TRANSPORT OF CO_2 BY SEA GOING VESSELS - SCENARIOS

Accident scenarios of seagoing vessels in transit consist out of LOC scenarios due to internal failure (e.g. leak of piping) or due external failure (e.g. collision).

The first group includes aspects like mechanical failure, material/construction errors, fire/explosions, failure of cooling system etc. which are not waterway related. Collision accidents on the other hand are related to a waterway.

The safety study will assess two possible LOC scenarios for the seagoing vessel:

1. A small leak

A leak in the cargo tank (5,000 m^3) with a diameter of 250 mm (10 inch) corresponding with a typical diameter of (un)loading connection.

2. A large leak

A leak in the cargo tank (5,000 m^3) with a diameter of 1100 mm (1.0 m^2).

These LOC scenarios were taken from the Protocol Risicoanalyse zee- en binnenvaart.

Modeling LOC scenarios seagoing vessels

The leak scenarios have been modeled with a leak model in Safeti-NL. The LOC scenarios have been modeled with a release height of 1 meter and a horizontal release direction.

All the effect distances of the scenarios have been calculated with a weather type F1.5 (steady atmosphere, low wind speeds), which is the most conservative for toxic scenarios, and D5 (normal atmosphere, higher wind speeds).

Modeling of LOC scenarios of liquid CO_2

The leak scenarios have been modeled with a pressure of 7 bara and a temperature of −50°C. Under these conditions the CO_2 is in liquid phase and solid (ice) formation will take place when a LOC scenario occurs (see also paragraph 2.1.4.2).

The LOC scenario of a tank will firstly drain liquid CO_2 until the liquid CO_2 level is lowered to the release height of the tank. At that moment, the tank will depressurize, the remaining liquid CO_2 in the tank starts evaporating and only vapor CO_2 will be released through the leak. The liquid CO_2 in the tank will cool down due to the evaporation of the CO_2. When the liquid CO_2 cools down to −78°C all the remaining CO_2 will instantly turn into solid CO_2.

It is assumed in the calculations that 2/3 of the inventory of the tank will be released before the remaining CO_2 turns into solid CO_2. This is based on the assumption that the leak of the tank is located at half the tank height and part of the CO_2 has to be evaporated to cool down the remaining liquid CO_2.

Part of the released liquid CO_2 will “rain” out from the CO_2 jet as solid CO_2 and sublimates from the water. This sublimation will cause locally, at the release location, a higher CO_2 concentration. However, the influence of the sublimating CO_2 is negligible compared to the release of gaseous CO_2. Therefore, this effect is not considered for horizontal releases and it is assumed that all the CO_2 will be released as vapor. This is a conservative assumption and the calculated effect is as a result larger than in reality.

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