23 August 2016

**NOTICE**
AC/112(PHEWG)(EAPC)N(2016)0006

**PETROLEUM COMMITTEE (PC)**

**PETROLEUM HANDLING EQUIPMENT WORKING GROUP (PHEWG)**

# STANAG 4713 EDITION 1 STUDY DRAFT 1 / AFLP-4713 EDITION A VERSION 1 STUDY DRAFT 1 - GUIDANCE TO THE MANAGEMENT OF FIRE AND EXPLOSION RISK OF AREAS FOR THE STORAGE AND DISTRIBUTION OF HYDROCARBONS DURING OPERATIONS

**Note by the Staff Officer**

Reference: AC/112(PHEWG)(EAPC)DS(2015)0001, paragraph 17

1. Further to reference, the French Custodian for the new STANAG 4713/AFLP-4713 has prepared on behalf of the PHEWG Study Draft 1 of the subject documents at Enclosure 1 and 2.

2. Nations are requested to review the attached Study Drafts and to send their comments to the French Custodian (stephane.romanowski@intradef.gouv.fr), copy Staff Officer (van-exem.philippe@hq.nato.int) by Friday, 8 September 2016. Comments/suggestions received will be further discussed at the 2016 PHEWG meeting in order to decide on the way ahead.

(Signed) P. VAN EXEM

2 Enclosures

Original: English

**NATO/EAPC UNCLASSIFIED**
**OTAN/CPEA SANS CLASSIFICATION**

**STANDARDIZATION AGREEMENT** | **ACCORD DE NORMALISATION**

# STANAG 4713

**GUIDANCE TO THE MANAGEMENT OF FIRE AND EXPLOSION RISK OF AREAS FOR THE STORAGE AND DISTRIBUTION OF HYDROCARBONS DURING OPERATIONS**

**GUIDE DE MAÎTRISE DE RISQUE INCENDIE ET EXPLOSION DES ZONES DE STOCKAGE ET DE DISTRIBUTION D'HYDROCARBURES EN OPÉRATION**

**EDITION 1/ÉDITION 1**
**Study Draft 1/1er Projet d'étude**
**August/août 2016**

**NORTH ATLANTIC TREATY ORGANIZATION**

**ORGANISATION DU TRAITÉ DE L'ATLANTIQUE NORD**

**Published by**
**THE NATO STANDARDIZATION AGENCY (NSA)**

**Publié par**
**L'AGENCE OTAN DE NORMALISATION (AON)**



**NATO/EAPC UNCLASSIFIED**
**OTAN/CPEA SANS CLASSIFICATION**

**XX August/août 2016**

**STANAG 4713**
**Edition/Édition 1**
**Study Draft 1/**
**1er Projet d'étude**

## LETTER OF PROMULGATION

### STATEMENT

The enclosed NATO Standardization Agreement (STANAG), which has been ratified by member Nations, as reflected in the NATO Standardization Documentation Database (NSDD), is promulgated herewith.

### IMPLEMENTATION

This STANAG is effective upon receipt and ready to be used by the implementing Nations and NATO bodies.

The partner Nations are invited to adopt this STANAG.

### SUPERSEDED DOCUMENTS

This STANAG supersedes the following document:

Nihil

### ACTIONS BY NATIONS

Nations are invited to examine their ratification of the STANAG and, if they have not already done so, advise the NSA of their intention regarding its implementation.

Nations are requested to provide to the NSA their actual STANAG implementation details.

## LETTRE DE PROMULGATION

### DÉCLARATION

L'accord de normalisation OTAN (STANAG) ci-joint, qui a été ratifié par les pays membres dans les conditions figurant dans la Base de données des documents de normalisation OTAN (NSDD), est promulgué par la présente.

### MISE EN APPLICATION

Ce STANAG entre en vigueur dès réception et est prêt à être mis en application par les pays et les organismes OTAN d'exécution.

Les pays partenaires sont invités à adopter ce STANAG.

### DOCUMENTS ANNULÉS ET REMPLACÉS

Ce STANAG annule et remplace le document suivant :

Nihil

### MESURES À PRENDRE PAR LES PAYS

Les pays sont invités à examiner l'état d'avancement de la ratification du STANAG et d'informer, s'ils ne l'ont pas encore fait, l'AON de leur intention concernant sa mise en application.

Les pays sont priés de fournir à l'AON des informations détaillées sur la mise en application effective de ce STANAG.

**SECURITY CLASSIFICATION**

This STANAG is a NATO/EAPC UNCLASSIFIED document to be handled in accordance with C-M(2002)60.

**CLASSIFICATION DE SÉCURITÉ**

Ce STANAG est un document OTAN/CPEA SANS CLASSIFICATION qui doit être traité conformément au C-M(2002)60.

**RESTRICTION TO REPRODUCTION**



**RESTRICTION CONCERNANT LA REPRODUCTION**



**Dr. Cihangir AKSIT**
**Director, NATO Standardization Agency**

**Dr. Cihangir AKSIT**
**Directeur de l'Agence OTAN de normalisation**

**STANAG 4712 Edition/Édition 1**

**STANDARDS FOR MAINTENANCE OF DEPLOYABLE FUEL RECEIPT, STORAGE AND DISPENSING SYSTEMS**

**NORMES D'ENTRETIEN DES INSTALLATIONS DÉPLOYABLES DE RÉCEPTION, DE STOCKAGE ET DE DISTRIBUTION DE CARBURANTS**

**AIM**

The aim of this NATO standardization agreement (STANAG) is to respond to the following interoperability requirements.

**BUT**

Le présent accord de normalisation OTAN (STANAG) a pour but de répondre aux exigences d'interopérabilité suivantes.

**INTEROPERABILITY REQUIREMENTS**

To give POL depot operators simple tools for managing the risk of fire and explosion inherent to their work.

**EXIGENCES D'INTEROPERABILITÉ**

D'établir aux exploitants des dépôts pétroliers des outils simples pour faire face aux risques d'incendie et d'explosion inhérents à leur activité.

**AGREEMENT**

Participating Nations agree to implement the following standard.

**ACCORD**

Les pays participants conviennent de mettre en application la norme suivante.

**STANDARD**

AFLP-4713 – Guidance to the management of fire and explosion risk of areas for the storage and distribution of hydrocarbons during operations

**NORME**

AFLP-4713 – Guide de maîtrise de risque incendie et explosion des zones de stockage et de distribution d'hydrocarbures en opération

**OTHER RELATED DOCUMENTS**

Nihil

**AUTRES DOCUMENTS CONNEXES**

Nihil

**NATIONAL DECISIONS**

The national decisions regarding the ratification and implementation of this STANAG are provided to the NSA.

The national responses are recorded in the NATO Standardization Document Database (NSDD).

**IMPLEMENTATION OF THE AGREEMENT**

This STANAG is implemented when a nation has issued instructions that all future equipment procured for its forces will be manufactured in accordance with the detail specified in this agreement. No retrofit action is necessary.

Nations are invited to report on their effective implementation of the STANAG using the form at Annex H to AAP-03(J).

Partner Nations are invited to report on the adoption of the STANAG using the form at Annex G to AAP-03(J).

**REVIEW**

This STANAG is to be reviewed at least once every three years. The result of the review is recorded within the NSDD.

Nations and NATO Bodies may propose changes, at any time, through a standardization proposal to the tasking authority (TA), where the changes will be processed during the review of the STANAG.

**DÉCISIONS NATIONALES**

Les décisions nationales concernant la ratification et la mise en application du présent STANAG sont communiquées à l'AON.

Les réponses nationales sont consignées dans la Base de données des documents de normalisation OTAN (NSDD).

**MISE EN APPLICATION DE L'ACCORD**

Le présent STANAG est mis en application lorsqu'un pays a donné pour instructions à ses forces que tout matériel nouvellement acquis réponde aux spécifications décrites en détail dans le présent accord. Aucune mesure de rattrapage n'est nécessaire.

Les pays sont invités à rendre compte de la mise en application effective du présent accord au moyen du formulaire figurant à l'Annexe H à l'AAP-03(J).

Les pays partenaires sont invités à rendre compte de l'adoption du présent STANAG au moyen du formulaire figurant à l'Annexe G à l'AAP-03(J).

**RÉEXAMEN**

Le présent STANAG doit être réexaminé au moins une fois tous les trois ans. Le résultat de ce réexamen est consigné dans la NSDD.

Les pays et les organismes OTAN peuvent, à tout moment, proposer des modifications en soumettant une proposition de normalisation à l'autorité de tutelle (TA), qui traitera ces modifications lors du réexamen du STANAG.

**TASKING AUTHORITY**

This STANAG is supervised under the authority of:

**AUTORITÉ DE TUTELLE**

Le présent STANAG est sous la responsabilité de :

AC/112 Petroleum Committee (PC)

Mr. P. Van Exem, NATO HQ, E-mail: van-exem.philippe@hq.nato.int

**CUSTODIAN**

The custodian of this STANAG is:

**PILOTE**

Le pilote du présent STANAG est :

AC/112 Petroleum Handling Equipment Working Group (PHEWG)

Mr. P. Van Exem, NATO HQ, E-mail: van-exem.philippe@hq.nato.int

**FEEDBACK**

Any comments concerning this STANAG shall be directed to:

**INFORMATIONS EN RETOUR**

Tous les commentaires concernant le présent STANAG doivent être adressés à :

**NATO Standardization Office**
**(NSO)**

**Bureau OTAN de normalisation**
**(NSO)**

**Boulevard Léopold III**
**1110 BRUXELLES – Belgique**

# NATO STANDARD

# AFLP-4713

# GUIDANCE TO THE MANAGEMENT OF FIRE AND EXPLOSION RISK OF AREAS FOR THE STORAGE AND DISTRIBUTION OF HYDROCARBONS DURING OPERATIONS

**Edition A Version 1**
**Study Draft 1**
**August 2016**

**NORTH ATLANTIC TREATY ORGANIZATION**

**ALLIED FUEL AND LUBRICANTS PUBLICATION**

Published by the
NATO STANDARDIZATION OFFICE (NSO)

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**NORTH ATLANTIC TREATY ORGANIZATION (NATO)**

**NATO STANDARDIZATION AGENCY (NSA)**

**NATO LETTER OF PROMULGATION**

[Date]

1. The enclosed Allied Fuel and Lubricants Publication AFLP-4786, Facilities and Equipment for Receipt, Storage and Delivery of Aviation Gasoline Fuels, has been approved by the nations in the AC/112 Petroleum Handling Equipment Working Group, is promulgated herewith. The agreement of nations to use this publication is recorded in STANAG 4786.

2. AFLP-4786 is effective upon receipt/will come into effect on receipt.

3. No part of this publication may be reproduced, stored in a retrieval system, used commercially, adapted, or transmitted in any form or by any means, electronic, mechanical, photo-copying, recording or otherwise, without the prior permission of the publisher. With the exception of commercial sales, this does not apply to member nations and Partnership for Peace countries, or NATO commands and bodies.

4. This publication shall be handled in accordance with C-M(2002)60.

Edvardas MAŽEIKIS
Major General, LTUAF
Director NATO Standardization Office

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**RESERVED FOR NATIONAL LETTER OF PROMULGATION**

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# RECORD OF RESERVATIONS

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Note: The reservations listed on this page include only those that were recorded at time of promulgation and may not be complete. Refer to the NATO Standardization Database for the complete list of existing reservations.

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# RECORD OF SPECIFIC RESERVATIONS

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## TABLE OF CONTENTS

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## SECTION 1 GENERAL

0101. Security is of particular importance for nations which have the mission of storing, transporting and distributing fuels in areas of operational engagement. The handling of fuels, which are flammable by nature, automatically carries a risk of fire or explosion.

0102. The consequences of a fire or an explosion in a POL depot are serious and lasting:

- loss of operational capability by the force being supported;
- potentially extensive loss of human resources and equipment;
- environmental damage which may be lasting and serious;
- impaired image of the force in the eyes of the local population.

0103. The aim of this guide is to give POL depot operators simple tools for managing the risk of fire and explosion inherent to their work.

0104. It establishes the measures to be taken to prevent and combat fire in field POL depots that are isolated or incorporated in operational bases.

0105. The guide offers, inter alia:

- a method for general analysis of the fire/explosion danger in an operational depot and a presentation of the different methods for combating this risk;
- a simple method for determining the size of the danger zones;
- a simple method for assessing the distances of the effects of heat flow;
- a simple method for establishing the assets required to combat the risk of fire/explosion.

0106. The guide also defines the different fire safety levels that can be assigned to operational POL depots.

## SECTION 2 SCOPE OF THE GUIDE

0201. Storage depots

This guide deals with field depots and points where activities:

- give rise to danger areas because flammable substances are present;
- form part of an operational deployment.

The guide also applies to vehicles which are temporarily used for storing bulk or packaged hydrocarbons.

0202. Particular facilities

Facilities which are not specifically devoted to storage (reception, field laboratory, workshops, etc) may also be concerned to the extent that they are within the “domino effect” area.

## SECTION 3 DEFINITIONS

FLASH POINT

0301. The danger of hydrocarbons burning is measured by the flash point, which is the minimum temperature to which the substance must be raised so that the vapours emitted burn spontaneously in the presence of a flame.

BURNING TEMPERATURE

0302. The burning temperature is the lowest temperature at which a liquid emits sufficient vapours to form a flammable mixture with the ambient air which, once it is ignited, can continue to burn by itself when the ignition source is removed. The burning temperature is slightly higher than the flash point.

FLAMMABLE ATMOSPHERE

0303. A flammable atmosphere consists of a mixture of air and flammable substances in the form of gases, vapours or mists in such concentrations that, under normal operating conditions (pressure and temperature), an ignition source is enough to cause the mixture to burn.
This occurs within a precise range of concentrations bounded by the upper and lower flammability limits.

EXPLOSIVE ATMOSPHERE

0304. An explosive atmosphere is a mixture, in atmospheric conditions, of air and flammable substances in the form of gases, vapours, mists or dust, in which, after ignition, the combustion spreads to the entire unburned mixture (Article R232-12-24 of the Labour Code).
The explosion occurs within a precise range of concentrations bounded by the upper and lower explosive limits. The explosion zone lies within the flammability zone.

LOWER EXPLOSIVE LIMIT (LEL)

0305. The concentration of flammable gas or vapour in the air, below which the gaseous atmosphere is not explosive.

UPPER EXPLOSIVE LIMIT (UEL)

0306. The concentration of flammable gas or vapour in the air, above which the gaseous atmosphere is not explosive.

THE DIFFERENT DANGER ZONES

0307. Permanent danger zone, designated type 0:
A zone where an explosive atmosphere (mixture of air and flammable substances in the form of gases, vapours or mists) is present continuously, over long periods, or frequently.

0308. Occasional danger zone, designated type 1:
A zone where an explosive atmosphere (mixture of air and flammable substances in the form of gases, vapours or mists) is liable to arise occasionally under the normal operating conditions of the facility.

0309. Danger zone resulting from an accident, designated type 2
A zone where an explosive atmosphere (mixture of air and flammable substances in the form of gases, vapours or mists) is not liable to arise under the normal operating conditions of the facility or, if it does arise, lasts only a very short time.

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## SECTION 4 GENERAL POINTS ON CONTROLLING THE RISK OF FIRE AND EXPLOSION

0401. As the risks of fire and of explosion are very similar, this guide deals with both together under the heading of “fire”.

0402. In general, personnel trained in the control of hydrocarbon fire risk are essential to the fire safety of a POL facility.

0403. If this condition is met, the management of the fire risk is based on two pillars:

a. **prevention** of the fire risk, to avoid the outbreak of fire or limit the extent of its consequences by means of permanent preventive measures

b. **protection**, to limit the consequences of any fire which does occur.

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## SECTION 5 PREVENTION OF THE RISK OF FIRE: PREVENT THE OUTBREAK OF FIRE

To avoid the outbreak of fire, the facility operator will at all times strive to limit the close proximity of possible ignition sources and explosive or flammable atmospheres. This is achieved by first identifying the danger zones and potential ignition sources and then by taking steps to stop them interacting.

### DETERMINING THE DANGER ZONES

To establish where the danger zones are, the operator should first identify the POL facilities which may suffer leaks or which generate hydrocarbon vapours or mists. He should then determine the size of the associated danger zones using one of the procedures described in this guide. Once the danger zones have been determined (location and size), they should be indicated by appropriate marking.

0501. The risks posed by different types of facility

a. Storage tanks

In normal conditions of use (storage, filling and emptying), flexible tanks give off vapours through their apertures (vents, connections, etc). Furthermore, a fault may give rise to leaks, either through overflowing or through loss of integrity (cracking, bursting, etc).
However, there is no layer of gas in this type of tank, and this makes it impossible for the fuel stored in it to explode.

b. Pipes

Pipes may accidentally give rise to danger zones because of bursting or perforation. This may then cause liquid puddles, vapours or mists of flammable substances.

c. Joints

Joins between pipes and between all components of the network (valves, meters, filters, etc) are supposed to be tight, but they may leak if their seals deteriorate; this can lead to liquid puddles, vapours or mists of flammable substances.

d. Pumping units and manifolds

In normal mode, the valves on pumps and manifolds create danger zones. Moreover, in the event of an accident, leaks (at seals, connections, etc) may give rise to liquid puddles, vapours or mists of flammable substances.

e. Loading and unloading areas

During normal operation, the dangers produced by these areas are due to:
- the release of hydrocarbon vapours from the valves of tanker vehicles;
- the handling of POL products for quality and quantity controls;
- and so on.

Moreover, in the event of an accident, leaks due to loss of integrity of the vehicle tank, a failure or perforation of a pipe, or a defect in ancillary equipment may give rise to liquid puddles, vapours or mists of flammable substances.

Furthermore, tanks exposed to the sun may reach an internal temperature above the ignition temperature of the product under transportation, generating an explosive atmosphere.

f. Parking areas

Normally, the dangers inherent to these areas are due to:
- the release of vapours from the valves of parked-up tanker vehicles;
- the handling of POL products for quality and quantity controls;
- the formation of closed circuits of fuel with a view to checking the functioning of the loading operation;
- and so on

In the event of a fault, leaks may appear owing to loss of integrity of the vehicle tank, a defect or perforation of a hose, and this may give rise to liquid puddles, vapours or mists of flammable substances.

These parking areas are sometimes protected by an oil separator, which itself often contains substances liable to give off dangerous vapours at its surface.

g. Storage area for packaged products

Danger zones are caused by leaks from the packaging.

The choice of storage areas for ingredients, various substances distributed by the SEA and those used in workshops is crucial for the containment of possible leaks.

Incompatible substances which could cause dangerous reactions (fire, degradation) if mixed should be stored separately.

h. Field laboratories

Danger zones are caused by the handling of fuels, which should therefore be strictly limited to quality control operations.

0502. Procedures for determining the size of danger zones

To simplify the work of operators setting up a hydrocarbon depot in the field, Annex 1 identifies the danger zones generated by the installations used.

This initial approach may then be refined with a detailed risk analysis carried out by qualified persons.

a. Determining the size by manual measurement

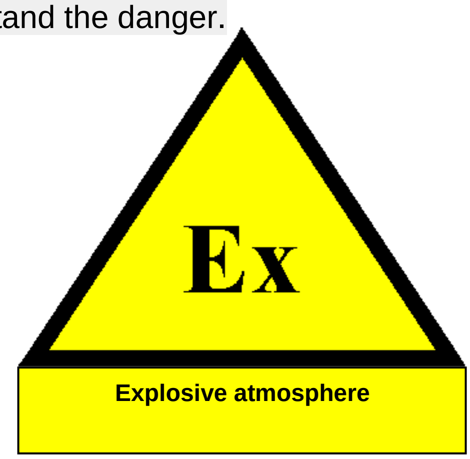
The zones are determined by measurement using an explosimeter or flammable gas detector.
The purpose of this device is to measure quantities such as the LEL percentage (from 0 to 100%) of a flammable gas (generally methane).

b. Determining the size by calculation

This involves mathematical modelling of the danger zones (vapours, propagation of explosion blast wave or fire temperature). These models are available on the Internet.

0503. Marking of explosive atmosphere zones

Locations where explosive atmospheres may occur are indicated at access points by the ATEX (*atmosphère explosive*) warning pictogram below. It must be large enough for good visibility and to ensure that personnel with access to the installations in question understand the danger.



IDENTIFICATION OF IGNITION SOURCES

0504. Internal ignition sources

Internal ignition sources result from all the thermal, mechanical, electrical and chemical processes employed in the normal operation of the facilities. The main sources are:

- naked flames;
- hot surfaces;
- hot gases;
- sparks from mechanical friction;
- electrical installations;
- stray currents;
- and so on.

Internal sources also include all clothing, accessories, etc, used, worn or carried by the personnel in the establishment. The risks are usually due to the practices and habits of the staff (cigarettes, lighters, mobile phones, audio or video devices, etc).

0505. External ignition sources

External ignition sources originate from either natural causes or man-made causes (neighbouring facilities, acts of deliberate destruction, etc).
Lightning is always present in a storm and is a major risk of ignition owing to the energy it releases.
The immediate neighbourhood of dangerous facilities involves a risk which should be taken into account in the different protection plans and in the analysis of the danger, where it will be identified as a potential source of fire.
Malicious action and attacks also constitute threats which should be taken into account.

0506. Intrinsic ignition sources

Intrinsic ignition stems from the nature of the substances stored or handled. Under certain storage or handling conditions, the physico-chemical characteristics of these substances may cause hot spots by:

- electrostatic discharge;
- chemical reactions.

The temporary storage of waste must also be treated as a possible source of intrinsic ignition.

MEASURES TO LIMIT THE RISK OF OUTBREAK FO FIRE

0507. Controlling the access of personnel to danger zones

The first step to take is to control the access of personnel to danger zones. The only personnel authorized to enter these zones are those whose mission so requires.
To this end, the depot must be enclosed with fencing which cannot be crossed accidentally, and access via depot entrances must be screened systematically.
If there is no adequate physical system, appropriate human surveillance may be used instead on a temporary basis.
There is special equipment for dangerous areas. This equipment, designated ATEX (explosive atmosphere), is designed not to produce ignition in fire danger areas. The ATEX classification is detailed in Annex 2.

0508. Establishing permanent safety instructions

Once access is controlled, the head of the depot should establish permanent safety instructions. These should be known to all depot staff and anyone who may enter the depot.
The instructions may include the following (non-exhaustive list):

- the use of lighters, mobile phones and any unsuitable equipment is forbidden;
- all personnel entering the danger zones must wear clothing which does not cause sparks from electrostatic discharge (cotton);
- all personnel entering the depot should sign an acknowledgement that they have read and understood the permanent instructions. Persons entering or leaving the depot could be recorded in a special register.

0509. Avoiding the risk associated with electrostatic discharge and lightning

All equipment must be connected in accordance with STANAG 3682 and earthed.

0510. Limiting the risk of direct firing on the facilities

To limit this risk, progressive measures may be taken depending on the funding available and the force's priorities:

- setting up screens to break the line of sight; they do not provide any real protection but prevent precision fire at potentially flammable targets;
- setting up "bastion wall" type barriers, which, in addition to the concealing effect of the screens, give real protection against direct fire.

ADDITIONAL PREVENTIVE MEASURES

0511. Movement of products

At least two members of the operational staff must always be involved in the movement of products, so that one person can carry out the movement while another checks that it is being done properly. The head of the depot must be informed immediately of any anomaly such as a leak or overflow of the product, so that he or she can take the necessary measures to contain it.

0512. Duty personnel

Two members of the depot personnel shall be on duty at all times. This duty may be concurrent with the operations duty if appropriate. The personnel concerned should be accommodated in the immediate vicinity of the depot if possible, and they must be able to inspect the depot visually at all times. The following tasks should appear in their instructions:

- upkeep of the depot: the POL depot must always be in meticulous order and operational. Any misplaced or incongruous item at the depot must be put in its proper place.
- patrols at the end of activities: before a period of inactivity at the depot (e.g. the evening), the duty personnel must carry out a patrol, half an hour after activity has ceased, to check the condition of the tanks, hoses, lorries and, in general, all the POL containers. They shall report or remedy any equipment faults and/or leaks they find.

0513. Fuel leaks

As soon as a fuel leak is detected, the following measures must be taken immediately:

- Alert the head and all personnel of the depot
- Contain the product escaping from the leak
- Prohibit access to the depot by third parties
- Recover leaked product by pumping
- Clean the affected area completely (using an absorbent, etc)
- Check the condition of the equipment concerned and replace faulty items
- Resume operations with preliminary tests
- Describe the incident/accident in a written/formal report to the base's security officer.

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**SECTION 6 PREVENTION OF THE RISK OF FIRE: LIMITING THE CONSEQUENCES**

LIMITING THE CONSEQUENCES OF A FIRE IN FLOWING FUEL

If a fire starts in a fuel depot, it can spread very rapidly (in a few minutes). The consequences depend on many factors such as the type and volume of fuel, the natural slope of the ground and the potential vulnerable targets (the camp, stored equipment, etc).

0601. Slope

Before setting up a depot it is essential to analyse the general slope of the ground under consideration and the flow of rainwater: burning fuel in this area will follow the same path.
A depot should, therefore, not be situated above potential targets, taking account of the path of flow.
If this is unavoidable, however, it is possible to reduce the risk by making drainage ditches which direct the flow into a containment basin in a non-sensitive area.

0602. Containment

The risk described in the previous paragraph can be greatly limited by setting up a retaining basin for flow caused by the facilities (storage areas, distribution point, etc).
To be effective, retaining basins must be fire-resistant and impervious.
They may be formed with:

- concrete basins
- earth ramparts with liner
- “bastion walls” with liner

If ramparts or bastion walls are used, particular care must be taken to ensure that the junction between the ground and the retaining basin is sealed and impermeable.
This basin must be able to hold the maximum amount of fuel contained in the protected facility.

LIMITING THE CONSEQUENCES OF HEAT FLOW FROM A FIRE

0603. The different effects of heat flow

The heat radiation given off by a hydrocarbon fire depends essentially on its surface area. The distance at which the heat flow causes damage also depends on the surface area (see Annex 3).
The consequences may be of two kinds:

- damage to a target (for example, shattering of windows, burns suffered by individuals, etc);
- ignition of a target (for example, ignition of another flexible tank, explosion of a munition depot, etc).

The ignition of a target causing the extension of the fire is called the “domino effect”.

0604. Fighting the heat flow

a. Distance

Distance is the most reliable means of avoiding the effects of heat radiation.
Special care should therefore be taken to avoid proximity to vulnerable targets outside the depot – munition depots and highly sensitive facilities such as command posts, hospitals, or living areas.
Special care should also be taken to avoid the domino effect between the different fuel storage containers. A safety distance should also provide the necessary space for firefighting teams to go into action between two tanks.

b. Limiting the heat flow with passive barriers

In operational conditions, the space available is not always sufficient to meet the distance requirements. If so, it is still possible to limit the effects of heat radiation by setting up passive barriers to limit such radiation.
These barriers may take the following forms:

- “bastion walls”
- earth ramparts
- concrete walls

These obstacles should be sufficiently high (more than 2 m).

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## SECTION 7 FIGHTING THE FIRE

PRINCIPLES

Firefighting measures are intended to reduce the consequences of this undesirable event. They are devised on the basis of risk analyses which establish the means required and how they should be deployed.
During the build-up phase of military operations, in view of uncertainties about operational depots (deployment on unknown ground and for an unknown period), a reduced firefighting capability is acceptable.
It is therefore up to the person in charge of the site, in liaison with his or her fuels adviser, to define the level of firefighting assets for the operational context (degree of stability, impact on potential targets, resources available, etc).

LEVELS OF ACTION

Firefighting involves three levels of action:

- level one, with assets suitable for the beginnings of a fire, including alarm procedures and emergency operating procedures capable of limiting the immediate consequences of the fire;
- level two, with internal response assets;
- level three, with external assets.

0701. Level one

The personnel who witness the beginning of a fire must raise the alarm and try to contain the initial flames using the equipment close at hand, without taking unnecessary risks or courting a likely accident. At the same time the first-response team goes into action in accordance with the depot's permanent firefighting instructions.

0702. Level two

The level two assets are deployed under the orders of the head of the depot (or the senior person present). They are employed in accordance with the response plans, and all the personnel present at the depot are concerned. Back-up depot personnel are called in.
The head of the depot alerts the base's security officer, who is responsible for bringing the level three assets into action, and informs him or her of the development of the situation.

0703. Level three

On bases, level three generally involves all or part of the military fire safety assets. These are usually vehicles manned by professional firefighters.

They work under the supervision of the security officer of the base to which the depot belongs.

0704. Static assets

Static assets may be automatic or operated by personnel. In the latter case they must be simple, rapidly deployable, and easier to use than the mobile assets. They must also provide good protection for their operators.

<u>FIREFIGHTING ASSETS</u>

0705. Extinguishing agents

The main extinguishing agents for hydrocarbon fires are:

- foams and floating films produced by expanding aqueous film-forming foams (AFFF)
- dry powders
- inert gas
- sands
- damp cloths or fire-proof blankets

Because of its physical characteristics, water is one of the best extinguishing agents known, but its direct use is totally prohibited for hydrocarbon fires (as it breaks up and spreads the fire sources without any extinguishing effect). On the other hand, it is essential for its cooling action and is the carrier agent for emulsifiers.

0706. Calculation of the assets required

The assessment of the different assets required is set out in Annex 4.

0707. Checking the firefighting assets

Frequent checks must be carried out to ensure that the permanent instructions are always complied with and to remedy any failings observed. The head of the depot shall verify the presence and good general condition of the firefighting assets during regular site inspections.
The base's security officer may also carry out checks

<u>PREPARATIONS FOR FIREFIGHTING</u>

Firefighting assets will not be of use unless proper preparations have been made for firefighting:

- as early as possible, a firefighting plan must be drawn up jointly by the head of the depot, the site security officer and the person in charge of level three assets;
- all those involved in firefighting must know the plan and take part regularly in firefighting exercises. The exercises must be as concrete

as possible and complemented by a feedback mechanism for learning from experience.

FIREFIGHTING RESPONSIBILITIES DURING OPERATIONS

The responsibilities will evolve in line with the seriousness of the incident.

0708. The head of the depot
The head of the depot is responsible for applying the firefighting instructions and shall coordinate firefighting as long as the incident can be controlled using level two assets.

0709. The security officer of the base to which the depot belongs
The security officer shall coordinate the use of the additional assets available and has authority over all response assets as soon as the level three assets are brought into action. It is essential for all personnel involved in the firefighting to be informed of this transfer of responsibility. The head of depot shall act as his or her technical adviser for hydrocarbon fires.

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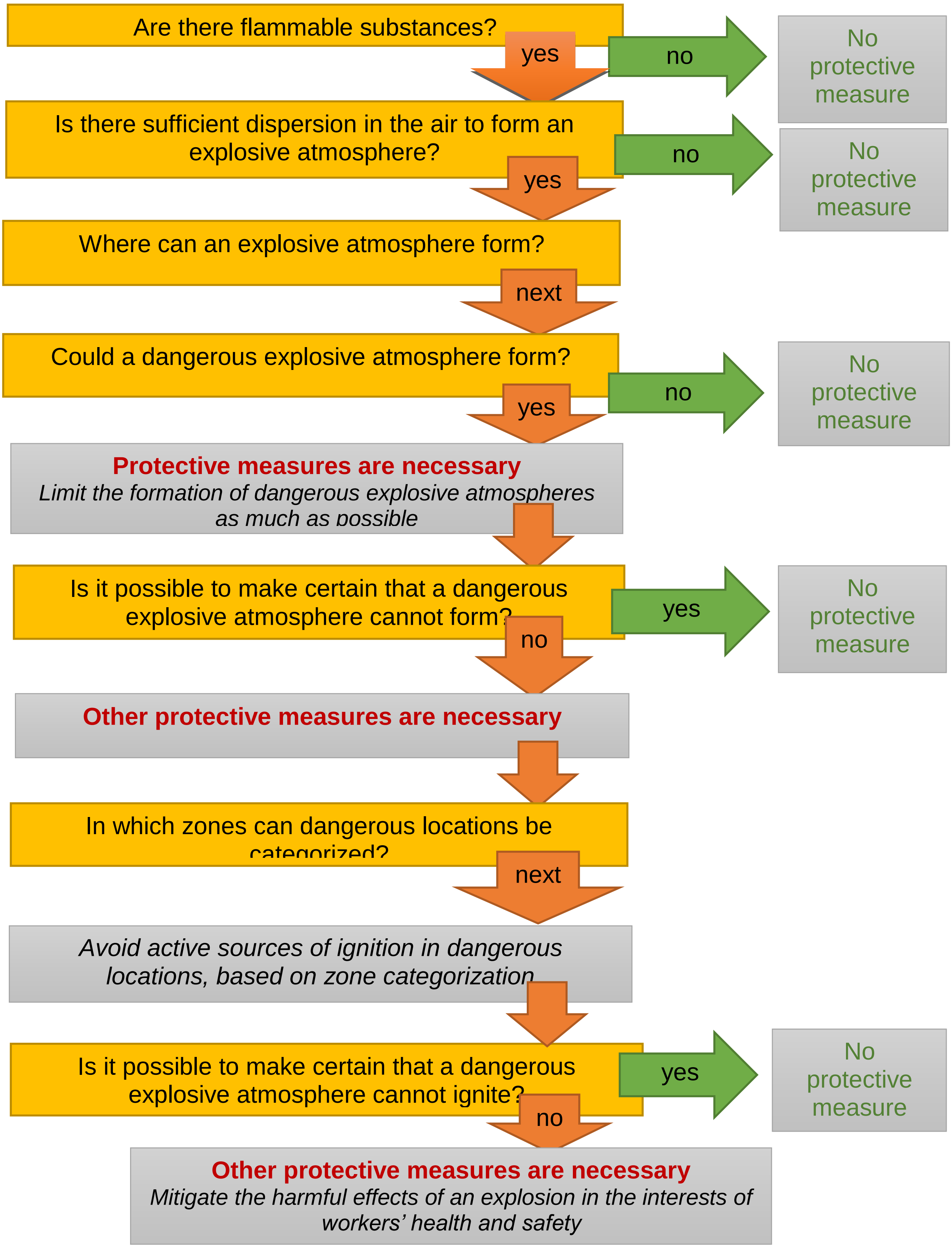
# TABLE OF CONTENTS

## ANNEXES

## **ANNEX 1** - DETERMINING THE SIZE OF THE DANGER ZONES

**Decision-making flow chart**



**1. Definition of danger zones**

Type 0 zones are defined in accordance with the diagrams in Paragraph 2.
Their volumes are determined following a risk analysis which takes account of:

- an evaluation of the quantities of inflammable substances
- an analysis of the processes being used
- the preventive measures taken to eliminate or mitigate the risk

Around a potential source of flammable gas release, danger zones may take the form of a sphere or a cylinder. The limits of these zones may change over time for various reasons:

- variation in the parameters of the equipment concerned (temperature, pressure, volume, flow rate)
- poor ventilation of a confined space
- climatic variations
- error in handling
- change in the wind
- and so on.

**2. Determining the size of danger zones**

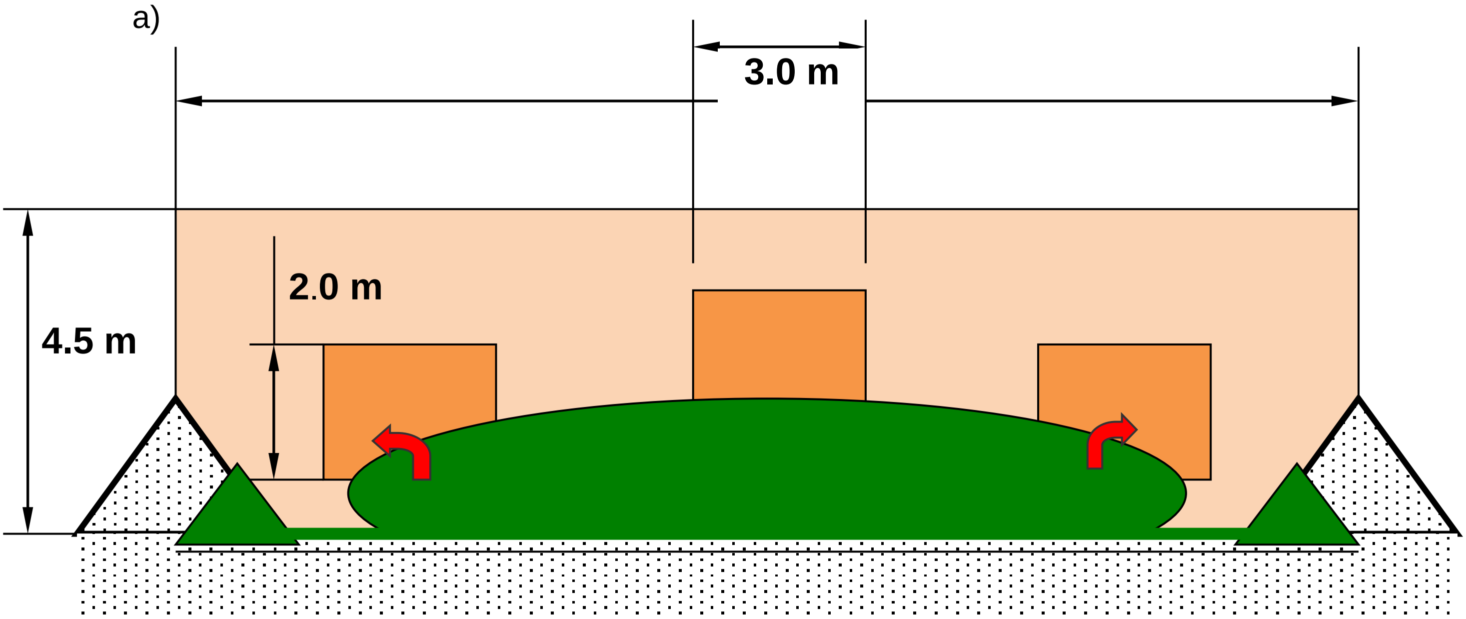
The diagrams below are provided for informational purposes and are intended as examples. The basic elements of the analysis are: identification of the source; the amount of the release of hydrocarbon gas; and ventilation.

| Probability of an explosive atmosphere (ATEX) | | | |
|---|---|---|---|
| High | Medium/Low | Very low | Unlikely |
| Location where there is an ATEX at all times, for long periods or frequently | Location where an ATEX may arise occasionally or during normal operation | Location where an ATEX is unlikely to arise during normal operation or, if it does, lasts only a short time | Location which is not dangerous |
| Zone 0 | Zone 1 | Zone 2 | Outside Zones |

**2.1. Flexible tanks placed in retaining basins**

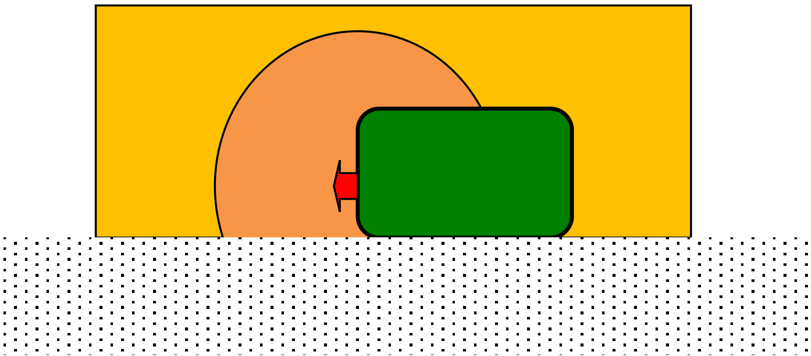
Type 0 zone: the interior of valves and filling/draining inlets/outlets
Type 1 zone: a cylinder centred on the valves and filling/draining inlets/outlets:
diameter: 3 metres
height: 2 metres
Type 2 zone: a parallelepiped 4.5 metres high in relation to the bottom of the retaining basin and bordered laterally by the edges of this basin. The basin should have a fire resistance of at least one hour.

a)

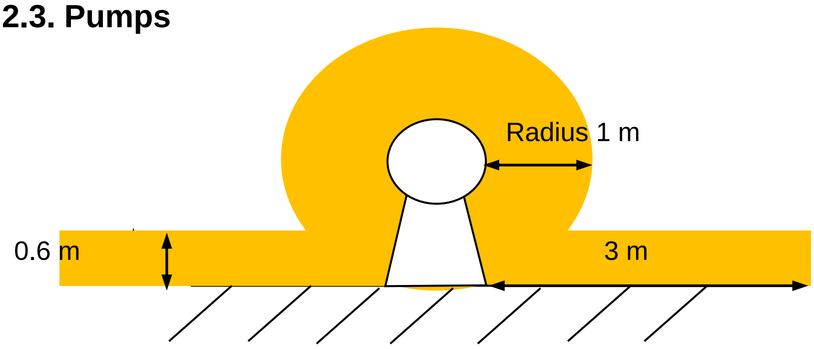



**1. 2.2. Mobile flexible tanks**

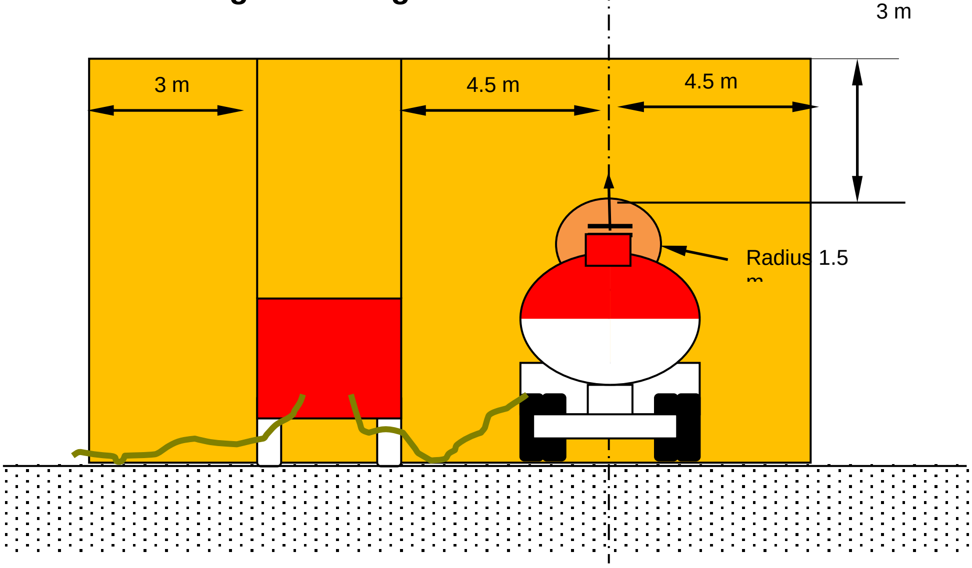
Type 0 zone: the interior of valves and filling/draining inlets/outlets
Type 1 zone: a sphere with 2 metre radius, centred on the valves and filling/draining inlets/outlets:
Type 2 zone: a parallelepiped with dimensions about 1.5 metres greater than type 1



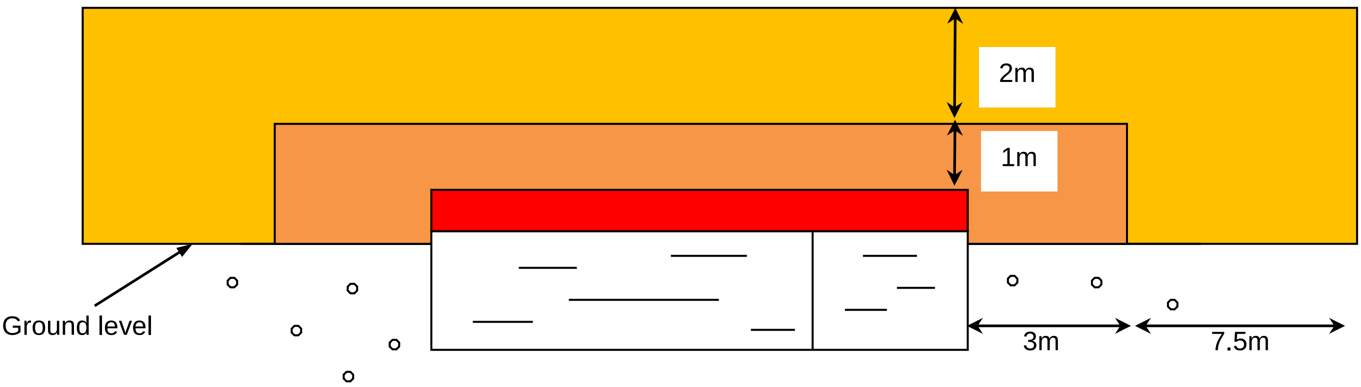
### ▪2.3. Pumps



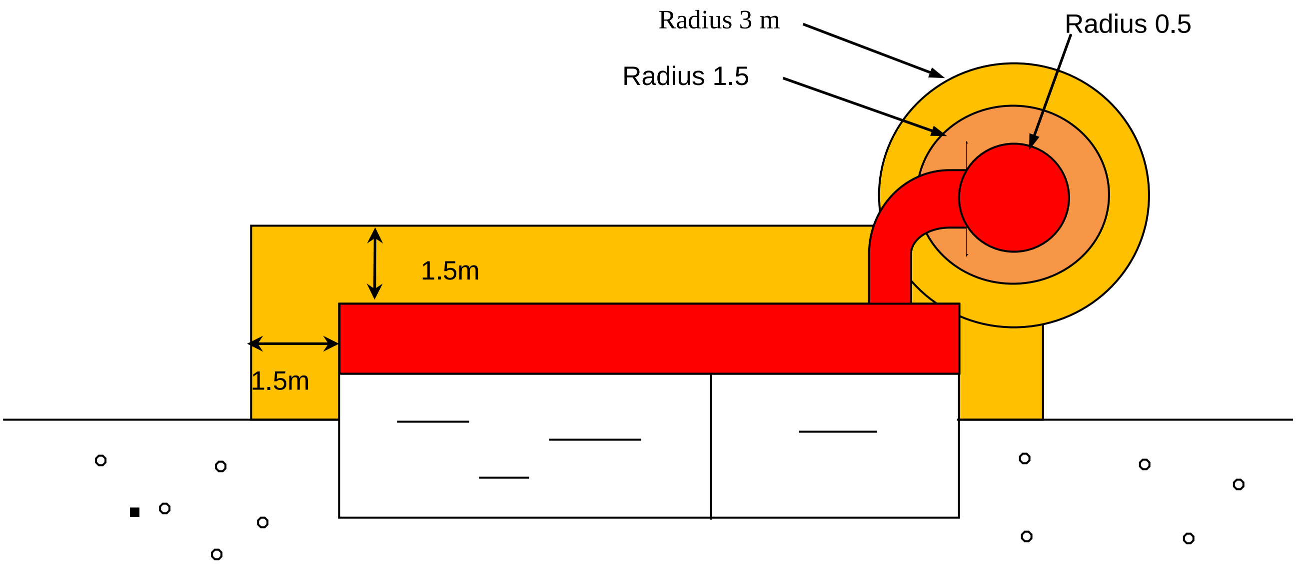

### ▪2.4. Loading/unloading of lorries



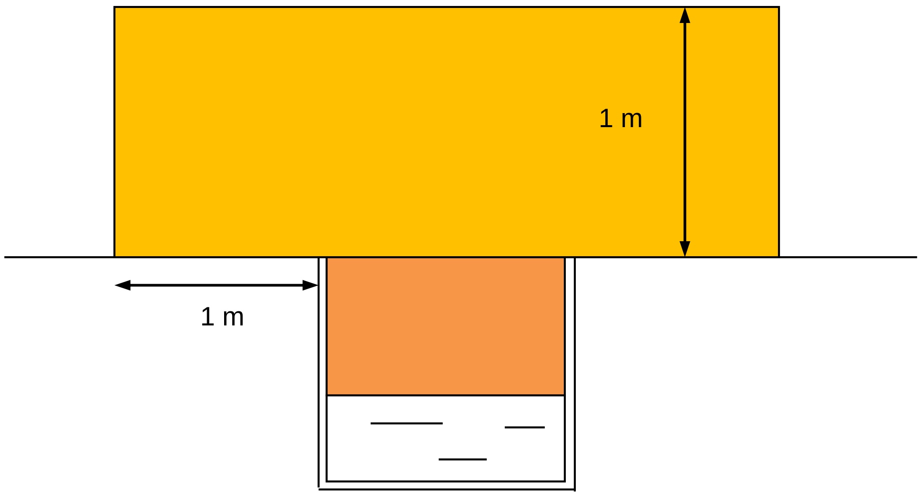

### ▪2.5. Uncovered hydrocarbon separator



### 2.6. Covered hydrocarbon separator




### 2.7. Hydrocarbon containment system




### 3. Modification of ATEX zones

The delineation of zones for a storage area, operations area or workshop should be systematically checked whenever changes are made to the facilities, whether these changes are temporary or permanent.

# ANNEX 2

## EQUIPMENT THAT CAN BE USED IN INTERNAL DANGER ZONES

### 1. Categories of equipment

The safety level of the equipment inside danger zones is clearly defined. Too restrictive an analysis can endanger the safety of persons. Too liberal a definition can have financial consequences resulting from the unjustified placement of equipment whose safety level is too high for the danger inherent to the zone where it will be used.

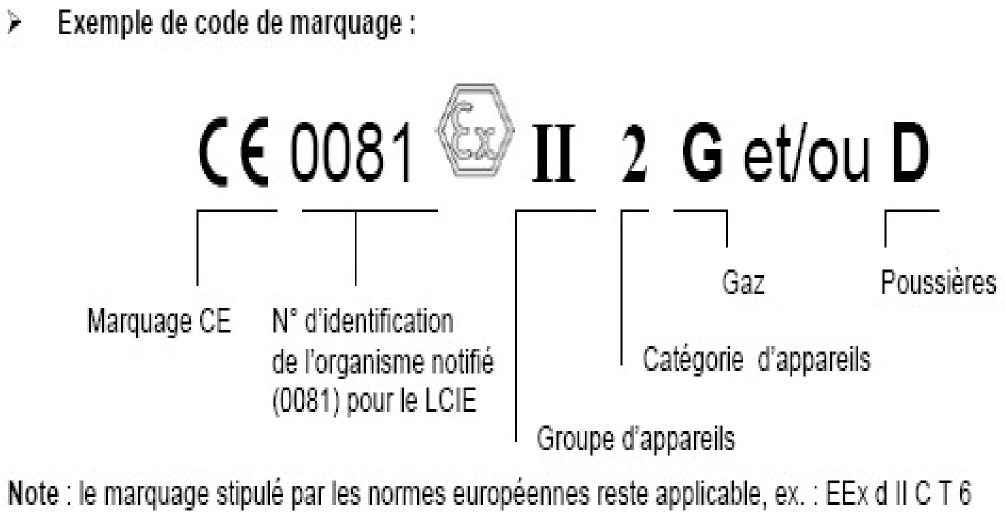
### 2. Classification

The following categories of Group II devices (industrial zones) must be used:
- Zone 0: Category 1 equipment, gas;
- Zone 1: Category 1G or 2G equipment;
- Zone 2: Category 1G, 2G or 3G equipment.

| Group II equipment category | Equipment categories | Substances | Level of protection | Danger zones |
|---|---|---|---|---|
| | 1 | Gas, vapour, mist, dust | Very high | 0 |
| | 2 | | High | 1 |
| | 3 | | Normal | 2 |

### 3. Marking of equipment

Example of marking code




Note: the marking stipulated in European standards remains applicable.
e.g. : Eex dII C T 6

# ANNEX 3

## DETERMINING THE SIZE OF THE HEAT FLOW ZONES

### 1. Levels of heat flow

This part of the guide deals with the effect of heat flows and high pressure due to a pool fire or an atmospheric explosion of a rigid receptacle containing hydrocarbons. As regards flexible tanks, only the heat effects from a pool fire the size of the retaining basin are considered. The effects of high pressure are not considered because there is no gas phase in a flexible tank. As regards above-ground tanks, account is taken of the effects of high pressure due to an atmospheric explosion of the tank and the heat flows caused by a fire in the basin or tank.
Three thresholds are established for heat flow:

- **3 kW/m²**: threshold of irreversible effects corresponding to the zone of significant danger to human life;

- **5 kW/m²**: - **3 kW/m²**: for human life: threshold of initial lethal effects corresponding to the zone of serious danger to human life;
for equipment and infrastructure: threshold of significant glass destruction;;

- **8 kW/m²**: for human life: threshold of significant lethal effects corresponding to the zone of extreme danger to human life;
For equipment and infrastructure: threshold of domino effect and of serious damage to structures.

Nothing should be kept in 8kW/m² zones apart from tank operation accessories (pump, filters, etc).
Furthermore, there should be no day-to-day facilities (sleeping quarters, catering, office) in 3kW/m² zones.

Three typical thresholds are established for the effects of high pressure from an explosion:

- **ΔP 50 mb**: propulsion of projectiles, 75% shattered glass and window frames, minor damage to building structures, damage to eardrums.
- **ΔP 140 mb**: Complete destruction of glass, partial collapse of building walls and roofs.
- **ΔP 200 mb**: severe damage to storage tank, building 50% destroyed, glass shattered, personnel thrown to the ground.

There is no high pressure effect with flexible tanks.

### 2. A few calculations

Calculation assumptions:

- The fire zone is of rectangular shape.
- The sides are of equal length.

| Length of the side (metres) | Range of heat effects (metres) | | |
|---|---|---|---|
| | 3 kW/m² | 5 kW/m² | 8 kW/m² |
| 10 | 30 | 25 | 20 |
| 15 | 35 | 30 | 25 |
| 20 | 40 | 30 | 25 |
| 25 | 40 | 35 | 25 |

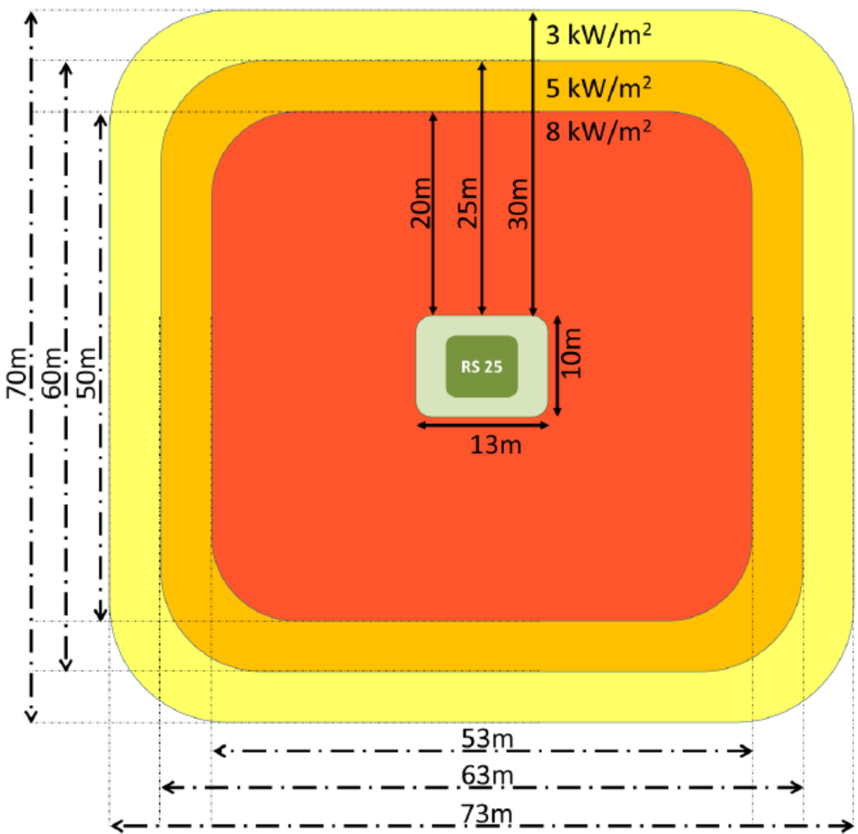
## 3. Examples

<u>FT 25 with retaining basin (translation of table below)</u>

| | | Length (metres) | Width (metres) |
|---|---|---|---|
| Dimensions of FT and basin | Flexible tank | 7 | 6 |
| | Retaining basin | 13 | 10 |
| Distance (m) of heat effects at thresholds for FT 25 in its basin | Threshold 8 kW/m² | 20 | 20 |
| | Threshold 5 kW/m² | 25 | 25 |
| | Threshold 3 kW/m² | 30 | 30 |
| | | | |

<u>RS 25 avec sa cuvette de rétention</u>

| | | Longueur (m) | Largeur (m) |
|---|---|---|---|
| Dimensions RS et cuvette | Réservoir souple | 7 | 6 |
| | Cuvette de rétention | 13 | 10 |
| Distance (en m) d'effets thermiques aux seuils pour un RS 25 dans sa cuvette | Seuil 8 kW/m² | 20 | 20 |
| | Seuil 5 kW/m² | 25 | 25 |
| | Seuil 3 kW/m² | 30 | 30 |

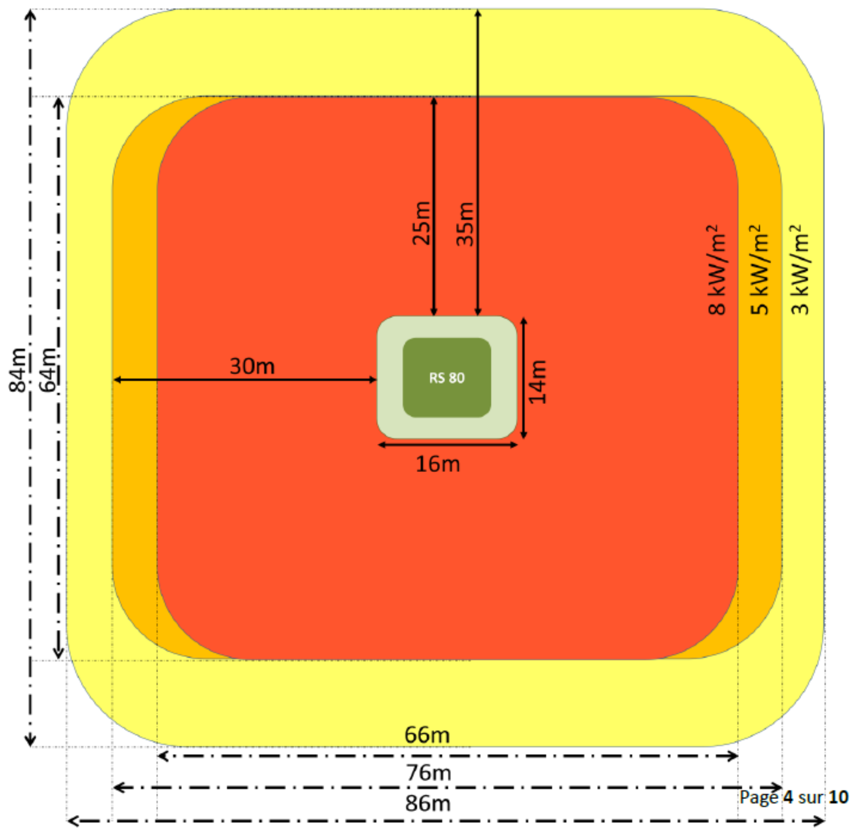


FT 80 with retaining basin (translation of table below)

| | | Length (metres) | Width (metres) |
|---|---|---|---|
| Dimensions of FT and basin | Flexible tank | 10 | 9 |
| | Retaining basin | 16 | 14 |
| Distance (m) of heat effects at thresholds for FT 80 in its basin | Threshold 8 kW/m² | 25 | 25 |
| | Threshold 5 kW/m² | 30 | 25 |
| | Threshold 3 kW/m² | 35 | 35 |

RS 80 avec sa cuvette de rétention

| | | Longueur (m) | Largeur (m) |
|---|---|---|---|
| Dimensions RS et cuvette | Réservoir souple | 10 | 9 |
| | Cuvette de rétention | 16 | 14 |
| Distance (en m) d'effets thermiques aux seuils pour un RS 80 dans sa cuvette | Seuil 8 kW/m2 | 25 | 25 |
| | Seuil 5 kW/m² | 30 | 25 |
| | Seuil 3 kW/m² | 35 | 35 |

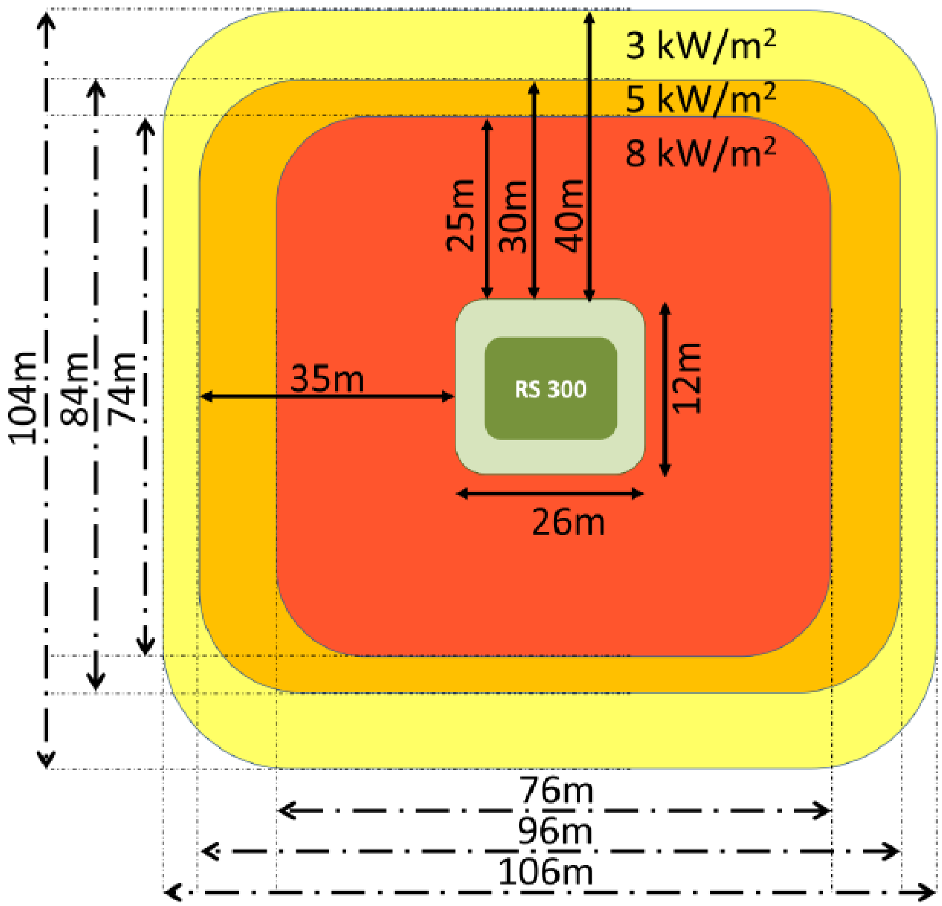


FT 300 with retaining basin (translation of table below)

| | | Length (metres) | Width (metres) |
|---|---|---|---|
| Dimensions of FT and basin | Flexible tank | 18 | 14 |
| | Retaining basin | 26 | 24 |
| Distance (m) of heat effects at thresholds for FT 300 in its basin | Threshold 8 kW/m² | 25 | 25 |
| | Threshold 5 kW/m² | 35 | 30 |
| | Threshold 3 kW/m² | 40 | 40 |

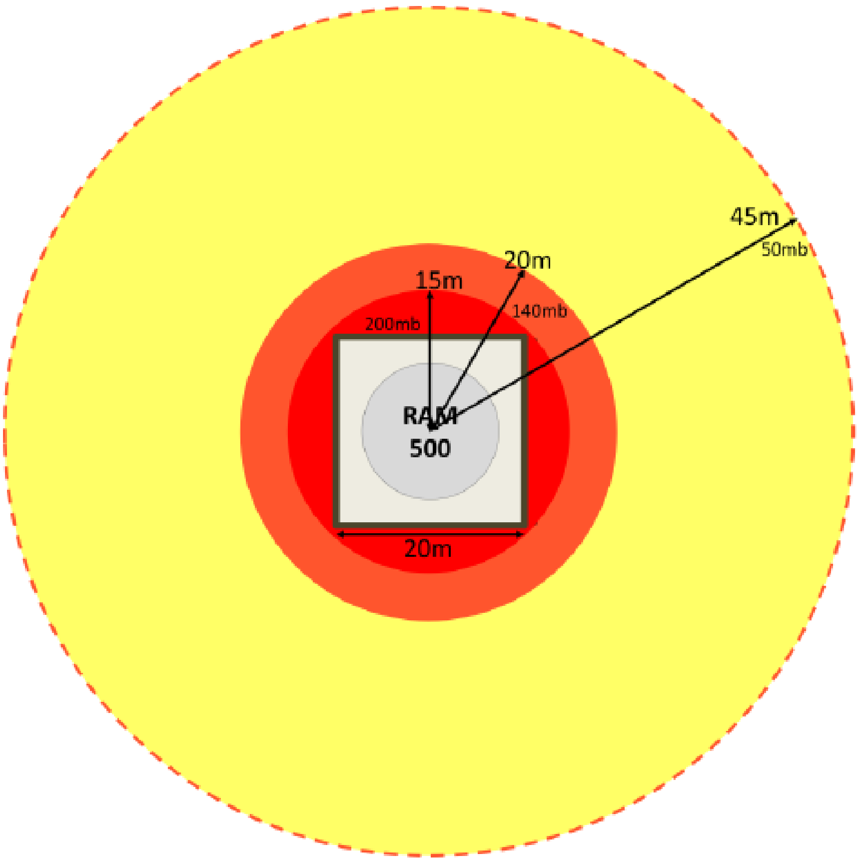
RS 300 avec sa cuvette de rétention

| | | Longueur (m) | Largeur (m) |
|---|---|---|---|
| Dimensions RS et cuvette | Réservoir souple | 18 | 14 |
| | Cuvette de rétention | 26 | 24 |
| Distance (en m) d'effets thermiques aux seuils pour un RS 300 dans sa cuvette | Seuil 8 kW/m2 | 25 | 25 |
| | Seuil 5 kW/m² | 35 | 30 |
| | Seuil 3 kW/m² | 40 | 40 |



<u>Evaluation des effets de surpression dus à une explosion de bac atmosphérique :</u>

Pour ce calcul, la modélisation des effets de surpression dus à une explosion de bac atmosphérique faite par le GTLDI (Groupe de Travail Dépôt Liquides Inflammables) a été utilisée. Il existe de nombreuses modélisations des effets de surpression donnant des résultats différents mais l'ordre de grandeur reste le même (étude INRS). La modélisation ci-dessous a pour hypothèse de base un RAM 500 vide non dégazé de 15 mètres de diamètre pour 3 mètres de haut à la pression atmosphérique standard au niveau de la mer (1013 hPa).




<u>Assessing the effects of high pressure due to an atmospheric tank explosion</u>:

This calculation uses the modelling of the effects of high pressure due to an atmospheric tank explosion done by the GTLDI (*Groupe de Travail Dépôt Liquide Inflammables* or Flammable Liquid Depot Working Group). There are many modellings of the effects of high pressure, giving different results, but the order of magnitude is the same (INRS study). The modelling shown is based on an empty RAM 500, not degassed, 15-metre diameter, 3 metres high, with standard sea-level atmospheric pressure (1013 hPa).

**ANNEX 4**

**DETERMINING THE QUANTITY OF SPECIFIC FIREFIGHTING ASSETS**

## 1. First response assets

### 1.1. Positioning and calculation of the number of extinguishers

Managers must take the necessary decisions to ensure that fires are quickly and effectively doused in the interests of their staff and infrastructure. The initial response will involve the use of fire extinguishers, which must be in good operating condition and present in sufficient numbers. If the premises present any special fire risks, they must be equipped with extinguishers whose number and type are commensurate with the assessed risk.
The number, location and type of extinguishers to be installed is established on the basis of an inventory of those locations where a specific activity is carried out, independent of the general protection of the site, in the interests of rapid response.

### 1.2. Basic equipment

In the context of first response, the basic unit is one 9 kg ABC powder extinguisher (or one 9 litre foam extinguisher, or three 5 kg CO2 extinguishers) for a basic zone, i.e. a maximum surface area of 200 $m^2$.

The methodology is established as follows:
1st operation: identify those zones where the activity being carried out necessarily involves POL products (storage, pump units, filtering operations, POL workshops, industrial water systems, POL vehicle parking areas, etc).
2nd operation: identify those zones where the same class of fire predominates, and where all parts communicate.
3rd operation: differentiate communicating from non-communicating zones (non-communicating zones are areas separated by obstacles or partitions which prevent movement from one to the other with an extinguisher to put out a fire).
4th operation: equip each basic zone (200 $m^2$ floor area, or each fraction of 200 $m^2$ if the total area is equal to or less than 200 $m^2$) with a basic unit.
In every case, facilities should include a minimum of two basic units.

### 1.3. Additional equipment

In areas presenting specific risks (POL workshops, above-ground storage, multiple handling operations, pipes, pump units, overpressure/leakproofness devices, etc), the basic equipment must be supplemented by additional assets.

For the above-ground storage of flammable liquids, each fraction of a 200 $m^2$ area must be equipped as follows:

| Quantity of flammable liquids | Action |
|---|---|
| Less than 500 litres | No additional equipment |
| Between 501 and 2,500 litres | One 9 kg ABC powder extinguisher |
| Between 2,501 and 5,000 litres | Two 9 kg ABC powder extinguishers |
| More than 5,000 litres | Two 9 kg ABC powder extinguishers and one 50kg ABC powder extinguisher on wheels. |

In zones where hydrocarbon transfer operations take place or when two communicating zones are involved, an additional 50 kg extinguisher must be put in place.

When one zone has to be provided with additional equipment several times, only the most restrictive solution should be chosen. However, all hazards or risks that are 10 metres or more from each other shall be treated independently.

Local dangers may exist, especially in POL workshops,  and additional equipment shall be provided for these areas.

Regardless of the configuration, extinguishers must always be placed less than 5 metres from the danger and less than 1.2 metres above the floor.   They must remain accessible should a danger arise in the area they are intended to protect.

## 2. Second response assets

These assets must be provided whenever storage exceeds 200 $m^3$ in order to:

- prevent a fire from spreading outside the depot;
- save fuel stocks not affected by the incident.

### 2.1. Emulsifier and water reserves

The method is based on the calculation of an emulsifier application rate determined by means of a series of tests. This rate can be increased depending upon the time required to render the assets operational, the accessibility of the fire and the emulsifier being used.

Using these assets, it must be possible to extinguish, within a period of 20 minutes, a fire in the retaining basin of the largest tank present on the site. They shall be appropriately supplemented by other assets using water to cool down adjacent facilities.

### 2.2. Choice of emulsifier

AFFF-type emulsifiers (Class I emulsifiers) are preferred because they are more effective. The fire attack rules, product concentrations and rates of application for this type of emulsifier limit the quantities of water used as compared with a classic emulsifier. The concentration rate of AFFF-type emulsifiers is compatible with the proportioners used for ordinary foams and, contrary to classic foams, spreading of the film does not depend on the equipment being used.

### 2.3. Determination of volumes and flow rates

In the example given below, an application rate of 3.0 l/$m^2$/min and a concentration of 3% with the use of an AFFF emulsifier have been established.

The requirements are determined by means of a test on the concrete basin of the largest tank present on the site.

- The surface area (S) of the retaining basin needs to be determined.
- The mix rate (Dm) is equal to 3xS.
- The emulsifier flow rate (De) is equal to 3% x Dm.

Water and emulsifer requirements are 20 times the flow rates calculated (extinguishment of the fire in 20 minutes).

Sample calculations

| | | | |
|---|---|---|---|
| Surface area of retaining basin | 100 $m^2$ | 200 $m^2$ | 600 $m^2$ |
| **Application rate** | **3.0** | **3.0** | **3.0** |
| Mix rate (Dm) | 300 litres/min | 600 litres/min | 1,800 litres/min |
| Emulsifier flow rate (De) | 9 litres/min | 18.0 litres/min | 54.0 litres/min |
| Duration of extinguishing (minutes) | 20 | 20 | 20 |
| **Water requirement** | **6 $m^3$** | **12 $m^3$** | **36 $m^3$** |
| **Emulsifier requirement** | **180 litres** | **360 litres** | **1,080 litres** |

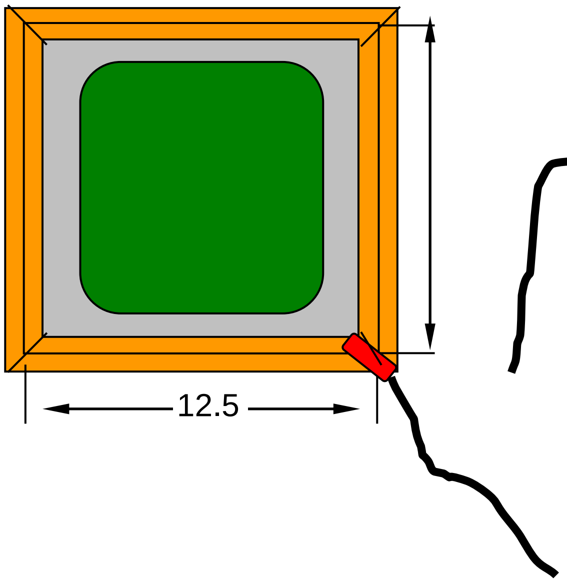
## 2.4. Positioning of emulsifier

Emulsifiers are positioned at corners in order to permit flow in both directions.

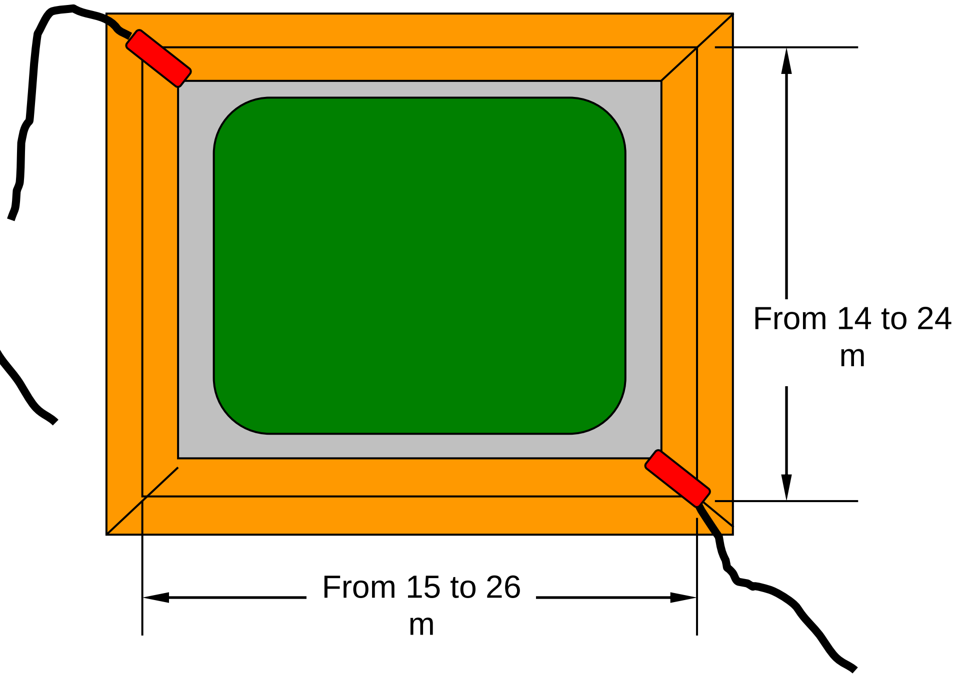
One emulsifier shall be positioned on retaining basins whose area is less than 200 $m^2$.

Two emulsifiers for each storage tank shall be positioned on retaining basins whose area is greater than 200 $m^2$. They shall be placed at opposite sides of the tank.

**Small tanks**




**Large tanks**



# ANNEX 5

## FIRE SAFETY LEVELS FOR FUEL DEPOTS IN OPERATION

A safety level is assigned to a POL depot only if all the following actions are actually carried out.

| Actions to be carried out \ Level | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Personnel trained to deal with hydrocarbon fire risks | X | X | X | X | X |
| Study of site layout (slope, environment) | X | X | X | X | X |
| Site access is controlled | X | X | X | X | X |
| Safety personnel always on duty | X | X | X | X | X |
| Containment measures with fire resistance of more than 1 hour | | X | X | X | X |
| Firefighting procedures | | X | X | X | X |
| First response assets | X | X | X | X | X |
| Second response assets | | X | X | X | X |
| Third response assets | | X | X | X | X |
| No domino effect towards the exterior | | | X | X | X |
| No domino effect between containers | | | | X | X |
| Eye protection | | | X | X | X |
| Fire drill (at least once a year) | | | X | X | X |
| Protection against heat radiation | | | | X | X |
| Used of buried tank | | | | | X |

NATO does not accept a safety level of less than 1. In such a case, the Command must take the steps required to remedy the safety deficit (simplified survey of on-site risks (para 5), emergency training, guards, etc).

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