



The American Osteopathic College of Occupational and Preventive Medicine 2024 Midyear Educational Conference

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION

Jet Fuel Contamination of a Hawaii Drinking Water System: Red Hill Fuel Depot

AOCOPM Presentation 22 March 2024
Alan Philippi, DO, MS

0

Distribution Statement A. Approved for public release; distribution is unlimited.

DISCLAIMER

The views expressed in this presentation are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, or the U.S. Government.

The authors are employees of the U.S. Government. This work was prepared as part of their official duties. Title 17, U.S.C., §105 provides that copyright protection under this title is not available for any work of the U.S. Government. Title 17, U.S.C., §101 defines a U.S. Government work as a work prepared by a military Service member or employee of the U.S. Government as part of that person's official duties.

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION | 1

1

Learning Objectives

1. Comprehend the November 2021 release of JP-5 jet fuel into the Joint Base Pearl Harbor Hickam Drinking Water System and the subsequent health impacts.
2. Recognize the limitations of evaluating health impacts and the difficulty in predicting long-term health impacts from this exposure.
3. Outline the lessons learned and key takeaways from this environmental health exposure to inform future responses.
4. Future steps being used to evaluate long term health effects from this exposure.

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION AOCOPM Midyear Meeting 22 March 2024 | 2

2

RED HILL BULK FUEL STORAGE FACILITY

- 20 tanks with 100 million gallons of fuel just 100 feet above Oahu's primary drinking water supply
- Built in the 1940s
- 2.5 miles mauka (uphill) of Pearl Harbor with connecting tunnel and pipes
- History of spills, three reported releases from 2014 - 2021

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION | 3

3

Housing areas served by the Joint Base Pearl Harbor-Hickam Water System

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION | 4

4

Timeline

2014	2015	2016	2017	2018	2019	2020	2021
January 13, 2014: Navy reported release of approximately 27,000 gallons from Tank 5	May 2015: DCH, EPA and Navy enter into Administrative Order on Consent				March 17 & June 2, 2020: Navy notifies DCH of release into surface water at Hotel Pier		May 6, 2021: Navy reported approximately 38 gallons of JP-5 was released into the environment from pipeline reliners near Tanks #18 and #20 July 23, 2021: Navy reported release of approximately 150 gallons at Kilo Pier November 20, 2021: Navy reported approximately 14,000 gallons of water and JP-5 were released from a cracked valve in a fire suppression drain line at a location approximately 1/2 mile downhill of the bulk fuel tank and contained in a sump located in close proximity to Red Hill Shaft. November 28, 2021: The Navy and DCH received complaints about fuel-like odors in drinking water.

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION | 5

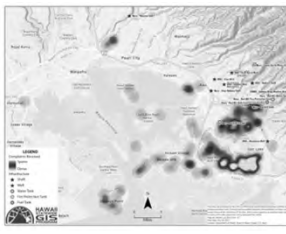
5




The American Osteopathic College of Occupational and Preventive Medicine 2024 Midyear Educational Conference

**NOVEMBER 28-29, 2021
IDENTIFICATION OF A PROBLEM**

- Hundreds of calls to Hawaii Department of Health (HDOH) Safe Drinking Water Branch reporting fuel-like odor in drinking water and health symptoms
- Hawaii Poison Center received 30 calls and identifies a "sentinel event"
- November 29, 2021 – HDOH issues "Do Not Drink" health advisory for the Navy's Joint Base Pearl Harbor-Hickam (JBPHH) water system




| 6

6


**UNPRECEDENTED
EVENT?**

No historical or experimental model of this type of exposure

Short – Medium term exposure to JP-5 jet fuel in drinking water

How do we assess immediate health impacts?

How do we predict long-term health impacts?



| 7

7

JP-5

- Kerosene-like military jet fuel
- 1000+ different constituents


Contaminant	Estimated Concentration
Benzene	0.2%
Toluene	0.1%
Xylenes	3.5%
Methylnaphthalenes	4.6%
Naphthalene	3.0%
C5-C8Aliphatics	12%
>C8-C18Aliphatics	68%
>C18-C32Aliphatics	0.0%
>C8Aromatics	9%


| 8

8

**NATIONAL Technical 1
No. 310**

Clinical Toxicology C
Copyright © 2014 Int
ISSN: 1556-3650 print
DOI: 10.3109/155636



Permissible Exposure Levels
for Selected Military Fuel Vapors

IESIS

dermatitis

SUBCOMMITTEE ON PERMISSIBLE EXPOSURE LEVELS FOR MILITARY FUELS

COMMITTEE ON TOXICOLOGY

BOARD ON ENVIRONMENTAL STUDIES AND TOXICOLOGY

COMMISSION ON LIFE SCIENCES

NATIONAL RESEARCH COUNCIL

Indianapolis, IN, USA


IN, USA USA

NATIONAL ACADEMY PRESS
WASHINGTON, D.C., 1996

MILITARY MEDIC

Jet


¹Department of A
²Department of A
³Department of E



| 9

9

SYMPTOMS FROM EXPOSURE TO PETROLEUM HYDROCARBONS IN DRINKING WATER

- Stomach upset, nausea, vomiting and diarrhea
- Lightheadedness, headache and difficulty concentrating
- Skin irritation, redness or peeling skin
- Difficulty breathing, coughing and aspiration pneumonitis




| 10

10

HOW MUCH JP-5 DID PEOPLE GET EXPOSED TO?




| 11

11



The American Osteopathic College of Occupational and Preventive Medicine 2024 Midyear Educational Conference

Public Websites

<https://www.atsdr.cdc.gov/sites/red-hill/index.html>

18

18

CDC/ATSDR Assessment of Chemical Exposure (ACE) Investigation

- January 7 – February 10, 2022
- Extensive Recruitment
- 2,289 participants

HEALTH IMPACT SURVEY

Water Use Health Symptoms Medical Care Children Pets

19

19

Participation

<p>2,289 Baseline 986 Follow-up</p> <p>participants submitted surveys</p>	<p>14% Baseline 8% Follow-up</p> <p>of affected households were represented</p>	<p>88% Baseline 90% Follow-up</p> <p>were affiliated with the military</p>
---	---	--

20

20

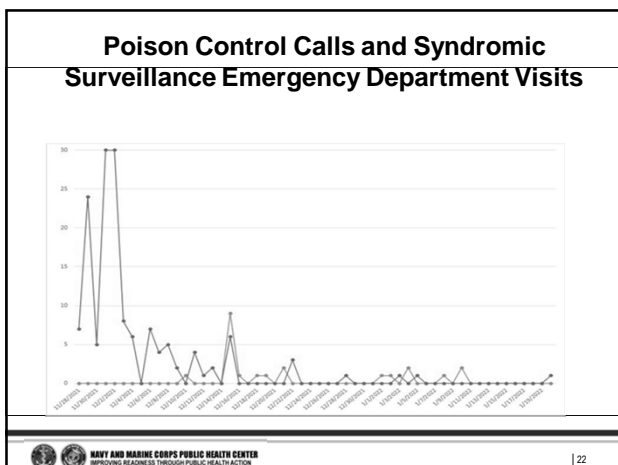
CDC/ATSDR ACE INITIAL RESULTS

MMWR published 05/27/2022
https://www.cdc.gov/mmwr/volumes/71/wr/mm7121a4.html?cid=mm7121a4_w

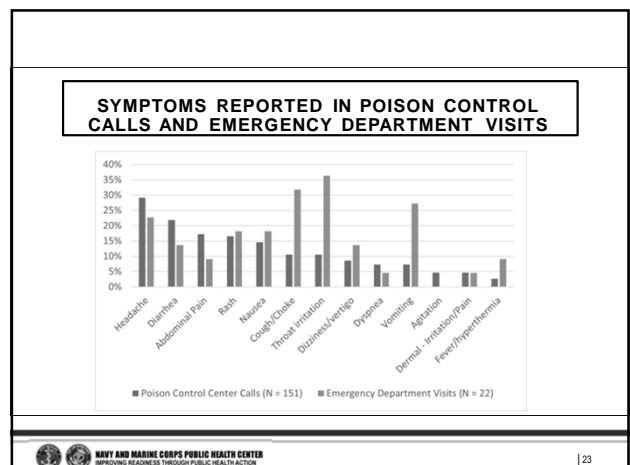
- 87% of participants reported symptoms with 80% of those reporting improvement in their symptoms after switching water source
- 37% (853) sought medical care
- Hundreds of people reported new mental health symptoms
- Hundreds reported symptoms in pets
- Majority received information from online sources

21

21



22



23



LONG-TERM HEALTH EFFECTS

- Unknown
- Roster vs Registry
- Experimental Models

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION | 24

24

MENTAL HEALTH

- Event was an extreme source of stress
- Likely to be persistent
- Significant reports of mental health impacts in health impact survey, DOH complaints and observed in callers, on social media

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION | 25

25

8 MONTH FOLLOW UP CDC/ATSDR ACE SURVEY RESULTS

September 2022
health.hawaii.gov/about/files/2022/11/ATSDR-Follow-Up-Survey-One-Pager.pdf

- 80% of participants reported symptoms in the last 30 days with 65% convinced related to the water
- Headaches, Anxiety, dry/itchy skin, fatigue
- 85% are still using an alternative water source
- 50% reported worse mental health
- Massive concern and frustration with communication, transparency and trust

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION | 26

26

OVERALL HEALTH AT FOLLOW-UP

- 55%** reported worse physical health after the incident when compared to before
- 50%** reported worse mental health after the incident when compared to before
- 21%** kept from usual activities for 14+ of the past 30 days due to poor health

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION | 27

27

LIMITATIONS

- Study design
 - Convenience sampling
 - Self-reported/parent reported symptoms
 - Lack of exposure data
 - Outreach Barriers

Strengths

- Widespread partner engagement
- Large number of responses
- Timely data for action

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION | 28

28

DIRECT IMPACTS OF ACE


- Red Hill Clinic set up
- DHA sharing of syndromic surveillance data
- DHA EpidemiologicAid for medical record review
- DHA to fund 3rd party health registry to include medical records, surveys, communications and referrals.
- Support for Providers including case conferences, Continuing Medical Education (CME), tele-health Toxicology consults

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION | 29

29




The American Osteopathic College of Occupational and Preventive Medicine 2024 Midyear Educational Conference



WHAT'S NEXT

- Tracking health effects
- ATSDR Public Health Assessment Activities


ATSDR Agency for Toxic Substances and Disease Registry
 Division of Community Health Investigations (DCHI)


NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION
| 30


30

Red Hill National Academies Consensus Study Report

- *Planned activity; contract task order pending*
- VA and DoD collaboration
- Independent committee review of health risks and clinical guidance
- Community involvement in process
- Scientifically rigorous, evidence-based
- Lengthy; anticipate two years to final report
- Independence critical to loss of trust in DoD



Example Report



NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION
| 31

31

Challenge of Persistent, Complex Symptoms

My ongoing symptoms are as follows, I would like answers to each question regarding each symptom individually.


- CHRONIC FATIGUE
- BRAIN FOG
- MIGRAINE HEADACHES
- BALANCE DISTURBANCES
- RANDOM TWITCHING IN VARIOUS AREAS OF MY BODY INCLUDING FINGERS
- MUSCLE SPASMS
- MUSCLE CRAMPS
- SORE THROAT
- STOMACH IRRITATION
- NOT BEING ABLE TO TOLERATE EATING DESPITE BEING HUNGRY
- NUMBNESS IN EXTREMITIES
- FREQUENT NAUSEA
- FREQUENT DIARRHEA
- NEUROLOGICAL CHALLENGES
- JOINT PAIN, RANDOM AND SUDDEN
- ANXIETY ABOUT MANY THINGS RELATED TO MY HEALTH AND FUTURE NOW
- DIZZINESS, FREQUENT, RANDOM, SUDDEN
- PROBLEMS FOCUSING AND STAYING ON TASK, FREQUENT ALMOST DAILY
- PROBLEMS WITH ATTENTION, FREQUENT
- NARCOSSIS, FREQUENT AND SUDDEN
- CONFUSION
- NEUROPATHY
- TROUBLE GRIPPING ITEMS
- DEEP, CONSTANT, INTENSE INNER EAR PAIN


NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION
| 32

32

Parallels with Other Complex Problems (Long COVID)

Whole Health System Approach
to Long COVID



Patient Aligned Care Team (PACT) Guide
U.S. Department of Veterans Affairs
August 1, 2022

AUTONOMIC NERVOUS SYSTEM DYSREGULATION

The autonomic nervous system (ANS) regulates many of the body's internal functions, including heart rate, blood pressure, and digestion. It is composed of the sympathetic (fight or flight) and parasympathetic (rest and digest) systems. Dysregulation of the ANS can lead to a variety of symptoms, including dizziness, fatigue, and gastrointestinal issues.

What is Long COVID?

Long COVID, also known as post-acute sequelae of SARS-CoV-2 infection (PASC), is a condition that occurs in some people who have recovered from COVID-19. It is characterized by a wide range of symptoms that persist for weeks, months, or even years after the initial infection. The exact cause of Long COVID is still unknown, but it is thought to be related to the damage caused by the virus to the body's cells and tissues.

Long COVID Symptoms


- Fatigue
- Shortness of breath
- Headaches
- Brain fog
- Dizziness
- Nausea
- Diarrhea
- Joint pain
- Skin rashes
- Hair loss
- Loss of taste or smell
- Anxiety and depression
- Sleep problems
- Heart palpitations
- Blurred vision
- Tinnitus
- Ringing in the ears
- Lightheadedness
- Chest pain
- Coughing
- Sore throat
- Hoarseness
- Swallowing difficulties
- Constipation
- Urinary problems
- Menstrual irregularities
- Weight changes
- Hair loss
- Skin rashes
- Hair loss
- Loss of taste or smell
- Anxiety and depression
- Sleep problems
- Heart palpitations
- Blurred vision
- Tinnitus
- Ringing in the ears
- Lightheadedness
- Chest pain
- Coughing
- Sore throat
- Hoarseness
- Swallowing difficulties
- Constipation
- Urinary problems
- Menstrual irregularities
- Weight changes

Long COVID Management by Condition

- Fatigue: Rest, pacing, and energy management.
- Shortness of breath: Breathing exercises, oxygen therapy, and physical therapy.
- Headaches: Pain relievers, hydration, and stress management.
- Brain fog: Cognitive behavioral therapy, memory aids, and brain training.
- Dizziness: Vestibular rehabilitation, hydration, and stress management.
- Nausea: Small, frequent meals, ginger, and stress management.
- Diarrhea: Hydration, fiber, and stress management.
- Joint pain: Physical therapy, pain relievers, and heat/cold therapy.
- Skin rashes: Topical steroids, antihistamines, and stress management.
- Hair loss: Hair care, stress management, and medical treatments.
- Loss of taste or smell: Flavor enhancers, zinc, and stress management.
- Anxiety and depression: Therapy, medication, and support groups.
- Sleep problems: Sleep hygiene, relaxation techniques, and medication.
- Heart palpitations: Stress management, hydration, and medical treatments.
- Blurred vision: Eye exams, hydration, and stress management.
- Tinnitus: Sound therapy, hearing aids, and stress management.
- Ringing in the ears: Sound therapy, hearing aids, and stress management.
- Lightheadedness: Hydration, salt intake, and stress management.
- Chest pain: Stress management, hydration, and medical treatments.
- Coughing: Hydration, humidifiers, and stress management.
- Sore throat: Warm liquids, lozenges, and stress management.
- Hoarseness: Voice rest, hydration, and stress management.
- Swallowing difficulties: Soft foods, hydration, and stress management.
- Constipation: Fiber, hydration, and stress management.
- Urinary problems: Hydration, stress management, and medical treatments.
- Menstrual irregularities: Stress management, hormonal therapy, and medical treatments.
- Weight changes: Nutrition counseling, stress management, and medical treatments.

Long COVID by Condition

- Fatigue
- Shortness of breath
- Headaches
- Brain fog
- Dizziness
- Nausea
- Diarrhea
- Joint pain
- Skin rashes
- Hair loss
- Loss of taste or smell
- Anxiety and depression
- Sleep problems
- Heart palpitations
- Blurred vision
- Tinnitus
- Ringing in the ears
- Lightheadedness
- Chest pain
- Coughing
- Sore throat
- Hoarseness
- Swallowing difficulties
- Constipation
- Urinary problems
- Menstrual irregularities
- Weight changes


NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION
| 33

33

**WHAT'S NEXT
ENVIRONMENTAL**


Long Term Monitoring of the
Drinking Water System

Defueling (99.5% complete)

Facility Closure

Aquifer recovery

Environmental Remediation


NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION
| 34

34








NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION
| 35

35



The American Osteopathic College of Occupational and Preventive Medicine 2024 Midyear Educational Conference

KEY LESSONS LEARNED

Clear and consistent communication
Engage expert resources early
Transparency and data sharing
Recognizing alternate agendas
Remember the goal

**PROTECTING HUMAN HEALTH AND
THE ENVIRONMENT**

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION | 36

36

REFERENCES

Centers for Disease Control and Prevention. (2022, May 26). Notes from the field: Self-reported health symptoms following petroleum contamination of a drinking water system - Oahu, Hawaii, November 2021 - February 2022. Morbidity and Mortality Weekly Report (MMWR). https://www.cdc.gov/mmwr/volumes/71/wr/mm7121a4.html?_id=mm7121a4_w

Contestabile, J. J. (2017). Jet fuel-associated occupational contact dermatitis. *Military Medicine*, 182(3). <https://doi.org/10.7205/mlmed-6-16-00217>

Hawaii Department of Health. (2022, November 8). Follow-up survey results Navy Water Contamination Navy Water Contamination Follow-Up Survey Results. <https://health.hawaii.gov/about/files/2022/11/ATSDR-Follow-Up-Survey-One-Page.pdf>


National Research Council. (1996). Permissible Exposure Levels for Selected Military Fuel Vapors. <https://doi.org/10.17226/9133>

Tarmoehlen, L. M., Takahiro, K. J., Bang, Nefajga, K. A. (2014). Hydrocarbon toxicity: A Review. *Clinical Toxicology*, 52(5), 479-489. <https://doi.org/10.3109/1563650.2014.923904>

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION | 37

37

QUESTIONS?



Photos: Daniel Davila

alan.f.philippi.civ@health.mil

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER
IMPROVING READINESS THROUGH PUBLIC HEALTH ACTION | 38

38