South Coast
Air Quality Management District
South Coast AQMD
21865 Copley Drive, Diamond Bar, CA 91765-4178
(909) 396-2000 · www.aqmd.gov

REVISED

REFINERY COMMITTEE MEETING

COMMITTEE MEMBERS
Dr. Clark E. Parker, Sr., Chair
Mayor Larry McCallon, Vice Chair
Mayor Ben Benoit
Dr. Joseph K. Lyou
Mayor Pro Tem Judith Mitchell
Dr. William A. Burke, Ad Hoc Member

Saturday, September 22, 2018 - 9:00 a.m.

Wilmington Middle School
Auditorium
1700 Gulf Avenue
Wilmington, CA 90744

AGENDA

Members of the public may address this body concerning any agenda item before or during consideration of that item (Gov't. Code Section 54854.3(a)). Please provide a Request to Address the Committee card to the Committee Secretary if you wish to address the Committee on an agenda item. If no cards are available, please notify SCAQMD staff or a Board Member of your desire to speak. All agendas for regular meetings are posted at District Headquarters, 21865 Copley Drive, Diamond Bar, California, and Wilmington Middle School at 1700 Gulf Avenue, Wilmington, CA, at least 72 hours in advance of the regular meeting. Speakers may be limited to three (3) minutes or less each.

Items are expected to be completed in the order listed below. However, items may be taken in any order.

1. **Welcome / Opening Remarks** — *Dr. Clark E. Parker, Sr.*, *Committee Chair*

2. **Introduction** — *Wayne Nastri*, *Executive Officer*

3. **Staff Presentation - Status Update of PR1410** — *Dr. Philip Fine*, *Deputy Executive Officer*, *Planning and Rules*

4. **Regulatory and MOU Approach** — *Bayron Gilchrist*, *General Counsel*

5. **Potential Earthquake Risk** — *Dr. Kenneth Hudnut*
Science Advisor for Risk Reduction
United States Geological Survey

6. **Dispersion and Water Mitigation Testing** — *Dr. Ronald Koopman*
Hazard Analysis Consulting

7. **Assessment of Additional HF/MHF Testing** — *John Cornwell*
Principal Engineer
Quest Consultants, Inc.

8. **Emergency Preparedness and Treatment of HF** — *Michael Mastrangelo*
Program Director, Institutional Preparedness
University of Texas, Medical Branch

9. **Public Comments**
At the end of the meeting agenda, an opportunity is provided for the public to speak on any subject within the Committee's authority that is not on the agenda. Speakers may be limited to three (3) minutes or less each.

10 **Refinery Committee Discussion** — *Committee Members*

11. **Closing Remarks** — *Committee Members*

12. **Closed Session** — *Bayron Gilchrist*
<u>Conference with Legal Counsel – Anticipated Litigation</u>
It is necessary for the Committee to recess to closed session pursuant to Government Code section 54956.9(d)(2) to confer with its counsel because there is a significant exposure to litigation against the SCAQMD (one case)—Letter from Steven J. Olson, O'Melveny & Myers LLP, on behalf of ExxonMobil Corporation, dated August 22, 2018.

Adjournment

Document Availability
All documents (i) constituting non-exempt public records, (ii) relating to an item on the agenda, and (iii) having been distributed to at least a majority of the Committee after the agenda is posted, are available prior to the meeting for public review at the South Coast Air Quality Management District Public Information Center, 21865 Copley Drive, Diamond Bar, CA 91765, and will also be available at the meeting site on the day of the meeting.

Americans with Disabilities Act
The agenda and documents in the agenda packet will be made available, upon request, in appropriate alternative formats to assist persons with a disability [Govt. Code Section 54954.2(a)]. Disability-related accommodations will also be made available to allow participation in the meeting. Any accommodations must be requested as soon as practicable. Requests will be accommodated to the extent feasible. Please contact Cristina Lopez at 909-396-2114 from 7 a.m. to 5:30 p.m. Tuesday through Friday, or send the request to clopez@aqmd.gov.

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Status Update on PR1410 – Hydrogen Fluoride Storage and Use at Petroleum Refineries

South Coast AQMD

SCAQMD REFINERY COMMITTEE

September 22, 2018
Wilmington, California

SUMMARY OF APRIL 28TH 2018 REFINERY COMMITTEE MEETING

- SCAQMD staff presented two possible rule concepts
  - Tier I+ mitigation and phase-out MHF in 5 years
  - Tier I/II+ mitigation and phase-out MHF in 6–8 years
- Refinery Committee directed to staff:
  - Pursue release of MHF testing and technology documentation from Honeywell
  - Provide information on HF usage in other industries
  - Develop Tier I/II+ mitigation rule requirements
  - Provide information on seismic/terrorism risk at refineries
  - Report back on Regulatory vs. MOU approach

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SCAQMD MEETINGS SINCE THE LAST REFINERY COMMITTEE

Working Group Meetings
- June 20, 2018 (Tier I Mitigation)
- September 6, 2018 (Tier II+ Mitigation)

Refinery Meetings with Staff
- Torrance Refining Company August 28, 2018
- September 13, 2018

Community Meetings with Staff
- Torrance Refinery Action Alliance August 31, 2018

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RELEASE OF MHF TESTING AND TECHNOLOGY DOCUMENTATION FROM HONEYWELL

RESPONSE:

- May 2018: Requested information from Honeywell
- June 2018: Honeywell said permission needed from ExxonMobil (technology developer)
- August 2018: ExxonMobil "does not consent to the public disclosure in any form (redacted or not)" and claims documents contain trade secret and confidential business information
- Staff is still exploring options to make information public

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OTHER USES OF HF IN THE BASIN

RESPONSE:

- Identified ~50 facilities that use HF in the Basin
  - Aerospace, metal finishing and fabrication, semiconductor, glass etching*
  - Concentrations less than 50%**
  - Usage less than 5 gallons monthly
  - Used at temperatures below boiling point
- Comparison to refinery usage
  - Concentrated HF (>80%) with additive
  - Used at temperatures above boiling point and under pressure
  - >20,000 gallons of MHF on-site

* SCAQMD permit database 2011–2017 and Annual Emissions Reporting data

** U.S. EPA Risk Management Program requires HF concentrations 50% or more to provide off-site consequence analysis

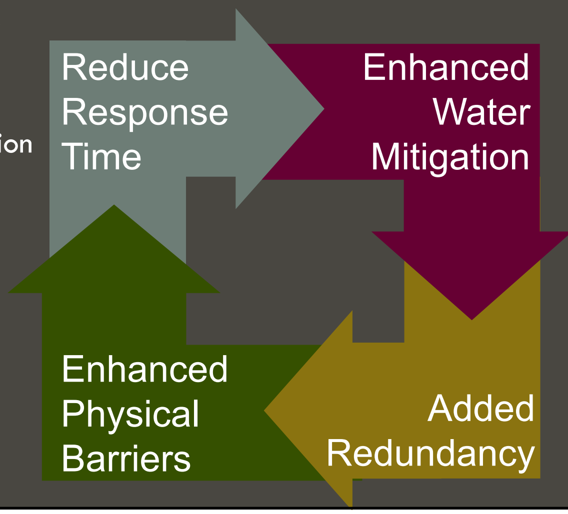
SCAQMD STAFF'S APPROACH FOR MITIGATION MEASURES

- Must mitigate a large consequential release
- Build upon existing mitigation
- Sufficient redundancy to address a catastrophic event with cascading effects such as fire, damage to mitigation system, loss of power, communication, transportation access, etc.
- Proposed implementation of all mitigation by 2021

OVERVIEW OF KEY SCAQMD RECOMMENDED MITIGATION ENHANCEMENTS

- Improved monitoring for early detection
- Enhanced video
- Automatic water activation
- Improve response time for Rapid Acid Dump

- Physical barrier around key MHF usage areas to minimize dispersion and improve water effectiveness



- Upgrade water mitigation to a water to HF ratio of 60:1
- Multi-layer water
- Varying heights
- All high risk areas

- Back-up power
- Back-up water supply
- Redundant pumps
- Redundant surveillance

CHALLENGE OF WATER MITIGATION

- Properly designed water mitigation can reduce HF up to 95%* if:
  - 60 gallons of water is applied to every 1 gallon of HF released (60:1 water to HF ratio)
  - This means that 30,000 gallons per minute of water is needed for a 500 gallon per minute release of HF
- Challenges
  - Designing a mitigation system that can apply enough water at the right locations for a large release
  - Ensuring the amount of water needed can be sustained throughout the release
  - Ensuring there is sufficient redundancy for water and power if there is a system failure or delayed response to applying water

* *Water Spray Mitigation of Hydrofluoric Acid Releases, Schatz and Koopman, 1990 and Effectiveness of Mitigation Systems in Reducing Hazards of Hydrogen Fluoride Leaks, Quest Consultants Inc., 1995*

CONSIDERATIONS FOR USE OF MHF

- Ability of MHF to prevent formation of a vapor/aerosol cloud is uncertain*
  - ❑ Some, but uncertain, HF mitigation benefits offered by MHF (<35%)
  - ❑ Conditions of testing are different from current operating conditions
  - ❑ Large hole sizes were not considered
- A release of MHF will still result in exposure to HF**
  - ❑ Liquid droplet "rainout" and vapor cloud will be HF
  - ❑ Material Safety Datasheets for HF and MHF lists the same hazards and medical treatment


Honeywell

Material Safety Data Sheet

MODIFIED HYDROFLUORIC ACID

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

2. COMPOSITION/INFORMATION ON INGREDIENTS

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: Clear, colorless, corrosive fuming liquid with an extremely acrid odor. Forms dense white vapor clouds if released. Both liquid and vapor can cause severe burns to all parts of the body. Specialized medical treatment is required for all exposures.

* Staff presentation at January 20, 2018 Refinery Committee

** Staff presentation at April 28, 2018 Refinery Committee

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CONSIDERATIONS FOR USE OF MHF *(CONTINUED)*

- Torrance Refining Company and Valero are located in densely populated areas*
- Accidents happen*
- Uncertain if a large consequential release can be mitigated
- Conflicting "shelter in place" procedures for chemical release versus post-earthquake safety to evacuate the building

Torrance Refining Company	Valero Wilmington Refinery

Torrance Refining Company	Valero Wilmington Refinery
Alkylate: 25,500 BPD 245,000 People within 3 Miles Nearest Residence 1,500 Feet	Alkylate: 20,000 BPD 153,000 People within 3 Miles Nearest Residence ~4,100 Feet

* Staff presentation at April 28, 2018 Refinery Committee

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MEDICAL TREATMENT OF HF

- Potential exposure can be to dermal (skin), eyes, or inhalation
- Local hospitals can treat HF exposure
- Patients with significant HF exposure will need to be transported to a burn unit
- One hospital with a burn unit within a 10 mile radius
  - ❑ Torrance Memorial Medical Center (8 beds)
- Three hospitals with burn units within a 10 to 30 mile radius
  - ❑ LAC+USC Medical Center (21 beds)
  - ❑ University of California, Irvine Medical Center (16 beds)
  - ❑ Grossman Burn Center/Santa Ana (5 beds)

SUPPLY OF CALCIUM GLUCONATE (ANTIDOTE TO TREAT HF BURNS)

- Calcium gluconate is currently on the national shortage list of medications*
- All local hospitals have calcium gluconate – but amount is unknown
- For significant inhalation exposure – nebulizer every 4 hours for 48 hours**
- LA County Emergency Medical Services can treat approximately 500 single treatments
  - ❑ Treat ~40 people if significant inhalation exposure

U.S. Food and Drug Administration, FDA Drug Shortages

** *Recommended medical treatment of hydrofluoric acid, Honeywell, Version 7.0, 2018*

CONSIDERATIONS FOR PHASING OUT HF (DISCUSSED AT APRIL 2018 REFINERY COMMITTEE MEETING)

- Estimated cost impact is between $300 and $600 million*
- Potential market impacts
  - Any impacts would be temporary
  - Planned phase-out is different than an unplanned shutdown – less disruptive
- Possible schedule
  - Sulfuric acid alkylation: 4 to 6 years
  - Emerging technology (Solid Acid Catalyst and Ionic Liquid Catalyst): 10 to 12 years

* *Conversion of a HF Alkylation unit to a Sulfuric Acid Alkylation unit must include a thorough review of the entire unit in order to determine if any equipment can be re-used. It is expected that the Fractionation section of the HF Alkylation Unit may be able to be re-used, but further evaluation, especially of metallurgy requirements between the two technologies would need to be conducted (Norton Engineering, Alkylation Technology Study, 2016). $300 million is based on cost of post-processing equipment included in the Burns & McDonnell Alkylation Study & Estimate, 2017.*

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POSSIBLE OPTIONS

Implement Enhanced Mitigation Measures (No Performance Standard)	• Implement enhanced mitigation measures
Implement Enhanced Mitigation Measures with Performance Standard	• Implement enhanced mitigation measures • Conduct testing of MHF and efficacy of mitigation to minimize risk of large consequential release
Implement Enhanced Mitigation AND Phase-out MHF if Performance Standard Cannot be Met	• Implement enhanced mitigation measures • Phase-out MHF unless testing of MHF and efficacy of mitigation minimizes risk of large consequential release
Implement Enhanced Mitigation Measures and Phase-out MHF (No Performance Standard)	• Implement enhanced mitigation measures • Phase-out MHF

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BIOS AND GENERAL OVERVIEW OF GUEST PRESENTERS

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KENNETH W. HUDNUT, PH.D.

- Ph.D. in Geology from Columbia University and A.B. in Earth Sciences from Dartmouth
- Former Science Advisor for Risk Reduction for the Earthquake Science Center for the United States Geological Survey (USGS)
- Currently USGS Geophysicist that has studied earthquakes for over 30 years
- Served multiple terms on the board of the Southern California Earthquake Center

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DR. HUDNUT'S PRESENTATION WILL DISCUSS

- Faults near the two refineries
- What is considered a major earthquake and possible effects
- Possibility of a major earthquake near Torrance Refining Company and Valero refineries
- Possible secondary effects associated with a major earthquake

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RONALD P. KOOPMAN, PH.D., P.E.

- Ph.D. in Applied Physics from the University of California at Davis, M.S. Nuclear Engineering and B.S. in Mechanical Engineering from the University of Michigan
- Retired Manager and Senior Scientist at Lawrence Livermore National Laboratory (36 years) conducting experiments involving large-scale releases of hazardous gases at the Department of Energy Spill Test Facility in Nevada
  - Managed and conducted large-scale field experiments with HF releases – referred to as the "Goldfish Test"
- Published papers on release experiments of hazardous gases and HF water mitigation
- Currently the Principal of Hazard Analysis Consulting

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DR. KOOPMAN'S PRESENTATION WILL DISCUSS

- The 1986 Goldfish Test
  - Dispersion of HF as a dense vapor cloud
  - Use of water spray mitigation
- Water spray mitigation of HF releases – referred to as the Hawk Study (Small-scale testing of water mitigation)

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JOHN B. CORNWELL

- M.S. in Mechanical Engineering and B.S. in Chemical Engineering from the University of Texas at Austin
- Currently an Engineer at Quest Consultants Inc. directing the development and use of consequence and risk analysis software for modeling the impacts associated with toxic and flammable fluid releases
- Quest oversaw large scale outdoor testing to determine the effects of additives on suppressing aerosol formation during release of superheated hydrogen fluoride
- Published technical and analytical papers on HF and the effectiveness of mitigation
- Over 30 years of experience in the fields of consequence and risk analysis

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MR. CORNWELL'S PRESENTATION WILL DISCUSS

- Experience with conducting HF and MHF testing
- Type of testing needed to understand the effects of a large scale release of MHF with and without mitigation from an acid settler
  - Key parameters and considerations for testing
  - Timeframe (engineering, implementation, and final report)
  - Estimated cost

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MICHAEL MASTRANGELO

- Program Director, Institutional Preparedness at the University of Texas Medical Branch (UTMB)
- Responsible for all aspects of preparedness at UTMB which is the only Level 1 trauma and burn center in the region
- Developed the Annual Hydrofluoric Acid Symposium and Exercise for University of Texas Medical Branch (Since 2014)
- Serves on many regional, state, and national emergency preparedness committees and received numerous awards for his innovative work

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MR. MASTRANGELO'S PRESENTATION WILL DISCUSS

- Background about UTMB Galveston Annual HF Symposium
  - Why HF Symposium was initiated
  - Key objectives and findings of the HF Symposium
- Key concerns about a large release of HF
  - Potential health impacts
  - Emergency response and treatment
  - Challenges

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Regulatory and MOU Approach

SCAQMD REFINERY COMMITTEE

September 22, 2018
Wilmington, California

COMPARISON: REGULATORY APPROACH AND MEMORANDUM OF UNDERSTANDING

Parameter	Regulatory Approach	Memorandum of Understanding (CEQA)	Memorandum of Understanding (No CEQA Prior to MOU)
Public Process	Yes (Part of rule-making process)	Yes (Part of CEQA process)	Yes (Not legally required, but agency would have a public process)
CEQA	Yes	Yes (Simultaneous with MOU process)	Yes (After MOU signed)
Approval	SCAQMD Board	SCAQMD Board and Facility	SCAQMD Board and Facility

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AGREEMENTS AND CEQA – GENERAL PRINCIPLES

Save Tara v. City of West Hollywood (2008) 45 Cal.4th 116

In Save Tara, the California Supreme Court addressed when an agreement (such as an MOU) was essentially approving a project and therefore needed to be analyzed under CEQA.

Although "[d]esirable," there is no "bright-line rule defining when an approval occurs."

Courts should look at the agreement and the surrounding circumstances, and "determine whether, as a practical matter, the agency has committed itself to the project as a whole or to any particular features." The agency should not "effectively preclude any alternatives or mitigation measures that CEQA would otherwise require to be considered, including the alternative of not going forward with the project.'"

Although including a condition that an agency will comply with CEQA is helpful, it "will not save an agreement [that essentially approves a project] from being considered an approval requiring prior environmental review."

AGREEMENT A PROJECT: CEQA REQUIRED

Save Tara v. City of West Hollywood (2008) 45 Cal.4th 116

West Hollywood effectively approved a project where the City bound itself to sell land for private development conditioned on CEQA approval, committed itself to financially supporting the project, made public statements that confirmed the city's commitment to the project, and proceeded with tenant relocation.

RiverWatch v. Olivenhain Municipal Water Dist. (2009) 170 Cal.App.4th 1186

Water District entered into an agreement to provide water to landfill for up to 60 years, and outlined the construction required to allow that delivery, before a revised draft EIR addressed the environmental impacts of the water being trucked to the landfill site.

AGREEMENT NOT A PROJECT: CEQA NOT REQUIRED

Delaware Tetra Technologies v. San Bernardino (2016) 247 Cal.App.4th 352

Court held that MOU could be executed without a full environmental review because it did not foreclose alternatives or mitigation measures; it did not commit the County to a particular course of action that would cause an environmental impact; and the County retained full discretion over the Project despite its execution of the MOU.

The report and recommendation to the San Bernardino County Board of Supervisors stated: "The County, at this time, is not committing to approve or undertake the Cadiz Project. And while the [MOU] sets a framework for development and enforcement of the [Plan] if approved, the [MOU] reserves to the County all necessary discretionary authority to approve, deny, or condition the Cadiz Project, including the authority to adopt any mitigation measures or alternatives necessary to avoid or substantially lessen the environmental impacts of the Project. Any approval of the Cadiz Project itself is expressly conditioned on final CEQA review. The County's approval of the [MOU] therefore does not constitute an approval of the Project, and is not a decision subject to CEQA."

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AGREEMENT NOT A PROJECT: CEQA NOT REQUIRED

Cedar Fair, L.P. v. City of Santa Clara (2011) 194 Cal.App.4th 1150

CEQA not required for 49ers Stadium term sheet because it did not commit the City or redevelopment agency to the project. The "Stadium Term Sheet merely 'memorialize[s] the preliminary terms' and only mandates that the parties use the term sheet as the 'general framework' for 'good faith negotiations.' Under the express language of the term sheet agreement, the City and the Redevelopment Agency 'retain the absolute sole discretion' to make decisions under CEQA, including deciding 'not to proceed with the Stadium project,' and the term sheet creates '[n]o legal obligations' 'unless and until the parties have negotiated, executed and delivered mutually acceptable agreements based upon information produced from the CEQA environmental review process.'"

Notably, the term sheet had a high level of detail, the City's redevelopment agency had invested a large amount of money in the process of reaching the agreement, and the city council had approved the term sheet.

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MOU CONSIDERATIONS FROM RECENT CASES

MOU with simultaneous CEQA review:

- May take similar time to rulemaking.
- Would have public process because of CEQA requirements.
- MOU requirements might be incorporated into a refinery's Title V Permit. The MOU requirements would become enforceable once incorporated.
- Incorporation into a refinery's Title V Permit would also result in, at least, one other public process when the EPA reviews the revised Title V Permit.
- If not incorporated into the Title V Permit, then enforcement of a condition may require litigation.

MOU CONSIDERATIONS FROM RECENT CASES

MOU without simultaneous CEQA review:

- Could be faster than rulemaking.
- Although not legally required, a public process would likely be helpful to ensure transparency.
- MOU requirements might be incorporated into a refinery's Title V Permit after the CEQA process, and then become enforceable. Until such incorporation into the Title V Permit, enforcement of a condition may require litigation.
- MOU can set a general framework.
- MOU can have a high level of detail, but should not foreclose alternatives or mitigation measures required under CEQA.
- MOU should include the alternative of not going forward with the project.
- Should not commit the SCAQMD to a particular course of action that would cause an environmental impact under CEQA.
- SCAQMD should retain full discretion over the Project despite its execution of the MOU.

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Potential Earthquake Risk:

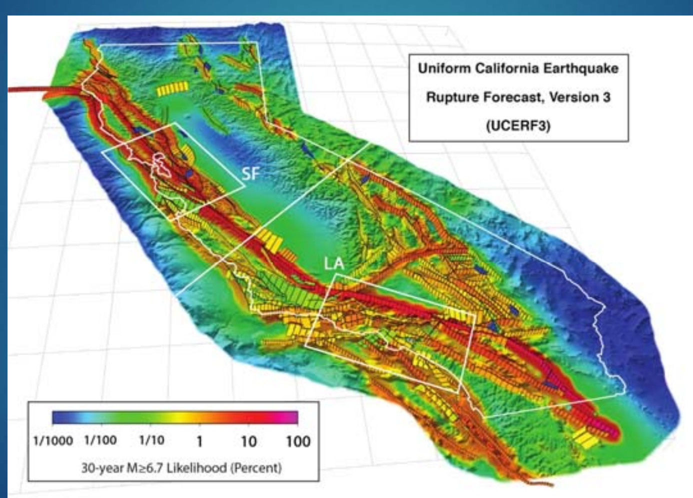
Faulting, Shaking & Ground Failure Hazards

by Ken Hudnut, Ph.D.
U.S. Geological Survey
Pasadena, CA

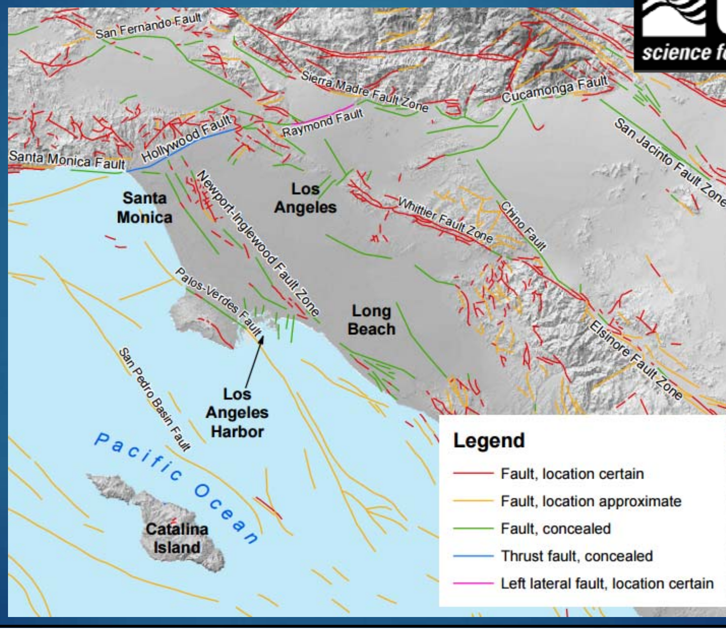
South Coast Air Quality Management District
Refinery Committee Meeting

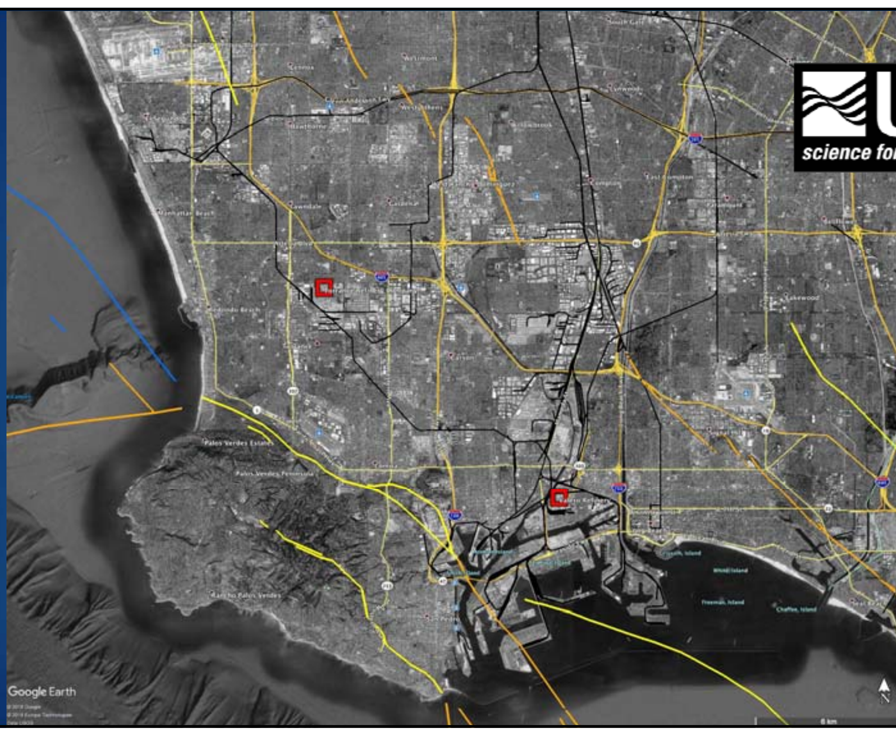
Wilmington, CA
September 22, 2018

The earthquake threat is real in California; We need to be *ready!*



Los Angeles "in-basin" active faults





Fault Map:

Orange – Holocene
Yellow – late Quat.

Refineries:

Red Square Symbols:
- TORC
- Valero

These refineries are from 3 to 5 miles from the mapped surface fault traces; other faults are at depth (less certain).

Scenario Earthquakes – What to Expect?
- Surface Fault Rupture
- Other Ground Failure; landslides, liquefaction
- Shaking-related Damage

- Surface fault rupture of 6 to 9 feet of right-lateral (horizontal shift) offset that would contribute significantly to the overall damage, i.e., offset pipelines.
- Significant disruption at lifeline infrastructure intersections with fault rupture & damage especially to facilities along the fault zone (also from strong shaking).
- Extensive soil liquefaction causing lateral spreading and subsidence in the Ports of Los Angeles – Long Beach Complex.
- Fire following earthquake (FFE) would likely increase casualties and total losses.
- Potential for spills and leaks; sloshing of fluids in certain tanks can cause buckling failures.

What Can Go Wrong? Surface Fault Rupture

Photo Credits: CUREe, Keith Johnson, NZ

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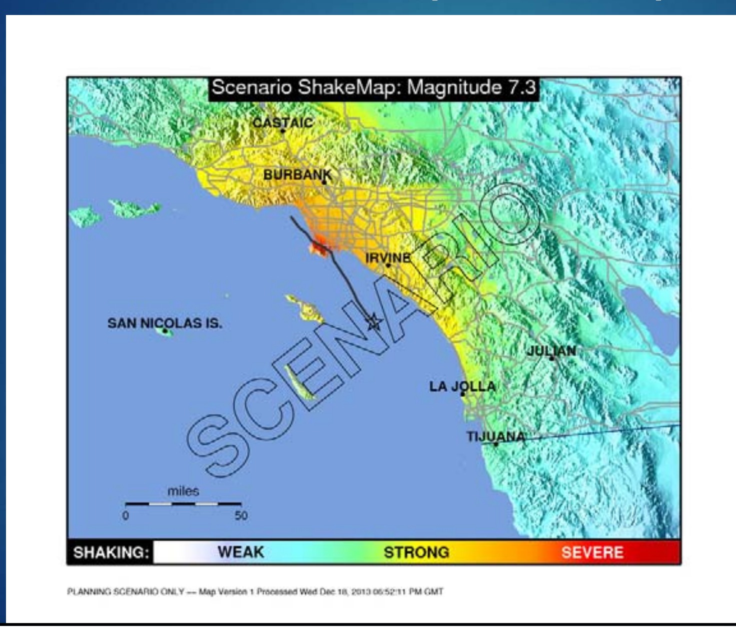
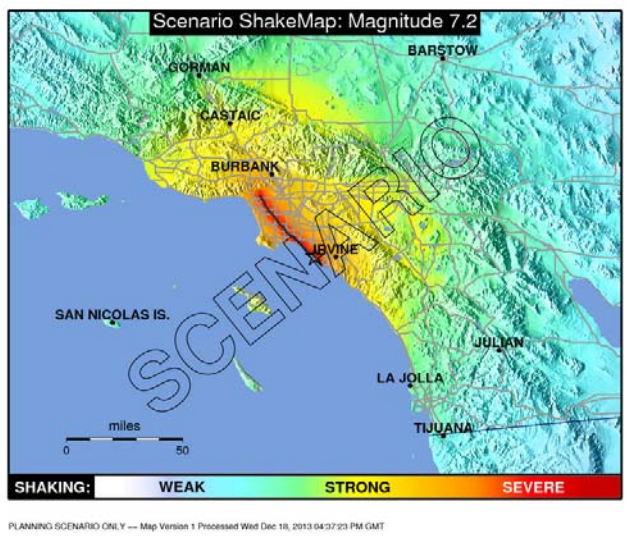
Scenario: Magnitude 7.3 Earthquake on the Palos Verdes fault zone (LA Fleet Week)



Scenario: Magnitude 7.2 Earthquake on the Newport-Inglewood fault zone (LA Mayor's Exercise)

USGS
science for a changing world



Scenario Earthquakes – What to Expect?

- Surface Fault Rupture
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USGS
science for a changing world

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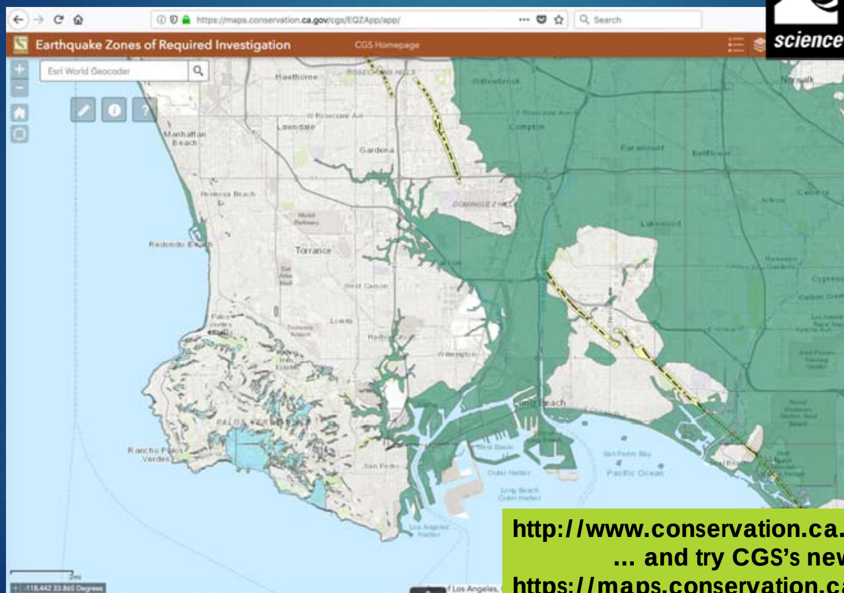
What Can Go Wrong? Liquefaction Potential Map from California Geological Survey (CGS)

USGS science for a changing world



Green is liquefaction

Blue is landslide

Yellow is active fault

Beige – no hazard zone

http://www.conservation.ca.gov/cgs/hazards/shzp
… and try CGS's new tool 'EQZApp' …
https://maps.conservation.ca.gov/cgs/EQZApp/app/

Scenario Earthquakes – What to Expect?
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USGS science for a changing world

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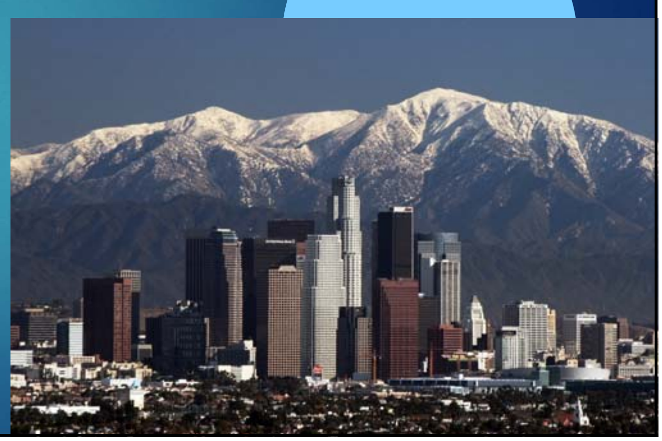
"Every major worldwide example of fire following earthquake has included at least one refinery fire" – Charles Scawthorn


Photo Credit: Reuters, Japan

Questions ?

Ken Hudnut, Ph.D.
U.S. Geological Survey
Pasadena, CA
hudnut@usgs.gov
(626)583-7232



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HF Dispersion and Water Mitigation Testing

Presented at:
SCAQMD Refinery Committee Meeting on September 22, 2018

Presented by:
Ron Koopman Ph.D, P.E.
Hazard Analysis Consulting
(retired from LLNL)

The Nevada Test Site

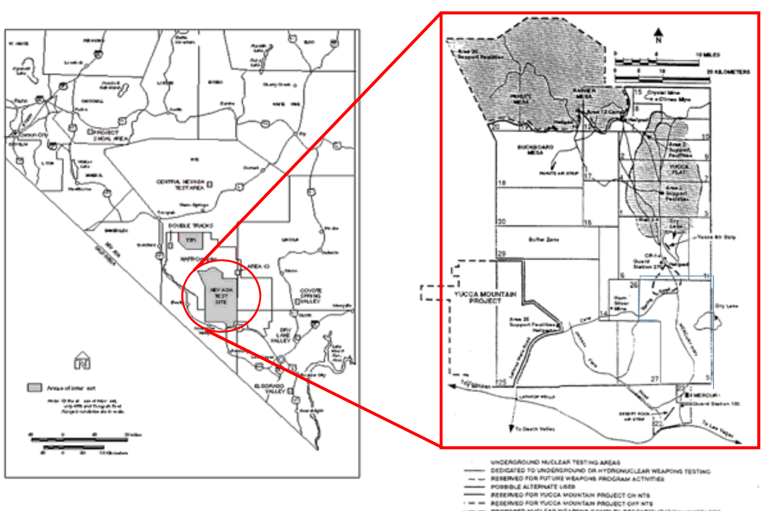


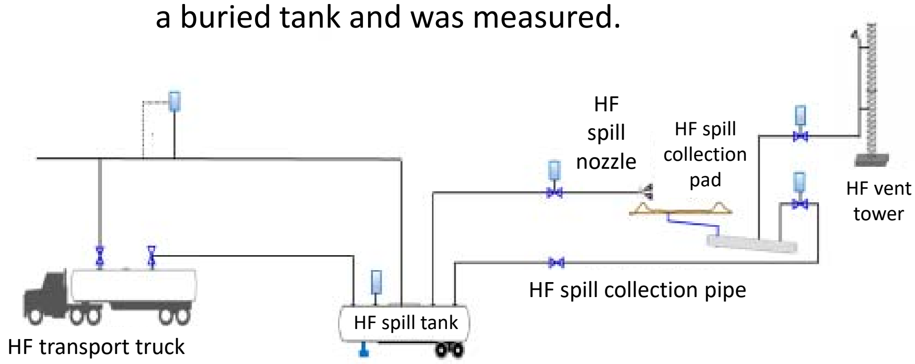
Figure 1. NTS Site Map

The Nevada Test Site:

- **65 miles northwest of Las Vegas**
- **5,470 square miles**
- **Site is divided into two site categories and seven zones**
- **Goldfish tests were conducted in the spill Test Facility Impact zone**

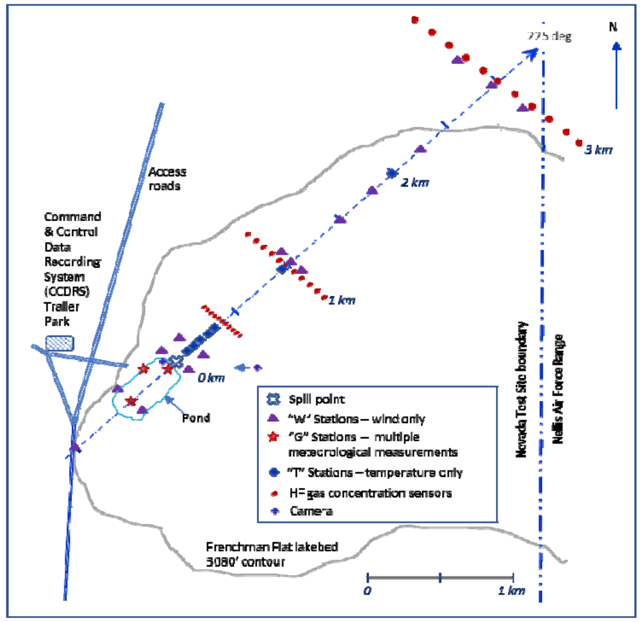
HF Facility

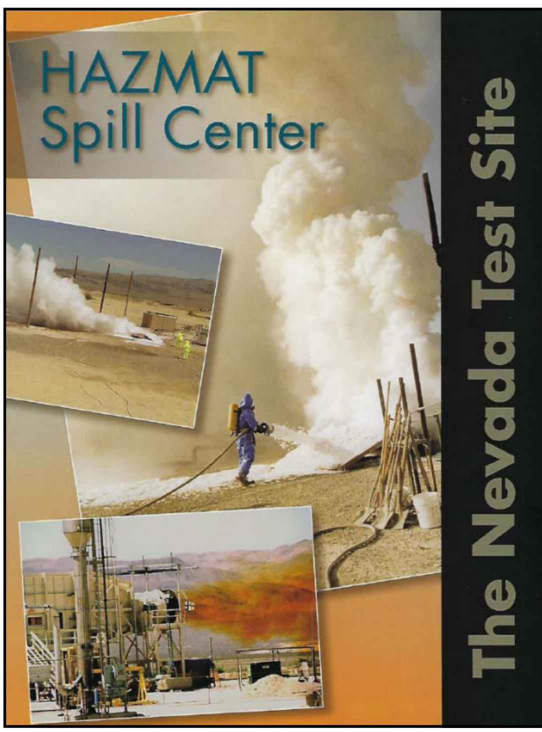
During the summer of 1987, to understand HF releases, effects of water spray, and provide data to develop and validate dense-gas dispersion models, LLNL and AMOCO conducted 6 test releases of from a 5000-gal tank, called the **Goldfish** series. HF at approximately 100 F and 115 psi was released at a controlled rate through an orifice where it flashed to aerosol and vapor. Any resulting liquid was collected on a pad where it drained into a buried tank and was measured.



Video from Goldfish Test

HAZMAT Spill Center Instruments





NTS provides an ideal location for atmospheric testing of hazardous chemicals, with controlled access and steady winds from the southwest

Name	Year	Material	Size (m^3)
Avocet	1978	LNG	5
Burro	1980	LNG	24-39
Coyote	1981	LNG	3-28
Desert Tortoise	1983	Ammonia	15-60
Eagle	1983	N_2O_4	1-4
Goldfish	1986	HF	4
Hawk	1988	HF	0.2

HAZMAT Spills Center Field Experiments

To understand dense gas releases, effects of water spray, and provide data to develop and validate dense-gas dispersion models, during the summer of 1987, LLNL and AMOCO conducted 6 releases of HF from a 5000-gal tank called the **Goldfish** series

Goldfish Release Data and Purpose

Test	Orifice (Inches)	Spill Rate (gpm)	Duration (Minutes)	Total Release (Gallons)	Wind speed (m/sec)	HF Temp (°F)	HF Pressure (psi)	Relative Humidity (%)	Purpose
1	1.65	469	2.1	980	5.6	104	111	5	Dispersion
2	0.953	175	6	1050	4.2	100	115	11	Dispersion
3	0.953	172	6	1032	5.4	103	117	19	Dispersion Humidity
4	0.584	68	14	952	6.8	97	116	15	Air & Water Spray
5	0.397	33	16	528	3.8	104	118	38	Up Water Spray
6	0.397	33	16	528	5.4	100	114	38	Down Water Spray

We will focus on the first and largest release, Goldfish 1

Test data came from a large array of gas concentration and atmospheric measurements

Each tower made measurements at 1 m, 3 m, and 8 m above grade

Goldfish 1

Typical arcs of instrument towers at 300 m, 1000 m, and 3000 m downwind

Data From Goldfish Tests

Data from arcs of instruments at 300 m, 1000 m, and 3000 m downwind from the release point

Goldfish Test	300 Meters (0.2 Mile)	1000 Meters (0.6 Mile)	3000 Meters (1.9 Miles)
1	26,489 ppm	3,220 ppm	427 ppm
2	19,978 ppm	2,493 ppm*	98 ppm*
3	18,422 ppm	2,468 ppm*	242 ppm
4	3,686 ppm	406 ppm	56.6 ppm
5	2,028 ppm	45 ppm	-
6	899 ppm*	21 ppm*	-

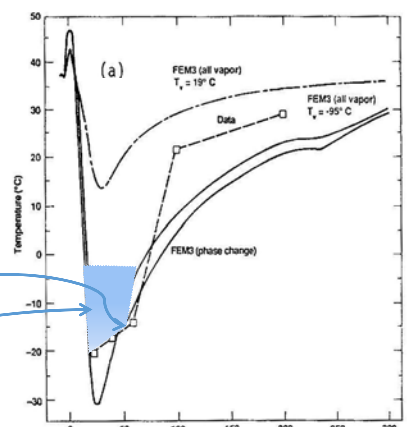
For Reference:
The 10-min Acute Emergency Guideline Levels (AEGLs):
- AEGL-3 = 170 ppm Threshold for lethality, extrapolates to 5 km (2.9 mi) downwind
- AEGL-2 = 95 ppm Serious health effects, extrapolates to 7 km (4.4 mi) downwind
- AEGL-1 = 1 ppm Mild health effects,

* Indicates possible missed plume centerline

Flashing resulted in a rapid 70º C drop in temperature

Release: 976 gal (469 gal/min for 2.08 min)
Weather: Wind at 5.6 m/s with D stability
37 °C or 99 °F at 5% RH

FEM3 reproduced the cold cloud temperatures



Goldfish 1 cloud temperatures measured at 1 m above ground along plume centerline compared with several FEM3 model calculations

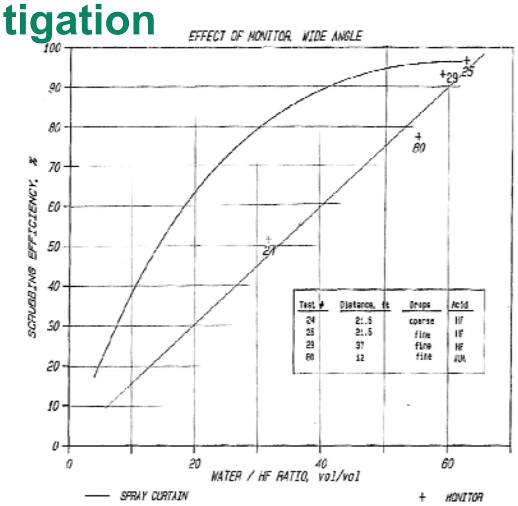
10

Test 5 With Up Spray

Goldfish 5 and 6 – Effects of Water Spray

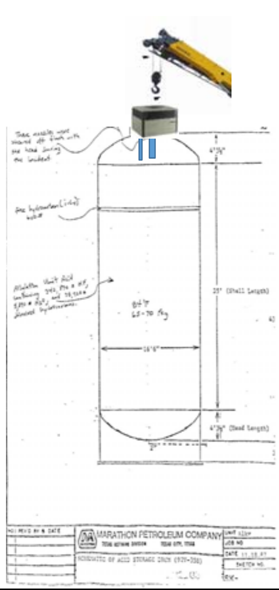
- Tests 5 and 6 showed the net effects of water spray, both upflow and downflow, was to reduce air concentration of HF by 36 to 49%
- Test 5 and 6 release rates were 33 gallons per minute
- In comparison Test 1 had a release rate of 469 gallons per minute

About 100 Hawk series HF water spray tests were conducted in the Nevada Test Site wind tunnel to explore details of water spray mitigation



With a water to HF ratio of 60 to 1, water sprays were 95% effective at removing HF

October 30, 1987 Texas City Marathon HF Accident



A crane drops a heater unit shearing two pipes (4" & 2"diameter) on top of the Alkylation Unit HF storage tank. The HF plume rises about 200' above ground before returning.

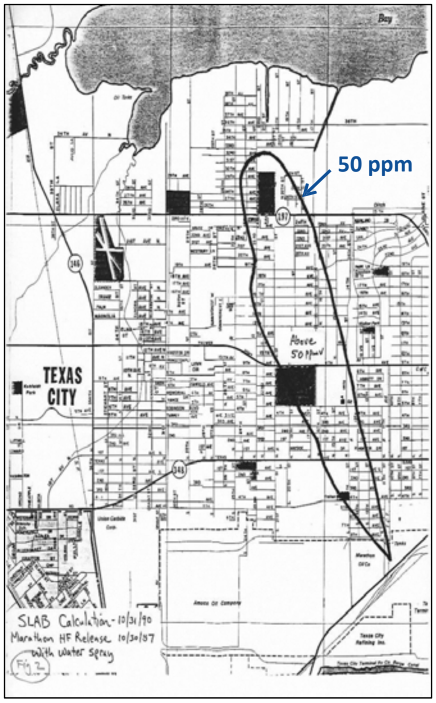
Estimates of released amounts

Inventory (lbs)	HF 342,829	Hydrocarbon 9,521
Reported Release Total First 100 minutes	 53,236 "most"	 6,643 "all"
Calculated Release Total First 100 minutes Remainder	 53,000 44,000 9,000	 6,600 6,600 0

Flashing inside the tank released a mixture of HF and hydrocarbon two-phase flow out of the broken pipes.

A "champagne effect" likely occurred where the vapor bubbles form throughout the liquid and carry much of the liquid out with them.

The post-accident modeling involved analyzing a complex set of conditions resulting in several estimates of released amounts.



Marathon 1987 Accident

SLAB average HF air concentration with water spray started 25 minutes after release began

The 50 ppm contour extended 2.8 km (1.7 miles)

- 5,800 people on 85 city blocks were evacuated.
- ~1,000 people were treated at hospital for respiratory problems and skin and eye irritations.
- Health effects would have been significantly greater were it not for the height and the vertical orientation of the initial plume which shot 200 ft over the neighborhood adjacent to the refinery before returning to ground level.

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Assessment of Additional HF/MHF Testing

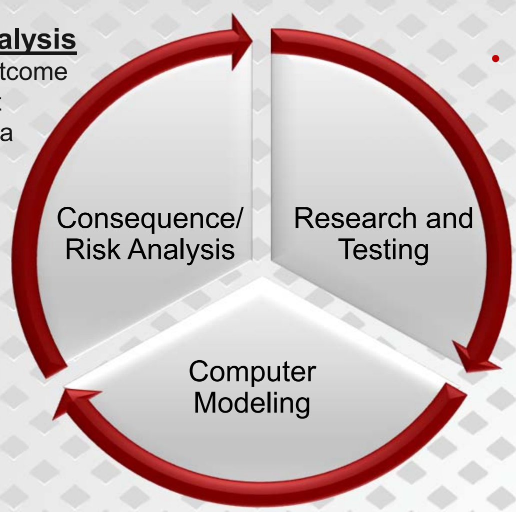
SCAQMD Refinery Committee Meeting
September 22, 2018

QUEST
CONSULTANTS INC.

Integrated Approach to Process Hazard Management

- **Consequence/Risk Analysis**
  Estimates the predicted outcome from an incident and how it affects the surrounding area (Example: How will a release of MHF impact the surrounding area)

- **Computer Modeling**
  Incorporates actual data from research and testing to estimate release and dispersion (Example: Incorporates testing data to modify models)



- **Research and Testing**
  Conduct actual laboratory and/or field tests to evaluate release and dispersion of a chemical under specified conditions (Example: Testing of MHF under specified conditions)

QUEST

Research & Testing
Aerosol Tests

SPONSORS

- U.S. Environmental Protection Agency
- U.S. Department of Energy
- Center for Chemical Process Safety
- Petroleum Environmental Research Foundation
- Individual Companies

Center for Chemical Process Safety and U.S. Department of Energy, Chlorine Test

QUEST

Mechanisms Driving the Formation of Aerosols
(Liquids to Liquid Drops and Vapor)

- Thermophysical – primarily the flashing (liquid to vapor) of the liquid as the pressure drops from the storage pressure to atmospheric pressure
- Mechanical – primarily due to the velocity of the liquid through the “hole”

QUEST

Research & Testing of Alkylation Acids

- Quest designed and conducted aerosol tests for:*
  - Hydrofluoric Acid (HF)
  - HF + Additive 1
  - HF + Additive 2
  - Sulfuric Acid
  - Sulfuric Acid + Alkylate

* Conducted aerosol tests for other chemicals

QUEST

Testing of MHF

- To Quest's knowledge only two outdoor test programs have been conducted
  - Quest has evaluated two additives (M)
    - Mobil/Phillips used additive #1
    - Texaco/UOP used additive #2
- Tests did not cover a full range of operating conditions (temperature, pressure, composition)

QUEST

Key Parameters for Aerosol Testing of Alkylation Unit (Acid Settler)

- Operating conditions
  - Temperature
  - Pressure
  - Composition of chemicals in acid settler (percentage of HF, Additive, Acid Soluble Oils, etc.)
- Release scenario
  - Orifice (hole) size
  - Mass release rate

QUEST

Importance of Representative Operating Parameters for Aerosol Testing

- Tests should be designed to represent actual operating conditions
  - If the test data does not represent the operating conditions, the release and dispersion results may not represent what could occur
- Tests should be performed under actual operating conditions
  - This is particularly important for mixtures

QUEST

Cost of Alkylation Acid Testing
(Designed, Built, and Directed by Quest)

- 1991-1992 Sulfuric acid/hydrocarbon release tests for Petroleum Environmental Research Forum
  - Testing conducted at Quest's test site in Oklahoma
  - Approximately $650,000 (in 1993 dollars)
- 1992-1993 Hydrofluoric acid/additive tests for Mobil and Phillips
  - Testing conducted at Quest's test site in Oklahoma
  - Approximately $1,700,000 (in 1993 dollars)
- 1992-1993 Hydrofluoric acid/additive tests for Texaco and UOP
  - Testing conducted at Quest's test site in Oklahoma
  - Approximately $1,000,000 (in 1993 dollars)
  - The cost was less as Texaco and UOP "rented" some of the equipment used by Mobil and Phillips

QUEST

Estimated Timeframe and Cost for Additional MHF Testing

- Estimated timeframe is 2 to 3 years (Includes design, set up and run, evaluation, and report writing)
- ~$3 to 5 Million dollars (based on previous outdoor testing)

QUEST

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Response Risk Assessment to Improve Chemical Incident Preparedness: Galveston County Texas

Hydrofluoric Acid Preparedness

utmb

Mike Mastrangelo
September 22, 2018

Background

- UTMB is a Level One Trauma and Level One Burn Center 12 miles south of Texas City where there is a major HF industrial presence (and transportation corridor)
- UTMB provided the medical response to the 1987 HF release in Texas City, and has dealt with several occupational exposures since then
- A large part of the UTMB workforce lives in the vicinity of the plants
- UTMB would be part of the response to any HF incident in the area

HF Preparedness Considerations

1. Risk Assessment Informed by Release Modeling
2. Whole Community Preparedness (Industry, EMS, HAZMAT, Fire, Medical Care, EM, etc.)
3. Scenario Planning
    1. Weather
    2. Release Characteristics
4. Community Response Capabilities and Capacities (e.g. hospital expertise in treating HF injuries)
5. Exercise Response Capabilities and Capacities Against Scenarios
6. Estimate Plausible Number of Casualties
7. Estimate a Reasonable Volume of Medical Countermeasures (MCM) Required (Calcium Gluconate)
8. Estimate number of Medical Resources Required (e.g. Burn Beds)

HF Preparedness Considerations *(Continued)*

9. Compare current response capability & capacity against scenarios
10. Multi-year program of continuous improvement based on response to exercises and real incidents
11. Communications: What communications and information are required for an optimal response.
12. What are current systems in place to convey this information
13. Consider Industrial Plant locations AND transport routes
14. Medical Treatment
    1. Occupational Exposures
    2. Community Exposures
15. Healthcare Coalitions – Specific well-rehearsed plan for HF Incidents
16. Long-term: Baseline Epi Study; Incident Specific Epi Survey

The Risk: HF

- Refineries and production units hold large volumes
- Toxic Vapor Cloud
- Requires Specific Medical Countermeasure: Calcium Gluconate (on shortage list)

1987 Texas City

- HF incident
- 937 patients seen at UTMB and Mainland Medical Center
- Smaller incidents since then: most recent in 2016 with 16 occupational injuries (one month before our annual HF exercise with industry)

Worst Reasonable Case

- The largest Texas City Plant - 1.2 million pounds in circulation
- 25 mile plume
- 640,000 people potentially at risk (Based on information filed with EPA)

Challenges Treating HF Exposures

- Decontamination of patients required (note issue of low concentration exposure)
- In some hospitals – may lack familiarity with HF
- Multi-disciplinary team needed (including mental health)
- Follow up care
- Availability of supplies (O2 bottles, Nebulizers)
- Evidence-based treatment protocols for respiratory injuries
- Number of burn beds (tub rooms) available
- Effective initial patient distribution

Medical Countermeasures

- Calcium Gluconate – national shortage list for many years
- Medical supplies in general
- “Burn Beds” available

How much is enough?

- Model plausible release scenarios
- Build a scenario ‘library’
- Determine population under the plume
- Estimate medical countermeasures needed (Not that easy)
- Plan for ‘worried well’
- Local customization of CHEMPACK based on risk (Develop strategies to have a reasonable level available)

Local Customization of CHEMPACK

- Healthcare Coalition (HCC) – coordinate with area hospitals
- Industry stockpiles
- Educate HCC members on the local need for Calcium Gluconate

2014 – Began work with community/ industry to improve preparedness

- Joint Exercises** – increasing complexity
  - Honeywell
  - Marathon
- Whole Community Approach – UTMB HF Symposia

** Hospital, EMS, Fire, Police, Industry, Public Health

UTMB Approach to HF Preparedness

Patient Type:

- Occupational Exposure to liquid HF Acid
- HF Exposure with Trauma
- Focus - Decon and Triage

Example of an HF Burn: New England Journal of Medicine

Exercise:
Patient Type

Build on 2015
PLUS
Expand patient type, modeling for scenario planning, whole community resilience

- Patient Type
  - Occupational exposure: HF, Blast, Trauma, Thermal Burn
  - Community Vapor cloud exposure (varying levels) skin, respiratory, eyes - Adult and Pediatric
  - A role for the Academic Medical Center (All Phases of Emergency Preparedness)
- Computational Modeling for Scenario Planning
  - Planning Scenarios based on release/weather/terrain/population
  - Validate Shelter-in-Place (e.g. Could be done at Dugway Proving Ground – mock urban area, vehicle movement)
- Whole Community Resilience - Building Community Linkages for Effective Preparedness (Build on based developed from Hurricane Preparedness)

2014 — 2015 — 2016 — 2017

Year 2: Model Response: Plant Incident

- Adequate Primary Decon in the Field
- (Plant Physician)Begin Treatment with Calcium Gluconate if waiting for Transport
- Communicate patient information to Hospital
- If supplied - EMS continue application of CG during transport
- Secondary (More Thorough if needed) Decon at Hospital
- Labs: Early/Often - especially Calcium and Magnesium
- Have supplies ON HAND to begin treatment (Calcium Gluconate (SurgiLube) (Skin, Respiratory Track, Eyes) Mineral Oil for ASO exposure
- Pharmacy and Supply Chain Support - continued supply of Calcium Gluconate

Build on 2014
PLUS
Symposium: What Would National Model for HF Response Look Like

Build on 2016
PLUS
Shifted focus from accidental releases to deliberate releases such as terrorist attacks

Working With Industry

Conclusion

- Encourage other communities to take a similar approach to emergency planning
- Share information with other communities or regions with an HF Risk