Date: 01JUL2024 1200Z
Version: Initial Product

IMAAC

Interagency Modeling and Atmospheric Assessment Center

EXERCISE

Port of San Francisco Lithium Battery Fire

(RFI 24-0520U)

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RD Directorate
Technical Reachback Division
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Request Summary

Requestor	Sergeant Keith Matthews, Sergeant, San Francisco Police Dept, Homeland Security, Marine Unit
Contact information	415-378-5402 keith.matthews@sfgov.org
Request	Request for modeling downwind hazard from lithium battery car fires on a ship in port.
Employment	Exercise
Hazards	• Hydrogen Fluoride, 34,000 lbs • Hydrogen Chloride, 18,678 lbs • Hydrogen Cyanide, 25,000 lbs Released as instantaneous and continuous (see next slide)
Location	San Francisco, CA Coordinates: 37.74840° N / 122.37861° W
Weather	Meteorological Observations: Winds 10 mph from the WNW
Incident Date & Time	11JUL2024 1600Z (0900 local)
Executive Summary	• Of the three gases modeled in the lithium-ion battery fire, HCN presents the greatest atmospheric hazard at the quantities specified. 51 people are estimated to be exposed to hazard levels that could possibly result in at least severe injury. Of this group, 45 people may be exposed to hazard levels that could possibly result in death. Note: AEGLs are conservative safety levels and assume an unsheltered general population (to include susceptible individuals). • Model does not account for synergistic effects of multiple hazardous chemicals.

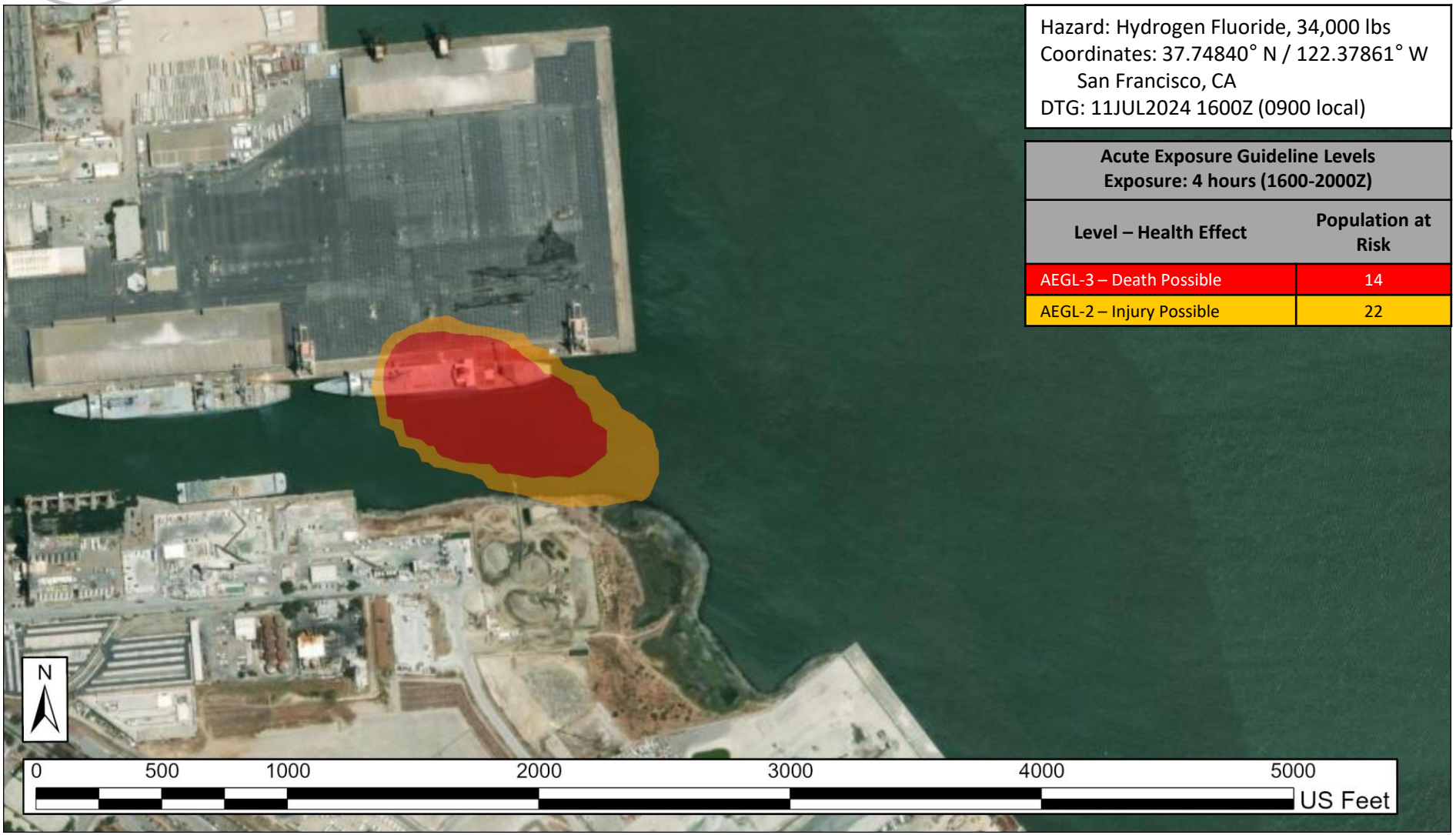
Modeling Assumptions / Comments

- A lithium battery fire is difficult to extinguish and may pose a localized explosive hazard.
- Battery fire duration is highly variable, and two scenarios are modeled here; an “instantaneous” fire, and a fire lasting 4 hours (referred to hereafter as the “continuous” case). The instantaneous fire is the worst case as its plume has the greatest extent. The 4-hour fire is the more realistic and a milder case.
- A fire of lithium-ion batteries can release the toxic or asphyxiant gases CO, CO_2, HF, and POF_3.

Modeling Assumptions / Comments (Cont'd)

- Metal oxides could be produced from battery fires and present environmental hazards but would not constitute atmospheric hazards.
- *The amounts of hazardous material modeled in this request were based on the requestor's guidance.*
- Hydrogen gas was not modeled due to being highly combustible – it was assumed to be consumed in the fire.
- **Note: Our model does not possess the ability to estimate the synergistic effects of multiple hazardous gases simultaneously. This may result in an underestimate of the overall downwind hazard.**

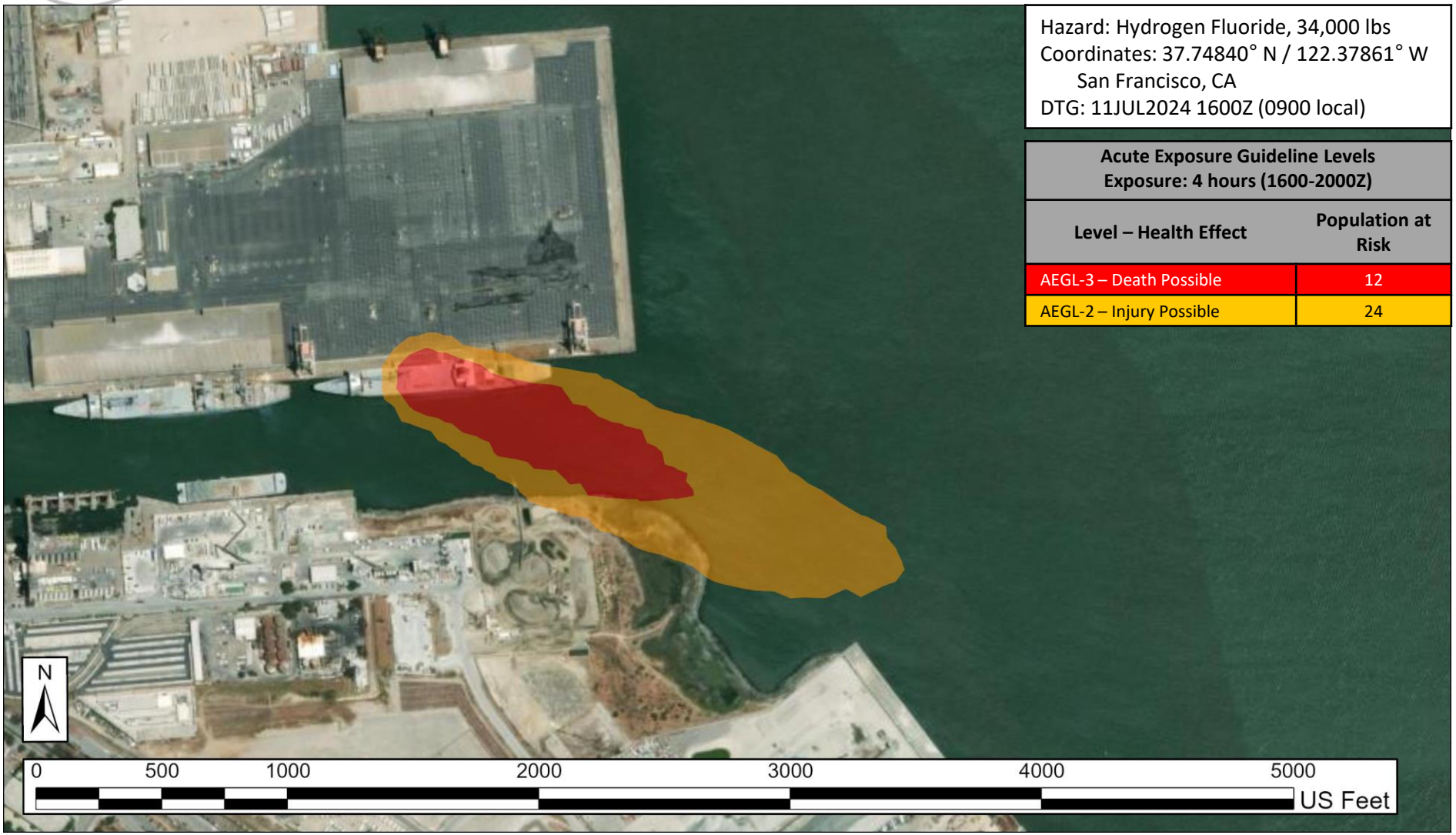
Hydrogen Fluoride (HF) – Instantaneous Release – AEGL



Hazard: Hydrogen Fluoride, 34,000 lbs
Coordinates: 37.74840° N / 122.37861° W
San Francisco, CA
DTG: 11JUL2024 1600Z (0900 local)

Acute Exposure Guideline Levels Exposure: 4 hours (1600-2000Z)	
Level – Health Effect	**Population at Risk**
AEGL-3 – Death Possible	14
AEGL-2 – Injury Possible	22

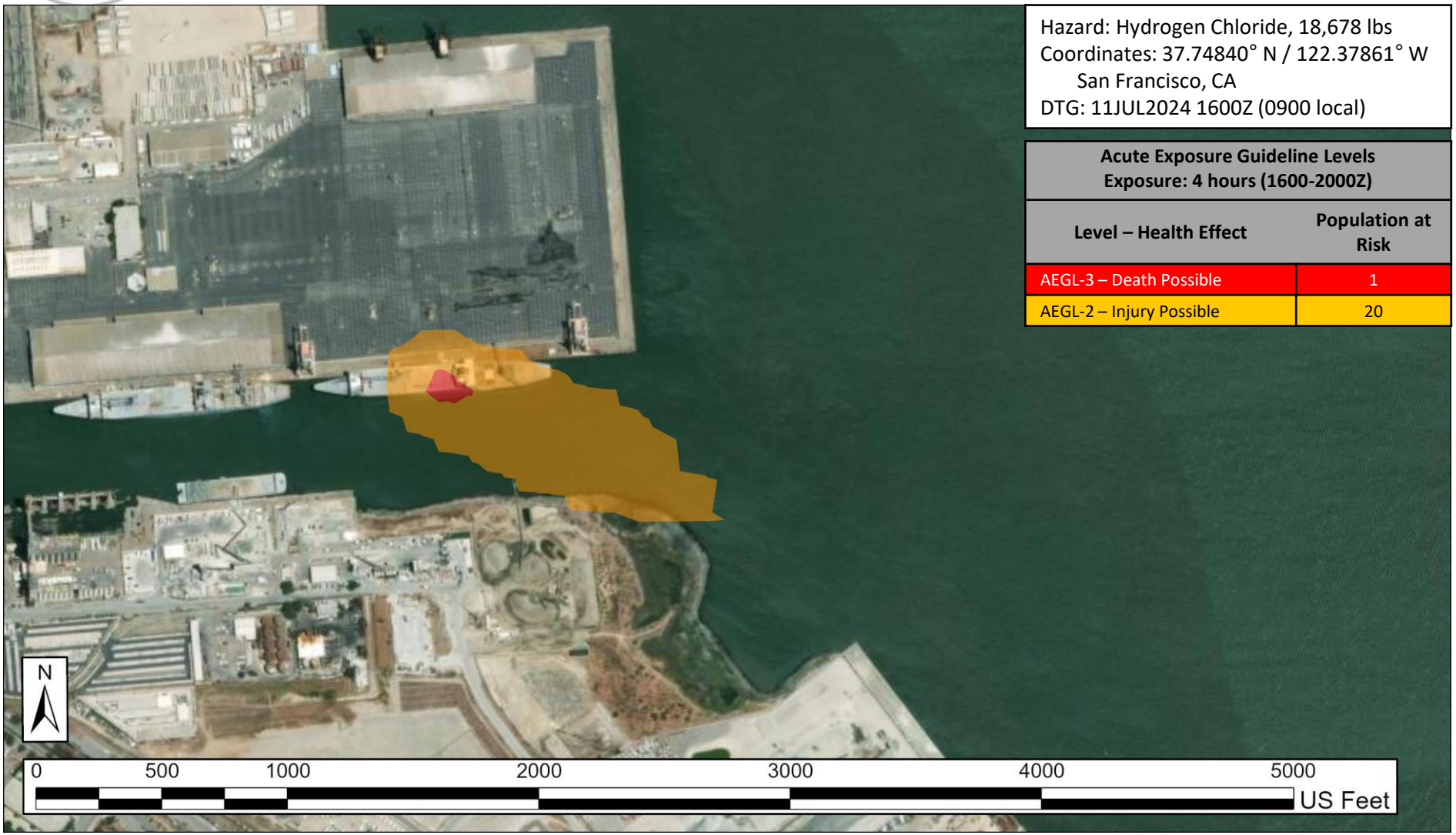
Hydrogen Fluoride (HF) – Continuous Release - AEGL



Hazard: Hydrogen Fluoride, 34,000 lbs
Coordinates: 37.74840° N / 122.37861° W
San Francisco, CA
DTG: 11JUL2024 1600Z (0900 local)

Acute Exposure Guideline Levels Exposure: 4 hours (1600-2000Z)	
Level – Health Effect	**Population at Risk**
AEGL-3 – Death Possible	12
AEGL-2 – Injury Possible	24

Hydrogen Chloride (HCl) – Instantaneous Release - AEGL



Hazard: Hydrogen Chloride, 18,678 lbs
Coordinates: 37.74840° N / 122.37861° W
San Francisco, CA
DTG: 11JUL2024 1600Z (0900 local)

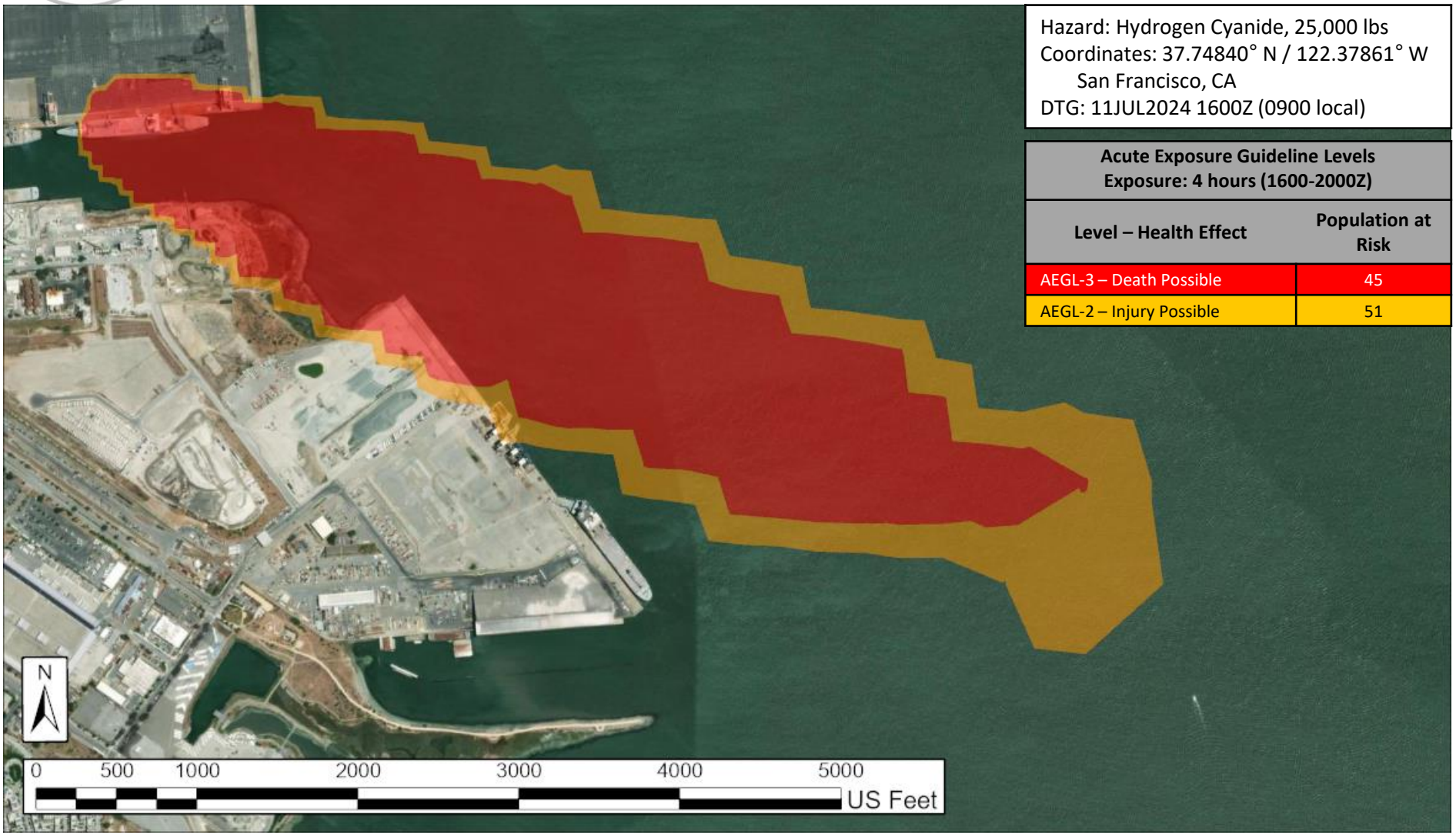
Acute Exposure Guideline Levels Exposure: 4 hours (1600-2000Z)	
Level – Health Effect	**Population at Risk**
AEGL-3 – Death Possible	1
AEGL-2 – Injury Possible	20

Hydrogen Chloride (HCl) – Continuous Release - AEGL

Hazard: Hydrogen Chloride, 18,678 lbs
Coordinates: 37.74840° N / 122.37861° W
San Francisco, CA
DTG: 11JUL2024 1600Z (0900 local)

Acute Exposure Guideline Levels Exposure: 4 hours (1600-2000Z)	
Level – Health Effect	**Population at Risk**
AEGL-3 – Death Possible	0
AEGL-2 – Injury Possible	2

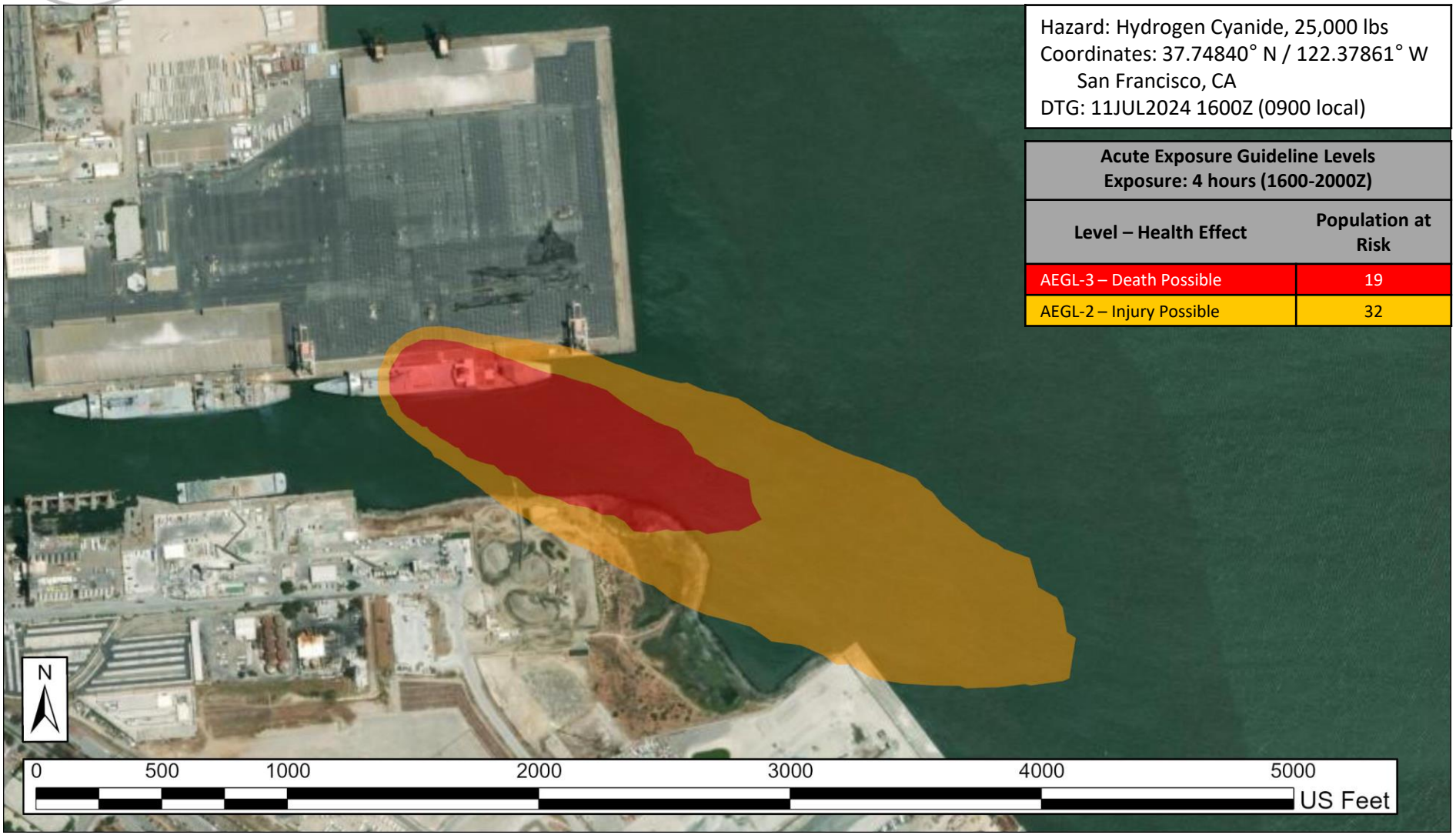
Hydrogen Cyanide (HCN) – Instantaneous Release - AEGL



Hazard: Hydrogen Cyanide, 25,000 lbs
Coordinates: 37.74840° N / 122.37861° W
San Francisco, CA
DTG: 11JUL2024 1600Z (0900 local)

Acute Exposure Guideline Levels Exposure: 4 hours (1600-2000Z)	
Level – Health Effect	**Population at Risk**
AEGL-3 – Death Possible	45
AEGL-2 – Injury Possible	51

Hydrogen Cyanide (HCN) – Continuous Release - AEGL



Hazard: Hydrogen Cyanide, 25,000 lbs
Coordinates: 37.74840° N / 122.37861° W
San Francisco, CA
DTG: 11JUL2024 1600Z (0900 local)

Acute Exposure Guideline Levels Exposure: 4 hours (1600-2000Z)	
Level – Health Effect	**Population at Risk**
AEGL-3 – Death Possible	19
AEGL-2 – Injury Possible	32

Acute Exposure Guideline Levels (AEGL)

Value	Description
AEGL-3	**Death Possible** - the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.
AEGL-2	**Injury Possible** - the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
AEGL-1 (May not be displayed or defined)	**Threshold** - the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

FINAL AEGLs – may be used on a permanent basis by all federal, state and local agencies, and private organizations.

INTERIM AEGLs – represents the best efforts of the AEGL Committee to establish exposure limits, and the values are available for use as deemed appropriate on an interim basis by federal and state regulatory agencies and the private sector.

AEGLs are developed by the EPA and represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from 10 minutes to 8 hours. These levels are applicable to the general population including infants and children, and other susceptible individuals.

Published AEGL times are 10 min, 30 min, 1 hr, 4 hr and 8 hr. Using these published guidelines, DTRA developed HPAC to plot human effects in a time weighted manner that better estimates the AEGL effects. These effects use extrapolations for very short time exposures.

Blood Agents (Cyanides & Arsine) – Facts

Physiological Effects/Associated Chemicals/Usage

- Blood Agents includes **Cyanogen chloride (CK), Hydrogen cyanide (AC), Sodium cyanide (NaCN), and Potassium cyanide (KCN)**.
- **Schedule III – Chemical Warfare Agent (CWA) by OPCW**

Routes of Exposure

- Inhalation of aerosolized forms, skin/eye contact and ingestion, or touching soil that contains cyanide.

Mechanism of Action

- Blood agents Interfere with oxygen metabolism in cells by preventing the normal utilization of oxygen leading to respiratory failure.

Time to Effect/Symptoms

- **Exposure route – dependent, immediate to minutes**
- Symptoms of cyanide's toxicity include, dizziness, headache, nausea, vomiting, rapid breathing, increased heart rate and fatigue.

Medical Countermeasures

- Asymptomatic – Several minutes post-exposure require no oxygen or antidotes.
- Symptomatic effects - convulsions, dyspnea or unconscious but breathing), administer oxygen and antidotes immediately.
- Antidotes - Sodium nitrite, amyl nitrite and/or hydroxocobalamin.

Environmental Fate/Effects

- HCN is highly volatile and is removed from the environment in less than an hour. CK is even less persistent.

Personal Protective Equipment

Respiratory Protection

- Disposable N100, R100, or P100 FFR
- PAPR
- Elastomeric APR
- SCBA

Face and Eye Protection

- Safety goggles/glasses

Hand Protection

- Double/thicker Nitrile gloves

Dermal Protection

- Wrist/Arm protection
- Particulate hazards protective ensemble (NFPA 1999 Single or Multi-Use or NFPA 1994 Class 4 Ensemble)
- Chemical hazards protective ensemble (NFPA 1994 Class 3 Ensemble)

Mission Oriented Protective Posture (MOPP)

- U.S. military personnel – For use against TIM/TIC, chemical, biological, radiological, or nuclear (CBRN) exposures.
- MOPP 4 - All protection worn (suit, boots, mask and gloves).

Patient & Personnel Decontamination

- Skin decontamination of AC - not needed due to high evaporation rates
- CK – Use water or standard non-bleach decontaminants

Field Detectors

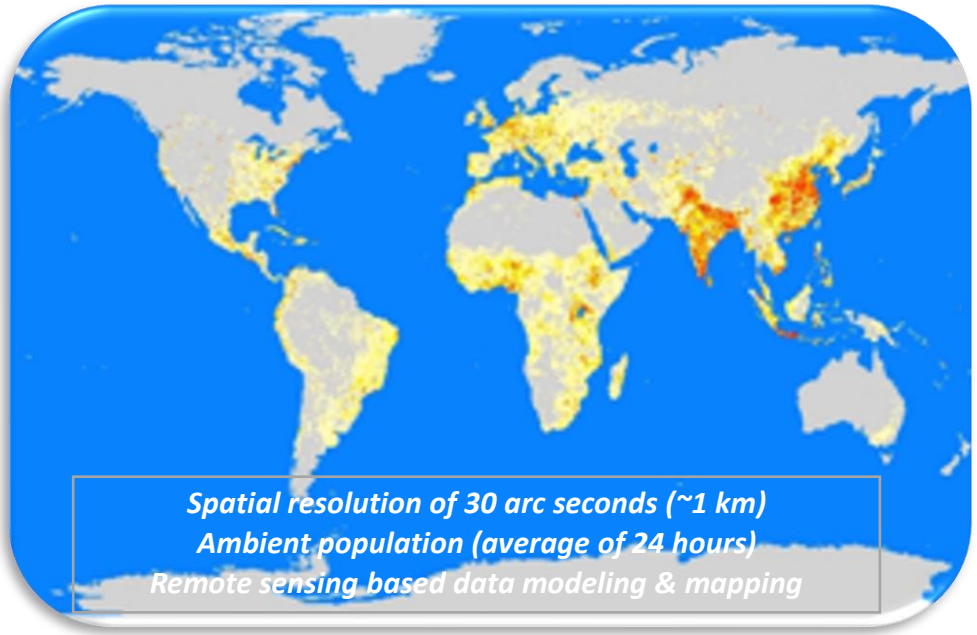
- Joint Chemical Agent Detector (JCAD)
- M256A2 Chemical Agent Detector Kits
- M272 Chemical Agent Water Testing Kit detects AC in water

https://www.cdc.gov/niosh/ershdb/emergencyresponsecard_29750037.html

Filed Management of Chemical and Biological Casualties handbook, 5th edition 2016 and TM 3-11.91
Ref: TM 3-6665-311-10

Population Data

- Population figures are based on LandScan™, a database produced by Oak Ridge National Laboratory.
- LandScan™ is based on the 2020 census for the U.S. (other nations vary), overhead imagery, geo-economic, and other observable data. It was updated in 2022 and refreshed annually.
- Reported population numbers are **based upon average day and night** time LandScan™ 2022 data.*



- This population data does not include major shifts in personnel such as relocations, special events, etc. In such cases the population database needs to be amended or population can be added or removed within HPAC.
- For planning purposes, estimates are assumed to be accurate within +10/-5%. Validation testing indicates agreement within 20% for select examined areas.
- More information is available at https://landscan.ornl.gov.

*Individual day or individual night data is available upon request for US and specialized OCONUS locations.