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ESD/Green Life Group/309
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Subject: Expert Opinion on the Safe Implementation of "GREEN UP FOG" in Neutralizing Explosive Environment within Large Fuel Tanks

References:

1) IEC 60079-2011: Explosive Atmospheres: General requirements (Also Israel Institute Standard 60079-2011)
2) NFPA 497-2004: Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas
3) Atex 137: Explosive Atmospheres

1) General

To cleanup fuel sludge in large fuel tanks it is imperative to begin the operation in neutralizing the existing explosive environment within the tank by utilizing the agent "GREEN UP FOG" that increases considerably the minimum ignition energy and the temperature flesh point of the explosive gas and also diminishes the strong odor of the gas.

Following the completion of the neutralizing process the sludge cleaning can be safely commence.

Neutralizing of the explosive atmosphere and diminishing of the fuel stench is obtained by spraying the agent known as "GREEN UP FOG" (See safety related details in Appendix B) as depicted in photo 1.

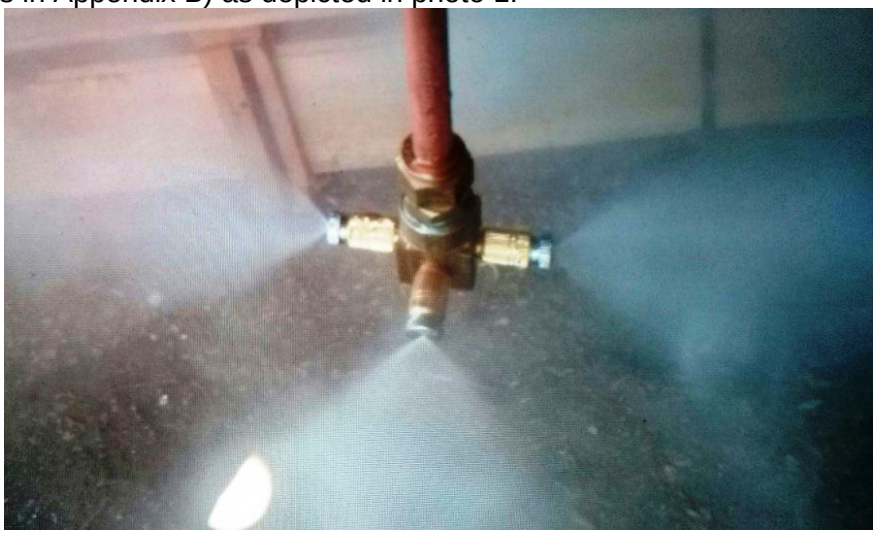

Photo 1: "GREEN UP FOG" spraying in a fuel tank

Method

- Between six to eight spraying units (as shown in photo 1) are placed inside the tank through the floating tank's manholes located on the floating roof.
- All units are well interconnected to earth ground.
- The neutralizing process requires continuous fogging operation between 24-36 hours.
- Each unit is connected to high pressure delivery pump. The pumps are deployed outside the tank structure and are grounded.
- Each unit spraying nuzzle emits between 10-20 liter per hour of neutralizing agent.
- Each unit containing 5 spraying nuzzles emits between 50-100 liter/hour of neutralizing agent.
- The number of spraying units is selected in accordance with the dimensions of the tank and the available manholes on the roof.
- There are several types of spraying nuzzles in accordance with the required spraying range.

Fogging process outcomes

- Gas temperature flesh point is increased to 80-90 ˚C
- Strong fuel odor is neutralized
- Tank manholes can be opened for tank cleaning commence.

During the fuel sludge cleanup the fogging process must continue to ensure efficient neutralizing of the potentially emission of explosive gas from the sludge.

Figure 1 shows a fuel tank with a floating roof, explosive gas within the tank ullage and the sludge in the bottom of the tank.

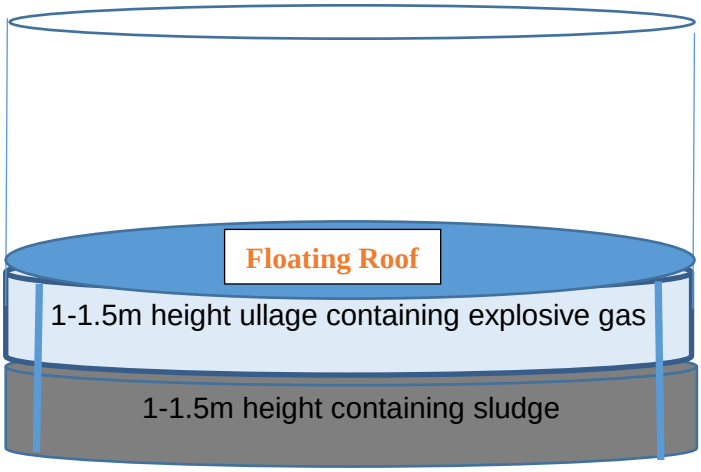

Figure 1: Floating Roof Tank layout

2. Purpose

The purpose of this discussion is to determine that the fuel tank fogging operation does not create a lightning-like threat due to static generation of the agent spraying and the charged up mist with static electricity. Also to define that the fogging operation is reducing the flammable zone from Zone 0 to unclassified zone.

Note that according to Ref. 1-3, flammable gas and vapors are defined as potentially creating "flammable/explosive environment" if the flash point temperature is less than 55^{o}C and minimum ignition energy is less than 5mJ.

3. Lightning like ESD

In principle, lightning like discharges can occur within dust/mist clouds or from dust clouds to earth when the field strength due to the charged particles is high enough. Such lightning like discharges have been observed in large ash clouds during the eruption of volcanoes. They are obviously capable of igniting flammable dusts/mists, but they have never been observed in dust/mist clouds of the size encountered in industrial operations.

According to experimental investigations such discharges are unlikely to occur in silos and tanks of volume less than 60 m^3 or in silos of diameter less than 3 m and of any height. Those dimensions are not necessarily the upper safe limits, they are based solely on the size of the equipment in the above mentioned investigations.

Such discharges are unlikely to occur in larger silos or tanks providing that field strengths remain below 500 kV/m.

The movement of pure gases or of a mixture of gases generates little, if any, static electricity but if the gases contain solid or liquid particles these can become charged. In industrial processes such particles are common. They can be due to contamination, such as dust or water droplets, they can be a condensed phase of the gas itself, such as carbon dioxide snow, or the droplets in wet steam, or they can be deliberately introduced, e.g. spraying "GREEN UP FOG".

Examples of processes where particle charging can give rise to significant amounts of electrostatic charging include: pneumatic transfer of materials; the escape or release of any compressed gas containing particles; the release of liquefied carbon dioxide; the use of industrial vacuum cleaners; and spray painting and fogging.

Charged particles produced by these mechanisms can give rise to a number of types of incendive discharges: spark discharges can occur when charge builds up on insulated conductors as a result of impingement or collection of particles; brush

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discharges can occur when charged clouds or jets of charged particles are close to earthed metal projections; propagating brush discharges can occur due to charged particles impinging on thin layers of non-conductive material; and cone discharges can occur when charged particles collect and form a cone, as in a silo. There is no evidence to suggest that lightning-like discharges can occur in industrial scale equipment.

It is not possible to prevent the electrostatic charging of particles but ignition can be avoided either by ensuring that the atmosphere is not flammable or by preventing incendive discharges. The precautions that can be taken to avoid incendive discharges include the following:

- Ensuring that all metal and other conducting objects are earthed;
- Avoiding the use of highly non-conductive materials;
- Reducing charge densities by restricting flow velocities or by suitable nozzle design;
- Removing the particles.

4. "GREEN UP FOG" Spraying Safety

The spraying operation within the tank begins within Zone 0 explosive atmosphere. It gradually diminishes the flammability nature of the fuel mist and gas. At the process end the flammable environment classification of the tank ullage per references 1-3 becomes "nonhazardous, unclassified zone". The mist generated by the spraying of the "Green up Fog" might become charged up with static electricity. Nevertheless it is incapable to create an incendive discharge as discussed above and herein:

- All metal and other conducting objects are earthed;
- Highly non-conductive materials do not exist inside the tank;
- Reducing charge densities by restricting flow velocities or by suitable nozzle design – Not relevant for the fogging process (relevant for transfer of liquids and bulk powder). The spraying nuzzle design reduces the amount of static charge generation.
- Removing the particles – Not relevant for the fogging process (relevant for solid particles)

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5. Conclusions

At the end of the fogging process the gas temperature flesh point is increased to 80-90 ˚C and MIE becomes much greater than 5mJ (no available information of the actual MIE). Therefore, the gas environment mixed with the "Green up Fog" agent becomes non-flammable in accordance with References 1-3.

Since the only theoretical ESD threat is lightning like discharge from the charged up mist particles it is certain that such discharge can't occur in the volume and characteristics of the Fuel Tank (see Section 3 above).

The conclusion is therefore obvious – the use of "Green up Fog" is safe for the purpose of neutralizing the odor and gas flammability prior and during cleanup of the fuel sludge in large fuel tanks with floating roofs.

Cordially,

Moshe Z. Netzer
ESD Reliability and Safety Expert

Appendix A: Excerpts from ATEX 137

HAZARDOUS AREA CLASSIFICATION

ATEX 137 specifies a particular organisational measure for the control of hazards associated with explosive atmospheres, that of Articles 7 and 8 and the associated Appendix 1. "Explosive atmospheres" are defined as mixtures, under atmospheric conditions, of air and one or more dangerous substances in the form of gases, vapours, mists or dusts in which, after ignition occurs, combustion spreads to the entire unburned mixture.

This definition ensures that most gas, vapour and dust explosions are covered by the ATEX 137 Directive, but some are excluded: initial pressure or temperature outside the normal "atmospheric" range and mixtures that contain more or less oxygen than normal air.

The requirements of Articles 7 and 8, specific to explosive atmospheres, are:

1. To carry out a Hazardous Area Classification;
2. To select equipment and protective systems for use in hazardous areas on the basis of the equipment groups and categories defined in the ATEX 100a Directive;
3. Where necessary to mark hazardous areas at their point of entry using a prescribed "EX" sign;
4. Before a workplace containing hazardous areas is used for the first time, to verify its overall explosion safety by a person competent in the field of explosion protection.

WHAT IS HAZARDOUS AREA CLASSIFICATION?

Hazardous Area Classification (HAC) or zoning identifies places where explosive atmospheres may occur in such quantities as to require special precautions to protect the health and safety of workers. These places are then classified in zones on the basis of the frequency and duration of an explosive atmosphere. This means that a "non-hazardous" area may contain an explosive atmosphere, but either too infrequent or too small to warrant special measures to protect people.

Three zones have been defined for gases, vapours and mists, as has been the case for many years. However, ATEX 137 now also defines three zones for dust. The definitions of gas zones and dust zones are identical with regard to the frequency of the explosive atmospheres, as can be seen when combining the definitions:

- **Zone 0 (for gases, vapours and mists) or Zone 20 (for dusts)**

  A place in which an explosive atmosphere is present continuously or for long periods or frequently.

- **Zone 1 (gas) or Zone 21 (dust)**

  A place in which an explosive atmosphere is likely to occur in normal operation occasionally.

- **Zone 2 (gas) or Zone 22 (dust)**

  A place in which an explosive atmosphere is not likely to occur in normal operation but, if it occurs, will persist for a short period only.

Appendix B: MSDS: Green up Fog

1. GENERAL

1.1 Product name: GREEN UP FOG

Company name: GREEN LIFE GROUP Ltd

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses of the substance/mixture: Washing and cleaning products (including solvent based products)

Not recommended uses of the substance/mixture: Uses other than the uses identified above.

1.3 Details of the supplier of the Safety Data Sheet: GREEN LIFE GROUP Ltd

3 Hapirion St., Ashdod

P.B. 12644 Ashdod Israel 77520

www.egreen up.com Email: grnlf01@walla.co.il

Tel: 972-8-8565648 Fax: 972-8-8565645

2. HAZARDS IDENTIFICATION

Main hazards:

Contains no hazardous components

R36/38: Irritating to eyes and skin

Accident of leakage, rinse with plenty of water

P statements:

P statements:

P264+ P280 - Wash...thoroughly after handling

P302+P353 - IF ON SKIN: Wash with plenty of soap and water.

P321 - Specific treatment (see on package label).

P332+P313 - If skin irritation occurs: Get medical advice/attention.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Hazardous ingredients: Blend of surfactants from natural sources, sequestrants, silicates and natural solvent carrier. Mixed with non-toxic components

Preparation/Mixture Description: Aqueous solution

Component	CAS number
Alkyl polyglycoside	110615-47-9
(2-methoxymethylethoxy)propanol	34590-94-8
Sorbitan monolaurate, ethoxylated	9005-64-5
Oleic acid	112-80-1
Sodium hydrogensulfite	7631-90-5
Xanthan gum	11138-66-2
Sodium Carbonate	497-19=8

Additional Information:

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in section 8.

See section 16 for the full text of the H-statements and R-phrases declared above.

4. FIRST AID MEASURES (SYMPTOMS)

Skin contact: There may be mild irritation at the site of contact.

To remove the material from skin, use water.

Eye contact: There may be mild irritation and redness.

Ingestion: No significant hazard. No specific first aid measures are required.
Do not apply (chemical) neutralizing agents.

Inhalation: No significant hazard. No specific first aid measures are required.
Do not apply (chemical) neutralizing agents.

FIRST AID MEASURES (ACTION)

Symptoms: No symptoms expected. Seek medical advice if symptoms persist

Skin contact: Wash off with water Seek medical advice if any discomfort persists

Eye contact: Bathe the eye with running water for 10 minutes.

Ingestion: Do not induce vomiting. If conscious, give half litre of water or milk to drink immediately. Seek medical advice if symptoms persist.

Inhalation: No significant hazard

5. FIRE-FIGHTING MEASURES

Nonflammable.

Flash Point (Opened Cup): Not Applicable

No special extinguishing recommendations eyes.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions: Refer to section 8 of SDS for personal protection details.

Environmental precautions: Do not discharge into drains or rivers. Contain the spillage using binding.

Clean-up procedures: Absorb into dry earth or sand. Wash the spillage site with large amounts of water.

7. HANDLING AND STORAGE

Handling requirements: Avoid contact with eyes, and prolonged skin contact.

Storage conditions: Store in cool, well ventilated area.

Keep out reach of children. Avoid frost and high temperatures.

Shelf Life - 3 Years from date of manufacture

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures: No significant hazard

Respiratory protection: No significant hazard

Hand protection: Exercise normal Industrial Hygiene,

Prolonged use of the material is recommended to use rubber gloves

Eye/Face protection: No special eye protection is normally required. Where splashing is possible, wear safety glasses with side shields as a good safety practice. Ensure eye bath is to hand.

Working spraying or splashing, use eye protection.

Skin protection: Avoid prolonged skin contact. No special protective clothing is normally required. Where splashing is possible, select protective clothing depending on operations conducted physical requirements.

Respiratory Protection: No respiratory protection is normally required.

9. PHYSICAL AND CHEMICAL PROPERTIES

State of matter:		liquid
Colour:		Pale coloured liquid
Odour:		Barely perceptible odour
Odour threshold:		not determined
Melting point / range:		no information available
Boiling temperature / range:	>100 °C	
Flash point:	none	
Flammability:		none flammable
Explosion hazard:		non explosive
Self-Ignition temperature:		no information available
Decomposition temperature:		no information available
Oxidizing characteristics:	-	not oxidising
Vapour pressure:		no information available
Relative density:	1.06	
Relative vapour density:		no information available
Speed of vaporization/evaporation rate:		no information available
Solubility in water:		soluble
pH	12	10% dilution @ 25 C
log P O/W (n-octanol / water):		no information available
Viscosity:		no information available

10. STABILITY AND REACTIVITY

Stability: Stable under normal conditions. **Chemical Stability:** This material is considered stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.

Hazardous Decomposition Products: None known (None expected)

11. TOXICOLOGICAL INFORMATION

Information on toxicological effects

Acute toxicity

No data available

Skin corrosion/irritation

No data available

Serious eye damage/eye irritation

No data available

Respiratory or skin sensitisation

No data available

Germ cell mutagenicity

No data available

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

Reproductive toxicity

No data available

Specific target organ toxicity - single exposure

No data available

Specific target organ toxicity - repeated exposure

No data available

Aspiration hazard

No data available

Additional Information

No long-term risks to man are associated with the normal handling and use of this material.

12. ECOLOGICAL INFORMATION

Mobility: Soluble in water.

Persistence and degradability: Biodegradable.

Bio accumulative potential: No bioaccumulation potential.

Other adverse effects: Negligible ecotoxicity.

This material is not expected to be harmful to aquatic organisms.

Bio concentration Factor: No data available.

13. DISPOSAL CONSIDERATIONS

Disposal of packaging: Dispose of as normal industrial waste.

NB: The user's attention is drawn to the possible existence of regional or national regulations regarding disposal.

14. TRANSPORT INFORMATION

ADR / RID

Shipping name: Not Classified

DOT Shipping Description: Not regulated as a hazardous material for transportation.
IMDG / IMO Shipping Description: Not regulated as a hazardous material for transportation.
IATA / ICAO Shipping Description: Not regulated as a hazardous material for transportation.

15. REGULATORY INFORMATION

Risk phrases:
R36/38: Irritating to eyes and skin.
Safety phrases:
S2: Keep out of the reach of children.
S26: In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

P statements:
P264+ P280 - Wash...Thoroughly after handling
P302+P353 - IF ON SKIN: Wash with plenty of soap and water.
P321 - Specific treatment (see on package label).
P332+P313 - If skin irritation occurs: Get medical advice/attention.

Note: The regulatory information given above only indicates the principal regulations specifically applicable to the product described in the safety data sheet. The user's attention is drawn to the possible existence of additional provisions which complete these regulations. Refer to all applicable national, international and local regulations or provisions.

16. OTHER INFORMATION

Other information: The phrases below refer to the raw materials used in the formulation, not the finished product.
The information herein has been compiled from dependable sources and is accurate to the best of Green Life Group knowledge and experience.
Risk phrases used in s.2:
R35: Causes severe burns.
The following documents were referred to in preparing this data sheet.
The Chemicals (Hazard Information and Packaging for Supply) Regulations 2002. No. 1689. Workplace Exposure Limits 2005 (EH40) Control of Substances Hazardous to Health Regulations 2002 (as amended) The Carriage of Dangerous Goods and use of transportable pressure equipment regulations 2004.
Legal disclaimer: The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. This company shall not be held liable for any damage resulting from handling or from contact with the above product.

Appendix C: Moshe Netzer Credentials

CERTIFIED ELECTROMAGNETIC COMPATIBILITY ENGINEER

Certified: March 26, 1990
Certificate Number: EMC-000785-NE
Date of Expiration: May 31, 2017

finds

Moshe Zecharia Netzer

has demonstrated knowledge, proficiency, education and experience in Electromagnetic Compatibility and Electromagnetic Interference, and is hereby certified as a fully qualified Electromagnetic Compatibility Engineer.

Issued in accordance with iNARTE administrative rules and guidelines in accordance with memoranda of agreement and guidelines as prescribed by specified elements of government and industry.

Peter Holtmann, President, Exemplar Global

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