WP5 Veiligheidsaspecten en risico's - HAZID studie, rapportage case 1: waterstof tankstation

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Aanleiding

WVIP WP5 heeft als doel om voor een aantal concrete toepassingen van waterstof in het publieke domein een Hazard identificatie (HAZID) uit te voren

WVIP WP 5 werkt aan veiligheidsanalyse en het bijdragen aan borging van waterstofveiligheid in het publieke domein en heeft als doelstelling:

1. Het systematisch inventariseren van alle mogelijke veiligheidsrisico's van een aantal concrete cases die gepaard gaan met de productie, opslag, transport en gebruik van waterstof.
2. Welke mitigerende maatregelen zijn noodzakelijk voor de gedefinieerde cases om waterstof als veilige en betrouwbare energiedrager grootschalig te kunnen introduceren en daarmee de publieke acceptatie te vergroten.

Dit document is bedoeld voor alle partijen die bezig waren, momenteel bezig zijn, dan wel in de nabije toekomst betrokken zullen zijn bij de ontwikkeling van de waterstof productie, waterstofinfrastructuur en specifiek voor partijen die zich bezig houden met waterstof productie en –infrastructuur, inclusief transportmethoden waterstof over de weg.

De HAZID cases zijn geselecteerd binnen de TEC van WVIP en betreffen :

- Case 1 Waterstof tankstation
- Case 2 Waterstof transport over de weg (trailer)
- Case 3 regionale productie
- Case 4 Huishoudelijk gebruik waterstof
- Case 5 Service & onderhoud
- Case 6 eind levensduur

Deze rapportage betreft case 1, waterstof tankstation

Dit document geeft, voor de specifieke situatie van een waterstof tankstation, handvatten voor de maatschappij om de vragen en antwoorden over de veiligheidssituatie rondom dit tankstation zijn centraal te ontsluiten met het doel de waterstofveiligheid te borgen.

Introduction

This Hazard identification session was organised in the context of the WVIP (Dutch acronym of Waterstof Veiligheid Innovatie Programma (WVIP, Dutch for Hydrogen Safety and Innovation Program), where, in working group 5, safety aspects are being investigated, using the methodology and approach of systematic hazard identification (HAZID). Further information can be found on the website of the WVIP , which also describes the complete WVIP scope.

The scope of the WVIP includes :

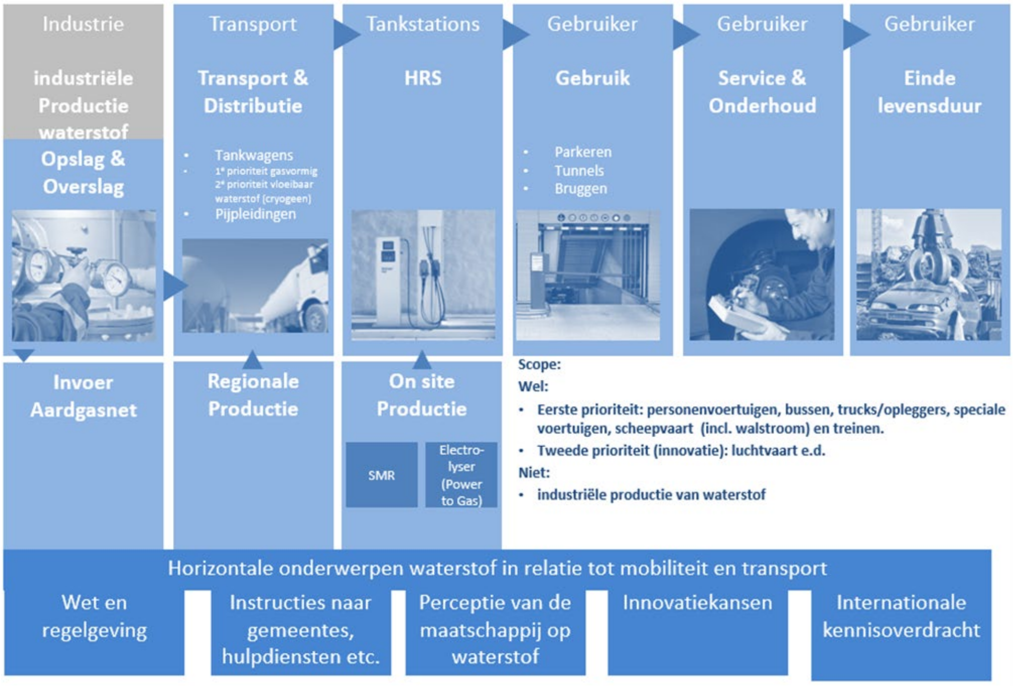

Figure 1. Scope WVIP This report contains the results and recommendations of the HAZID regarding a hydrogen fueling station in the public domain.

Activities and meetings

HAZID team

The HAZID team consisted of the following persons, with their respective roles:

TNO – Chairman HAZID
TNO – PM WP 5
NEN – Co PM WG 5
Experts:

- Gerwen Advies
- TNO (2 personen)
- Toyota
- RWS
- Veiligheidsregio Haaglanden
- Veiligheidsregio Rotterdam-Rijnmond

Meetings

The HAZID was conducted in 3 sessions in December 2020. Each session was about 3 hrs.

HAZID study approach and scope of work

The main objective of this HAZID study was twofold. First, to identify and evaluate potential issues (e.g. knowledge gaps in hydrogen safety) and risks connected to the use and operation of a hydrogen fueling station in the public domain. Second, to identify barriers and formulate recommendations to mitigate the identified risks. Both objectives for further uptake within WVIP if relevant.

The case concerns a hydrogen filling station in the public space. In this filling station, hydrogen is transferred from the local storage to a passenger car. Buses and (garbage) trucks were also considered. The typical layout of the filling station is shown in Figure 2 below. In the HAZID we used the BL (Battery Limits) from the buffer storage, with cooling and dispenser plus vehicle. Refueling takes place with H_2 pressure at the dispenser of max. 700 bar.

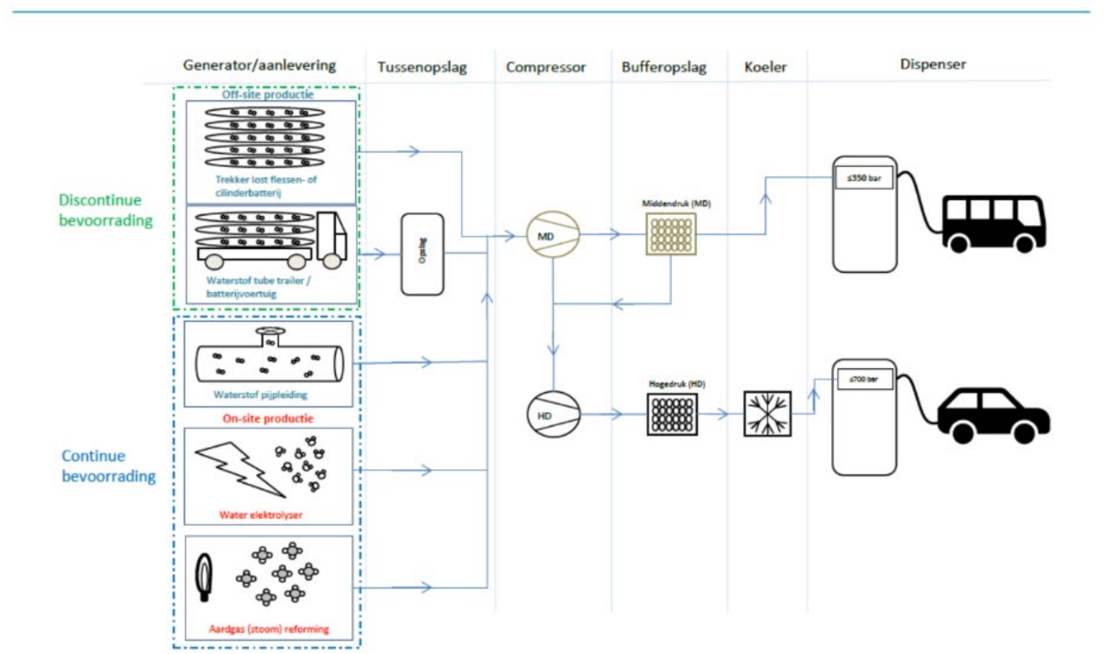

Figure 2. Hydrogen fueling station lay-out (ref. Kristof Custers, Philip Marynissen, Diane Huybrechts, Studie uitgevoerd door het Vlaams Kenniscentrum voor Beste Beschikbare Technieken (VITO),in opdracht van het Vlaams Gewest (2020).

The hazards as considered in the HAZID included the following categories:

1. External and environmental hazards
2. Facility hazards
3. Health Hazards
4. Project implementation issues

In each category, the HAZID assessment was carried out in 4 Steps: in step 1, with the use of guidewords and a typical associated scenario that could take place, in step 2 the consequences of the occurrence of these scenarios was evaluated. In step 3 the possible barriers towards the consequences were defined. Finally, in step 4 the risk assessment took place, in terms of probability (A-E) ,consequences for people and environment (1-6). With this analysis the risk factor was calculated (1-34) and also presented in a color scheme (figure 3).

These risk factors should not be regarded as absolute factors, since this should be evaluated in the context of the public domain area in which the events are envisaged to take place. The factors in the risk matrix should be therefore be used as relative to each other.

Risk matrix

Consequence (Effect class)				Probablity (Frequency of occurence)				
				Scarcely	Seldom / rarely	Now and than	Regular	Often
	People	Environment		Never heard of in industry	Has occurred in this type of industry/sector	Has occurred in similar type of company	Has occurred several times in similar type of company	Has occurred several times in a year on one location
				A	B	C	D	E
Zero	No injury Medical treatment (First Aid)	No / limited effect (pinhole leaks)	1	1,5	2,0	2,5	3,5	4,5
Minor	Medical Treatment case, substited work Slight health damage, no irreverse effects	Minor effect (small leak)	2	1,9	2,5	3,1	4,4	5,6
Major	Major injury, Lost Time injury Irreverse health seffects	Local effect (major leak)	3	3,8	5,0	6,3	8,8	11,3
Severe	Disability One fatality	Severe / regional effect (small equipment rupture, large leak)	4	5,6	7,5	9,4	13,1	16,9
Very severe	More than one fatality (<50)	Very severe / national effect (large equipment rupture, very large leak)	5	7,5	10,0	12,5	17,5	22,5
Catastropic	Many fatalities (>50)	Massive / international effect (loss of containment complete asset)	6	11,3	15,0	18,8	26,3	33,8

Green	1 t/m 4	Low risk level
Yellow	4,1 t/m 10	Medium risk level
Orange	10,1 t/m 15	High risk level
Red	15,1 t/m 34	Very high risk level

Figure 3. Risk matrix.

Main findings

The complete HAZID reporting is in Excel format and available on request, see the reference in the Annex of this document.

Main findings include :

- No ‘very high’ (red) risks
- No ‘high’ (orange) risk
- There are several hazards found in the ‘medium’ (yellow) risk regime, including:
  - Nr. 1.2.1: a Hydrogen fire and/or explosion can bring damage to people and property, in particular when there is proximity to population. A delayed ignition / gas cloud scenario is currently not included in Safeti-NL, QRA, and the guideline PGS-35.
  - Nr. 1.2.2: in line with 1.2.1, a domino effect can take place in case of a multi fuel station.
  - Nr. 1.2.4: in line with 1.2.1 and with proximity to transport corridors / roads. See above.
  - Nr. 2.6.3 : Commonality of equipment can give reason of e.g. trucks or buses to fuel at a passenger car facility, leading to e.g. tank overfilling, possible physical explosion.

Conclusions and recommendations

Main conclusions

With the proper safety barriers implemented, limited risks are expected in the use of a hydrogen fuelling station in the public domain. Risks for which additional measures should be implemented have been identified (see 2.4).

The HAZID methodology is a useful instrument to bring possible hazards to the surface. Upon project implementation, the HAZID results should be used as input for more detailed analysis, such as HAZOP.

Recommendations

The main recommendations of the HAZID analysis are:

1. Draw up an emergency plan per location. Not only emergency instructions on the emergency column, but also in the mind of the parties involved. Point of attention: scenario of an unmanned HRS with restaurant on location, which will be the first to respond, companies, locations to prepare for after care of fires exceeding 2 hrs.
2. Agree on dedicated labelling, coupling for trucks, busses, regular passenger cars; verify electronic handshake (pressure communication).
3. Organise proper training regarding maintenance for personnel, all parties involved.
4. Prepare maintenance philosophy (permit to work, workplans, shutdown procedures, etc.), also considering subcontractors.
5. Include items 3 and 4 in the HAZOP analysis.
6. Detection, alerting, flight behaviour is a point of attention because hydrogen is odourless and colourless. The flame is invisible during the day and ignites easily. It is important to recognize the danger timely (line 1.1.1 of HAZID)
7. Verify standards and regulation for set-up locations of tube trailers, containers, etc. in the public area & consider wind directions and number of set-up locations for emergency services.
8. To revise or develop national guidelines (including ATEX) concerning multifuel stations and possible domino effects. Especially considering and fitting into existing situations.
9. Special attention to activation of emergency button or emergency stop by public, focusing on typical deviations from existing systems at gas stations. Special attention to flaring e.g. after emergency stop (quantity and source of potential ignition etc.).
10. Legislation may be challenging to interpret, comprehend and apply. Point of attention as this is a topic which may only appear to be covered by legislation/regulation. A typical scenario could be that it concerns a relatively new technology, for which regulations are not yet adequately in place and that the safety net with regulations is not sufficient.

ANNEX: HAZID worksheet

The HAZID worksheet is a separate Excel file with all notes and conclusions and available on request. Please contact the Co-Projectmanager Lennart de Waart:
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