Research report

Atmospheric pressure above-ground storage tank loss of containment incidents involving petroleum, petroleum products, or other fuels

energy institute

RESEARCH REPORT: ATMOSPHERIC PRESSURE ABOVE-GROUND STORAGE TANK LOSS OF CONTAINMENT INCIDENTS INVOLVING PETROLEUM, PETROLEUM PRODUCTS, OR OTHER FUELS

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Contents

LIST OF TABLES, FIGURES AND PHOTOGRAPHS

List of tables

List of figures

List of photographs

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1 INTRODUCTION

Several major accidents resulting in atmospheric pressure AST LOC have occurred at bulk petroleum, petroleum products, or other fuels storage facilities worldwide. Often, incidents have occurred following a sequence of operational deviations, and some have resulted in catastrophic destruction of ASTs and LOCs, loss of the liquid inventory, including petroleum, petroleum products, or other fuels, or other hazardous liquids. Major accidents have detrimentally affected operating companies' reputation and market value, as well as resulting in fatalities and severe environmental impact.

Operators of petroleum, petroleum products, or other fuels bulk storage facilities, such as petroleum refineries, distribution terminals, crude oil import/export terminals and crude oil and gas separation plants, should identify and risk assess credible worst case scenarios in their safety reports required by NA *COMAH regulations* as part of their demonstration that all measures necessary (AMN) are being taken for prevention and mitigation of major accident hazards (MAH). Operating companies should use those risk assessments to identify risk reduction measures to control their operations.

In the UK and elsewhere, CAs and/or AHJs have suggested that CTF from ASTs, e.g. arising from a LOC such as sudden emptying of an AST via tank or pipework fracture, could cause secondary containment bunds to breach or overtop. Indeed, such CTFs have occurred in industry worldwide, and these incidents have the potential to result in significant environmental impact, asset loss and threats to life safety.

Thus there is a need to identify the likelihood of AST LOC, especially CTFs, and the likelihood that an incident will breach or overtop secondary containment, as well as the factors that influence their occurrence. These data may assist operating companies in determining whether there is an evidence-based need to better protect ASTs and to understand the potential demands on secondary and tertiary containment systems.

Moreover, it would be beneficial to understand through sensitivity analysis whether the determined frequencies of CTFs are likely to apply to ASTs in UK petroleum, petroleum products, or other fuels bulk storage facilities given the design methods, standards, metallurgies and ambient conditions typically in use.

This Research Report aims, therefore, to provide an evidence base to inform operators of petroleum, petroleum products, or other fuels bulk storage facilities about the risk of AST LOC, especially CTF.

The aims of the research project documented in this Research Report were to:

1. Critically review, interrogate and analyse existing data sources (e.g. literature and databases) on reported cases of AST LOCs, including those that are considered CTFs. Note that new data collection by operating company surveys was not in the scope of this research project.
2. Assess as far as possible from the available evidence, what proportion of reported AST LOCs are CTFs, and whether there is breach or overtop of secondary containment.
3. Identify as far as possible from the available evidence, what failure modes and failure causes have led to the AST LOCs, especially those primary failure modes relating directly to the AST and its appurtenances. In addition, assess as far as possible from the available evidence, the extent to which these failure modes and failure causes are likely to apply to UK facilities given the design methods, standards, metallurgies and ambient conditions in use in the UK rather than worldwide.

2 SCOPE

2.1 IN-SCOPE TANKS – TYPE

This Research Report applies to ASTs with the following characteristics and/or construction:

– operating at atmospheric pressure;
– vertical construction, and
– diameter ≥ 10 m.

These ASTs would typically comprise the following types:

– external floating roof tanks (EFRTs) (sometimes referred to as open-top floating roof tanks (OTFRTs));
– fixed roof tanks (FIXRTs) (often called 'cone roof' tanks);
– internal floating roof tanks (IFRTs) (including those with internal floating roofs of lightweight 'pan deck' construction, and those with internal roofs of a type normally associated with EFRTs), and
– those with geodesic domes (often EFRTs converted by the addition of domed roofs), but here are considered IFRTs.

This Research Report does not apply to the following AST types:

– horizontal construction (these tanks are excluded due to having insufficient liquid head to generate a significant LOC);
– pressurised storage tanks (for example, pressurised liquefied petroleum gas (PLPG) tanks), and
– refrigerated or cryogenic storage tanks (such as refrigerated liquefied petroleum gas (RLPG) and liquefied natural gas (LNG) storage tanks).

These tanks are characterised by special storage conditions which may or may not result in different failure modes and causes to ASTs; this together with the limited data available on these types of tank means they are not further considered in this Research Report.

2.2 LIQUID INVENTORY

This Research Report focuses primarily on petroleum, petroleum products, or other fuels stored in ASTs; most incident data reviewed involved these liquids due to the prevalence of such data. However, incident data involving other liquids stored in in-scope ASTs also were reviewed but with caution, since causative or mitigating factors might be the same or differ from those pertinent to petroleum, petroleum products, or other fuels. Consequently, the findings outlined in this Research Report apply mainly to petroleum, petroleum products, or other fuels; where known, AST failure modes and causes have been identified for other liquids.

2.3 INCIDENT CONSEQUENCES

This Research Report does not necessarily consider whether an AST LOC incident also resulted in a fire or explosion consequence due to ignition of the released liquid. Whilst many data sources do identify whether or not there was ignition (e.g. resulting in pool fires), the main objective of this study was to identify instances, failure modes and failure causes of AST LOCs that were CTFs, and whether they breached or overtopped secondary containment.

This Research Report recognises cases where the presence of an external fire was a factor in initiating an AST LOC.