400 Series:
Process Safety

EHS Area Classification and Management

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Global Environmental, Health and Safety
Indorama Ventures

Table of Contents

1. Purpose

This standard establishes Indorama Ventures process and minimum requirements for identifying and managing classified areas as required by the appropriate regulatory requirements, national codes, and other Indorama standards and procedures.

2. Scope

This standard applies to all Indorama Ventures owned/operated sites. This standard does not apply to third-party warehouses and tollers . This standard also does not apply to joint ventures (JVs) in which Indorama Ventures is a minority owner, unless specifically requested by the related Segment EHS Leader.

For the purpose of this standard, the term 'EHS' includes process safety, transportation, and security, as well as environmental, health and safety.

This standard must be implemented by each site. Until implementation of this standard is complete, each site must at a minimum be in compliance with the local applicable regulations.

3. Responsibilities

Following is an overview of key responsibilities for this standard. Additional responsibilities, as applicable, are included in Section 4, Requirements.

3.1. Corporate EHS

3.1.1. Provide ongoing technical assistance related to this standard.

3.1.2. Periodically audit sites to determine compliance with this standard.

3.1.3. Review, update and communicate to all Indorama Ventures sites any updates or changes to this standard and associated documents and tools.

3.1.4. Periodically review this standard to ensure its continuing adequacy and suitability to Indorama Ventures operations.

3.1.5. Ensure this standard is consistently implemented from site-to-site within Indorama Ventures.

3.1.6. Communicate, as applicable, any lessons learned as a result of best practices identified or any non-compliances associated with implementation of this standard.

3.2. Site Head or Designee

3.2.1. Ensure implementation of and compliance with this standard including that it is adhered to and that all personnel receive the proper training, resources, and communications.

3.2.2. Assist with the implementation of this standard; in particular:

- Be thoroughly familiar with the requirements of this standard and any associated procedures and work practices.
- Provide support, resources and training needed to carry out the requirements of this standard.
- Ensure required records of study results are maintained on file.
- Ensure compliance with this standard by personnel (as applicable).

3.2.3. Ensure that area classifications are determined and documented for the site by a qualified Area Classification Assignment Leader and updated for any modifications to equipment once initial area classifications are complete .

3.3. Segment EHS

3.3.1. Ensure that any site or local standard or procedure related to the same topic follows the corporate requirements at a minimum.

3.3.2. Support the site on any technical point related to the standard, including implementation.

3.3.3. Periodically evaluate each site's level of compliance with this standard.

3.4. Program Owner

3.4.1. Be thoroughly familiar with the requirements of this standard and local regulatory requirements.

3.4.2. Develop and implement a site-specific program that meets the requirements of this standard and any local/regional regulatory requirements.

3.4.3. Periodically review and monitor for compliance with the requirements of this standard, and per local regulatory requirements, at least every five (5) years.

3.4.4. Develop an action plan to correct any non-conformance with local regulatory or Indorama Ventures requirements.

3.5. Project Managers

3.5.1. Ensure that area classifications are developed or updated for capital projects.

3.6. Area Classification Assignment Leader

3.6.1. Lead the team of competent persons in area classification studies.

3.6.2. Develop and retain documentation required for the determination of the hazard classification status of an area.

3.7. Employees and Contractors

3.7.1. All personnel must understand and follow the requirements of the site-specific program including:

- Being aware of and trained on, as applicable, the legal, regulatory and other associated requirements.
- Immediately reporting any situations that may cause or have a potential to cause a non-compliance.
- Completing any assigned regulatory tasks or actions.
- Being aware of and trained on the process safety information relevant to the process(es) they operate and/or maintain.

3.8. In addition to the roles and responsibilities detailed above, the site-specific program must define and document the roles and responsibilities for all personnel who play a role in implementing the site-specific program, at a minimum:

- Supervisors

- Engineering and Maintenance
- EHS Personnel
- Other applicable functions, as staffed at individual site level

4. Requirements

The site shall develop and implement a written site-specific program which meets local regulatory requirements, and, at a minimum, fulfills the requirements in accordance with this standard.

4.1. An area classification study shall be performed to classify hazardous areas where flammable liquids, gases, vapours, combustible dust or fibre risks may arise, in order to ensure the proper selection and installation of equipment for use in those hazardous areas . Area classification studies will establish the identification and classification of all the materials to be used in the facility by their potential risk to create an explosive atmosphere . Documentation should be in sufficient detail to support the determination of controlled area boundaries.

4.1.1. The electrical equipment does not determine the area classification. This classification is based upon the properties of the flammable vapours, liquids, gases, combustible dusts or fibres along with an assessment of the likelihood that these chemicals may be or are likely to be present in the atmosphere in flammable or combustible concentrations. The properties for gases, vapours and liquids with regard to explosive atmospheres are well documented in a number of international standards (e.g., IEC 60079) . If the operating temperature of a fluid is above the respective flash point of the product, the flammability condition of this product must be evaluated in accordance with local or national regulatory criteria (e.g., NFPA 30 for North America) . In the absence of applicable regulatory criteria, reference the criteria and threshold amounts identified in Section B.3.3.

4.1.2. Generally, area classification in North America is in accordance with NFPA 497, NFPA 499, and Article 500 of the NFPA 70 National Electrical Code (NEC) method, and the rest of the world typically references the International Electrotechnical Commission (IEC) IEC 60079.

4.2. The area classification study shall be performed in accordance with the process and methodologies contained within Attachment B . However, where local codes and regulatory requirements are more stringent, then the facility shall follow the more stringent requirements.

4.3. Area classification studies shall be performed by a team of competent persons and led by an Area Classification Assessment Leader . The area classification team should typically consist of competent persons with expertise in the process, mechanical, operational, electrical, and EHS aspects of the area being evaluated . The personnel may be internal or external resources . One individual may cover multiple roles or disciplines for the purpose of participating in the study . The qualifications of the team members must meet the requirements of any applicable regulations, e.g., OSHA requires the classification of areas and selection of equipment and wiring methods to be done under the supervision of a qualified registered professional engineer.

4.4. The results of the area classification study shall be documented in accordance with Attachment B.

4.5. Actions related to compliance with this standard shall be implemented in accordance with IVL EHS-107, Management of Recommendations/Actions .

4.6. Area classification drawings / maps shall be controlled documents and should be reviewed periodically and managed per the requirements of the IVL EHS-402 Process Safety Information standard .

4.7. All equipment installed in hazardous areas which has been identified as a potential source of ignition shall be field labelled, registered, and assessed to ensure its suitability . The requirement for field labelling of ignition sources may be met by the manufacturers' tags located on the equipment with the

area classification ratings identified. Items such as lighting fixtures, junction boxes, wiring circuits, etc., can be addressed under a general documented specification for the area to which they are installed .

4.8. Unless more stringent local or national regulatory requirements apply, where there is documentation on file as to the suitability of equipment for use in the hazardous area and programs in place to maintain the integrity of this equipment, it is acceptable to register and label only the unique or non-standard ignition sources. Equipment and instrumentation currently assigned unique numbers and managed in accordance with a design specification for service in a hazardous area do not need to be included in the identification of ignition sources, see Attachment C, provided they are already included in an inspection, replacement, and maintenance program.

4.9. All equipment installed in hazardous areas which has been identified as a potential source of ignition shall be included in an inspection, replacement, and maintenance program to ensure the integrity of the equipment .

Such equipment shall be periodically inspected externally to ensure it is not damaged and provides protection against ignition . Internal inspections, by equipment type, are recommended to identify longer term failure mechanisms such as corrosion and seal failures (see IVL EHSG-1408A, IEC 60079-17 or NFPA 70B for further guidance) . These inspections shall be documented, and inspection records are required to be retained for the life of the equipment.

4.10. Within a hazardous (classified) location, the atmosphere around any energized instrument or electrical enclosure shall be checked to see that it is free from concentrations of flammable or combustible materials, before the enclosure is opened.

Note: Issuing a Hot Work Permit is the recommended method for accomplishing this requirement . See IVL EHS-302 Hot Work Standard for additional requirements, as applicable.

4.11. Non-certified devices shall not be taken into classified areas of any Zone (0, 1, 2, 20, 21 or 22) without additional precautions being taken, such as providing continuous gas monitoring. This includes personal devices such as smart watches, fitness monitors, battery banks, cell phones, etc .

4.11.1. As an exception to this requirement, devices containing up to 2 non-rechargeable button cells, such as basic electronic wrist watches, hearing aids, and simple pocket calculators may be allowed as they do not pose a credible ignition risk.

4.11.2. If any other exceptions are requested to allow for non-certified devices to be used within a classified area or zone without the need of special precautions, the site must perform a formal review. The review must be documented to show that the device does not pose a credible ignition risk and show the Site Head’s written approval for allowing these non-certified devices in a classified area .

4.12. Management of any work activity which could introduce an ignition source, including hot-work within zoned areas, shall be controlled through the facility’s safe work permitting program (IVL EHS-301, General Work Permits) .

4.13. Area classification information is considered Process Safety Information (IVL EHS-402) and shall be maintained up-to-date and current through the IVL EHS-204, Management of Change Standard. Electrical equipment, motor control centers and components intended to meet the specifications and requirements of the area classification are also subject to the replacement-in-kind management principles of the MOC process.

4.14. Timing

4.14.1. Area classification studies shall be conducted initially and revalidated every 5 years or earlier per the IVL EHS-204, Management of Change Standard whenever there are modifications /

changes to the process, products or equipment on the plants / sites, or as required by local regulatory requirements.

4.14.2. A current area classification study shall be maintained at the site, and records of all previous area classification studies shall be maintained for the life of the asset.

5. Training

Training requirements must be defined for the site-specific area classifications and management. At a minimum, all training must be documented with the training date, the names of personnel trained, the names of the trainer(s), the content of the training (or reference to content) and other site-specific/business segment requirements, when applicable.

5.1. Initial

Training on the requirements of this standard and the site-specific program must be provided to Indorama Ventures personnel based on their relevant responsibilities and shall be provided in the local language. At a minimum, personnel and/or management with direct responsibilities for this standard and site-specific program must be trained prior to conducting activities associated with the site-specific program. Additionally, operating and maintenance personnel shall be made aware of the outcome of area classification studies and the requirements for:

- Conducting activities within hazardous areas.
- Control of ignition sources.
- Management of the area.

5.2. Refresher

Refresher training shall be provided periodically according to the requirements of this standard, the site-specific program, and any local legal requirements, at appropriate intervals (e.g., changes to regulatory requirements, observed user deficiencies, changes to area classifications), or at least once every three (3) years.

6. Recordkeeping

Records associated with this standard and/or site-specific/regulatory requirements must be controlled and retained in accordance with regulatory or site business segment record retention requirements, whichever is more stringent . Examples of records to be maintained include but may not be limited to the area classification studies and associated assessment documentation, as well as all data required to be documented for the equipment in the hazardous area. Refer to the documentation requirements listed in Attachment B.

7. References

7.1. IVL EHS-107 Management of Recommendations/Actions

7.2. IVL EHS-204 Management of Change

7.3. IVL EHS-208 Risk Management Procedure and Matrix

7.4. IVL EHS-320 Electrical Safety and Equipment Integrity

7.5. IVL EHS-402 Process Safety Information

7.6. IVL EHS-403 Process Hazard Analysis

7.7. API Recommended Practice (RP) 500 – Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities

7.8. API Recommended Practice (RP) 505 - Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class 1, Zone 0, Zone 1 and Zone 2

7.9. ATEX 153: 1999/92/EC Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 concerning minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres

7.10. ATEX 214: 2014/34/EU: Directive 2014/34/EU of the European Parliament and of the Council of concerning minimum safety requirements for workplaces and equipment used in potentially explosive atmospheres

7.11. IVL EHSG-EHSG-1408A, Selection, Installation, Inspection, Maintenance & Repair of Equipment in Hazardous Areas

7.12. IVL EHSG-EHSG-1408B, Supplementary Guidance for IEC 60079-10

7.13. IEC 60079-(all applicable parts): Series of Explosive Atmosphere Standards .

7.14. IP Model Code of Safe Practice Part 15 – Area classification code for installations handling flammable fluids

7.15. NFPA 30 - Flammable and Combustible Liquids Code

7.16. NFPA 70 – National Electrical Code (NEC)

7.17. NFPA 70B -–Standard for Electrical Equipment Maintenance

7.18. NFPA 497 – Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapours and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas

7.19. NFPA 499 - Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas

8. Terms and Definitions

See IVL EHS Glossary and Attachment A.

9. Revision History

Version	Date	Summary of Update	Owner	Approver	Next Review Date
Original	22 June 2023	Initial Release	Chad Wyble, Global Process Safety Program Director	Todd Hogue, VP, Global Head of EH&S	22 June 2026
1.0	09 August 2024	Updated implementation timeframe (Section 2) and Responsibilities (Section 3); made minor editorial updates.	Chad Wyble, Global Process Safety Program Director	Todd Hogue, VP, Global Head of EH&S	09 August 2029

Attachment A: Definitions and Glossary

A.1 Area Classification

Area classification is a method of analyzing and classifying the environment where explosive gas, vapour or dust atmospheres may occur so as to facilitate the proper selection and installation of equipment to be used safely in that environment.

A.2 Atmospheric Conditions

Typically, atmospheric conditions include variations above and below reference levels of 101.3 kPa (1013 mbar) and 20°C (293 K), provided that the variations have a negligible effect on the explosion properties of the flammable materials.

A.3 Equipment

“Equipment” (including non-electrical equipment - see A.12) means machines, electrical apparatus, fixed or mobile devices, control components and instrumentation thereof and detection or prevention systems which, separately or jointly, are intended for the generation, transfer, storage, measurement, control and conversion of energy and/or the processing of material and which are capable of causing an explosion through their own potential sources of ignition (ATEX Directive 94/9/EC) .

A.4 Explosive Atmosphere

Mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapour, mist or dust, in which after ignition, combustion spreads throughout the unconsumed mixture.

A.5 Ex-Zones

Hazardous areas are classified into Ex-Zones based upon the frequency of the occurrence and duration of an explosive atmosphere.

A.6 Flammable material

Material, which is flammable of itself, or is capable of producing a flammable gas, vapour or mist.

A.7 Flashpoint

Lowest liquid temperature at which, under certain standardised conditions, a liquid gives off vapour in such quantities such as to be capable of forming an ignitable vapour/air mixture.

A.8 Hazardous Area

Area in which a flammable or explosive atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment (IEC EN 60079-10:2003). The area within which a person is deemed to be exposed to the hazard.

A.9 Hybrid Mixture

Combustible dust and gases or combustible vapours may coexist in air during the processing and manufacture of solvent containing products. This mixture results from two sources, and therefore, they are called hybrid mixtures.

A.10 Ignition Temperature of an explosive gas atmosphere

Lowest temperature of a heated surface at which, under specified conditions, the ignition of a flammable substance in form of a gas or vapour mixture with air will occur.

A.11 Lower Explosive Limit (LEL)

Concentration of a flammable gas, vapour or combustible dust in air, below which the atmosphere is not explosive.

A.12 Lower Flammability Limit (LFL)

The lower limit of the gaseous or vaporized fuel, combustible material or dust's concentration in the air, at a fixed temperature and pressure, which can lead to flame propagation, detonation or an explosion.

A.13 Minimum Exposable Concentration (MEC)

The lowest concentration of a combustible dust in air, expressed in grams per cubic meter that will propagate a flame.

A.14 Non-Electric Equipment

Non-electrical equipment which has a potential ignition source, in most cases due to moving parts able to create a potential ignition risk either from hot surfaces or fiction sparks. Examples are gears, fans, pumps, compressors, mixers, brakes, and V-belts.

A.15 Non-Hazardous Area

Area in which an explosive atmosphere is not expected to be present in quantities such as to require precautions for the construction, installation and use of apparatus.

A.16 Own Ignition Source

A defining element of equipment in the sense of area classification is that it has to have its own potential source of ignition.

Potential sources of ignition could be electric sparks, arcs and flashes, electrostatic discharges, electromagnetic waves, ionizing radiation, hot surfaces, flames and hot gases, mechanically generated sparks, optical radiation, chemical initiations and compression.

A.17 Relative Density

Of a gas or vapour relative to the density of air at the same pressure and at the same temperature (air is equal to 1.0).

A.18 Source of Release

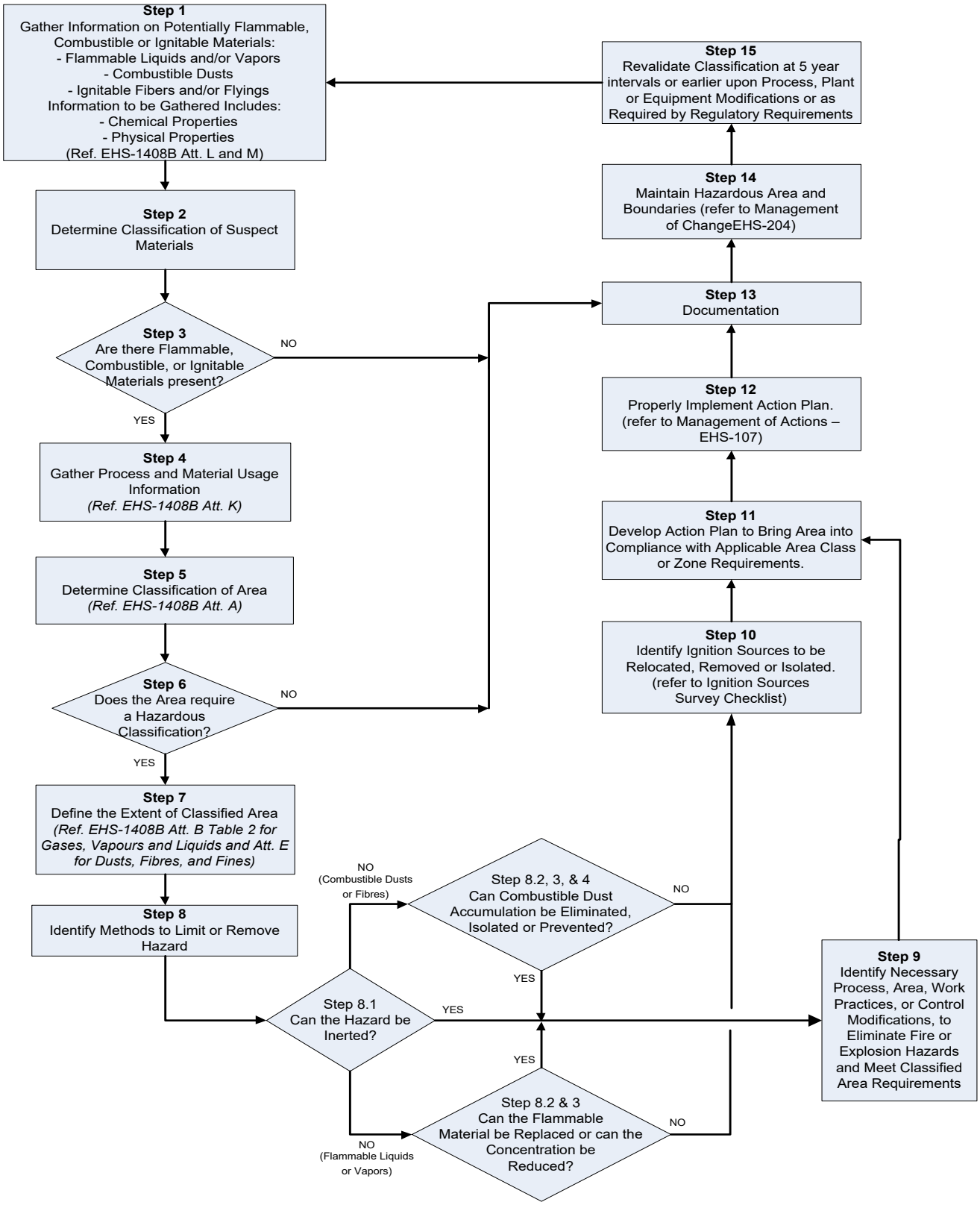
Point or location from which a flammable gas, vapour, liquid or a combustible dust may be released into the atmosphere in such a way, that an explosive atmosphere could be formed.

A.19 Upper Explosive Limit (UEL)

Concentration of a flammable gas, vapour or combustible dust in air, above which the atmosphere is not explosive of a gas or vapor relative to the density of air at the same pressure and at the same temperature (air is equal to 1.0).

Attachment B: Area Classification and Area Management Process

Figure 1 Area Classification and Management Flowchart



B.1 Step 1: Gather Information on Potentially Flammable, Combustible or Ignitable Materials

B.1.1 List all potentially flammable, combustible or ignitable materials that are present in the area in question in sufficient detail to support determination of the hazardous area classification. This includes:

B.1.1.1 Liquids

B.1.1.2 Gases or vapours

B.1.1.3 Dusts

B.1.1.4 Fibres or fines (flyings)

B.1.2 Identify physical and chemical properties for each material, or each material component, listed in step B.1.1, necessary to assess the hazard.

B.1.2.1 For Gases, Vapours, or Liquids reference Attachment L in IVL EHSG-1408B, Supplementary Guidance to Area Classification, for a form to document the needed properties.

B.1.2.2 For Dusts, Fibres, or Fines reference Attachment M in IVL EHSG-1408B for a form to document the needed properties.

B.1.3 Tests may need to be carried out in laboratories on the actual dusts used in the process as the characteristics of dust will determine if the dust can form an explosive atmosphere. Further information on the tests carried out on dusts is contained in Attachment P of IVL EHSG-1408B, Supplementary Guidance to Area Classification.

B.2 Step 2: Determine Classification of Suspect Materials

B.2.1 For the materials identified in step 1, determine applicable material classification based on local regulatory requirements or per the definitions provided in Attachment Q of IVL EHSG-1408B, Supplementary Guidance to Area Classification.

B.2.2 When considering area classification of dusts, the first step is to identify the dust material characteristics.

B.3 Step 3: Are there Flammable, Combustible or Ignitable Materials Present?

B.3.1 If no, proceed to step 13 and document appropriately.

B.3.2 If yes, additional review is necessary to determine the appropriate area classification status and requirements, proceed to step 4.

B.3.3 In the absence of local or national regulatory criteria for applicability, a facility can reference the following Global Harmonised System (GHS) values for determination of minimum mass required to perform an area classification study: (See chart below)

Description	Example	Minimum Amount for 'Open'/Well Ventilated Places [kg]	Minimum Amount for 'Closed'/Non Ventilated Spaces [kg]	GHS Classification(1)
Flammable gasses		50	5	Class 2, Category 1 and 2
Liquefied flammable gasses (aerosols)	LPG	50	5	Class 3, Category 1 and 2
Flammable liquids with flash point < 23 °C and initial boiling point ≤ 35 °C		50	5	Class 6, Category 1
Flammable liquids with flashpoint < 23 °C and initial boiling point > 35°C	Petrol, Kerosene	500	50	Class 6, Category 2
Flammable liquids with a flash point between 23 °C and 60 °C (inclusive) that can be released with a temperature higher than their flashpoint less 3°C safety margin (including gasoil, derv and light fuel oil with a flash point range of 55-75°C)	Diesel Fuel (derv)	5000	500	Class 6, Category 3
All other flammable liquids that can be released with a temperature higher than or equal to their flashpoint less 3°C safety margin	Fuel Oil (maritime), Aniline	5000	500	Not applicable

(1) If flammables are present from more than one category, then the amounts are added in relation to their minimum amounts. It the sum of fractions is higher than 1 (e.g., 40 kg flammable gas and 110 kg flammable liquid with flashpoint of 11 °C = 40/50 +110/500= 1.02) then a GHS Classification is required.

Note: Information in the table is excerpted from NPR 7910-1:2010

B.4 Step 4: Gather Process and Material Usage Information

B.4.1 The Area Classification Assessment Leader is responsible for documenting how a flammable, combustible, or ignitable material is used as key input into the determination of the hazard classification status of an area . The practices and parameters that contribute to the hazard classification of an area include:

B.4.1.1 How the material(s) are handled, processed, stored, or used

B.4.1.2 The material release sources or modes/mechanisms

B.4.1.3 The amount and concentration of material release necessary to produce an explosion **hazard**

B.4.1.4 Standard process material release rates

B.4.1.5 Non-standard process material release rates—maintenance activity or malfunction

B.4.1.6 Standard and non-standard process conditions—temperatures, pressures, production rates, release rates, area ventilation rates, etc.

B.4.1.7 Frequency and duration of material releases

B.4.1.8 Process location with respect to other classified hazardous areas

Reference IVL EHSG-1408B, Attachment K, List of Equipment for Area Classifications (LEAC), for a form on which to document the process and material usage information.

B.5 Step 5: Determine the Classification of the Area

B.5.1 Determine the required area classification based on the definitions referenced and guidance given in IVL EHSG-1408B Attachment A, Area Classification Meetings.

B.5.2 The hazardous area classifications are separated into Zones (per IEC), or Divisions (per NEC) based on an assessment of the frequency of the occurrence and duration of an explosive or ignitable atmosphere as follows:

B.5.2.1 International Electrotechnical Commission (IEC) Guideline

a. Zone 0, (Zone 20 – Dust): An area in which an explosive gas atmosphere is present continuously or for long periods . (>1000 hrs/y)
b. Zone 1, (Zone 21 – Dust): An area in which an explosive gas atmosphere is likely to occur in normal operation . (< 1000 hrs/y but >10 hrs/y)
c. Zone 2, (Zone 22 – Dust): An area in which an explosive gas atmosphere is not likely to occur in normal operation and, if it occurs, will only exist for a short time . (<10 hrs/y)

B.5.2.2 National Electrical Code

a. Class I, II, or III, Division 1: An area in which an explosive gas atmosphere is present under normal operating conditions, exist frequently because of repair or maintenance operations, or in which a breakdown or faulty operation may simultaneously release ignitable concentrations and cause a failure of electrical equipment.
b. Class I, II, or III, Division 2: An area in which an explosive gas atmosphere is not likely to occur in normal operation, occurs only due to a malfunction of equipment and will last only for a short time, normally controlled or prevented by mechanical ventilation, or is adjacent to a Division 1 location.

B.6 Step 6: Does the Area Require a Hazardous Classification?

B.6.1 If no, proceed to step 13 and document appropriately.

B.6.2 If yes, additional review is necessary to determine the extent and requirements of the classified area, proceed to step 7.

B.7 Step 7: Define the Extent of the Classified Area

B.7.1 Determine the extent of the classified area as per the applicable scenario as defined in:

a. NFPA 497 or IEC 60079-Part 10 for Class I, Divisions 1 and 2, or Zones 0, 1 and 2 areas for explosive gas atmosphere.
b. NFPA 499 or IEC 60079-Part 10-2 for Class II, Divisions 1 and 2, or Zones 20, 21 and 22 areas for combustible dust atmosphere.

Note: The UK Energy Institute's EI Model Code of Safe Practice Part 15: Area classification for installations handling flammable fluids (Formally IP15) is also acceptable for determining zone extents provided the application is applicable to the process conditions.

B.7.2 Further guidance is given in guide IVL EHSG-1408B, Supplementary Guidance to Area Classification.

Specifically reference IVL EHSG-1408B, Attachment B, Table 2, Extent of Zones, for definitions related to gases, vapours, and liquids . Reference IVL EHSG-1408B, Attachment E, Area Classification Guidance for Some Sources of Combustible Dust Release in Indoor Areas, for similar information related to combustible dusts, fibres, and fines.

B.7.3 The requirements specified in the referenced sources will define the shape and size of the classified area, as well as the classification requirements for the areas immediately surrounding the classified area.

B.7.4 Modelling is generally not required to complete the area classification.

B.7.4.1 Flammable modelling endpoint criteria, if used for purposes of area classification, should be 50% of the lower flammability limit (LFL).

B.7.4.2 Worst Credible Event Scenario flash fire maps from Facility Siting studies that utilize weather and leak conditions outside of those in the guidance documents should not be used for purposes of area classification.

B.8 Step 8: Identify Methods to Limit or Remove Hazards

Step 8 requires multiple evaluations to determine if the potential fire or explosion can be prevented by removing one of the three components of the fire triangle, or one of the five components of the explosion pentagram . The fire triangle defines the three components necessary to support combustion—fuel, oxygen, and an ignition source . The explosion pentagram defines the five components necessary to support an explosion—fuel, oxygen, an explosive concentration, a source of ignition, and an enclosed space . The necessary evaluations are as follows:

B.8.1 Can the hazard be inerted? Inertion involves depriving the area of sufficient oxygen to support combustion or an explosion . If the area can be inerted, proceed to Step 9.

B.8.2 Can the source of fuel be eliminated? This would include the following methods or alternatives:

B.8.2.1 Non-flammable alternative material.

B.8.2.2 Eliminate the process that releases or produces the flammable material.

If the fuel source can be eliminated, proceed to Step 9.

B.8.3 Can the flammable or ignitable concentration be controlled, isolated, or prevented? This would include

B.8.3.1 Additional mechanical ventilation to keep concentrations below lower explosive limit (LEL) for flammable liquids or vapours, or minimum exposable concentration (MEC) for dusts . The additional mechanical ventilation is subject to special conditions, the operation of the ventilation must be guaranteed.

B.8.3.2 Improved housekeeping practices (for dust) that do not agitate or create a dust cloud.

B.8.3.3 Process modifications or engineering design to prevent flammable material releases or dust/fine generation.

If flammable or ignitable concentration can be controlled, isolated, or prevented, proceed to Step 9.

B.8.4 Can the enclosed or confined space be enlarged or eliminated? If a flammable atmosphere exists in an enclosed space, an explosion hazard is created . If the spatial constraints are eliminated, the explosion hazard can be reduced to a fire hazard . If the enclosed or confined space can be eliminated, proceed to Step 9.

If none of the above modifications are possible to prevent a fire or explosion hazard, all ignition sources must be removed from the classified hazardous area . Proceed to Step 10.

B.9 Step 9: Identify Necessary Process Area, Work Practices, or Control Modifications to Eliminate Fire or Explosion Hazards and Meet Classified Area Requirements

B.9.1 Potential changes to mitigate fire or explosion hazards include, but are not limited to:

B.9.1.1 Inert the area by limiting oxygen levels to quantities insufficient to support combustion or an explosion.

B.9.1.2 Removal of the flammable or ignitable material(s).

B.9.1.3 Additional mechanical ventilation to reduce, limit, or eliminate combustible, ignitable, or explosive concentrations (see B.8.3).

B.9.1.4 Process modifications or engineering design to eliminate the release of flammable materials or the production of flammable dusts or fibres.

B.9.1.5 Modified housekeeping work practices.

B.9.1.6 Altering the spatial constraints of the area.

B.10 Step 10: Identify Ignition Sources to be Relocated, Removed, or Isolated.

B.10.1 Refer to the Ignition Source Survey Checklist – Attachment C.

B.11 Step 11: Develop Action Plan to Bring Area into Compliance with Applicable Area Class or Zone Requirements.

B.11.1 Document risk improvement actions and formally inform the Facility Manager.

B.11.1.1 Facility Manager shall appoint a competent person with responsibility for completing the actions in accordance with IVL EHS-107, Management of Recommendations/Actions.

B.11.2 Establish implementation schedule.

B.11.2.1 Timing must be relevant to the risk (see IVL EHS-208, Risk Management Procedure and Matrix).

B.11.3 Select the appropriate equipment for the zoned area (see IVL EHSG-1408A, Selection, Installation, Inspection, Maintenance & Repair of Equipment in Hazardous Areas) . Be sure to follow any regulatory requirements, such as following OSHA’s requirement that the selection of

equipment and wiring methods in a zoned area are to be done under the supervision of a qualified registered professional engineer.

B.11.4 Identify equipment to be purchased (see IVL EHSG-1408A, Selection, Installation, Inspection, Maintenance & Repair of Equipment in Hazardous Areas).

B.11.5 Identify initial inspection of the equipment (see IVL EHSG-1408A, Selection, Installation, Inspection, Maintenance & Repair of Equipment in Hazardous Areas).

B.11.6 Set up the routine maintenance systems of the equipment (see IVL EHSG-1408A, Selection, Installation, Inspection, Maintenance & Repair of Equipment in Hazardous Areas).

B.11.7 Identify administrative procedures that are required to be developed or updated.

B.12 Step 12: Properly Implement Action Plan (in line with IVL EHS-204, Management of Change and IVL EHS-107, Management of Recommendations/Actions).

B.12.1 Procure necessary equipment or materials identified in Steps 9 and 10.

B.12.2 Obtain necessary vendor/supplier documentation for any “guaranteed” specifications or performance.

B.12.3 Once installation of equipment or modifications of area are complete, perform controlled and monitored trials to ensure that all design specifications have been achieved.

B.12.4 Ensure all modifications are made in such a way as to prevent new hazards into the area . Follow IVL EHS-204, Management of Change.

B.13 Step 13: Documentation (all according to IVL EHS-402, Process Safety Information).

B.13.1 If no flammable, combustible or ignitable materials are present, or if the area does not require classification, then this conclusion should be recorded and retained as minutes of the study. If they are present, the following clauses apply:

B.13.2 Create area classification drawing or map, indicate all classified area perimeters or boundaries, label any adjacent hazardous areas, and update drawings as needed (whenever process is modified or altered). The drawing should be posted in a location where it can be readily referenced by plant operations and maintenance personnel.

B.13.2.1 Area classification documents shall include plans and elevations, as appropriate, which show both the type and extent of the classified areas or zones.

B.13.2.2 Where the topography of an area influences the extent of the hazardous areas or zones, this shall be documented.

B.13.3 Ensure equipment lists and drawings are updated as necessary (whenever equipment is replaced, modified, or added). (See IVL EHSG-1408B, Attachment K.)

B.13.4 Include completed Ignition Source Survey Checklist (see Attachment C).

B.13.5 If required by applicable legislative and regulatory requirements produce an Explosion Protection Document / Risk Assessment Document (see IVL EHSG-1408B, Supplementary Guidance to Area Classification).

B.13.6 The area classification study shall be undertaken in such a way that the various steps which lead to the final area classification are properly documented.

B.13.7 All relevant information used shall be documented and clearly cross-referenced in the study. Examples of such information, or of a method used, would be:

B.13.7.1 Recommendations from relevant codes and standards.

B.13.7.2 Gas and vapour dispersion characteristics and calculations.

B.13.7.3 Failure modes and frequencies for equipment likely to become a source of release and likely to produce an ignition source.

B.13.7.4 A study of ventilation characteristics in relation to flammable material release parameters so that the effectiveness of the ventilation can be evaluated.

B.13.7.5 Assessment of dust dispersion from all sources of release.

B.13.7.6 Process parameters, which influence the formation of dust/air mixtures and dust layers.

B.13.8 The result of the area classification study report and any subsequent alteration to it shall be recorded and made available in accessible areas for plant personnel reference.

B.13.9 For determining the area classification rating, the properties relevant to area classification concerning process materials used in the plant shall be documented. Refer to Attachment L of IVL EHSG-1408B . For gases, vapours and liquids these typically include molecular weight, flashpoint, boiling point, ignition temperature, vapour pressure, vapour density, explosive limits, gas group, and temperature class. For dusts, these include ignition temperature of clouds and layers, explosive limits, electrical conductivity, moisture content, particle size, and maximum permissible surface temperature of the equipment to be selected to avoid ignition.

B.13.10 The documents shall also include other relevant information such as:

B.13.10.1 The location and identification of sources of release. For large and complex plants / units or process areas, it may be helpful to itemize or number the sources of release so as to facilitate cross-referencing between the area classification data (List of Equipment for Area Classification – LEAC, Attachment K in IVL EHSG-1408B) sheets and drawings.

B.13.10.2 The position of openings in buildings (for example, doors windows and inlets and outlets of air for ventilation).

B.13.10.3 For dusts, information about housekeeping and other preventative measures to obtain the classification made.

B.13.10.4 The reasons for the decision taken to establish the extent of zones and the extent of dust clouds.

B.13.10.5 The names and qualifications of the people who formed the area classification team carrying out the study shall be recorded in the documentation.

B.13.10.6 The management system (i.e., written procedures, maintenance schedules, assignment of responsibility, etc.) necessary to ensure that the integrity of apparatus installed in the hazardous area is documented and maintained.

B.13.11 There are various preferred area classification symbols for drawings, which are given in a number of international standards (IEC 60079-10 and API RP 505 Appendix C).

B.14 Step 14: Maintain hazardous areas and boundaries

B.14.1 Refer to procedure IVL EHS-204, Management of Change.

B.15 Step 15: Revalidate classification at 5-year intervals or earlier upon process changes or as required by regulatory requirements . The Area Classification Revalidation Checklist found in Attachment D is intended to aid in the review and documentation of the revalidation process.

B.15.1 Set up a management system so that an area classification review is carried out at 5-year intervals or earlier whenever there are modifications / changes to the process, products or equipment, or as required by regulatory requirements. (See 3.13.1.)

Attachment C: Ignition Source Survey Checklist

C.1 Step 10 of Figure 1: Area Classification Study Flowchart

C.1.1 The control of ignition sources in or around areas where hazardous materials are being stored or processed is a key to effective fire and explosion hazard management . Many types of energy can be considered a potential ignition source and the energy types which typically can be found in industrial plants include, but are not limited to:

C.1.1.1 Electrical equipment, wiring, and lights

C.1.1.2 Open flames, heat sources, or hot surfaces

C.1.1.3 Friction, sparks, or arcs

C.1.1.4 Static discharges

C.1.1.5 Chemical reactions

C.1.1.6 Gas compression

C.1.1.7 Electromagnetic radiation

C.1.2 The Ignition Source Survey Checklist is intended to aid in the identification of potential ignition sources . Potential ignition sources to be considered include those that arise in normal operation and those which only occur as a result of an equipment failure, operator error, failure to follow procedure, or a maintenance activity.

C.1.3 Once identified, sources can be controlled by design measures or systems of work . Possible methods for the relocation, removal, or isolation of ignition sources include:

C.1.3.1 Avoiding unnecessary electrical/electronic equipment.

C.1.3.2 Using electrical equipment and instrumentation suitably designed and approved for use in the classified area in which it is located.

C.1.3.3 Maximizing the distance between a source of ignition and the possible source of release.

C.1.3.4 A system of flammable gas detection with the shutdown of ignition sources upon detection.

C.1.3.5 Elimination or shielding of surfaces above auto ignition temperatures of flammable materials being handled / stored in proximity to the source.

C.1.3.6 Avoid processing flammable materials near their auto ignition temperature.

C.1.3.7 Adequate ventilation.

C.1.3.8 Grounding of all plant / equipment.

C.1.3.9 Provision for lightning protection.

C.1.3.10 Correct selection of vehicles / internal combustion engines that have to work in the classified areas.

C.1.3.11 Correct selection of equipment to avoid high intensity electromagnetic radiation sources (e.g., limitations on the power input to fibre optic systems, avoidance of high intensity lasers or sources of infrared radiation).

C.1.3.12 Prohibition of smoking/use of matches/lighters.

C.1.3.13 Controls over activities that create intermittent hazardous areas (e.g., tanker loading/unloading).

C.1.3.14 Control of work and maintenance activities that may cause sparks/hot surfaces/open flames through a Permit to Work System.

C.2 Ignition Source Survey Checklist

Ignition Source Survey Checklist

Item	Potential Ignition Source	Survey Action	Possible Ignition Source Present (1)	Comments / Follow up
1	Electrical wiring and devices	Review electrical wiring and devices in area. (*e.g.,* process equipment, machinery, control equipment, lighting, instrumentation, alarms, communication equipment, control panels, computers, portable or personal equipment (cell phones, radios, fans, heaters), wiring connections and conduit, grounding, transformers, breakers, batteries, switch gear, motors, generators)	Yes / No	
2	Open flames, heat sources or hot surfaces	Review operations and procedures for the use of open flames, heat sources, or hot surfaces. (*e.g.,* smoking, welding, heaters, ovens, dryers, motors, heating and ventilation equipment, freeze protection, hot plate)	Yes / No	
3	Friction, sparks or arcs	Review operations and procedures which may result friction, sparks, or arcs. (*e.g.,* moving equipment, cutting, grinding, milling machine)	Yes / No	
4	Static discharges	Review operations and procedures which may result in static discharges. (*e.g.,* lightning; material handling or conveying, ventilation and climate control systems, grounding)	Yes / No	
5	Chemical reactions	Review operations and procedures which may result in exothermic chemical reactions.	Yes / No	
6	Gas compression	Review operations and procedures where flammable gases may be compressed. (*e.g.,* air compressor, pressure vessels)	Yes / No	
7	Electromagnetic radiation	Review operations and procedures for high intensity electromagnetic radiation sources. (*e.g.,* power supply for fibre optic systems, high intensity lasers, sources of infrared radiation)	Yes / No	
8	Other		Yes / No	

(1) Response of "Yes" should be further substantiated with listing of the identified ignition source in the register for the site.

Attachment D: Area Classification Study Revalidation Guidance Checklist

Area Classification Study Revalidation Checklist

Date of Study Under Review:	
Facility / Division:	
Assessor:	
Attendees:	
Date(s) of Review:	

Section I: Process Safety Information (PSI)
Collect relevant documentation to support the revalidation, including, but not limited to, the following information.

Process Safety Information (PSI)	Collected?		Notes
	Yes	No	
Site Area Classification (AC) Study Documentation			
Most Current Equipment List			
Most Current List of Ignition Sources			
Most recent audit(s) for IVL EHS-408 requirements and status of findings (self-assessment and Corporate)			
Open, closed and resolved action items in the site action tracking system related to AC for the last 5 years			
Most recent version of IVL EHS-408 and related site level management system procedures			
Open or past due work orders associated with the maintenance of ignition sources			
List of capital projects for the last 5 years at the site			
List of MOCs/PSSRs that involved changes to the process, products or equipment on the site over the last 5 years			
Current chemical inventory list for the site			
Most Current Facility Plot Plan			
Site Area Classification Drawings / Maps			

Section II: Existing Area Classification (AC) Review

Review the existing AC Study to assess if it is current, given changes since the last validation, and to identify actions required to close gaps that may exist as part of the revalidation.

No.	Procedure Requirement	Complete?		Scope / Actions to Complete Revalidation
		Yes	No	
1.1	Query current and historical records from the site action tracking system(s) for action items associated with audit findings and action items related to AC for the last 5 years. Note: Action Plans are generated per IVL EHS-204, Management of Change, and managed consistent with IVL EHS-107, Management of Recommendations/Actions.			
1.2	Review status/closure documentation used to close any gap recommendations from implementation of IVL EHS-408. If there are open past due action items or actions which could not be verified as closed, document the gaps and establish the scope of the AC analysis that must be completed as part of the revalidation.			
1.3	If an audit has not been completed and/or there has been a major revision to IVL EHS-408 since the last update of the AC study, verify the existing study is in compliance with the current version of Attachment B of IVL EHS-408.			
1.4	Review the site level procedures to determine if there have been any changes to the procedures which would impact the current AC Study.			
1.5	Review inspection records and any open or past due work orders associated with the inspection and maintenance of equipment in Hazardous areas (ignition sources) to determine if the periodic inspection, maintenance program is in place and functioning.			

2.0 Capital Projects and Management of Change					
2.1		Review the list of capital projects and 25% of non-capital project MOCs from the last five years to determine if there were any that could have, or should have, impacted the AC Study for the site and that the required changes were incorporated into the AC Study. Note: The sample set of MOCs should be representative of the volume of changes taking place and the practices in place to maintain the AC Study . Depending on the number of MOCs, a reasonable sample set should be reviewed; i.e. over a five year period it would be typical to review 50 to 100 . 25% is guidance . Bias the sample set to be those MOCs that required PHAs. If there is evidence that the AC documentation has not been kept up to date based on the 25% review, complete a broader review of MOC records to establish the scope of the AC analysis that must be updated as part of the revalidation.			

3.0 Chemical Inventory					
3.1		Cross check the chemical inventory documented in the existing AC Study with the current chemical inventory list to confirm that the flammable, combustible or ignitable materials and related process and usage data as it relates to the hazard classification is accurately documented in the AC Study . If it is outdated, update it as part of the revalidation effort .			
4.0 AC Drawings and Maps					
4.1		Review the AC drawings / maps to determine if all changes have been incorporated based on the review of facility plot plan, capital projects, MOCs, action items and current chemical inventory . Drawings / maps should indicate all classified area perimeters or boundaries. If the required updates were not complete, determine the scope of the AC analysis that must be updated as part of the revalidation.			
5.0 Field Verification					
5.1		Walk through several classified areas and observe that electrical, instrument, lighting and other potential sources of ignition installed in the classified areas are labelled appropriately, and that their physical condition has been properly maintained. Note: Look for potential deficiencies such as broken conduit, missing covers, open junction boxes, missing light covers and other signs of deteriorated condition.			
5.2		Confirm that the AC drawings are posted in a location where they can be readily referenced by plant operations and maintenance personnel.			

6.0 Qualifications					
6.1		Review the qualifications for the Area Classification Assessment Leaders that completed the study under review. Note: Qualifications should be available for the original AC Study and associated updates, as well as for Capital Projects . Qualifications should also be completed for the current AC Assessment Leader completing the 5-year revalidation.			
7.0 Management System Updates					
7.1		If there are changes made to the AC Study, capture the recommendations necessary to fully communicate and update the impacted systems; e.g., post the current drawings; training or communication to ops/maintenance; new ITPM updates, updated electrical area classifications, etc.			

7.2		Review the gaps identified above, if any, to determine if there are management system issues that need to be addressed in an effort to maintain the AC Study as current for the life of the asset (i.e., breakdown in MOC process, capital project process, etc.).			
8.0 Additional Items Reviewed / Updates					

Section III: Action Items

Action No.	Action	Assigned To	Due Date	Date Complete

Section IV: Documentation Updates
Document the required update and status of the AC Study based on the review above.

Document / Section	Updates Required?			Description of Changes Made
	Yes	No	Complete	
Area Classification Team Members Including Area Classification Assessment Leader				
Attachment L of IVL EHSG-1408B – Gas, Vapor and Liquid Properties Sheet				
Attachment M of IVL EHSG-1408B - Dusts, Fibres or Fines Properties Sheet				
Attachment K of IVL EHSG-1408B - List of Equipment for Area Classifications (LEAC)				
Explosion Protection Document / Risk Assessment Document (IVL EHSG-1408B)				

Document / Section	Updates Required?			Description of Changes Made
	Yes	No	Complete	
If required by legislative and regulatory requirements				
Attachment C of IVL EHS-408 - List of Ignition Sources to be Relocated, Removed or Isolated				
Register of Hazardous Areas and location of potential ignition sources				
Area Classification Drawings / Maps				
Routine Maintenance System Requirements Note: For potential ignition sources and associated equipment (i.e., written procedures, maintenance schedules, assignment of responsibility, etc.)				