SEVESO DOCUMENTS

GUIDANCE ON APPLICABILITY, ASSESSMENT AND LEGAL DOCUMENTS FOR DEMONSTRATING COMPLIANCE OF INDUSTRIAL GASES FACILITIES WITH DIRECTIVE 2012/18/EU "SEVESO DIRECTIVE"

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1 Introduction

The Seveso Directive ("Seveso") is intended to prevent major accidents to people or the environment. The applicability of Seveso is based upon the "foreseeable presence" of "dangerous substances". For all "establishments" coming into scope there is a general obligation to "take all measures necessary to prevent major accidents and to limit their consequences to people and the environment". Subsequent requirements are designed to implement this objective and/or to assist the site operators to demonstrate their compliance to the satisfaction of the relevant Competent Authority (CA).

The site operator shall make an assessment of the maximum foreseeable quantity of these dangerous substances, including seasonal or expected business fluctuations, raw materials, products, by-products, residue and/or intermediates. The site operator shall also include the "anticipated presence of dangerous substances which may be generated while an industrial process is out of control".

This document incorporates the collective experiences of EIGA member companies operating industrial gases facilities under the Seveso Directive across Europe.

This guidance document focuses on the legally required notification, Major Accident Prevention Policy and assessment of relevant scenarios (either with or without an Upper tier Safety Report).

COUNTRY NOTE: Where the contributors are aware of significant differences of country implementation, these are noted - by exception - in this green font. The team have reflected our understanding of implementation in: France, Italy, Belgium, the Netherlands, Republic of Ireland, Slovenia, Sweden, Norway, Denmark, Spain, Portugal, UK and Germany. Similar comments from other EU member countries are welcomed for future editions of this document.

In keeping with EIGA's philosophy, this document reflects the EIGA view of "best industry practice" for demonstrating compliance with the requirements of the Seveso Directives. It is presumed that the technical and organisational measures for preventing accidents of any kind, as described in other EIGA documents have been implemented effectively.

2 Scope and purpose

2.1 Scope

The EIGA guidance is intended to address Seveso compliance issues of industrial gases facilities which are subject to the Seveso regulations. Typical facility examples include the following establishments, where they have sufficient inventory of dangerous substance(s): Air Separation plants, acetylene production plants, cylinder transfilling plants and/or cylinder re-distribution facilities.

HyCO facilities are not specifically included because the typical site inventory is not sufficient to be included in Seveso. The legal duties for HyCO sites which do come into scope are in principle the same.

Nitrous oxide processes may also be subject to Seveso, especially when ammonium nitrate raw material is included within the installation inventory. The legal duties for Nitrous oxide processes which do come into scope are in principle the same.

(Examples relating to HyCO and Nitrous oxide are not included in this document).

This document addresses the requirements of Seveso 3 Directive 2012/18/EU published on 4 July 2012.[1][1]

Where the contributors are aware of significant differences in national regulations or implementation, these have been noted. However operating companies should assure themselves of exact national interpretation locally.

2.2 Purpose

This document provides information and guidance on the following key objectives:

[1] References are shown by bracketed numbers and are listed in order of appearance in the reference section.

- guidance on the applicability of the Seveso regulation to industrial gases facilities, by explaining the qualifying thresholds, including the summation logic;
- the process for Notification of establishment;
- guidance on the expected content of the Major Accident Prevention Policy including safety management systems – for Lower tier sites;
- guidance on identification, analysis, assessment and control of scenarios, which EIGA believe broadly meet the definition of “Seveso Major Accident hazard scenarios”;
- some typical gas industry “Seveso Major Accident hazard scenarios”;
- key points to be included in internal and external emergency plans, including restoration and clean-up of the environment;
- reference to some gases industry incidents world-wide, which met or could have met, the definition of “Seveso Major Accident hazard scenario”;
- an outline on the safety assessment of modifications having “significant repercussions” on major-accident hazards;
- examples of templates for information to neighbours; and
- guidance for sites which have potential “Domino effects” on other nearby Seveso establishments.

Additionally for Upper tier sites:

- Safety report.

These key objectives are listed at the beginning of each document section

This document does not cover in detail the following topics (of interest for facility managers and others):

- the legal duty to “guarantee a high level of protection for man and the environment”;
- how to demonstrate that appropriate action has been taken, in connection with various activities on site, to prevent major-accidents;
- how to demonstrate that appropriate means have been provided to limit the consequences of major-accidents, both on site and off site;
- keeping the MAPP up to date;
- guidance on “managing” Seveso inventory;
- maintaining technical and organisational safeguards identified in MAPP and/or major-accident scenario assessments;
- demonstrating effectiveness of technical and organisational safeguards identified in MAPP and/or major-accident scenario assessments;
- managing regulatory authority visits;
- responsibilities/involvement on internal emergency plans and communication with emergency services;
- consulting with employees;
- managing the safety of sub-contractors at site;
- requirements when “Domino effects” have been confirmed with other nearby Seveso establishments.

Additionally for Upper tier sites:

- demonstrating that the data and information provided in the safety report, or other reports submitted, adequately reflects the conditions at site;
- responsibilities/involvement for external emergency plans and communication with emergency services;

- demonstrating that information is supplied, without request, to potentially affected neighbours and updated; and
- involvement in land-use changes around the site (e.g. additional residential development in vicinity and "reverse Seveso").

3 Definitions

3.1 Publication terminology

3.1.1 Shall

Indicates that the procedure is mandatory. It is used wherever the criterion for conformance to specific recommendations allows no deviation.

3.1.2 Should

Indicates that a procedure is recommended.

3.1.3 May and need not

Indicates that the procedure is optional.

3.1.4 Will

Used only to indicate the future, not a degree of requirement.

3.1.5 Can

Indicates a possibility or ability.

3.2 Seveso legal definitions

The Seveso Directives include full legal definitions. The terms listed with *asterisk here are defined in the Directives. Only some key terms are listed here. It is important to note that some common words may have a slightly different meaning in Seveso than the usual (e.g. "operator", "risk").

It should be noticed that in this document, where practical, the exact legal phrasing has been reflected so that "shall" and "must" are mandatory legal instructions from within the Seveso Directives.

Some comments to definitions are added in italics.

Some informal terms which are intended to have a specific meaning within this document and/or are in colloquial use are also listed, together with abbreviations used here.

3.3 Technical Definitions

3.3.1 Domino effect potential

Where the risk or consequences of a major accident could be increased because of the geographical position and proximity of establishments and their inventories.

3.3.2 *Establishment

Means the whole location under the control of an operator where dangerous substances are present in one or more installations, including common or related infrastructures or activities; establishments are either lower-tier establishments or upper-tier establishments. *Colloquially known as a "Seveso site".*

3.3.3 Competent Authority (CA)

The relevant national regulatory organisation(s) responsible for carrying out the (legal inspection and other) duties laid down in the Seveso Directive.

3.3.4 *Dangerous Substance

A substance or mixture covered by Part 1 or Part 2 of Annex I, including in the form of a raw material, product, by- product, residue or intermediate. *Dangerous substances are either "Named" or known colloquially as "generic" and both are defined below*.

3.3.5 Europe

All countries subject to EU law, plus, for the purpose of this document the United Kingdom (UK) and Norway. The UK is considered to be part of Europe, post-BREXIT because their national regulations continue to reflect the Seveso Directive exactly. Norway has also enacted Major Accident hazard legislation which exactly reflects Seveso Directive.

3.3.6 Generic Substance

Any dangerous substance which is not "Named", but classified, according to the supplied Safety Data Sheet, with one or more dangerous properties listed in the "generic" categories list of Seveso Annex I Part 1.

3.3.7 *Hazard

Means the intrinsic property of a dangerous substance or physical situation, with a potential for creating damage to human health or the environment.

3.3.8 *Installation

Means a Technical unit within an establishment, whether at or below ground level, in which dangerous substances are produced, used, handled or stored; it includes all the equipment, structures, pipework, machinery, tools, private railway sidings, docks, unloading quays serving the installation, jetties, warehouses or similar structures, floating or otherwise, necessary for the operation of that installation.

3.3.9 Internal emergency plan

drawn up by the site operator describing the necessary actions to be taken inside the establishment, in response to identified major-accident scenarios and other emergency situations.

3.3.10 External emergency plan

Is drawn up by the designated authority for the measures to be taken outside the establishment. *Describes responsibilities and necessary actions in response to identified major-accident scenarios with off-site impact*.

3.3.11 *Lower-tier establishment

Means an establishment where dangerous substances are present in quantities equal to or in excess of the Lower tier quantities listed in Annex I, but less than the Upper tier quantities, where applicable using the summation rule.

3.3.12 *Upper-tier establishment'

Means an establishment where dangerous substances are present in quantities equal to or in excess of the Upper tier quantities listed in Annex I, where applicable using the summation rule.

3.3.13 *Major Accident (MA)

An occurrence (including in particular a major emission, fire or explosion) resulting from uncontrolled developments in the course of the operation of any establishment and leading to serious danger to human health or the environment, immediate or delayed, inside or outside the establishment and involving one or more dangerous substances.

3.3.14 Major Accident Prevention Policy (MAPP)

Not defined in Seveso Directive, see Section 8.

3.3.15 MATTE (Major Accident to the Environment)

Not defined in the Seveso Directive, see Section 9.4.2.

3.3.16 Maximum foreseeable inventory

See “presence of dangerous substances”.

3.3.17 Named Substance

A substance or group of substances which are included in the “Named Substance” list in Annex I Part 2 of the Seveso Directive.

3.3.18 *Neighbouring establishment

Means an establishment that is located in such proximity to another establishment so as to increase the risk or consequences of a major accident.

3.3.19 *Operator

Means any natural or legal person who operates or controls an establishment or installation or, where provided for by national legislation, to whom the decisive economic or decision-making power over the technical functioning of the establishment or installation has been delegated. *This is not the person who fills cylinders or operates process equipment!*

3.3.20 *Presence of dangerous substances

Means the actual or anticipated presence of dangerous substances in the establishment, or of dangerous substances which it is reasonable to foresee may be generated during loss of control of the processes, including storage activities, in any installation within the establishment, in quantities equal to or exceeding the qualifying quantities set out in Part 1 or Part 2 of Annex I.

3.3.21 *Public concerned

Means the public affected or likely to be affected by, or having an interest in, the taking of a decision on any of the matters covered by Article 15(1); for the purposes of this definition, non-governmental organisations promoting environmental protection and meeting any applicable requirements under national law shall be deemed to have an interest.

3.3.22 *Risk

Means the likelihood of a specific effect occurring within a specified period or in specified circumstances.

3.3.23 Relevant long term sub-contract personnel

Persons who work at an installation with a “long” term presence and therefore have a right to be consulted on, for example development, of internal emergency plans.

3.3.24 Safety Report

Required to be written for Upper tier Seveso sites. Contents are defined in the Directive.

3.3.25 Scenario

In this document the term “scenario” is used to describe a series of events, leading from an initiating event (which can be internal or external to the site), and resulting in a loss of containment with the potential to meet the definition of MA.

3.3.26 *Storage

Means the presence of a quantity of dangerous substances for the purposes of warehousing, depositing in safe custody or keeping in stock.

3.3.27 Seveso documentation

This term is not defined in Directives, but is used in this document to include ANY site-specific information which is shared with the CA for Seveso inspections and must be kept up to date to reflect changes at site. Examples include; Seveso notification, internal emergency plan, MAPP, safety report (if applicable).

3.3.28 Seveso site

See definition of "Establishment"

3.3.29 Site operator

"Site operator" is used colloquially in this document with same meaning as "operator" – see 3.3.19

3.3.30 Sub-Seveso

A site where the maximum foreseeable inventory of Dangerous Substances does not reach the Seveso Lower tier qualifying quantity, and is therefore outside (below) the scope of the Seveso Directive.

3.3.31 Summation rule

A requirement to calculate the contribution of different dangerous substances together to determine applicability of the Seveso regulations. See 6.6. *This is colloquially known as the Aggregation rule*.

3.3.32 Safety Data Sheet (SDS)

Safety Data Sheet of a substance or mixture, according to EU Regulation 1272/2008 "Classification, Labelling and Packaging" (CLP) and EU Regulation 1907/2006 "REACh" Regulation [2, 3].

4 Introduction and overview of Seveso Directive

The Seveso Directive ("Seveso") is intended to prevent major accidents to people or the environment. The applicability of Seveso is based upon the "foreseeable presence" of "dangerous substances". For all "establishments" coming into scope there is a general obligation to "**take all measures necessary to prevent major accidents and to limit their consequences to people and the environment**". Subsequent requirements are designed to implement this objective and/or to assist the site operator to demonstrate their compliance to the satisfaction of the relevant Competent Authority (CA).

The site operator shall make an assessment of the maximum foreseeable quantity of these dangerous substances, including seasonal or expected business fluctuations. The site operator shall also include the "anticipated presence of dangerous substances which may be generated while an industrial process is out of control". (See definition of "presence of dangerous substances" in 3.2)

The definition of dangerous substances for purposes of Seveso regulations refers to classification of substances and mixtures in accordance with the EU Regulation 1272/2008 "CLP" [2]. **Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.**

See EIGA Doc 169, *Classification and Labelling Guide in accordance with EC Regulation 1272/2008* for additional detail on classification of industrial and medical gases.[4]

There are two threshold levels within Seveso. For both the "Lower tier" and "Upper tier" sites there are some general duties including;

- the obligation to take all measures necessary to prevent major accidents and limit their consequences to human health and the environment;
- notification of the site to Seveso competent authorities (see 7);
- implementing a safety management system to prevent major accidents (see 8.2);
- documenting a Major Accident Prevention Policy (MAPP) (see 8);
- documentation of an internal emergency plan (see 10.5); and
- providing information to the "public concerned" i.e. neighbours (industrial as well as residential) who can be affected by a major accident on site (see 13).

If the higher threshold levels are exceeded the "Upper tier" site shall also;

- document a Safety report (see 16), with specified elements including MAPP and safety management systems (see 17);
- work with relevant authorities to develop an external Emergency plan (see 12); and
- ensure that information provided to neighbours includes additional items specified in section 13.

The content of EU (Seveso) Directives must be transposed into national law. According to European law countries may choose to include additional requirements, but the minimum standard described in any European Directive must be transposed.

Each country may decide whether its national Seveso legislation is stand-alone or combined with other laws, such as controlling environmental hazard or operating permits. Most countries transpose the Seveso Directive as distinct national legislation.

COUNTRY NOTE: In the UK the land-use planning permission and controls are implemented separately under Planning (Hazardous Substances) regulations – see 7.4.

COUNTRY NOTE: In the Republic of Ireland the land use planning aspects of Seveso are also implemented under separate Planning and Development Regulations. Planning applicants for new establishments are required to submit a Quantified Risk Assessment (QRA) (see 9.6 and 9.8.3) to the CA. The CA in Ireland will evaluate the submitted QRA before advising the local planning authority.

5 Seveso and Site (Environmental) Operating Permits

It is common for the legal duties for Seveso to be implemented in combination with all other legal duties so that authorities can issue a single site operating permit. So in countries such as France, the Netherlands, Portugal and Belgium the various legal requirements become merged at site level.

In Italy separate permits are issued for other legislation (Environment, Fire Prevention, etc.) and different authority inspections are performed for each set of regulations.

In countries, such as UK and Republic of Ireland, which do not require operating permits, the source of legal duties is clearer.

This document focuses only on the obligations from the European Seveso Directive. By exception a few country-specific regulations which add to and build upon the duties under Seveso are listed in this section, only to help understanding of the source of these obligations.

Some industrial gases sites may be required to have permits under the Industrial Emissions Directive 2010/75/EU [5]. This is principally relevant for hydrogen, HyCO, acetylene and nitrous oxide production. This Directive has similar requirements to Seveso for identifying emergency scenarios, off site releases and having preventive measures and an appropriate emergency plan in place.

5.1 [Flanders/Belgium only] Safety Report of the Surrounding area – "OVR"

In Flanders (Belgium) Upper tier sites are required to publish an OVR ("Omgevingsveiligheidsrapport") report – as well as the Seveso safety report. The OVR report documents risk to people in the surrounding area and must be made available (via municipal authority) to the public. See appendix G.

5.2 [France] Prevention Plan for Technological Risk – "PPRT"

This regulation manages land use and land use planning around Upper tier Seveso sites and – as in other countries - gives guidance to the city authority for future developments in hazards zones.

However in France this regulation also enables the local authority to place obligations on owners of existing premises which are close to Upper tier sites. For example private house owner could be required to sell his property to the local authority/city council and move out of the hazard zone. Another example is where night-time traffic is excluded from a port refinery area in Strasburg through the PPRT regulation. See appendix G.

6 Application of Seveso, Qualifying Quantities including the Summation rule

Key Objective: to give guidance on the applicability of Seveso to industrial gases facilities by explaining the qualifying thresholds including the summation rule.

The "foreseeable presence" of each dangerous substance shall be compared to thresholds published in Annex I of Seveso. Appendix A lists and compares the Lower tier and Upper tier thresholds for Named substances (see A.1) and generic substances (see A.2) in the Directive.

There are a series of tests to determine whether a site is subject to Seveso.

These are explained here as a series of questions and also illustrated by means of a flowchart in Appendix A.3.

6.1 Single Named substance

An establishment can be in scope, based on the presence of a single specific "Named Substance" listed in Seveso Annex I part 2. An example is oxygen. If oxygen is the only substance on site, the site will be Lower tier if it is foreseeable that the total quantity of oxygen present is 200 tonnes or more. If there could be 2000 tonnes or more of oxygen present, then the site qualifies as an Upper tier site.

The same logic applies for each Named substance separately.

6.2 Pure substances and mixtures

The Seveso text states in note 2 to Annex I: "Mixtures shall be treated in the same way as pure substances, provided they remain within concentration limits set according to their properties under Regulation (EC) No.1272/2008, or its latest adaptation to technical progress, unless a percentage composition or other description is specifically given. [2]

6.3 Substances outside scope of Seveso

Seveso focuses only on substances which are classified as hazardous to people or the aquatic environment. Inert gases are not included within the scope of Seveso.

Substances which are classified as: corrosive, mutagenic, with reproductive hazards *or* harmful (by any exposure route) may also be outside the scope of Seveso. (Most carcinogens are also excluded from Seveso, with the exception of a few "**single exposure**" or "one-shot" carcinogens which are *Named* in Annex I because of their immediate effect.)

Clearly there can be accident scenarios on a Seveso site which do not meet the definition of a major accident hazard, because there is no involvement of a Seveso hazardous substance. Simple examples include: drowning in water, asphyxiation, immersion in caustic or concentrated acid. Assessment and control of these risks is outside the scope of Seveso and this document.

COUNTRY NOTE: in France the authorities require that accident scenarios related to large leaks of inert gas are included in safety report of the sites which are Seveso classified due to other dangerous substances. This is not the case in existing regulations in most other European countries: Germany, Italy, Belgium, Republic of Ireland, Netherlands, Denmark, Sweden, Norway, Romania, Slovenia UK or Spain. This distinction is important in the UK; where any work by the CA which is related to Seveso (CoMAH) is chargeable at an hourly rate of approximately £200/hour [6].

6.4 Single Generic hazards group

After checking the Seveso applicability of an establishment for "single named substances", the applicability for generic hazard groups of substances, listed in Annex I Part 1, shall also be assessed.

So the maximum foreseeable quantity of all substances, which are not named, but are classified under CLP as 1 ACUTE TOXIC Category 1, by any exposure route, shall be added together. If these are the only substances present and the total quantity is 5 tonnes or more, the site is in Seveso as "Lower Tier". If there are 20 tonnes or more of "1 ACUTE TOXIC Category 1, all exposure routes" materials foreseeably present then the site is Upper tier.

Again this assessment shall be evaluated for each generic hazard category separately.

The supplier SDS is always the determining document for classification of substances placed on the market.

The tables in Appendix A provide Seveso Substance "Generic" Categories and Threshold Quantities.

In CLP a new hazard category O2 “Substances and mixtures which, in contact with water, emit flammable gases, Category 1” is added. Calcium carbide is included in this category with a lower tier threshold of 100 tonnes. It is important for Acetylene manufacturing site operators to understand that all of these “other hazards” are excluded from the summation rules.

Some substances may be classified under CLP with more acute health hazards where there is insufficient test data. Specifically note 7 in Annex 1 states: “Dangerous substances that fall within Acute Toxic Category 3 via the oral route (H 301) shall fall under entry H2 ACUTE TOXIC in those cases where neither acute inhalation toxicity classification nor acute dermal toxicity classification can be derived, for example due to lack of conclusive inhalation and dermal toxicity data”. Normally substances which are “only” Category 3 toxic would not come into scope of Seveso. Note 7 has in principle the consequence of introducing substances which are “only” Category 3 via oral route into the scope of Seveso when there is no evidence about toxic effects by inhalation or dermal absorption.

Industrial gases products are classified by EIGA WG9 who focus on inhalation effects, see EIGA Doc 169 [4]. Gases are unlikely to be classified as H301 but note 7 can have a major influence on the Seveso relevance of liquid chemicals.

6.5 Exceeding any single threshold category (Named or Generic)

If any single “Upper tier” threshold is exceeded, then the site is certainly an Upper tier site.

If any single “lower tier” threshold is exceeded, then the site is at least a Lower tier site, but can even be an Upper tier site, when the Summation rule is applied (see 6.6).

If no single “lower tier” threshold is reached, then the site can still qualify, as either a “Lower Tier” site or, even an Upper tier site, when the Summation rule is applied (see 6.6).

The results of the summation rule are also needed to finally confirm sub-Seveso status.

6.6 Summation Rule

Seveso requires that an assessment is made for similar hazards:

- health hazards – acute toxic/ specific target organ toxicity (STOT) – single exposure,
- physical hazards – oxidizing/flammable/explosive/self-reacting/pyrophoric,

  and
- environmental hazards, with risks to the aquatic environment.

Named substances shall be included in each calculation if they are assigned relevant hazard phrases, but using the Named threshold quantity i.e., for Oxygen only use 200 tonnes (lower tier) or 2000 tonnes (Upper tier).

The Lower or Upper threshold for the relevant property/substance shall always be used when aggregating "generic" substances. If a substance has more than one hazard property, it should be included in every relevant summation calculation (i.e. health, physical and environmental), with different thresholds.

The summation calculation shall be performed 3 times adding the contributions from; health hazards, and then physical hazards and lastly hazards to the environment. These shall be calculated once, using Lower tier thresholds and once again, using Upper tier thresholds.

Essentially this summation calculation evaluates the "fraction" of each threshold used and sums for similar hazards. If the total of any sum is greater than or equal to 1, then the Seveso status is achieved "on summation". The fractions from relevant Named substances, using their specific threshold quantities, shall be added with the fractions from relevant generic categories. In order to perform this calculation the SDS is needed for any Named substances so that all relevant (health, environment and fire/explosion) hazards are evaluated. Substances with multiple hazard properties, such as chlorine or arsine, need to be included in each calculation.

The detailed calculation is shown in Appendix A.4 with several examples.

The Directive shall apply to establishments if the sum:

$q_1 / Q_{T1} + q_2 / Q_{T2} + q_3 / Q_{T3} + q_4 / Q_{T4} + q_5 / Q_{T5} + \ldots$ is greater than or equal to 1,

where:

q_x = the quantity of the Named dangerous substance x

OR

q_x = total quantity of dangerous substances within generic category x

and

Q_{TX} = the relevant Upper or Lower tier qualifying threshold quantity for dangerous substance x, or generic category x, from the Named substance list or generic substance list in Annex I.

Note: "Other hazards" in the generic hazard categories (section O, now including Calcium Carbide) are excluded from summation.

6.7 2% rule

In the Notes to Annex I of the Seveso Directive, note 3 (copied below) is given. It has been interpreted and used very differently across Europe:

> *"The quantities to be considered for the application of the relevant Articles are the maximum quantities which are present or are likely to be present at any one time. Dangerous substances present at an establishment only in quantities equal to or less than 2 % of the relevant qualifying quantity shall be ignored for the purposes of calculating the total quantity present **if their location within an establishment is such that it cannot act as an initiator of a major accident elsewhere on the site.**"*

There is general practical agreement that any fire involving flammable dangerous substances could spread and so the 2% rule should not be applied unless the separation distance is significant.

Advice should be sought whether this rule can and should be used to exclude, for example the contents of a cylinder containing a non-flammable, toxic gas from the inventory calculations. Generally a gas cylinder would contain only a few kilograms, which is clearly well below 2% of the threshold quantities given in tonnes. Clearly there is a potential consequence to persons nearby, in the event of a release of toxic gas, but it is technically unlikely (or impossible) for this gas release to initiate another major accident on the site - but some authorities have a different view.

A case may be made to exclude substances in cylinders which are oxidising and non-toxic, if the consequences of a leak or release can be demonstrated not to affect people or interact with any other dangerous substances on site.

Similarly a diesel storage tank holding less than 2% of the relevant threshold might be excluded if the consequences of a release and/or fire can be shown not to initiate another major accident elsewhere on site.

Where any substances are present at less than 2%, and where the case is made that another Major accident is not possible, then these substances are simply excluded from the summation calculations described in section 6.6.

7 Notification

Key objective: to outline the information which must be provided to the CA in order to notify them of a site which is subject to Seveso.

Site operators shall notify basic details to the CA. The Directive outlines the minimum information to be submitted to the CA for Lower Tier sites. For Upper tier sites this may be included in the Upper Tier safety report. Some countries provide forms or templates for this notification.

Information about the quantity and physical form of anticipated dangerous substances is to be included in the notification. The site operator is responsible for submitting the Seveso notification and revising when necessary.

There is an important implied duty for the site operator (e.g. facility manager/operations director) to maintain the inventory below these notified levels and to revise that notification if information changes.

7.1 Content of Seveso Notification

The Seveso Directive [article 7] requires that the site operator sends a set of information to the national CA identifying: the site, its location, the person responsible, the foreseeable maximum inventory of dangerous substances, the physical form of the dangerous substances involved, as well as outlining the operating processes and the site surroundings. The Seveso Directive does not specify the notification format or communication method.

COUNTRY NOTE: In some countries notification of the Seveso Directive is included within a more comprehensive operating permit regime (e.g. France, Netherlands, Slovenia and Germany).

COUNTRY NOTE: in Portugal the authorities integrate the Seveso Notification with the Industrial Exploitation Permit. When the notified inventory qualifies the site as Seveso (lower or upper tier) the environment authority (APA) will always require the site operator to present an off-site risk study using recognized software (like EFFECTS or PHAST) to assess the impact (in terms of consequences and frequency) for a major accident. Based on this risk study, APA determines whether the site location is compatible with its proposed use and advises the Industrial Authority accordingly.

The 'Industrial Exploitation Permit' is then granted (or not). The Permit may or may not give approval to hold the requested Seveso inventory.

COUNTRY NOTE: In Italy, the content and the format of the notification, as well as the formal submittal to the CA, are defined and managed via the ISPRA web-based portal at the following webpage: https://www.isprambiente.gov.it/it/servizi/controlli-sui-pericoli-di-incidente-rilevante-direttiva-seveso-iii

7.2 Timing for sending Notification / updates

For new establishments the Notification shall be submitted to the CA at "a reasonable period of time prior to the start of construction".

For existing establishments the notification shall be updated; in the event of a significant increase in the amount of dangerous substances present or a significant change of the nature or physical form of those substances.

The CA shall be immediately informed upon permanent closure of the installation.

COUNTRY NOTE: In Germany the timing for submission of notification for a new site or for permanent closure of an installation, is defined in the regulations as 1 month prior to start of construction or 1 month before permanent closure.

7.3 Informing in the event of changes

The site operator is responsible to formally notify the CA "in advance of" any change in the site inventory, the operating processes or the physical form of the dangerous substances stored on site. (See also 14 about identifying and evaluating changes with "significant repercussions").

COUNTRY NOTE: In Germany the timing for submission of notification if significant changes, is defined in the regulations as 1 month beforehand.

7.4 [UK only] Hazardous Substance Consent

The Seveso Directive places duties on authorities to manage land use around Upper tier and Lower tier installations. Within the UK this aspect of Seveso is enacted under separate Planning regulations, which require a site operator to apply to the local civil authority for consent to hold their maximum foreseeable inventory of Dangerous Substances. The local authority is required to consult with the CoMAH Competent Authorities for environment and for health & safety, as well as the emergency services [6]. The consultees are obliged to respond within 6 weeks.

The GB/NI[2] H.S.E will determine consultation zone based on their calculations of the risk of a major accident. The HSE will also provide one of 2 verdicts; they will either "Advise Against" or "Do not Advise Against" the proposed installation. It can take several months, even up to 1 year for this determination to be made.

It is important to note that the ultimate decision rests with the local authority who will grant or deny "consent" to hold the dangerous substances based on their view of net benefit to the community that they represent.

The Hazardous Substance Consent must be granted before the Dangerous Substances at that site can exceed the Seveso/planning threshold. In most cases the planning threshold is the same as the Seveso Lower tier threshold quantity in Annex 1 of the Directive, but with 3 notable exceptions based on previous UK law:

	UK HSC threshold	***Seveso threshold***
Hydrogen	**2 tonnes**	5 tonnes
LPG	**15 tonnes**	50 tonnes
Natural gas / LNG	**25 tonnes**	50 tonnes

After the HSC is granted then the site operator must separately notify the CoMAH competent authority under the COMAH regulations enacted under the Health & Safety at Work Act [6, 7].

COUNTRY NOTE: Northern Ireland has always produced their own regulations. Due to the devolution of powers separate regulations and planning processes have been implemented during 2015 for England, Scotland and Wales.

8 Major Accident Prevention Policy and Safety Management Systems

Key Objective: to outline the expected content of the Major Accident Prevention Policy (MAPP) including safety management systems.

The Seveso Directive states that a MAPP shall be documented and properly implemented. The MAPP shall focus on the control of major accident hazards and on the means to protect people and the environment. The MAPP shall be proportionate to the level of hazards presented by the establishment. The MAPP shall be implemented by means of a safety management system (SMS) or – for Lower Tier sites - by other management systems taking into account the basic principles listed in Annex III, for the prevention of major accidents.

According to the Seveso Directive, the MAPP is required as a separate document for all establishments. The MAPP shall be implemented by the safety management system for upper tier establishments, by other appropriate management systems for lower tier establishments

The interpretation and practical application of MAPP are significantly different among the European member states. This is evidenced in the European Commission's Joint Research Centre report [8].

COUNTRY NOTE: in UK, Republic of Ireland, Italy, Germany, the Netherlands, Belgium, Spain and Portugal both the MAPP and an SMS to implement the MAPP are explicitly required for both Lower Tier and Upper tier sites. In Belgium the CA have included additional detailed criteria for the content of the MAPP in the national legislation. The Belgian, Dutch and Italian CA have developed detailed inspection tools (checklists) to assess the MAPP and SMS at both Upper tier and Lower tier sites. In France Upper tier sites must have MAPP and SMS, while Lower tier sites require a MAPP, but no SMS. (The focus in France for Lower tier sites is on compliance with the operating permit.)

[2] Strictly the United Kingdom (UK) comprises Great Britain (GB) (England, Scotland and Wales) plus Northern Ireland (NI). Northern Ireland produces its own regulations and has separate CA. Broadly speaking the approach to CoMAH is consistent across UK and distinctions are only made in the document for accuracy of regulations, CA and publications.

For these reasons EIGA members should always refer to their own national regulations and guidance about MAPP/SMS. Some key guidance documents published by authorities for MAPP/SMS are referenced in Appendix G with hyperlinks.

However, the following sections of this document include a general outline of what is considered by EIGA members to be good industry practice in terms of the content of a suitable MAPP for Seveso and how it can be implemented. It is important for Seveso that the MAPP addresses management of Major Accident hazards.

EIGA has published Doc 186 *Guideline for Process Safety Framework* intended to provide a design basis for the development of a process safety management (PSM) system, where an organisation does not have one [9]. Twenty one (21) Process Safety Elements are defined and described in Doc 186 and listed in Appendix C of this document. These elements are individually referenced in 8.2 below.

8.1 MAPP - content

The MAPP should describe - at high level - the company's approach to the prevention of Major Accidents. The MAPP needs to outline; the overall aim [to prevent MA], the role and responsibility of management and how the organisational controls will deliver a high level of protection for people and the environment and shall include a commitment towards continuously improving the control of major-accident hazards. The MAPP shall be proportionate to the level of hazards presented by the establishment.

COUNTRY NOTE: In the UK the CA expects that the most senior company official within the country will (co-)sign the MAPP in order to demonstrate a company commitment to providing all of the necessary resources required to prevent major accident. In the Netherlands, Germany and Belgium there is no requirement for a signature on the MAPP. In Italy the MAPP shall be signed by the site *operator. In Republic of Ireland the MAPP must be signed by the managing director of the company or equivalent. In Spain and Portugal there is no specific requirement for either the CEO or the facility manager, to sign the MAPP document, but it must be signed by a company representative.

It is EIGA's opinion that it is good practice for the MAPP to be signed both by the facility manager and by the most senior company official within the country. That senior company official represents the site "*operator" – see 3.3.18 and is effectively the person who makes the financial decision about committing resources in terms of time or hardware, to adequately control major accident hazards at each site. (See also 10.4)

The MAPP must include a commitment towards continuously improving the control of major-accident hazards. The MAPP may be incorporated in a single integrated Health, Safety and Environmental protection policy provided it clearly addresses MA hazards and not only "worker safety". In some countries however there is less distinction between a concise Policy statement and a description of the management system to implement the policy. This means that in some countries the MAPP is a one-page document, supported by a description statement, explaining the implementation of SMS, and in other countries the CA expect a comprehensive SMS description to be included within the MAPP itself.

In some countries the CA may expect that the MAPP is a Seveso specific document, different from the company HSE Policy.

The MAPP needs to address two requirements:

- The policy, or statement of intent, setting out the aims and principles of action with respect to the prevention of major accidents,
- A description of the management system for achieving the stated aims, including the key issues which are specified in Annex III of the Directive (see 8.2).

The MAPP may refer to other documents such as; procedures, job descriptions, risk assessments and other records, which can be part of the safety management system.

See "MAPP guidance links" in Appendix G.

8.2 MAPP - Implementation

Seveso requires that all site operators document how the organisational and management systems are intended to, and are effective in, preventing MA. Whether those management systems are required to be formally recognised as a SMS is interpreted differently across Europe.

Minimum requirements for SMS for prevention of Major Accidents are defined in Annex III of the Directive.

As for any management system, the Seveso SMS is based on the Deming Plan-Do-Check-Act circle (DEMING, WE, https://deming.org/explore/pdsa/ [10]. The Seveso SMS may be a stand-alone system or integrated within an overall management system, which addresses other matters such as quality or workers' safety. The elements of the Seveso SMS are strongly related to safety culture and should include human factors. See Info EIGA HF 01 *Human Factors Overview* [**Error! Reference source not found.**. In some countries, the CA may expect that the Seveso SMS is a specific Management System or at least that the Seveso elements are clearly identified, when included in a wider scope Management System (e.g. ISO 45001, *Occupational health and safety management systems — Requirements with guidance for use* and/or 14001, *Environmental management systems — Requirements with guidance for use* etc.).[12, 13]

The Seveso SMS shall address the following issues:

- Organisation and personnel:
  - Definition of roles and responsibilities of personnel at all levels, involved in the management of major hazards;
  - Identification of training needs and provision of training;
  - Selection of competent personnel and monitoring of their performance;
  - Delivery of information and training to subcontractors;

  PSM Framework Elements 1, 3, 4 and 18 in EIGA Doc 186 are relevant. [9]

  See EIGA Info HF 02 *Training and Competence*, EIGA Doc 23 *Safety Training of Employees* and *EIGA Oxygen e-Learning* 0

- Identification and evaluation of major hazards, in particular:
  - Identification of hazards from the site activities and substances present, in both normal and abnormal operation including subcontracted activities where applicable and the assessment of their likelihood and severity. (See EIGA Doc 04 *Fire Hazards of Oxygen and Oxygen Enriched Atmospheres,* EIGA Doc 75 *Determination of Safety Distance*, EIGA Doc 189 *The Calculation of Harm and No-Harm Distances for the Storage and Use of Toxic Gases in Transportable Containers*, EIGA HF 13 *Organisation - "Human Reliability"* [17, 18, 19, 20]);
  - Consideration of the lessons learnt from previous incidents and accidents, from operating experience and from previous safety inspections and audits (See EIGA Doc 90 *Incident/Accident Investigation and Analysis*, EIGA Info HF 03 *Organisation - "Human Factors in Incident Investigation"*, Doc 102 *Safety Audit Guidelines*, Appendix L and EIGA TP-INC's [21, 22, 23, 24]);
  - Documentation of the risk assessment (see section 9) and definition of required safeguards (see section 10.3).

  PSM Framework Element 6 in EIGA Doc 186 are relevant. [9]

- Operational control:
  - Documented procedures and instructions for safe operation of the plant in all phases: normal operation, maintenance, alarm management and temporary stoppage.; including safe systems of work such as; permit-to-work, energy isolation, confined space entry (See EIGA Doc 40 *Work Permit Systems* and EIGA Doc 44 *Hazards of Inert Gases and Oxygen Depletion* [25, 26].

- Implement best practices for process monitoring and control, to minimise the risk of system failure; control of the risks from ageing equipment and corrosion (see EIGA DOC 190 *Plant integrity management [27]*;

PSM Framework Elements 8, 9, 11, 13, 15, 16 and 17 in EIGA Doc 186 are relevant. [9]

- Management of change system, (see EIGA Doc 51, Management of change [28]) which includes:
  - A clear requirement to identify, assess and authorize modifications to; process plant, technical control measures and organizational changes;
  - Consideration of all changes which may affect the control of major accident hazards;
  - Evaluation of the consequences of the changes;
  - Obligation to update all relevant documentation;

  PSM Framework Elements 12 and 13 in EIGA Doc 186 are relevant. [9]

- Planning for emergencies (on-site plan):
  - Identification of foreseeable emergency scenarios in order to prepare procedures for mitigating the consequences (see 11) (see EIGA HF 06 *Organisation: Site Emergency Response and* EIGA HF 13 Organisation - "Human Reliability"[29, 20]);
  - Testing and review of those emergency procedures
  - Specific training appropriate to roles in emergencies of all personnel including relevant subcontractors
  - Provision of information to people nearby who can be affected (see 13)

  PSM Framework Elements 3, 5 and 14 in EIGA Doc 186 are relevant. [9]

- Monitoring performance:
  - Definition, monitoring and review of relevant performance indicators to measure the effectiveness of safeguards to prevent MA. (See UK HSE Guidance HSG254: Developing process safety indicators: A step-by-step guide for chemical and major hazard industries [30] and EIGA Doc 223 *Monitoring of process safety performance* [31]).
  - Periodic inspection of equipment and instrumentation. See EIGA Doc 190 *Plant Integrity Management and* Doc HF 05 Task – “Maintenance Error" [27,32];
  - Pro-active assessment of compliance with written instructions and procedures (active monitoring) (see EIGA Doc 102, *Safety Audit Guidelines* [23];
  - Reporting of incidents and accidents (reactive monitoring) and requirement to perform root-cause analysis to identify and implement preventative actions. See EIGA Doc 90, *Incident/Accident Investigation and Analysis* and EIGA Info HF 03, Organisation - "Human Factors in Incident Investigation" [21,22]

  PSM Framework Elements 8, 15, 19 and 21 in EIGA Doc 186 are relevant. [9]

- Audit and review:
  - Implementation of a formal audit plan addressing the effectiveness of systems which prevent or mitigate against MA;
  - Requirement for periodic review and update of the MAPP and SMS by senior management, reflecting performance indicators and audit findings, in order to define improvement objectives.

  (See EIGA Doc 135 *Environmental Auditing Guide* and EIGA Doc 102 *Audit Guidelines* [34, 23])

  PSM Framework Element 20 in EIGA Doc 186 are relevant. [9]

  The MAPP shall be reviewed at least every five years (or more frequently if mandated by local regulations) or in case of relevant changes.

COUNTRY NOTE: In Italy the MAPP must be re-issued at least every 2 years.

9 Identification and assessment of Major Accident scenarios

Key objective: to provide guidance on the identification, analysis, assessment and control of scenarios, which EIGA believe broadly meet the definition of "Seveso Major Accident hazard scenarios."

Seveso requires that site Operators (as defined by Seveso, see 3.3.18) take all necessary measures to prevent MA and to limit their consequences for people and the environment. Furthermore, the Operator shall be able to prove to the CA that all necessary measures have been taken and that the measures are sufficient to guarantee a high level of protection. So in most countries the CA expects that some form of risk assessment is documented for all MA scenarios.

COUNTRY NOTE: in Germany the fundamental legal structure precludes the concept of "risk" and instead of "risk assessment" the duty under Seveso legislation is to demonstrate that the "best available safety technology" ("Stand der Sicherheitstechnik") has been implemented to prevent and mitigate any Major Accident hazards.

9.1 What does Scenario mean?

In this document the term "**scenario**" is used to describe a series of events, leading from an initiating event (which can be internal or external to the site), and resulting in a loss of containment of a Dangerous Substance, with the potential to meet the definition of MA. The frequency of each combination of events shall be assessed as part of the evaluation of the acceptability of the scenario – this is discussed in section 10.3.

9.2 Types of initiating events to be considered

For Seveso all credible initiating events which could result in loss of containment should be considered. These include:

- operational causes such as; failure of equipment or human error, including sub contracted activities at the site, whether during normal operations, process start-up, shutdown, or maintenance etc.
- external emergencies from other nearby facilities which could impact the site,
- natural causes such as earthquake, flood or other severe weather.

A checklist of initiating events is included in Appendix E0. See also 9.7.

9.3 Risk Assessment process/methodology

No single risk assessment method or approach is mandated or recommended for Seveso at European level, but there is general agreement that a risk assessment and evaluation approach should include the following steps:

a) Identifying the hazards and possible consequences; determining which scenarios can result in a MA (See and 9.2);

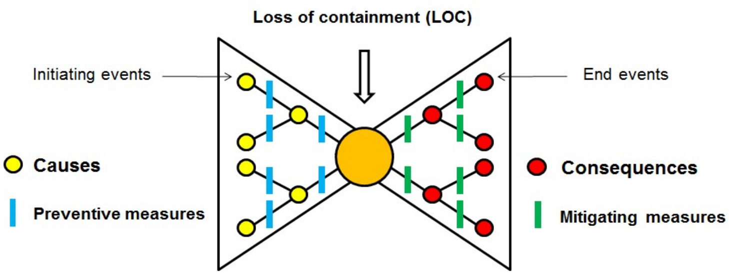
b) Examining the residual risk after taking existing preventative and mitigating measures (safeguards) into account, including the human factor aspects; see 9.6 to 9.9);

c) Deciding upon the requirement for additional measures, based on the evaluation of each scenario in comparison to the member company risk acceptance criteria (see 10 and 10.4);

d) Implementing the decisions for additional measures (see 10.4);

e) Evaluating the effectiveness of the additional measures and revising where necessary (see 10.4).

Appendix D provides more detail on how a scenario can be identified and constructed, using for example the Bow tie approach.



Process Hazard Analysis, like "HazOp – Hazard and Operability Studies" or Bowtie, are examples of accepted scenario assessment methodologies.

Only when frequency assessment is incorporated into HAZOP or Bowtie does the outcome meet the definition of "Risk Assessment"

9.4 What is a Major Accident?

In order to identify the scenarios that need to be documented, it is necessary to take a closer look at the definition of a **major accident** according to the Directive:

***Major Accident (MA)**: "An occurrence (including in particular a major emission, fire or explosion) resulting from uncontrolled developments in the course of the operation of any establishment and leading to serious danger to human health or the environment, immediate or delayed, inside or outside the establishment and involving one or more dangerous substances."*

The Directive also places an obligation on member states to inform the European Commission about Major Accidents with consequences exceeding specified thresholds given in Annex VI for people's health, the environment and property on site or outside the establishment, for the purposes of shared prevention and mitigation.

9.4.1 Major Accident – harm to people

The first element states that only emissions, fires or explosions resulting from uncontrolled developments in the operation of a plant are included. So vehicle accidents on public roads, e.g. with bulk trailers, should not be considered; in fact, the transport of dangerous substances and directly related intermediate temporary storage by road, rail, internal waterways, sea or air are out of the scope of the Major Accident Directive.

Only those occurrences which involve the dangerous substances covered in Annex I are relevant. This means that loss of containment scenarios of substances such as nitrogen, carbon dioxide or other inert gases are not "major accidents", even if they can result in fatalities.

COUNTRY NOTE: in France the authorities require that accident scenarios related to large leaks of inert gas are included in safety report of the sites which are Seveso classified, due to other dangerous substances.

This is not the case in existing Seveso regulations in most other European countries (confirmed for; Belgium, Germany, Italy, Netherlands, Portugal, Republic of Ireland, Romania, Slovenia, Spain or UK)

The last element is that the occurrence leads to "serious danger" to human health and/or the environment, immediate or delayed, inside or outside the establishment. It is therefore clear that major accidents are **not** limited to events with consequences outside the plant, as often falsely thought.

EIGA proposes to use as a criterion for "serious danger to human health"; having the potential to cause life-changing injury or permanent damage to health for people on site or off-site. Examples might include loss of an eye, chronic (long-term) respiratory problems, loss of use of part of the body or permanent impairment of the function of the body. See definitions in EIGA Doc 904, *Work Injury Statistics,* Appendix **Error! Reference source not found.**.

For consequences to people outside the facility there may be an argument to use a lower threshold of harm. There is little published guidance from most CA on this subject, but care should be taken to determine the exact interpretation of "serious danger" in each country.

9.4.2 Major Accident – harm to environment

Annex VI to the Directive includes a list of criteria for environmental accidents with immediate significant or long-term damage to the environment, which shall be reported by the national competent authority to the European Commission. These criteria are not used explicitly in the Directive to define a Major Accident to the Environment (MATTE). In fact it could be interpreted that these are the worst of accidents to the environment and some incidents with a smaller impact could also meet the definition of MA.

COUNTRY NOTE: the GB CA has published guidance on "serious danger" to people, property and the environment. **Error! Reference source not found.**,**Error! Reference source not found.**. No other CA has published guidance on what might constitute a Major Accident to the Environment (MATTE).

COUNTRY NOTE: In Germany serious danger to the environment is defined in the Environmental Protection Act [38] as "harm to the environment, especially to animals and plants, the soil, water, the atmosphere as well as cultural or other material assets, in the event that public welfare would be compromised by a change in their condition or usability."

For industrial gas plants EIGA believes that the Seveso environmental risk assessment (in the form of source-pathway-receptor evaluation) for MATTE would focus on:

- A substance dangerous to the aquatic environment, entering a relevant water system such as stream, river or groundwater (directly or indirectly through soil contamination, drain or sewer) or
- A toxic gas release affecting sensitive species or habitats.
- An acidic or alkaline gas release, or a release that creates acidic or alkaline by products affecting sensitive species or habitats.
- Consequences arising from other accident scenarios, such as contaminated water from firefighting, explosions or smoke from fires.

Examples might include; diesel fuel or biocides classified as marine pollutants entering a stream or a chlorine release into an area of "Special Scientific Interest" (SSSI) or internationally important wetlands ("RAMSAR sites") [39, 40]. See also Appendix J.

9.5 Risk

Risk is normally understood to be the combination of severity of consequence and the likelihood of that undesired outcome. The term "risk" is defined within the Directive as:

> ***Risk:** means the likelihood of a specific effect occurring within a specified time period or in specified circumstances.

A risk may be expressed, for example, as; x fatalities per 100 years, or the probability of life-changing injury is 10^{-4} per year, or the risk of explosion is 0.03 per year.

The full risk assessment eventually needs to incorporate the probability of the undesired outcome (loss of containment/ fire etc.) and the likelihood of a person/people (or habitat/species) being affected. Most often this assessment is carried out in stages as described in following sections.

9.6 Consequence Assessment

First of all, a list of all possible loss of containment scenarios needs to be identified, for example from existing design hazard reviews, existing process hazard analysis studies or from a group brainstorming event. This exercise should include a review of incidents at similar facilities. (See Appendix L)

The usual next step is to understand the severity of the outcomes or consequences resulting the identified scenarios.

This assessment may be qualitative or quantitative (e.g. dispersion calculations, safety distances) and the test is to determine whether any outcome meets the severity definition of a Major Accident considering people and the environment, as described in section 0 above. If the consequence does not involve a dangerous substance or does not result in potential "serious harm", then the Seveso assessment can stop at this stage.

When considering the consequences of fire/explosion where a person could be present close by, then it is clear that the scenario will always meet the MA definition.

For the release of any substance which is dangerous to the environment or has health effects for people then reference needs to be made to the Safety Data Sheet... and usually some release modelling (dispersion calculations) will be required.

See:

EIGA Doc 189 *Toxic Gases* **Error! Reference source not found.**

EIGA Doc 75 *Determination of Safety Distance* **Error! Reference source not found.**

EIGA Doc 187 *Guideline for the Location of Occupied Buildings in Industrial Gas Plants* **Error! Reference source not found.**

Similar consequence modelling is required for releases resulting in oxygen enrichment in order to determine the distance or area that can be affected.

See EIGA Doc 04 *Fire hazards of Oxygen and Oxygen Enriched Atmospheres* **Error! Reference source not found.**

COUNTRY NOTE: as mentioned in 7.1, in Portugal CA for Seveso, when the Notification qualifies the site as Seveso (lower or upper tier) the environment authority (APA) requires the site operator to present a risk study including consequence assessment using recognized software (like EFFECTS or PHAST). Based on this Risk Study APA determine if the location of the site is compatible with its use.

COUNTRY NOTE: In Germany the recognized calculations are based on VDI standards. It should be made clear to the Authorities that cryogenic tanks are vacuum jacketed and have different failure modes and smaller consequences than single walled tanks used elsewhere in the chemical industry.

9.7 Initiating events

It is important at this stage to be able to demonstrate that *all* causes of scenarios which might meet the MA definition have been considered. Annex III of the Seveso Directive identifies that the MAPP (and therefore the scenario risk assessment) should address risk associated with ageing plant and corrosion as well as alarm management.

Appendix E0 includes a checklist of initiating events which in the view of EIGA should always be considered when identifying or reviewing Seveso scenarios for industrial gas facilities. This list is based on various published lists, member company experience under Seveso and has been informed by a review of incidents reported to EIGA Safety Advisory Council. This checklist is offered as a best practice starting point for the industrial gases industry, but teams should always search for other challenges to the mechanical integrity of a containment system (physical envelope).

See:

EIGA Doc 190 *Plant Integrity Management* **Error! Reference source not found.**

EIGA Doc 39 *Safe Preparation of Gas Mixtures* **Error! Reference source not found.**

EIGA Doc 139 *Safe Preparation of Compressed Oxidant-Fuel Gas Mixtures* [**Error! Reference source not found.**

EIGA Doc 175 *Safe Practices for the Production of Nitrous Oxide from Ammonium Nitrate* [44]

EIGA Doc 176 *Safe Practices for Storage and Handling of Nitrous Oxide* [45]

Annex III of the Seveso Directive, additionally identifies that the MAPP (and therefore the scenario risk assessment) should address risks associated with ageing plant and corrosion as well as alarm management.

9.8 Frequency Assessment

Broadly there are 3 types of frequency assessment: qualitative, semi-quantitative and quantitative.

9.8.1 Qualitative frequency estimation

A multi-disciplined team can make a reasonable judgement of the likelihood of an initiating event or scenario, especially if a company has defined a range of frequencies in terms of descriptors and/or numbers. Examples of frequency descriptors include "improbable, possible, probable..." or "likely to happen during the lifetime of a facility", "has occurred in industry", "occurs normally each year", etc.

9.8.2 Semi Quantitative

The Centre for Chemical Process Safety (CCPS) developed a simplified method for process risk assessment, called LOPA, or "Layer of Protection Analysis" **Error! Reference source not found.**. This method uses the concept of "Independent Protection Layers" or "IPLs".

Each IPL for a scenario contributes to the risk reduction of that scenario. This contribution is quantified by a figure, expressing the reliability of the IPL. The risk reduction factors of all the IPLs for the scenario are multiplied with each other and with the frequency of the initiating event, to estimate the frequency of occurrence of the scenario. Failure frequencies are multiplied for typical IPLs to estimate a frequency for the scenario outcome (consequence). For more information see Appendix D and 9.9 below.

NOTE that LOPA is an effective method for assessing process plant "deviations" including the likelihood of operator error. Other methods should be applied for assessing human tasks without process equipment such as cylinder handling; sorting; and loading and unloading cylinder trucks.

COUNTRY NOTE: in Belgium the CA prefer the use of LOPA for the evaluation of scenarios related with process installations and it is integrated in a software tool, called PLANOP, that they have made freely available for documenting and evaluating MA scenarios. (See **Error! Reference source not found.**).

COUNTRY NOTE: In France scenarios with only on-site consequences are excluded from Seveso safety reports – because these are addressed by general worker protection laws.

9.8.3 Quantitative frequency assessment (e.g. Fault Trees)

This type of frequency assessment is mostly referred to as QRA or "Quantitative Risk Assessment". It is based on detailed computer calculations of likelihood using statistical failure frequencies. It is quite complex and requires specialized resources.

Full fault tree analysis requires specific failure rate / reliability information for each component of a process system, modelling both the normal operating components (valves, instruments and control devices, pumps etc.,) and the potential failure on demand of any protective measures such as software trips, hard-wired trips and relief devices. Care needs to be taken that the tree logic properly reflects active and passive failure modes. As for dispersion modelling, specialist advice should be sought from in-company experts or external consultants.

Fault tree analysis, if used correctly, can combine human and technical failure modes.

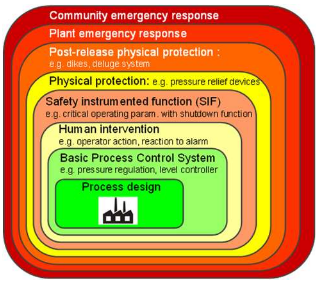
It is important when developing fault tree assessments for Seveso to ensure that the input data is relevant and acceptable to the CA. Studies have shown that the outcome of a QRA for identical scenarios can give very different results, depending on the dataset and software used.

COUNTRY NOTE: In the Netherlands the issues regarding input data and software programmes have led to the development of a standardized version of DNV's PHAST/Risk, named "SAFETI-NL" for the purpose of authority-required assessments in the Netherlands. This "SAFETI-NL" program is maintained by the National Institute for Public Health and the Environment (RIVM) to ensure defined settings and consistent "rules of calculation".

COUNTRY NOTE: France requires Safety Report to include quantitative assessment for off-site scenarios for Lower tier as well as Upper tier sites.

COUNTRY NOTE: In Spain the Safety Report must include a Consequence Study of the different risk scenarios. The QRA defines the required safeguards.

9.9 Safeguards and Layers of Protection



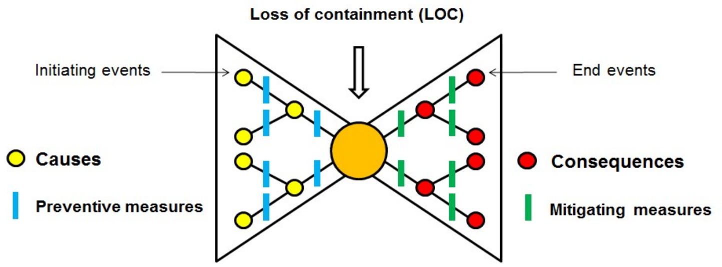
As the outcome of the final evaluation of scenarios (see 10) will heavily depend on the availability and the quality of safeguards, it is very important to make sure that all available safeguards are captured in the scenario documentation.

Safeguards are also called "protection layers". They may be grouped in different categories (see Figure on the left).

For more information see Appendix D.

Some safeguards will stop an initiating event resulting in a loss of containment. These are called "preventative" measures.

When represented on a "Bowtie" the preventive measures are on the left side "before" the Loss of Containment (LOC).



There are also measures needed help to minimise the effects of an incident after the loss of containment has occurred, such as bunds, fire suppression system and emergency plans. These are called mitigating measures (and are shown on the right-hand side of a Bowtie). Seveso requires that site operators identify, implement and maintain both preventive and mitigative measures. Although the main focus is per the Directive to take all measures necessary to prevent.

See:

EIGA Doc 127 *Bulk Liquid Oxygen, Nitrogen and Argon Storage System at Production Sites* [**Error! Reference source not found.**

EIGA Doc 115 *Bulk Liquid Oxygen, Nitrogen and Argon Storage System at Customer Sites* [**Error! Reference source not found.**

EIGA Doc *139 Safe Preparation of Compressed Oxidant-Fuel Gas Mixtures* **Error! Reference source not found.**

COUNTRY NOTE: In Denmark and in France the CA require that the risks (frequency and consequence) are documented without the benefit of any safeguards (preliminary, unprotected or "naked risk") as well as evaluating the risk recognising all existing safeguards. This allows a demonstration of the effectiveness of the safeguards.

9.10 Hierarchy of Controls

For any form of risk assessment there is an obligation to first explore whether the hazard source can be completely eliminated, rather than installing additional controls. This concept is equally valid for workplace task risk assessments and for Seveso risk assessment. It is sometimes called the "Hierarchy of Controls".

Briefly the Hierarchy is:

1. **Eliminate** the hazard completely wherever practical.
2. **Reduce** hazard - by dilution or substituting with something similar, but less hazardous.
3. **Isolate** people from hazard (e.g. technical separation such as barriers to protect from sound or chemical spray).
4. **Controls** – for example to provide software trips to close valves and avoid the hazard or alarms to make operators aware of situation.

5. Operating **procedures** - providing clear instructions to avoid hazardous operating conditions, and to ensure that steps to be taken infrequently or in abnormal situations are clearly documented and available.

Then and only then can any reliance be placed on personal protective equipment (**PPE**) or operating **discipline** (such as formal warnings and disciplinary measures) to keep workers safe.

Some technical measures (layers 1, 2 or 3 in the hierarchy) can prevent against several different scenarios (e.g. a hard-wired high pressure trip can also help prevent overfilling of a liquid tank). These clearly have a greater effect than warnings, procedures or PPE.

9.11 Identification of Safety Critical equipment

The competent authorities in some countries encourage Operators to use the information in scenario risk assessments to clearly identify specific equipment items or systems whose failure could result in a MA. This "safety critical equipment" includes relief devices as well as important trips, switches and protections. The concept of safety critical equipment is not included in the Seveso Directive.

The intent of identifying and clearly designating "safety critical equipment" has the benefit of improving understanding throughout a company about the relative importance of key protective systems and ensuring that their maintenance is properly prioritised.

In the industrial gases industry there is also the possibility to widen the definition of "safety critical equipment" to include systems which protect against non-Seveso scenarios such as a major release of cryogenic inert substances. The counter argument is that this widened definition can then include all ASU process systems for example which defeats the object of "prioritising" important systems.

Any such designation should be clearly defined within the company and consistently applied.

COUNTRY NOTE: this concept is expected or demanded by authorities in UK, Italy, Belgium, France, Denmark and Republic of Ireland.

COUNTRY NOTE: in Germany there is an obligation for all Seveso sites to present a list of safety critical equipment. Equipment is safety critical when the inventory exceeds 0.5% of higher tier Seveso limits or 2% of lower tier Seveso limits or because of its protective function. For more guidance, see KAS-1 "Kommission für Anlagensicherheit" at Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection [50].

9.12 Example of gas industry MA scenarios

Key objectives: to introduce and illustrate assessment of some typical gas industry Major Accident hazard scenarios and to introduce a list of some gases industry incidents world-wide which met or could have met the definition of "Seveso Major Accident" with lessons learned.

Appendix E contains examples of different methodologies (ranging from specialized commercial software to simple Excel tables) which can be used to document assessment of major accident scenarios. Two typical gases industry loss of containment scenarios are used to illustrate these methodologies. Note that CA in all countries will demand site-specific assessments and justifications for any component failure rates used.

For Upper tier sites, the Seveso Directive requires that the safety report must include a review of past accidents and incidents involving the same substances and processes, consider lessons learned and describe specific measures to prevent such events. (See also 16).

Appendix L contains a list of incidents which met or could have met the definition of Seveso Major Accident. This list and in-company incident lists can be referenced when identifying major accident scenarios for each site.

COUNTRY NOTE: after a specific accident in Italy, all establishments which vaporise cryogenic products must implement the requirements from Circolare ISPESL n. 9 del 10 luglio 2004: "Impianti che utilizzano gas ottenuti dalla gassificazione dei corrispondenti fluidi criogenici" [51].
Plants using gases obtained from the gasification of the corresponding cryogenic fluids.

10 Evaluation of Major Accident hazard scenarios

Key objective: to discuss management's responsibility for accepting the assessed risk of identified scenarios, which broadly meet the definition of "Seveso Major Accident"

Once a list of potential Major Accident scenarios has been compiled as described in 9, modelling the existing plant arrangements, to determine the consequence and frequency, then some evaluation shall be made of the acceptability of the consequences and frequency of these Major Accidents. This process can be iterative, but in simple terms can be described as a decision tree:

- Do the modelled consequences actually meet the company definition of a MA? (Yes/No)
- Is the risk (i.e. combination of consequence and likelihood) "acceptable" for the plant as it stands today? (Yes/No)
- What additional safeguards or mitigation measures could be added? And is the cost of these additional measures justified in terms of risk reduction benefit?

There is no acceptability criteria included in the European Seveso Directive. According to the Directive it is the duty/obligation of:

- The "operator" to take "all measures necessary" to prevent major accidents and to limit their consequences for people and the environment.
- The CA to ensure that the Operator is required to prove ("demonstrate") that the Operator has taken all the necessary measures specified in the Directive.

Remember that the definition of "Operator" in the Directive refers to the "person who operates or controls an establishment or installation or... to whom the decisive economic or decision-making power over the technical functioning of the establishment or installation has been delegated". In most instances this not the facility manager, but a more senior manager or governing director who holds the responsibility for major capital expenditure and the implementation of central engineering resources.

10.1 Acceptability Criteria – National CA guidance

The legal structure in some countries prescribes either a benchmark or an approach on how to determine whether the risk of a MA is "acceptable". The country note below summarises in simple terms some of the different approaches.

Where an industrial gas company operates in only one country and the CA has defined "acceptable risk" – as for example in France, then it is clear which benchmark should be used for evaluation of the MA scenarios identified in section 9.

The national legal framework regarding "risk" and "cost/benefit" is the overriding influence for Seveso "acceptability".

COUNTRY NOTE: In France the government has prescribed a risk matrix for people off-site (around Upper tier and lower tier establishments, because both need to write answer in safety reports). See Appendix H. In France for people on-site only a qualitative assessment is required.

COUNTRY NOTE: In UK the duty is on the site operator to demonstrate that the facility is "safe enough" so that the risk to people is tolerable if "As Low As Reasonably Practicable" and the risk to Environment is BAT (Best Available Techniques). **Error! Reference source not found.**.

COUNTRY NOTE: In Belgium risk contours ("Risicocriteria") are published by the Flemish environmental authority and used for assessing scenarios with off-site risks for land-use planning **Error! Reference source not found.**.

COUNTRY NOTE: In Italy societal risk (to people outside the establishment) is acceptable if the frequency of fatality is less than 10^{-6}
Decreto Ministeriale 9 maggio 2001 "Requisiti minimi di sicurezza in materia di pianificazione urbanistica e territoriale per le zone interessate da stabilimenti a rischio di incidente rilevante.". [55]
Minimum safety requirements regarding urban and territorial planning for areas with establishments at risk of major accidents."

COUNTRY NOTE: In Romania, the authorities have issued a normative document Monitorul Oficial al Romaniei nr. 755 din 21 Sep 2017 [57] by which, depending on the probable effects of a major accident, 4 impact zones are established: the high mortality zone, the mortality threshold zone, the zone of irreversible effects and the zone of reversible effects. The area with the strongest impact is set at a distance equal to the radius of the fire-ball for BLEVE, or LC50 (for toxic substances), or LFL for flash fire, or 12.5 KW/m2 for fire, jet-fire and pool-fire, or 0.3 bar for VCE/UVCE. The other 3 zones were established according to the values of AEGL 3 (Acute Exposure Guideline Levels), AEGL2 and respectively AEGL 1, values established by the Environmental Protection Agency (USA). Also, this document introduces a zoning matrix of the sites around economic operators subject to Seveso legislation, through which, depending on the danger zone / distance from the source of risk and the estimated frequency of occurrence of a major accident, the categories of permitted constructions are allocated or prohibited, respectively houses, institutions, objectives of cultural and sporting interest, etc

EIGA does not prescribe or recommend risk acceptance criteria. EIGA in its publications will define industry best practice in terms of recognising and controlling gas industry hazards.

10.2 Acceptability Criteria – to be defined by governing directors of company

In the absence of criteria prescribed by a country CA, then the governing directors of a company need to define and be able to justify their own criteria. This becomes even more important for any industrial gas company that operates in more than one country; the governing directors need to be able to define consistent MA acceptability criteria for their company, or they shall be prepared to defend – potentially in a court of law - why different criteria were used in different European countries.

This set of company-specific acceptability criteria effectively define “how safe” a Seveso operating site shall be for the governing director(s) to accept the existing risk, rather than invest in further risk reductions. Clearly there is extreme commercial sensitivity to a company’s own risk criteria.

In the event of a Seveso Major accident it is the “controlling minds” of these directors who may well have to defend in a court of law why they had not invested in additional prevention measures.

When the pan-European context of these acceptability decisions is understood, it is clear that:

- Decisions should not be made by individual site or project teams.
- Acceptability decisions shall be understood, debated and defined at senior (director) level, with input from process safety specialists together with an appreciation of the different country legal frameworks and risk guidance.
- The company-risk criteria shall be considered commercially confidential.

By analogy with the variety of national risk benchmarks described in 10.1, it should become clear that there is no set format for internal company risk acceptance criteria. Remembering that the definition of a Seveso major accident is not restricted only to fatal accidents on site and off, but also includes “serious harm” to people and harm to the environment, then internal company acceptance criteria could be defined, for example as:

- Frequency of individual fatality on-site;
- F-N curve for cumulative societal risk;
- Frequency/consequence matrix;
- Frequency of loss of containment event; and/or
- Risk of environmental accident – including mitigation and weather effects.

Or a combination of the above.

However they are formatted, the company risk criteria, like the national competent authority criteria in 10.1, effectively give a benchmark for comparison of the frequency/consequence/risk assessments made as described in 9.

Where there is no country guidance given, the competent authority may reasonably require a brief outline of how the company selected its risk acceptance criteria – either in a Safety report for Upper tier sites or in the MAPP or scenario assessments for lower tier sites.

It is worth noting that, where an explicit risk acceptance guideline has not been defined in-company, the “operator” or controlling mind of the company will, in practice, knowingly or unknowingly carry the legal responsibility for the current risk and investment decisions.

10.3 Evaluate each scenario (safeguards) to determine if "acceptable"

Whatever the source or format of the risk acceptance criteria, the evaluation step is relatively straightforward. For each scenario identified in section 9, the frequency and consequence shall be tested against the benchmark and deemed "acceptable" or not. In simple terms if the consequence and frequency is less (i.e. better than) the relevant benchmark, then no further action is required. This assessment shall be done for scenarios resulting in harm to the environment as well harm to people.

Using the French risk matrix shown in Appendix H as an example, for any scenario whose combination of frequency and severity is plotted in the green "Acceptable" zone, then no further improvement is required. The considerations required if the answer is not "acceptable" are explored in 10.4.

10.4 Action required if scenario (safeguards) are not "acceptable"

Most risk acceptance criteria are not "black and white", there is usually a range where the calculated combination of severity and frequency is clearly evaluated as unacceptable (the red "NO" zone using the French risk matrix in Appendix H) and there is usually an intermediate range (e.g. the orange or yellow as low as reasonably practicable (ALARP) zones on the matrix in Appendix H) which requires further evaluation.

In simple terms the most usual first step for an "unacceptable" evaluation is to review the detail and accuracy of the initial scenario assessment. Sometimes it is worth placing extra resource into developing more exact quantitative frequency and consequence assessments which might, being more accurate, determine that the combination of severity and frequency is in fact acceptable. This is because in qualitative or semi-qualitative assessments simplifying assumptions are often made.

The next step is then to identify which possible additional safeguards (preventative and mitigating) are required to improve (reduce) the frequency and/or severity so that the evaluated scenario reaches the "acceptable" zone. In practice this phase should involve a comparison of a range of additional safeguards – considering the hierarchy of controls mentioned in 9.10 and their beneficial impact on any related scenarios. The cost of each these additional measures should be weighed against the risk benefit they generate. This is a sensible engineering decision making process whether or not "cost benefit analysis" is part of the legislation or guidance in each country. With the information about the cost of proposed safeguards and the risk benefit they deliver, the "operator" (ideally the Director as the "controlling mind" of the company) should make the decision about additional investment in order to bring the resultant risk to an "acceptable" level, as defined by the competent authority and the company.

Unless the cost of proposed improvement is insignificant, this stage of the process typically requires escalation of the investment decision to senior management. Depending on the country legal framework, it will either be mandated to move out of an "unacceptable" risk zone or it might be defensible for the company to tolerate that high risk, if the cost of additional improvement is severely disproportionate to the risk benefit.

COUNTRY NOTE: This cost-benefit analysis is at the heart of the UK concept of ALARP **Error! Reference source not found.**.

EIGA recommends that in-company risk management processes will formally document the risk improvement and escalation process for decision-making.

10.5 Consider clean-up costs after environmental damage

Key objective: to remind that restoration and clean-up of the environment should be addressed.

In addition to evaluating and reducing the risks to the environment, and implementing necessary mitigation measures, the Seveso Directive as well as the Environmental liability Directive require operators be prepared for remedying damage to the environment after a major accident. **Error! Reference source not found.**

The time, resources and costs involved in addressing after-effects of a MATTE can be significant.

11 Internal Emergency Plans

Key objective: to outline the factors which should be included in internal emergency plans, including restoration and clean-up of the environment.

Both Upper tier and Lower tier sites shall have an internal emergency plan which is designed to minimise the consequences of a MA. According to the Directive, for Lower tier sites the internal emergency plan can be part of the MAPP or a standalone document. For lower tier sites the internal emergency plan is a company internal document. For Upper tier sites the internal emergency plan is usually shared with, and reviewed by, other organisations involved in developing the External Emergency plan. The site operator has a duty to share information with the local authority responsible for making the External emergency plan and this requirement for collaboration means that outside organisations may comment on and influence the internal emergency plans for Upper tier sites.

In developing emergency action plans all of the major accident scenarios, from chapter 9, shall be addressed.

However, it is EIGA's recommendation (see Doc 233 emergency response planning [59]) that the internal emergency plan should also include "non-Seveso emergencies" such as:

- major release of inert gas/liquid; or
- simple causes of severe workplace injuries e.g. resulting from slip, trip or fall; or
- events without loss of containment of a Seveso dangerous substance such as:
    - natural events such as floods, earthquakes, severe weather conditions etc.,
    - vehicle incidents on site,
    - loss of utility (e.g. power to site);
- security incidents (unauthorised access, intruders etc.);
- environmental incidents, not related to hazardous substances, per the MA Directive (e.g. perlite);

The Seveso Directive and other European regulations to EU Safety at Work Directive 89/391 require that all personnel on site (employees and long-term contractors) shall be consulted on the proposed internal emergency plan. Examples include security personnel, contracted maintenance personnel, on-site permanent third parties) [60]. There may be country-specific regulations defining representation of worker groups and how this consultation must be performed.

COUNTRY NOTE: In Italy and Denmark, the Workers' Safety Representative shall also be consulted, when issuing/revising the Internal Emergency Plan; for Upper tier site this shall be according to the procedure outlined by law.

The Directive lists objectives and information required to be included in internal emergency plans for Upper tier sites. In the experience of EIGA member companies it is generally best practice – and encouraged by authorities - to include the majority of this information in internal emergency plans for Lower tier sites.

Emergency plans (see EIGA Doc 233) should be developed to meet the following objectives [59]:

- To identify action required to contain and control the consequences of incidents, to minimize the effects for people, property and the environment, including a description of the equipment required for on-site emergency response and the resources available.
- To describe how essential information would be exchanged with the emergency services, the public and authorities during an incident, including how warnings are to be given and the actions persons are expected to take on receipt of a warning.
- To plan for restoration and clean-up of the environment.

Additionally for sites which are included in an external emergency plan, the internal emergency plan should outline arrangements for providing:

- Early warning of the incident to the authority responsible for setting the external emergency plan in motion, the type of information which should be contained in an initial warning and the arrangements for the provision of more detailed information as it becomes available.
- Assistance with off-site mitigation response.

The internal emergency plan should also document the requirements for training and practice by personnel in the duties that they are expected to perform in the event of an incident, including co-ordination and communication with off-site emergency services. Care should be taken that instructions for emergency response by on-site personnel are available in a practical format. Examples of so-called "emergency action sheets" are given in Appendix F.

Note that Appendix F is intended to illustrate the format and type of information for emergency action sheets. The exact contents are not necessarily EIGA-recommended emergency response actions.

The internal emergency plan should be reviewed, tested and updated at suitable intervals of no longer than 3 years.

In practice, yearly or more frequent reviews and drills are recommended and often required by competent authorities. Note that there are several different formats available to practice the actions outlined in an internal emergency plan, including; team-based "what-if" discussions, table top exercises, practical drills or evacuations as well as exercises with off-site emergency services. It is important that the drills address the actions and decisions expected of the site team, as described in the internal emergency plan. Each practice session should be documented and include a review of successes and learnings for improvement. See EIGA Doc 233 and EIGA HF 06 Organisation - "Site Emergency Response" [59, 29]

It is recommended, but not required by the Directive, for Lower tier sites to involve external emergency services in on-site exercises.

It is also good practice to schedule an annual review and update of information that can typically change such as; contact names/telephone numbers, lists of utility supply companies and neighbours.

EIGA recommends that all the emergency action scenarios are tested in a defined timeline.

COUNTRY NOTE: In Italy, the drills shall be performed every six months.

COUNTRY NOTE: In Denmark the Authorities require that all scenarios are tested within a 3 year period.

12 Off-site Emergency planning (around Upper tier sites)

Key objective: to list the main points that should be included in external ("Off-site") emergency plans, including restoration and clean-up of the environment and requirements for periodic testing of this plan.

The Seveso Directive requires that the Local (city/region) Authorities draw up an External Emergency Plan for the measures to be taken outside Upper tier establishment(s). The Directive also requires that all sites identified in possible "domino relationships" (see section 16) must co-operate in supplying information to the authority responsible for preparing a single integrated emergency plan for the locality.

The obligation on each Seveso site is limited to providing information to the authorities to enable them to prepare for the possible major accidents at that site and being involved in exercising the (shared) external emergency plan at intervals not exceeding 3-years.

COUNTRY NOTE: In some countries (e.g. Italy, France), an External Emergency Plan may additionally be required around Lower Tier sites.

The External Emergency Plan is established, by the relevant local authority, with the following objectives:

- detailing, containing and controlling the possible major accident scenarios;
- implementing the measures necessary to protect people and the environment from the effects of major accidents;
- communicating information on the accident and behaviour to be adopted in the event of such accidents, to neighbouring Seveso sites, to nearby sites that are outside the scope of Seveso, to the public and the services or authorities concerned in the area;
- providing for the restoration and clean-up of the environment following a major accident.

External Emergency Plans shall be reviewed, tested, and where necessary revised and updated at "suitable intervals", of no longer than 3 years.

Upper tier sites are obliged to participate in exercises with external emergency services. These exercises allow fire services, police, etc. to be more familiar with the site installations and to test communication mechanisms between the various organisations.

Where Lower tier sites are included in External Emergency plans, it is good practice for them to be involved in relevant exercises, but this is not explicitly required in the Directive.

13 Information to the public

Key objective: to outline the information that shall be provided to the public, which is an obligation for Lower tier sites as well as Upper tier sites. EIGA template answers are given in Appendix K.

The Seveso Directive requires that the information listed below is made "permanently available to the public, including electronically". It is not defined in the Directive whether the site operator, the CA or others are responsible to make this information "permanently available"; country regulations should specify how this is to be done.

The information shall be kept up to date, reviewed, where necessary updated and re-issued at least every five years.

The information to the public shall contain at least, the following items:

- Name of operator and address of the establishment.
- Confirmation that the establishment is subject to the Directive, confirmation that a notification (for Lower tier site) or Safety report (for Upper tier site) has been submitted to the CA.
- An explanation in simple terms of the activity or activities undertaken at the establishment.
- The names of the substances which could give rise to a major accident, with an indication of their principal dangerous characteristics.
- Adequate information about how the public concerned will be warned and kept informed in the event of a major accident.
- Information on actions that the public concerned should take and how to behave in the event of a major accident.
- The date of the last inspection visit, or where that information can be accessed and the way to obtain more detailed information about the inspection plan, upon request.
- Details of where further information can be obtained.

Additional information required for Upper tier sites only:

- General information relating to the nature of the major-accident hazards, including their potential effects on the population and the environment.
- summary details of the main types of major-accident scenarios and the control measures to address them.
- Confirmation that the site operator is prepared for emergency situations and liaising with emergency services.
- Key information from the external emergency plan
- Advice to for the public to follow instructions from emergency services.
- Where this establishment is located close to the border with another country, and there is the potential for transboundary effects according to the Convention of the United Nations Economic Commission for Europe on the Transboundary Effects of Industrial Accidents. [61].

The Directive also requires that information listed above for Upper Tier sites shall be supplied to; all buildings and areas of public use, including schools and hospitals, and all sites identified in possible "domino relationships" (see section 16) which may be affected by a major accident.

Appendix K provides EIGA template answers for Lower tier or Upper tier ASU, Lower tier or Upper tier Cylinder filling facility and for Acetylene manufacturing facilities. It is recommended that Member companies use the relevant parts of this information to provide consistent information to the public for similar installations in different countries.

COUNTRY NOTE: in Portugal the site operator is required by law to have an internet page updated with relevant safety information for the establishment. It is also mandatory to update this information when plant manager changes.

COUNTRY NOTE: in GB and Republic of Ireland, the CAs make this information publicly available via the HSE/ HSA website. The information has to be provided via the CA online portal, which involves completing a form with dropdown menus. .

14 Confidentiality

CA are required by the Aarhus convention [62] to ensure, in the interests of transparency, that information received, for example under the Seveso Directive(s), is made available to any person who requests it. Information provided to the CA includes content of the notification, inspection reports, Safety Reports, as well as information to be provided to the public.

The Aarhus convention [62] and Seveso also allow member states to keep some of this information confidential, if sharing of that information calls into question:

- Confidentiality of the deliberations of CA
- Confidentiality of international relations or national defence
- Public security
- Investigations or legal proceedings
- Commercial and industrial secrets including intellectual property
- Personal data and/or files
- Where a third party providing the data requests for it to be kept confidential.

This power to restrict access to Seveso information held by authorities, may be enforced very differently in various countries.

15 Site changes with "significant repercussions" on major-accident hazards

Key objective: to outline site changes which have "significant repercussions" on the overall major accident hazards of the site, and which must therefore be submitted to CA.

Any change in inventory or process should be assessed according to the company Management of Change (MoC) process. The MoC should determine whether this change results in a "significant repercussion" on major-accident hazards. For a Seveso site, lower tier or Upper tier, "significant repercussion" would generally be understood to mean a measurable change in offsite consequence or risk, or a significant change in on-site risk.

It is also possible for a new development (such as residential housing, hospital or supermarket) to be granted building permission close to an existing Seveso site. The change in the affected population can have "significant repercussions" on the site risk profile and the CA may require the site operator to revise the risk assessment and possibly install additional safeguards.

The Directive requires that any modification which could have significant repercussions on major-accident hazards is reviewed and that the CA is advised in advance of the modification.

Changes to any of the following could in principle result in "significant repercussion" and should therefore be properly evaluated during the company management of change process.

- Dangerous substance not included in existing notification
- Nature of dangerous substances (for example as a liquid or as a gas)
- Quantity of dangerous substances
- Storage capacity (tank size, cylinder size)
- Storage parameters (pressure, temperature)
- Location of storage equipment within the site
- Location of process equipment within the site
- Site boundary
- Domino effects to or from this site
- Process operating conditions (pressure, temperature, flow rate, composition, inventory) beyond the current design operating envelope
- Design of process equipment

- Design and set points of safety systems
- Organisational re-structuring
- Delivery frequency or modes of transport for bulk products or raw materials

And/or when informed by relevant authorities about changes around the establishment such as;

- Population and land-use changes in the surrounding area
- Domino effects to or from this site.

In advance of the proposed modification or when advised by CA, the operator shall review and where necessary revise all relevant Seveso documents, such as; notification, scenario risk assessments, internal emergency plan, MAPP, information to the public and/or Safety Report as applicable.

On the basis of the information supplied by the operator, the authorities have responsibility to make decisions about risk acceptability, land-use policy and the external emergency plan.

In countries with operating permits, the proposed significant changes must be submitted to the authorities and permission granted before the change is installed.

COUNTRY NOTE: In Italy in the event of a significant change, where there is an impact on Fire prevention and/or toxic gas storage then approval from the relevant Authority is required prior to implementation.. Any modification, that results in changes to a major accident scenario, requires the Operator to submit an updated Seveso notification once the modification is in place.

COUNTRY NOTE: In Portugal, any change in inventory must be communicated to CA before it takes place and then the CA decides on the procedure to follow according to ‘how significant’ the change is, even for lower tier sites.

16 Duties for Seveso sites with Seveso neighbours (Domino, etc.)

Key objective: to outline the site operator responsibilities when advised of possible Domino relationship by CA.

It is the responsibility of the CA to identify where there are Seveso or other industrial sites in the vicinity of each other, to advise those establishments of the possibility of a “Domino effect” and to ensure that the identified establishments exchange information. The establishments are legally required to exchange detailed information about their Major Accidents in order to determine whether an incident at one site can initiate a separate MA on a nearby site, or escalate the consequences of the original incident due to the vicinity of additional dangerous substance inventory at the next site (this is the strict meaning of "Domino effect").

There is no list of information prescribed in the Directive for the exchange of information about Domino effects between neighbouring sites. Based on the experience of EIGA members to date, the following information should typically be shared between neighbouring establishments:

- Nature and extent of major accidents that could have effects outside of the establishment.
- Providing standard reference values for consequences (concentration, overpressure etc.) and the effect distances from the boundaries of the establishment is the most common way to share this data.
- Maximum duration of the dangerous concentration/heat radiation level.
- Interdependency on utilities (for example air separation plants may obtain electrical power from a customer refinery and be reliant to some extent on that power to continue to provide safety nitrogen to the refinery).

In practice many companies will require the discussion partners to develop and sign confidentiality or non-disclosure agreements before sharing sensitive information with other companies.

Where a Domino effect is identified, both sites shall include all possible Domino cause and effect scenarios in their own scenario risk assessment process and formally determine what additional precautions for prevention and mitigation might be possible or necessary. Where relevant, any potential for escalation of consequences needs to be input into the internal and external emergency plans (see 11 and 12) and reflected in the information provided to the public (see 13).

In many cases neighbouring Seveso sites can determine that there is no potential for a Domino effect.

However, it is common for the consequences of a major accident on one site to travel to and impact people on a nearby site. This is NOT a Domino effect, but shall be considered as an off-site cause of a potential MA for the purpose of scenario assessment (9.2) and emergency planning as described in 11 and 12.

COUNTRY NOTE: in Netherlands there is formal guidance to authorities (Instrument Domino Effects **Error! Reference source not found.**) describing the process for different authority groups to identify establishments which have potential Domino relationships.

COUNTRY NOTE: In France there is guidance for the consequence criteria to determine Domino relationships (e.g. 8 kW/m^2 for thermal radiation, 200 mbar for overpressure) **Error! Reference source not found.**

17 The Safety report (for Upper tier site)

Key objective: to outline the mandated elements of an Upper tier Safety Report.

The Seveso Directive requires that the operator of an Upper tier site compiles a Safety Report and submits it to the competent authority for examination. The minimum information to be provided in the Safety Report content is defined in Annex II of the Directive.

The safety report shall demonstrate that all the necessary measures have been taken by the operator to prevent major accidents and to limit their consequences to people and the environment. This is achieved through a comprehensive review of the site activities and a systematic identification of potential major accidents.

Appendix G, lists with hyperlinks, guidance published by some CA or other national authorities on writing safety reports.

In outline the safety report shall address the following issues:

- Information about the site including a description of the installation and its surrounding environment.
- Management measures to prevent major accidents - MAPP and SMS (see 8).
- Identification and risk assessment of potential major accident scenarios including prevention and mitigation measures. The steps required for this have been described in earlier sections of this document and are only summarised here:
    - Identify each potential major accident, possible cause and the sequences of events which could lead to that outcome (see 9).
    - Assess the extent and severity of the consequences (see examples in EIGA Doc 75 **Error! Reference source not found.**).
    - Identify the existing technical and organisational safeguards (see 9).
    - Estimate probability that each major accident can happen (see 9).
    - Evaluate the risk acceptability and determine if improvement is necessary (see 10).
    - Review of past accidents and incidents involving the same substances and processes, with the safety measures to prevent such events. Appendix L provides a list of past accidents and incidents which may have met the definition of major accident, together with indicated industry lessons learned and guidance.

Operators shall review the safety report at least every five years and also when any changes occur that could have a significant repercussion on the safety of the site (see 14). The competent authority can request a revision of the safety report if it is justified by new facts or new technical knowledge about safety issues. The updated safety report shall be sent to the competent authority.

In the experience of EIGA companies, the generation of a new safety report requires at least 1 man-year of work (in practice, several persons usually contribute to the creation of the safety report).

Operators should note that information, such as the safety report and inventory of dangerous substances, should according to the Directive be made available to the public upon request. As described in section 14 site operators may request that confidential parts are not disclosed. This aspect is implemented differently in various countries.

COUNTRY NOTE: In France, lower tier sites are also required to generate a safety report. The inventory and basic site contact details (including company name, city location) is made publicly available by the CA. During any consultation phase a summary of the Safety report is posted by the local "department" CA.

COUNTRY NOTE: In UK the site operator may request in writing that parts of the safety report are kept confidential where allowed under the Environmental Information regulations UKSI 2004 No3391 or the Environmental Information (Scotland) regulations SSI 2004 520 [66, 67] .

18 Information to be supplied by Operator following a Major Accident

Key objective: to summarise the obligation to report specified information after a major accident.

The Seveso Directive places an indirect duty on operators to report certain information after a Major Accident. (Actually the Directive places the obligation on CA to ensure that the operator is required to report by most appropriate means). In most countries there are other pre-existing regulations which require operators to inform authorities immediately about the consequences and causes of certain accidents, and this fact explains why the duty to inform authorities about major accidents is not often seen by operators as a Seveso obligation.

The information required includes; the circumstances of the accident, the emergency measures taken and the steps envisaged to prevent any re-occurrence.

19 References

[1]	Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012, on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (so called "Seveso III"), http://eur-lex.europa.eu Seveso III : Questions & Answers *https://www.mase.gov.it/sites/default/files/archivio/allegati/rischio_industriale/questions_answers_seveso3_march_2016.pdf*
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Appendix A: Thresholds, Qualifying Quantities and the Summation Rule

A1 Named Substance Thresholds (Annex I, part 2)

The *notes referred to in this table are included in Seveso. Please refer to the text of the Directive for the exact and correct explanatory note.

Column 1		**Qualifying quantity** (tonnes) **for the application of:**	
NAMED Dangerous Substances	CAS number (shown only for indication)	Column 2 Lower Tier	Column 3 Upper Tier
1. Ammonium nitrate (see *note)	----	5 000	10 000
2. Ammonium nitrate (see *note)	----	1 250	5 000
3. Ammonium nitrate (see *note)	----	350	2 500
4. Ammonium nitrate (see *note)	----	10	50
5. Potassium nitrate (see *note)	----	5 000	10 000
6. Potassium nitrate (see *note)	----	1 250	5 000
7. Arsenic pentoxide, arsenic (V) acid and/or salts	1303-28-2	1	2
8. Arsenic trioxide, arsenious (III) acid and/or salts	1327-53-3		0,1
9. Bromine	7726-95-6	20	100
10. Chlorine	7782-50-5	10	25
11. Nickel compounds in inhalable powder form (nickel monoxide, nickel dioxide, nickel sulphide, trinickel disulphide, dinickel trioxide)	----		1
12. Ethyleneimine	151-56-4	10	20
13. Fluorine	7782-41-4	10	20
14. Formaldehyde (concentration ≥ 90 %)	50-00-0	5	50
15. Hydrogen	1333-74-0	5	50
16. Hydrogen chloride (liquefied gas)	7647-01-0	25	250
17. Lead alkyls	----	5	50
18. Liquefied flammable gases, *CLP-Category 1 or 2* (including LPG) and natural gas (see *note)	----	50	200
19. Acetylene	74-86-2	5	50
20. Ethylene oxide	75-21-8	5	50
21. Propylene oxide	75-56-9	5	50
22. Methanol	67-56-1	500	5 000
23. 4, 4-Methylenebis (2-chloraniline) and/or salts, in powder form	101-14-4		0,01
24. Methylisocyanate	624-83-9		0,15

Column 1		Qualifying quantity (tonnes) for the application of:	
NAMED Dangerous Substances	CAS number (shown only for indication)	Column 2 Lower Tier	Column 3 Upper Tier
25. Oxygen	7782-44-7	200	2 000
26. 2,4 -Toluene diisocyanate 2,6 -Toluene diisocyanate	584-84-9 91-08-7	10	100
27. Carbonyl dichloride (phosgene)	75-44-5	0,3	0,75
28. Arsine (arsenic trihydride)	7784-42-1	0,2	1
29. Phosphine (phosphorus trihydride)	7803-51-2	0,2	1
30. Sulphur dichloride	10545-99-0	1	1
31. Sulphur trioxide	7446-11-9	15	75
32. Polychlorodibenzofurans and polychlorodibenzodioxins (including TCDD), calculated in TCDD equivalent (**note)	----		0,001
33. The following CARCINOGENS *or the mixtures containing the following carcinogens* at concentrations above 5% by weight: 4-Aminobiphenyl and/or its salts, Benzotrichloride, Benzidine and/or salts, Bis (chloromethyl) ether, Chloromethyl methyl ether, 1,2-Dibromoethane, Diethyl sulphate, Dimethyl sulphate, Dimethylcarbamoyl chloride, 1,2-Dibromo-3-chloropropane, 1,2-Dimethylhydrazine, Dimethylnitrosamine, Hexamethylphosphoric triamide, Hydrazine, 2- Naphthylamine and/or salts, 4-Nitrodiphenyl, and 1,3 Propanesultone	----	0,5	2
34. Petroleum products (a) gasolines and naphthas, (b) kerosenes (including jet fuels), (c) gas oils (including diesel fuels, home heating oils and gas oil blending streams) *(d) heavy fuel oil*	----	2500	25 000
35. Anhydrous Ammonia	7664-41-7	50	200
36. Boron trifluoride	7637-07-2	5	20
37. Hydrogen sulphide	7783-06-4	5	20
38. Piperidine	110-89-4	50	200
39. Bis(2-dimethylaminoethyl) (methyl)amine	3030-47-5	50	200
40. 3-(2-Ethylhexyloxy)propylamine	5397-31-9	50	200

Column 1		Qualifying quantity (tonnes) for the application of:	
NAMED Dangerous Substances	CAS number (shown only for indication)	Column 2 Lower Tier	Column 3 Upper Tier
41. Mixtures (*) of sodium hypochlorite classified as Aquatic Acute Category 1 [H400] containing less than 5 % active chlorine and not classified under any of the other hazard categories in Part 1 of Annex I. (*) Provided that the mixture in the absence of sodium hypochlorite would not be classified as Aquatic Acute Category 1 [H400].	----	200	500
42. Propylamine (see *note)	107-10-8	500	2 000
43. Tert-butyl acrylate (see *note)	1663-39-4	200	500
44. 2-Methyl-3-butenenitrile (see *note)	16529-56-9	500	2 000
45. Tetrahydro-3,5-dimethyl-1,3,5,-thiadiazine-2-thione (Dazomet) (see *note)	533-74-4	100	200
46. Methyl acrylate (see *note)	96-33-3	500	2 000
47. 3-Methylpyridine (see *note)	108-99-6	500	2 000
48. 1-Bromo-3-chloropropane (see *note)	109-70-6	500	2 000

A2 Seveso "Generic" Categories and Threshold (Annex I, part 1)

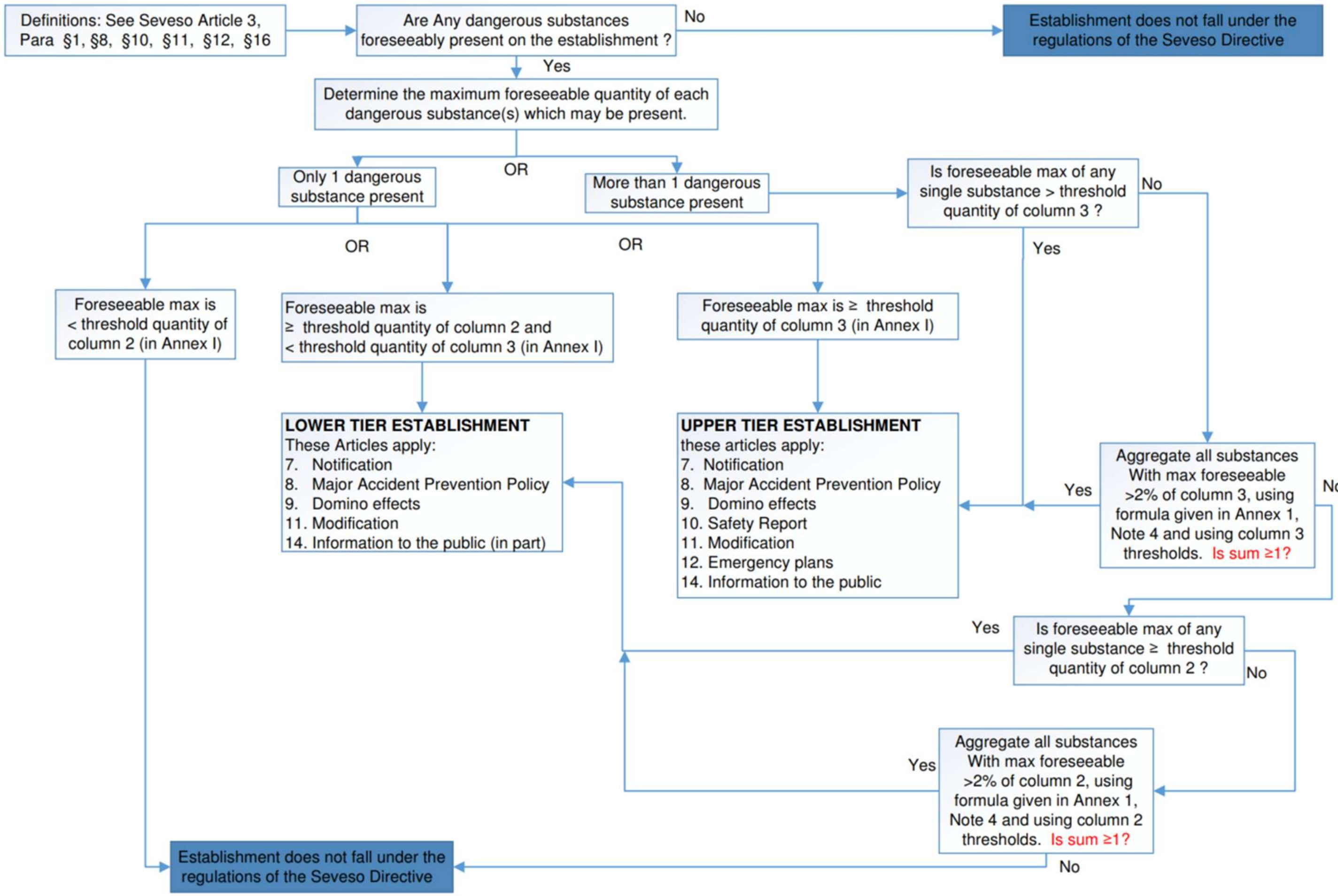
. Reference should ALWAYS be made to the Material Safety Data Sheet for correct classification.

The *notes referred to in this table are included in Seveso. Please refer to the text of the Directive for the exact and correct explanatory note

Seveso Hazard Categories In accordance with (i.a.w.) Regulation EC 1272/2008 **(GHS)** Column 1	**Qualifying quantity (tonnes) for:**	
	Column 2 Lower Tier	Column 3 Upper Tier
Health Hazards		
H1 ACUTE TOXIC Category 1, all exposure routes	5	20
H2 ACUTE TOXIC Category 2, all exposure routes Category 3, inhalation exposure routes (see *note)	50	200
H3 STOT Specific Target Organ toxicity – single exposure STOT SE Category 1	50	200
Physical Hazards		
P4 OXIDISING GASES Oxidising gases, Category 1	50	200
P8 OXIDISING LIQUIDS AND SOLIDS Oxidising Liquids, Category 1, 2 or 3, or Oxidising Solids, Category 1, 2 or 3	50	200
P1b EXPLOSIVES (see *note) Explosives, division 1.4 (see *note)	50	200
P1a EXPLOSIVES (see *note) – Unstable explosives or – Explosives, division 1.1, 1.2, 1.3, 1.5, or 1.6 or – Substances or mixtures having explosive properties according to method A.14 of Regulation (EC) No 440/2008 (see *note) and do not belong to the hazard classes Organic peroxides or Self-reactive substances and mixtures	10	50
P5c FLAMMABLE LIQUIDS	5 000	50 000
Flammable liquids, categories 2 or 3 not covered by P5a and P5b	5 000	50 000
P5b FLAMMABLE LIQUIDS – Flammable liquids, categories 2 or 3, where particular processing conditions, such as high temperature or pressure may create major accident hazards, or – Other liquids with a flash point ≤ 60°C where particular processing conditions, such as high temperature or pressure may create major accident hazards (see *note)	50	200
P2 FLAMMABLE GASES Flammable gases, categories 1 or 2	10	50
P5a FLAMMABLE LIQUIDS – Flammable liquids, Category 1, or – Flammable liquids Category 2 or 3 maintained at a temperature above their boiling point, or – Other liquids with a flash point ≤ 60 °C, maintained at a temperature above their boiling point (see *note)	10	50

Seveso Hazard Categories In accordance with (i.a.w.) Regulation EC 1272/2008 **(GHS)** Column 1	**Qualifying quantity (tonnes) for:**	
	Column 2 Lower Tier	Column 3 Upper Tier
P6a SELF-REACTIVE SUBSTANCES AND MIXTURES and **ORGANIC PEROXIDES** Self-reactive substances and mixtures, Type A or B or organic peroxides, Type A or B	10	50
P6b SELF-REACTIVE SUBSTANCES AND MIXTURES and **ORGANIC PEROXIDES** Self-reactive substances and mixtures, Type C, D, E or F or organic peroxides, Type C, D, E, or F	50	200
P7 PYROPHORIC LIQUIDS AND SOLIDS Pyrophoric liquids, Category 1 Pyrophoric solids, Category 1	50	200
Environmental Hazards		
E1 Hazardous to the Aquatic Environment in Category Acute 1 or Chronic 1	100	200
E2 Hazardous to the Aquatic Environment in Category Chronic 2	200	500
Other Hazards		
O1 Substances or mixtures with hazard statement **EUH014**	100	500
O2 Substances and mixtures which **in contact with water emit flammable gases**, Category 1	100	500
O3 Substances or mixtures with hazard statement **EUH029**	50	200

A3 Flowchart for the application of Seveso3 Directive



A4 Summation examples

Some simple examples are given here to illustrate the logic.

Example 1: Single Named Substance

If the site only ever holds one substance, for example OXYGEN then determination is simple. Compare the Maximum foreseeable amount of that substance with the Qualifying Quantity shown in Column 2 for Lower Tier and Column 3 for Upper tier.

Column 1	Column 2	Column 3
Dangerous substances	Qualifying quantity (tonnes) for the application of	
	Articles 6 and 7	Article 9
Methylisocyanate		0,15
Oxygen	200	2 000
Toluene diisocyanate	10	100

Site Max foreseeable inventory (tonnes)	Seveso status
199 tonnes Oxygen	Sub-Seveso
200 tonnes Oxygen	Lower Tier
200 tonnes ≥ Oxygen < 2000 tonnes	Lower Tier
≥ 2000 tonnes Oxygen	Upper (TOP) tier

Example 2: No Named Substances, substances in ONLY one Generic category

If the site will not hold any Named substances and only ever holds substances from ONE generic category, for example Toxic Gas mixtures then the determination is simple. Compare the Maximum foreseeable amount of that substance with the Qualifying Quantity shown in Column 2 for Lower Tier and Column 3 for Upper tier.

Column 1	Column 2	Column 3
Categories of dangerous substances	Qualifying quantity (tonnes) of dangerous substances as delivered in Article 3 (4), for the application of	
	Articles 6 and 7	Article 9
1. VERY TOXIC	5	20
2. TOXIC	50	200

Site Max foreseeable inventory (tonnes)	Seveso status
49.5 tonnes Toxic gas	Sub-Seveso
50 tonnes Toxic gas	Lower Tier
50 tonnes ≥ Toxic gas < 200 tonnes	Lower Tier
≥ 200 tonnes Toxic gas	Upper (TOP) tier

A4 Summation examples (continued)

This Directive shall apply to upper-tier establishments if the sum:

$q_1/Q_{U1} + q_2/Q_{U2} + q_3/Q_{U3} + q_4/Q_{U4} + q_5/Q_{U5} + \ldots$ is greater than or equal to 1,

where q_x = the quantity of dangerous substance x (or category of dangerous substances) falling within Part 1 or Part 2 of Annex I.

and Q_{UX} = the relevant qualifying threshold quantity for dangerous substance or category x from Column 3 of Part 1 or from Column 3 of Part 2 of Annex I.

This Directive shall apply to lower-tier establishments if the sum:

$q_1/Q_{L1} + q_2/Q_{L2} + q_3/Q_{L3} + q_4/Q_{L4} + q_5/Q_{L5} + \ldots$ is greater than or equal to 1,

where q_x = the quantity of dangerous substance x (or category of dangerous substances) falling within Part 1 or Part 2 of Annex I.

Example 3 Summation

A site holds the following substances. What is its Seveso status?
For the purposes of this example ignore the 2% rule.

Substance	Max foreseeable on site	GHS classification	Named?	Health	Physical (Fire/ explosion	Environ-ment
	(tonnes)		Y/N	nr = not relevant		
Oxygen	1950	Ox Gas 1	Y	nr	Yes	nr
Hydrogen	3.5	Flamm Gas 1	Y	nr	Yes	nr
Acetylene	2.5	Flamm Gas 1	Y	nr	Yes	nr
"Fictitious generic toxic liquid"	25	Acute Tox. Inha 2	N	Yes	nr	nr
Arsine (arsenic trihydride)	0.005	Flam. gas 1 Acute Tox. Inha 2 Aquatic Chronic 1	Y	Yes	Yes	Yes
Diesel Fuel for heating	100	Flam. Liq 3 Aquatic Chronic 2	Y	nr	Yes	Yes

This site holds more than the Lower tier threshold of **200 tonnes for Oxygen**, so it is **at least a Lower tier site.** Calculation must be done to determine whether it exceeds Upper tier thresholds on summation. Remember to use the Column 3 threshold quantities (for Upper Tier) either from Named substance part or generic values.

Environmental Summation:
Arsine (0.005/1) + Diesel (100/25000) = 0.005+ 0.004 = 0.009 less than 1 so below Upper tier for Environment

Health Summation:
Fictitious toxics (25/200) + Arsine (0.005/1) = 0.125 +0.005 = 0.13 less than 1 so below Upper tier for health hazards

Physical hazards Summation (Fire/explosion etc.)
Oxygen (1950/2000) + Hydrogen (3.5/50) + Acetylene (2.5/50) + Arsine (0.005/1) + Diesel (100/25000) = 0.975 + 0.70 + 0.50 + 0.005 + 0.004 = 2.184. **This site would be Upper tier!**

NOTE for Generic substances use the relevant threshold. For Named substances always used the Named threshold quantity.

Example 4 Summation

A site holds the following substances. What is its Seveso status?
For the purposes of this example ignore the 2% rule.

Substance	Max foreseeable on site	GHS classification	Named?	Health	Physical (Fire/ explosion	Environ-ment
	(tonnes)		Y/N	nr = not relevant		
Chlorine	2.0	Ox Gas 1 Acute Tox. Inha 2 Aquatic Chronic 1	Y	Yes	Yes	Yes
Acetylene	0.5	Flam. Gas 1	Y	nr	Yes	nr
Arsine (arsenic trihydride)	0.0008	Flam. gas 1 Acute Tox. Inha 2 Aquatic Chronic 1	Y	Yes	Yes	Yes
Anhydrous Ammonia	3.5	Flam. gas 2 Acute Tox. Inha 3 Aquatic Chronic 1	Y	Yes	Yes	Yes
Boron trifluoride	0.45	Acute Tox. Inha 2	Y	Yes	nr	nr
Hydrogen fluoride	0.68	Acute Tox. Oral 1 Acute Tox. Dermal 1 Acute Tox. Inha 2	N	Yes	nr	nr
Carbon Monoxide	8.0	Flam. gas 1 Acute Tox. Inha 3	N	Yes	Yes	nr
"water treatment liquid"	1.2	Aquatic Chronic 2	N	nr	nr	Yes
Calcium Carbide	80	O2 in contact with water releases Flam. Gas 1	N	nr	*Yes	nr

This site does not hold more than the Lower tier threshold of any single substance. Calculation must be done to determine whether it exceeds Lower tier thresholds on summation. Remember to use the **Column 2** threshold quantities (for **Lower Tier**) either from Named substance part or generic values.

Environmental Summation:
Chlorine (2/10) + Arsine (0.0008/0.2) Ammonia (3.5/50) + Water Treatment Liquid (1.2/200) = 0.20+ 0.004+0.07+0.006 = 0.280 less than 1 so below Lower tier for Environment

Health Summation:
Chlorine (2/10) + Arsine (0.0008/0.2) + Ammonia (3.5/50) +Boron Trifluoride (0.45/5) + Hydrogen Fluoride (0.68/5) + Carbon monoxide (8/50) = 0.20+0.004+0.07+0.09+0.136+0.16 = 0.66 less than 1 so below Lower tier for health hazards

Physical hazards Summation (Fire/explosion etc.)
Chlorine (2/10) + Acetylene (0.5/5) + Arsine (0.008/0.2) + Ammonia (3.5/50) + Carbon monoxide (8/10) = 0.20+0.10+0.004+0.07+0.80 = 1.174**, so this site would be Lower tier!**

NOTE for Generic substances use the relevant threshold. For Named substances always used the Named threshold quantity.
Remember that substances with "Other Hazards" (O1, O2 or O3) such as Calcium Carbide is excluded from summation.

Lastly, logically the summation rule should be applied again, for the Physical hazards to ensure that the site has not also exceeded Upper Tier thresholds.

Appendix B: not used

Appendix C: EIGA PSM: Process Safety Elements (Doc 186)

- Leadership, commitment and responsibility (Element 1)
- Compliance with legislation and industry standards (Element 2)
- Employee selection, training and competency (Element 3)
- Workforce involvement (Element 4)
- Communication with Stakeholders (Element 5)
- Hazard identification and risk assessment (Element 6)
- Documentation, records and knowledge management (Element 7)
- Process and operational status monitoring and handover (Element 8)
- Operating procedures (Element 9)
- Management of operational interfaces (Element 10)
- Standards and practices (Element 11)
- Management of change (Element 12)
- Operational readiness and Process start-up (Element 13)
- Emergency management (Element 14)
- Inspection and maintenance (Element 15)
- Management of safety critical devices (Element 16)
- Work control, permit-to-work and task risk management (Element 17)
- Contractors and suppliers – selection and management (Element 18)
- Incident investigation (Element 19)
- Audit, management review and intervention (Element 20)
- Measures and metrics (Element 21)

Appendix D Bow tie model as a method for describing MA Scenarios

Introduction

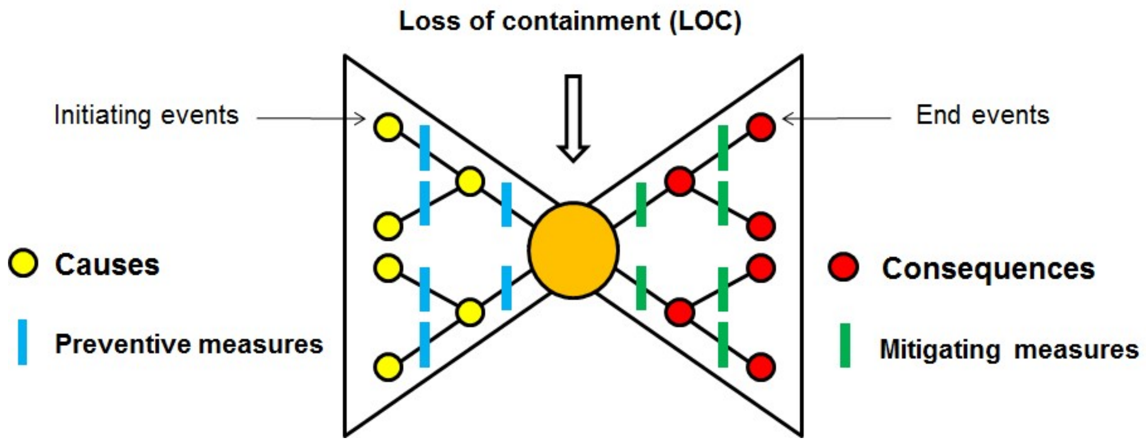
Documents produced with classical process hazard analysis (PHA) methods, such as HAZOP, FMEA, What If etc. are not intended to identify and to evaluate individual scenarios. Most PHA methods don't explore the time sequence of an evolving major accident scenario. These PHA reports can be difficult to read for someone who was not involved in the study. Use of "Bow-tie" type models to Seveso scenarios is considered a best practice for depicting initiating events and safeguards. However PHA studies do provide a useful input to identify initiating events and safeguards for scenarios.

What is a bowtie model?

This model presents a group of scenarios in the form of a bow tie. The "knot" of the bow tie represents an uncontrolled release of product, or energy, from a particular installation or equipment. This is commonly called "loss of containment", or LOC.

In the left side, a cause tree is constructed with all paths that can lead to the same type of loss of containment. Each branch of the tree starts with an initiating event and shows the sequence of consecutive events resulting in the LOC. The right side shows the sequence of consequences (for people, the environment or property) that can result from the LOC. Safeguards and measures form barriers along the path that should interrupt the chain of events. The ones on the left side are called "preventive" measures, as they prevent the LOC from happening. The measures on the right side are called "mitigating measures" because they reduce the severity of consequences.

Each path to/from the LOC is an individual scenario that needs to be evaluated.



Practical workflow to document major accident scenarios

In practice these scenarios can be derived from existing PHA documentation, such as HAZOP, FMEA or other studies. The logic can also be directly documented for simpler scenarios e.g. manual operations such as cylinder loading /unloading. #

The following steps can be defined:

Step 1: Identification of installations or equipment

List all installations or equipment on the Seveso site from which releases of hazardous substances or related energy could occur.

Step 2: Consequence filtering

Select from the PHA documentation (or from a group brainstorm or review of accident history) from those installations or equipment listed in step 1, the scenarios with consequences that are severe enough to be considered as a major accident. Note that Seveso relevant consequences are not only fatalities, but also any that could cause serious danger to human health (section 9) or MATTE.

When a risk matrix is used, this filtering can be done by selecting all those scenarios with a severity ranking that meets the major accident definition.

In certain cases dispersion calculations or modelling can help to clarify potential consequences.

Step 3: Cause tree

Construct for all selected scenarios, one by one, the paths that lead to a LOC. A path consists of an initiating event, followed by one or more consecutive events necessary to result in the LOC.

Incident history is an important source of information in this process.

Step 4: Consequence tree

Construct for each type of LOC the sequence of events that can result from it, stopping with all end events that result in serious harm to people, the environment or property.

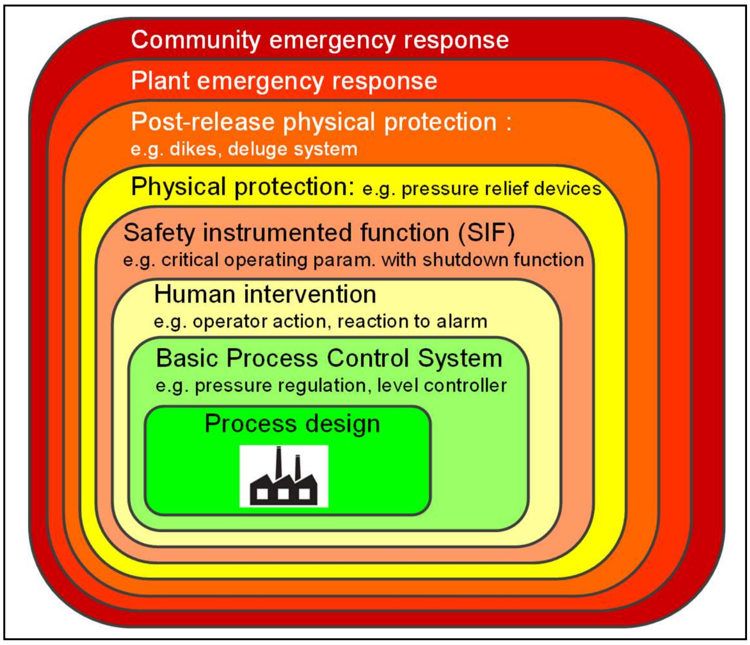
Step 5: Safeguards

Safeguards can be identified from many different sources such as PHA reports or incident investigations. Identify where they interrupt the chain of events in the cause (preventative measures) or consequence (mitigating measures) trees.

Identification of safeguards

The final acceptability of each scenario (see chapter 10) will heavily depend on the availability and the quality of identified safeguards, so it is essential to ensure that all available safeguards are captured in the "Bow-tie".

Safeguards are also called "protection layers". They can be grouped into different categories (see figure below) and can be preventative or mitigating as described next.



Preventative Safeguards

Identification of safeguards begins with good process design. By applying principles of intrinsic safety certain scenarios can be avoided. For example, if an equipment item that could be susceptible to cold embrittlement due to contact with cryogenic liquid, is constructed in cold-resisting material, a major accident scenario, based on this cause can be eliminated at source. This can result in an "acceptable" evaluation for that particular scenario.

In automated processes, the so-called "process control system" (PCS) usually forms a first layer of protection, e.g. a pressure control loop in a PLC that keeps the pressure in a tank within normal operating limits.

Human interventions are another important category of safeguards or protection layers. These include operators carrying out certain procedures, operators reacting to alarms etc.

So-called "safety instrumented functions" (SIFs) are high reliability systems that result in specific actions when critical parameters reach defined limits, e.g. a level switch that shuts a valve if a high high level is reached in a tank.

Physical protections, such as pressure relief devices, are often the last safeguard which can prevent a major loss of containment scenario. Note that a controlled discharge from process relief device does not meet the definition of Seveso MA because the discharge is designed to provide a safe release.

All these categories of safeguards act on the left side of the bowtie.

Mitigation measures

Remaining categories of safeguards shown in the previous figure are mitigating measures that act on the right side of the bowtie.

These include post release physical protection systems such as: fixed fire-fighting systems, deluges, dikes, secondary containment systems, fire extinguishers.

Plant and community emergency response procedures and other organisational measures are other categories of mitigating protection layers. (For Seveso these are called internal and external emergency plans respectively).

Semi-quantitative LOPA philosophy

The Centre for Chemical Process Safety (CCPS) developed a simplified method for process risk assessment, called LOPA, or "Layer Of Protection Analysis" **Error! Reference source not found.**. This method uses the concept of "Independent Protection Layers" or "IPLs".

Each IPL for a scenario contributes to the risk reduction of that scenario. This contribution is quantified by a figure, expressing the reliability of the IPL. The risk reduction factors of all the IPLs for the scenario are multiplied with each other and with the frequency of the initiating event, to estimate the frequency of occurrence of the scenario. Failure frequencies are multiplied for typical IPLs to estimate a frequency for the scenario outcome (consequence).

It is crucial for this methodology that protective layers identified are truly independent. (If protective layers are not completely independent then there can be a benefit in doing a quantitative Fault tree assessment as described in 9.8.3).

There are 3 criteria for a safeguard to be considered as an IPL:

It has to be

- effective (this means it has to be capable of preventing the major accident from happening)
- independent of other safeguards and of the initiating event
- inspectable or auditable

Where there are safeguards which are vulnerable to a common cause of failure, then they cannot be considered as separate IPLs and full credit shall not be taken in LOPA.

Appendix E0: Initiating Events

To start a Seveso risk assessment, it is first necessary to evaluate all possible initiating events which might lead to loss of containment.

Here is a list of initiating events which could be considered. This list is based on various published lists, member company experience under Seveso and has been informed by a review of incidents and accidents reported to EIGA Safety Advisory Council. This list is offered as a best practice starting point for the industrial gases industry, but there can be other specific challenges to mechanical integrity. The list is not all inclusive: the Site Operator should include additional items, as deemed appropriate for the considered process and location.

PROCESS / EQUIPMENT FACTORS - *Phenomena leading to containment challenges*

Phenomena leading to high pressure

- ☐ Excessive heat or gas production by desired reaction (- example Carbide/Water reaction to form Acetylene in Generator)
- ☐ Heat or gas production by undesired reaction
- ☐ Build-up of hydrocarbons (especially in Oxygen-rich liquid)
- ☐ Ingress/ Build-up of contaminants (especially in oxygen service)
- ☐ Internal decomposition (e.g. C_2H_2, N_2O)
- ☐ Heat or gas production by thermal decomposition
- ☐ Loss of insulation effectiveness (non VJ cryogenic storage tank)
- ☐ Interspace purge overpressure
- ☐ Loss of vacuum (VJ cryogenic storage tank/trailers)
- ☐ Loss of vacuum in insulation space
- ☐ Air ingress
- ☐ (Inert) Purge failure
- ☐ Loss of cooling fluid resulting in no or insufficient cooling
- ☐ Fouling of heat exchange surface resulting in no or insufficient cooling
- ☐ Other causes of no or insufficient cooling
- ☐ Freezing of Gasholder water seal
- ☐ Internal explosion
- ☐ Heat input from external fire
- ☐ Compression of vapour phase during filling
- ☐ Failure of level control
- ☐ Overfilling of liquefied gases cylinder/container (including cryogenic)
- ☐ Overfilling gas cylinder/container
- ☐ Hydraulic overpressure-overfilling of liquefied gas (including cryogenic)
- ☐ Feed to an isolated subsystem
- ☐ Loss of raw material (water for carbide/Acetylene reaction, leading to accumulation...)
- ☐ Accumulation/ Build-up of unreacted raw material
- ☐ Uncontrolled reaction
- ☐ Incorrect (quality) specification of raw material/utility (e.g. acid concentration, carbide particle size etc.)
- ☐ Internal leak with high pressure system
- ☐ Under-pressure (as variation of vacuum)
- ☐ Pressure control failure - Exceeded maximum operating pressure
- ☐ Breakthrough of high pressure utility flow (e.g. steam, N2)
- ☐ Breakthrough of high pressure from upstream subsystem
- ☐ Breakthrough of high pressure from downstream subsystem
- ☐ Maximum static head
- ☐ Thermal expansion of liquid or liquefied gas in an isolated piping section or internal dead volumes of components (such as ball valves)
- ☐ Heat Leak into trapped cryogenic liquid
- ☐ Pressure control (valve/instrument) failure
- ☐ Pressure Build Up unit (PBU) ineffective/inadequate on cryogenic storage tank/tanker
- ☐ Thermal expansion in an isolated subsystem filled with liquid
- ☐ Liquid hammer (in large cryogenic liquid lines or water pipes)

- ☐ Adiabatic compression (with consequent ignition)
  Note: the ignition creates the pressure hazard. For temperature effects of adiabatic compression without ignition see “Phenomena leading to high temperature”
- ☐ Reaction between fuel and oxidizers in a gas mixture
- ☐ Reaction between unsaturated hydrocarbon and hydrogen in a gas mixture

Phenomena leading to low pressure

- ☐ Condensation of vapours or gases (including condensation of steam when cooling down)
- ☐ Connection with vacuum system
- ☐ Vacuum
- ☐ Liquid withdrawal
- ☐ Unintended cooling
- ☐ Upstream feed shutoff for running compressor or pump.

Phenomena leading to other physical forces than pressure

- ☐ Vehicle impact e.g. collision by a bulk tanker, cylinder truck FLT (Fork Lift Truck) or crane
- ☐ Mechanical impact (vehicles, projectiles)
- ☐ Airplane crash/impact (in some countries the CA requires that the location of the installation should be described in relation to the local airport and flight paths. Any nearby public airport or military airbase or overhead flying should be mentioned).
- ☐ Uncontrolled or unauthorised drone (crash/damage)
- ☐ Dropped/falling cylinder
- ☐ Tow away of bulk cryogenic trailer, tube trailer, or other bulk dangerous material transport container
- ☐ Pullaway cylinder pack or pallets whilst connected
- ☐ Movement of vehicles connected to the component
- ☐ Low flow in suction line of centrifugal pump (dry running)
- ☐ Low pressure in suction line of centrifugal compressor (vibrations)
- ☐ Pipe movement (e.g. expansion/contraction)
- ☐ Wear and tear of bearing on a rotating axle
- ☐ Incorrect alignment of rotating axle (centrifugal pump or compressor, agitator)
- ☐ Mechanical failure of component part
- ☐ Brittle failure (including low temperature embrittlement)
- ☐ Fatigue failure
- ☐ Forced Draft or ventilation failure
- ☐ Basic Process Control System (BPCS) failure
- ☐ Liquid present around outside of vessel (upward forces)
- ☐ Frost heave (cryogenic components) (freezing underneath storage tanks)
- ☐ Weight of ice/frost build-up (e.g. on atmospheric vaporizer) and ice-fall
- ☐ Presence of liquid (in system designed for gases or vapours)
- ☐ Blast pressure wave
- ☐ Earthquake
- ☐ Flooding (e.g. a nearby river bursting its banks, extreme tides/storm surge)
- ☐ Land subsidence (ground collapse for example due to historic mining activities)
- ☐ High winds/ wind loading including damage to trees, property and flying debris which then impact process and other equipment)
- ☐ Other extreme weather effects such as; snow loading, hail, lightning/thunderstorms
- ☐ Low external temperature (causing freezing/expansion of water in lines)
- ☐ Wrong composition/wrong substance

Phenomena leading to corrosion or chemical attack

- ☐ Presence of internal corrosive conditions under normal process conditions
- ☐ Presence of internal corrosive conditions from abnormal process conditions
- ☐ External corrosion due to environment factors such as maritime or industrial location
- ☐ Presence of hydrogen
- ☐ Presence of water in the subsystem
- ☐ Presence of water between support and structure
- ☐ Ingress of water underneath tank bottom
- ☐ External exposure to corrosive substances released from other subsystems
- ☐ Exposure to atmospheric conditions

- ☐ Presence of corrosive conditions underneath insulation (“under lagging corrosion”)
- ☐ Exposure to corrosive conditions in the ground or at soil/air interface
- ☐ Improper material selection
- ☐ Exposure of Acetylene to inappropriate materials (for example moist acetylene in contact with unalloyed copper, silver and mercury can form explosive acetylides)
- ☐ Backflow of oxidant or other incompatible material
- ☐ Design/Manufacturing Fault
- ☐ Lack of Nitrogen
- ☐ Contamination
- ☐ Contact with incompatible or reactive materials
- ☐ Exposure of aluminium (cylinders) to chloride or other incompatible materials and /or sustained load, causing cracking
- ☐ Presence of water/moisture in gas cylinders of CO_2 or CO_2 mixtures creating acidic conditions

Phenomena leading to decomposition reaction (e.g. C_2H_2 or N_20)

- ☐ Failure of the porous mass
- ☐ External overheating
- ☐ No or insufficient cooling – during filling
- ☐ Failure of flame arrester (mechanical failure or not installed/correctly)
- ☐ Other failure causing incorrect acetylene/solvent ratio
- ☐ Adiabatic compression
- ☐ Silane or Acetylene liquefaction at low ambient temperatures (become unstable)
- ☐ Lack of solvent (for Dissolved Acetylene cylinder/pack filling)
- ☐ Temperature control failure - exceed maximum operating temperature
- ☐ Static electricity
- ☐ Formation of explosive acetylides (from exposure of Acetylene to inappropriate materials (such as unalloyed copper, silver and mercury)

Phenomena leading to high temperature (threatening integrity)

- ☐ Internal fire
- ☐ Lack of oxygen cleanliness
- ☐ Impact of particles in the gas flow with solid surfaces or edges
- ☐ Hydrocarbon accumulation in LOX
- ☐ Contaminant present (oil, hydrocarbons) in Oxygen/oxidiser service
- ☐ Oxygen analysis failure/not available/ not on-line
- ☐ Loss of cooling fluid resulting in no or insufficient cooling
- ☐ Fouling of heat exchange surface resulting in no or insufficient cooling
- ☐ Other causes of no or insufficient cooling
- ☐ Fuel and oxygen/oxidiser plus ignition source
- ☐ Reaction between fuel and oxidizers in a gas mixture
- ☐ Reaction between unsaturated hydrocarbon and hydrogen in a gas mixture.
- ☐ Failure of flame arrester (mechanical failure or not installed/correctly)
- ☐ External fire
- ☐ Failure of earthing/grounding/bonding
- ☐ Static electricity
- ☐ Short circuit, current overload
- ☐ Friction
- ☐ Inadequate lightning protection
- ☐ Ignition sources present/not controlled
- ☐ Ignition source in ATEX zone
- ☐ Unsuitable equipment in ATEX zone
- ☐ Insufficient lubrication/lubrication fluid
- ☐ Seal failure, leading to loss of lubrication/friction and overheat
- ☐ Lack of Nitrogen/purge
- ☐ Exothermic reaction
- ☐ Adiabatic compression (with or without ignition)
- ☐ Contact with incompatible or reactive materials (e.g. acetylides
- ☐ Temperature control failure - Exceed maximum operating temperature
- ☐ External heat exposure (e.g. extreme weather, intentional overheating, unintentional heating etc.)

- ☐ Uncontrolled compressed gas pressure cascading (e.g. from bundle to small cylinder)
- ☐ Exceeding maximum operating temperature

Phenomena leading to erosion and wear

- ☐ High fluid velocities
- ☐ Abrasive particles present in flow
- ☐ Bearing failure e.g. on rotating axle
- ☐ Bending / overuse of flexible hoses
- ☐ Bending / overuse of flexible pigtails
- ☐ Reuse of gaskets when making connections
- ☐ Insufficient lubrication/lubrication fluid
- ☐ Seal failure, leading to loss of lubrication/friction and wear
- ☐ High vibration
- ☐ In service defects
- ☐ Material failure
- ☐ Thermal expansion / contraction stress
- ☐ Cyclic service, fatigue
- ☐ Ageing

Phenomena leading to low temperatures

- ☐ Excessive Cooling via heat exchanger
- ☐ Fouling of heat exchange surfaces, including ice build-up on atmospheric vaporizers
- ☐ Loss of heating fluid resulting in no or insufficient heating
- ☐ Other causes of no or insufficient heating
- ☐ Throttling (over valve or narrowing)
- ☐ Entry of low temperature feed flow
- ☐ Ingress of cold fluids or gases through a leak
- ☐ Backflow of a cold flow
- ☐ Flashing off of liquefied gases
- ☐ Cryogenic temperature (causing condensation of air and oxygen enrichment outside process/piping)
- ☐ Low external temperature (extreme weather)

Phenomena leading to cyclic or other mechanical stresses (introducing the risk of metal fatigue)

- ☐ Cyclic pressurisation
- ☐ Vibration
- ☐ Pipe movement (e.g. expansion/contraction)
- o Failure of a filling component e.g. flexible hose, connector, etc.
- ☐ Bending / overuse of flexible hoses
- ☐ Bending / overuse of flexible pigtails
- ☐ Low temperature embrittlement
- ☐ Brittle failure
- ☐ Poorly controlled first fill
- ☐ Insufficient lubrication/lubrication fluid
- ☐ Geometric stress (excessive stress due to poor mechanical design or inadequate support)
- ☐ Exceeding maximum operating temperature, causing weakness of metal especially aluminium.
- ☐ Ageing/ prolonged exposure to heat, leading to creep and/or fatigue (e.g. reformer tubes)

PROCESS / EQUIPMENT FACTORS -Phenomena leading to a release from an opening in the equipment

Manual operations involving the opening of the installation

- ☐ Breakthrough of dangerous phase through drain valve
- ☐ Valve leaking to atmosphere
- ☐ Acetylene cylinder: a fusible plug leaks/fails (NB Fusible plugs generally used by Industrial Gas companies in Europe)
- ☐ Inadvertent valve opening
- ☐ Accidental opening of valve to atmosphere
- ☐ Disconnecting of flexible hose or loading arm containing product

- ☐ Opening a subsystem in unsafe condition (e.g. containing hazardous substances, under pressure)
- ☐ Solvent spill associated, for example with Acetylene fill operations (Acetone/DMF)
- ☐ Drain not closed at start-up
- ☐ Overfilling (of tank, cylinder or sampling container)
- ☐ Inadequate or ineffective isolation for maintenance
- ☐ Failure of safe system of work (SWP/LOTO)

Process upsets leading to a release through an opening

- ☐ Overfilling of storage tank from continuous feed (e.g. pipeline)
- ☐ Overfilling of storage tank when discharging truck, rail wagon or ship
- ☐ Flash from tanker filling (due to temperature difference between tank and tanker contents)
- ☐ Malfunctioning of scrubber
- ☐ Overfilling of transport container (e.g. cylinder, pack, truck)
- ☐ External fire (lifting relief device)
- ☐ Failure of relief device (pressure relief valve, bursting disc)

Secondary effects (May initiate a separate incident....)

- ☐ Dust cloud deflagration (even as secondary effect)
- ☐ Blast pressure wave
- ☐ Run off of contaminated Fire Water (e.g. fuel, oils, diesel etc.)
- ☐ Release of pyrophoric gas (e.g. silane)
- ☐ Inadequate/ ineffective ventilation of ATEX area
- ☐ Lack of control of ignition sources in ATEX zones

HUMAN FACTORS – which influence actions of people adversely or have undesired outcomes

Design/Construction

- ☐ Illogical Design of Equipment and Instruments
- ☐ Inadequate Specification/Purchase
- ☐ Inadequate Installation
- ☐ Failure of design / construction
- ☐ Improper material selection
- ☐ Incorrect materials
- ☐ Wrong materials selection leading to low temperature embrittlement
- ☐ Design/Manufacturing Fault
- ☐ Unstable operations/process upsets
- ☐ Insufficient lighting
- ☐ Insufficient labelling, identification of components
- ☐ Inadequate weather protection (design and/or maintenance)

Management Systems/Procedures

- ☐ Missing or Unclear Written Instructions
- ☐ Missing or unclear supplier obligations
- ☐ Missing or unclear roles/responsibilities for shared process equipment or pipelines
- ☐ Lack of Safety Management System
- ☐ Inadequate Standards
- ☐ Inadequate Education/Training
- ☐ Inadequate training/ training not effective or not provided
- ☐ Inadequate initial or ongoing competence assessment
- ☐ Missing or Inadequate Risk Assessment
- ☐ Inadequate ATEX area zoning or equipment classification
- ☐ Failure to provide Safe System of Work (such as SWP/LOTO/ MoC)
- ☐ Safe System of Work Ineffective
- ☐ Inadequate or ineffective isolation for maintenance
- ☐ Failure of safe system of work (such as SWP/LOTO/MoC)
- ☐ Inadequate Tow-away prevention for filling/discharge (trailer)
- ☐ Inadequate Pull-away prevention during filling/discharge (cylinder, pack or tube trailer)
- ☐ Safety equipment (analyser/trip/alarm) overridden or not effective

- ☐ Poor Management of Change
- ☐ Inadequate processes for investment (funding of additional safeguards)
- ☐ Inadequate maintenance (not identified, not scheduled, not completed)
- ☐ Maintenance error
- ☐ ***Procedures:*** Procedures not followed, not existing, not correct
- ☐ First fill procedures for cryogenic tank/tanker/process vessels not followed, not existing, not correct
- ☐ Commissioning procedure not followed, not existing, not correct
- ☐ Shutdown procedure not followed, not existing, not correct
- ☐ Start-up procedure not followed, not existing, not correct
- ☐ Pre-fill cylinder inspection process not followed, not existing, not correct
- ☐ Periodic/ routine cylinder re-test or inspection process (especially C_2H_2) not followed, not existing, not correct
- ☐ Checklist missing or not used properly
- ☐ Filling/discharge procedure (trailer) not followed, not existing, not correct
- ☐ Filling procedure cylinder/pack/drum not followed, not existing, not correct

Use of Tools/Equipment

- ☐ Incorrect tools (failure to use non-sparking tools)
- ☐ Failure of work equipment

External Causes

- ☐ Extreme Weather/Natural Causes
- ☐ Cybersecurity / IT security challenges
- ☐ Security violation (theft or damage)
- ☐ Unauthorised person /intruder - aggression
- ☐ Sabotage/ Malicious Intent
- ☐ Earthquake/subsidence/land slide
- ☐ Domino impact – effects from neighbouring site

Human Factors - Task

- ☐ Disturbance/Interruptions
- ☐ Poor Workstation/Task Ergonomics
- ☐ Noisy/Unpleasant Working Environment
- ☐ Demands of Non-Routine Situations
- ☐ Alarm flooding or overflow (too many alarms at the same time)
- ☐ Repetitive action/task

Human Factors - Individual

- ☐ Low Skills/Competence Levels
- ☐ Fatigue
- ☐ Improper Motivation
- ☐ Medical or Physical condition
- ☐ Psychological Stress – irrespective of cause
- ☐ Private personal, medical or family matters
- ☐ Lack of Knowledge
- ☐ Unintentional Mistake
- ☐ Under the Influence of Drug/Alcohol
- ☐ Physical impairment (e.g. unable to distinguish colours, short-sighted, hearing impairment)
- ☐ Unable to properly understand written or spoken language
- ☐ Employee Unsuitable for Job for any other reason (capacity or motivation)

Human Factors - Organisation

- ☐ Failure of management systems and procedures
- ☐ Inadequate Resource/ Staffing inadequate /Organisational Workload too high
- ☐ Inadequate investment decision (for funding of additional safeguards)
- ☐ Inadequate Follow-Up to Previous Incidents or Accidents
- ☐ Management Communication Failure
- ☐ Poor Management decision making
- ☐ Inadequate Supervision
- ☐ Unclear Roles/Responsibilities
- ☐ Poor Management of Health & Safety Issues

- ☐ Poor Health & Safety Culture
- o Training Needs not addressed
- ☐ Inadequate Management/Leadership
- ☐ Lack of operational discipline

At Risk and Unsafe Behaviours

- ☐ Taking shortcuts
- ☐ Inadequate focus of attention/concentration
- ☐ Using Equipment Improperly
- ☐ Making Safety Devices Inoperable
- ☐ Using Defective Equipment
- ☐ Operating Equipment without Permission
- ☐ Failing to Warn Co-workers
- ☐ Servicing Equipment in Motion/Live Electrical Work/Pressurised
- ☐ Failure to Communicate/Co-ordinate
- ☐ Failure to Follow Safe System of Work
- ☐ Failure to React to/Correct Unsafe Conditions
- ☐ Inadequate Assessment of Hazard or Risk
- ☐ Inadequate Preparation/Planning
- ☐ Mal-operation of Plant
- ☐ Operating Vehicle/Equipment at Improper Speed
- ☐ Negligence

Substandard/Unsafe Conditions

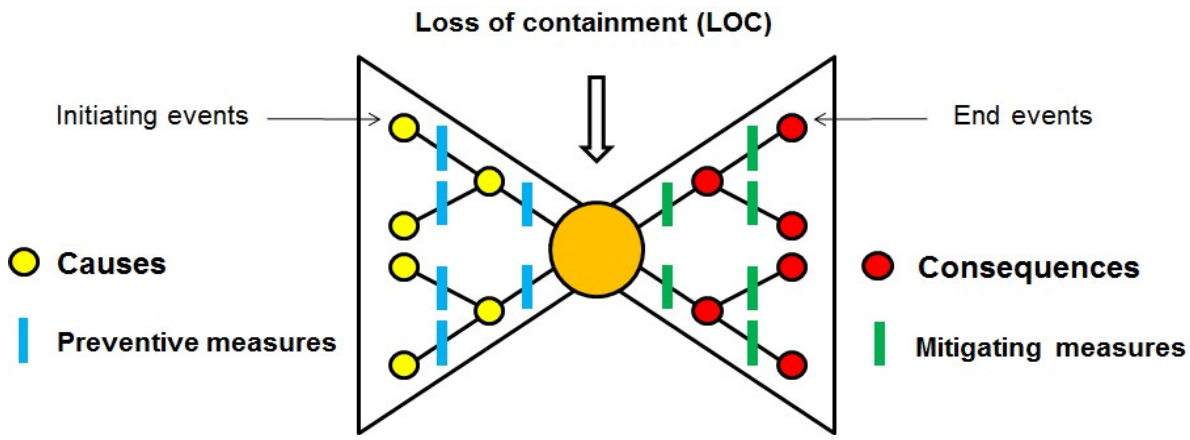
- ☐ Congested Workplace
- ☐ Bad Condition of Tools/Equipment/Supplies
- ☐ Inadequate Warning Systems
- ☐ Poor Housekeeping
- ☐ Poor Ventilation/Room temperature
- ☐ Surface Conditions
- ☐ Poor Lighting
- ☐ Poor Site Layout/Traffic Management

Human Injury causes

- ☐ Exposure to oxygen deficient atmosphere
- ☐ Exposure to harmful gases and vapours
- ☐ Exposure to other chemicals
- ☐ Exposure to heat, or substances
- ☐ Exposure to cold atmospheres,
- ☐ Rupture / burst arising from pressure energy release (other than resulting from chemical reaction or combustion)
- ☐ Other exposure such as high noise levels,

Appendix E1/E2: Examples of Scenarios

IMPORTANT NOTE
In the following pages a few examples of initiating events and relevant safeguards are given to illustrate how a Seveso risk assessment could be documented either in a simple word/excel table, or PlanOp [47] (software offered free by Belgian government intended to help construct MA scenarios) or Bow tie programmes (such as BowTie Pro™ software [68]). The content shown in each “format” is the same and is intended to illustrate the method and documentation. These examples do not illustrate all possible MA scenarios or all possible initiating events or all required safeguards!

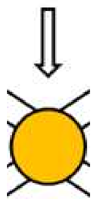


In the following sections 2 Loss of Containment (LOC) scenarios are illustrated in each of the 3 formats (word/excel, PlanOP [47] and Bowtie®):

- Loss of containment of oxygen from a typical 30 tonne vacuum jacketed (VJ) tank
- Leak from a cylinder of a generic Toxic Gas

In each format the same initiating events, preventive measures, LOC, mitigating measures and consequences are presented.

Here is a summary of the symbols used in Bowtie®

Causes Preventive measures	The **initiating events** (yellow dots) and possible **preventive measure** (blue bars) are listed. If any preventive measure is successful, then the loss of containment should not occur or would be less severe. Some preventive measures can protect against more than one initiating event.
	**Loss of Containment (LOC)** For a defined scenario this would be a release of a Seveso dangerous substance. Depending on the scenario, this might include; major or minor spill of liquid, as a pool or a spray, a release of a gas through a pipework leak or a cylinder valve shear. These represent the **“knot”** of the bowtie shown by the orange circle in the figure.
Consequences Mitigating measures	Once the loss of containment has occurred there may be technical or organisational measures which might prevent a possible “end event” or **consequence** (e.g. eliminating ignition sources to prevent fire) - these are called **mitigating measures**. They cannot prevent a loss of containment event, but they reduce or modify the harmful effects of that release.

Appendix E1: Examples of Scenarios for LOX VJ tank 30 tonnes

Photos illustrate: typical Vacuum Jacketed cryogenic liquid storage tanks, drivers offloading / loading cryogenic liquids.



NOTE that the “small” tank/tanker in this E1 example presumes that the site holds sufficient other dangerous substances to qualify as a Seveso site – clearly 30 tonnes of oxygen alone would not be a Seveso site.

Appendix E1: Examples of Scenarios for LOX VJ tank 30 tonnes (Text)

	Loss of containment: Oxygen could be released from a liquid oxygen storage tank or associated piping resulting in a major or minor spill of cryogenic liquid and an oxygen-enriched cloud, with an increased risk of fire if there are combustible materials and an ignition source nearby.

Causes	A liquid oxygen release could be caused by; • Towaway (driver drives away while hose is still connected) • A fill hose failure • A flange or connection leak during filling • Corrosion of the outer wall, resulting eventually in significant loss of vacuum and overpressure of tank • Failure of pressure regulator (on the pressure build up unit or PBU) leading to overpressure of tank • The tanker pump exceeds tank MAWP resulting in overpressure during filling • External fire • Mechanical (vehicle) impact resulting in damage to piping • Contamination introduced or remaining after maintenance so that piping or valve metal burns

Relevant prevention measures are listed for each of these causes next.

Causes Preventive measures	CAUSE: Towaway (driver drives away while hose is still connected). Measures which help to prevent Towaway include: ✓ Competent ADR licensed driver, and ✓ Driver is trained/assessed in hazards, local equipment and procedures, and ✓ Written Fill procedure (includes check steps to prevent towaway) and ✓ ADR requires use of a wheel chock during filling (which means the driver needs to walk around the vehicle to remove the wheel chock after filling) and ✓ Cryogenic tank-vehicle design includes interlocks which keep brakes on during filling (e.g. when the cabinet door is open or hose is connected) For more detail see EIGA Doc 63, *Prevention of Towaway Incidents* **Error! Reference source not found.**

Causes Preventive measures	CAUSE: Fill hose failure. Measures which help to prevent fill hose failure include: ✓ Certified pressure hose, suitable for cryogenic service and ✓ Pre-use inspection by the competent ADR driver and ✓ External spiral provides protection against erosion (of hose against ground) and ✓ Design of hose connection (collar) minimises hose twist (maintains integrity) and ✓ Proper hose location (storage shelf for hoses on the tanker) and ✓ Periodic visual examination of hose and ✓ inspection and ✓ Competent ADR licenced driver remains present throughout filling
Causes Preventive measures	CAUSE: A flange or connection leak during filling. Measures which help to prevent flange or connection leaks include: ✓ Competent ADR licenced driver remains present throughout filling and ✓ Company specific standard connections (proven robust designs) and ✓ Fill procedure (includes leak checks during cool down) For more detail on connection coupling design, see also EIGA Doc 909, *EIGA Cryogenic Gases Couplings for Tanker Filling* **Error! Reference source not found.**
Causes Preventive measures	CAUSE: Corrosion of the outer wall, resulting eventually in significant loss of vacuum and tank overpressure. Measures which help to prevent tank overpressure from loss of vacuum include: ✓ External painting of tank and ✓ Design of VJ tank (vacuum precludes internal corrosion of outer wall) and ✓ Pre-fill tank inspection procedures (check for frosting) and ✓ Periodic inspection/test programme required for certified pressure vessels and ✓ Perlite in jacket assists insulation and ✓ Pressure relief valve(s) on tank and ✓ Bursting disk on tank For more information see EIGA Doc 115, *Storage of Cryogenic Air Gases at User Premises* **Error! Reference source not found.**

Causes Preventive measures	CAUSE: Failure of pressure regulator (on the pressure build up unit or PBU) leading to overpressure of tank. Measures which help to prevent tank overpressure from pressure control failure include: ✓ Periodic inspection/test programme required for certified pressure vessels and ✓ Pressure relief valve(s) on tank and ✓ Bursting disk on tank For more information see EIGA Doc 115 *Storage of Cryogenic Air Gases at User Premises* **Error! Reference source not found.** and EIGA TB 11 *Recommendations for the Prevention of Brittle Failure of the Outer Jacket of Vacuum Insulated Cryogenic Storage T*anks **Error! Reference source not found.**
Causes Preventive measures	CAUSE: The tanker pump exceeds tank MAWP resulting in overpressure during filling Measures which help to prevent or reduce tank overpressure from tanker pump operation include: ✓ Burst pressure of tank/piping is >design pressure and ✓ Pressure relief valve(s) on tank (even if not fully sized for tanker pump flow)and ✓ Burst disk on tank (even if not fully sized for tanker pump flow) and ✓ Competent ADR licenced driver remains present throughout filling and ✓ High Pressure sensing device with fill line closure valve For more information see EIGA Doc 151, *Prevention of Excessive Pressure During Filling of Cryogenic Vessels* ***Error! Reference source not found.***
Causes Preventive measures	CAUSE: External Fire. Measures which help to prevent external fire include: ✓ Safety distance around tank (exclusion of combustibles) and ✓ Tanks installed on concrete plinth (made ground, not asphalt) and ✓ Vacuum jacket for insulation and ✓ Tank located inside fenced site/compound (no unauthorised access) and ✓ Pressure relief valve(s) on tank and ✓ Bursting disk on tank and ✓ Hot work/ Ignition sources controlled and ✓ Site housekeeping rules For more information see EIGA Doc 115, *Storage of Cryogenic Air Gases at User Premises* **Error! Reference source not found.**

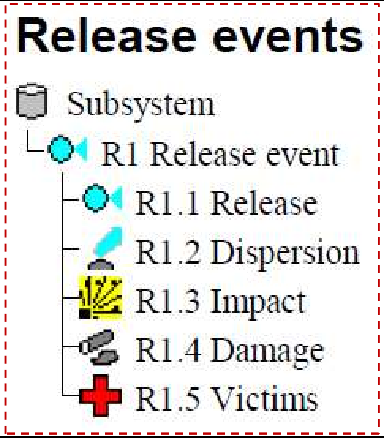
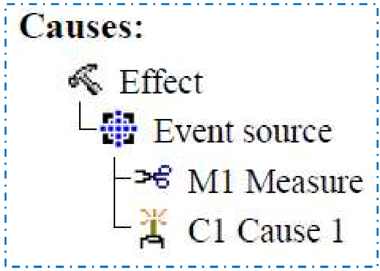
Causes Preventive measures	CAUSE: Mechanical (vehicle) impact resulting in damage to piping. Measures which help to prevent mechanical impact include: ✓ Tank and piping located inside fenced site / compound (no unauthorised access) and ✓ Impact protection (e.g. bollards or "Armco" barriers) and installation layout minimises exposed piping and ✓ Site traffic plan, with identified vehicle routes and ✓ Site speed limits and ✓ Competent ADR licenced tanker drivers See also EIGA Doc 179, *Liquid Oxygen, Nitrogen and Argon Cryogenic Tanker Loading System* **Error! Reference source not found.**
Causes Preventive measures	CAUSE: Contamination introduced / remaining after maintenance so that piping or valve metal burns. Measures which help to prevent contamination of oxygen systems include: ✓ Competent maintenance personnel (aware of oxygen hazards) and ✓ Maintenance procedures and ✓ Maintenance requirements for oxygen clean equipment (avoid invasive inspections i.e. do not need to open pump) and ✓ Permit to Work required for line opening / maintenance tasks and ✓ Prescribed oxygen cleaning methods See EIGA Doc 33*, Cleaning of Equipment for Oxygen Service – Guideline* [74]

Consequences	CONSEQUENCES: a minor or major spill of cryogenic oxygen from its storage tank or associated piping could result in a pool of cryogenic liquid and an oxygen-enriched cloud, with an increased risk of fire if there are combustible materials and an ignition source nearby. The fire could hurt people in the area but is unlikely to have a significant effect on the environment (no "major accident to the environment")

Consequences Mitigating measures	Once there has been a minor or major spill of cryogenic oxygen, then the following measures can help mitigate the consequences of that release: ✓ Competent ADR licenced driver pushes emergency stop (to close tanker valve) ✓ Employee awareness of oxygen enrichment hazards ✓ Cryogenic storage tank located outside (i.a.w - in accordance with - industry best practice) ✓ Tanks installed on concrete plinth (made ground, not asphalt) ✓ Exclusion of combustibles inside safety distance around tank (i.a.w. industry best practice) ✓ No manways, sewers within safety distance around tank (i.a.w. industry best practice) or diversion kerbs ✓ Trained site emergency response (close manual tank isolation valve) ✓ On-site emergency plan (evacuate area, first aid actions, call external emergency services) ✓ Site personnel wearing suitable work wear / PPE For further guidance see EIGA Info HF 06 *Organisation: Site Emergency Response* ***Error! Reference source not found.*** It is also important to investigate any release incident or near miss to identify additional prevention measures. See EIGA Doc 90 Incident/Accident Investigation Analysis **Error! Reference source not found.** and EIGA TP-INC Training Packages on Recent Incidents (Members only) [24]

Appendix E1: Examples of Scenarios for LOX VJ tank 30 tonnes (PLANOP) [47]

On the following pages the same scenarios are shown as extracts of the output report from PLANOP. The consequences (release) together with mitigating events (safeguards), – the “right hand side” of the bow-tie are shown first, outlined in red. The following snapshots show individual scenario trees with different causes (events) and relevant prevention measures (safeguards) which might lead to the Loss of Containment of Oxygen from this kind of tank. The cause trees are outlined in blue.

	**Loss of Containment** Dispersion (gas cloud) Fire/explosion Property damage Consequence (to human health)			**Loss of containment** Preventive OR mitigation measure Initiating event (or contributing factor)

Consequences

Mitigating measures

Release events

- Liquid oxygen tank
  - M1 Competent ADR driver pushes emergency stop button on tanker to close automatic valve
  - R1 LOX release
    - M2 Evacuation procedure
    - M3 Personal protective equipment
    - M4 First aid treatment in accordance with SDS (fresh air, oxygen or special treatment)
    - M5 Employee awareness of oxygen enrichment and cryogenic hazards
    - R1.1 Cryogenic burns
    - M6 Trained site emergency response (e.g. closing manual tank isolation valve)
    - M7 Location of tank outdoors
    - R1.2 Formation of oxygen enriched atmosphere
      - M8 Safety distances to storage of combustibles
      - M9 Safety distance or diversion curbs to sewer inlets
      - M10 Smoking and open ignition sources prohibited
      - M11 Work permit system for hot work
      - M12 Housekeeping and tidyness
      - M13 Contractor safety procedures

- R1.2.1 Ignition of combustible materials
  - R1.2.1.1 Fire
    - M14 Evacuation procedure

contd

    - M15 Call ambulance
    - R1.2.1.1.1 Burns by flames or radiation
    - M16 External fire brigade actions
    - R1.2.1.1.2 Rupture of nearby dangerous substance storage (cylinders, tanks,...)
    - M17 External fire brigade actions
    - R1.2.1.1.3 Property damage
- M18 External fire brigade actions
- R1.3 Rupture of nearby carbon steel cylinders by embrittlement
  - M19 Call ambulance
  - R1.3.1 Injury by fragments

Description:

R1 LOX release

Potential for release of complete content from tank and/or trailer

Causes

Preventive measures

Causes:

- Product release
  - Loss of jacket vacuum
    - C1 Tank ruptures
      - M1 Bursting disk
      - C1.1 Pressure exceeds MAWP
        - M2 Pressure relief valve
        - C1.1.1 Evaporation of liquid product in tank
          - C1.1.1.1 Loss of insulation
            - M3 Vacuum jacket filled with perlite ensures remaining insulation
            - C1.1.1.1.1 Loss of vacuum
              - M4 Periodic inspection of tank
              - M5 Pre-fill tank inspection by driver (check for frosting)
              - M6 Vacuum eliminates potential for internal corrosion of outer wall
              - M7 External painting of tank
              - C1.1.1.1.1.1 Perforation of outer tank wall by corrosion

Release events:

- Product release
  - LOX release

Causes

Preventive measures

Causes:

- Product release
  - Overfilling of tank
    - M1 Burst pressure > design pressure
    - M2 Driver is alerted by opening of PRV or bursting disk and stops pump
    - C1 Pressure exceeds MAWP of tank
      - M3 Fill line closure valve closes based on signal from pressure sensing device
      - C1.1 Tank pressure rises
        - M4 Driver stops pump when liquid spills from the full trycock valve
        - M5 Driver stops pump based on level meter reading
        - M6 Driver remains present throughout filling
        - C1.1.1 Tanker connected for filling and pump started

Release events:

- Product release
  - LOX release

Causes

Preventive measures

Causes:

- Product release
  - Tow away of connected trailer
    - C1 Hose or piping beaks
      - C1.1 Driver drives away with connected hose
        - M1 Vehicle interlocks prevent driving away (brakes activated when pump cabinet door open or hose connected)
        - M2 Use of wheelchocks (requred by ADR) : forces driver to walk around truck
        - M3 Fill procedure (incudes check steps to prevent tow away)
        - M4 Driver trained and assessed in hazards and local equipment/procedures
        - M5 Competent ADR licensed driver
        - C1.1.1 Driver drives off with hose still connected

Release events:

- Product release
  - LOX release

- Causes
- Preventive measures

Causes:

- Product release
  - Vehicle impact
    - C1 Piping damage
      - M1 Competent ADR tanker drivers
      - M2 Site speed limit
      - M3 Site traffic plan (with identified vehicle routes)
      - M4 Physical impact protection (eg..bollards, Armco barriers) , minimising exposed piping
      - M5 Fenced site with access control
      - C1.1 Vehicle hits tank piping

Release events:

- Product release
  - LOX release

Causes	**Causes:**
Preventive measures	

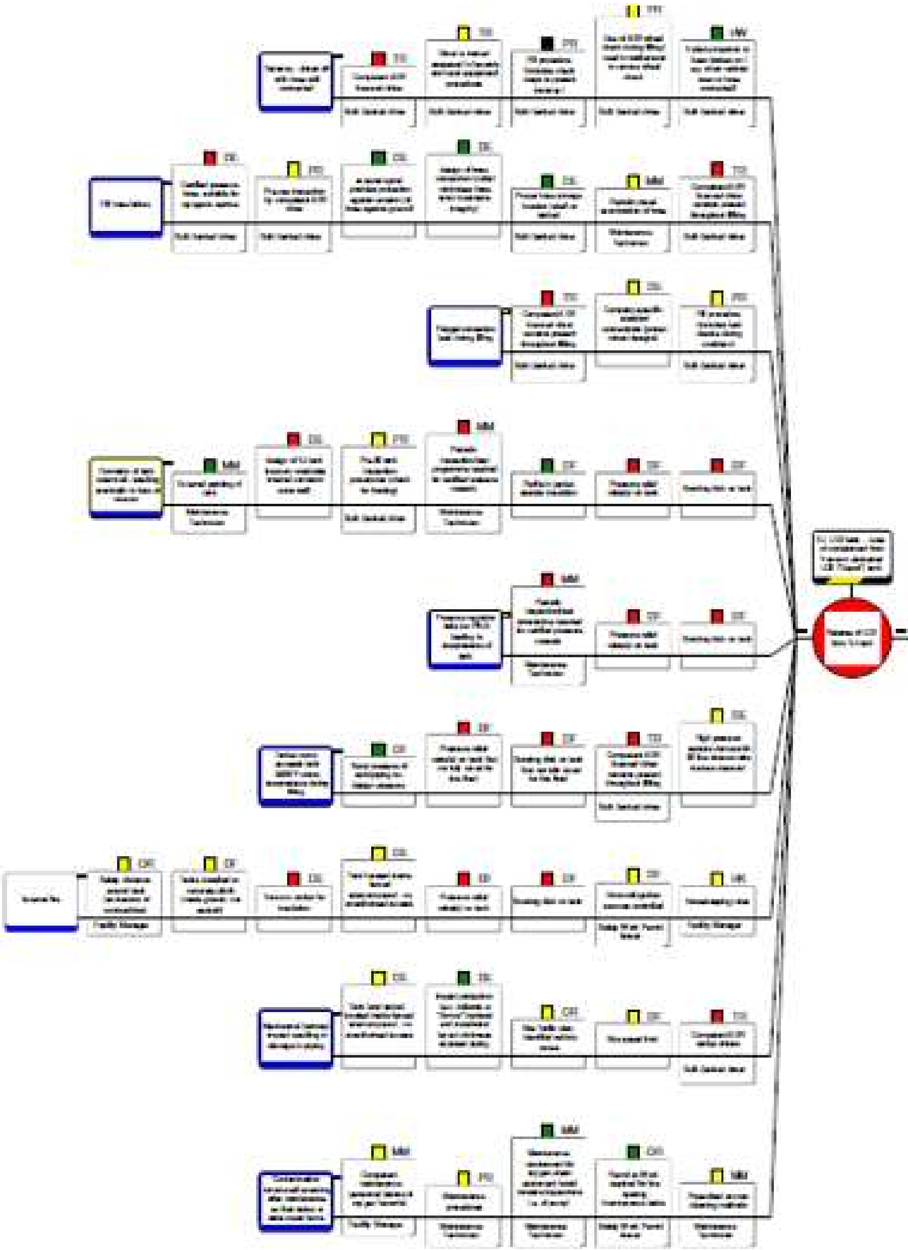
Causes:

- Product release
  - Hose failure
    - C1 Hose beaks during filling
      - M1 Driver remains present throughout filling
      - M2 Periodic visual examination by maintenance
      - M3 Proper storage of the hose in the vehicle
      - M4 Hose connection design minimises twisting of the hose
      - M5 Protective external spiral (protects braid against erosion from dragging over the ground
      - M6 Pre-use inspection of hose by driver
      - M7 Certified pressure hose
      - C1.1 Hose connected for filling

Release events:

- Product release
  - LOX release

Appendix E1: Examples of Scenarios for LOX VJ tank 30 tonnes (Bowtie®)



Threat Types:
- Operations
- Environment

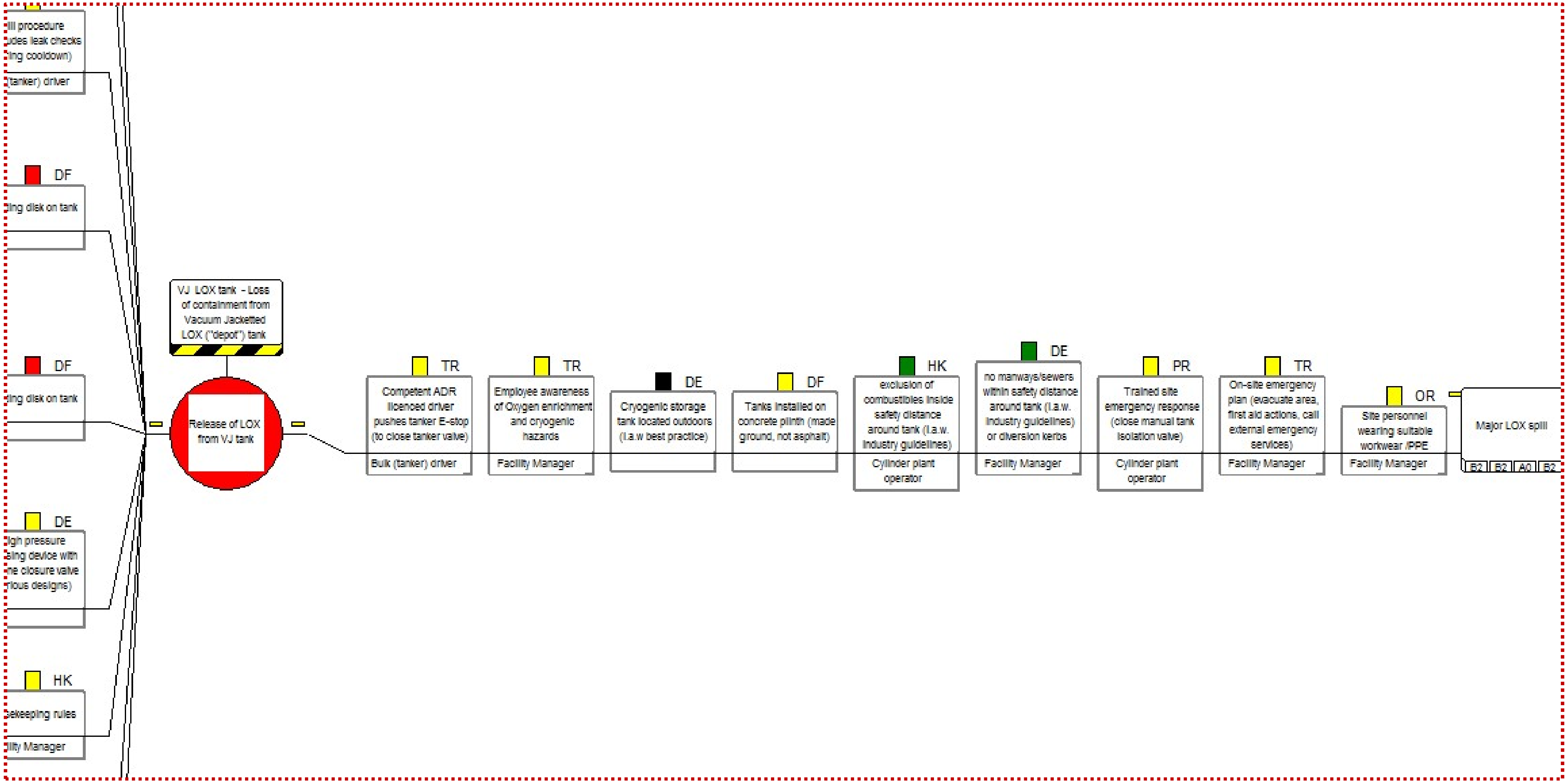
Control Types:
- Mandatory
- Required/Actual
- un-defined
- Optional

Post	Description
BD	Bulk (tanker) driver
Cust	Customer personnel
FLT	Forklift Truck driver
FMgr	Facility Manager
MT	Maintenance Technician
Op	Cylinder plant operator
SWP	Safety Work Permit Issuer
TD	(cylinder) Truck Driver

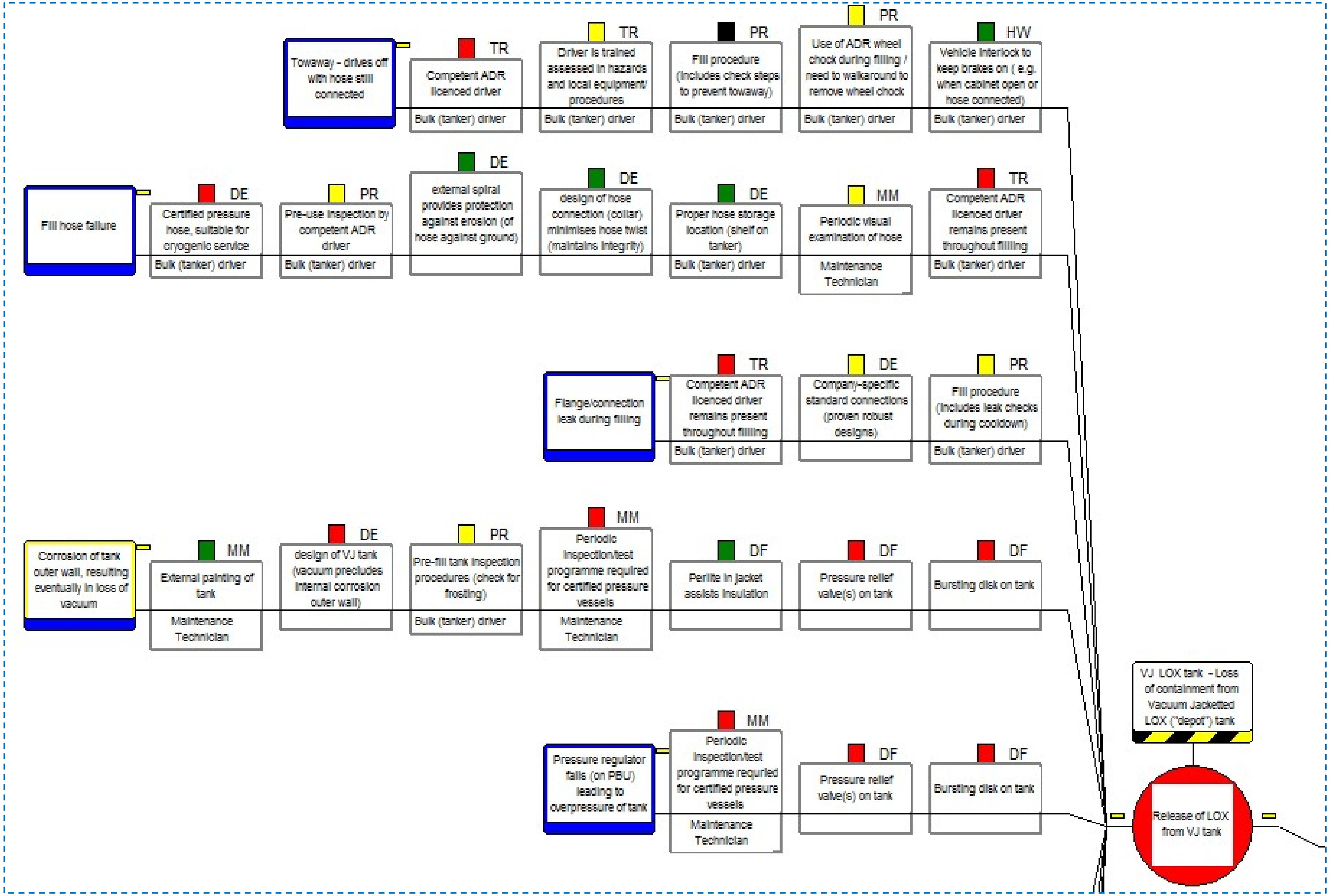
The preceding page shows an overview of the Bowtie® drawing for leak/release of liquid oxygen from a VJ storage tank or associated pipework.

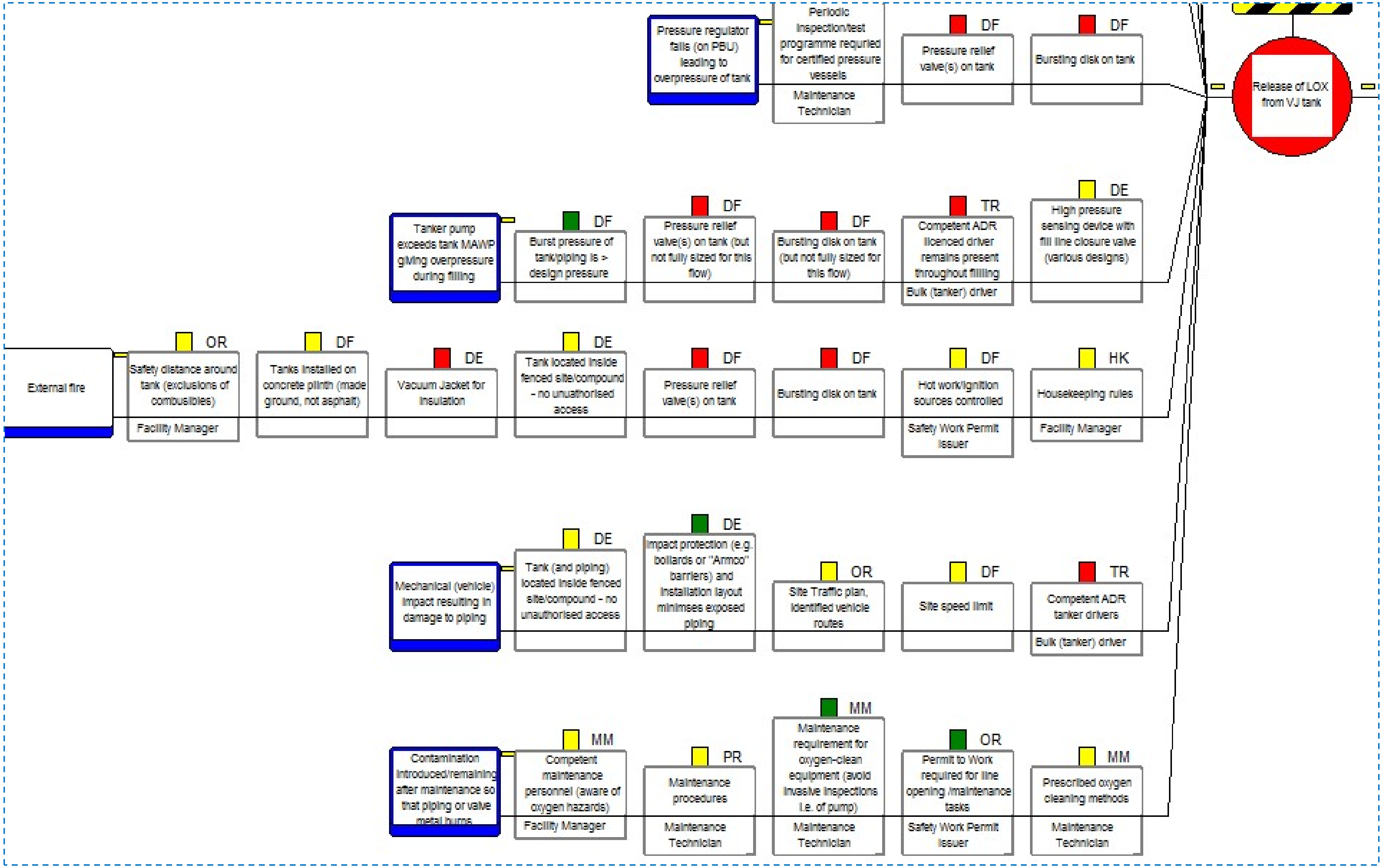
This and following pages show enlarged snapshots of different sections of the same diagram, so that the text is readable. To make navigation easier the “knot” of the bow-tie is included on each page.

The “right hand side” of the bow-tie is shown first, below, outlined in red. This depicts the mitigating events (safeguards).



The next 2 pages show snapshots of individual scenario trees with different causes (events) which might lead to the Loss of Containment of Oxygen from this kind of tank and relevant prevention measures (safeguards). The cause trees are outlined in blue.


Towaway - drives off with hose still connected
TR
Competent ADR licenced driver
Bulk (tanker) driver
TR
Driver is trained assessed in hazards and local equipment/ procedures
Bulk (tanker) driver
PR
Fill procedure (includes check steps to prevent towaway)
Bulk (tanker) driver
PR
Use of ADR wheel chock during filling / need to walkaround to remove wheel chock
Bulk (tanker) driver
HW
Vehicle interlock to keep brakes on (e.g. when cabinet open or hose connected)
Bulk (tanker) driver
Fill hose failure
DE
Certified pressure hose, suitable for cryogenic service
Bulk (tanker) driver
PR
Pre-use inspection by competent ADR driver
Bulk (tanker) driver
DE
external spiral provides protection against erosion (of hose against ground)
DE
design of hose connection (collar) minimises hose twist (maintains integrity)
DE
Proper hose storage location (shelf on tanker)
Bulk (tanker) driver
MM
Periodic visual examination of hose
Maintenance Technician
TR
Competent ADR licenced driver remains present throughout filling
Bulk (tanker) driver
Flange/connection leak during filling
TR
Competent ADR licenced driver remains present throughout filling
Bulk (tanker) driver
DE
Company-specific standard connections (proven robust designs)
PR
Fill procedure (includes leak checks during cooldown)
Bulk (tanker) driver
Corrosion of tank outer wall, resulting eventually in loss of vacuum
MM
External painting of tank
Maintenance Technician
DE
design of VJ tank (vacuum precludes internal corrosion outer wall)
PR
Pre-fill tank inspection procedures (check for frosting)
Bulk (tanker) driver
MM
Periodic inspection/test programme required for certified pressure vessels
Maintenance Technician
DF
Perlite in jacket assists insulation
DF
Pressure relief valve(s) on tank
DF
Bursting disk on tank
Pressure regulator fails (on PBU) leading to overpressure of tank
MM
Periodic inspection/test programme required for certified pressure vessels
Maintenance Technician
DF
Pressure relief valve(s) on tank
DF
Bursting disk on tank
VJ LOX tank - Loss of containment from Vacuum Jacketted LOX ("depot") tank
Release of LOX from VJ tank

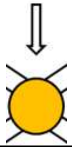

Pressure regulator fails (on PBU) leading to overpressure of tank
Periodic inspection/test programme required for certified pressure vessels
Maintenance Technician
DF
Pressure relief valve(s) on tank
DF
Bursting disk on tank
Release of LOX from VJ tank
Tanker pump exceeds tank MAWP giving overpressure during filling
DF
Burst pressure of tank/piping is > design pressure
DF
Pressure relief valve(s) on tank (but not fully sized for this flow)
DF
Bursting disk on tank (but not fully sized for this flow)
TR
Competent ADR licenced driver remains present throughout filling
Bulk (tanker) driver
DE
High pressure sensing device with fill line closure valve (various designs)
External fire
OR
Safety distance around tank (exclusions of combustibles)
Facility Manager
DF
Tanks installed on concrete plinth (made ground, not asphalt)
DE
Vacuum Jacket for insulation
DE
Tank located inside fenced site/compound - no unauthorised access
DF
Pressure relief valve(s) on tank
DF
Bursting disk on tank
DF
Hot work/ignition sources controlled
Safety Work Permit issuer
HK
Housekeeping rules
Facility Manager
Mechanical (vehicle) impact resulting in damage to piping
DE
Tank (and piping) located inside fenced site/compound - no unauthorised access
DE
Impact protection (e.g. bollards or "Armco" barriers) and installation layout minimises exposed piping
OR
Site Traffic plan, identified vehicle routes
DF
Site speed limit
TR
Competent ADR tanker drivers
Bulk (tanker) driver
Contamination introduced/remaining after maintenance so that piping or valve metal burns
MM
Competent maintenance personnel (aware of oxygen hazards)
Facility Manager
PR
Maintenance procedures
Maintenance Technician
MM
Maintenance requirement for oxygen-clean equipment (avoid invasive inspections i.e. of pump)
Maintenance Technician
OR
Permit to Work required for line opening /maintenance tasks
Safety Work Permit issuer
MM
Prescribed oxygen cleaning methods
Maintenance Technician

Appendix E2: Examples of Scenarios for Toxic Gas Cylinder Leak

Photos illustrate a storage cage for Toxic and Corrosive gases, leaking Hydrogen Bromide cylinder and Hydride storage cage (for Arsine/Phosphine).

Scenario: Loss of Containment of single cylinder of toxic gas (storage)

Appendix E2: Examples of Scenarios for Toxic Gas Cylinder leak (Text)

	**Loss of containment**: In the event of damage to the cylinder or valve, there could be a release of a toxic gas (with adverse effects to health or the environment).

Causes	A toxic gas release could be caused by; • Corrosion of the valve (usually caused by minor leak and presence of moisture) • Impact of forklift fork on cylinder wall • Impact of forklift fork on cylinder valve resulting valve shear • Dropping during loading/unloading, resulting valve shear • External fire nearby which then engulfs toxic gas cylinder causing rupture and then release/ • outer corrosion of the cylinder • Inner corrosion of the cylinder (usually caused by presence of moisture or contaminant)

Preventive measures	There are some general cylinder storage measures which help to protect against several (but not all) of the listed causes. These are: ✓ Toxic gas cylinder storage area separated from normal traffic areas and (3m) away from boundary fence. ✓ Site speed limit ✓ Site traffic plan ✓ Competent drivers and site personnel ✓ Site security (access control, ...) ✓ Packages are ADR compliant (drop test) ✓ Control of ignition sources ✓ Outdoor cylinder storage (does not require an ATEX zone) ✓ Secured (cages) for highly toxic substances See also: EIGA Doc 130, *Principles for the Safe Handling and Distribution of Highly Toxic Gases and Mixtures* **Error! Reference source not found.**, EIGA Doc 134 *Potentially Explosive Atmospheres EU Directive 1999/92/EC* **Error! Reference source not found.**, EIGA Info 21*, Cylinder Valves Design Considerations* **Error! Reference source not found.** and EIGA Doc 922, *Site Security* **Error! Reference source not found.**

Relevant prevention measures for each of the causes are listed next.

Causes **Preventive measures**	CAUSE: Corrosion of the valve (usually caused by minor leak and presence of moisture). Additional measures which help to prevent valve corrosion include: ✓ Selection of the valve material for the gas (per ISO 11114) and ✓ Blind plugs (required by ADR) and ✓ ADR driver checks and ✓ Leak checks on receipt/arrival at site and ✓ Pre-fill inspection of valve & cylinder condition and ✓ Tightness checks at the end of filling ✓ Periodic replacement of the valve Refer to ISO 11114, *Gas Cylinders - compatibility of cylinder and valve materials with gas contents* **Error! Reference source not found.** and EIGA Doc 188 *Safe Transfer of Toxic Liquefied Gases* **Error! Reference source not found.**

Causes Preventive measures	CAUSE: Impact of forklift fork on cylinder wall. Additional measures which help to prevent forklift fork damaging the cylinder wall include: ✓ Cylinders moved in pallets ✓ Integral strength of the cylinder ✓ Forklift driving good practices [travelling with lowered forks] ✓ Approved FLT forks
Causes Preventive measures	CAUSE: Impact of forklift fork on cylinder valve resulting valve shear. Additional measures which help to prevent forklift fork damaging the cylinder valve include: ✓ Cylinders moved in pallets ✓ Protective cap ✓ Forklift driving good practices [travelling with lowered forks] ✓ Approved FLT forks
Causes Preventive measures	CAUSE: Dropping during loading/unloading, resulting valve shear. Additional measures which help to prevent cylinder damage during loading/unloading include: ✓ Cylinders moved in pallets ✓ Protective cap ✓ Approved FLT forks ✓ Design of the pallet [fork pocket or sleeve] ✓ Cylinders strapped securely in the pallet ✓ Loading/unloading operations in a dedicated area of the site ✓ Checks of the strap conditions ✓ Checks of the pallets See also EIGA TB 13, Safe Design And Use Cylinder of Pallets **Error! Reference source not found.**
Causes Preventive measures	CAUSE: External fire nearby which then engulfs toxic gas cylinder causing rupture and release/. Additional measures which help to prevent cylinder rupture from nearby fire include: ✓ Safety distance to keep combustible materials away from cylinder storage areas ✓ Segregation of toxic, flammable and oxidising gas cylinders (i.a.w – in accordance with – industry best practice) ✓ Fire-fighting equipment (allowing nearby small fire to be extinguished before it reaches the cylinder) ✓ Contractor safety procedures

Causes Preventive measures	CAUSE: <u>outer corrosion of the cylinder.</u> Additional measures which help to prevent external cylinder corrosion include: ✓ Periodic inspection and testing of cylinders (as required by ADR) ✓ Pre-fill checks ✓ Painting of the cylinders See pre and post-fill checks in EIGA Doc 188, *Safe Transfer of Toxic Liquefied Gases* **Error! Reference source not found.**
Causes Preventive measures	CAUSE: <u>Inner corrosion of the cylinder</u> (usually caused by presence of moisture or contaminant) Additional measures which help to prevent internal corrosion of cylinder include: ✓ Periodic inspection and testing of cylinders (as required by ADR) ✓ Pre-fill checks (including hammer/ring test) ✓ Correct selection of cylinder material See also EIGA Doc 62, *Methods to Avoid and Detect Internal Gas Cylinder Corrosion* **Error! Reference source not found.** and EIGA Doc 188, *Safe Transfer of Toxic Liquefied Gases* **Error! Reference source not found.**

Consequences	CONSEQUENCES: a leak or release of a toxic gas could have with adverse effects to health or the environment. The symptoms and severity depend on the gas being stored and the leak rate. See EIGA Doc 189 *The Calculation of Harm and No-Harm Distances for the Storage and Use of Toxic Gases in Transportable Containers* **Error! Reference source not found.**.

Consequences Mitigating measures	Once there is a leak or release of a toxic gas, then the following measures can help mitigate the consequences of that release: ✓ Toxic substances are packaged in small product quantities (limiting possible release quantity) ✓ (On site) Site Emergency Plan - go indoors, shut windows, stop ventilation ✓ Operators observe Windsock to indicate wind direction (for safe escape route) ✓ First aid in accordance with SDS (fresh air, oxygen or special treatment.) ✓ On site emergency response e.g. use of water curtain or deluge or valve leak containment cap (emergency caps) or overpack containers (cylinder containment vessel) For further guidance see EIGA Info HF 06, *Organisation: Site Emergency Response* **Error! Reference source not found.** and EIGA Info 02*, Handling of Gas Cylinders During and After Exposure to Heat or Fire* ***Error! Reference source not found.*** . It is also important to investigate any release incident or near miss to identify additional prevention measures. See EIGA Doc 90 *Incident/Accident Investigation Analysis* **Error! Reference source not found.** and SAC Training Packages on Recent Incidents (Members only).

Appendix E2: Examples of Scenarios for Toxic Gas Cylinder leak (PLANOP) [47]

On the following pages the same scenarios are shown as extracts of the output report from PLANOP. The consequences (release) together with mitigating events (safeguards), – the "right hand side" of the bow-tie are shown first, outlined in red. The following snapshots show individual scenario trees with different causes (events) and relevant prevention measures (safeguards) which might lead to Leak of Toxic Gas. The cause trees are outlined in blue.

Release events				
Subsystem				
└ R1 Release event	**Loss of Containment**		**Causes:**	
├ R1.1 Release			Effect	
├ R1.2 Dispersion	Dispersion (gas cloud)		└ Event source	**Loss of containment**
├ R1.3 Impact	Fire/explosion			
├ R1.4 Damage	Property damage		├ M1 Measure	Preventive OR mitigation measure
└ R1.5 Victims	Consequence (to human health)		└ C1 Cause 1	Initiating event (or contributing factor)

- Consequences
- Mitigating measures

Release events

- Toxic cylinder
  - R1 Release of cylinder content
    - M1 Natural ventilation (outdoor storage)
    - M2 Limited product quantity in individual containers
    - M3 Minimise inventory
    - M4 On-site emergency response e.g. use of vlave containment cap or cilinder containment vessel to stop release
    - R1.1 Formation of toxic cloud
      - M5 Actions by external fire brigade
      - R1.1.1 Dispersion of toxic cloud
        - M6 Windsock indicates safe escape route
        - M7 On-site personnel go indoors, shut windows, stop ventilation in accordance with on-site emergency plan
        - M8 First aid treatment in accordance with SDS (fresh air, oxygen or special treatment)
        - R1.1.1.1 Adverse effects to health or the environment

Causes

Preventive measures

Causes:

- Product release
  - Forklift impact on cylinder body
    - C1 Forlift fork perforates cylinder body
      - M1 Integral strength of cylinder body
      - M2 Approved forklift forks
      - C1.1 Forklift hits cilinder
        - M3 Only authorized and competent forklift truck drivers
        - M4 Cylinders moved in pallets
        - M5 Good driving practices (including lowered forks, slow speed)
        - C1.1.1 Forklift driver error

Release events:

- Product release
  - Release of cylinder content

Causes	**Causes:** Product release └ Forklift impact on cylinder valve └ C1 Cylinder valve shears off ├ M1 Cylinder/valve design, subject to ADR drop test ├ M2 Approved forklift forks ├ M3 Cylinders moved in pallets └ C1.1 Fork hits cylinder valve ├ M4 Only authorized and competent forklift truck drivers ├ M5 Protective cap on cylinder valve ├ M6 Good driving practices (including lowered forks, slow speed) └ C1.1.1 Driver error
Preventive measures	**Release events:** Product release └ Release of cylinder content

Causes **Preventive measures**	**Causes:**

- Product release
  - Dropping of cylinder during loading/unloading
    - C1 Cylinder valve shears off
      - C1.1 Cylinder valve hits ground
        - M1 Truck key removed from contact and wheels chocked
        - M2 Only authorized and competent forklift truck drivers
        - M3 Desinated loading/unloading areas
        - M4 Cylinder/valve design, subject to ADR drop test
        - M5 Approved forklift forks
        - M6 Quick visual check of pallet condition
        - M7 Cylinder pallet design (with fork pocket)
        - M8 Check of pallet strap condition
        - M9 Cylinders securely strapped in pallet
        - M10 Cylinders moved in pallets
        - M11 Protective cap on cylinder valve
        - C1.1.1 Cylinder falls during loading/unloading

Causes Preventive measures	**Causes:**

- Product release
  - Valve corrosion
    - M1 Blind plug on valve
    - C1 Valve becomes untight
      - M2 Periodic cylinder/valve inspection & maintenance acc. to TPED
      - M3 Leak checks on receipt/arrival at site
      - M4 ADR driver checks
      - M5 Tightness check at end of filling
      - M6 Pre-fill checks (including hammer/ring test)
      - C1.1 Valve material internally attacked by corrosion
        - M7 Valve material selection
        - C1.1.1 Presence moisture combined with minor leak

Causes
Preventive measures
	Causes:
	Product release
	└ Outer corrosion of cylinder body
	  └ C1 Perforation of cylinder body
	    ├ M1 Periodic cylinder/valve inspection & maintenance acc. to TPED
	    ├ M2 Pre-fill checks (including hammer/ring test)
	    └ C1.1 Cylinder body externally attacked by corrosion
	      ├ M3 Painting of cylinder body
	      └ C1.1.1 Exposure of cylinder body to atmospheric conditions

Causes
Preventive measures
	Causes:
	Product release
	└ Internal corrosion of cylinder body
	  └ C1 Perforation of cylinder body
	    ├ M1 Periodic cylinder/valve inspection & maintenance acc. to TPED
	    ├ M2 Pre-fill checks (including hammer/ring test)
	    └ C1.1 Cylinder body internally attacked by corrosion
	      ├ M3 Cylinder material selection compatible for intended product
	      └ C1.1.1 Presence of moisture or contaminant inside the cylinder

Causes

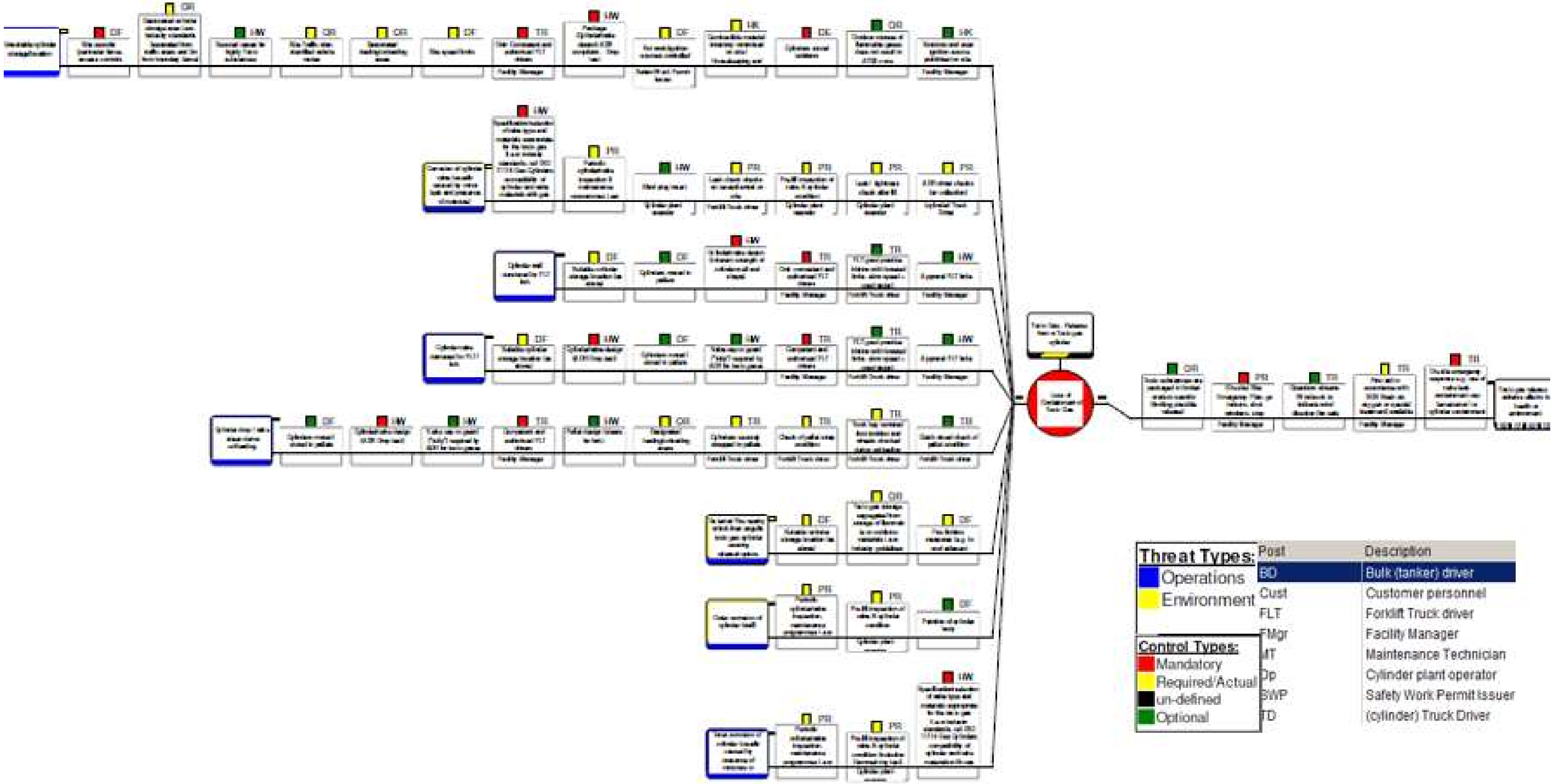
Preventive measures

Causes:

- Product release
  - External fire
    - C1 Melting of valve seat and/or weakening of body material
      - C1.1 Fire engulfs cylinder
        - M1 Contractor safety procedures
        - M2 Housekeeping and tidyness
        - M3 Smoking and open ignition sources prohibited
        - M4 Work permit system for hot work
        - M5 Emergency response by trained personnel (extinguishing of starting fire)
        - M6 Availability of appropriate fire fighting equipment to extinguish a nearby small fire
        - M7 Safety distance to storage of other combustible products
        - M8 Segregated storage of toxic, flammable and oxidizing cylinders
        - C1.1.1 Fire near toxic cylinder storage

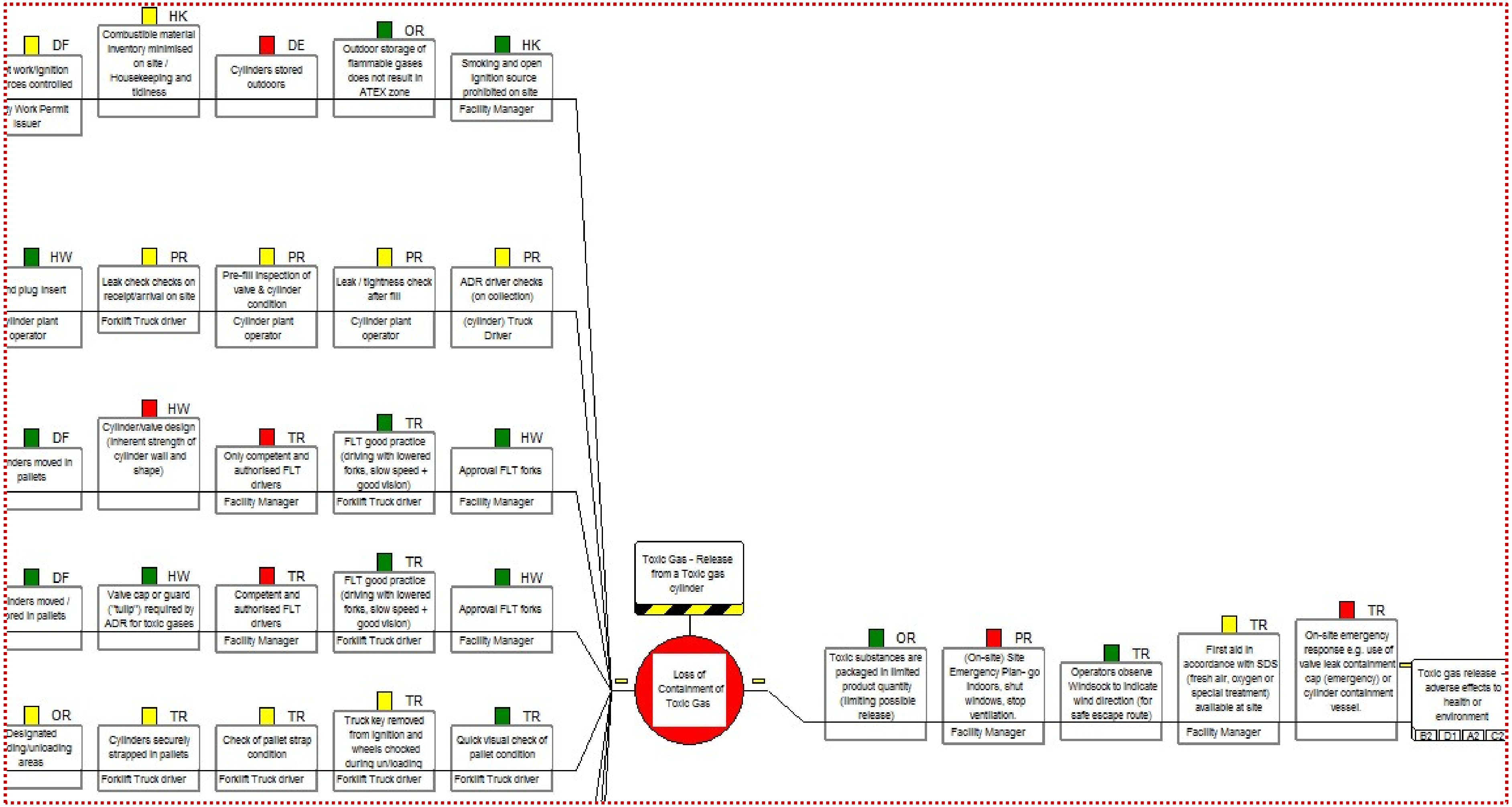
Appendix E2: Examples of Scenarios for Toxic Gas Cylinder leak (Bowtie®)

This shows an overview of the Bowtie® drawing for a release from a toxic gas cylinder.



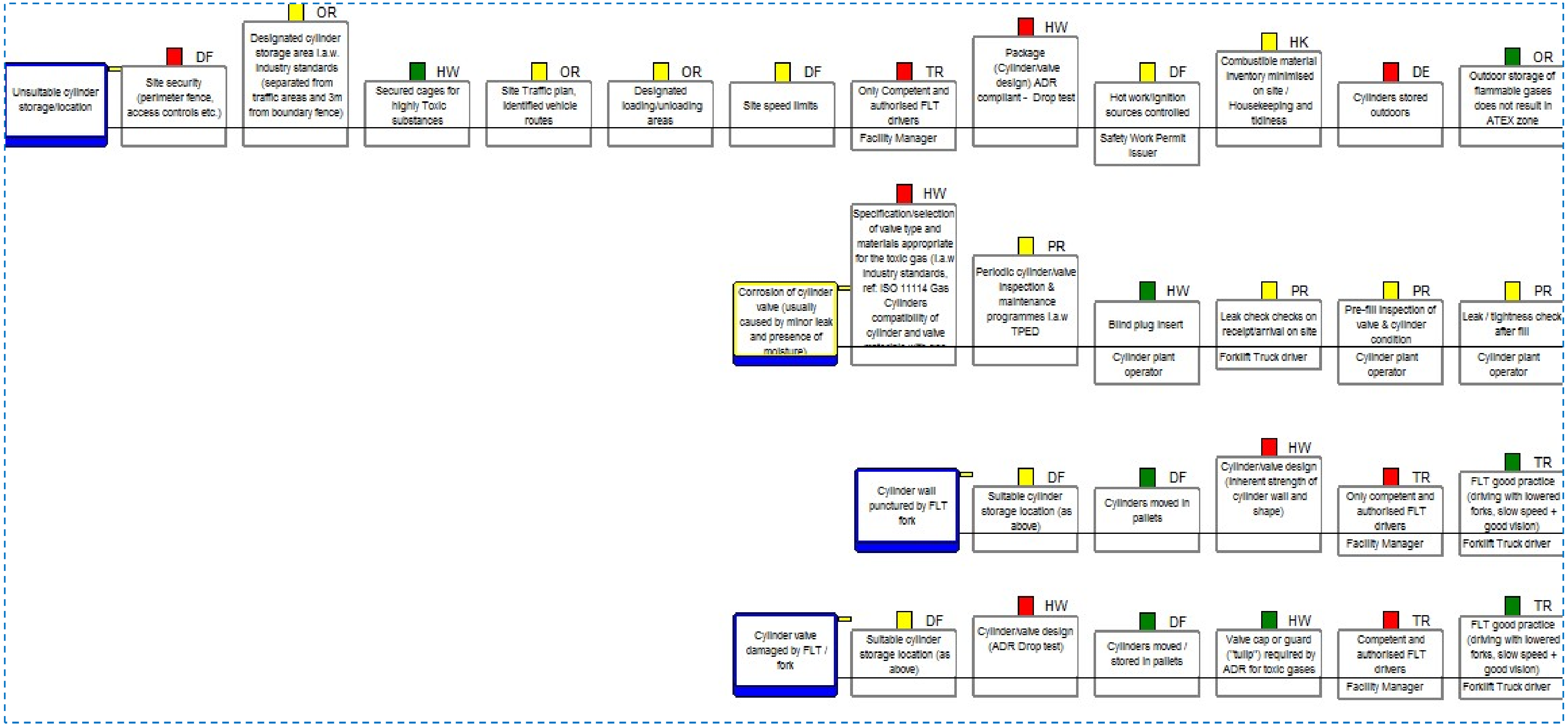
The following pages show enlarged snapshots of different sections of the same diagram, so that the text is readable. The "knot" of the bow-tie is included on the first page with the mitigating measures outlined in red (and a repeat of the last of the preventive measures immediately before the "knot").

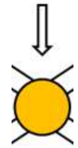
Causes Preventive measures (last in these rows)		Consequences Mitigating measures

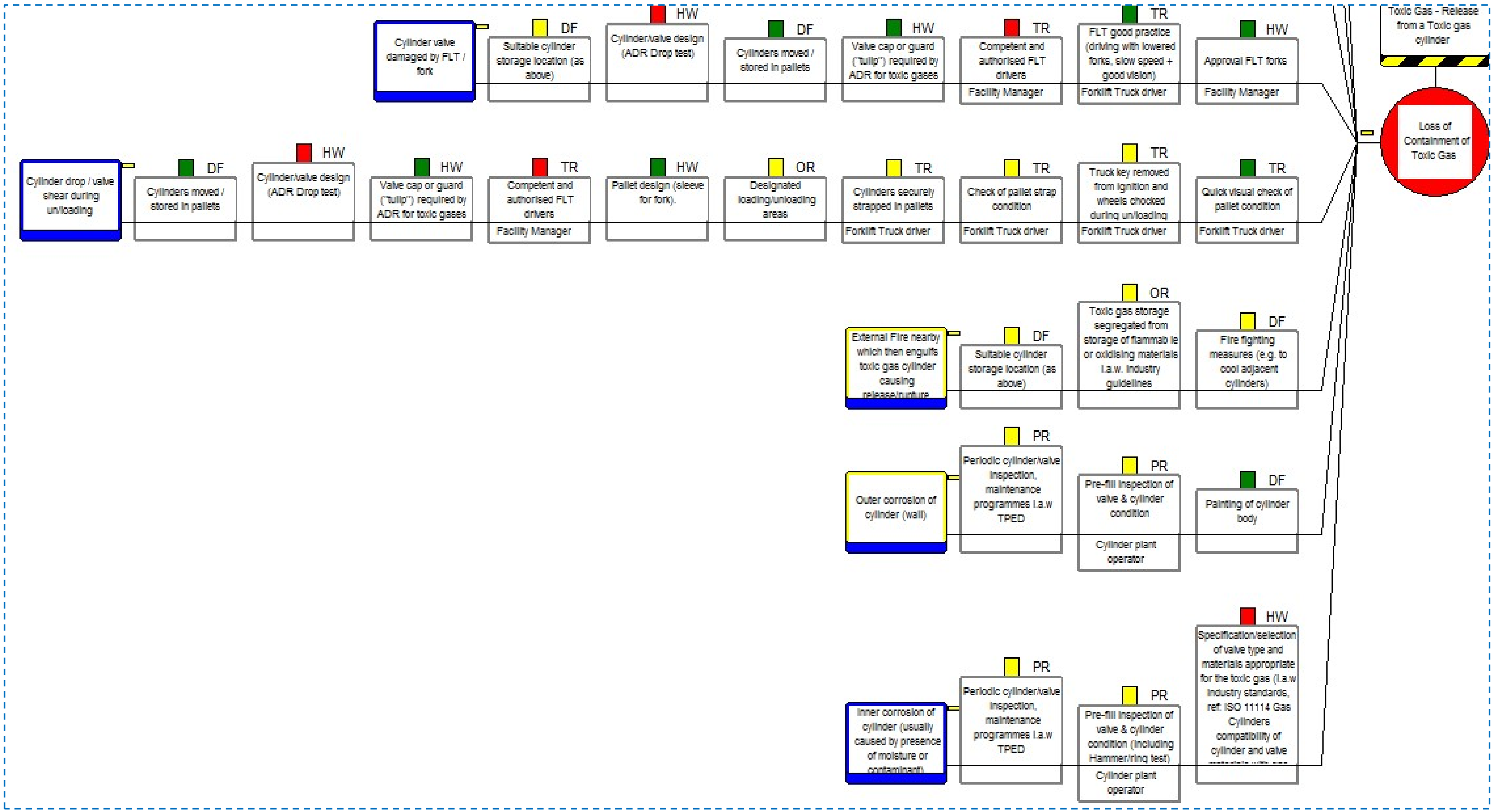


DF
t work/ignition rces controlled
y Work Permit issuer
HK
Combustible material inventory minimised on site / Housekeeping and tidiness
DE
Cylinders stored outdoors
OR
Outdoor storage of flammable gases does not result in ATEX zone
HK
Smoking and open ignition source prohibited on site
Facility Manager
HW
nd plug insert
ylinder plant operator
PR
Leak check checks on receipt/arrival on site
Forklift Truck driver
PR
Pre-fill inspection of valve & cylinder condition
Cylinder plant operator
PR
Leak / tightness check after fill
Cylinder plant operator
PR
ADR driver checks (on collection)
(cylinder) Truck Driver
DF
nders moved in pallets
HW
Cylinder/valve design (inherent strength of cylinder wall and shape)
TR
Only competent and authorised FLT drivers
Facility Manager
TR
FLT good practice (driving with lowered forks, slow speed + good vision)
Forklift Truck driver
HW
Approval FLT forks
Facility Manager
DF
nders moved / red in pallets
HW
Valve cap or guard ("tulip") required by ADR for toxic gases
TR
Competent and authorised FLT drivers
Facility Manager
TR
FLT good practice (driving with lowered forks, slow speed + good vision)
Forklift Truck driver
HW
Approval FLT forks
Facility Manager
OR
Designated ding/unloading areas
TR
Cylinders securely strapped in pallets
Forklift Truck driver
TR
Check of pallet strap condition
Forklift Truck driver
TR
Truck key removed from ignition and wheels chocked during un/loading
Forklift Truck driver
TR
Quick visual check of pallet condition
Forklift Truck driver
Toxic Gas - Release from a Toxic gas cylinder
Loss of Containment of Toxic Gas
OR
Toxic substances are packaged in limited product quantity (limiting possible release)
PR
(On-site) Site Emergency Plan- go indoors, shut windows, stop ventilation.
Facility Manager
TR
Operators observe Windsock to indicate wind direction (for safe escape route)
TR
First aid in accordance with SDS (fresh air, oxygen or special treatment) available at site
Facility Manager
TR
On-site emergency response e.g. use of valve leak containment cap (emergency) or cylinder containment vessel.
Toxic gas release - adverse effects to health or environment
B2
D1
A2
C2

This page shows the causes and almost all the prevention measures for the first 4 scenarios. The last box is each row is missing from this page but was shown on the previous page (with the adjacent boxes being duplicated).	Causes Preventive measures (missing last box on each row)



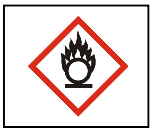
The cylinder valve damaged by FLT fork scenario is duplicated here in its entirety together with the Loss of Containment "knot". The causes and all prevention measures for the next 4 scenarios are shown completely on this page.	Causes Preventive measures	



Toxic Gas - Release from a Toxic gas cylinder
Loss of Containment of Toxic Gas
Cylinder valve damaged by FLT / fork
DF
Suitable cylinder storage location (as above)
HW
Cylinder/valve design (ADR Drop test)
DF
Cylinders moved / stored in pallets
HW
Valve cap or guard ("tulip") required by ADR for toxic gases
TR
Competent and authorised FLT drivers
Facility Manager
TR
FLT good practice (driving with lowered forks, slow speed + good vision)
Forklift Truck driver
HW
Approval FLT forks
Facility Manager
Cylinder drop / valve shear during un/loading
DF
Cylinders moved / stored in pallets
HW
Cylinder/valve design (ADR Drop test)
HW
Valve cap or guard ("tulip") required by ADR for toxic gases
TR
Competent and authorised FLT drivers
Facility Manager
HW
Pallet design (sleeve for fork).
OR
Designated loading/unloading areas
TR
Cylinders securely strapped in pallets
Forklift Truck driver
TR
Check of pallet strap condition
Forklift Truck driver
TR
Truck key removed from ignition and wheels chocked during un/loading
Forklift Truck driver
TR
Quick visual check of pallet condition
Forklift Truck driver
External Fire nearby which then engulfs toxic gas cylinder causing
DF
Suitable cylinder storage location (as above)
OR
Toxic gas storage segregated from storage of flammable or oxidising materials i.a.w. industry guidelines
DF
Fire fighting measures (e.g. to cool adjacent cylinders)
Outer corrosion of cylinder (wall)
PR
Periodic cylinder/valve inspection, maintenance programmes i.a.w TPED
PR
Pre-fill inspection of valve & cylinder condition
Cylinder plant operator
DF
Painting of cylinder body
Inner corrosion of cylinder (usually caused by presence of moisture or
PR
Periodic cylinder/valve inspection, maintenance programmes i.a.w TPED
PR
Pre-fill inspection of valve & cylinder condition (including Hammer/ring test)
Cylinder plant operator
HW
Specification/selection of valve type and materials appropriate for the toxic gas (i.a.w industry standards, ref: ISO 11114 Gas Cylinders compatibility of cylinder and valve

Appendix F1: Site Emergency Action sheet example LOX Spill

Emergency Response sheet



X1. SCENARIO N°# Safety Report

X2. LOX release from a storage tank

1 – Scenario description:

- LOX line rupture (DN 20 – tank pressure 10 bar)
  LOX release flow rate: 4.3 kg/s
- Tank emptying through the breach
  LOX tank inventory: XXXXX litres
- Liquid pool setting up on the ground
  Maximum pool radius: 2.4 m
- O2 rich cloud is generated from:
  a. The gaseous fraction of the initial release (**flow rate 1 kg/s**),
  b. The evaporation from the liquid pool (**flow rate 2.8 kg/s**)
  Maximum height of the O2 rich cloud: 1.2 m

Estimated time to empty the tank : 1h 30

2 – Distance of the hazardous zones:

Size of O2 rich cloud	**Harm threshold** (25 % O_2)	**Lethal threshold** (37 % O_2)	**High lethal threshold** (42 % O_2)
Max distance at ground level	25 m	13 m	11 m
Max height	1.2 m	0.55 m	0.5 m

3 – Oxygen physical data:

Gas density (air =1): 1, 1
Liquid density (water =1): 1, 1

Liquid-Gas conversion:

kg	litre	m^3
1	0,88	0,74
1,1415	1	0,85

Boiling temperature vs. pressure:

1 bar	2 bar	4 bar	6 bar	8 bar	10 bar
-183°C	-176°C	-168°C	-163°C	-158°C	-155°C

Safety Data Sheet: reference xxx

4 – Emergency actions (by site personnel):

Immediate actions

- Electricity shut off with the emergency stop button,
- Activate the alarm and evacuate the employees,
- Close the rainwater (surface water) drain,
- Isolate the area for at least 25 m in all directions (harm threshold)

Risk assessment before intervention

- Evaluate the visibility in the area ➔ **FOG**,
- Is it safe to walk in the area? ➔possible **ICE PATCH** on the ground,
- Check that O2 concentration is < 23.5% ➔ O2 enrichment and **FIRE HAZARD** above 23.5% of oxygen.

Intervention is not allowed if one of these conditions is present.

IF Intervention is possible

- Use the following PPE:
  - CLEAN working clothes, with long sleeves,
  - Safety shoes,
  - Cryogenic gloves,
  - Safety goggles or face mask,
  - Portable oxygen detector,
- Close the valve of the liquid line at tank outlet (tag xxx),
- Check that LOX is not spilling towards critical points: low lying areas, sewers, building inlets.
- **After the intervention**: Remove the clothes to aerate them and check the O2 concentration on the persons who entered enriched areas.

IF Intervention is not possible

- Establish or estimate the liquid level remaining the tank,
- Evaluate the emptying time of the tank,
- Check that LOX is not spilling towards critical points: low lying areas, sewers, building inlets
- Protect the area, nearby people, equipment and property
- with the fire brigade:
  - Ventilate to avoid the O2 concentration increase,
  - Monitor the O2 concentration,
  - Have firefighting equipment ready for use in case ignition occurs,
- Evaluate the **need** to move any gas cylinders from vicinity of the spill (NOTE: forklift use may be hazardous in an O2 rich atmosphere).
- Evaluate the need to close the building doors, windows, ventilation intakes - in order to avoid indoor O2 accumulation.

Safety

- All known extinguishants can be used,
- Use no oil or grease in contact with O2,
- Use water only if ignition occurs (risk of ice patch on the ground)

Appendix F2: Site Emergency Action sheet example LOX Spill

Loss of containment cryogenic liquid (LOX) –non-bunded tank rupture, hose failure,

Scenario:	Loss of containment cryogenic liquid (LOX) –non-bunded tank rupture, hose failure,	Location: LOX tank or mini tanks	L1
Incident Potential Hazards	Enriched oxygen cloud – fire hazard, Cold burns.		

	Actions / by	Equipment/ Resources	Information/comment
ASSESS the hazards: **How bad is situation now?** **What could go wrong with any action you take?**	Discoverer: Advise personnel in area confirm safe exit route leave area Inform Site Emergency Controller (**SEC**) of release details / location		Liquid will generate a dense vapour cloud. Visible boundary (water mist vapour) is only a guide to extent of cloud – fire hazard may extend further. Fires enriched by oxygen may burn almost all materials and will spread at an accelerated rate (2 to 8 times faster than expected)
CONTROL the situation:	**SEC:** Keep people away from the area. Stop release via remote valve if possible Consider site alarm / evacuation		Cold vapours will collect in low areas Secondary hazards are cryogenic (i.e. super cold) BURNS from contact with the liquid oxygen and lung damage can occur from breathing the cold vapour in the vicinity of a release.
MITIGATE the situation:	Consider informing Emergency Services to prevent false fire calls based on clouds *Consider call Fire Services to assist with any isolation activity using Self Contained Breathing Apparatus* Contact “GasCo” Bulk Engineering [Tel: xxx] for engineering support.		The secondary effects of Hypothermia can be experienced by personnel exposed to cold vapour clouds in the area of any cryogenic liquid release.

Appendix F3: Site Emergency Action sheet example Toxic Gas Leak

Cylinder loss of containment / leak of Toxic vapour

Scenario:	Cylinder loss of containment / leak of Toxic vapour	Location: Toxic cylinder storage area	TX
Incident Potential Hazards	Potential harm to people on site and Off site		

	Actions / by	Equipment/ Resources	Information/comment
ASSESS the hazards: How bad is situation now? What could go wrong with any action you take?	Discoverer: Advise personnel in area Is the leak immediately and safely containable – if yes, isolate or minimise leak. Do NOT intervene alone. Consider wind direction, evacuation routes, confirm safe exit route leave area Inform Site Emergency Controller (**SEC**) of details and location Do NOT activate the site alarm – it will potentially aggravate the incident. Leave this decision to the SEC Can you identify product?	Windsock Gas detector Customer Emergency response kit – has various caps etc. for securing minor leaks.	Toxic vapours generated from onsite releases at this site are typically heavier than air; - they will hug the ground and fill low lying areas. See specific SDS if product can be identified
CONTROL the situation:	**SEC:** Contact the emergency services Isolate or minimise leak if safe to do so. Keep people indoors, close windows and doors to minimise exposure to vapours	NOTE: "GasCo" personnel are not trained to undertake emergency actions using SCBA	Most materials have initial effects of irritation (watering eyes, smell etc.) Loss of smell may NOT imply SAFE – the olfactory % range for many materials may be exceeded. If outdoors stay upwind and out of low-lying areas
MITIGATE the situation:	Contain spill, minimise generation of vapours Consider water spray (curtain) to either absorb material, or encourage mixing to dilute cloud concentration Contact "GasCo" Emergency response team (Tel: xxx) for salvage container intervention.	Spill control kits. Fire water Monitors or with assistance of Fire Service	Any release with potential off-site impact is likely to require immediate notification i.a.w. "GasCo" Crisis Management

Appendix G: Authority Guidance on Seveso, Safety Reports, MAPP or inspection checklists

This Appendix gives web links to documents published by CA or national governments regarding their expectations of what information should be included in MAPP and/ or the Seveso Safety report for upper tier sites and/or inspection checklists.
Information is correct at time of publication but may change as authorities review or revise their requirements and guidance for Seveso Directive. Information is generally given in the following format;

COUNTRY

Web site address

Title of document in original language
Approximate translation of title into English

BELGIUM

For federal Belgium the general Seveso requirements are listed in the legislation under "Samenwerkingsakkoord van 16 februari 2016"/ "Accord de coopération du 16 février 2016", see http://www.ejustice.just.fgov.be/cgi_loi/change_lg.pl?language=nl&la=N&cn=2016021613&table_name=wet
and information on the federal Belgian authorities website https://werk.belgie.be/nl/themas/welzijn-op-het-werk/seveso-preventie-van-zware-ongevallen
For Federal inspection checklists see : Inspectie-instrumenten | Federale Overheidsdienst Werkgelegenheid, Arbeid en Sociaal Overleg (belgie.be), page available in Dutch and French

For Wallonia: general Seveso obligations are given here http://environnement.wallonie.be/seveso/
MAPP Wallonia : Respecting your obligations as a Seveso company (wallonie.be) see section "Procedures"
additional requirements for high tier are listed here : http://environnement.wallonie.be/Seveso/rapports.htm
And : https://omgeving.vlaanderen.be/nl/omgevingsvergunning/externe-veiligheid-en-veiligheidsrapportage/over-veiligheidsrapportage/samenwerkingsakkoord-en-seveso-inrichtingen/het-veiligheidsrapport-bij-het-samenwerkingsakkoord outlines content of the Safety report and "Samenwerkingsakkoord SWA3" / "Accord de cooperation".

For Flanders regions: general Seveso obligations are given here https://omgeving.vlaanderen.be/nl/seveso
MAPP Flanders : https://werk.belgie.be/nl/themas/welzijn-op-het-werk/seveso-preventie-van-zware-ongevallen/toelichting-bij-de-wetgeving-14
And per the local legislation, see https://omgeving.vlaanderen.be/nl/verplichtingen-van-seveso-inrichtingen which also describes the additional requirements for upper tier sites, including an OVR (Omgevingsveiligheidsrapport) content.
Flanders region Upper Tier safety report content is outlined here with "Samenwerkingsakkoord SWA3" / "Accord de cooperation".:
https://omgeving.vlaanderen.be/nl/omgevingsvergunning/externe-veiligheid-en-veiligheidsrapportage/over-veiligheidsrapportage/samenwerkingsakkoord-en-seveso-

inrichtingen/het-veiligheidsrapport-bij-het-samenwerkingsakkoord. This page gives info on the content of the Upper Tier safety report

CHECKLISTS
Inspectie-instrumenten | Federale Overheidsdienst Werkgelegenheid, Arbeid en Sociaal Overleg (belgie.be), page available in Dutch and French

DENMARK

Virksomheder – Risikohåndbogen (risikohaandbogen.dk)
Miljøstyrelsen har, i samarbejde med de myndigheder der i fællesskab administrerer reglerne, der skal forhindre og mindske effekten af større uheld, udarbejdet en risikohåndbog. Risikohåndbogen henvender sig til virksomheder, myndigheder og borgere der vil vide mere om, hvordan arbejdet med at vurdere risikovirksomheder udføres og hvem der deltager I det.

The Danish Environmental Protection Agency, in collaboration with the authorities that jointly administer the rules to prevent and reduce the effects of major accidents, has prepared a risk handbook. The risk handbook is aimed at companies, authorities and citizens who want to know more about how the work of assessing risk activities is carried out and who participates in it.

FRANCE

http://www.ineris.fr/aida/consultation_document/7029
Circulaire du 10/05/10 récapitulant les règles méthodologiques applicables aux études de dangers, à l'appréciation de la démarche de réduction du risque à la source et aux plans de prévention des risques technologiques (PPRT) dans les installations classées en application de la loi du 30 juillet 2003

Guidance from 10/05/10, Defining the rules and methodologies for Safety Reports, evaluating possible risk reduction at source and for assessing the risks from technical installations subject to the 30 July 2013 PPRT regulation

GERMANY

http://www.kas-bmu.de/

Kommission für Anlagensicherheit (KAS) beim Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit

Commission for plant safety at the Ministry for Environment, Nature Protection, Buildings and Reactor safety

GREAT BRITAIN and Northern Ireland

www.hse.gov.uk/comah
HSE Control of Major Accident Hazards (COMAH)

http://www.hse.gov.uk/pubns/books/hsg190.htm
HSE HSG190 Preparing safety reports: Control of Major Accident Hazards Regulations 1999 (COMAH)

www.hse.gov.uk/comah/ca-guides.htm#sram
GB HSE COMAH 2015 - Safety Report Assessment Manual:

MAPP
http://www.hse.gov.uk/pubns/books/l111.htm
Paragraphs 127-139 of HSE L111 Control of Major Accident Hazards Regulations 2015 –Guidance on regulations

LAND USE Planning

Land Use Planning methodology
HSE: Land use planning - HSE's land use planning methodology

ITALY

https://www.mase.gov.it/pagina/rischio-industriale
Ministero dell'Ambiente e della Sicurezza Energetica – pagina web su Rischio Industriale con ulteriori collegamenti.
Ministry of the Environment and of Energetic Security – Industrial Risk webpage, with relevant links

https://www.mase.gov.it/sites/default/files/archivio/allegati/rischio_industriale/lineaguidainvecchiamento2021.pdf
Ministero dell'Ambiente e della Sicurezza Energetica – Valutazione sintetica dell'adeguatezza del programma di gestione dell'invecchiamento delle attrezzature negli stabilimenti Seveso - Linea guida
Ministry of the Environment and of Energetic Security – Guideline on management of equipment ageing in Seveso sites.

MAPP
Guidance: https://store.uni.com/en/uni-10617-2019

Norma UNI 10617 "Stabilimenti con pericolo di incidente rilevante - Sistemi di gestione della sicurezza - Requisiti essenziali".

Norm UNI 10617 "Establishments with risk of Major Accident - Safety management systems - Essential requirements"

https://store.uni.com/en/uni-10616-2022

Norma UNI 10616 "Stabilimenti con pericolo di incidente rilevante - Sistemi di gestione della sicurezza - Linee guida per l'applicazione della UNI 10617".

Norm UNI 10616 "Establishments with risk of Major Accident - Safety management systems - Guidelines for the application of UNI 10617".

CHECKLISTS
https://www.isprambiente.gov.it/files/seveso-iii-1/AllegatoH.pdf
Criteri per la pianificazione, la programmazione e l'effettuazione delle ispezioni (Allegato H del D.Lgs. 105/2015, inclusa Appendice 3 "lista di controllo" da pag. 33 del file pdf).
Criteria for planning, programming and performing of inspections (Attachment H to Legislative Decree 105/2015, including Inspection Checklist from page 33 of the pdf file).

https://store.uni.com/en/uni-11226-1-2017

Norma UNI 11226-1 "Impianti a rischio di incidente rilevante - Sistemi di gestione della sicurezza - Parte 1: Linee guida per l'effettuazione degli audit"

Norm UNI 11226-1 "Plants at risk of Major Accident - Safety management systems - Part 1: Guidelines for carrying out audits"

(Note: whilst the scope of this norm is the auditing process, it indirectly defines SMS requirements that should be assessed during the audit).

In Italy, the site Operator should take in consideration these UNI Norms, when implementing the MAPP and setting up and maintaining the management system for MA prevention.

NETHERLANDS

https://zoek.officielebekendmakingen.nl/stb-2015-272.html

Besluit risico's zware ongevallen 2015
Major Accident Hazards decree 2015

MAPP

https://brzoplus.nl/@151803/vbs/

PBZO (preventiebeleid zware ongevallen) en VBS (veiligheidsbeheerssysteem)
PBZO (major accident prevention policy) and VBS (safety management system)

Let op: de informatie over regelgeving geldt niet meer door de inwerkingtreding van de Omgevingswet op 1 januari 2024. Lees op de website van het IPLO hoe het werkt onder de Omgevingswet.
Please note that regulatory information no longer applies due to the entry into force of the Environment Act on 1 January 2024. Read how it works under the Environment Act on the IPLO website.

https://iplo.nl/regelgeving/omgevingswet/introductie/totstandkoming/invoeringsspoor-omgevingswet/

Het invoeringsspoor Omgevingswet regelt de overgang van de bestaande naar de nieuwe wetgeving. Ook vult het invoeringsspoor de Omgevingswet, de AMvB's en de Omgevingsregeling aan
The Omgevingswet introduction track regulates the transition from the existing to the new legislation. The introduction track also complements the Environment Act, the AMvBs and the Environment Regulation

NORWAY

https://www.dsb.no/contentassets/d64a8ad56281432fa286f2d6a68efa3c/storulykkeforskrift-mveiledning_april_2021.pdf
Forskrift om tiltak for å forebygge og begrense konsekvensene av storulykker i virksomheter der farlige kjemikalier forekommer (storulykkeforskriften) med veiledning
"Regulations on measures to prevent and limit the consequences of major accidents in businesses where hazardous chemicals are present"

https://www.dsb.no/veiledere-handboker-og-informasjonsmateriell/
Direktoratet for samfunnssikkerhet og beredskap - Veiledere, håndbøker og informasjonsmateriell
Norwegian Directorate for Civil Protection and Emergency Planning - Guides, manuals and information materials

In this website of the Norwegian DSB, several Guidelines are available; some of them are related to the Major Accident prevention, for example:

https://www.dsb.no/globalassets/dokumenter/veiledere-handboker-og-informasjonsmateriell/tema/informasjon_fra_storulykkevirksomheter_til_allmennheten_om_sikkerhetstiltak.pdf

Informasjon fra storulykkevirksomheter til allmennheten om sikkerhetstiltak
Information from major accident companies to the general public about safety measures

https://www.dsb.no/globalassets/dokumenter/veiledere-handboker-og-informasjonsmateriell/tema/temaveiledning_om_storulykkeforskriften_og_vurdering_av_avfall.pdf
Temaveiledning om storulykkeforskriften og vurdering av avfall
Topic guidance on the major accident regulations and assessment of waste

https://www.dsb.no/veiledere-handboker-og-informasjonsmateriell/veileder-om-vurdering-av-naturfarer-som-kan-gi-risiko-for-kjemikalieulykker-natech/
Veileder om vurdering av naturfarer som kan gi risiko for kjemikalieulykker (Natech)
Guide to assessing natural hazards that may pose a risk of chemical accidents (Natech)

https://www.dsb.no/veiledere-handboker-og-informasjonsmateriell/temaveiledning-til-storulykkeforskriften--7-om-strategi-for-a-forebygge-og-begrense-storulykker/
Temaveiledning til storulykkeforskriften § 7 om strategi for å forebygge og begrense storulykker
Thematic guide to Section 7 of the Major Accident Regulations on strategy for preventing and limiting major accidents

https://www.dsb.no/veiledere-handboker-og-informasjonsmateriell/informasjon-fra-storulykkevirksomheter-til-nod--og-beredskapsetater/
Informasjon fra storulykkevirksomheter til nød- og beredskapsetater
Information from major accident enterprises to emergency and emergency response agencies

https://www.dsb.no/veiledere-handboker-og-informasjonsmateriell/temaveiledning-mal-for-sikkerhetsrapport-etter-storulykkeforskriften/
Temaveiledning: mal for sikkerhetsrapport etter storulykkeforskriften
Thematic guidance: template for safety report pursuant to the Major Accident Regulations

https://www.dsb.no/veiledere-handboker-og-informasjonsmateriell/temaveiledning-mal-for-melding-etter-storulykkeforskriften/
Temaveiledning: mal for melding etter storulykkeforskriften
Thematic guidance: template for notification pursuant to the Major Accident Regulations

PORTUGAL

https://apambiente.pt/prevencao-e-gestao-de-riscos/prevencao-de-acidentes-graves-pag
Prevenção de acidentes graves (PAG) | Agência Portuguesa do Ambiente (apambiente.pt)
Prevention of major accidents (PAG) / Portuguese Environment Agency

SAFETY REPORTS
https://apambiente.pt/sites/default/files/_SNIAMB_Prevencao_gestao_riscos/PAG/Guia_Orientacao_RS_PAG.PDF Guia de orientação para a elaboração do Relatório de Segurança
Guidance for drawing up Safety Report

MAPP
https://apambiente.pt/sites/default/files/_SNIAMB_Prevencao_gestao_riscos/PAG/Linhas_Orient_PPAG_SGS.pdf
Desenvolvimento de uma Política de Prevenção de Acidentes Graves e de um Sistema de Gestão da Segurança para a Prevenção de Acidentes Graves
Development of a Major Accident Prevention Policy and a Safety Management System for the Prevention of Major Accidents

REPUBLIC OF IRELAND

https://www.irishstatutebook.ie/eli/2015/si/209/made/en/print?q=Major+Accident
S.I. No. 209/2015 - Chemicals Act (Control of Major Accident Hazards Involving Dangerous Substances) Regulations 2015

https://www.hsa.ie/eng/Your_Industry/Chemicals/Legislation_Enforcement/COMAH/A_Guide_to_COMAH_SI_No_209_of_2015.pdf
A Guide to the Chemicals Act (Control of Major Accident Hazards Involving Dangerous Substances) Regulations 2015 (S.I. No. 209 of 2015)

https://www.hsa.ie/eng/your_industry/chemicals/legislation_enforcement/comah/
COMAH guidance web pages

LAND USE PLANNING
Consultation Distance (generic risk zones, based on frequency of fatality around an establishment within which technical Land Use Planning advice is required)
https://www.hsa.ie/eng/your_industry/chemicals/legislation_enforcement/comah/land_use_planning/#Consultation%20Distance

https://www.hsa.ie/eng/your_industry/chemicals/legislation_enforcement/comah/land_use_planning/guidance_on_technical_land_use_planning_feb23.pdf
Guidance on technical Land-use Planning advice (February 2023) interprets the Authority's policy on technical land-use planning (TLUP) advice under the Seveso-III Directive, and it contains a rigorous and consistent risk-based approach across all sectors. It was revised in February 2023 to include an amended section 3.4 covering Hydrogen Installations.

SLOVENIA

MAPP
Smernica za Zasnovo zmanšanja tveganja za okolje /GOV.SI
SMERNICE za podrobnejšo vsebino zasnove zmanjšanja tveganja za okolje skladno z 9. Členom Uredbe o preprečevanju večjih nesreč in zmanjševanju njihovih posledic (Uradni list RS, št. 22/2016)
GUIDELINES for the detailed content of the environmental risk reduction concept in accordance with Article 9 of the Regulation on the Prevention of Major Accidents and the Reduction of Their Consequences (Official Gazette of the Republic of Slovenia, No. 22/2016)

SAFETY REPORT GUIDANCE
Smernice za varnostno poročilo /GOV.SI
SMERNICE za podrobnejšo vsebino varnostnega poročila skladno z 12. členom Uredbe o preprečevanju večjih nesreč in zmanjševanju njihovih posledic (Uradni list RS, št. 22/2016)
GUIDELINES for the detailed content of the safety report in accordance with Article 12 of the Regulation on the Prevention of Major Accidents and the Reduction of Their Consequences (Official Gazette of the Republic of Slovenia, No. 22/2016)

OTHER
https://www.gov.si/zbirke/storitve/pridobitev-ali-sprememba-okoljevarstvenega-dovoljenja-za-obrat-seveso/
Pridobitev okoljevarstvenega dovoljenja za obrat ali sprememba le tega (SEVESO)
Obtaining an environmental protection permit for the plant or changing it (SEVESO)

SPAIN

https://www.insst.es/normativa/riesgos-quimicos/seguridad-quimica-y-productos-quimicos?p_r_p_resetCur=true&p_r_p_querydoc=&p_r_p_categoryIds=&p_r_p_year=2015
Normativa nacional de Riesgos químicos: Seguridad química y Productos químicos
National Chemical Hazards Regulations: Chemical Safety and Chemicals

MAPP
RD 840/2015 https://boe.es/buscar/pdf/2015/BOE-A-2015-11268-consolidado.pdf

SAFETY REPORT GUIDANCE
content indicated in the Basic Chemical Risk Directive (Royal Decree 1196/2003):
https://www.proteccioncivil.es/documentacion/normativa

CHECKLISTS
UNE 192001-1:2021 Procedimiento de inspección en establecimientos...
UNE 192001-1 “Procedimiento de inspección en establecimientos afectados por la reglamentación de accidentes graves en los que intervengan sustancias peligrosas. Parte 1: Generalidades.”
Inspection procedure for establishments affected by major-accident hazards involving dangerous substances. Part 1: General

SWEDEN

https://www.msb.se/sv/publikationer/sakerhetsrapport---ett-stod-vid-det-systematiska-arbetet-med-att-uppratta-fornya-och-granska-en-sakerhetsrapport/
Säkerhetsrapport - Ett stöd vid det systematiska arbetet med att upprätta, förnya och granska en säkerhetsrapport
Safety report - Support for the systematic work of drawing up, renewing and reviewing a safety report

Appendix H: France Risk Acceptability Matrix

Approximate translation of Acceptability criteria from French authorities for Seveso safety reports

For original guidance see references:

http://www.ineris.fr/aida/consultation_document/5015 [64]

http://www.ineris.fr/aida/consultation_document/7465 [65]

Severity levels (off site consequences)

Severity level	Zone of lethal effects with 5% probability	Zone of lethal effects with 1% probability	Zone of serious injuries
Disastrous	> 10 exposed persons	> 100 exposed persons	> 1 000 exposed persons
Catastrophic	< 10 exposed persons	> 10 and < 100 exposed persons	> 100 and < 1 000 exposed persons
Important	< 1 exposed person	> 1 and <10 exposed persons	> 10 and < 100 exposed persons
Serious	No exposed person	< 1 exposed person	< 10 exposed persons
Moderate	No zone of lethal effects off site		< 1 exposed person
Exposed person: full time equivalent excluding site personnel and subcontractors The level of severity must be defined for the 3 zones, and then the highest one is retained.			

Frequency level (per unit and per year)

E	D	C	B	A
$\leq 10^{-5}$	$> 10^{-5}$ and $\leq 10^{-4}$	$> 10^{-4}$ and $\leq 10^{-3}$	$> 10^{-3}$ and $\leq 10^{-2}$	$> 10^{-2}$

Acceptability matrix

		Frequency				
		E	**D**	**C**	**B**	**A**
Severity	**Disastrous**	ALARP high priority	NO	NO	NO	NO
	Catastrophic	ALARP low priority	ALARP high priority	NO	NO	NO
	Important	ALARP low priority	ALARP low priority	ALARP high priority	NO	NO
	Serious	Acceptable	Acceptable	ALARP low priority	ALARP high priority	NO
	Moderate	Acceptable	Acceptable	Acceptable	Acceptable	ALARP low priority

Appendix J: Acceptability of risk of Major Accident to the Environment

The consequences and likelihood of the identified accident scenarios from section 9 also need to be evaluated to establish if a Major Accident To The Environment (MATTE) is possible if the risk of that event is acceptable.

The Directive requires that the environmental impact should to include an assessment of short and long term impact of emissions and releases on habitat, flora, fauna, civic amenities, water supplies, soil, and groundwater, and surface water, marine and terrestrial environment and to buildings.

The first step should be a **screening exercise** to determine if there are significant sources of; environmental pollution, if there are pathways for that pollution to reach each receptor and to determine if those receptors that could be adversely impacted by the quantity/concentration and duration of pollutants likely to reach them.

For the purpose of this assessment "**pollutants**" should be considered to include; direct emission or release of dangerous substances stored, used or generated at the installation as well as any substances from any secondary or consequential pollution such as smoke, dust or fumes from fires, run off of contaminated fire-water.

The basic ("source-pathway-receptor") assessment steps are as follows:

1. Identify all of the substances that are classified as dangerous to the aquatic environment or can cause acute environmental damage if released or can be released in case of major fire.
2. Identify **accident scenarios** involving these substances (leaks, spills, releases, explosions etc). This step shall consider both the quantity and concentration of the **pollutants** as well as the duration of the generating scenario.
3. For each scenario identify possible **sources** of pollution / damage to the environment, for example toxic products released to air, aquatic pollutants released to water
4. Identify any **pathways** by which pollutants can travel off site, for example via surface drains, culverts, waterways, rivers and tides or through air dispersion including weather effects (wind and rain). For this step it is common for CA to ask that the initial assessment disregards any physical mitigation measures such as bunds, scrubbers, ditches or catch ponds. (This approach is similar to the "naked risk" mentioned in section 9.9).
5. Identify the possible **receptors** around the site that could be that could be impacted by the pollutant releases for example sites of Special Scientific Interest SSSI Error! Reference source not found., historic buildings, waterways, as well as individually protected species or vulnerable habitats. In this step it is useful to evaluate if the predicted quantity or concentration and exposure duration of the modelled release is likely to have any impact on the receptor. For example could the worst case toxic release reach the receptor in any credible weather conditions to cause an adverse impact?

Following these basic steps if there are any scenarios that have not screened out (i.e. been eliminated as credible MATTEs) these need to undergo a further, more detailed evaluation to establish the possible extent and duration of the harm as well as understanding the ability of the habitat and/or individual species to recover from that exposure. At this stage detailed information is needed about the susceptibility of individual species and habitats of interest. Competent authorities may ask for detailed quantified assessment to demonstrate that such residual risks are in the tolerable range.

One example methodology for this risk assessment is published by UK Chemical and Downstream Oil Industries Forum **Error! Reference source not found.**. Through this detailed assessment operators must demonstrate that effective, suitable sufficient preventive and mitigating measures and in UK represent BAT (Best Available Technique).

If any MATTEs are determined then clean up plans should also be put in place.

Appendix K: Information to the Public for typical EIGA Lower and Upper tier installations

As outlined in section 13 of this document, there are obligations under Seveso for information about all sites to be made “permanently available to the public, including electronically”. For Upper tier sites there are additional requirements.

The following tables list the requirements from Annex V of Seveso and give template answers for typical member company installations. It is recommended that member companies use the relevant parts of this appendix to provide consistent information to the public for similar installations in different countries.

Note that the Seveso Directive does not specify by whom or how this information is to be made “permanently and publicly available” – this should be defined in country legislation. It is expected – but not absolutely required - that in most countries the information will be posted on the internet. Either the Competent Authority or the authority responsible for emergency plans or the operating company may be tasked with sharing this information. See ‘Submitting public information to the Competent Authority’ **Error! Reference source not found.** as an example for input and public access to GB information on H.S.E website.[84]

K1: Lower tier or Upper tier ASU

PART 1 For all establishments covered by this Directive:	**Lower tier or Upper tier Air Separation Unit (ASU)**
1. Name or trade name of the operator and the full address of the establishment concerned.	
2. Confirmation that the establishment is subject to the regulations and/or administrative provisions implementing this Directive and that the notification referred to in Article 7(1) or the safety report referred to in Article 10(1) has been submitted to the competent authority.	For Lower tier: “This site is within the scope of national legislation which implements Seveso Directive 2012/18/EU in this country.” “This site qualifies as a Lower tier site and the required notification has been submitted to the national Competent Authority.” OR For Upper tier: “This site qualifies as an Upper tier site, the required notification and the Safety report have been submitted to the national Competent Authority.”
3. An explanation in simple terms of the activity or activities undertaken at the establishment.	At this installation air is drawn in, compressed, cooled and distilled (separated) into its primary components (Oxygen, Nitrogen and Argon). The products are collected and stored as cryogenic liquids in tanks. The products are delivered; • As a gas, via a pipeline to our (nearby) customer and/or • As a cryogenic liquid in tankers by road.
4. The common names or, in the case of dangerous substances covered by Part 1 of Annex I, the generic names or the hazard classification of the relevant dangerous substances involved at the establishment which could give rise to a major accident, with an indication of their	The only product on this installation which classified as “dangerous” under Seveso is Oxygen. **<u>Oxygen – Oxidising gas, Cat 1.</u>** H270 – may cause or intensify fire; oxidiser H281 – contains refrigerated gas; may cause cryogenic burns or injury. Oxygen is not toxic to people, plant or animals. It is not hazardous to the environment.

PART 1 For all establishments covered by this Directive:	Lower tier or Upper tier Air Separation Unit (ASU)
principal dangerous characteristics in simple terms.	In addition to this product there are some utility materials on this installation which are also relevant for Seveso: **Diesel** (if stored on site as fuel for vehicles, electricity generator or heating systems) H226 Flammable Liquid and vapour Cat 3. H411 Toxic to aquatic life, with long lasting effects, Cat 2. For Seveso the main hazards from Diesel are that it can burn and/or have persistent harmful effects for water habitats. **Anhydrous ammonia** (if used as Refrigerant in a closed cooling circuit) H221 Flammable gas Cat 2. H331 Toxic if inhaled, Cat 3. H400 Very toxic for aquatic life Cat 1. This gas can burn, is toxic for humans and is very harmful for water habitats. Some cooling water treatment chemicals (e.g. biocides) used in open circuit cooling tower water, may be classified as Dangerous to the aquatic environment. **Hydrogen** (if used to help purify Argon) H220 Extremely Flammable gas Cat 1. This gas can burn very easily. It is not toxic for people and is not hazardous to the environment **Nitrogen and Argon** Inert gases such as nitrogen and argon, are not classified as Seveso dangerous substances and are therefore outside the scope of Seveso. Inert gases are asphyxiants in high concentrations and when cold; may cause cryogenic burns or injury (H281 – contains refrigerated gas). Inert gases are not toxic, but releases create low oxygen atmospheres, which can result in suffocation (anoxia). They are not hazardous to the environment.
5. General information about how the public concerned will be warned, if necessary; adequate information about the appropriate behaviour in the event of a major accident or indication of where that information can be accessed electronically.	For Lower tier: In the unlikely event of a Major Accident at this lower tier site, the site operators will raise an on-site alarm and alert the emergency services. You should: ✓ shut off ignition sources (stop smoking, shut off any open flames...) ✓ go/stay indoors, closing windows and doors ✓ obey any instructions from emergency services, who may evacuate people from the immediate downwind area if necessary ✓ wait for instruction that the incident is over – this will usually be communicated by the emergency services This information about appropriate behaviour in the event of a Major Accident is also available from the company web-page for this site: (add company link) OR

PART 1 For all establishments covered by this Directive:	Lower tier or Upper tier Air Separation Unit (ASU)
	For Upper tier: In the unlikely event of a Major Accident at this Upper tier site, the site operators will inform the local authority who is responsible for the Off-site emergency plan. According to that plan you should: ✓ shut off ignition sources (stop smoking, shut off any open flames...) ✓ go/stay indoors, closing windows and doors ✓ turn on TV/radio stations as defined in that Off-site plan ✓ obey any instructions from emergency services, who may evacuate people from the immediate downwind area if necessary ✓ wait for instruction that the incident is over – this will usually be communicated by the emergency services Information about your actions under the Off-site Emergency plan is available from the local authority (include web-link or physical address)
6. The date of the last site visit in accordance with Article 20(4), or reference to where that information can be accessed electronically; information on where more detailed information about the inspection and the related inspection plan can be obtained upon request, subject to the requirements of Article 22.	The date of the last Competent Authority (CA) Seveso inspection visit is posted in the national CA web-site (include CA link). More detailed information about the inspection and the related inspection plan can be requested from the national CA.
7. Details of where further relevant information can be obtained, subject to the requirements of Article 22.	Further information can generally be obtained, in accordance with the Seveso Directive, from the national CA, subject to restrictions outlined in the national legislation (include CA web-link or physical address).

PART 2 : For upper-tier establishments, in addition to the information referred to in Part 1 of this Annex:	Air Separation Unit (ASU) Upper Tier
1. General information relating to the nature of the major-accident hazards, including their potential effects on human health and the environment and summary details of the main types of major-accident scenarios and the control measures to address them.	[To be summarised from the Upper tier safety report for this site] ASU major accident scenarios theoretically include: • Sudden release of cryogenic liquid from storage tanks • Rupture of Cold Box due to contaminants • Spill of cryogenic liquid during tanker filling operations • Spill of diesel when filling site tank or re-fuelling vehicles • Release of ammonia from closed cooling circuit during maintenance The Air Separation Process, the storage tanks and tanker filling areas are constantly monitored by local operators and/or process experts in remote control centres. The potential causes and control measures to prevent each of these theoretical scenarios is described below: <u>Sudden release of cryogenic liquid from storage tanks</u>

PART 2 : For upper-tier establishments, in addition to the information referred to in Part 1 of this Annex:	Air Separation Unit (ASU) Upper Tier
	The design of these cryogenic liquid tanks is long established globally and they are constructed and maintained in accordance with national regulations and recognised international design standards. Failure of the tank is only likely in the event of overfilling or overpressure. The tank is protected by advanced computerised process control systems which will close off feeds if the level or pressure goes out of normal limits. In addition there are “hard-wired” signals outside of the computer control which will shut off feeds if the computer fails or on loss of site power. A sudden release of liquid oxygen would create a pool of very cold liquid on the site, which would evaporate to generate a large oxygen enriched cloud which could go off-site. As described above Oxygen is not toxic to human health or the environment, but it does encourage *violent fires*. The vapour in the cloud may be very cold and people should stay away. A sudden release of liquid nitrogen or argon would create a pool of very cold liquid on the site, which would evaporate to generate a large oxygen-poor cloud which could go off-site. As described above Nitrogen/Argon are not toxic to human health or the environment, but by displacing normal air create a risk of anoxia (suffocation). The vapour in the cloud may be very cold and people should stay away. The Off-site emergency alarm would be sounded for any major release of cryogenic liquid and as described in that plan, you should: shut off ignition sources (stop smoking, shut off any open flames...) go/stay indoors, closing windows and doors, to protect you, your family and others nearby. The likelihood of <u>all</u> of the protective systems failing and resulting in a sudden release from any cryogenic liquid storage tank is considered by EIGA to be “improbable”. <u>Rupture of Cold Box due to contaminants</u> The Air Separation Process draws air in from the atmosphere, compresses and cools it to a liquid at (-195°C). The cryogenic liquid is then distilled in columns inside the cold box. If the process is not designed and operated correctly contaminants, which are present at very small quantities in the normal air, such as hydrocarbons, can collect in the oxygen rich liquid inside the distillation system and there is a potential for a very violent reaction. This could result in catastrophic damage to the cold box. The design of ASUs is long established globally and all equipment is constructed, operated and maintained in accordance with national regulations and recognised international design standards. The process includes a filter (molecular sieve) to adsorb contaminants from the air before it enters the distillation process. The concentration (very low ppm) of contaminant is constantly analysed at various points in the process both after the molecular sieve and especially in the oxygen-rich liquid in the column. Only if there is something extraordinary happening near to our installation (like a prolonged forest fire or major fire at a refinery) would there be any concern over the level of contaminants in the incoming air. Even if this happens, it would take several days for the hydrocarbon levels to rise to dangerous levels and our

PART 2 : For upper-tier establishments, in addition to the information referred to in Part 1 of this Annex:	Air Separation Unit (ASU) Upper Tier
	operators would be immediately monitoring the situation and are under instruction to simply turn the whole ASU off. The likelihood of the extraordinary event occurring and all of our systems failing to switch the ASU off is considered by EIGA to be extremely unlikely. <u>Spill of cryogenic liquid during tanker filling operations</u> Tanker drivers are legally required to be certified under ADR to transport dangerous goods such as liquid oxygen, liquid nitrogen or argon. They receive additional training in the specific tanker loading and off-loading procedures and the hazards involved. Filling tankers at this ASU is controlled by the ASU computerised process control systems which will close off feeds if the level or pressure goes out of normal limits. The tanker filling activity is always monitored by the driver and can be monitored by operators in the control room. In the event of any problems the driver can stop the operation using an emergency stop button on his tanker. There are also emergency stop buttons in the fill yard and control room. Cryogenic tanker drivers are very specialised and dedicated to delivering cryogenic liquids safely every day. In principle the tanker loading and off-loading is very similar to what you see when a fuel tanker delivers to your local petrol station – we just deliver a different (very cold) product. If a tanker driver makes a mistake, it is possible for a small quantity of cryogenic liquid to be spilled; from the contents of his filling hose or the contents of the tanker (about 20 tonnes). The consequences of liquid oxygen spill or liquid nitrogen/argon spill are as described above, but for this quantity the smaller cloud may not even travel off-site. The Off-site emergency alarm would be sounded for any major release of cryogenic liquid and as described in that plan, you should: shut off ignition sources (stop smoking, shut off any open flames...) go/stay indoors, closing windows and doors, to protect you and your family. The likelihood of a driver making a mistake resulting in Spill of cryogenic liquid during tanker filling operations is considered by EIGA to be “possible”. <u>Spill of diesel when filling site tank or re-fuelling vehicles</u> Diesel is delivered to our site tank by a fuel company. The process is exactly the same as what you see when a fuel tanker delivers diesel to your local petrol station. Our installation meets national regulations and recognised international design standards. Diesel does not burn very easily and the concern is to ensure that any spills are minimised and kept away from unmade ground and water courses. As at the petrol station this area is concreted and there are no nearby water drains. The diesel tank and re-fuelling station is located away from our ASU process and cryogenic storage tanks. Tanker drivers are legally required to be certified under ADR to transport dangerous goods such as diesel. If a tanker driver makes a mistake, it is possible for a small quantity of diesel to be spilled; from the contents of his filling hose or the contents of the tanker (about 20 tonnes). The cryogenic tanker drivers also use diesel to re-fuel their tankers exactly as you re-fuel your car.

PART 2 : For upper-tier establishments, in addition to the information referred to in Part 1 of this Annex:	Air Separation Unit (ASU) Upper Tier
	The likelihood of any driver making a mistake resulting in spill of diesel is considered by EIGA to be “possible”, but most spills would not result in a major accident to the environment or any offsite impact. <u>Release of ammonia from closed cooling circuit during maintenance</u> At this site we have some refrigeration units to cool the large compressors using ammonia in a closed circuit. The process is similar to a domestic refrigerator. Ammonia, like several other refrigeration substances is strictly controlled by environmental legislation (so-called F-gases), so the ammonia system is regularly inspected for leaks and only opened if necessary by a qualified maintenance technician. Ammonia can burn, is toxic for humans and is very harmful for water habitats. It has a very strong smell and any released liquid will evaporate quickly to create a large cloud which can travel off-site, depending on the weather. The Off-site emergency alarm would be sounded for any major release of ammonia and as described in that plan, you should: shut off ignition sources (stop smoking, shut off any open flames...) go/stay indoors, closing windows and doors, to protect you, your family and others nearby.
2. Confirmation that the operator is required to make adequate arrangements on site, in particular liaison with the emergency services, to deal with major accidents and to minimise their effects.	“As an Upper tier site, the company has adequate arrangements in place to liaise with emergency services, to deal with major accidents and to minimise their effects.”
3. Appropriate information from the external emergency plan drawn up to cope with any off-site effects from an accident. This should include advice to cooperate with any instructions or requests from the emergency services at the time of an accident.	“Information about the Off-site Emergency plan is available from the local authority (include web-link or physical address...and summarise “appropriate information” from that plan). It is important for you to understand and follow the recommended actions in that Off site Emergency plan, and to obey any instructions from the emergency services, in order to minimise the effects of any major accident consequences and to protect you, your family and others nearby.”
4. Where applicable, indication whether the establishment is close to the territory of another Member State with the possibility of a major accident with transboundary effects under the Convention of the United Nations Economic Commission for Europe on the Transboundary Effects of Industrial Accidents. EN 24.7.2012 Official Journal of the European Union L 197/31	Not applicable.

K2: Cylinder filling depot

PART 1 For all establishments covered by this Directive:	**Lower tier or Upper tier Cylinder filling depot**
1. Name or trade name of the operator and the full address of the establishment concerned.	
2. Confirmation that the establishment is subject to the regulations and/or administrative provisions implementing this Directive and that the notification referred to in Article 7(1) or the safety report referred to in Article 10(1) has been submitted to the competent authority.	For Lower tier: "This site is within the scope of national legislation which implements Seveso Directive 2012/18/EU in this country." "This site qualifies as a Lower tier site and the required notification has been submitted to the national Competent Authority." OR For Upper tier: "This site qualifies as an Upper tier site, the required notification and the Safety report have been submitted to the national Competent Authority."
3. An explanation in simple terms of the activity or activities undertaken at the establishment.	At this installation "air-gases" (of Nitrogen, Oxygen, Argon and Carbon Dioxide) are drawn from cryogenic storage tanks and trans-filled into compressed gas cylinders, as pure products and mixtures of gases. There are tanks containing; cryogenic liquid oxygen, nitrogen, argon and carbon dioxide at this site. In addition some mixtures are filled including flammable gases (such as Propane and/or Hydrogen) which are taken from cylinder packs or bundles. Other gas products and mixtures including Seveso Named substances such as Acetylene, Hydrogen and toxic gases are stored here for re-distribution and sale, but are not trans-filled on this site. The majority of these products are stored as compressed gases in cylinders. There is also a workshop for the periodic inspection and maintenance of compressed gases cylinders and valves. Cylinders for inspection are safely vented in accordance with national regulations for Seveso and the Environment.
4. The common names or, in the case of dangerous substances covered by Part 1 of Annex I, the generic names or the hazard classification of the relevant dangerous substances involved at the establishment which could give rise to a major accident, with an indication of their principal dangerous characteristics in simple terms.	The majority of these products are stored as compressed gases in cylinders. *These dangerous substances are specifically Named in the Seveso Directive:* **Acetylene** H230 may react explosively even in the absence of air H220 Extremely Flammable gas Cat 1 H280 – contains gas under pressure; may explode if heated. For Seveso the main hazard from Acetylene is that it burns very easily and can under certain conditions explode. It is not toxic to people. It is not hazardous to the environment. **Oxygen – Oxidising gas, Cat 1.** H270 – may cause or intensify fire; oxidiser H280 – contains gas under pressure; may explode if heated. Oxygen is not toxic to people, plant or animals. It is not hazardous to the environment.

PART 1 For all establishments covered by this Directive:	**Lower tier or Upper tier Cylinder filling depot**
	Hydrogen H220 Extremely Flammable gas Cat 1. H280 – contains gas under pressure; may explode if heated. This gas can burn very easily. It is not toxic for people and is not hazardous to the environment **Liquefied Flammable gases (LPG/Propane)** H220 Extremely Flammable gas Cat 1. H280 – contains gas under pressure; may explode if heated. These gases can burn very easily, they are not toxic for people and not hazardous to the environment. **Anhydrous ammonia** H221 Flammable gas Cat 2. H331 Toxic if inhaled, Cat 3. H400 Very toxic for aquatic life Cat 1. H280 – contains gas under pressure; may explode if heated. This gas can burn, is toxic for humans and is very harmful for water habitats. **Chlorine** H270 – may cause or intensify fire; oxidiser H280 – contains gas under pressure; may explode if heated. H330 Fatal if inhaled, Cat 2. H400 Very toxic for aquatic life Cat 1. This gas does not burn, but like oxygen can support fires. It can be fatal if inhaled and is very harmful for water habitats. **Hydrogen Chloride** H280 – contains gas under pressure; may explode if heated. H331 Toxic if inhaled, Cat 3. This gas is toxic to people if inhaled. It does not burn and is not hazardous to the environment **Diesel** (if stored on site as fuel for vehicles or heating systems) H226 Flammable Liquid and vapour Cat 3. H411 Toxic to aquatic life, with long lasting effects, Cat 2. For Seveso the main hazards from Diesel are that it can burn and/or have persistent harmful effects for water habitats. *The following Generic groups of substances and mixtures are also included in the Seveso Directive:* **Oxidising gases and mixtures** H270 – may cause or intensify fire; oxidiser H280 – contains gas under pressure; may explode if heated. For Seveso the main hazard from oxidising gases is that they encourage fire, they are not toxic to people, plant or animals. They are not hazardous to the environment. **Flammable/Extremely Flammable gases** H280 – contains gas under pressure; may explode if heated. H220 - Extremely Flammable gas Cat 1 H221 - Flammable gas Cat 2. For Seveso the main hazard is that this type of gas can burn very easily. Flammable gas releases may also create a potentially

PART 1 For all establishments covered by this Directive:	Lower tier or Upper tier Cylinder filling depot
	explosive atmosphere. It is not toxic for people and is not hazardous to the environment *Non-toxic, non-flammable gases are outside the scope of Seveso, but these “inert” products are also stored as cryogenic liquids and transfilled into gas cylinders on this site:* **Nitrogen, Argon and Helium** H280 – contains gas under pressure; may explode if heated. Inert gases such as nitrogen, argon and helium, are not classified as Seveso dangerous substances and are therefore outside the scope of Seveso. Inert gases are asphyxiants in high concentrations and when cold may cause cryogenic burns or injury (H281 – contains refrigerated gas). Inert gases are not toxic, but releases create low oxygen atmospheres, which can result in suffocation (anoxia). They are not hazardous to the environment. **Carbon dioxide (CO2)** H280 – contains gas under pressure; may explode if heated. CO2 is not classified as a Seveso dangerous substance and is therefore outside the scope of Seveso. Although not classified as toxic, CO2 may impair your respiratory system (see EIGA Safety Information SI 24 www.eiga.eu/uploads/documents/SI024.pdf [85]) or result in suffocation (anoxia). It is not classified as hazardous to the environment.
5. General information about how the public concerned will be warned, if necessary; adequate information about the appropriate behaviour in the event of a major accident or indication of where that information can be accessed electronically.	For Lower tier: In the unlikely event of a Major Accident at this lower tier site, the site operators will raise an on-site alarm and alert the emergency services. You should: ✓ shut off ignition sources (stop smoking, shut off any open flames...) ✓ go/stay indoors, closing windows and doors, ✓ in case of fire/explosion stay away from windows to protect from glass fragments ✓ obey any instructions from emergency services, who may evacuate people from the immediate downwind area if necessary. ✓ wait for instruction that the incident is over – this will usually be communicated by the emergency services. This information about appropriate behaviour in the event of a Major Accident is also available from the company web-page for this site: (add company link) OR For Upper tier: In the unlikely event of a Major Accident at this Upper tier site, the site operators will inform the local authority who is responsible for the Off-site emergency plan. According to that plan you should: ✓ shut off ignition sources (stop smoking, shut off any open flames...) ✓ go/stay indoors, closing windows and doors, ✓ in case of fire/explosion stay away from windows to protect from glass fragments.

PART 1 For all establishments covered by this Directive:	Lower tier or Upper tier Cylinder filling depot
	✓ turn on TV/radio stations as defined in that Off-site plan ✓ obey any instructions from emergency services, who may evacuate people from the immediate downwind area if necessary ✓ wait for instruction that the incident is over – this will usually be communicated by the emergency services Information about your actions under the Off-site Emergency plan is available from the local authority (include web-link or physical address)
6. The date of the last site visit in accordance with Article 20(4), or reference to where that information can be accessed electronically; information on where more detailed information about the inspection and the related inspection plan can be obtained upon request, subject to the requirements of Article 22.	The date of the last Competent Authority (CA) Seveso inspection visit is posted in the national CA web-site (include CA link). More detailed information about the inspection and the related inspection plan can be requested from the national CA.
7. Details of where further relevant information can be obtained, subject to the requirements of Article 22.	Further information can generally be obtained, in accordance with the Seveso, from the national CA, subject to restrictions outlined in the national legislation (include web-link or physical address).

PART 2 : For upper-tier establishments, in addition to the information referred to in Part 1 of this Annex:	Upper tier Cylinder filling depot
1. General information relating to the nature of the major-accident hazards, including their potential effects on human health and the environment and summary details of the main types of major-accident scenarios and the control measures to address them.	[To be summarised from the Upper tier safety report for this site] Cylinder Fill site major accident scenarios theoretically include: • Sudden release of cryogenic liquid or Carbon dioxide (CO_2) from storage tanks • Spill of cryogenic liquid during tanker off-loading operations • Spill of diesel when filling site tank or re-fuelling vehicles • Leak from a single cylinder containing toxic/flammable gas (*Other gas products and mixtures including Named substances such as Acetylene, Hydrogen and toxic gases are stored here for re-distribution and sale, but are not trans-filled on this site.*) • Release of flammable gas/fire during transfilling • Fire <u>Sudden release of cryogenic liquid from storage tanks</u> The design of these vacuum-jacketed (VJ) cryogenic liquid tanks is long established globally and they are constructed and maintained in accordance with national regulations and recognised international design standards. Failure of the tank is only likely in the event of overfilling or overpressure. The driver is in control of the off-loading process and remains present

PART 2 : For upper-tier establishments, in addition to the information referred to in Part 1 of this Annex:	Upper tier Cylinder filling depot
	throughout. A release of liquid oxygen would create a pool of very cold liquid on the site, which would evaporate to generate an oxygen enriched cloud which could go off-site. As described above Oxygen is not toxic to human health or the environment, but it does encourage *violent fires*. The vapour in the cloud can be very cold and people should stay away. A release of liquid nitrogen or argon would create a pool of very cold liquid on the site, which would evaporate to generate a large oxygen-poor cloud which could go off-site. As described above Nitrogen/Argon are not toxic to human health or the environment, but by displacing normal air create a risk of anoxia (suffocation). The vapour in the cloud may be very cold and people should stay away. A release of Carbon dioxide would result in the formation of a cold pile of “dry ice” snow which would form a CO2 cloud that is unlikely to extend off site. The Off-site emergency alarm would be sounded for any major release of cryogenic liquid and as described in the Off-site emergency plan, you should: shut off ignition sources (stop smoking, shut off any open flames...) go/stay indoors, closing windows and doors, to protect you, your family and others nearby. The likelihood of <u>all</u> the protective systems failing and resulting in a sudden release from any cryogenic liquid storage tank is considered by EIGA to be “improbable”. <u>Spill of cryogenic liquid during tanker off-loading operations</u> Cryogenic Tanker drivers are legally required to be certified under ADR to transport dangerous goods such as liquid oxygen, liquid nitrogen or argon. Cryogenic Tanker drivers receive additional training in the specific tanker loading and off-loading procedures and the hazards involved. The tank filling activity is always monitored by the driver. In the event of any problems the driver can stop the operation using an emergency stop button on the tanker. Cryogenic tanker drivers are very specialised and dedicated to delivering cryogenic liquids safely every day. In principle the tanker off-loading is very similar to what you see when a fuel tanker delivers to your local petrol station – we just deliver a different (very cold) product. If a tanker driver makes a mistake, it is possible for a quantity of cryogenic liquid to be spilled; from the contents of the filling hose or the contents of the tanker (about 20 tonnes). The consequences of liquid oxygen spill or liquid nitrogen/argon spill are as described above, but for this quantity the smaller cloud may not even travel off-site. The Off-site emergency alarm would be sounded for any major release of cryogenic liquid and as described in that plan, you should: shut off ignition sources (stop smoking, shut off any open flames...) go/stay indoors, closing windows and doors, to protect you, your family and others nearby. The likelihood of a driver making a mistake resulting in spill of cryogenic liquid during tanker filling operations is considered by EIGA to be “possible”. <u>Spill of diesel when filling site tank or re-fuelling vehicles</u> Diesel is delivered to our site tank by a fuel company. The process is exactly the same as what you see when a fuel tanker delivers diesel to your local petrol station. Our installation meets

PART 2 : For upper-tier establishments, in addition to the information referred to in Part 1 of this Annex:	Upper tier Cylinder filling depot
	national regulations and recognised international design standards. Diesel does not burn very easily and the concern is to ensure that any spills are minimised and kept away from unmade ground and water courses. As at the petrol station this area is concreted and there are no nearby water drains. The diesel tank and re-fuelling station is located away from cylinder storage areas, cylinder filling process and away from cryogenic storage tanks. Tanker drivers are legally required to be certified under ADR to transport dangerous goods such as diesel. If a tanker driver makes a mistake, it is possible for a small quantity of diesel to be spilled; from the contents of his filling hose or the contents of the tanker (about 20 tonnes). The forklift truck drivers and cylinder truck drivers also use diesel to re-fuel their vehicles exactly as you re-fuel your car. The likelihood of any driver making a mistake resulting in a spill of diesel is considered by EIGA to be “possible”, but most spills would not result in a major accident to the environment or any offsite impact. <u>Protection of Cylinder storage areas</u> The layout of the cylinder depot is designed so that vehicle traffic is kept away from cylinder storage areas. Cylinders containing flammable gases are kept segregated away from oxidising or toxic gases, in dedicated zones following industry best practice guidelines. Very toxic gases are held in secure cages under CCTV. There is a strictly enforced site speed limit and only authorised vehicles are allowed on site. Our forklift truck drivers are trained and their competence is periodically reassessed. Cylinder truck drivers are legally required to be certified under ADR to transport dangerous goods such as the compressed gases described here. Precautions are taken to prevent unauthorised access or theft of products. The site is fenced and access controlled, the perimeter fence is monitored remotely by a security company. <u>Leak from a single cylinder containing toxic/flammable gas</u> The design and manufacture of cylinders used for any compressed or liquefied gas must adhere to strict international standards required for the Transport of Dangerous Goods under ADR. These standards require for example that cylinder must survive a drop from >1m onto concrete without leaking and define strict periodic inspection and testing protocols. Potential causes of leaks from a cylinder include damage from the fork of a Forklift truck or corrosion. In addition to the general controls listed above, leaking cylinders are prevented by moving cylinders securely strapped together in pallets and by performing pre- and post- fill inspection procedures in accordance with industry guidance. The Off-site emergency alarm would be sounded for any major leak or fire and as described in that plan, you should shut off ignition sources (stop smoking, shut off any open flames...) go/stay indoors, closing windows and doors, to protect you, your family and others nearby. <u>Release of flammable gas/fire during transfilling</u>

PART 2 : For upper-tier establishments, in addition to the information referred to in Part 1 of this Annex:	Upper tier Cylinder filling depot
	Cylinders and bundles are filled at this site with mixtures of gases including oxygen, nitrogen, argon, carbon dioxide and some flammable gases such as hydrogen or propane. All equipment is constructed, operated and maintained in accordance with recognised industry standards. There is a risk of fire or explosion if flammable gas leaks out. All areas around the flammable gas filling process are strictly controlled in accordance with ATEX workplace regulations to control the risk of potentially explosive atmospheres. <u>External Fire</u> Combustible materials including wastes are not allowed in cylinder storage areas. In accordance with industry best practice, cylinders may only be stored several metres away from the site fence line. Cylinders which are stored outdoors and not connected to any fill process do not create a potentially flammable atmosphere (according to ATEX workplace regulations). Even so all ignition sources including smoking, hot work and use of mobile phones is controlled at our depots. The Off-site emergency alarm would be sounded for any major fire and as described in that plan, you should shut off ignition sources (stop smoking, shut off any open flames...) go/stay indoors, closing windows and doors, to protect you,your family and others nearby. The likelihood of a major fire occurring in the cylinder storage area is considered by EIGA to be unlikely.
2. Confirmation that the operator is required to make adequate arrangements on site, in particular liaison with the emergency services, to deal with major accidents and to minimise their effects.	“As an Upper tier site, the company has adequate arrangements in place to liaise with emergency services, to deal with major accidents and to minimise their effects.”
3. Appropriate information from the external emergency plan drawn up to cope with any off-site effects from an accident. This should include advice to cooperate with any instructions or requests from the emergency services at the time of an accident.	“Information about the Off-site Emergency plan is available from the local authority (include web-link or physical address...and summarise “appropriate information” from that plan). It is important for you to understand and follow the recommended actions in that Off-site Emergency plan, and to obey any instructions from the emergency services, in order to minimise the effects of any major accident consequences and to protect you and your family.”
4. Where applicable, indication whether the establishment is close to the territory of another Member State with the possibility of a major accident with transboundary effects under the Convention of the United Nations Economic Commission for Europe on the Transboundary Effects of Industrial Accidents. EN	Not applicable

PART 2 : For upper-tier establishments, in addition to the information referred to in Part 1 of this Annex:	Upper tier Cylinder filling depot
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K3: Acetylene manufacturing facility

Note that typically Acetylene manufacturing facilities are co-located on a cylinder filling depot and the status of the site under Seveso will be determined by the combined inventory. The template answers below are compiled for a conceptual site which ONLY manufactures and stores Acetylene. Acetylene manufacturing facilities are subject to the Industrial Emissions Directive 2010/75/EU (IED) as well as Seveso. Most EIGA member company Acetylene manufacturing sites with Cylinder depot will need to provide answers which combine K2 and K3.

PART 1 For all establishments covered by this Directive:	Lower tier or Upper tier Acetylene manufacturing facility
1. Name or trade name of the operator and the full address of the establishment concerned.	
2. Confirmation that the establishment is subject to the regulations and/or administrative provisions implementing this Directive and that the notification referred to in Article 7(1) or the safety report referred to in Article 10(1) has been submitted to the competent authority.	For Lower tier: “This site is within the scope of national legislation which implements Seveso Directive 2012/18/EU in this country.” “This site qualifies as a Lower tier site and the required notification has been submitted to the national Competent Authority.” OR For Upper tier: “This site qualifies as an Upper tier site, the required notification and the Safety report have been submitted to the national Competent Authority.”
3. An explanation in simple terms of the activity or activities undertaken at the establishment.	Acetylene is generated in a carefully controlled reaction where solid calcium carbide is added to water. The gas is collected, compressed and cooled before being filled into special cylinders where it is stored as dissolved gas. Lime – water is generated as a by-product. Dried lime is sold for use, for example, in agriculture. There is also a workshop for the periodic inspection and maintenance of cylinders and valves used with dissolved acetylene. Cylinders for inspection are safely vented in accordance with national regulations for Seveso and the Environment.
4. The common names or, in the case of dangerous substances covered by Part 1 of Annex I, the generic names or the hazard classification of the relevant dangerous substances involved at the establishment which could give rise to a major accident, with an indication of their	Acetylene is specifically Named in Seveso: **Acetylene** H230 may react explosively even in the absence of air H220 Extremely Flammable gas Cat 1 H280 – contains gas under pressure; may explode if heated. For Seveso the main hazard from Acetylene is that it burns very easily and can under certain conditions explode. It is not toxic to people. It is not hazardous to the aquatic environment. (Acetylene is considered as a Volatile Organic Compound when emitted to air under the Industrial Emissions Directive (IED)).

PART 1 For all establishments covered by this Directive:	Lower tier or Upper tier Acetylene manufacturing facility
principal dangerous characteristics in simple terms.	**Calcium Carbide** H260 In contact with water emits flammable gas which may ignite spontaneously Cat 1 For Seveso the main hazard is that if Calcium carbide is exposed to moisture it will generate acetylene, with a risk of fire. **Acetone** H225: Highly flammable liquid and vapour For Seveso the main hazard from Acetone is that it burns very easily. It is not toxic to people or hazardous to the aquatic environment. Lime (Calcium dihydroxide) is not classified as dangerous for Seveso. It is a severe respiratory irritant and can damage eyes.
5. General information about how the public concerned will be warned, if necessary; adequate information about the appropriate behaviour in the event of a major accident or indication of where that information can be accessed electronically.	For Lower tier: In the unlikely event of a Major Accident at this lower tier site, the site operators will raise an on-site alarm and alert the emergency services. You should: ✓ Shut off ignition sources (stop smoking, shut off any open flames...) ✓ go/stay indoors, closing windows and doors, ✓ in case of fire/explosion stay away from windows to protect from glass fragments ✓ obey any instructions from emergency services, who may evacuate people from the immediate downwind area if necessary ✓ wait for instruction that the incident is over – this will usually be communicated by the emergency services This information about appropriate behaviour in the event of a Major Accident is also available from the company web-page for this site: (add company link) OR For Upper tier: In the unlikely event of a Major Accident at this Upper tier site, the site operators will inform the local authority who is responsible for the Off-site emergency plan. According to that plan you should: ✓ Shut off ignition sources (stop smoking, shut off any open flames...) ✓ go/stay indoors, closing windows and doors, ✓ in case of fire/explosion stay away from windows to protect from glass fragments ✓ turn on TV/radio stations as defined in that Off-site plan ✓ obey any instructions from emergency services, who may evacuate people from the immediate downwind area if necessary ✓ wait for instruction that the incident is over – this will usually be communicated by the emergency services Information about your actions under the Off-site Emergency plan is available from the local authority (include web-link or physical address).

PART 1 For all establishments covered by this Directive:	**Lower tier or Upper tier Acetylene manufacturing facility**
6. The date of the last site visit in accordance with Article 20(4), or reference to where that information can be accessed electronically; information on where more detailed information about the inspection and the related inspection plan can be obtained upon request, subject to the requirements of Article 22.	The date of the last Competent Authority (CA) Seveso inspection visit is posted in the national CA web-site (include CA link). More detailed information about the inspection and the related inspection plan can be requested from the national CA.
7. Details of where further relevant information can be obtained, subject to the requirements of Article 22.	Further information can generally be obtained, in accordance with the Seveso, from the national CA, subject to restrictions outlined in the national legislation (include web-link or physical address).

PART 2 : For upper-tier establishments, in addition to the information referred to in Part 1 of this Annex:	**Upper tier Acetylene manufacturing facility**
1. General information relating to the nature of the major-accident hazards, including their potential effects on human health and the environment and summary details of the main types of major-accident scenarios and the control measures to address them.	[To be summarised from the Upper tier safety report for this site] Acetylene manufacturing scenarios theoretically include: • Acetylene generator rupture • Fire or explosion in compression, drying or filling system • Fire involving Acetylene cylinder storage • Calcium Carbide container dropped/leaking • Acetone system leak or spill <u>Acetylene generator rupture</u> Calcium carbide pieces are fed into the generator vessel and contacted with water to generate Acetylene Gas. The design of Acetylene generators is long established globally and all equipment is constructed, operated and maintained in accordance with recognised industry standards. All areas of the plant are strictly controlled in accordance with ATEX workplace regulations to control the risk of potentially explosive atmospheres. The process is normally operated at low temperature and pressure and very carefully controlled. Excess pressure can only occur in the event of several system failures and could lead to a release of acetylene inside the generator building, which may result in a fire or explosion. This is unlikely to result in risk to people off-site. In the view of EIGA the complete rupture of an acetylene generator is highly unlikely. The Off-site emergency alarm would be sounded for any major fire and as described in that plan, you should shut off ignition sources (stop smoking, shut off any open flames...) go/stay indoors, closing windows and doors, to protect you, your family and others nearby. <u>Fire or explosion in compression, drying or filling system</u>

PART 2 : For upper-tier establishments, in addition to the information referred to in Part 1 of this Annex:	Upper tier Acetylene manufacturing facility
	Acetylene gas is collected after the generator in a low pressure gas holder, dried, purified and then compressed in order to fill into cylinders. Acetylene gas cannot be safely compressed to very high pressure and is therefore dissolved into acetone inside specially designed cylinders. There is a risk of fire or explosion either if air enters the process or if acetylene leaks out. The design of acetylene filling plants is long established globally and all equipment is constructed, operated and maintained in accordance with recognised industry standards. All areas of the plant are strictly controlled in accordance with ATEX workplace regulations to control the risk of potentially explosive atmospheres. Fire/explosion would only occur in the event of several system failures and is unlikely to result in risk to people off-site. In the view of EIGA a fire in acetylene compression/filling plant is unlikely. The Off-site emergency alarm would be sounded for any major fire and as described in that plan, you should shut off ignition sources (stop smoking, shut off any open flames...) go/stay indoors, closing windows and doors, to protect you, your family. <u>Calcium carbide container dropped/leaking</u> The design and manufacture of containers used for transporting calcium carbide must adhere to strict international standards required for the Transport of Dangerous Goods under ADR. These standards require for example that container must survive a drop from >1m onto concrete without leaking and define strict periodic inspection and testing protocols. The main concern is that the calcium carbide container remains watertight as contact between calcium carbide and water will generate Acetylene. Potential causes of container damage could include dropping, damage from forks of Forklift truck or corrosion. In addition to the general controls listed above, container leakage is prevented by inspection on receipt at this site in accordance with industry guidance. The Off-site emergency alarm would be sounded for any major leak or fire and as described in that plan, you should shut off ignition sources (stop smoking, shut off any open flames...) go/stay indoors, closing windows and doors, to protect you, your family and others nearby. <u>Acetone leak or spill</u> Acetone is delivered to our site in a tanker. The acetone is piped into the acetylene fill building and used to “top up” cylinders before acetylene is added. Acetone is highly flammable. The delivery process is similar to what you see when a fuel tanker delivers diesel to your local petrol station. Our installation meets national regulations and recognised international design standards. The acetone installation is designed, operated and maintained in accordance with ATEX workplace regulations to control the risk of potentially explosive atmospheres. The acetone storage tank is bunded to contain spillage, is located away from cylinder storage areas and away from cryogenic storage tanks.

PART 2 : For upper-tier establishments, in addition to the information referred to in Part 1 of this Annex:	Upper tier Acetylene manufacturing facility
	Acetone tanker drivers are legally required to be certified under ADR to transport dangerous goods. If a tanker driver makes a mistake, it is possible for a small quantity of acetone to be spilled; from the contents of the filling hose or the contents of the tanker (about 10 tonnes). The likelihood of any driver or operator making a mistake resulting in a spill of acetone is considered by EIGA to be “possible”. Not all spills would result in a fire. Protection of Cylinder storage areas The layout of the acetylene site is designed so that vehicle traffic is kept away from cylinder and calcium carbide storage areas. Cylinders containing Acetylene or containers of calcium carbide are stored in dedicated areas following industry best practice guidelines. There is a strictly enforced site speed limit and only authorised vehicles are allowed on site. Our forklift truck drivers are trained and their competence is periodically reassessed. Cylinder truck drivers and calcium carbide delivery drivers are legally required to be certified under ADR to transport dangerous goods such as Acetylene or calcium carbide. Precautions are taken to prevent unauthorised access or theft of products. The site is fenced and access controlled, the perimeter fence is monitored remotely by a security company. External Fire The design and manufacture of cylinders used for acetylene (filled as a dissolved gas) must adhere to strict international standards required for the Transport of Dangerous Goods under ADR. These standards require for example that cylinder must survive a drop from >1m onto concrete without leaking and define strict periodic inspection and testing protocols. In addition to the general controls listed above, cylinder leaks are prevented by moving cylinders securely strapped together in pallets or bundles, and by performing pre- and post- fill inspection procedures in accordance with industry guidance. Cylinders which are stored outdoors and not connected to any fill process do not create a potentially flammable atmosphere (according to ATEX workplace regulations). Even so all ignition sources including smoking, hot work and use of mobile phones is controlled at our depots. Combustible materials including wastes are not allowed in cylinder storage areas. In accordance with industry best practice, cylinders may only be stored several metres away from the site fence line. The Off-site emergency alarm would be sounded for any major fire and as described in that plan, you should shut off ignition sources (stop smoking, shut off any open flames...) go/stay indoors, closing windows and doors, to protect you, your family and others nearby. The likelihood of a major fire occurring in the acetylene cylinder storage area is considered by EIGA to be unlikely.

PART 2 : For upper-tier establishments, in addition to the information referred to in Part 1 of this Annex:	**Upper tier Acetylene manufacturing facility**
2. Confirmation that the operator is required to make adequate arrangements on site, in particular liaison with the emergency services, to deal with major accidents and to minimise their effects.	"As an Upper tier site, the company has adequate arrangements in place to liaise with emergency services, to deal with major accidents and to minimise their effects."
3. Appropriate information from the external emergency plan drawn up to cope with any off-site effects from an accident. This should include advice to cooperate with any instructions or requests from the emergency services at the time of an accident.	"Information about the Off-site Emergency plan is available from the local authority (include web-link or physical address...and summarise "appropriate information" from that plan). It is important for you to understand and follow the recommended actions in that Off-site Emergency plan, and to obey any instructions from the emergency services, in order to minimise the effects of any major accident consequences and to protect you and your family."
4. Where applicable, indication whether the establishment is close to the territory of another Member State with the possibility of a major accident with transboundary effects under the Convention of the United Nations Economic Commission for Europe on the Transboundary Effects of Industrial Accidents. EN 24.7.2012 Official Journal of the European Union L 197/31	Not applicable

Appendix L: List of relevant accidents

SEE SEPARATE DOCUMENT Doc 60.1