Supporting the deployment of safe Li-ion stationary batteries for large-scale grid applications

Environmental regulatory and normative framework

Amandine Lecocq, National Institute of Industrial Environment and Risks (INERIS – www.ineris.fr)

Düsseldorf, 10 March 2015

INERIS general presentation

Our goal:
to provide technical support for risk assessment and management related to substances, products, processes and hazardous installations

INERIS's work is based on an original methodology that combines an experimental approach, modelling and experience feedback.

- **Long-time experience of the industrial world**
- **Multidisciplinary teams**
- A budget of **80 M€**
- A staff **of 600,** including **350** engineers or researchers
- Full scale tests facilities
- Headquarters extend to **50 ha**
- **25 000 m²** of laboratories
- More than **1 000 French & international** customers per year
- **50 PhD** students

Testing and measurement

- Tests on equipment and products (i.e. batteries)
- Assessment of hazardous substances : flammability, …
- Measurement of emissions, analysis of the pollutants

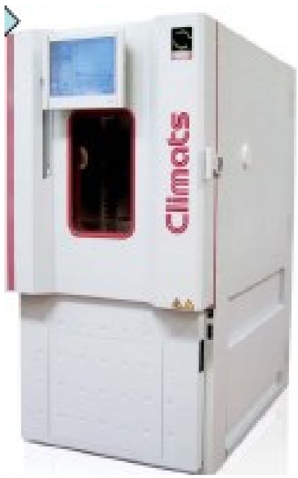
Consulting:

- Modelling, risk analysis, risks control and organization
- Methods of prevention, protection, fight and surveillance
- Support in regulatory procedure: impact studies, hazard studies, Reach, …
- Regulatory and normative monitoring

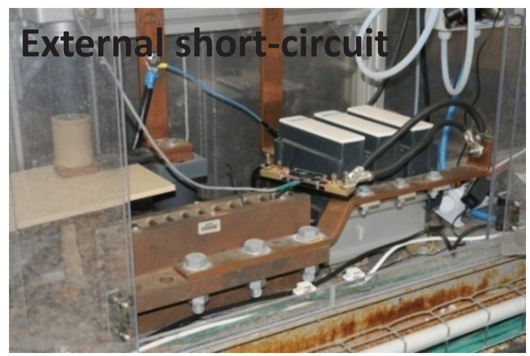
Commercial activities and certification, participation in research projects, support to public authorities

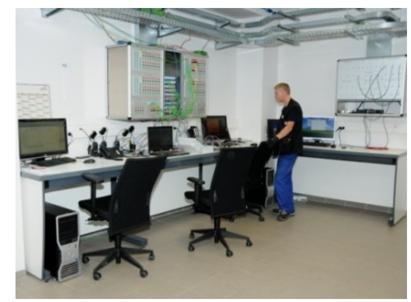
In STABALID Project, INERIS is leader of the WPs on « validation of stationary battery safety tests » and on « harmonized environmental regulatory framework ». INERIS mainly contributes to the performance of the safety tests thanks to STEEVE Safety platform facilities and to the regulatory work.

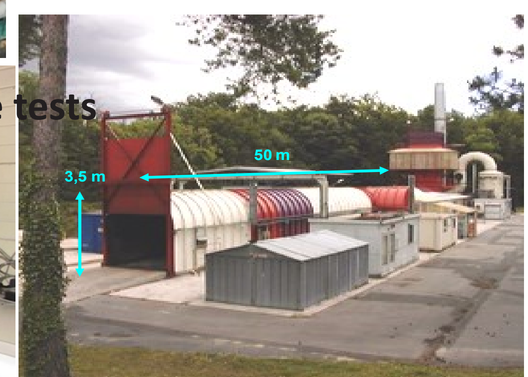
INERIS battery safety tests facilities



Climatic chambers / depression chamber







Environmental regulatory and normative framework

- **Objectives**
  - To identify the relevant regulations in Europe and in Japan defining the safety requirements for stationary batteries
  - To propose a harmonized regulatory framework to accompany the safe deployment of stationary battery system

- **Tasks**

Task 4.1: Survey of existing regulations in the EU

- Spread out of a survey aiming at assessing the regulatory framework related to stationary battery systems in different countries of Europe

Task 4.2: Proposal of a harmonized environmental regulatory framework

- analysis of the existing codes and regulations in force in Europe, US and Japan related to large stationary battery systems and identification of relevant standards
- safety recommendations for stationary storage
- Feedback related to large scale battery storage accidents
- Guidelines to ensure adequate safety in large battery storage implementation

Environmental regulatory and normative framework

Overview of regulations in force in Europe and Japan on Li-ion stationary battery system with a survey (report publically available) (1/2)

- **Method**
  - construction of a survey with around 10 questions related to the stationary battery technology implemented, their energy storage capacity and the regulatory framework, existing guidelines or recommendations
  - spread out of the survey to the STABALID and STALLION consortium, IAB, The European Technology on Industrial Safety, The European Association for Storage of Energy and all relevant experts from partners network.

- **Respondents**
  - 13 persons participated in this survey
  - 9 countries represented:

Spain (1)	Poland (1)
Portugal (1)	Germany (3)
France (2) + French Islands (1)	Italy (1)
Slovenia (1)	Belgium (1)
Japan (1)	

Environmental regulatory and normative framework

Overview of regulations in force in Europe and Japan on Li-ion stationary battery system with a survey (report publically available) (2/2)

- **Main results of the survey**
  - Type of storage facilities: there is a lack of knowledge about the existing installation. The exchange of feedback and best practices could be improved.
  - Regulation in force

Country	Main information obtained from the survey concerning the regulations
Japan	• Fire protection law • JIS C 8715-2 standard « safety standard for Lithium-ion cells and batteries for industrial applications »
Portugal	Accident prevention regulation
Germany	Battery directive 2006/66/EC on recycling or end of life Safety tests for the transportation of dangerous goods
Spain	• Seveso Directive 96/82/EC on the control of major-accident hazards • Battery directive 2006/66/EC on recycling or end of life
Slovenia	• Seveso Directive 96/82/EC on the control of major-accident hazards • Battery directive 2006/66/EC on recycling or end of life • Occupation health and safety Directive 89/391/EEC • Environnemental Impact Assessment Directive (2014/92/EU), Strategic Environmental Assessment Directive (2001/42/EC)
Italy	Seveso Directive 96/82/EC on the control of major-accident hazards
France	• French regulations on classified facilities (Law of 19th July 1976) • Battery directive 2006/66/EC sur le recyclage des batteries

Seveso Directive widely quoted by EU countries

Environmental regulatory and normative framework

Analysis of the EU regulations quoted in the survey

Regulation	Scope	Analysis
Seveso Directive 2012/18/EU	▪ This Directive lays down rules for the **prevention of major accidents which involve dangerous substances,** and the limitation of their consequences for human health and for the environment. ▪ Main objective: to reduce the possibility for a dangerous substance, to cause a release of matter or energy that could create a major accident **under both normal and abnormal conditions** which can reasonably be foreseen.	• The implementation of the Seveso Directive into laws at national level can generate differences in terms of regulation between the European Member States • **does not take into account the specificity of the large stationary batteries and its environment** into a dedicated section for example (i.e. in France)
Environnemental Impact Assessment Directive (2014/92/EU)	Concerns the assessment of the effects of certain public and private projects on the environment	Electrochemical storage by secondary battery types are not listed in the projects (closer item mentioned: “Industrial installations for the production of electricity”)
Battery directive 2006/66/EC	▪ Minimise the negative impact of batteries/accumulators and waste batteries/accumulators on the environment, thus contributing to the protection, preservation and improvement of the quality of the environment. ▪ Requirements essentially focus on collections schemes and on waste treatment	The scope includes industrial and automotive batteries and batteries used in connection with solar panel, photo-voltaic, and other renewable energy applications, so **this directive applies to large storage of Li-Ion batteries.**
Occupation health and safety Directive 89/391/EEC	The employer shall have a duty to ensure the safety and health of workers in every aspect related to the work.	**General concern.** In the case of electrochemical storages, electrical, mechanical, temperature, fire hazards have to be avoided.

Environmental regulatory and normative framework

Codes and regulations applicable in other regions (international perspective)

Some codes that may affect energy storage systems in US

Code/ Regulation	Title	Impact
NFPA 70	National Electrical Code (NEC)	Basis for many local building electrical codes
IEEE C2	National Electrical Safety Code (NESC)	Electrical Code for utilities
ICC IFC	ICC International Fire Code	Used in many local building fire codes
49CFR173.185 **(PHMSA)**	Code of Federal Regulations - Part 173, Section 173.185 - Lithium cells and batteries.	Transport of systems that use lithium ion batteries
47CFR15.109 **(FCC)**	Code of Federal Regulations - Part 15, Section 15.109 Radiated Emissions limits	System needs to meet FCC criteria for emissions
29CFR1910 **Occupational Safety and Health Administration (OSHA)**	Code of Federal Regulations – Part 1910, Occupational Safety and Health Standards	Regulations regarding workplace safety

*Some codes that may affect energy storage systems in Japan**

Type	Regulations		Governing Organization
Guideline (Technical Requirement)	Technical requirements guideline of grid interconnection to secure electricity quality (2004, revised in 2013)		Ministry of Economy, Trade and Industry (METI)
Guideline (Technical Requirement)	Grid Interconnection Code (JEAC 9701-2006) (superseded by JEAC 9701-2012.)		Japan Electric Association (JEA)
Law	Electricity Business Act	Required approval for large electricity storage system more than 80,000kWh	Ministry of Economy, Trade and Industry(METI)
Law	Fire Service Act	Dangerous material for more than 1,000ℓ organic electrolyte solution	Fire and Disaster Management Agency,
Law	Fire Prevention Ordinance	Required approval for large battery (4,800Ah)	Ministry of Internal Affairs and Communications
Law	Building Standards Act	Construction application for building regarding to fire prevention property	Ministry of Land, Infrastructure, Transport and Tourism

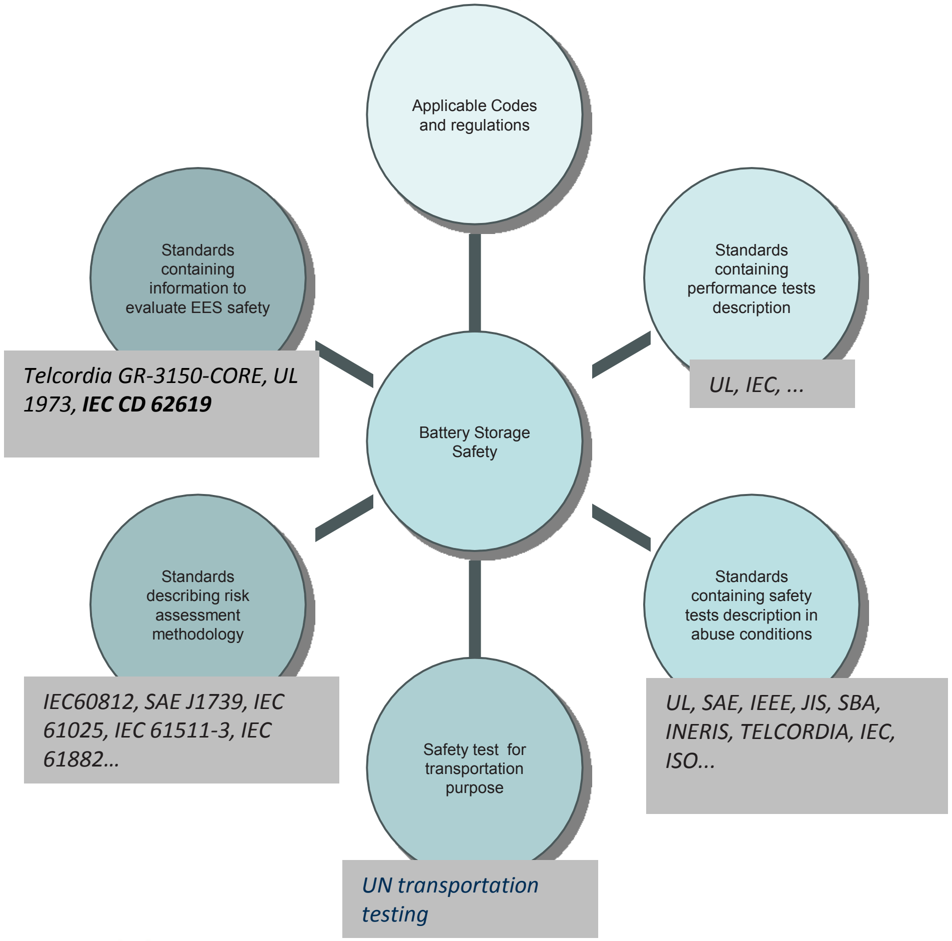
** Some procedures have been simplified or removed for promoting batteries (deregulation)*

Source: Institute of Energy Economics of Japan (IEEJ)

Environmental regulatory and normative framework

Safety recommendations for stationary storage (1/3)

Standards related to stationary battery safety, current landscape



Standards under construction aiming at assessing energy storage systems safety:

- **UL 9540 (draft):** standard for safety for energy storage systems and equipment
- **IEC technical specification 62937** (in preparation): "safety considerations related to the installation of grid integrated electrical energy storage systems"
- **IEC 62897 (approved new work)** on "stationary energy storage systems with lithium batteries – safety requirements"

Environmental regulatory and normative framework

Safety recommendations for stationary storage (2/3)

- **UL 9540 (draft)**

Section	Example of issues discussed
Construction	
Non-Metallic materials	mechanical strength, electrical insulation, gaskets and seals
Metallic Parts Resistance to Corrosion	Guidance on methods to achieve corrosion protection
Enclosures and guarding of hazardous parts	Resistance to possible physical abuses. Designed to prevent inadvertent access to hazardous parts. Rated to the level of exposure to water
Wiring and electrical supply connections	Wiring insulation, connection, routing. Lightning surges.
General electrical service equipment	Fuses, disconnection, power transformers
Electrical spacings and separation circuit	Physical distance between electrical circuits
Insulation levels and protective grounding	Insulation recommendations and grounding methods
Safety analysis and control systems	FMEA – SIL level
Remote controls	Safety requirements
Communication systems	Communication protocols between storage and grid
Heating and cooling systems	Safety shutdown upon failure of the thermal management system
Containment of moving parts	Safety enclosure
Hazardous liquid spill containment	Liquid spill containements; means of neutralization
Combustible concentrations	Flammable atmosphere ventilation – Electrical compartment safety
Fire detection and suppression	Fire risk assessment
Utility grid interaction	Interconnection performance

Section	Issues discussed
Performance	
Electrical tests	Check of operating temperatures. Dielectic voltage withstand test to evaluate electrical spacing and insulation. Grounding and bonding test. Insulation resistance measurement.
Mechanical tests	Over speed test or faulted securement test or blocked rotor test to see if containment means can contain the parts. Leakage test on hazardous fluid containments. Strength test for fuel cells
Environmental tests	Exposure to special environments (salt fog, seismic ratings …) Manufacturing and production tests
Markings	Marking recommendations
Instructions	For installation and decommissioning at the end of the life, operation and maintenance

Environmental regulatory and normative framework

Safety recommendations for stationary storage (3/3)

- **IEC 62937 (in preparation) – based on IEC Guide 104**

Section	Issues discussed
Safety integration	Equipment shall be designed and manufactured so that adequate protection is afforded in normal condition and in single fault condition. Take into account situations of normal use and situations of reasonably foreseeable misuse.
Protection against electrical hazards	Accessible conductive parts of equipment shall not be hazardous live protective measures to keep good insulation adequate protection against leakage current; energy supply; stored charges; arcs; electric shock; burns.
Protection against mechanical hazards	Watch internal forces arising from : • instability; • break-down during operation; • falling or ejected objects; • inadequate surfaces, edges or corners; • moving parts, especially where there may be variations in the rotational speed of parts; • vibration; • improper fitting of parts.
Protection against other hazards	• Explosion • Hazards arising from electric, magnetic and electromagnetic fields, other ionizing and non-ionising radiations • Electric, magnetic or electromagnetic disturbances • Optical radiations • Fire • Temperature • Acoustic noise • Biological and chemicals effects • Emissions, production and/or use of hazardous substances (e.g. gases, liquids,dusts, mists, vapour) • Unattended operations • Connection to and interruption from power supply • Combination of equipments • Implosion • Hygiene conditions • Ergonomics
Functional safety and reliability	Equipment shall be designed and constructed to be safe and reliable so as to prevent hazards arising,
Information requirements	Markings and instructions

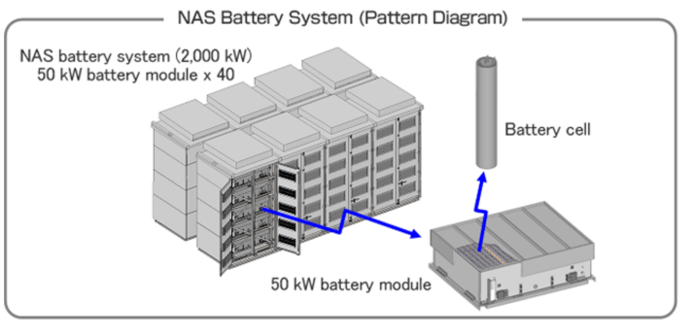
Environmental regulatory and normative framework

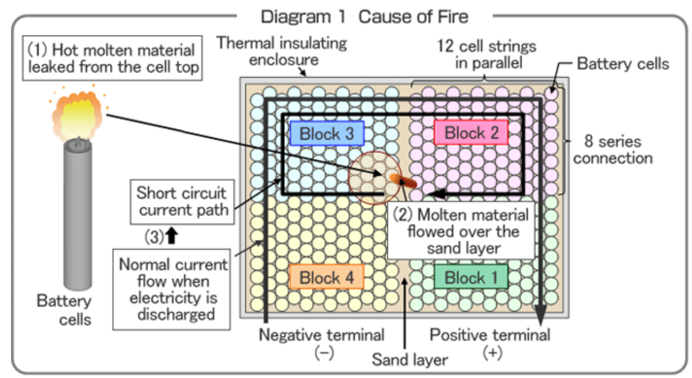
Feedback related to large scale battery storage accidents

→ ***Only few incidents reported***

Fire of a Na-S system in Japan (Joso City), September, 2011

2 MW NAS storage caught fire and burnt several days in Joso, Japan. NGK manufacturer ask its customers to stop their facilities during investigations.





Necessary:

•To prevent short circuit between blocks (implement sufficient number of fuses).
•To prevent short circuits to add insulation boards in battery assembly.
•To add anti-fire boards between modules to stop fire propagation to the whole battery.
•To develop fire fighting strategy and means to assist fire crew.

Fire of a Li-ion system in US (Flagstaff), November, 2012

1.5 MWh Li-ion storage caught fire. The fire, initially reported as transformer fire is finally identified as a fire in the storage system Li-ion. The fire crew waited until the site operator APS (Arizona Public Service Company) has cut off all power source to extinguish the fire with water within 30 minutes. The fire did not spread to the related site facilities.

Environmental regulatory and normative framework

Guidelines to ensure adequate safety in large battery storage implementation (1/2)

- **Prevention of major accidents (Seveso Directive)**

➡ in some cases the total mass of hazardous products can exceeds the classifying thresholds. However, the mass is strongly decoupled in numbers of cells and modules such that the propagation of accidental effects is more difficult: ***the specificity of these facilities must be taken into account by the Seveso Directive*** and by the National Regulations implementing the Directive.

➡ ***the operator should provide to the competent authority the relevant pieces of information in the form of a safety report**. **This will be used to prepare emergency plans and response measures too*** by taking into account the storage type and geographical location of the premises with possible occurrence of natural disasters.

- **Occupational safety**

Staff is involved in installation, commissioning, maintenance and end of life operations. ***These issues required adapted safety measures as protection against electrical and mechanical hazards; and others hazards (fire, explosion, emission of hazardous substances that may be toxic, corrosives …)***

- **Risk analysis and safety testing**

  - ***the system must reach the expected performances*** "in normal conditions of use",
  - ***the system's response to some abuse conditions should be evaluated***. For a stationary system, we can assume that these conditions should entail both internal and external disorders including natural hazards interactions (lightning, earthquake, flooding) and external aggressions (fire, violent shock)
  - stationary systems being potentially fairly large, ***it may be necessary to determine what elements should be tested separately***.

Environmental regulatory and normative framework

Guidelines to ensure adequate safety in large battery storage implementation (2/2)

- **Mitigation measures**
  - As resulting from risk analysis conclusions, the necessary measures must be taken to prevent accidents and limit their consequences,
  - The NAS battery feedback shows that it *is **necessary to codify the means of intervention to be implemented in case of accident and to have emergency stop procedures*** with grid decoupling,
  - As the facility is generally remotely controlled, the monitoring of all parameters useful for the safety management must be defined.

- **Identification of opportunities to develop new codes, standards, regulations (CSR)**

  There are no CSR defining criteria and there are a lot of different CSR that each address a part of energy system storage, that could be better combined into one document. This could be the objective of the IEC TC 120 standardization effort started in 2013

- **Link with the Industrial Emission Directive and the BREF on Energy Efficiency**

  Electrochemical energy storage systems (EESS) not considered in the BREF on Energy efficiency

  ↳ Proposal to include the EESS in the Energy Efficiency BREF **or**

  ↳ Proposal to develop a dedicated BREF on EESS as part of the grids where they efficiently deliver sustainable, economics and secure electricity supplies

Supporting the deployment of safe Li-ion stationary batteries for large-scale grid applications

Thank you!

Environmental regulatory and normative framework

Amandine Lecocq, National Institute of Industrial Environment and Risks (INERIS)

amandine.lecocq@ineris.fr

Düsseldorf, 10 March 2015