 1604)

About the CSB

All completed investigation reports are available at www.csb.gov





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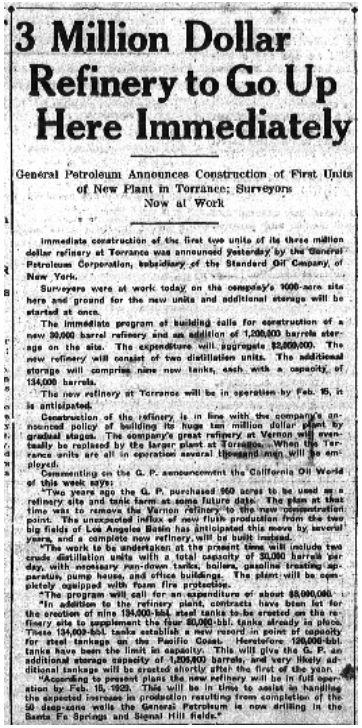
Torrance Refinery Overview

City of Torrance incorporated in 1921

Refinery constructed in 1928-29



3 Million Dollar Refinery to Go Up Here Immediately

General Petroleum Announces Construction of First Units of New Plant in Torrance; Surveyors Now at Work

Immediate construction of the first two units of its three million dollar refinery at Torrance was announced yesterday by the General Petroleum Corporation, subsidiary of the Standard Oil Company, of New York.

Surveyors were at work today on the company's 1000-acre site here and ground for the new units and additional storage will be started at once.

The immediate program of building calls for construction of a new 30,000 barrel refinery and an addition of 1,200,000 barrels storage on the site. The expenditure will aggregate $3,000,000. The new refinery will consist of two distillation units. The additional storage will comprise nine new tanks, each with a capacity of 134,000 barrels.

The new refinery at Torrance will be in operation by Feb. 15, it is anticipated.

Construction of the refinery is in line with the company's announced policy of building its huge ten million dollar plant by gradual stages. The company's great refinery at Vernon will eventually be replaced by the larger plant at Torrance. When the Torrance units are all in operation several thousand men will be employed.

Commenting on the G. P. announcement the California Oil World of this week says:

"Two years ago the G. P. purchased 960 acres to be used as a refinery site and tank farm at some future date. The plan at that time was to remove the Vernon refinery to the new concentration point. The unexpected influx of new flush production from the two big fields of Los Angeles Basin has anticipated this move by several years, and a complete new refinery will be built instead.

"The work to be undertaken at the present time will include two crude distillation units with a total capacity of 30,000 barrels per day, with necessary run-down tanks, boilers, gasoline treating apparatus, pump house, and office buildings. The plant will be completely equipped with foam fire protection.

"The program will call for an expenditure of about $3,000,000.

"In addition to the refinery plant, contracts have been let for the erection of nine 134,000-bbl. steel tanks to be erected on the refinery site to supplement the four 80,000-bbl. tanks already in place. These 134,000-bbl. tanks establish a new record in point of capacity for steel tankage on the Pacific Coast. Heretofore 120,000-bbl. tanks have been the limit in capacity. This will give the G. P. an additional storage capacity of 1,205,000 barrels, and very likely additional tankage will be erected shortly after the first of the year.

"According to present plans the new refinery will be in full operation by Feb. 15, 1929. This will be in time to assist in handling the expected increase in production resulting from completion of the 50 deep-sand wells the General Petroleum is now drilling in the Santa Fe Springs and Signal Hill fields."

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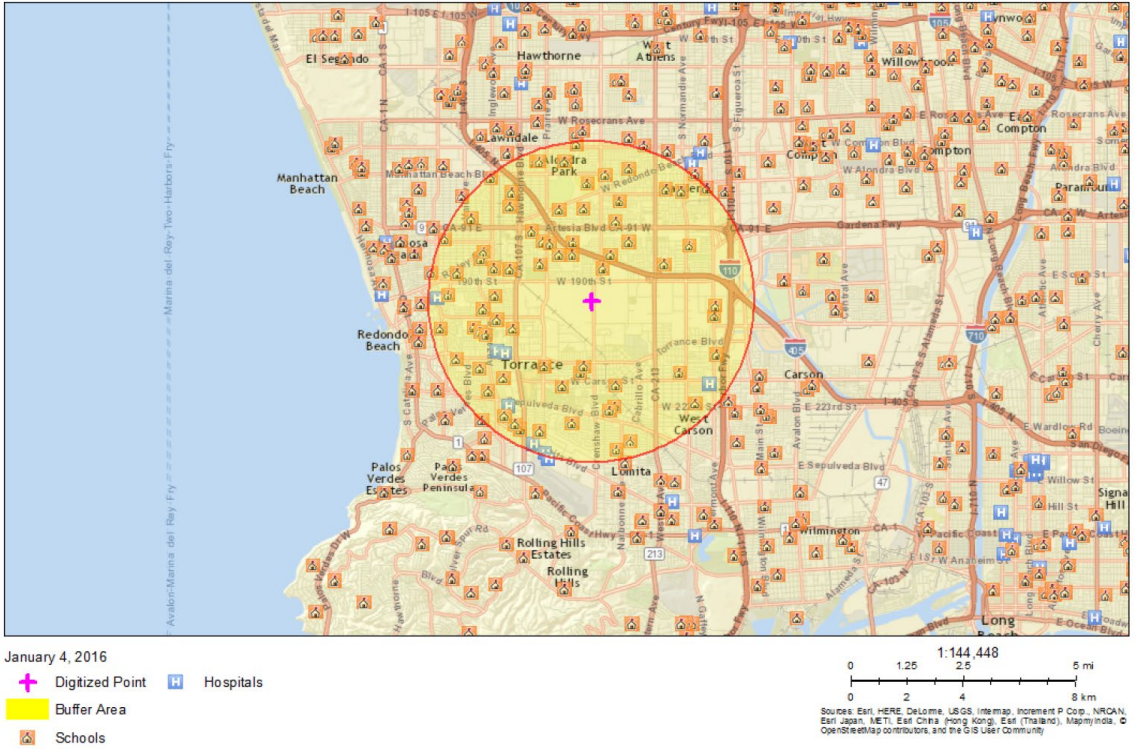
Torrance Refinery Overview

Refinery Proximity to Public Receptors:

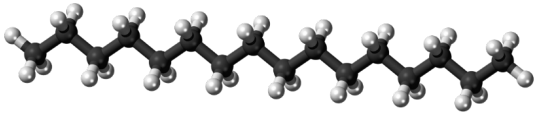
Within a 3-mile radius of the refinery, there are:

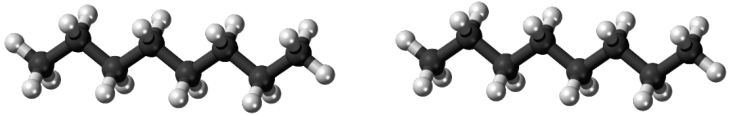
- 330,000 people
- 71 schools
- 8 hospitals

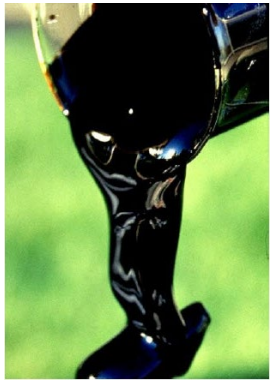


Fluid Catalytic Cracking (FCC) Overview

The FCC converts low-value, thick oil to higher value gasoline by "cracking" the large molecules apart into smaller molecules

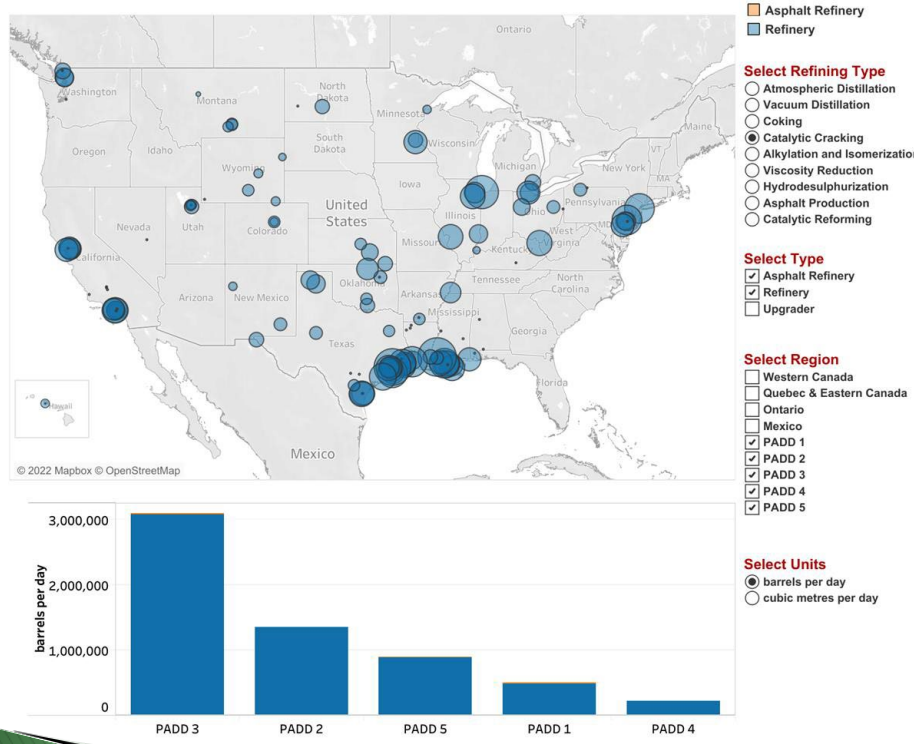






Catalytic Cracking

Fluid Catalytic Cracking (FCC) Overview

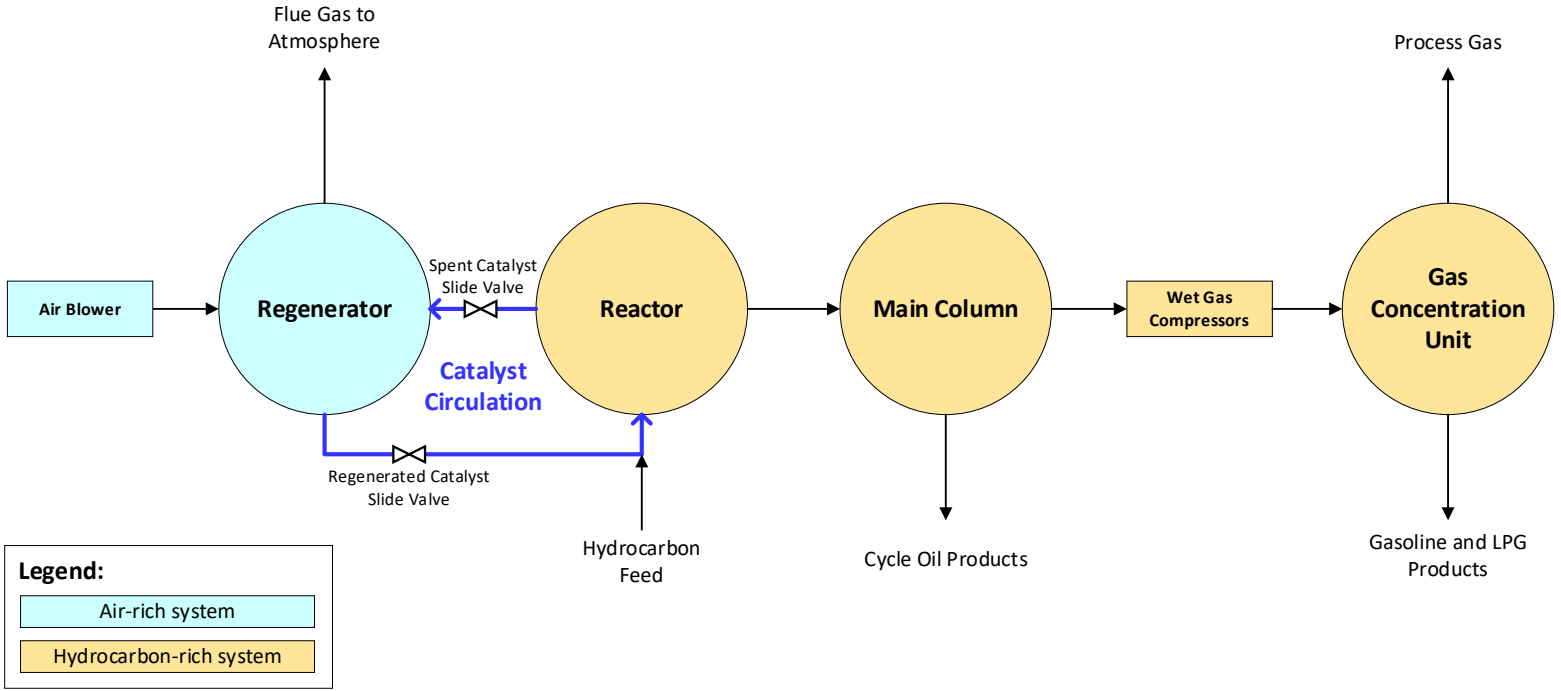


Source: [Canada Energy Regulator]

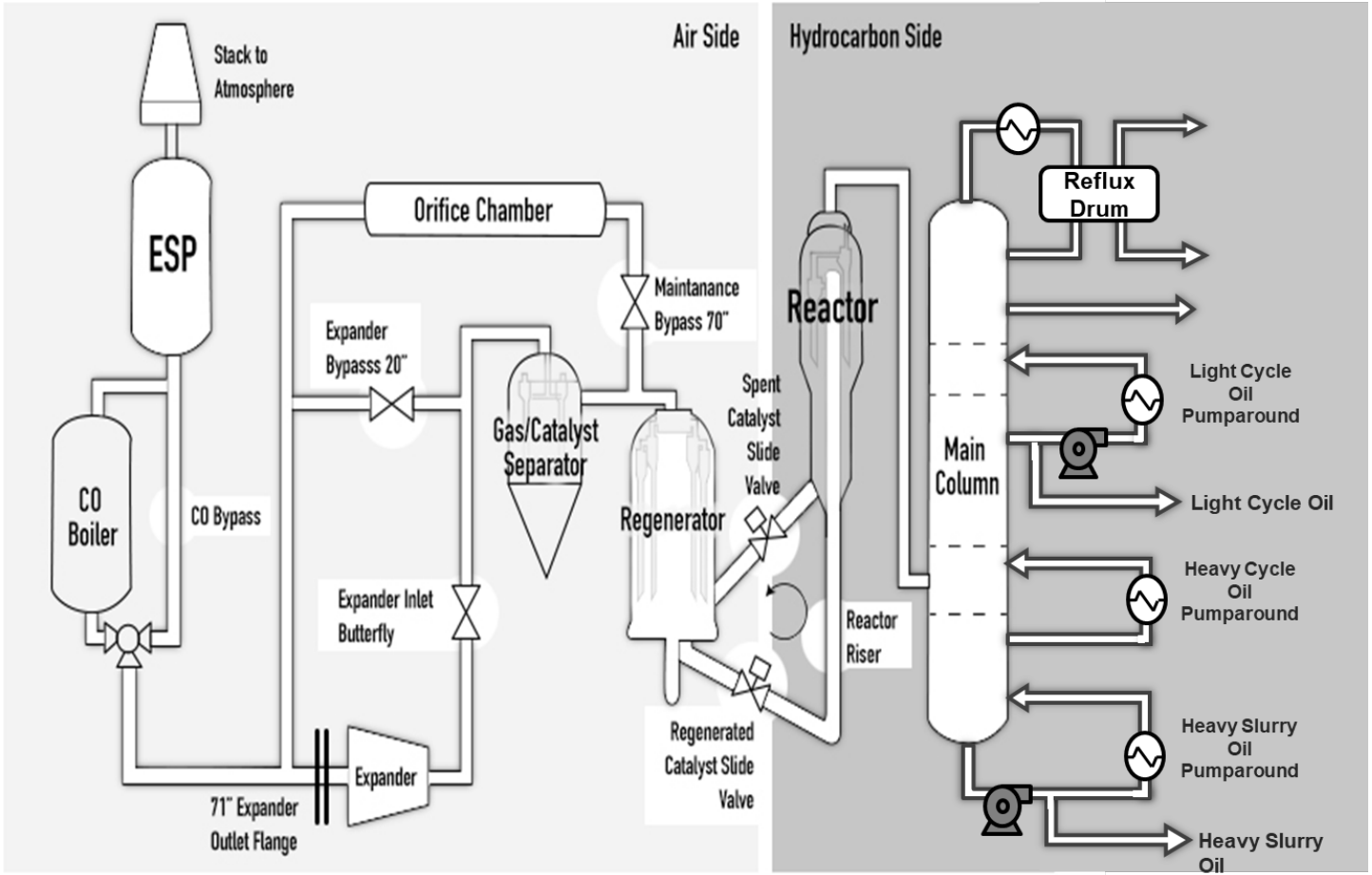
FCC Units in Northern California (as of 1/1/23)	
Chevron	Richmond
PBF	Martinez
Valero	Benicia
FCC Units in Southern California (as of 1/1/23)	
Chevron	El Segundo
Phillips 66	Wilmington
Marathon	Carson
PBF	Torrance
Valero	Wilmington

Source: [EIA]

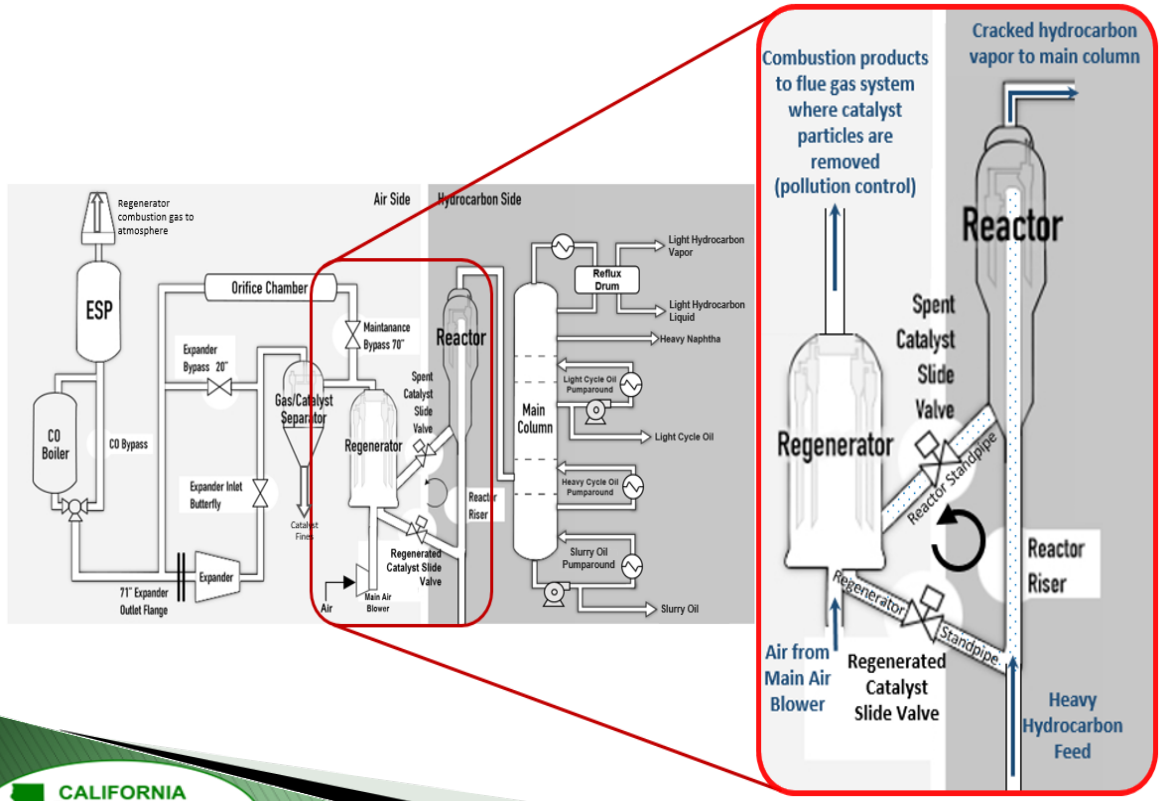
Fluid Catalytic Cracking (FCC) Overview

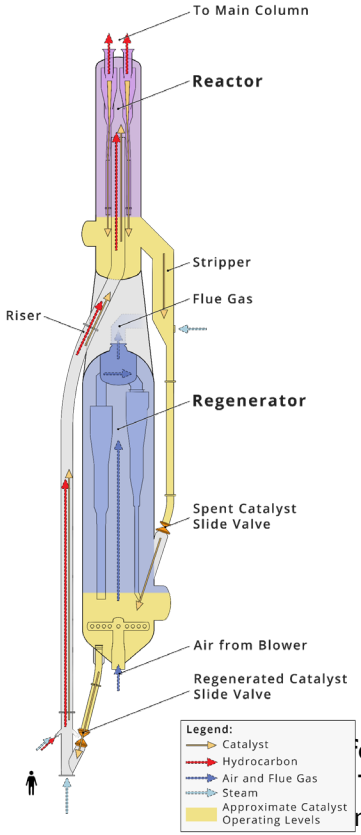


Fluid Catalytic Cracking (FCC) Overview


Air Side
Hydrocarbon Side
Stack to Atmosphere
ESP
Orifice Chamber
Maintanance Bypass 70"
Expander Bypasss 20"
Gas/Catalyst Separator
Spent Catalyst Slide Valve
Reactor
Reflux Drum
Light Cycle Oil Pumparound
Main Column
Light Cycle Oil
CO Boiler
CO Bypass
Regenerator
Heavy Cycle Oil Pumparound
Expander Inlet Butterfly
Reactor Riser
Regenerated Catalyst Slide Valve
Heavy Slurry Oil Pumparound
Expander
71" Expander Outlet Flange
Heavy Slurry Oil

Fluid Catalytic Cracking (FCC) Overview



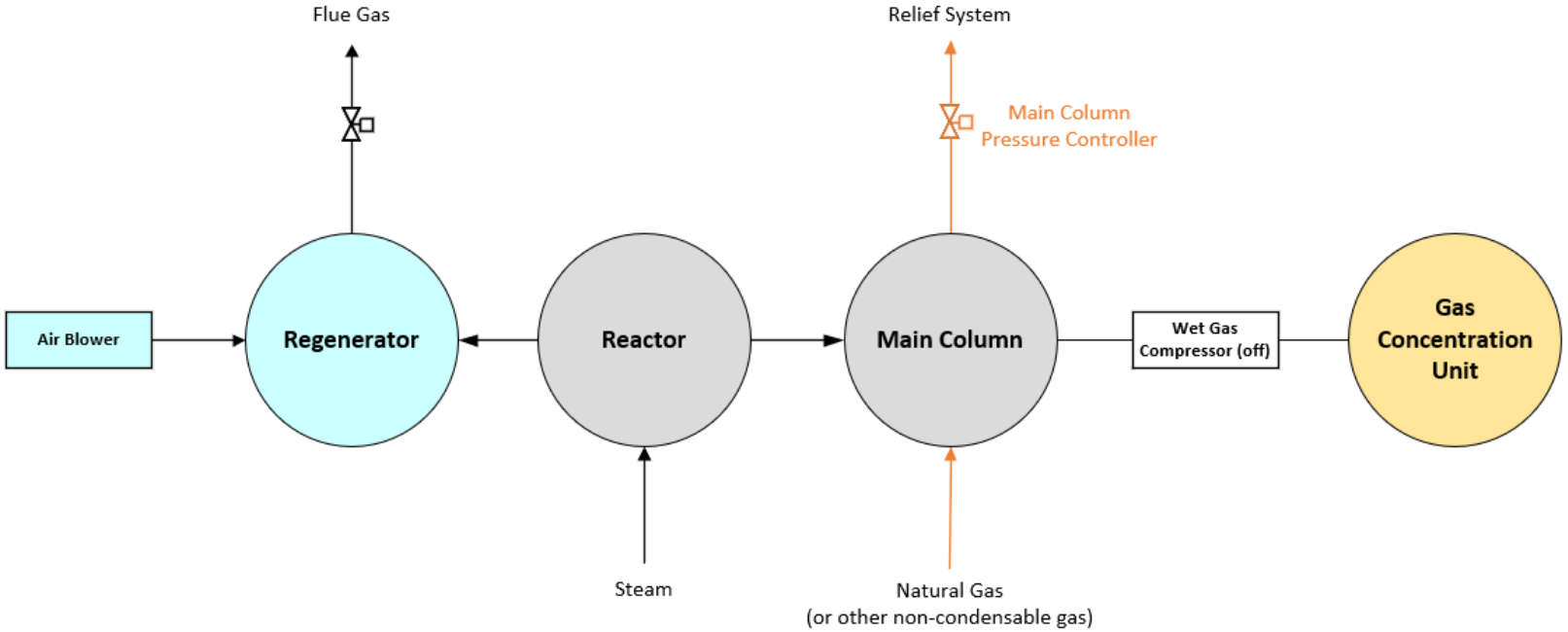


Transient Operations

Transient Operation:
The operating mode when the process is in transition and is not in its normal operations mode.

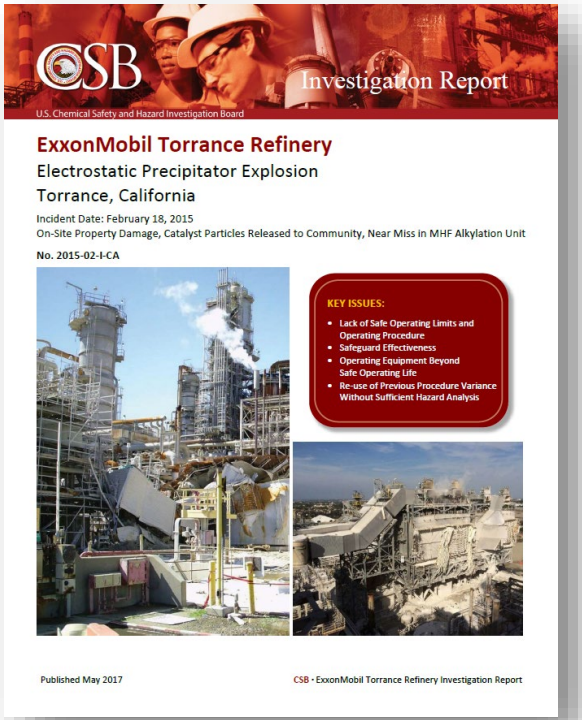
Examples:
Startup, shutdown, standby, emergency, procedure-based operations

Transient Operations



During transient operation, steam pressure separates the air and hydrocarbon sides of the process

2015 Torrance, CA Incident



February 18, 2015
FCC unit was idled for unplanned maintenance
Pressure deviation allowed hydrocarbons to backflow in the process and ignite in the ESP

Consequences:

- Four contractors sought first aid; no serious injuries/ fatalities
- Catalyst dust dispersed into the community

CSB report / YouTube video


©CSB

2015 Torrance, CA Incident

Safety Issues Identified by the CSB:

1. Safe Operating Limits: Lack of “safe park” procedure and verifiable operating parameters
2. Process Hazard Analysis: Reliance on 2012 variance without verifying safeguards
3. Mechanical Integrity
4. ESP Operation
5. Refinery management permitted opening process equipment without confirming to refinery standards

Industry Responses to Torrance Incident

- CSB investigation lessons shared widely across the refining industry
- YouTube video used as training tool
- Most refiners now automatically shut down the ESP during FCC unit transient operations
  - Process safety vs. Environmental impact
  - EPA updated 40 C.F.R. § 63.1564(a)(5)

Deployment Activities

Stretch Break

(5 minutes)

2018 Superior, WI Incident

April 26, 2018

FCC unit was shutting down for a planned turnaround

Two vessels exploded around 10:00 a.m.

- Explosion debris struck asphalt storage tank

Asphalt fire around 12:00 p.m.

- Evacuation lifted at 6:00 a.m. the next morning

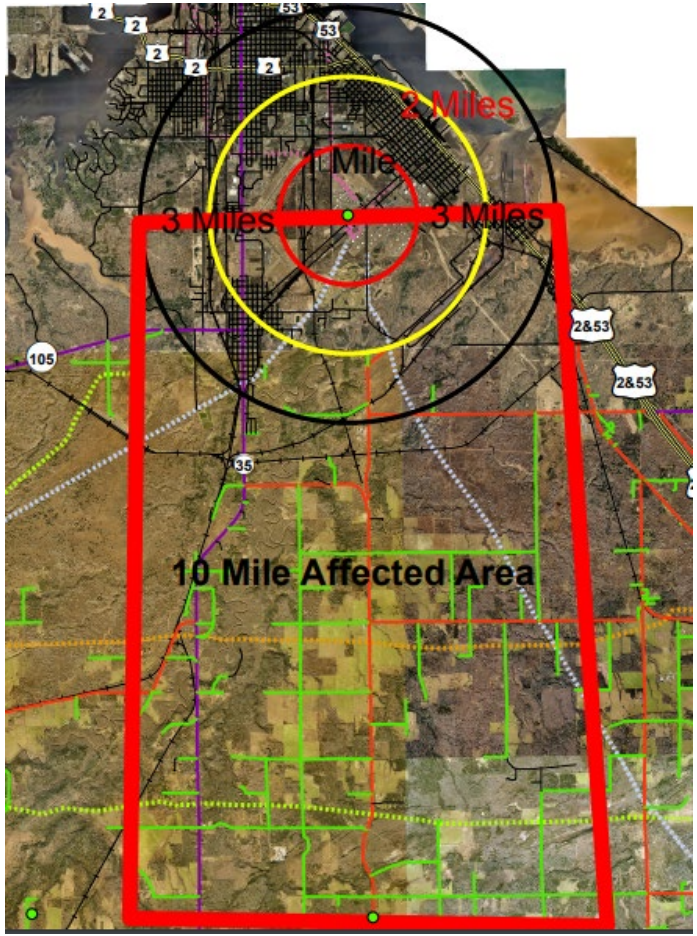
Consequences:

- 36 injuries (including 11 OSHA recordable injuries); no fatalities
- 39,000 pounds of flammable hydrocarbon vapor released
- $550 million property damage

CSB report / YouTube video

2018 Superior, WI Incident

Source: WDIO ABC News



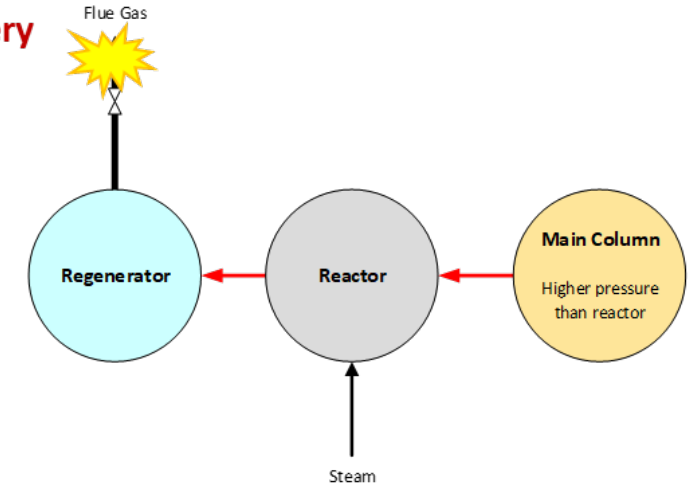
Source: Douglas County, Wisconsin

2018 Superior, WI Incident

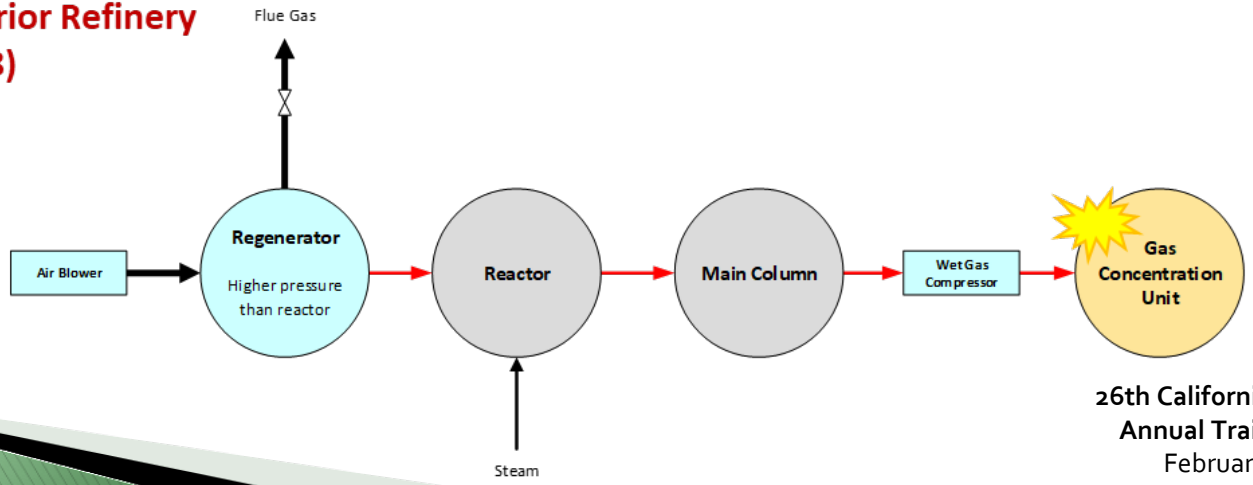
Safety Issues Identified by the CSB:

1. Transient Operation Safeguards
2. Process Knowledge
3. Process Safety Management Systems
4. Industry Knowledge and Guidance
5. Brittle Fracture During Extreme Events
6. Emergency Preparedness

Torrance Refinery (2015)



Superior Refinery (2018)



2018 Superior, WI Incident

Refinery's FCC technology knowledge was not sufficient to safely shut down the FCC unit. As a result, refinery workers were not aware of explosion risk

CSB recommendations to Cenovus Energy:

- Develop an FCC PHA guidance document for use at all Cenovus-operated refineries
- Develop and implement a technology-specific knowledge-sharing network program across all Cenovus-operated refineries, which at a minimum includes an FCC technology peer network

2018 Superior, WI Incident

- Husky Superior Refinery knew about the Torrance incident, but workers did not recognize that inadvertent flow in the reverse direction was also possible
- Similar knowledge gaps may exist at other U.S. refineries
- Many different FCC unit designs exist through multiple technology licensors
- Currently, there is no industry publication that establishes common basic process safety expectations for all FCC units

Industry Response to Both FCC Incidents

- **2015: Torrance incident**
- **2017: CSB publishes Torrance report;** shared in conferences
- **2018: Superior incident; CSB publishes factual investigative update**
- **2019:** Refining industry survey on safe FCC operating practices
- **2020:** Webinar on safeguarding the FCC unit during transient operation
- **2020-2022:** AFPM publishes multiple webinars and practice sharing documents
- **2022: CSB publishes Superior report**
- **2023-2025:** FCC Process Safety Regional Workshops ("Safety Roadshow")

Open CSB Recommendations for FCC Units

CSB Recommendation to API:
Develop a publicly available technical publication for the safe operation of FCC units

CSB Recommendation to EPA:
Develop a program that prioritizes and emphasizes inspections of FCC units in refineries that operate HF alkylation units

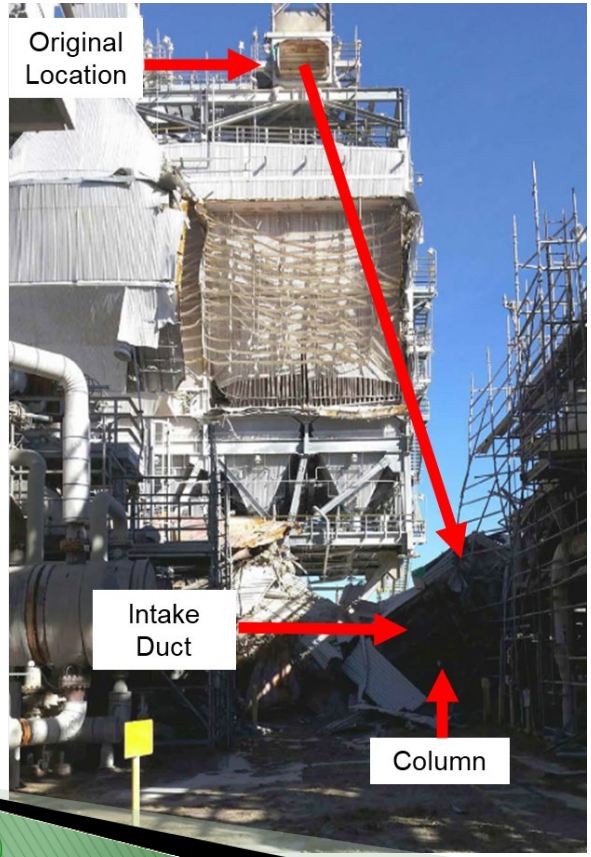
Hydrogen Fluoride (HF) Near-Misses

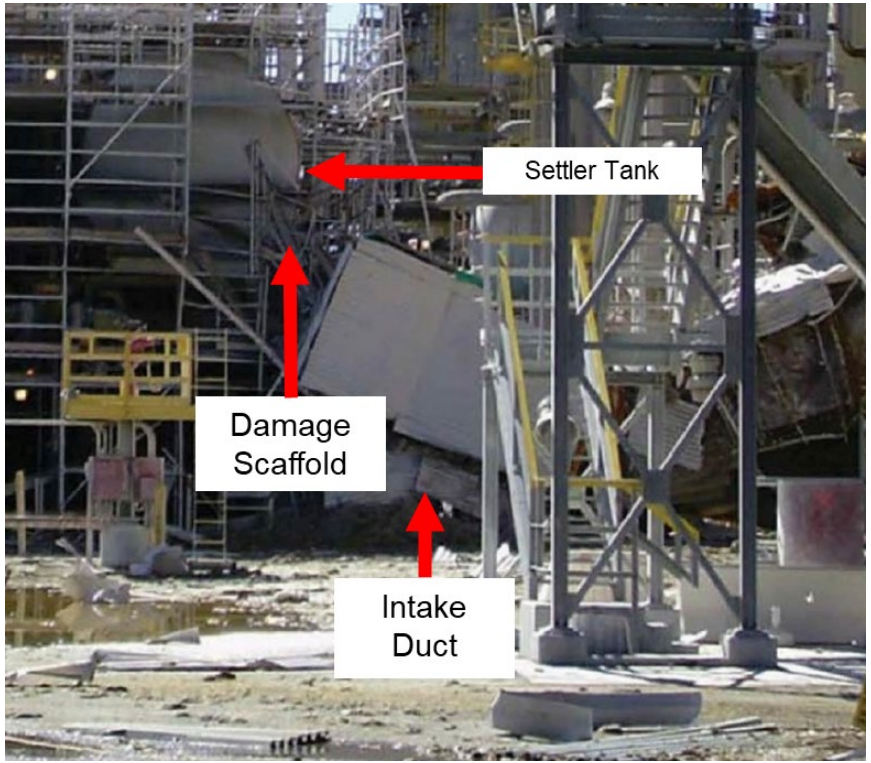
- HF acid is a toxic chemical and poses a severe hazard to the population and environment when a release occurs
- Causes severe damage to skin, respiratory system, and bones after exposure and can lead to death (30 ppm)
- Large release could impact hundreds of thousands of residents
- Torrance Refinery used Modified HF (MHF)
- **No HF was released in the Torrance and Superior incidents**

HF Near-Miss: Torrance

- Two MHF tanks approximately 80 feet south of the ESP
- Temporary scaffolding around tanks at time of incident
- Outside of ExxonMobil's minimum equipment spacing requirement

HF Near-Miss: Torrance





HF Near-Miss: Torrance

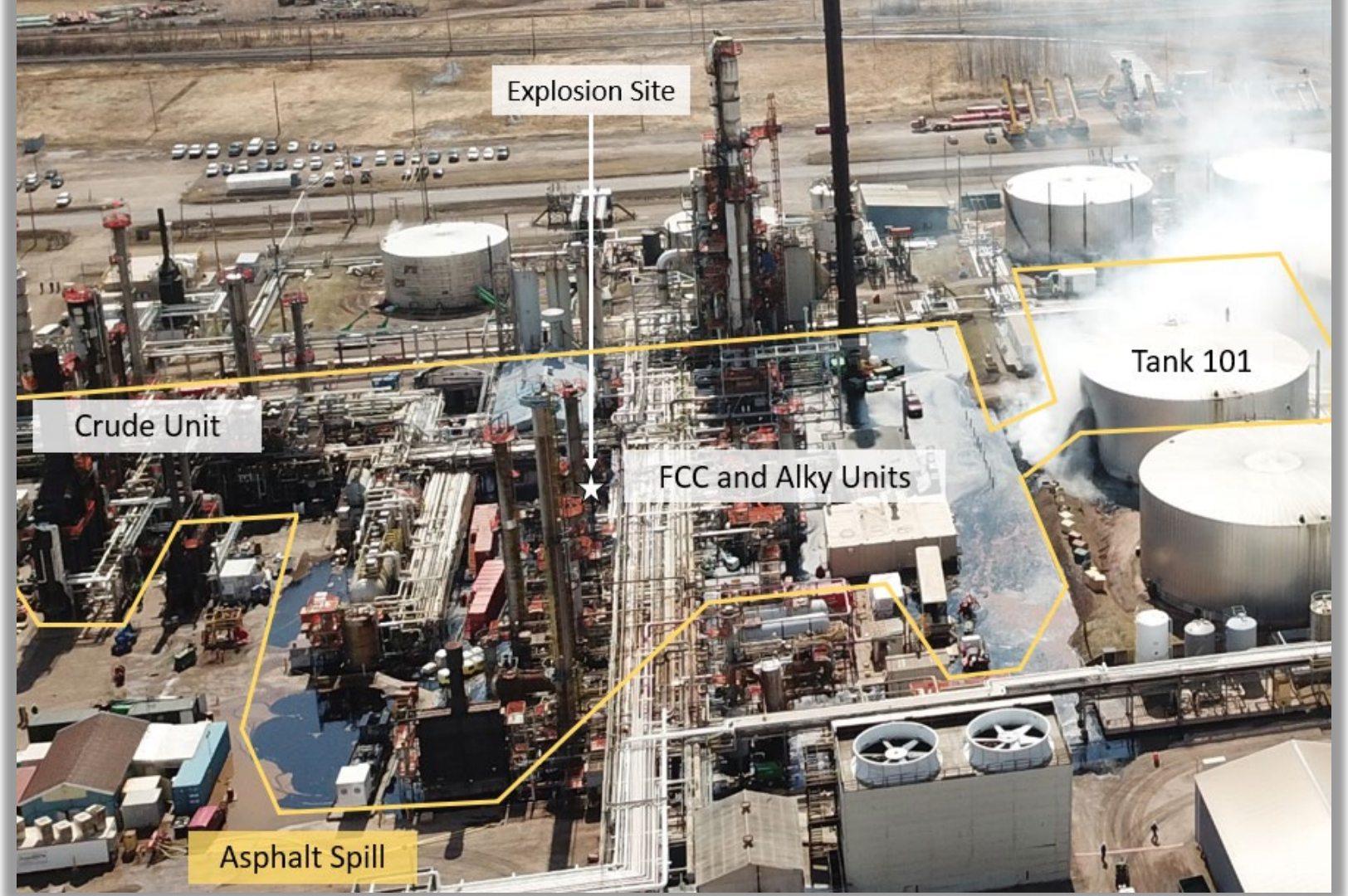
Another nearby vessel hit by explosion debris (not MHF)

HF Near-Miss: Torrance

Perimeter laser detection system compromised

HF Near-Miss: Superior

HF tank was 50 feet closer to the explosion than the punctured asphalt tank
(HF tank was not compromised)


Explosion Site
Tank 101
Crude Unit
FCC and Alky Units
Asphalt Spill

HF Near-Miss: Superior

- Post-incident, Superior Refinery implemented additional HF mitigation, including:
  - Rapid acid transfer system
  - Enhancements to existing water mitigation system
  - Additions and modifications of other safety features
- Providing assistance to the Douglas County Emergency Management Department on its emergency community alert system and community evacuation plan, including interactive drills

Source: Cenovus

Philadelphia Energy Solutions (PES)

June 21, 2019
Piping in HF alkylation unit ruptured
Vapor cloud ignited, fire led to other explosions

HF response:

- Approximately 5,000 lbs of HF released (no off-site impacts reported due to HF release)
- Rapid acid de-inventory: 339,000 lbs of HF drained
- Explosion compromised control system to remotely operate the water spray HF mitigation system

CSB report / YouTube video

Philadelphia Energy Solutions (PES)

"[A]ctive" safeguards—or safeguards that require a person or technology to trigger their activation—have the potential to fail in major incidents involving fire or explosions.
Refiners operating HF alkylation units need to improve the availability and reliability of active safeguards during incidents involving fire and explosions.

From CSB report: *Fire and Explosions at Philadelphia Energy Solutions Refinery Hydrofluoric Acid Alkylation Unit* (October 2022)

Open CSB Recommendations for HF

- **To EPA:** "Develop a program that prioritizes and emphasizes inspections of refinery HF alkylation units" and "FCC units in refineries that operate HF alkylation units"
- **To API:** "Update API RP 751 *Safe Operation of Hydrofluoric Acid Alkylation Units* "
- **To EPA:** "Revise 40 C.F.R. Part 68 (EPA Risk Management Plan) to require new and existing petroleum refineries with HF alkylation units to conduct a safer technology and alternatives analysis (STAA) and to evaluate the practicability of any inherently safer technology (IST) identified"
- **To EPA:** Initiate prioritization and, as applicable, risk evaluation of HF under the Toxic Substances Control Act

California PSM Reform

- California updated its PSM regulation for petroleum refineries (Section 5189.1) in 2017 in response to previous regulatory gaps the CSB identified:
  - Chevron Refinery Fire (2012)
  - Tesoro Anacortes Refinery Fatal Explosion and Fire (2010)
- Intended to make California petroleum refineries safer, including:
  - Hierarchy of Hazard Controls Analysis
  - Process Hazard Analysis that documents the effectiveness of safeguards
  - Damage Mechanism Review
  - Employee Participation, Human Factors, Process Safety Culture Assessment, and others

Open Discussion

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