RECOMMENDATION OF THE C.T.E.F.

LIST OF THE TYPE OF LEAKAGE INCIDENTS WHICH COULD OCCUR ON EQUIPMENT CONTAINING HYDROFLUORIC ACID

Second Edition

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This document can be obtained from : CTEF - Avenue E. Van Nieuwenhuyse 4
Box 2 - B -1160 BRUXELLES

PREFACE

Hydrogen Fluoride (HF) is essential in the chemical industry and there is a need for HF to be produced, transported, stored and used.

The HF industry has a very good safety record ; nevertheless, the European HF producers, acting within CTEF have drawn up this document to promote continuous improvement in the standards of safety associated with HF handling.

This Recommendation is based on the various measures taken by member companies of the CTEF.

It in no way is intended as a substitute for the various national or international regulations, which should be respected in an integral manner.

It results from the understanding and many years experience of the HF producers in their respective countries at the date of issue of this particular document.

Established in good faith, this recommendation should not be used as a standard or a comprehensive specification, but rather as a guide which should, in each particular case, be adapted and utilised in consultation with an HF manufacturer, supplier or user, or other experts in the field.

It has been assumed in the preparation of this publication that the user will ensure that the contents are relevant to the application selected and are correctly applied by appropriately qualified and experienced people for whose guidance it has been prepared.

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The contents of this recommendation are based on the most authoritative information available at the time of writing and on good engineering practice, but it is essential to take account of appropriate subsequent technical developments or legislative changes. It is the intent of the CTEF that this guideline be periodically reviewed and updated to reflect developments in industry practices and evolution of technology. Users of this guideline are urged to use the most recent edition of it, and to consult with an HF manufacturer before implementing it in detail.

This edition of the document has been drawn up by a Working Group "Storage, Transport and Safety" to whom all suggestions concerning possible revision should be addressed through the offices of CTEF. It may not be reproduced in whole or in part without the authorisation of CTEF or of members companies.

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LIST OF THE TYPE OF LEAKAGE INCIDENTS WHICH COULD OCCUR ON EQUIPMENT CONTAINING HYDROFLUORIC ACID

1 INTRODUCTION

The safety requirements in the operation of plants or equipment designed to produce, handle, store or transport HF necessitates a particular care in the choice of :

- materials of construction,

- codes and standards appropriate to the specification and design,

- properly defined procedures for construction, receipt and inspection of components, operation and maintenance.

It is of equal importance that a full study is carried out of the hazards involved on the plant or its equipment, in order to avoid in all practical aspects, the likelihood of incidents and in all cases to be able to limit their consequences.

In each situation this study should take into account the specific character of each plant involving its technical expertise, the management system and the methods of operation used in the plant concerned. These needs, which are specific to each individual installation means that it is not possible to lay down detailed rules for a particular safety study, which covers the multiplicity of types of plants which exist or could be built in the future. It is nonetheless possible to lay down a certain number of standard elements which can be used for the detailed safety case. This document proposes to lay out a typical list of hazards which could lead to loss of containment of HF and which could occur on installations containing, using or transporting HF. It should be considered, however, only as a guide which provides the first step on the detailed assessment of the risks which could be associated with a potential loss of containment. It is not a substitute for a detailed study for any installation which takes into account the specific characteristics of the equipment actually installed.

2 LEAKAGE CIRCUMSTANCES ON PLANT EQUIPMENT AND MATERIALS

The table provided hereafter gives a listing of the leakage circumstances which could occur on equipment currently used in the industry to contain, transport or to handle HF.

For each type of component or equipment, the table suggests the equivalent hole size which might be associated with the circumstances of the leak, the magnitude of the frequency which might be expected for this type of leakage, and the reference to the measures for containment of the risk.

This table has been established taking into account the experience obtained with typical installations in the past, and taking into account the specific high standards normally applied on all equipment handling hydrofluoric acid.

Available statistics for the failure rate of engineering equipment constructed in conformity with the strictest codes of design and construction, the precautions taken at the design stage, the choice of materials and the quality control during construction of equipment and associated pipework, the safety margin maintained between the design pressure and the maximum operating pressure, the tripping of various safety devices, all render highly improbable the failure of plant items with particularly grave consequences. For example, the correct application of standards should lead to a situation where catastrophic failure of a storage tank is not considered to be a feasible incident. As far as the failure of a branch or of pipework associated with a storage is concerned, the magnitude of failure depends on the overall arrangement and geometry of storage accessories.

ACCIDENT SITUATIONS IN HF PRODUCING OR CONSUMING FACTORIES : CORRECTIVE MEASURES

EQUIPMENT CONCERNED	NATURE OF INCIDENT	PROBABLE CAUSE OF INCIDENT	EQUIVALENT HOLE SIZE	FREQUENCY	EMERGENCY PROCEDURES
1. Valves (*)	1.1 Leak from a packed gland and/or a bellow	- Inadequate tightening; - packing has become oval ; - deformation of spindle etc.	Limited by the construction. Accepted as being equivalent to the leakage on a gasket from a tongue and groove flange (cf 1.2).	Rare	- Re-tighten - Open the valve fully to use the back-seating arrange-ment. - If venting down is possible : • Repack the packed gland • Change the valve bonnet - If venting down is not possible rapidly : • Call a specialist resource • Plastic bag
	1.2 Leakage on a bolted flange	Defect in the gasket or the flange face of the body or bonnet joint, or on the inlet and outlet flanges	For flat faced flanges the equivalent section for the thickness of joint displaced between two adjacent bolts can be taken up to 50 mm^2. On a tongue and groove flange one should take a failure of the gasket over a width of 1 mm with bearing in mind the engineering tolerances of the tongue and groove flange.		- Carefully re-tighten the joint - Gas tight box - Enclose in a plastic bag - Vented box - Call a specialist resource

(*) WARNING :Special attention must be paid in the inspection of the valves before installation, in order to verify that the supplier has used correct specified materials of construction and to check the absence of any apparent defect in all parts which will be in contact with HF.

EQUIPMENT CONCERNED	NATURE OF INCIDENT	PROBABLE CAUSE OF INCIDENT	EQUIVALENT HOLE SIZE	FREQUENCY	EMERGENCY PROCEDURES
	1.3 Porosity in the valve body or bonnet	Concerns particularly a cast valve : foundry defect.	This is equivalent to a hole size of 1.0 mm diameter	Extremely rare bearing in mind the specification and inspection on receipt of valves	- Drive in plug - Cast in cement - Hammer affected area closed - Use of self tapping screw
2. Piping	2.1 Leakage from a bolted flange	Defect of the gasket or the flange faces	Identical to 1.2	Rare	- Tighten the joint with care - Gas tight box - Enclose in a plastic bag - Vented box - Call a specialist resource.
	2.2 A hole in the pipework wall	- Defect in the material or at a weld. - Internal corrosion or erosion. - External corrosion.	This is equivalent to a hole size of 2 mm dia. possibly increasing to 3 mm by erosion/corrosion.	Very rare bearing in mind the material specifications, procedures for welding and piping inspections.	Isolate the section of pipework and then : Pipe clip, graphite cement, enclose in plastic bag, sealed box, call specialist resource, apply self tapping screw or use plug driven in.
	2.3 A leakage on a connection by failure of the flange or rupture of the pipework.	Expansion of liquid trapped between two closed valves.	Depends on the overall arrangement of flange gasket and bolting.	Very rare if equipment is installed to limit any pressure rise. Rare when one rely only on operating instructions.	- Isolate the section of pipework. - Re-tighten the flanges with care. - Sealed box. - Call a specialist resource.

EQUIPMENT CONCERNED	NATURE OF INCIDENT	PROBABLE CAUSE OF INCIDENT	EQUIVALENT HOLE SIZE	FREQUENCY	EMERGENCY PROCEDURES
			If deformation of the flange is not possible and there is rupture of the pipework, one should assess on the basis of effective instantaneous loss of contents, except for piping of increased lengths for which a study needs to be done of the time taken to vent down and lose all of the contents.	Extremely rare.	
	2.4 Rupture due to lack of flexibility.	Defect at the design stage. Installation of supports or additional anchor points during maintenance operations for example.	Full pipe diameter. (Take into account in the calculation the loss of liquid from the two sections of pipe).	Extremely rare if one is following the appropriate design standards	- Attempt at all costs to isolate the defective section. - Trap the leakage between two clamps or collars.
	2.5 Rupture due to external impact.	Impact by a crane or some other maintenance equipment or for example a tipper lorry in the upright position etc...	50% of the cross section.	Extremely rare if provisions are taken to protect the pipe.	As above.
			Full pipe diameter (Taking into account both ends of the fractured pipe).	Extremely rare to be studied on a case by case basis.	

EQUIPMENT CONCERNED	NATURE OF INCIDENT	PROBABLE CAUSE OF INCIDENT	EQUIVALENT HOLE SIZE	FREQUENCY	EMERGENCY PROCEDURES
	2.6 Piping failure at a hot point on liquid line	Excessive external heat, exit of a compressor, internal reaction, etc...	Leakage equivalent to full pipe diameter. (Taking into account both ends).	To be studied case by case but extremely rare if the correct engineering standards are followed	Attempt at all costs to isolate the fault section, in particular from the storage.
	2.7 Damage to instrument connection	External impact	Diameter of the connection	Very rare assuming that instrument connections are installed according to process specifications.	
3. Storage Vessels (and on-site transport containers).	3.1. Leakage at the gasket on the flanges of the branches.	Defect in the gasket or on the flange face.	Identical to 1.2.	Rare	- Transfer the contents as rapidly as possible. - Tighten the joint with care. - Sealed box. - Close in a plastic bag. - Vented box. - Call specialist resource.
	3.2 Failure of a branch.	Defect in the material or at a weld. Internal corrosion or erosion. External corrosion	For the design case one assumes a hole size equivalent to 2 mm dia,	Extremely rare	- Transfer the contents as rapidly as possible. - Drive in plug. - Pipe clip. Call a specialist resource.
	3.3 A hole in the vessel wall	Defect in the material or at a weld. Internal corrosion or erosion. External corrosion	possibly increasing to 3 mm with corrosion / erosion effects		-Transfer the contents as rapidly as possible. -Lower the pressure. -Clamp the leakage withe the use of a screwed clamp of shaped pad.

EQUIPMENT CONCERNED	NATURE OF INCIDENT	PROBABLE CAUSE OF INCIDENT	EQUIVALENT HOLE SIZE	FREQUENCY	EMERGENCY PROCEDURES
	3.4 Vessel failure due to reaction with water.	Contamination with water.	To be studied case by case.	Extremely rare.	-Transfer and isolate the vessel as rapidly as possible. -Then use a conical wedge. -Call a specialist resource.
4. Transfer Equipment	4.1 Leakage on a joint or a bolted flange.	Defect in the joint or the flange face.	Identical to 1.2	Rare	-Stop the HF transfer. -Depressurise and drain.
	4.2 Leakage in the pipe wall	Defect in the material or at a weld. Internal corrosion or erosion. External corrosion.	One can assume a hole size equivalent to 2mm dia, possibly increasing to 3 mm by erosion / corrosion.	Rare	-Isolate the section of defective equipment or piping which is providing the means of transfer. -Vent down the transfer equipment to an absorption system. -Purge with nitrogen or dry air.
	4.3 Rupture	Due to abnormal stress or movement of the transport container.	Full pipe diameter.	Very rare.	-Isolate as rapidly as possible.
5. Rotating Machinery	5.1. Leakage at the gland on the pump rotor.	Deterioration in the sealing arrangement or loss of fluid in the seal.	To be studied case by case	Very rare	-Stop the machine and isolate. Depressurise and drain.
	5.2. Cavitation	Cavitation. Two phase flow	To be studied case by case	Very rare	-Isolate then vent the machine down to the treatment plant.
	5.3. Liquid hammer in the pipework		To be studied cas by case	Very rare if proper process designed	

DISTANCES FROM THE POINT OF ISOLATION

N°	ARRANGEMENT	DEFINITION	COMMENTS	CONDITIONS	PROPOSAL
1		Manhole	Integral with the storage cylinder construction	Length of the branch is less than its diameter	Diameter not taken into account.
2		Extended branch	d_1 diameter of the branch of length l_1.	l_1 greater than 5 d_1	d_1 taken into account
3		Short branch	d_1 diameter of a short branch of length l_1. d_2 diameter of the pipework of length l_2.	l_1 lower than 5 d_1	l_1 not taken into account l_2 taken into account
4		Automatic valve on an extended branch.	V_1 isolation valve V_2 automatic valve	l_2 greater than 5 d	l_1 not taken into account l_2 taken into account
5		Automatic valve on a short branch.	V_1 isolation valve V_2 automatic valve	l_2 lower than 5 d_2 The short branch can be specially protected by the use of specific measures (metallic or reinforced gasket).	Recommended : l_1 not taken into account l_2 not taken into account
6		Internal automatic valve	V_1 isolation valve d_2 diameter of the pipework of length l_2.	Disadvantage : maintenance impossible on the internal automatic valves whilst on line.	Recommended : l_2 not taken into account