

EURISG

European Industrial Sizing Group

EURISG Sizing Case Report

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Dispersion calculation for an
emergency discharge of ammonia gas
from a refrigeration system

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1 Task description

The dispersion for an emergency discharge of ammonia gas from a refrigeration system, located close to a residential district, shall be calculated (see Figure 1-1). The ammonia is discharged through the safety valve SV001 from the collector vessel B110 into the atmosphere.

The pressure of the ammonia inside the collector vessel increases due to a heat input and the gaseous phase is discharged into the environment through a vertical pipe. Constant side wind should be considered during the dispersion calculation.

In the following case, the ammonia concentration due to atmospheric dispersion shall be determined with the following objectives:

- (1) Determination of the explosion range in the environment of the outlet.
- (2) Calculation of the ammonia concentration at the factory fence, which is located in a distance of 100 m to the collector vessel (see Figure 1-3) and beyond up to a distance of 1 km.

Limit concentrations regarding the lower explosion limit and toxicity are publicly accessible. The specification for the discharge scenario is given in Table 1-1.

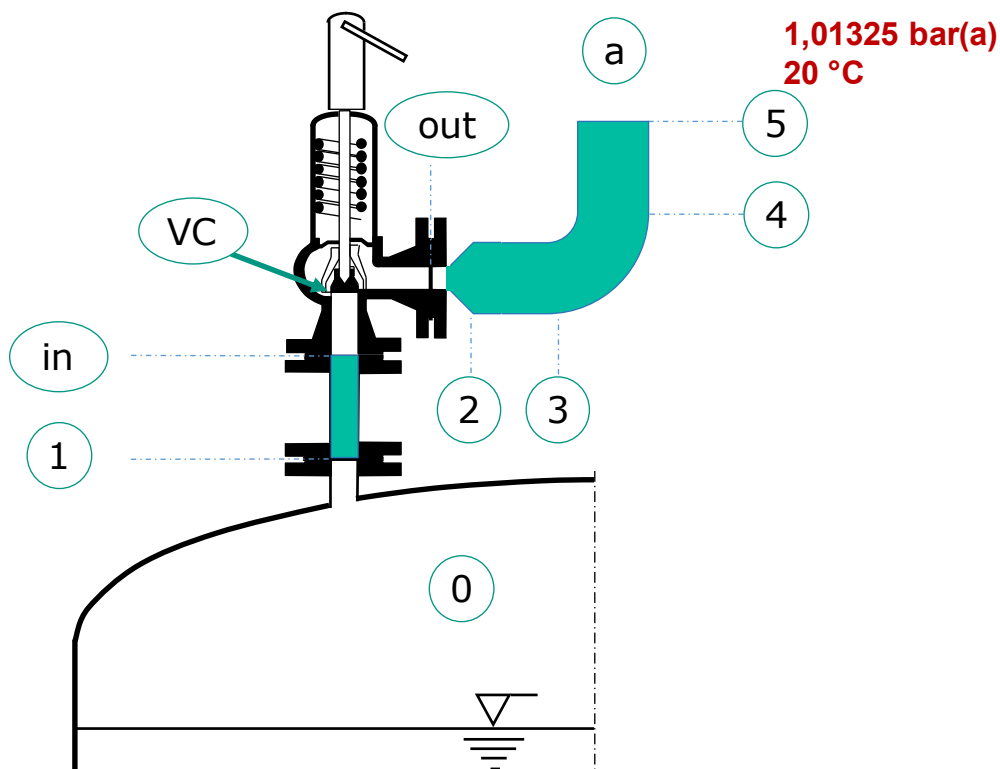


Figure 1-1: Isometry of the venting system

Table 1-1: Input parameters for the dispersion calculation

Property data:

Medium ammonia
 Physical state at operating conditions: condensing vapor

Isometry data:

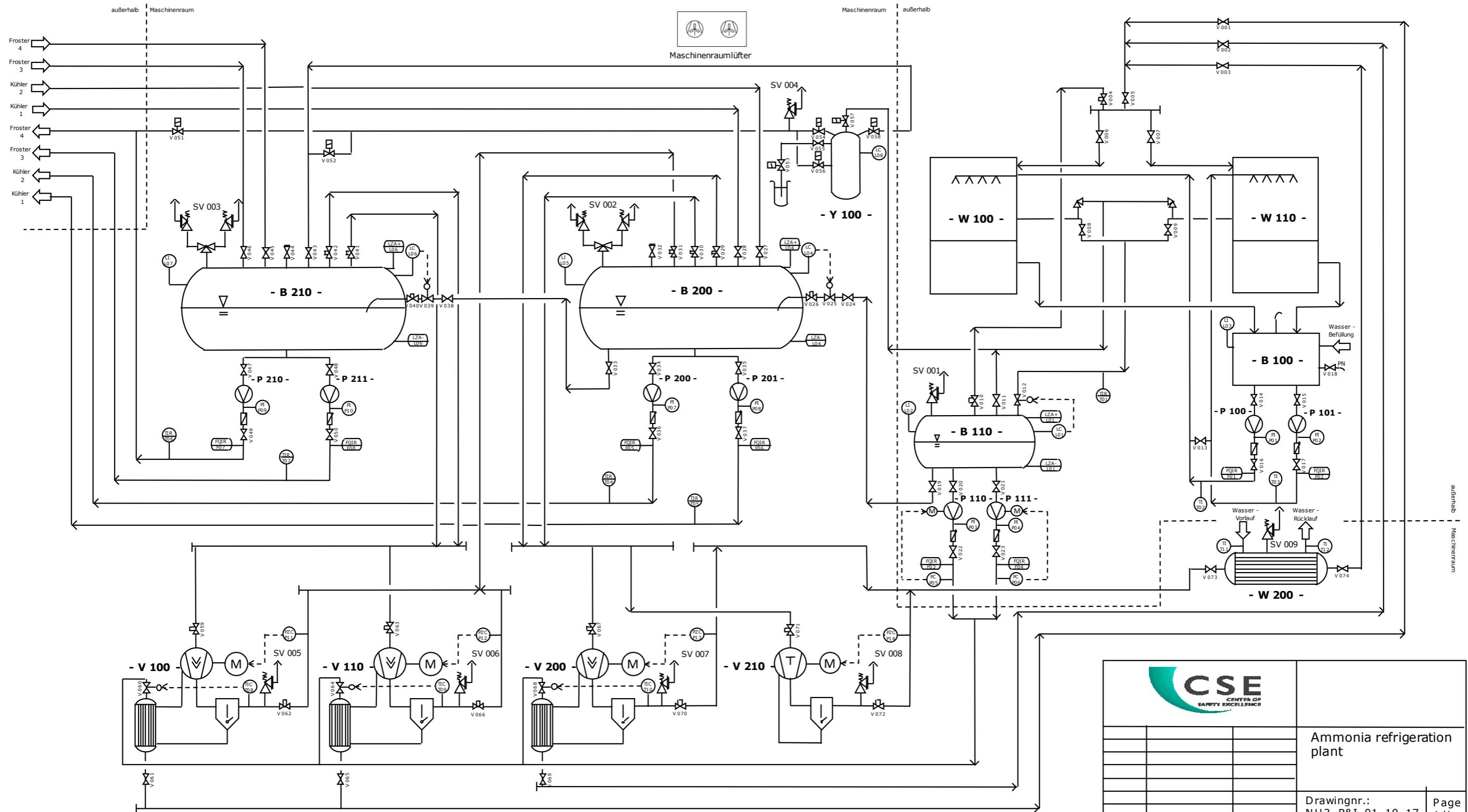
Inlet line diameter $d_{1,in}$: 28.5 mm
 Inlet line length $l_{1,in}$: 0.5 m
 Conical enlargement inlet diameter d_{out} : 43.1 mm
 Conical enlargement outlet diameter d_2 : 107 mm
 Conical enlargement length $l_{out,2}$: 102 mm
 Vent line diameter $d_{2,3}, d_{4,5}$: 107 mm
 Vent line length $l_{2,3}$: 0.898 m
 Vent line length $l_{4,5}$: 6 m
 Bent radius diameter ratio: 1.5
 Bent angle: 90°

Discharge data:

Set pressure p_{set} : 22 bar g
 Safety valve capacity SV001 $Q_{m,ammonia}$: 0,651 kg/s
 (based on the unrated discharge coefficient K_D)
 Height of discharge 8 m
 Mean building heights 6 m
 Emission time 1 hr

Environmental data:

Ambient pressure p_a : 1,01325 bar a
 Ambient temperature T_a : 20°C
 Average wind velocity (10 m height) w_a : 3 m/s



			Ammonia refrigeration plant	
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Figure 1-2: P&ID of the refrigeration plant

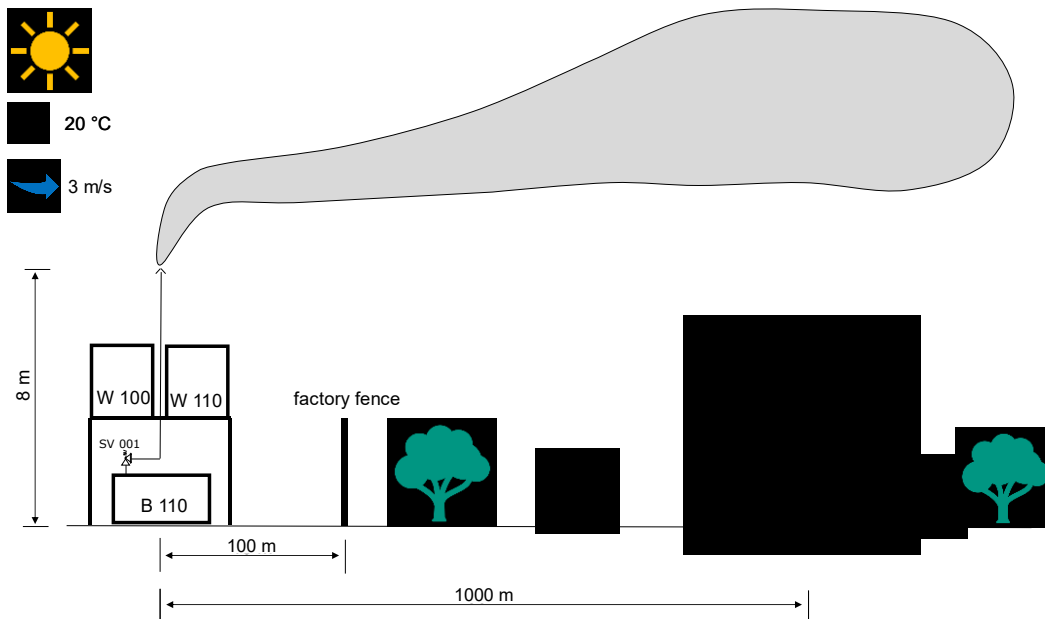


Figure 1-3: Scenario of discharge

2 Approach

In the following chapter the calculation approach for the dispersion calculation based on the chosen sizing scenario and considerations from Chapter 1 are presented.

2.1 Scenario boundary conditions

In the following sections, the boundary conditions relevant for this sizing case are shown. To estimate the jet propagation behind the vent line system of the safety valve SV001, the relieving conditions have to be determined at first, as input parameters for the dispersion calculation. Those are:

Blow down pressure p_0 : 25.2 bar a
Blow down temperature T_0 : 331.6 K

2.1.1 Medium

Only pure ammonia is discharged through the safety valve during the emergency relief of the collector vessel B110. In order to evaluate the hazard potential of ammonia or the mitigation consequences of an ammonia relief, several properties from the safety data sheet are needed [1]. Herein, the ammonia is labelled with the signal word "danger".

- Medium: Ammonia
- CAS-No.: 7664-41-7
- Molecular Formula: NH_3