



# Emerging Trends in ER Case Studies

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**M-12**

**March 20, 2023**



25th California Unified Program  
Annual Training Conference  
March 20 – 23, 2023



# LITHIUM BATTERY EMERGENCIES:

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# Common Lithium Batteries?



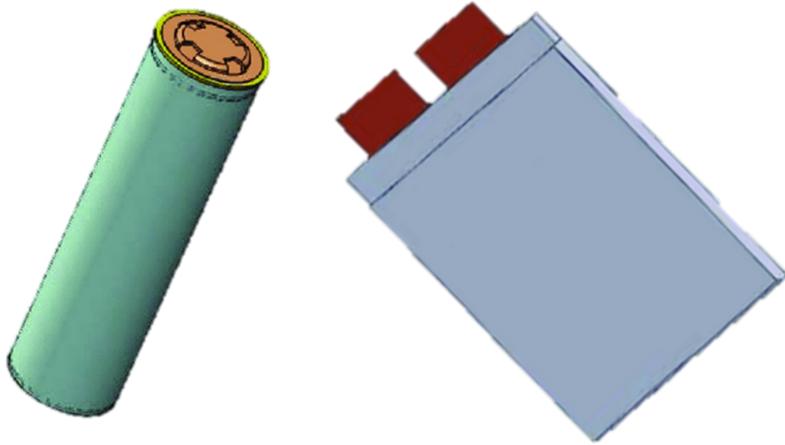
## Non-rechargeable Batteries (Lithium Metal)

Highest energy density

Very stable medium

Lithium metal found inside  
is extremely water reactive

# Common Lithium-Ion Batteries



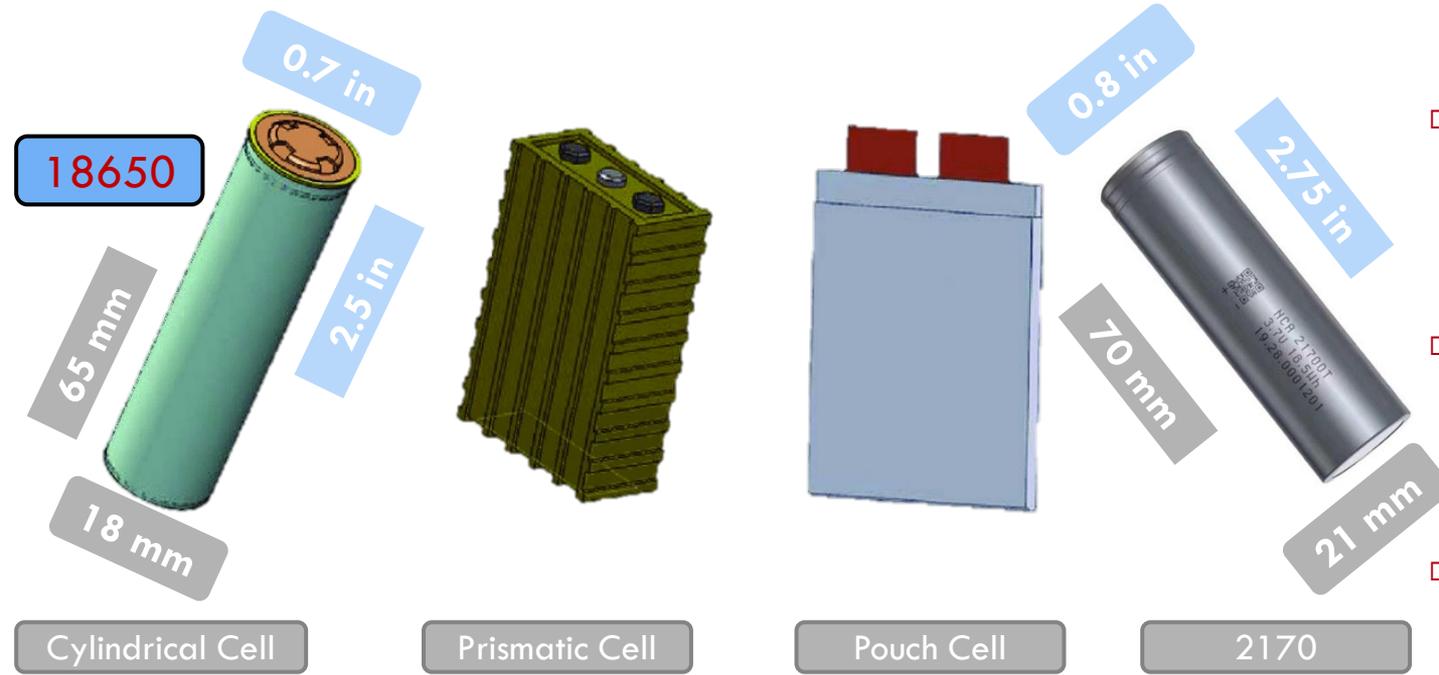
**Rechargeable Batteries**

Good memory resistance

Very stable medium



# Lithium-Ion Battery Types



- Cylindrical Cells (18650) are the most common battery in most mobile applications (bikes, scooters, etc.)
- Cylindrical Cells are also used by electric vehicles, where you can find anywhere from 3K-7K individual cells
- Prismatic and Pouch Cells are found in all other electric vehicles

# Evolution of the Cylindrical Cell



- Here is an example of how the cylindrical cell size has evolved over time

# Exponential Increase – Infrastructure

## Federal Infrastructure Investment and Jobs Act (11/15/2021)

- \$6 Billion
  - Battery Storage
- \$7.5 Billion
  - Rapid charging stations –  
500,000 along highways and in  
communities
- \$1 Billion
  - School Buses





## School Buses?

Rapid smoke and flame production



# Three Primary Presentations of LIB

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- ▣ Energy Storage Systems
- ▣ Electric Vehicles
- ▣ Micro-mobility



## Battery Energy Storage System (ESS)



# Battery Energy Storage System (ESS)

- ❑ Large Systems
- ❑ Multiple racks of batteries
- ❑ Surprise, AZ - 2019
  - ESS Fire/Explosion
    - Injuries to Hazmat FF's
      - Chemical Burns
      - Compression Blast Injuries
  - NFPA 1855





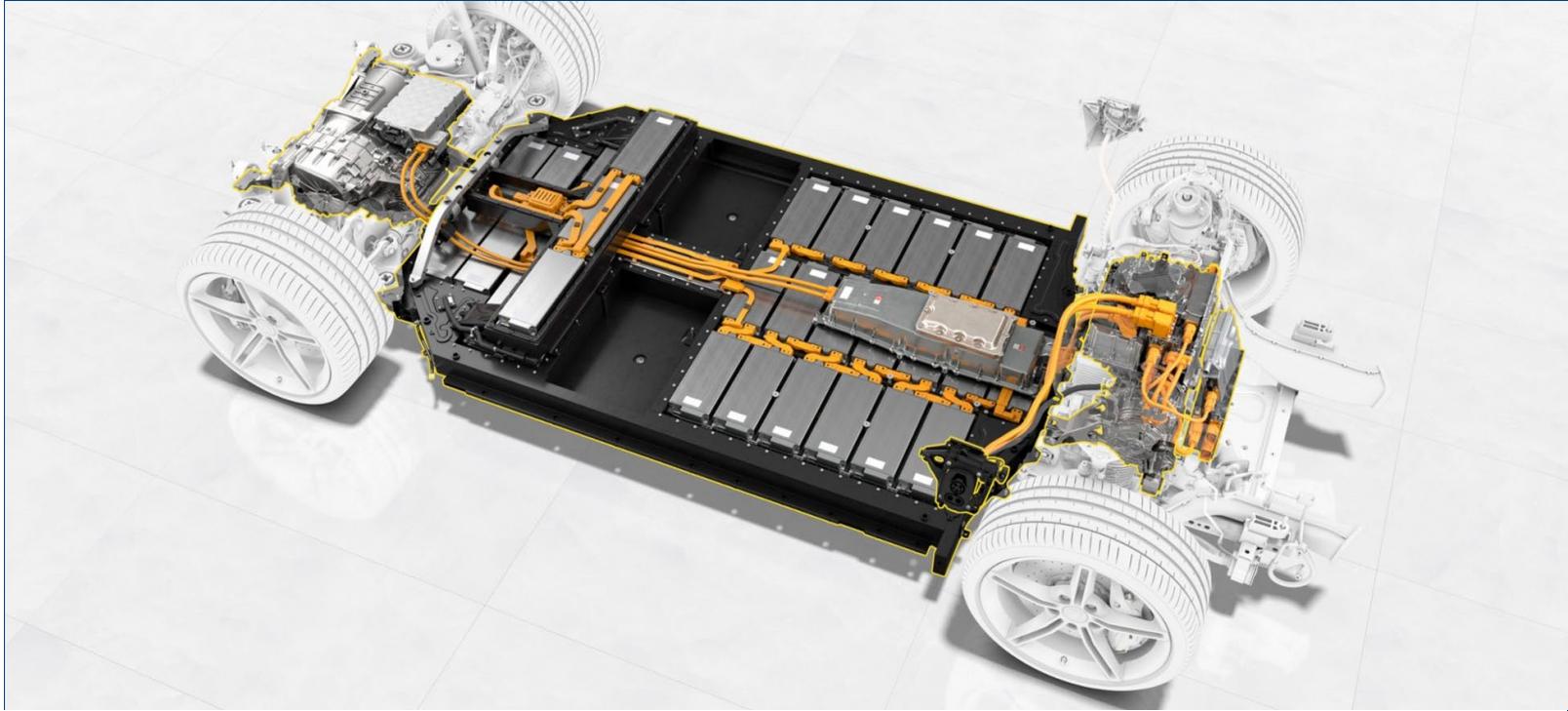
KEY TAKEAWAYS FROM APS EXPLOSION REPORT  
SEVERAL VALLEY FIREFIGHTERS HURT IN 2019 BLAST



# Battery Energy Storage System (ESS)

- ❑ September 20, 2022
- ❑ Moss Landing, CA
- ❑ Tesla Battery Energy Storage Facility





## Electric Vehicles (EV)





# Exponential Increase – Electric Vehicles (EV)

## % of EVs Global Auto Sales

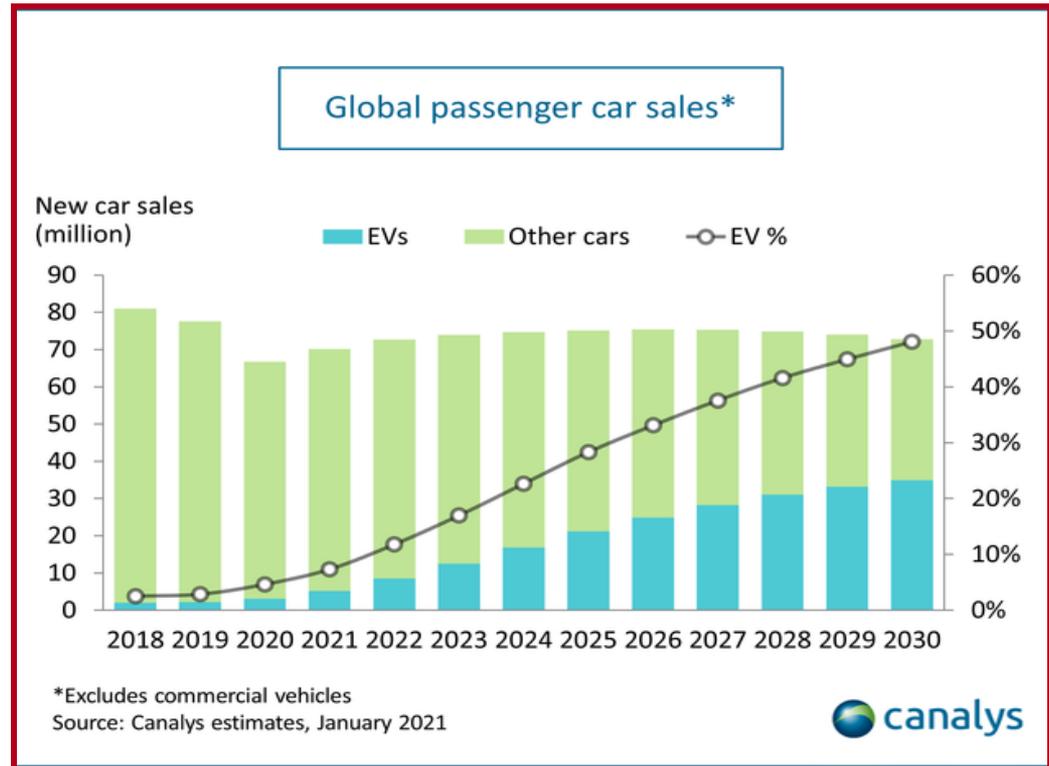
4.7% - 2020

15% - 2025

48% - 2035

California forecasted to be much higher.

By 2035 100% of all vehicle sales in CA must be battery or hydrogen powered



# Electric Vehicles (EV)

- ❑ Lithium-Ion Batteries primarily located in underside of vehicle
  - White smoke
  - Battery cell projectiles
  - Hissing/popping sounds
  - Water is considered best cooling agent for suppression
    - Water needs to be applied under the vehicle and up at the batteries.
  - **Rekindle is likely and can occur up to 21 days later!**



**Tesla – Cylindrical Cell Batteries**  
*18650 cell generation*

**LOTS OF WATER**

# 3 Keys to Success



EV  
Identification



Let it Burn  
PROTECT  
EXPOSURES!



Secure a  
Water  
Supply



# WHAT DOES THE FUTURE BRING FOR EV?





## Micro-Mobility Devices

**E-BIKES, SCOOTERS, HOVER BOARDS, ETC.**



HOW FAST DO THEY FAIL?

UL/FSRI DEMONSTRATION



# Differences in Lithium-Ion Battery Fires

- ❑ Very toxic atmospheres
- ❑ Burn temperatures are higher than normal
- ❑ Fires can burn without Oxygen – can't smother!
- ❑ Explosive potential – Hydrogen Gas
- ❑ Thermal Runaway reaction
  - Chemical reaction – rapid degradation
  - Does not require Oxygen
  - Nearly impossible to stop once it starts
  - Could happen in seconds or days
- ❑ Re-ignition is common – As much as 21 days later!



# Micro-Mobility Devices

- ❑ Public exposure concerns
  - Stored and charged inside occupied residences and businesses
  - Often near children's bedrooms
  - Can ignite with little-to-no warning
  - **Rekindle is likely. Remove all batteries outside as part of overhaul**



# Micro-Mobility Devices

- Lithium-Ion batteries do not require Oxygen to burn and are water reactive.



# San Diego 3<sup>rd</sup> Alarm Fire

- Although small, these batteries pose a major problem for fire prevention, fire suppression, and public safety.





Battery  
Charger  
location



Air  
Monitoring  
in SCBA!  
4-gas, PID,  
 Draegers



HCN  
readings



CO  
readings

# Interferants/Cross Sensitivities (CO 20:1 HCN)

## Hydrogen Cyanide (HCN)

<b>Sensor Type:</b>	Electrochemical
<b>Range:</b>	0 to 50 ppm
<b>Max Overload:</b>	100 ppm
<b>Resolution:</b>	1 ppm
<b>Bias/Equilibration:</b>	No bias/10 min. after installation
<b>Temperature Range:</b>	-4° F to 122° F (-20° C to 50° C)
<b>Pressure Range:</b>	Atmospheric ±10%
<b>Operating Humidity:</b>	15 to 90% RH non-condensing
<b>Drift:</b>	<2% signal/month
<b>Storage Life:</b>	6 months in sealed container
<b>Storage Temperature:</b>	32° F to 68° F (0° C to 20° C)
<b>Operating Life:</b>	2 years in air
<b>Warranty:</b>	1 year from date of shipment
<b>Calibration Gas:</b>	10 ppm HCN, balance N <sub>2</sub>
<b>Part Number(s):</b>	170-0012-000, 008-1117-000, <a href="#">C03-0949-000</a>

Cross-Sensitivity Data, HCN Sensor		
Gas	Concentration	Response
CO	300 ppm	15 ppm
Ethylene	100 ppm	25 ppm
H <sub>2</sub>	200 ppm	0 ppm
H <sub>2</sub> S	15 ppm	90 ppm <sup>1</sup>
NO	35 ppm	-28 to ~0 ppm <sup>2</sup>
NO <sub>2</sub>	5 ppm	-20 to -10 ppm <sup>2</sup>
SO <sub>2</sub>	20 ppm	40 to ~75 ppm

- 1 - Due to a very high cross-sensitivity to H<sub>2</sub>S, this sensor is unsuitable for use in atmospheres that contain H<sub>2</sub>S.
- 2 - **CAUTION!** Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

# Be Careful how you relay Detection Information!

Correct: Your meter is showing a reading of 1 ppm of HCN.

Incorrect: We are detecting 1 ppm of Hydrogen Cyanide. If you're not careful, by the time it goes from HM Entry to HM Group to Chief to Media... the public will hear that the building was evacuated due to hydrogen cyanide!

**Know the equipment you are using.**

**All Hazmat Detection Devices Have Limitations!**

# How to Respond to a Lithium-Ion Battery Fire?

Point Loma  
October 5, 2022  
6am



Point Loma  
One week  
post incident  
Hydrogen=  
LEL reads.  
CO Alarm



# Why am I reading LEL?

Point Loma Ebike Bucket:

10% LEL alarm up to one week post incident when agitating bucket.

Pedicab: 0% LEL

UPS Warehouse: LEL- 2

Drums with Ebike/Scooter batteries- up to 100% LEL

Carbon Monoxide is flammable, but... too low to measure in %LEL.

**We are reading Hydrogen.**

Cross Sensitivities/Interferents?



Carlsbad- Electric Scooters Used Battery Pile





# Put Batteries in with Vermiculite/Cell Block?





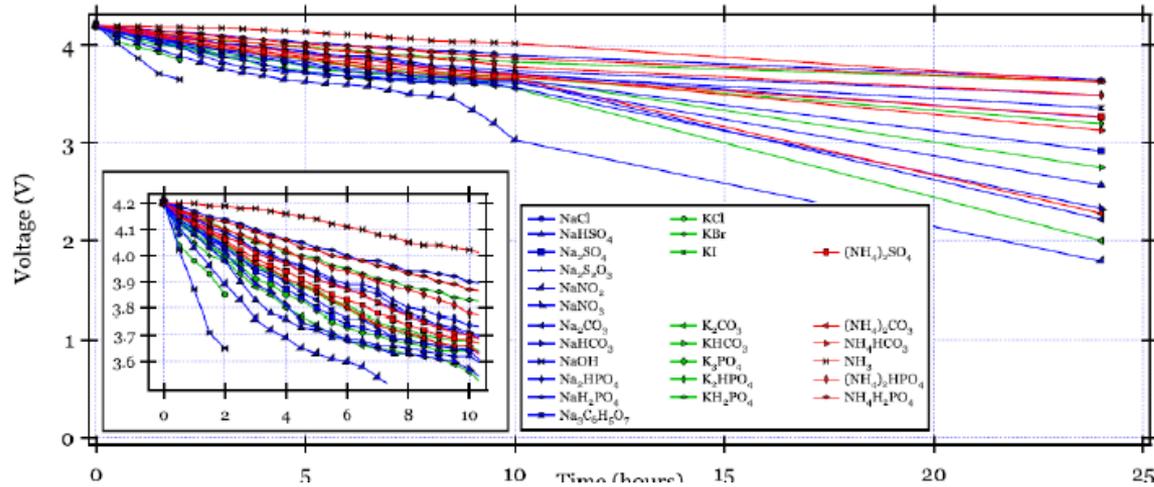
IMG\_0204



IMG\_0211

# De-energizing Batteries

- ◆ Recycling facilities regularly mentioned that prior to shredding they “soak” the batteries in salt water prior to shredding TO REDUCE EXPLOSIONS during the shredding process.





## Battery De-energizing Test

- ◆ Salt water solution – Approximately 0.5% NaCl
- ◆ 1 lb NaCl per 25 gallons water
- ◆ Soak from 3 days to 3 months
- ◆ Potentially HF, Cl<sub>2</sub>, HCl, other gases similar to plastic fires released during combustion
- ◆ 24 hour results indicated full discharge of test batteries



## Air Monitoring

- ◆ Due to the proximity of the surrounding community, EPA maintained air monitoring until all batteries were in drums and awaiting shipment

Location 7 - Southwest of Staging Area at Suites 114 & 116 Loading Dock Stairwell							
Instrument	Analyte	Action Level Exceedance?	Number of Readings	Number of Detections	Concentration Range	Period Average	Action Level
AreaRAE 3	VOC	No	2875	0	0 - 0 ppb	0 ppb	1000 ppb
	CO	No	2875	0	0 - 0 ppm	0 ppm	27 ppm
	H <sub>2</sub> S	No	2875	0	0 - 0 ppm	0 ppm	0.33 ppm
	SO <sub>2</sub>	No	2875	0	0 - 0 ppm	0 ppm	0.2 ppm
	Cl <sub>2</sub>	No	2875	720	0 - 0.3 ppm	0 ppm	0.5 ppm
	V	No	2875	2875	1 - 6 µrem/h	4.9 µrem/h	9 µrem/h

Location 8 - Eastern Side of Northern Roll-Off Battery Box							
Instrument	Analyte	Action Level Exceedance?	Number of Readings	Number of Detections	Concentration Range	Period Average	Action Level
SPM Flex 4	HCl	No	1490	0	0 - 0 ppm	0 ppm	1.8 ppm
SPM Flex 5	HF	No	867	0	0 - 0 ppm	0 ppm	1 ppm

# EVOLVE SKATEBOARDS POST INCIDENT SAMPLING

by Wirschem, Leon

8/29/22

NO.2619050058

Zhejiang Tianhong Lithium-ion Battery Co., Ltd

## SAFETY DATA SHEET

Lithium-ion Battery 36volt C 36V 14Ah 504Wh

### SECTION1 PRODUCT AND COMPANY IDENTIFICATION

Product name: Lithium-ion Battery 36volt C 36V 14Ah 504Wh  
 Company: Zhejiang Tianhong Lithium-ion Battery Co., Ltd  
 Address: No. 559 Changcheng Road, Taihui Street, Changxing Town, Huzhou City, Zhejiang Province, 313100, P.R.China  
 Email: xiexin369958@cnthpower.com  
 Fax: 86-572-6216061  
 Emergency Phone: 86-572-6216650  
 SDS Number: 2619050058  
 Effective Date: 2019-06-19

### SECTION2 HAZARDS IDENTIFICATION

Hazards Identification:  
 Class 9, miscellaneous. The battery has passed the test items of UN Model Regulations, Manual of Test and Criteria Section UN 38.3.

Emergency Overview:  
 Caution: Avoid contact and inhalation the electrolyte contained inside the battery.

### SECTION3 INFORMATION ON INGREDIENTS

Product name: Lithium-ion Battery 36volt C 36V 14Ah 504Wh

Ingredient	Concentration	CAS No.	EC No.
Lithium Manganese Nickel and Cobalt Teary	15-35%	346417-97-8	620-032-4
Carbon/Graphite	10-25%	7440-44-0	231-153-3
Copper	10-20%	7440-50-8	231-159-6
Electrolyte	10-20%	96-49-1	202-510-0
Aluminum	5-15%	7429-90-5	231-072-3
Silicon Rubber	2-10%	63394-02-5	/
Nickel Tab	1-5%	7440-02-0	231-111-4
Conductive Carbon	1-2%	7782-42-5	231-955-3
Polyethylene (PE)	0-2%	9002-88-4	618-339-3





evolve  
SKATEBOARDS  
18650 3.7V  
Rechargeable Battery

36 Wh  
18.00Wh/Hours  
500 mAh/Hours  
18650 3.7V 3500 mAh

CAUTION  
Do not short the battery terminals.  
Do not charge the battery in a fire or other high temperature environment.  
Do not dispose of the battery in a fire or other high temperature environment.

CE

18650 3.7V 3500 mAh





Client: County of San Diego  
Project/Site: Evolve

Job ID: 570-108005-1  
SDG: 2870 Whiptail Loop #103, Carlsbad, CA

Client Sample ID: 20044

Lab Sample ID: 570-108005-1

Date Collected: 08/29/22 10:40

Matrix: Water

Date Received: 08/29/22 18:10

Method: 6010B - Metals (ICP) - STLC Citrate

Analyte	Result	Qualifier	RL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		2.0	mg/L		09/01/22 09:12	09/01/22 09:31	1
Selenium	ND		1.0	mg/L		09/01/22 09:12	09/01/22 09:31	1
Molybdenum	ND		1.0	mg/L		09/01/22 09:12	09/01/22 09:31	1
Lead	ND		1.0	mg/L		09/01/22 09:12	09/01/22 09:31	1
Zinc	ND		5.0	mg/L		09/01/22 09:12	09/01/22 09:31	1
Vanadium	ND		0.20	mg/L		09/01/22 09:12	09/01/22 09:31	1
Thallium	ND		1.0	mg/L		09/01/22 09:12	09/01/22 09:31	1
Nickel	ND		1.0	mg/L		09/01/22 09:12	09/01/22 09:31	1
Copper	1.4		1.0	mg/L		09/01/22 09:12	09/01/22 09:31	1
Cobalt	ND		1.0	mg/L		09/01/22 09:12	09/01/22 09:31	1
Chromium	ND		1.0	mg/L		09/01/22 09:12	09/01/22 09:31	1
Cadmium	ND		0.20	mg/L		09/01/22 09:12	09/01/22 09:31	1
Beryllium	ND		0.20	mg/L		09/01/22 09:12	09/01/22 09:31	1
Barium	ND		0.20	mg/L		09/01/22 09:12	09/01/22 09:31	1
Arsenic	ND		2.0	mg/L		09/01/22 09:12	09/01/22 09:31	1
Silver	ND		0.20	mg/L		09/01/22 09:12	09/01/22 09:31	1

Method: 7470A - Mercury (CVAA) - STLC Citrate

Analyte	Result	Qualifier	RL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.0025	mg/L		08/31/22 15:55	09/01/22 13:14	1

General Chemistry

Analyte	Result	Qualifier	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH	8.2	HF	0.1	SU			08/31/22 11:23	1

Client Sample ID: 20045

Lab Sample ID: 570-108005-2

**Client Sample ID: 20045**

Date Collected: 08/29/22 10:45

Date Received: 08/29/22 18:10

**Lab Sample ID: 570-108005-2**

Matrix: Water

**Method: 6010B - Metals (ICP) - STLC Citrate**

Analyte	Result	Qualifier	RL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		2.0	mg/L		09/01/22 09:12	09/01/22 09:50	1
Selenium	ND		1.0	mg/L		09/01/22 09:12	09/01/22 09:50	1
Molybdenum	ND		1.0	mg/L		09/01/22 09:12	09/01/22 09:50	1
Lead	ND		1.0	mg/L		09/01/22 09:12	09/01/22 09:50	1
Zinc	ND		5.0	mg/L		09/01/22 09:12	09/01/22 09:50	1
Vanadium	ND		0.20	mg/L		09/01/22 09:12	09/01/22 09:50	1
Thallium	ND		1.0	mg/L		09/01/22 09:12	09/01/22 09:50	1
Nickel	ND		1.0	mg/L		09/01/22 09:12	09/01/22 09:50	1
Copper	3.0		1.0	mg/L		09/01/22 09:12	09/01/22 09:50	1
Cobalt	ND		1.0	mg/L		09/01/22 09:12	09/01/22 09:50	1
Chromium	ND		1.0	mg/L		09/01/22 09:12	09/01/22 09:50	1
Cadmium	ND		0.20	mg/L		09/01/22 09:12	09/01/22 09:50	1
Beryllium	ND		0.20	mg/L		09/01/22 09:12	09/01/22 09:50	1
Barium	ND		0.20	mg/L		09/01/22 09:12	09/01/22 09:50	1
Arsenic	ND		2.0	mg/L		09/01/22 09:12	09/01/22 09:50	1
Silver	ND		0.20	mg/L		09/01/22 09:12	09/01/22 09:50	1

**Method: 7470A - Mercury (CVAA) - STLC Citrate**

Analyte	Result	Qualifier	RL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.0025	mg/L		08/31/22 15:55	09/01/22 13:20	1

Eurofins Calscience



# Disposal procedures for batteries

- ❑ After battery no longer poses a fire hazard and when ready for disposal, do the following:
  - ❑ At Residence: Provide resident contact information for their local Household Hazardous Waste program to determine requirements for acceptance. Provide guidance to ensure safety during transportation (background temperature, Properly sealed container for waste with liquids, lid ajar if transporting solids only). The haulers list also includes HHW contacts. Let them know that if HHW does not take it, they will need to contact a private hazardous waste hauler, may want to talk to their insurance provider.
  - ❑ At Business: Provide business the hazardous waste haulers list and provide proper disposal guidance. Refer to DEHQ for follow-up.

# Batteries taken off site for safety reasons

(congratulations you likely now own them):

- 1) Check the temperature with TIC.
- 2) When waste is at ambient temperature and ready for disposal, pH the saltwater.
- 3) Contact hazardous waste hauler or battery recycler, provide photos and documentation on temperature/pH to determine if waste can be taken as is with saltwater solution and battery(s). If they can take it, go to step 5.
- 4) If waste hauler/recycler cannot accept batteries in water and pH is between 5 and 12.5, the waste is sewerable pending no EPA regulated heavy metals present (consult DEHQ). Previous incidents by EPA and DEHQ have determined this is not a corrosive waste or toxic due to regulated heavy metals.
- 5) Take photos and send documentation information to your recycler/hauler for disposal/recycling.

# Need Help?

- If you need additional assistance, you can contact a DTSC Duty Officer at 916-255-6504 or (800) 260-3972 during work hours or afterhours via CalOES Warning Center at 800-852-7550
- If the incident is large you can also contact Fed EPA Duty Officer at 800-300-2193

# Another Option- DOT Special Permit containers



The kit includes individual packaging for the battery, a drum liner, cell block, stickers and instructions with the containers





## □ SOG- Fire Damaged or Reacting Lithium ion Battery Management

- Refer to Departmental SOGs for suppression and extermination of fire.
- If battery can be determined something other than Lithium Ion battery can be packaged in a suitable container, neutralized if needed, and left to cool. Give guidance for disposal of such battery such as HHW or recyclers. This document is for Lithium ion batts

### **Incident considerations** for batteries should include the following:

1. Don proper PPE- Fire Turnouts with SCBA for suppression. Other PPE to be considered as needed.
  2. Prepare monitoring equipment- TIC for reaction temps, CGI for H<sub>2</sub>, pH paper for HCl or sulfuric acid, FI paper for HF. For smoke consider also RAE for Cl<sub>2</sub> vapors, RAE or Draeger for HCl vapors
  3. Other Equipment needed- Battery removal tools, Bucket/Drum, Salt and water
  4. Mix Solid salt (*e.g.* Morton's) into container for 0.5% NaCl solution as follows:
    - 4 ounces for 5 gallons,
    - 1 lb for 25 gallons water (need space for batteries)
    - 2 pound for 50 gallons water
  1. If possible, Disconnect the battery and Remove the battery from the equipment/device.
  2. Take photos of the battery condition.
  3. Place the battery in the 0.5% NaCl water away from combustibles, see below. Keep **lid ajar** or bung open and place in safe area away from combustibles and ignition sources.
  4. Check temperature with TIC, mark date/time and temp on the container. Let battery sit for minimum 24 hours, per EPA recommended time is 3 days to 3 months.
  5. Determine safe location for battery(s) to remain secured away from combustibles and ignition sources. If no safe location is available on site consider use of Hazardous Waste Transporter variance for legal transport to offsite location. The waste accumulation site should be a unified program permitted facility. A temporary site could include a facility such as a landfill or bomb range where there is ample space and area is controlled.
  6. Provide responsible party with hauler list and provide disposal guidance.
- (SDFD only procedure): For residential related incidents in the City of San Diego, **after incident stabilization, buckets with batteries will be turned over to responsible party for disposal with safe handling instructions and recommended website links for disposal assistance. If determined not safe to remain on site by Hazmat Captain (no responsible party, no suitable location for overnight storage, concern over tampering with waste, any other public safety concern), the waste will be transported back to Station 45 for continued monitoring and disposal. *Refer to ERT, Hazardous waste variance and DOT transport requirements.***



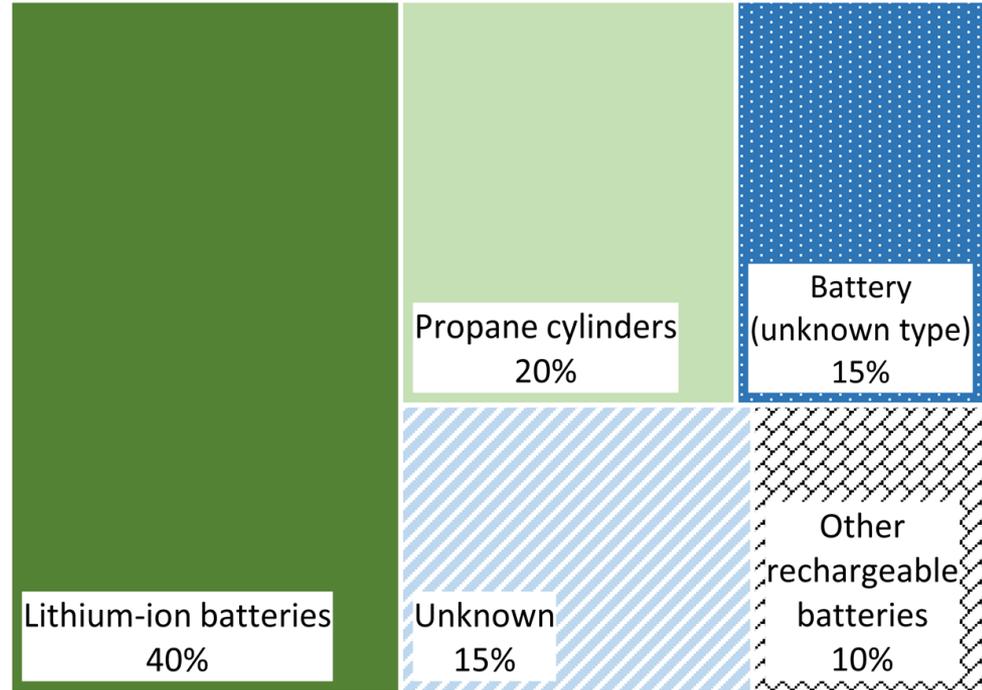
## Waste Management Fires



# Disposal Challenge

- Trash trucks/recycling facilities

## Sources of Fires at Waste Management Facilities





# What Can We Do?



# Recommendations

- Public Education
- Develop an improved waste stream process and access for citizens
  - Not only regular Lithium-Ion recycling but DAMAGED battery recycling
- Recommend regulations and code updates
- What is industry doing to ensure proper disposal and recycling?

# FAQ

- Why is this problem coming up now? Haven't they been around for a while?
- What extinguishers should we have on hand for LIB?
- What are the residential disposal options for LIB?
  - [www.call2recycle.org](http://www.call2recycle.org)?
  - Is this enough? Damaged? Cost prohibitive?
- How does SDFD Hazmat handle damaged batteries?
- What is the runoff concern when fighting a LIB fire?

# Want More on Lithium Ion Batteries?

- Don't Miss: Building the Plane as We Fly It
- Wednesday 1-2:45 pm
- Bobby Salveson, IEC & NYFD

# THANK YOU!

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MUCH MORE TO COME ON THIS!

STAY SAFE!!

# THC Extraction- Trending

- From Butane to Hexane
- From Heptane to Hydrogenation
- Alcohol processing



# Butane- January 2023 San Francisco



# 2019 THC Extraction Lab Fire/Explosion

## 920 El Cajon BLVD, EL CAJON, CA 92020

On 5/16/19 at 10:00 PM HIRT responded to a BHO Lab located at 920 El Cajon Blvd El Cajon, 92020. The lab was discovered by El Cajon Fire during a structure fire. A burn victim was transported to the hospital after being picked up at Walmart. Scott Rosecrans was diverted to the hospital and interviewed the victim who claimed he was just working with gasoline. HIRT cleared the building after the fire was put out, sampled, and identified materials. The lab was large using a bubbler bag ether extraction method. NTF took control of the scene after obtaining a warrant and posted a police officer for security until the site can be processed for evidence and hazardous waste removal this morning. Daytime HIRT to return to the site to assist while NTF processes the site. There was no media observed, however it seems likely they were not there.

05.17.19 DEH HIRT responded back out to this location to assess the hazardous waste for removal. This process is using mesh bags to soak the marijuana in hexane that will remove the THC from the plant and then it was cooked down to recapture the hexane and remove it from the product. DEH HIRT conducted area monitoring in the and found it safe to process the evidence, except the pile of marijuana did have some trapped solvent residues giving about 6% Lower Explosive Limit on our 4-Gas meter. This material was moved outside to ventilate. On scene there were 33 x 55 gallon drums there were assessed by DEH HIRT. The drums were surveyed with a combustible gas indicator and infrared analysis.

<https://www.youtube.com/watch?v=SNvObB0H9Eo>





<https://www.youtube.com/watch?v=nMOuCdWvbrl>



42 3:20

-1  
13:25  
16:00

19.13

22-09

1.06

4.00

7:00

10:00

13:15

16:40

20:00

23:00

2.00

5:00

8:30

11:25

14:25

12:35

20:26

23:26

2.10

4.55

7:30

10:20

13:10

16:00

19:00

22:00

25:00

28:00

31:00

34:00

37:00

40:00

43:00

46:00

49:00

52:00

55:00

58:00

61:00

64:00

67:00

70:00



Drum 1-8 Hexane 100% Lower Explosion Limit (LEL)

Drum 9-14 Empty with residual hexane 100% LEL

Drum 15 Solids 100% LEL

Drum 16-19 Empty

Drum 20 1/2 solids 4% LEL

Drum 21 Empty 0% LEL

Drum 22, 1/2 Full Hexane 100% LEL

Drum 23 1/2/ Full Hexane 75% LEL

Drum 24 1/4 Full Hexane 50% LEL

Drum 25-33 Hexane 100% LEL

Also the distillation apparatus was sampled and it was 100% Hexane in the round bottom flask inside the heating mantle and the receiving flask.

# Hexane Extraction Lab

12/2/2021

These containers held mesh bags  
and/or cannabis



Cannabis  
in mesh  
bags  
ready to  
wash in  
hexane  
drums



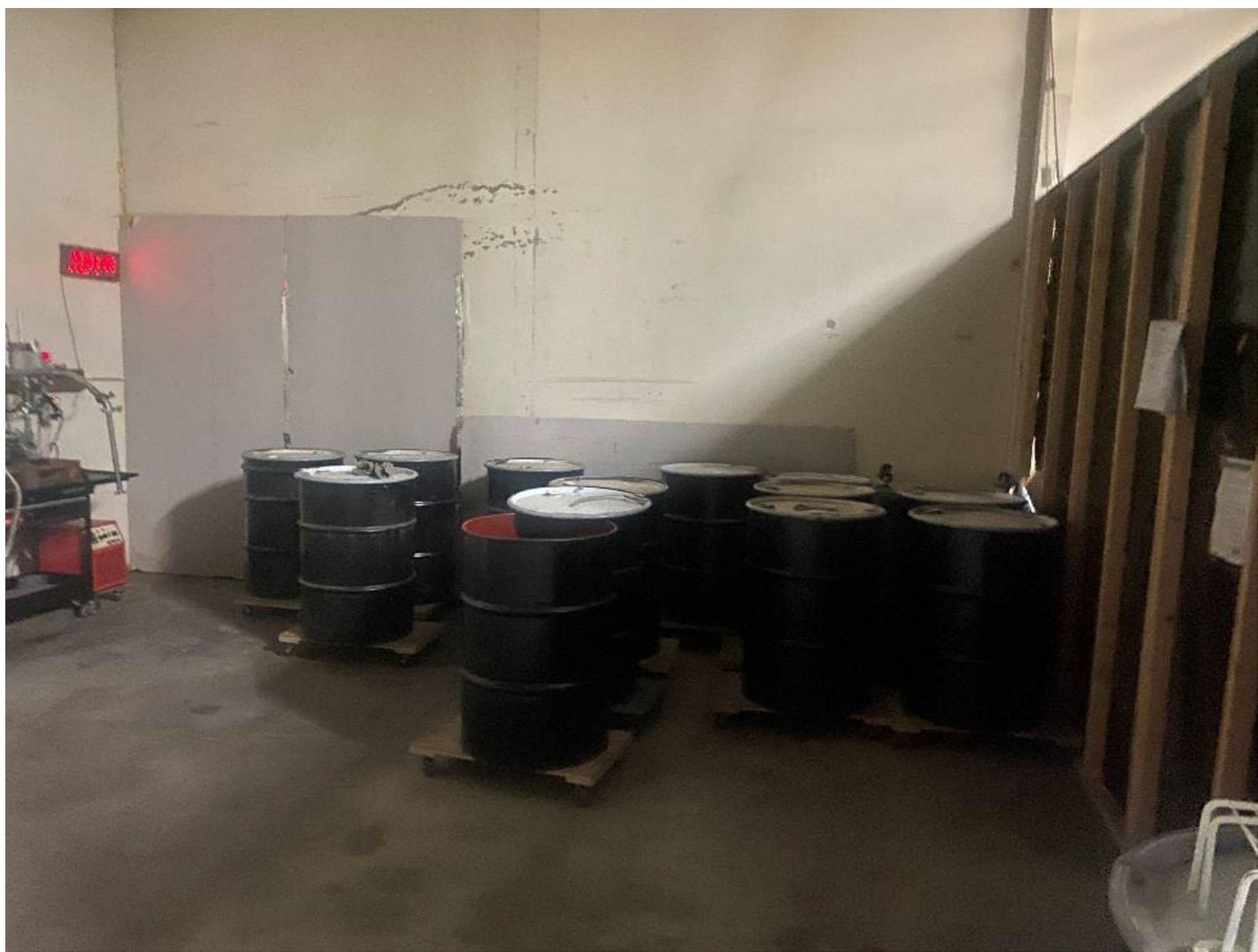
Heater next to bag of spent flammable cannabis waste, fire hazard?



Cannabis waste with hexane, after airing out outside for 2 hours, still at 100% LEL



These are  
55 gallon  
drums used  
to “wash”  
cannabis  
with  
hexane.  
Hexane in  
bottom of  
most drums

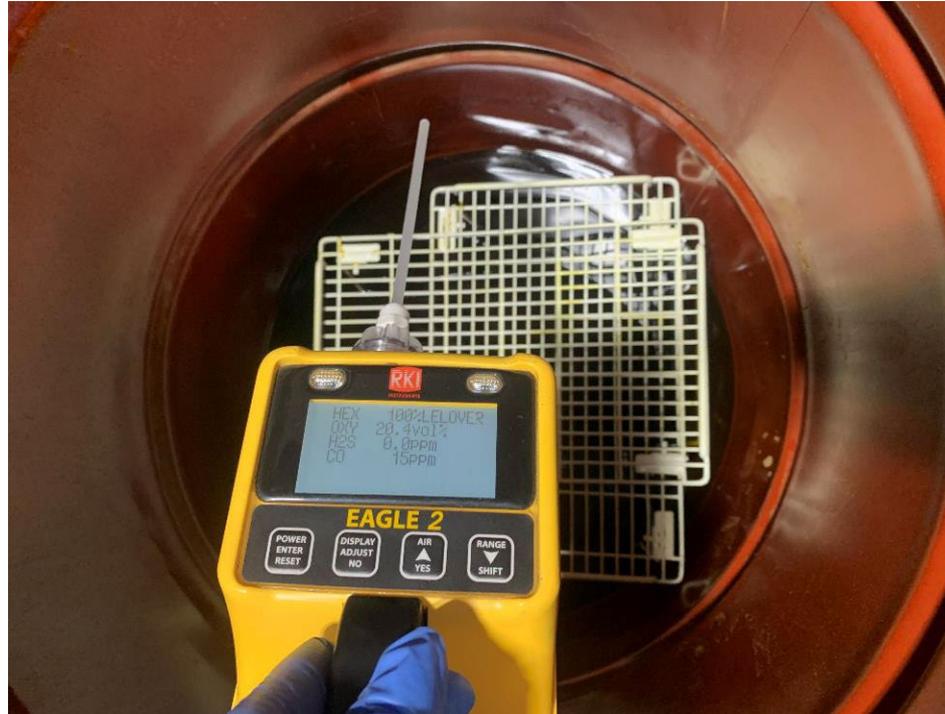


Upon  
removing lid  
on drum, you  
see this mesh  
bag with  
plant  
material



# 100% Lower Explosive Limit (LEL)

A drum after mesh bag with cannabis waste was removed. Hexane is in the bottom few inches.



Hexane  
Transfer  
Device,  
from  
drums into  
portable  
tank, then  
to vessel



# Transfer/Storage vessel for extracted cannabis and hexane



Hexane  
transfer to  
stainless  
vessel, then  
batches  
pumped  
over to  
distillation  
unit



Processing unit in use. Cannabis being condensed on left, hexane evaporated and condensed into vessel on right using elevated temperature and vacuum



The hexane and cannabis extract enter here where hexane is removed, honey oil drained from here.



Finished product comes from here



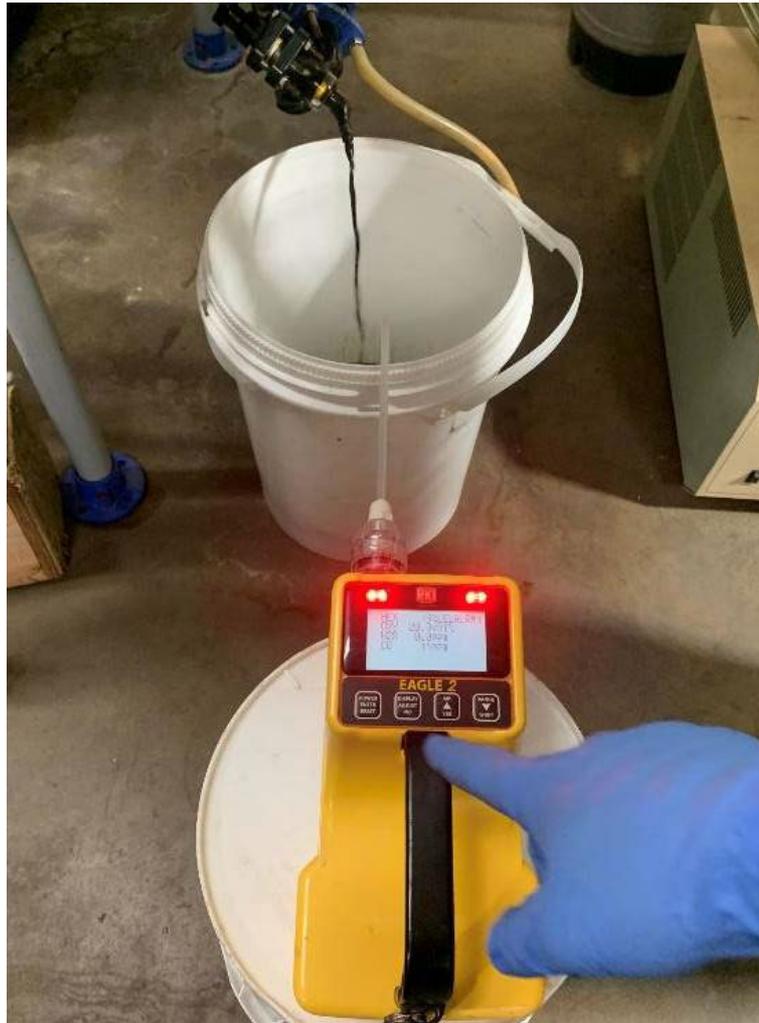
# Infrared spectroscopy unit on reclaimed hexane.

\*

Distillation is a Hazardous Waste treatment process, requires labeling and reporting



100% LEL  
due to  
hexane.



Drained  
product,  
nearly  
finished.  
Honey  
oil



# Spectroscopy identified extract as containing hexanes



# Disposal- DTSC or DEA?

# DEA Felony Case

Form Approved OMB No. 2050-0029

Please print or type.

UNIFORM HAZARDOUS WASTE MANIFEST		1. Generator ID Number <b>CLU000000037</b>	2. Page 1 of <b>1</b>	3. Emergency Response Phone <b>888-423-6060</b>	4. Manifest Tracking Number <b>023444578 JJK</b>
5. Generator's Name and Mailing Address <b>U.S. Department of Justice 1900 E. 1st Street Santa Ana CA 92075</b>					
Attn: <b>Robert Pangellian</b>					
Generator's Site Address (if different than mailing address) <b>1478 Fayette Street El Cajon, ca 92020</b>					
6. Transporter 1 Company Name <b>American Integrated Services, Inc.</b>				U.S. EPA ID Number <b>CAR000148338</b>	
7. Transporter 2 Company Name				U.S. EPA ID Number	
8. Designated Facility Name and Site Address <b>Crosby &amp; Swinton, Inc. 1630 W. 17th Street Long Beach CA 90813</b>					
Facility's Phone: <b>562 430-5445</b>					
U.S. EPA ID Number <b>CAD028409019</b>					
GENERATOR	9a. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No. Type	11. Total Quantity	12. Unit wt./vol.	13. Waste Codes
	1. <b>UN1950, Toxic Aerosols, Flammable, 2.1</b>	<b>001 DM</b>	<b>50</b>	<b>P</b>	<b>214 343</b> D001
	2. <b>NEW RCRA Hazardous Waste, Solid (Lab Debris, PPE)</b>	<b>003 CF</b>	<b>1500</b>	<b>P</b>	<b>181</b>
	3. <b>NEW RCRA Hazardous Waste, Solid (Empty Drums)</b>	<b>007 DM</b>	<b>140</b>	<b>P</b>	<b>512</b>
14. Special Handling Instructions and Additional Information <b>Wear appropriate PPE while handling. Weights or Volumes are approximate.</b> <b>HAZ Projects 41022-07, 963, 962, 961, 960, 959, 958, 957, 956, 955, 954, 953, 952, 951, 950, 949, 948, 947, 946, 945, 944, 943, 942, 941, 940, 939, 938, 937, 936, 935, 934, 933, 932, 931, 930, 929, 928, 927, 926, 925, 924, 923, 922, 921, 920, 919, 918, 917, 916, 915, 914, 913, 912, 911, 910, 909, 908, 907, 906, 905, 904, 903, 902, 901, 900, 899, 898, 897, 896, 895, 894, 893, 892, 891, 890, 889, 888, 887, 886, 885, 884, 883, 882, 881, 880, 879, 878, 877, 876, 875, 874, 873, 872, 871, 870, 869, 868, 867, 866, 865, 864, 863, 862, 861, 860, 859, 858, 857, 856, 855, 854, 853, 852, 851, 850, 849, 848, 847, 846, 845, 844, 843, 842, 841, 840, 839, 838, 837, 836, 835, 834, 833, 832, 831, 830, 829, 828, 827, 826, 825, 824, 823, 822, 821, 820, 819, 818, 817, 816, 815, 814, 813, 812, 811, 810, 809, 808, 807, 806, 805, 804, 803, 802, 801, 800, 799, 798, 797, 796, 795, 794, 793, 792, 791, 790, 789, 788, 787, 786, 785, 784, 783, 782, 781, 780, 779, 778, 777, 776, 775, 774, 773, 772, 771, 770, 769, 768, 767, 766, 765, 764, 763, 762, 761, 760, 759, 758, 757, 756, 755, 754, 753, 752, 751, 750, 749, 748, 747, 746, 745, 744, 743, 742, 741, 740, 739, 738, 737, 736, 735, 734, 733, 732, 731, 730, 729, 728, 727, 726, 725, 724, 723, 722, 721, 720, 719, 718, 717, 716, 715, 714, 713, 712, 711, 710, 709, 708, 707, 706, 705, 704, 703, 702, 701, 700, 699, 698, 697, 696, 695, 694, 693, 692, 691, 690, 689, 688, 687, 686, 685, 684, 683, 682, 681, 680, 679, 678, 677, 676, 675, 674, 673, 672, 671, 670, 669, 668, 667, 666, 665, 664, 663, 662, 661, 660, 659, 658, 657, 656, 655, 654, 653, 652, 651, 650, 649, 648, 647, 646, 645, 644, 643, 642, 641, 640, 639, 638, 637, 636, 635, 634, 633, 632, 631, 630, 629, 628, 627, 626, 625, 624, 623, 622, 621, 620, 619, 618, 617, 616, 615, 614, 613, 612, 611, 610, 609, 608, 607, 606, 605, 604, 603, 602, 601, 600, 599, 598, 597, 596, 595, 594, 593, 592, 591, 590, 589, 588, 587, 586, 585, 584, 583, 582, 581, 580, 579, 578, 577, 576, 575, 574, 573, 572, 571, 570, 569, 568, 567, 566, 565, 564, 563, 562, 561, 560, 559, 558, 557, 556, 555, 554, 553, 552, 551, 550, 549, 548, 547, 546, 545, 544, 543, 542, 541, 540, 539, 538, 537, 536, 535, 534, 533, 532, 531, 530, 529, 528, 527, 526, 525, 524, 523, 522, 521, 520, 519, 518, 517, 516, 515, 514, 513, 512, 511, 510, 509, 508, 507, 506, 505, 504, 503, 502, 501, 500, 499, 498, 497, 496, 495, 494, 493, 492, 491, 490, 489, 488, 487, 486, 485, 484, 483, 482, 481, 480, 479, 478, 477, 476, 475, 474, 473, 472, 471, 470, 469, 468, 467, 466, 465, 464, 463, 462, 461, 460, 459, 458, 457, 456, 455, 454, 453, 452, 451, 450, 449, 448, 447, 446, 445, 444, 443, 442, 441, 440, 439, 438, 437, 436, 435, 434, 433, 432, 431, 430, 429, 428, 427, 426, 425, 424, 423, 422, 421, 420, 419, 418, 417, 416, 415, 414, 413, 412, 411, 410, 409, 408, 407, 406, 405, 404, 403, 402, 401, 400, 399, 398, 397, 396, 395, 394, 393, 392, 391, 390, 389, 388, 387, 386, 385, 384, 383, 382, 381, 380, 379, 378, 377, 376, 375, 374, 373, 372, 371, 370, 369, 368, 367, 366, 365, 364, 363, 362, 361, 360, 359, 358, 357, 356, 355, 354, 353, 352, 351, 350, 349, 348, 347, 346, 345, 344, 343, 342, 341, 340, 339, 338, 337, 336, 335, 334, 333, 332, 331, 330, 329, 328, 327, 326, 325, 324, 323, 322, 321, 320, 319, 318, 317, 316, 315, 314, 313, 312, 311, 310, 309, 308, 307, 306, 305, 304, 303, 302, 301, 300, 299, 298, 297, 296, 295, 294, 293, 292, 291, 290, 289, 288, 287, 286, 285, 284, 283, 282, 281, 280, 279, 278, 277, 276, 275, 274, 273, 272, 271, 270, 269, 268, 267, 266, 265, 264, 263, 262, 261, 260, 259, 258, 257, 256, 255, 254, 253, 252, 251, 250, 249, 248, 247, 246, 245, 244, 243, 242, 241, 240, 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226, 225, 224, 223, 222, 221, 220, 219, 218, 217, 216, 215, 214, 213, 212, 211, 210, 209, 208, 207, 206, 205, 204, 203, 202, 201, 200, 199, 198, 197, 196, 195, 194, 193, 192, 191, 190, 189, 188, 187, 186, 185, 184, 183, 182, 181, 180, 179, 178, 177, 176, 175, 174, 173, 172, 171, 170, 169, 168, 167, 166, 165, 164, 163, 162, 161, 160, 159, 158, 157, 156, 155, 154, 153, 152, 151, 150, 149, 148, 147, 146, 145, 144, 143, 142, 141, 140, 139, 138, 137, 136, 135, 134, 133, 132, 131, 130, 129, 128, 127, 126, 125, 124, 123, 122, 121, 120, 119, 118, 117, 116, 115, 114, 113, 112, 111, 110, 109, 108, 107, 106, 105, 104, 103, 102, 101, 100, 99, 98, 97, 96, 95, 94, 93, 92, 91, 90, 89, 88, 87, 86, 85, 84, 83, 82, 81, 80, 79, 78, 77, 76, 75, 74, 73, 72, 71, 70, 69, 68, 67, 66, 65, 64, 63, 62, 61, 60, 59, 58, 57, 56, 55, 54, 53, 52, 51, 50, 49, 48, 47, 46, 45, 44, 43, 42, 41, 40, 39, 38, 37, 36, 35, 34, 33, 32, 31, 30, 29, 28, 27, 26, 25, 24, 23, 22, 21, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0</b>					
15. GENERATOR/SOFFERER'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/ placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent. I certify that the waste characterization statement identified in 40 CFR 261.27(a) (1) or (2) is for a large quantity generator or (3) (4) is for a small quantity generator (if true).					
Generator/Officer's Printed Name: <b>Greg Mendez</b> Signature: <i>[Signature]</i> Month Day Year: <b>12 13 12</b>					
16. International Shipments <input type="checkbox"/> Import to U.S. <input type="checkbox"/> Export from U.S. Port of entry/exit: _____ Date leaving U.S.: _____					
17. Transporter Acknowledgment of Receipt of Materials					
Transporter 1 Printed Name: <b>Ben Burgos</b> Signature: <i>[Signature]</i> Month Day Year: <b>12 10 12</b>					
Transporter 2 Printed Name: _____ Signature: _____ Month Day Year: _____					
18. Discrepancy <input type="checkbox"/> Quantity <input type="checkbox"/> Type <input type="checkbox"/> Residue <input type="checkbox"/> Partial Rejection <input type="checkbox"/> Full Rejection					
19. Alternate Facility (or Generator) Manifest Reference Number _____ U.S. EPA ID Number _____					
Facility's Phone: _____					
20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18. Printed Name: _____ Signature: _____ Month Day Year: _____					

EPA Form 6700-22 (Rev. 12-17). Previous editions are obsolete.

DESIGNATED FACILITY TO EPA's e-MANIFEST SYSTEM

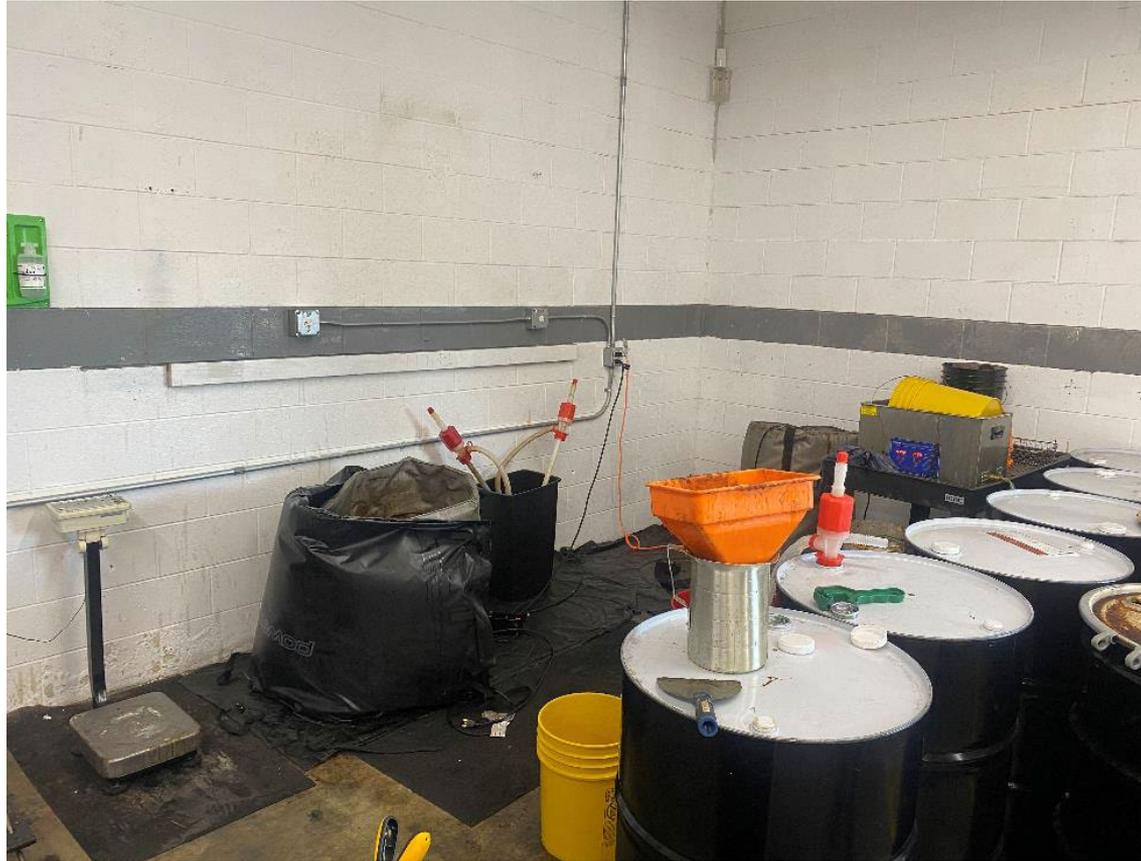
Remedy Processors LLC

Escondido, CA 92025

by Wirschem, Leon

4-19-22

Process begins here with product (hemp or cannabis) and Heptane.



Drums stored here included waste drums, not all labeled, recycled heptane, heptane and ethanol, all exceed disclosure limits



Heptane,  
product  
and acidic  
material go  
in,  
eventually  
mixed with  
basic  
material to  
neutralize



Acidic material used, total quantity not determined



These vessels separate into 2 layers (not shown).  
Top layer gets processed, bottom layer contains  
water and is disposed to sink



# For neutralization



Heptane  
separated at  
the rotovap,  
sent to recycle,  
waste product  
to waste drums



# Rotovap to finish product, or further process



Waste  
containers  
are  
behind  
the  
cardboard  
boxes



Waste containers. These drums appeared full, except for one currently in use. One drum had a hazardous waste label, the others did not.



# Product received in these containers



Funnels  
observed on  
drums for  
used/reused  
or waste.

Pumps  
observed on  
product  
drums

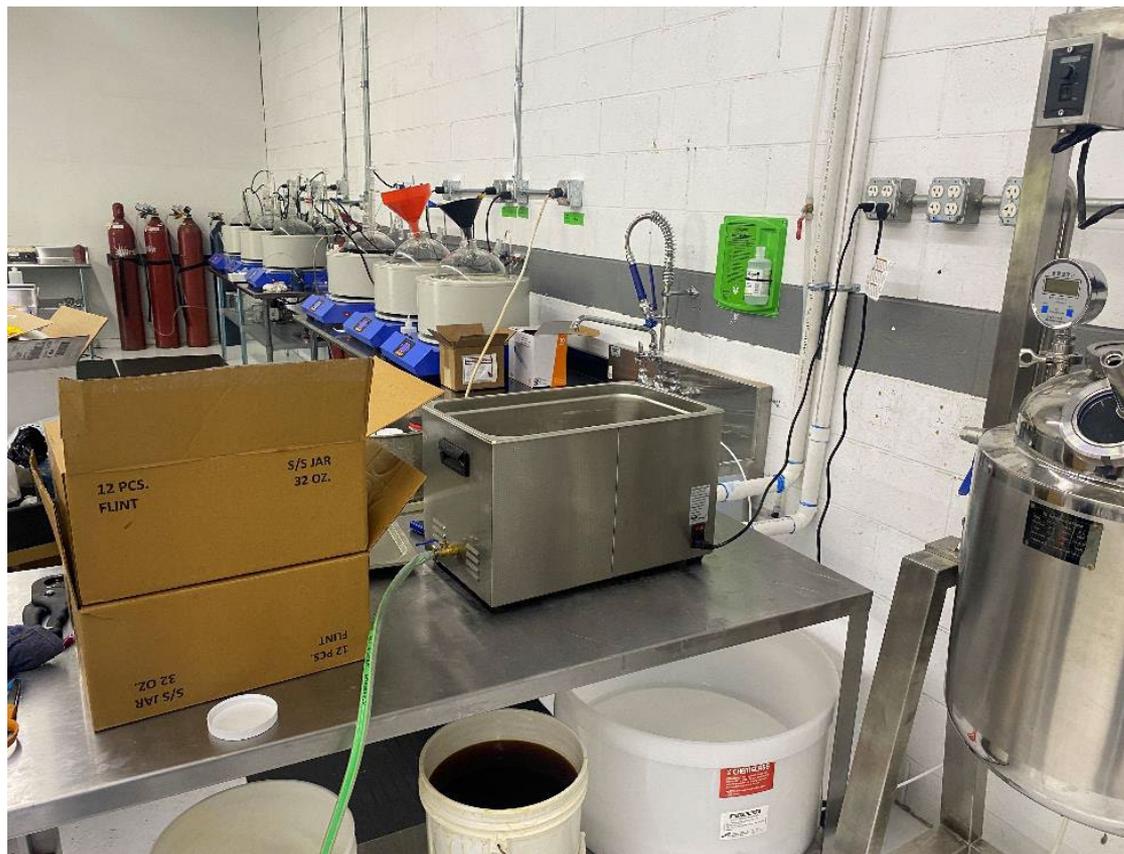


# Processing post heptane rotovap



# Methanol processing line, post heptane rotovap.

## Hydrogen in red cylinders



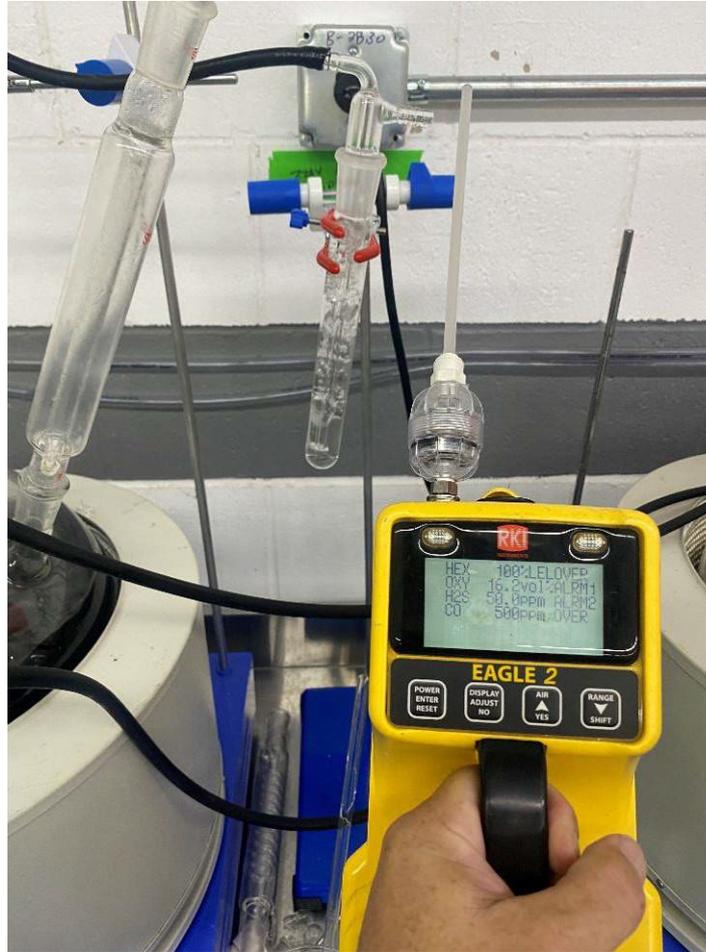
# Methanol drums for additional processing, HHC conversion



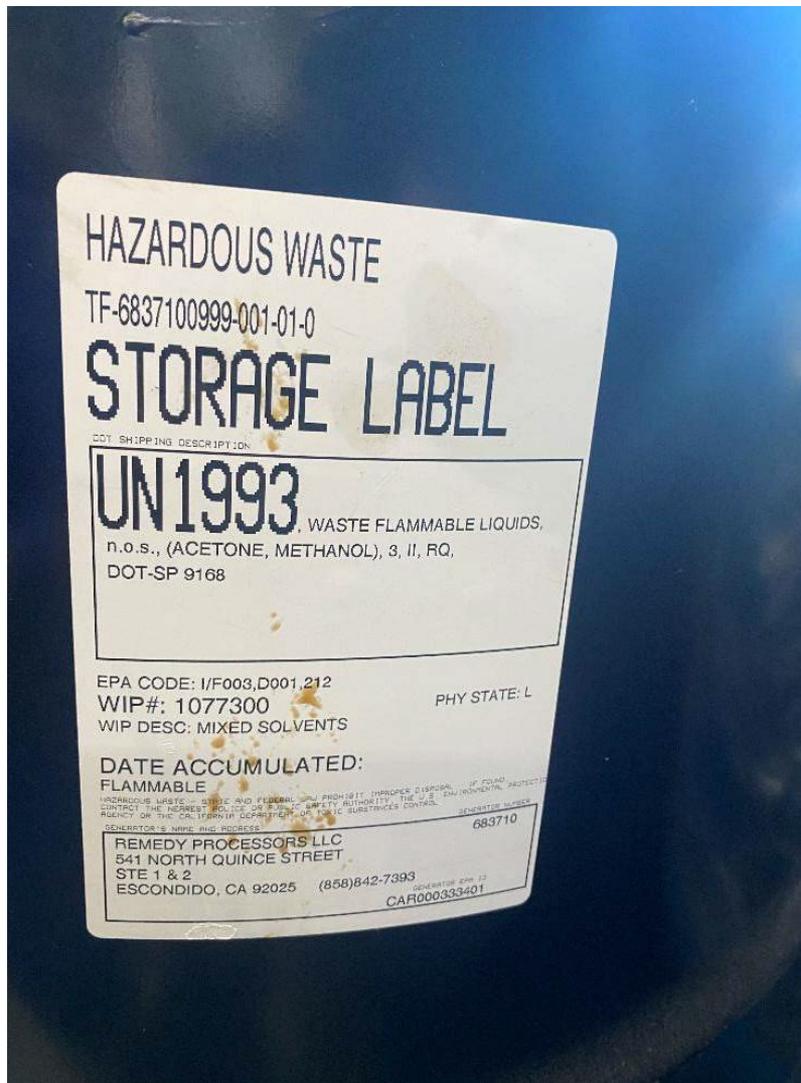
Red cylinders contain hydrogen, bubbled into the methanol solution



The area near this condensate recovery device was 100% the Lower explosive limit. Hydrogen was being put into methanol here.



One of the drums had a hazardous waste label, the others did not.



# Hydrocarbon Processes

Chemical	MW	Physical State	Vapor Pressure mmHg	Flashpoint (F)	IDLH	Ionization Potential (eV)	Flam Range (%)
Propane	44	Gas	6384	-156 F	2100 ppm/ 10% LEL	11.07	2-10 %
n-Butane	58	Gas	1558	-76 F	1600 ppm/ 10% LEL	10.63	1.6-8.4
n-Pentane	72	Liquid	420	-57 F	1500 ppm/ 10% LEL	10.34	1.5-7.8
n-Hexane	86	Liquid	124	-7 F	1100 ppm/ 10% LEL	10.18	1.1-7.5
Heptane	100	Liquid	40	25 F	750 ppm	9.90	1.05-6.7
Ethanol	46	Liquid	44	55 F	3300 ppm/ 10% LEL	10.47	3-19 %
Isopropanol	60	Liquid	33	53 F	2000 ppm/ 10% LEL	10.10	2-13 %

## CCR Title 4, Division 19, Chapter 10: Manufactured Cannabis Safety Definitions

“Volatile solvent” means any solvent that is or produces a flammable gas or vapor that, when present in the air in sufficient quantities, will create explosive or ignitable mixtures. Examples of volatile solvents include, but are not limited to, butane, hexane, and propane.

Cannabis.ca.gov: Type 7: Volatile Solvent Manufacturing includes- Propane, Butane, Hexane, Heptane

# RESPONDER NOTES

- MW corresponds directly to Vapor Pressure and Flashpoint in saturated hydrocarbons
- All of these will flash below room temperature, liquid processes often use heat!
- The primary hazard is fire/explosion, except for Heptane, where the primary hazard is toxicity, but also Fire.
- Alcohols have a wider flammable range than the saturated hydrocarbons.
- Primary monitoring tool for Emergency Responses is a CGI
- Primary PPE is turnouts.
- VOC detector (PID) can be used to see all of these except propane, and limited butane.

# Alcohol Extraction/processing



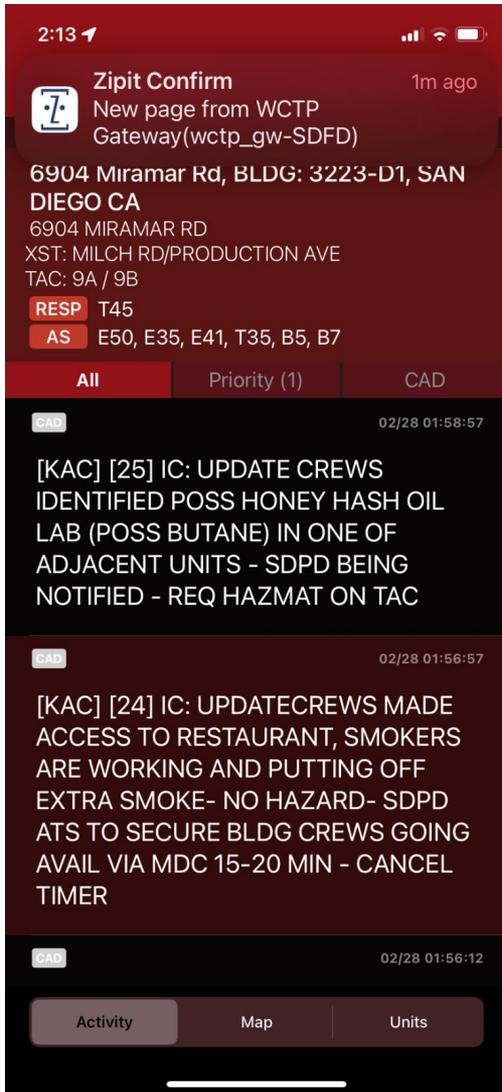


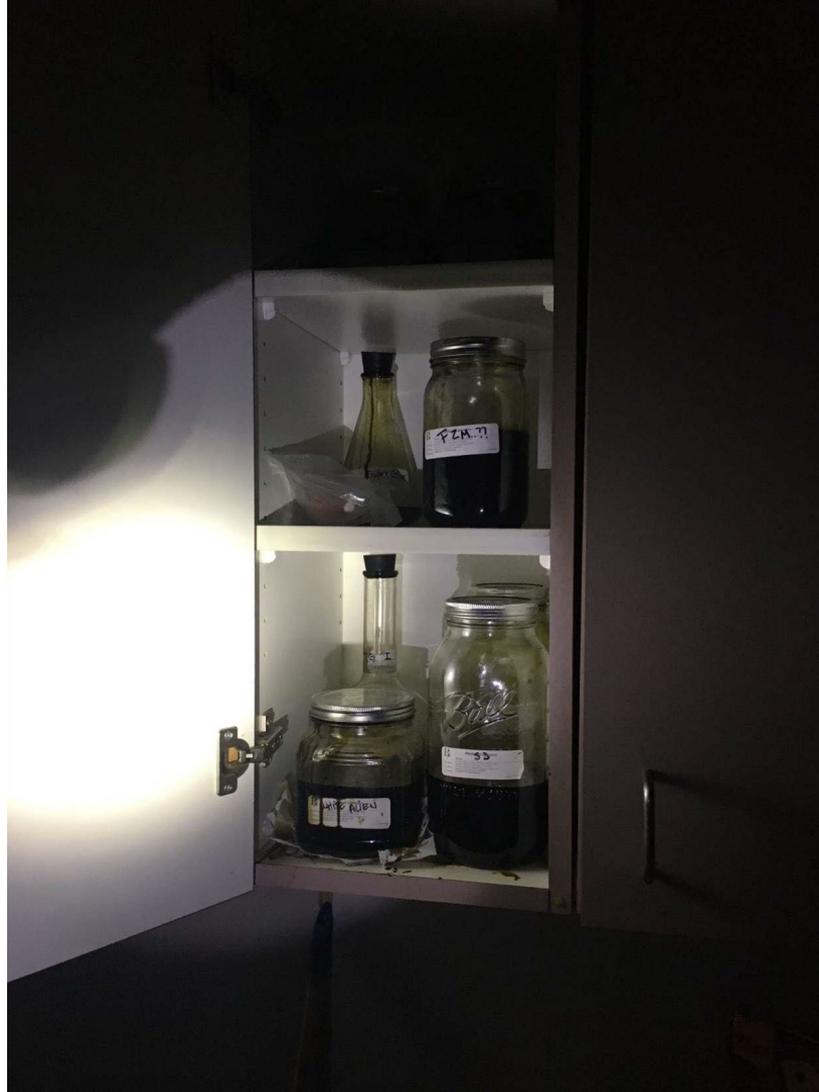
Or, Any Plant  
Material with oils



# Dirty Ethyl 100% LEL







# Follow Up Visit with Fire Marshal

This “lab” is extracting essential oils from Hibiscus here, yields a red color. Moringa yields a green color. CBD Oil also processed here.



While in freezer (-  
38F) the 90%  
alcohol measured  
only 17% LEL  
inside head space







Rotary Evaporation Explained

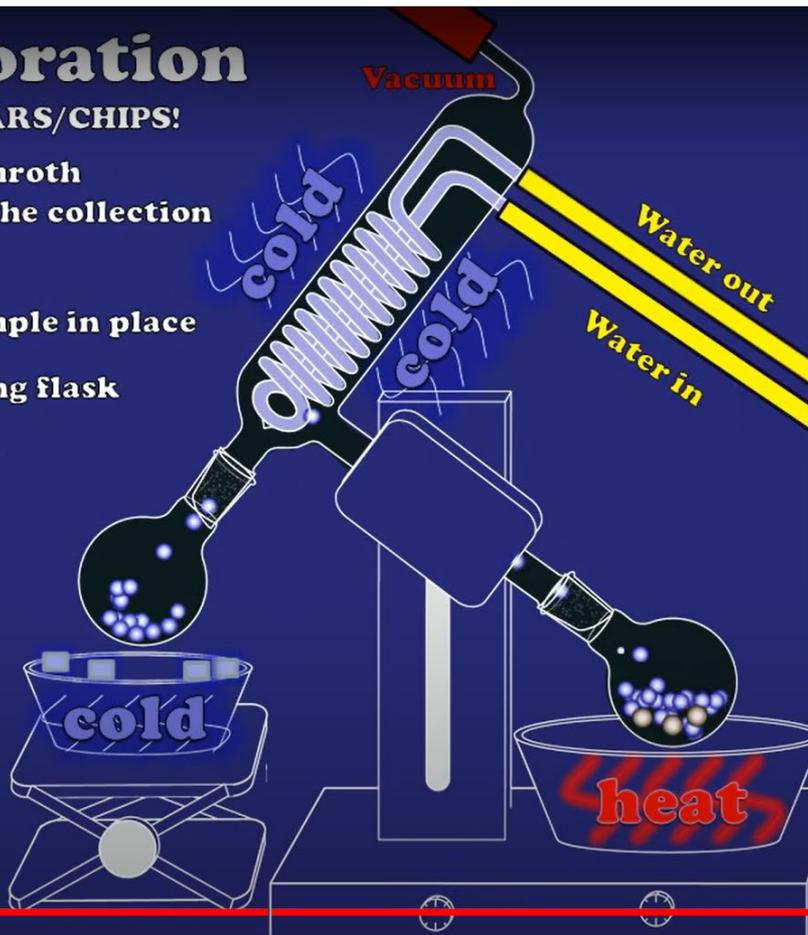
# Rotary Evaporation

**PRE - CHECK - CRACKS/STARS/CHIPS!**

- 1. Run cold water to the Dimroth condenser and add ice to the collection flask bath (if needed)**
- 2. Clip boiling flask with sample in place**
- 3a. Commence rotation boiling flask**
- 3b. SLOWLY evacuate system**
- 4. Apply heat via the warm water bath**

**5. Enjoy the magic of rotary evaporation!!!**

-  = volatile solvent
-  = non volatile solute



<https://youtu.be/hf6nPZjOTXo> credit: [ChemSurvival](#)- subscribe on youtube



# Any Questions?

[Rob Rezende: rrezende@san Diego.gov](mailto:rrezende@san Diego.gov) / 858-442-2695

[Leon.Wirschem@sdcounty.ca.gov](mailto:Leon.Wirschem@sdcounty.ca.gov), 858-888-0610,





# LUNCH TIME!

