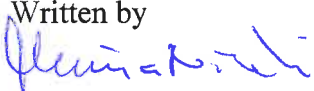


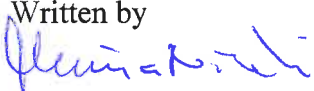


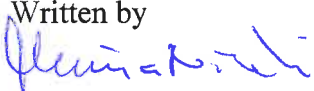






## Demonstration of fuel cell applications at Vuosaari Harbour – review of legislation requirements

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<p>Summary</p> <p>The Tekes Fuel Cell Programme (2007 – 2013) facilitates the development of successful fuel cell technologies and services. Demo2013 is a fuel cell demonstration project planned to present the results of the Tekes Fuel Cell Programme.</p> <p>The demonstration of fuel cell solutions and applications e.g. for working machines is planned to take place at Vuosaari Harbour, in Helsinki. To be able to use fuel cell applications a hydrogen refuelling station will be needed at Vuosaari Harbour. Hydrogen will be transported to the harbour (at the first stage of demonstration no on-site production of hydrogen is planned) and the refuelling station will be inside the harbour area.</p> <p>For large scale demonstration of fuel cell applications it is important to understand the properties of hydrogen and safety requirements for storage, refuelling and use of hydrogen. A short review of Finnish legislation concerning chemical safety, prevention of chemical accidents, transport of dangerous goods, emergency response, land use and building and safety of pressure equipment and machines is given in this report. The main focus is on regulations important for planned Demo2013 project.</p>				
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<p>Tampere, 30.5.2011</p> <table border="0"> <tr> <td>Written by  Minna Nissilä Research Scientist</td> <td>Reviewed by  Riitta Molarius Research Scientist</td> <td>Accepted by  Helena Kortelainen Technology Manager</td> </tr> </table>		Written by  Minna Nissilä Research Scientist	Reviewed by  Riitta Molarius Research Scientist	Accepted by  Helena Kortelainen Technology Manager
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## 1 Introduction

The Tekes Fuel Cell Programme (2007 – 2013) facilitates the development of successful fuel cell technologies and services. The programme helps to create viable new businesses and business models, by bringing together key players along the fuel cell chain. The programme aims to speed up the development and application of innovative fuel cell technologies<sup>1</sup>.

Demo2013 is a fuel cell demonstration project that is planned to present the results of the Tekes Fuel Cell Programme. The demonstration of fuel cell solutions and applications are planned to take place at Vuosaari Harbour, in Helsinki. Port of Helsinki and its new Vuosaari Harbour offer modern services for container and trailer traffic. It is an ideal place for pioneering clean energy technologies, because its location within the city means that noise pollution and polluting emissions should be minimised<sup>2</sup>. Fuel cell powered working machines are examples of applications, which will meet the requirements of the emission control. Applications from different areas of energy use are planned to be demonstrated in harbour environment.

In order to be able to use fuel cell applications, a hydrogen refuelling station will be needed at Vuosaari Harbour. Hydrogen will be transported to the harbour (i.e. no on-site production at first stage of demonstration) and the refuelling station will be inside the harbour area. However, the refuelling station will be located so that also other fuel cell vehicles (e.g. local buses) can use it (without entering the fenced harbour area).

## 2 Safety aspects to be considered in Demo2013 project

For large scale demonstration of fuel cell applications it is important to understand the properties of hydrogen and safety requirements for storage, refuelling and use of hydrogen. In most cases, hydrogen displays extreme characteristics, either very low (density, ignition energy at stoichiometric ratio) or very high (buoyancy in air, diffusion coefficient in air, flammability range, velocity of laminar burning at stoichiometric ratio, heat of combustion and detonation sensitivity) as compared to other fuels (methane, propane, gasoline vapour).

The primary risk with hydrogen is through fire and explosion. Hydrogen is extremely flammable in air with very wide flammability limits, indicatively from 4% to 75% in volume in air. Actual flammability limits vary with pressure, temperature, ignition energy and water vapour content. For a flammable mixture to exist, a concentration three times higher is required for gasoline, yet hydrogen dissipates about ten times faster than gasoline vapour. Similar comparisons are true for methane and propane versus hydrogen. Hydrogen has a low ignition energy, i.e., as little as 0.017 mJ at 30% volume concentration in air, in contrast to

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<sup>1</sup> <http://www.tekes.fi/programmes/Polttokennot>

<sup>2</sup> [http://akseli.tekes.fi/opencms/opencms/OhjelmaPortaali/ohjelmat/Polttokennot/fi/Dokumenttiarkisto/Viestinta\\_ja\\_aktivointi/Julkaisut/FUEL\\_CELL2010.pdf](http://akseli.tekes.fi/opencms/opencms/OhjelmaPortaali/ohjelmat/Polttokennot/fi/Dokumenttiarkisto/Viestinta_ja_aktivointi/Julkaisut/FUEL_CELL2010.pdf)

0.25 mJ for other hydrocarbon fuels. However, at their lower flammability limits (4% to 5% in air), methane and hydrogen have very similar ignition energies of about 10 mJ<sup>3</sup>.

The small molecular size of hydrogen that increases the likelihood of a leak also results in very high buoyancy and diffusivity. So indoors a leak could result in the accumulation of hydrogen but hydrogen, leaked outdoors, rises and becomes diluted quickly without accumulation. The resulting region of flammability is localized and disperses quickly, reducing the risk of a fire or an explosion.

Detailed information about hydrogen properties and safety procedures in handling hydrogen can be found in numerous handbooks, standards and guidelines. One example is Handbook for Hydrogen Refuelling Station Approval<sup>3</sup>.

In addition to hydrogen safety (transport, storage, refuelling, use, emergency response etc.) safety and reliability of the demonstrated applications (occupational safety, machinery safety) have to be considered. There are also specific regulations and orders concerning operation and safety in port areas.

A short review of Finnish legislation concerning chemical safety, prevention of chemical accidents, emergency response, land use and building, and safety of machines is given in the next chapter. The main focus is on regulations important for Demo2013 project.

### 3 Review of Finnish legislation concerning Demo 2013 project

#### 3.1 Chemical safety

The **Chemicals Act (744/1989)**, the **Act on the safety of the handling of dangerous chemicals and explosives (390/2005)** and the **Decree on the industrial handling and storage of dangerous chemicals (59/1999)** aim at the prevention of hazards (health, environment, fire and explosion) caused by dangerous substances.

Regulations concerning the control of major-accident hazards involving dangerous substances (Seveso II directive, Directive on the control of major-accident hazards involving dangerous substances 96/82/EC) have been transposed into Finnish chemicals legislation with the Act on the safety of the handling of dangerous chemicals and explosives (390/2005) and the Decree on the industrial handling and storage of dangerous chemicals (59/1999).

In addition to Seveso II directive obligations there are licence and notification demands for industrial handling and storage of dangerous chemicals. The Decree on the industrial handling and storage of dangerous chemicals (59/1999) defines the establishment as either large scale or small scale depending on the dangerous substances present and their amount.

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<sup>3</sup> WP2 HyApproval – Handbook for Hydrogen Refuelling Station Approval, version 2.1 (June 2008)

**Large scale industrial handling and storage** of dangerous chemicals is supervised by the Safety Technology Authority of Finland (Tukes). Tukes grants licenses for large scale establishments and carries out inspections of them. It also examines safety reports and handles notifications of accidents, investigates larger scale accidents and maintains a register on accidents. **To be a large scale establishment the total amount of hydrogen (if hydrogen is the only dangerous substance present) possibly present at any time should be more than 2 000 kg.**

**Small scale industrial handling and storage** of dangerous chemicals is supervised by the regional rescue authority. If the quantity of dangerous chemicals in the installation reaches a specified threshold, a notification is needed. **For hydrogen the threshold limit for a notification is 100 kg.** A notification is required when establishing a new installation, creating extensions or carrying out significant modifications to an installation.

Detailed requirements for the content of notification can be found in the Decree on the industrial handling and storage of dangerous chemicals (59/1999). The notification shall include, for instance, a description of the potential dangers and accident possibilities caused by the dangerous chemicals. Also the actions for fire prevention, chemical leak control and other emergency procedures shall be described.

It is recommended that the local rescue authority consults with the municipal chemical and environmental authorities prior to the notification being finalized. The rescue authority inspects an establishment no later than three months after the start up of operations. It is also possible, that an inspection is carried out by an official inspection body.

No matter how small the amount of industrial handling and storage of dangerous substance is, all operators are required to fulfil all common safety demands in Act on the safety of the handling of dangerous chemicals and explosives (390/2005).

The general duties of the operator handling chemicals are described in the Chemicals Act (744/1989). These are the operator's duty

- to exercise proper care in production, import and handling of chemicals to avoid health and environmental hazards,
- to be aware of the physical and chemical properties of chemicals and their effects on health and environment and
- to select, when reasonably practicable, the least harmful chemical.

The manufacturer, importer, distributor or any other operator who is placing chemicals on the market is also responsible for proper packaging and labelling of the chemicals.

## 3.2 Occupational safety

The objectives of the Occupational safety and health Act (738/2002) are to improve the working environment and working conditions in order to ensure and maintain the working capacity of employees as well as to prevent occupational accidents and diseases and eliminate other hazards from work and the working

environment to the physical and mental health, hereinafter referred to as health, of employees.

Act 738/2002 applies to work carried out under the terms of an employment contract and to work carried out in an employment relationship in the public sector or in comparable service relation subject to public law.

Employers are required to take care of the safety and health of their employees while at work by taking the necessary measures. For this purpose, employers shall consider the circumstances related to the work, working conditions and other aspects of the working environment as well as the employees' personal capacities.

Employees shall, in accordance with the user instructions and other directions provided by the employer, as well as according to their occupational skills and work experience, use machinery, work equipment and other devices as well as their incorporated safety devices and guards correctly. Employees shall follow safety instructions when using and handling dangerous substances.

Chemical agents and dangerous substances used at work are dealt in section 38:

(1) Employees' exposure to chemical agents that cause hazards or risks to safety or health shall be reduced to such a level that no hazard or risk from these agents is caused to the employees' safety or health or reproductive health. Particularly, protective measures necessary for preventing poisoning, oxygen deficiency or other similar serious risks shall be ensured.

(2) Special caution shall be exercised when handling, storing or transferring explosive, flammable or corrosive substances or other substances involving similar hazards. The employees shall be given such information on dangerous substances that is necessary considering the working.

### 3.3 ATEX

ATEX is the name commonly given to the framework for controlling explosive atmospheres and the standards of equipment and protective systems used in them. It is based on the requirements of two European Directives:

- Directive 99/92/EC (also known as the 'ATEX Workplace Directive') on minimum requirements for improving the health and safety protection of workers potentially at risk from explosive atmospheres.
- Directive 94/9/EC (also known as 'the ATEX Equipment Directive') on the approximation of the laws of Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres.

For the purposes of ATEX-Directive, "explosive atmosphere" means a mixture with air, under atmospheric conditions, of flammable substances in the form of gases, vapours, mists or dusts in which, after ignition has occurred, combustion spreads to the entire unburned mixture.

In Finland the requirements of the ATEX Workplace Directive were put into effect through **Government decree on prevention of the danger caused by explosive atmospheres (576/2003)**. According to Decree (576/2003) the employer shall assess the specific risks from explosive atmospheres taking account at least of



- the likelihood that explosive atmospheres will occur and their persistence,
- the likelihood that ignition sources, including electrostatic discharges, will be present and become active and effective,
- the installations, substances used, processes, and their possible interactions,
- the scale of the anticipated effects.

The employer shall

- ensure the health and safety of the workers by taking all technical and/or organisational measures to prevent the formation of explosive atmospheres, or where the nature of the activity precludes this to remove sources of ignition, and mitigate the detrimental effects of an explosion
- classify hazardous areas and identify them with an Ex-sign
- draw up an Explosion protection document.

With an Explosion protection document the employer demonstrates that

- explosion risks have been determined and assessed
- adequate measures will be taken
- hazardous areas have been classified into zones and appropriate signs displayed
- workplace and work equipment is designed, operated and maintained with due regard of safety
- procedures are in place for the safe use of equipment.

In Finland the requirements of the ATEX Equipment Directive 94/9/EC were put into effect through the **Decree on equipment and protective systems intended for use in potentially explosive atmospheres (917/1996)** and the **Decision of Ministry of trade and industry on equipment and protective systems intended for use in potentially explosive atmospheres (918/1996)**.

The regulations apply to all equipment intended for use in explosive atmospheres, whether electrical or mechanical, including protective systems.

The ATEX directive requirements will be applied to any hydrogen refuelling station.

### 3.4 Transport of dangerous goods

The **Act on transport of dangerous goods (719/1994)** shall apply to transport of dangerous goods 1) by road; 2) by railroad or in other rail traffic; 3) by aircraft over Finnish territory and by Finnish aircraft outside Finnish territory; and 4) by Finnish vessel in Finnish waters and outside Finnish waters as well as by foreign vessel in Finnish waters. This Act shall also apply to the transport of dangerous goods in a port, at an airport and in another terminal. In these places, this Act shall also apply to the temporary storage of dangerous goods.

Further provisions on the definition of temporary storage may be issued by the **Government decree on the transport and temporary storage of dangerous goods in a port area (251/2005)**. However the Decree 251/2005 does not apply to areas accommodating permanent storage tanks or distribution warehouses.



Because of this exclusion the demands of dangerous goods transport legislation are not valid for hydrogen refuelling station at Vuosaari port area.

The Act on transport of dangerous goods and all the relevant transportation decrees are of course applied to the transport of hydrogen by road (or by railroad) to the port area.

### 3.5 Pressure equipment

The **Pressure equipment Act (869/1999)** applies to pressure equipment the safety of which shall be ensured. Pressure equipment must be constructed, placed, maintained, operated and inspected so that nobody's health, safety or property will be endangered. To pressure containers and tanks referred to in the Act on Transport of Dangerous Goods (719/1994) Act 869/1999 only applies insofar as their placement and operations are concerned.

The **Decision of ministry of trade and industry on pressure equipment safety (953/1999)** is applied to placement, operation and inspection of transportable pressure equipment. It contains special requirements e.g. for filling of transportable pressure equipment.

### 3.6 Environment protection

The **Environmental protection Act (86/2000)** applies to all activities that lead, or may lead, to environmental pollution as laid in this Act. According to this Act an Environmental permit is required for activities that pose a threat of environmental pollution. Activities subject to a permit are prescribed in more detail by the **Environmental protection Decree (169/2000)**.

**On the basis of Decree 169/2000 hydrogen storage and refuelling stations are not activities subject to environmental permit.**

### 3.7 Rescue

The **Rescue Act (468/2003)** and the **Government Decree on rescue (787/2003)** will be reformed in the near future. The reformed rescue legislation is expected to enter into force in 2011. Both according to the present rescue legislation and the reformed legislation emergency preparedness is required. The owner of a building and the operator of an activity are required to prevent hazardous situations, protect people, property and the environment in emergency situations and to conduct possible emergency operations.

An Emergency plan has to be prepared for activities if there is risk for injuries or damages to the environment or property. **An Emergency plan has to be prepared e.g. for activities where flammable or explosive substances are handled or stored. The Emergency plan has to be kept up-to-date and delivered to the regional rescue authorities.**

Detailed requirements for the content of an Emergency plan can be found in the Decree 787/2003 (and in the reformed decree).

### 3.8 Land use and building

The **Land use and building Act (132/1999)** and the **Land use and building decree (895/1999)** provide the permits required for buildings and the permit procedure. On the basis of the Decree, **an action permit** is required for the erection or location of a structure or installation that cannot be considered a building. For the construction of e.g. a mast, smokestack, **storage tank**, ski lift, monument, largish antenna, wind power station or largish lighting column or corresponding structure (separate equipment) an action permit is needed. However, if a structure or installation is deemed minor in view of the circumstances in the municipality or part thereof, an action permit may not be needed.

**For the Demo2013 project discussions with Helsinki building supervision authority and Vuosaari Harbour port authority are necessary to clarify the permit procedure for the hydrogen storage and refuelling station.**

### 3.9 Machinery and technical devices

The objective of the **Act on the conformity of certain technical devices to relevant requirements (1016/2004)** is to ensure that machinery, work equipment, personal protective equipment or other technical devices (technical device) meet the relevant requirements and do not cause a risk of accident or harm to health when used as intended by the manufacturer. The aim of Act 1016/2004 is also to ensure that technical devices, when appropriately designed, manufactured and equipped, may without hindrance be placed on the market or provided for use.

This Act is applied to manufacturers, importers, sellers and other persons who place technical devices, predominantly intended for use at work, on the market or provide them for use. Separate provisions shall be issued regarding employer obligations as to the acquisition, safe use and inspection of technical devices.

The manufacturer shall design and manufacture a technical device with its structures, equipment and other properties so that the device is fitted for its function and, when used in the intended way, is not causing a risk of accident or harm to health. If the risk of an accident or harm to health cannot be eliminated adequately enough in any other way, appropriate protective measures shall be used in the manufacture. Effective warnings of the risks and harmful effects shall be given. Personal protective equipment must be effective against the dangers from which it is to provide protection.

If a dangerous substance is permanently incorporated in a technical device, the manufacturer shall provide the device with the name of the substance and with a necessary marking to indicate the dangerousness of the substance in use and in case of an accident. Appropriate operating and safety instructions for the substance shall be provided with the device.

Further provisions are issued by the **Government decree on machinery safety (400/2008)**. By that Decree the Directive 2006/42/EC on machinery has been adopted to Finnish legislation.

### 3.10 Harbour regulations

The **Ship and Port Facility Security Act (485/2004)** lays down the provisions for national implementation provided under the European Parliament and Council Regulation on Enhancing Ship and Port Facility Security (EC) No. 725/2004. The objective of port safety measures is to guarantee the safety of the passengers, cargo, and the personnel working at ports. The measures are to be effective in preventing terrorism as well as common crime.

The **Harbour Regulations for the Port of Helsinki** (approved by the City Council on the 28th of January, 2004, and amended 2007 and 2008) contains regulations for e.g. advance notices provided by the vessels, unloading, loading and warehousing of cargo, environmental protection, precautions against fire, procedure in the event of accident or violation.