GAIL (India) Limited
Noida

Date: 28.11.2018

Subject: Committee Report on Evaluation of Alternatives of Environment Friendly Fire Suppression Systems

1. Background / Reference:
Vide Note Sheet reference no. GAIL/NOIDA/HSE/18 19, dtd. 27.07.2018, a committee was constituted to study and evaluate new fire suppression systems available worldwide in line with revised PNGRB/ OISD guidelines. The Committee was asked to deliberate the advantages & disadvantages, interact with various manufacturers/distributors and look into the modalities with respect to GAIL’s existing facilities and fire protection systems.

2. Committee Members:
The Committee comprises of the following members:-
Shri D K Sharma, CGM (F&S), Vijaipur
Shri R P Singh, DGM (HSE), Noida
Shri Dinesh Mendhukar, DGM (F&S), Mumbai
Shri Umesh Akote, CM (F&S), Pune
Shri Rajendra P Tathe, CM (F&S), Jamnagar
Shri Prashant Rathor, CM (F&S), NCR

Study Process of Committee:
Different types of Environment friendly fire extinguishing agents available as per NFPA 2001 and NFPA 2010 are as under.

<table>
<thead>
<tr>
<th>Available Chemicals</th>
<th>Chemical Name</th>
<th>Chemical Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>PK-5-1-12</td>
<td>Nonhalo-4-trifluoromethyl-3-pentanone</td>
<td>C₄F₇O</td>
</tr>
<tr>
<td>HCFC Blend A</td>
<td>Dichlorofluorothane</td>
<td>CH₂Cl₂F₂</td>
</tr>
<tr>
<td></td>
<td>Chlorodifluoromethane</td>
<td>CH₂F₂Cl</td>
</tr>
<tr>
<td>HFC 23</td>
<td>Trifluoromethane</td>
<td>CHF₃</td>
</tr>
<tr>
<td>HCFC-124</td>
<td>Chlorotetrafluoroethane</td>
<td>CH₃CF₂Cl</td>
</tr>
<tr>
<td>HFC 125</td>
<td>Pentfluoroethane</td>
<td>CHF₂CF₃</td>
</tr>
<tr>
<td>HFC-227ea</td>
<td>Hexafluoropropene</td>
<td>CF₃C₂H₂F₂</td>
</tr>
<tr>
<td>HFC-236fa</td>
<td>Hexafluoropropane</td>
<td>CF₃CH₂CF₂</td>
</tr>
<tr>
<td>Available Chemicals</td>
<td>Chemical Name</td>
<td>Chemical Formula</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>HFC Blend B</td>
<td>Terafluorohane(85%), Pentafluorohane(9%), Carbon Dioxide (5%)</td>
<td>CH₃, FCF₃, CHF₃, CF₃, CO₂</td>
</tr>
<tr>
<td>IG-01</td>
<td>Argon</td>
<td>Ar</td>
</tr>
<tr>
<td>IG-100</td>
<td>Nitrogen</td>
<td>N₂</td>
</tr>
<tr>
<td>IG-541</td>
<td>Nitrogen (52%), Argon (40%), Carbon dioxide (8%)</td>
<td>N₂, Ar, CO₂</td>
</tr>
<tr>
<td>IG-55</td>
<td>Nitrogen (50%), Argon (30%)</td>
<td>N₂, Ar</td>
</tr>
<tr>
<td></td>
<td>Powdered Aerosol A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Powdered Aerosol C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Powdered Aerosol D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Powdered Aerosol E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Powdered Aerosol F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Powdered Aerosol G</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Dry Sprinkler Powdered Aerosol)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Condensed Aerosol particulates consist of Potassium Carbonate (K₂CO₃) that are produced from the thermal decomposition of a solid aerosol-forming compound that includes potassium nitrate as an oxidizer.</td>
<td></td>
</tr>
</tbody>
</table>

Environmental properties of Environment Friendly Agents are as under:

<table>
<thead>
<tr>
<th>Description</th>
<th>Fluoro Ketone</th>
<th>HFC125</th>
<th>Inert gases</th>
<th>Aerosol</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODP</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Global Warming Potential</td>
<td>1</td>
<td>3500</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Atmospheric lifetime( yrs.)</td>
<td>0.014</td>
<td>29</td>
<td>0</td>
<td>The typical particulate life time is 3-10 days on average</td>
</tr>
</tbody>
</table>

Committee has studied the various alternatives as above. And thus it is observed that keeping in view low ODP and GWP, the above agents can be considered for fire protection as an alternative in various areas of plants, pipelines and offices where it is required to be installed as per the prevailing statutory guidelines and compliances.

Since, GWP of HFCs is much higher than other alternatives, phase out by 2020 and thus have disadvantage over other alternatives as far as environmental regulations are considered. Therefore, Committee is of opinion that HFC based systems shall not be taken for further deliberation and hence ruled out.

3. Site Visit and Deliberations:
In order to deliberate the issue, Committee has collected the details of various systems installed at GAIL locations and committee members interacted with various vendors during committee meeting at Mumbai office. Committee also visited M/s ONGCL office at Mumbai.
to see Aerosol system installed in "11 High office building" and interacted with fire officials. Deliberations with UL representatives were also held for the new advancements and alternatives available as far as environment friendly fire extinguishing systems are considered.

4. Technical Presentations and Demonstration by Vendors:
Technical Presentations were organized at GAIL Mumbai office to know more advancement regarding other environment friendly fire extinguishing system from following vendors:

a) M/s Sure safety, Vadodara
b) M/s Askia, Mumbai
c) M/s Chemours India Pvt. Ltd, Delhi
d) M/s Swastik Energy, Mumbai
e) M/s Cease Fire, Mumbai
f) M/s Rotarex, Mumbai

During their presentation, vendors had shown samples of newly developed fire suppression systems like Aerosol modules, clean agent tube system, clean agent direct/indirect localized system, etc. along with live demo of Aerosol system and Fluorinated Ketone system installed in panels. They had also shown the video of all above said systems.

After going through the presentations given by different vendors for environment friendly fire suppression systems, committee further deliberated and are of the opinion that the Aerosol based systems, Inert gas & Fluorinated Ketone based media are most suitable as far as fire extinguishing systems are concerned.

Committee had gone through all the technical deliberations, live demo, site visit and related standards for above fire suppression system and discussions within the committee members. Considering the applicable NFPA standards, overall applicability, less space required, effective easy installation and less maintenance cost, lead time, the committee has considered following options for environment friendly fire extinguishing systems.

Condensed Aerosol Systems:
- NFPA: 2010-2015 recommends condensed aerosol system as one of the substitutes of HFC based systems, having the ODP & GWP zero.

- Installation/ Maintenance: Aerosol based fire suppression system requires no distribution piping or pressurized vessels for agent. As such maintenance activities are also minimized.

- As per certificate from 'UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C. 20460, Office of Air and Radiation, Dated September 17, 2010, the U.S. Environmental Protection Agency's (EPA) Significant New Alternatives Policy (SNAP) program published a final rule finding Powdered Aerosol D (under the tradenames of Aero-K® and Stat-X®) acceptable, subject to use conditions (for use only in normally unoccupied areas), as a halon 1301 substitute for total flooding fire protection uses.

- Subsequently, As per NFPA federal register of 2016, (Reference-Federal Register / Vol. 81, No. 231 / Thursday, December 1, 2016 / Rules and Regulations 86781), For fire suppression total flooding uses, EPA is clarifying the listing for Powdered
Aerosol D (Stat-X®), which was previously listed as both “acceptable” and “acceptable, subject to use conditions,” by removing the listing as “acceptable, subject to use conditions,” as of January 3, 2017.

- As per UL 2775 standard for safety for Fixed Condensed Aerosol Extinguishing System Units, dated April 3, 2014. UL recommends aerosol for installation of extinguishing systems.
- Formation of BIS standard and DRDO standard on condensed Aerosol system is in developmental phase. However, ISO15779:2011 on condensed Aerosol system is available.
- Condensed Aerosol system in combination with smoke detection & alarm system and can also be integrated with existing Fire Detection and Alarm System.

5. Advantages of Aerosol Based Fire Suppression System as Described by Various Vendors during Technical Presentations:
   - The Condensed Aerosol system does not require any periodic maintenance and checking. However, the system can be checked randomly through dump test.
   - Condensed Aerosol system does not require any space for storing cylinders, piping, moving parts and electro-magnetic parts for installation.
   - Condensed Aerosol system does not require any components to ensure operability, thus maintenance is very low as compared to other conventional fire suppression systems.
   - In case of change of equipment in the area under protection, aerosol system can be easily installed.
   - Condensed Aerosol system does not require any regular Annual Maintenance contract for upkeep and checking of system.
   - Aerosol based system generators can be readily replaced with the available spare stock, in case of system actuation. The lead time to replace generators is minimal.
   - This system is very economical as compared to other conventional fire suppression systems.

6. Deliberations for applicability of Condensed Aerosol Based Fire Extinguishing System in GAIL:

Condensed Aerosol based fire extinguishing system can be installed in pipeline stations containing SV/IPv/TP/terminal/ receipt & dispatch terminals, unmanned/occupied compressors stations control room, where electrical panels and other panels are kept in separate rooms, porta cabins to maintain the pipeline operation requirements. The Condensed Aerosol fire extinguishing system along with fire detection and visual alarm system is recommended for electrical panels, switch gear room, SCADA, and battery room etc. However, it is not intended to replace any total flooding system or fire suppression system installed in line with applicable standards / Regulations.

If required, in case of closed Cable trenches, closed isolated false floor areas in process plants where it is very difficult to install the total flooding system due to space constraints, the localized condensed aerosol fire extinguishing system may also be installed, in line with applicable standards / Regulations.
7. **Deliberations for Applicability of Inert Gas Fire Extinguishing System**:

Fire extinguishing systems with different compositions of inert gas can be used wherever site conditions permit its installation as per NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems, 2018 and applicable OISD guidelines/ Regulations.

Since inert gas is comparatively a high pressure system, this type of system can be installed in process/compressor stations manned/occupied control rooms, UPS room, PLC cabinets, switch gear room, battery room, rack rooms, satellite control room etc.

8. **Deliberations for Applicability of Fluorinated Ketone Based Fire Extinguishing System**:

Fluorinated Ketone based Fire extinguishing systems can be used wherever site conditions permits its installation as per NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems, 2018 and applicable OISD guidelines/ Regulation.

Since, Fluorinated Ketone based clean agent is a comparatively low pressure system, this type of system can be installed in data centres, server room, computer rooms, etc.

Fluorinated Ketone based (Localized Indirect System) Fire extinguishing systems can also be used at pipeline stations containing SVIPTOP/terminal/ Receipt & Dispatch terminals, Compressor Stations control room where electrical panels and other panels are kept in separate rooms, Porta cabins to maintain the pipeline operation requirements. It can also be used in process control room as per the site conditions and applicable standards/ Regulations.

9. **Committee Recommendations**:

In view of above, the committee recommends the following:

1) **Condensed Aerosol Based Fire Extinguishing System** can be installed in pipeline stations containing SVIPTOP/terminal/ Receipt & Dispatch terminals, unmanned/unoccupied compressor stations control room, where electrical panels and other panels are kept in separate rooms, Porta cabins to maintain the pipeline operation requirements. The Condensed Aerosol fire extinguishing system along with fire detection and visual alarm system is recommended for electrical panels, switch gear room, SCADA, and battery room etc. However, it is not intended to replace any total flooding system or fire suppression system installed in line with applicable standards/ Regulations.

   If required, in case of closed Cable trenches, closed isolated false floor areas in process plants where it is very difficult to install the total flooding system due to space constraints, the localized condensed aerosol fire extinguishing system may also be installed in line with applicable standards/ Regulations.

2) **Inert Gas Fire Extinguishing System**, with different compositions of inert gas can be used wherever site conditions permit its installation as per NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems, 2018 and applicable OISD guidelines/ Regulations.

Since, Inert Gas is comparatively a high pressure system, this type of system can be installed in process/compressor stations manned/occupied control rooms, UPS room, PLC etc.
cabinets, switch gear room, battery room, rack rooms, satellite control room etc. in line with applicable standards/Regulations.

3) Fluorinated Ketone Based Fire Extinguishing System can be used wherever site conditions permits its installation as per NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems, 2018 and applicable OISD guidelines/Regulations.

Since, Fluorinated Ketone based clean agent is a comparatively low pressure system, this type of system can be installed in data centres, server room, computer rooms, etc.

4) Fluorinated Ketone Based (Localized Indirect System) Fire Extinguishing Systems can also be used at pipeline stations containing SV/IP/TOP/terminal/Receipt & Dispatch terminals, Compressor Stations control room where electrical panels and other panels are kept in separate rooms, Porta cabins to maintain the pipeline operation requirements. It can also be used in process control room as per the site conditions and applicable standards/Regulations.

Submitted for approval please.

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