SolidStandards

Enhancing the implementation of quality and sustainability standards and certification schemes for solid biofuels (EIE/11/218)

D6.3

Recommendation Paper on Standard Development for Solid Biofuel Storage

Co-funded by the Intelligent Energy Europe Programme of the European Union

The SolidStandards project

The SolidStandards project addresses on-going and recent developments related to solid biofuel quality and sustainability issues, in particular the development of related standards and certification systems. In the SolidStandards project, solid biofuel industry players will be informed and trained in the field of standards and certification and their feedback will be collected and provided to the related standardization committees and policy makers.

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About this document

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The SolidStandards project is co-funded by the European Union under the Intelligent Energy Europe Programme (Contract No. EIE/11/218).

Co-funded by the Intelligent Energy Europe Programme of the European Union

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Foreword

This recommendation paper on “Standard development for solid biofuel storage” is developed as part of the Intelligent Energy Europe funded project, SolidStandards (www.solidstandards.eu).

The SolidStandards project addresses the development of standards and certification systems for the quality and sustainability of solid biofuels. Ensuring both the quality and the sustainability of solid biofuels is critical for the further development of markets for solid biomass. These issues are being addressed through the on-going development of standards at CEN and ISO level, and the introduction of various voluntary certification systems. The SolidStandards project aims at enhancing the uptake of standards within the industry by providing training on standards implementation to solid biofuel producers across Europe. Furthermore, the project aims at providing input to on-going standardisation processes and policy decisions by gathering and providing industry feedback to standardisation committees and decision makers.

With the increasing use of solid biofuels in Europe, several issues related to biofuel storage have emerged in recent years. A lot of other research and projects for quality, safety, security and health aspects of solid biofuel storage and transport deliver significant input for this recommendation paper. This recommendation paper is the result of relating available results from (ongoing) research and projects to project findings from the SolidStandards project (2011-2014).

Chapter 1 describes the scope, objective and research methodology. Chapter 2 gives an overview and description of available documents about quality, safety, security and health aspects of solid biofuel storage and transport. Chapter 3 continues by providing suggestions for topics about these issues that can be standardized. Chapter 4 describes conclusions and recommendations.

Content

1. Scope, objective and research methodology

1.1. Introduction

This chapter describes the scope, objective and research methodology.

1.2. Scope

The scope of this recommendation paper is based on the project description of the SolidStandards Work Package 6.3. That is:

- The quality of biofuel storage containers (especially those used by small end-users).
- Fire safety (auto-ignition has occurred in several cases).
- Health risks in small to large storage and during transport (risk of suffocation through oxygen repletion and CO formation).

REMARK: **Not** part of the scope are:

- Quality, safety, security and health aspects issues during the production process itself.
- General labour conditions (for example working at heights).
- Outdoor storage.
- Policies and legislation at country/European level

1.3. Objective

The objective of this recommendation paper is:

"To provide an overview of topics, related to quality, safety, security and health aspects of solid biofuel storage and transport for which standardisation is needed. The coverage of this recommendation paper is solid biofuels, which implies directly that gaseous and liquid biofuels are excluded."

1.4. Research methodology

The following sources of information were used for writing this recommendation paper:

- Desk research.
- SolidStandards training sessions, part of the SolidStandards project.
- National industry position papers, part of the SolidStandards project.
- Interviews with experts.

1.4.1. Desk research

The desk research is aimed at collecting as much as relevant and available documents about quality, safety, security and health aspects of solid biofuel storage and transport in order to provide a (not comprehensive) overview. These available documents can be used for future standardisation activities on these matters.

1.4.2. SolidStandards training sessions

Quality, safety, security and health aspects of solid biofuel storage and transport are also part of the SolidStandards training sessions. This means that these issues were discussed during 35 trainings, spread over 10 different European countries (with 705 participants).

Additionally, participants of these training sessions were asked to complete a questionnaire (feedback module). At the moment of writing this recommendation paper, the results of already more than 400 questionnaires were available. The most relevant outcomes are used in this recommendation paper.

It is important to know that not all of the participants completed a questionnaire. In addition, some participants did not answer all the questions. The gathering of information is not completely performed like a quantitative scientific research. However, it offers a great opportunity to get familiar existing needs from the solid biofuels industry and solid biofuel standards users.

1.4.3. National industry position papers

Part of SolidStandards Work Package 6 is the delivery of national industry position papers of 10 different European countries. These papers were written by the SolidStandards partners, who also used outcomes of the questionnaires for this purpose (see paragraph 1.4.2). When this recommendation paper was written, 4 out of 10 (draft versions of) papers were submitted, also due to overlapping planning. This means that additional information of four countries can be used (e.g. The Netherlands, Austria, Croatia and Bulgaria).

Since the project partners are also obliged to discuss their national industry position papers with experts and industry representatives (e.g. the national standardisation mirror committees), (local) standardisation needs and demands are already integrated in this recommendation paper in an indirect way.

1.4.4. Interviews with experts

Conducting interviews offers a good opportunity to exchange information, knowledge and experience with, for example, experts in the field. Interviews can be used for the purpose of validation of data, for example for the outcomes of desk research (see paragraph 1.4.1). They can also offer additional and relevant information, as well as additional insight.

NEN has conducted three interviews. It was agreed that the names of the interviewed persons and their companies will not be published. Their answers have already been integrated in this recommendation paper. The profiles of the interviewed persons are:

- An international expert at European and global standardisation level, is well known, and has been active in standardisation activities for solid biofuels for several years.
- An industry representative from The Netherlands, with sufficient insight in standardisation about solid biofuels in The Netherlands and, potentially, outside The Netherlands.
- An industry representative from a country other than The Netherlands, with sufficient insight in standardisation about solid biofuels in a specific European country and, potentially, outside that country/for a certain (European) region as well.

2. Overview and description of available documents

2.1. Introduction

This chapter contains an overview and description of available documents about quality, safety, security and health aspects of solid biofuel storage and transport. For standardisation purposes, it is important to understand the industry’s perspective towards these aspects. If the industry does not consider these aspects as problematic (in the future), a foundation for standards neither exists. Paragraph 2.2 therefore describes the industry’s perspective (in a general way). Paragraph 2.3 describes the overview of available documents. Paragraph 2.4 deals with relevant future developments and aspects that need to be addressed before “good standards about quality, safety, security and health aspects of solid biofuel storage and transport” can be developed.

2.2. Industry’s perspective

2.2.1. Introduction

In order to get an idea of the industry’s perspective towards quality, safety, security and health aspects of solid biofuel storage and transport in relation to possible future standardisation activities, feedback from the SolidStandards projects can be used (e.g. feedback from questionnaires (thus training sessions) as well as national industry position papers.

2.2.2. Feedback from SolidStandards training sessions

During the interactive part of several SolidStandards training sessions, quality, safety, security and health aspects of solid biofuel storage and transport were mentioned consistently. The discussions during these interactive sessions offer a lot of insight in industry needs (in several different European countries). Although industry needs differ per country, it can be concluded that a need for standards on these issues is exists.

Based on the SolidStandards training’s questionnaires:

- 125 participants (31%) mention ‘dust explosion’ as a specific risk/topic relevant for standardisation.
- 95 participants (24%) mention ‘off-gassing’ as a specific risk/topic relevant for standardisation.
- 89 participants (22%) mention ‘self-ignition’ as a specific risk/topic relevant for standardisation.
- 55 participants (14%) indicated that other risks/topics (than those mentioned above) need to be standardised. Specifically mentioned are mixed (bio)fuels, unprocessed and processed (torrefied) pellets, waste pills, torrefied biomass in soil content of stumps (ash content), grass related issues, and combined streams in pellets.

REMARK: Although there is not a majority addressing the issues that are described above, it can be concluded that part of the industry is aware of these issues. Standardisation can, in their opinion, contribute to the prevention of such dangerous situations.

It seems most countries have certain policies, legislation and regulation at national level to cope with these issues (related to fire safety, transportation, storage). However, policies, legislation and regulation for solid biofuels were not mentioned specifically. The interviewed persons and participants of the SolidStandards training sessions indicated that government regulations should be sharpened at both national *and* European level.

It is also clear that all different types of biomass ask for different types of quality, safety, security and health specifications in standards.

2.3. Available documents

There are plenty of (ongoing) studies, projects, guidelines, et cetera available (all described in documents) about quality, safety, security and health aspects of solid biofuel storage and transport. This paragraph gives an overview of relevant documents that were mentioned during SolidStandards training sessions and interviews or were found by desk research.

It is especially useful to already have an overview about quality, safety, security and health aspects of solid biofuel storage and transport before future (European) standardisation activities take place. This might prevent 'reinventing the wheel'.

The overview is described next:

A. The FP7 *"Safe Pellets Project"* (2012-2014) including the project report on '*Results and Main Lines of Action based on the First International Workshop on Pellet Safety (2013)*'.

   This project already offers a lot of useful information for solid biofuels (quality, safety, security and health aspects of solid biofuel storage and transport) despite the fact that the focus is on wood pellets. The project also takes the role of standardisation into account. This project aims[1] to derive technical solutions to prevent from self-heating and spontaneous ignition of pellets stored in bulk, to provide technical solutions for fire protection, to prevent from off-gassing and to provide technical solutions to overcome the threat of formed CO and VOCs in storage systems. Overall findings will be introduced into best practice guidelines for quality assurance measures along the whole wood pellets production and supply chain, which shall be the basis for a Europe wide unique standard for quality and safety measures of pellets supply to industrial and private customers. The available product and quality assurance standards (CEN/TS 14961 and CEN/TS 15234) do not include sufficient safety considerations regarding prevention from self-heating and spontaneous ignition of bulk storages and from off-gassing of toxic emissions like carbon monoxide (CO) and volatile organic compounds (VOCs, e.g. aldehydes and low molecular carboxylic acids). A number of incidents due to spontaneous ignition of wood pellets and accidents due to CO intoxication have been reported. Therefore, both on CEN level (e.g. CEN/TC 335) as well as on ISO level (e.g. ISO/TC 238) activities should be launched to derive solutions to overcome these threats to industry and customers.

   The Pellet Safety Project report on 'Results and Main Lines of Action based on the First International Workshop on Pellet Safety (March 2013, Austria) offers insight in the discussions on several health and safety issues that took place during this workshop. The workshop had over 70 participants, spread over 27 sessions[2].

B. The NT Method – '*Guidelines for storing and handling of solid biofuels, Nordic Innovation Centre'* (2008). This document describes[3]: "The personnel operating storage sites and transports have in some cases a very short history of experience, and CEN standards or any other national standards do not cover solid biofuel storage and handling issues. However, there exist instructions on company level which are used as guidelines. For this reason it is argued that a guideline for correct handling and storing of solid biofuels, based on existing research and knowledge, would help to prevent accidents and loss of

[1] http://www.safepellets.eu/about-project/project-objectives/
[2] http://www.pelletcouncil.eu/en/safety-workshop/
[3] Guidelines for storing and handling of solid biofuels, Nordic Innovation Centre' Center (2008), page 2

solid biofuels through fires and can furthermore prevent unnecessary deterioration of solid biofuel in storage".

[4]"This best practice guideline gives recommendations for utilizing best available knowledge, experience, methods and technology in storage and handling to secure the quality of the solid biofuel and to minimize health and safety risks. It is intended for persons and organisations that manufacture, plan, sell, install or use machinery, equipment, tools and entire plants related to the production, purchase, sale and utilization of these fuels on a commercial and industrial level. The guideline is not addressed to single households and individual small producers."

C. The IEA paper '*Health and Safety Aspects of Solid Biomass Storage transportation and Feeding'* (2013). This EIA paper provides a lot of detailed information about solid biofuels. The document describes quality, safety, security and health aspects of solid biofuel storage and transport in much (useful) detail. The report is also about issues not relevant for the SolidStandards project (like food waste, manure, household garbage, and municipal sewage waste). This IEA paper[5] describes that, in accordance with a collaborative agreement made October 15 (2010) between CEN/TC 335 and ISO/TC 238, new standards will be developed by ISO in order to increase the applicability of standards internationally but they will also be adopted as European (EN-ISO) standards. ISO/TC 238 is also in the process of incorporating standards specifically for safety and health when handling and solid biofuels"

D. The following standards are useful to a certain extent:
   - *'EN 14778'* and *'EN 14780'* (both about sampling).
   - *'EN 15234-series'* (Fuel quality assurance). EN 15234-3[6] describes "Health, safety… issues for solid biofuels are important and need special attention, however they are outside the scope of this European Standard." Based on the SolidStandards questionnaires, 205 participants (51%) indicate that quality issues during transport and logistics are mainly relevant for pellets. They think that quality issues in pellet transport and logistics are sufficiently addressed in EN 15234.

E. *ÖNORM M 7137 "Compressed wood in natural state – Woodpellets (Requirements for storage of pellets at the ultimate consumer)'* provide useful specifications for quality of wood pellets. These standards do not cover the whole field (specific types of biomass, specific health and safety issues). ÖNORM M 7137 is very useful for household purposes. Not all training participants were familiar with the fact that ÖNORM M 7137 was updated in 2012. The 2003 version only described (as one of the preliminary notes):[7] "Storage rooms of consumers built according this ÖNORM (M 7137) shall assure operating safety, fire protection, compliance with static requirements and preservation of pellet quality". Regarding safety, the 2003 version only described[8]:"A storage room…shall not be equipped with any exposed electrical installations (lamps…light switches, etc.)." This standard was updated in 2012, and included new/updated specifications for explosion and ventilation.[9] For specific fire safety related aspects, ÖNORM M 7137 refers to national specifications of Austrian Fire Brigades' organisation/society (for example prTRVB H 118 (about automatic wood burning equipment).

   Based on the SolidStandards training:

[4] Mapping of international standards of solid biofuels for ISO TC 238 , VTT (2008), page 37
[5] Health and safety aspects of solid biomass storage, transportation and feeding, IEA (2013), page 1
[6] (NEN-)EN 15234-1:2011, page 5
[7] ÖNORM M 7137 Austrian Standards Institute (2003), page 3
[8] ÖNORM M 7137 Austrian Standards Institute (2003), page 4
[9] ÖNORM M 7137 Austrian Standards Institute (2012), page 3

- 82 participants (20%) indicate that they are aware of the Austrian standard ÖNORM M 7136 on pellet transport and storage.

REMARK: The majority of these participants attended a SolidStandards training outside Austria.

- 57 participants (14%) think that this kind of standard is also needed in their country or at EU level.
- 73 participants (18%) are aware of the Austrian standard ÖNORM M 7137 on pellet storage silos and storage rooms for small end-users.
- 49 participants (12%) think that this kind of standard is also needed in their country or at EU level.

One of the interviewed persons stated that these Austrian standards contain very high quality matters connected with the quality assurance in the field of logistics of transport and storage for wood pellets. A lot of pellets producers and transport and logistics companies use these standards at the moment in that specific country.

F. '*ASTM D3178-89– Standard Test Methods for Carbon and Hydrogen in the Analysis Sample of Coal and Coke'* involves hazardous materials, operations, and equipment. "This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. The values stated in SI units are to be regarded as the standard. Comments: This standard has been used in the US on solid biofuels as no specific"[10].

G. The NT-method *'NT009 - Quality Guidelines for Fuel Peat'* also describes some transportation, handling and storage principles.

H. The document *'Sustainable Woodfuel Harvesting – Finnish Practical Applications by AFO (2010)'* describes good storage processes.

I. With regard to certification, 'DINCERTO' and 'EN Plus' are useful to a certain extent. – The document *'ENplus handbook 2.0, European Pellet Council (2013)'*describes health issues in a more general way, and nothing specifically about safety. [11]

SolidStandards' training feedback shows that:

- 57 participants (14%) are aware of certification systems (e.g. offered by German DINCERTCO) for pellet storage rooms and silos for small end-users.
- 135 participants (34%) are aware of certification systems (e.g. offered by German DINCERTCO or EN plus) for pellet logistics and transport companies.
- 102 participants (25%) think that this kind of certification would also be helpful in their country or at EU level.

SolidStandards' training feedback also shows that:

- 41 participants (10%) think that this kind of certification would also be helpful in their country or at EU level.
- 128 participants (32%) indicate that similar initiatives should be taken for wood chips.
- 84 participants (21%) indicate that similar initiatives should be taken for wood briquettes.
- 73 participants (18%) indicate that similar initiatives should be taken for non-woody fuels.
- 61 participants (15%) indicate that similar initiatives should be taken for fire wood.

REMARK: These answers were given by participants that deal with one (or more) type(s) of solid biofuels, and sometimes even answered for a specific type of solid biofuels they do not deal with it (yet).

[10] Mapping of international standards of solid biofuels for ISO TC 238 , VTT (2008),, page 47
[11] ENplus handbook 2.0, European Pellet Council (2013), page 12 and page 42

One of the interviewed persons stated: The certification will have significant role connected with the quality of products, decreasing the producers overhead and increasing their profits. The certification will improve the competiveness of the market players as well.

Another interviewed person stated more or less the opposite: Certification has been introduced in the market (EN Plus), but a majority of consumption is based on import from other countries that do not apply certification. This influences the competitiveness (e.g. price) of local producers that apply certification.

It is concluded that the role of certification for the quality, safety, security and health aspects of solid biofuel storage and transport is not completely clear. In order to better understand the needs of the industry, additional research should be done to identify certification needs specifically (this is not part of this recommendation paper about standardisation).

2.4. Future developments and aspects

The relevant future developments and aspects that need to be addressed before "good standards about quality, safety, security and health aspects of solid biofuel storage and transport" are described below. These developments and aspects were mentioned during training sessions, in industry position papers and/or in (one of) the documents described in the previous paragraph of this recommendation paper.

Torrefaction

Product quality standards and specific test methodologies for torrefied materials are currently under development by ISO/TC 238.[12]

Interviewed persons stated that torrefaction asks for a different approach to quality, safety, security and health aspects of solid biofuel storage and transport (e.g. raw material, biorefinery) than other types of solid biofuels. Attention should be paid to these issues as well.

Issues that need to be further investigated

The following needs for further research were expressed:

- More research on differences in the use of raw material is needed to better understand the significance of different parameters affecting self-heating, e.g. the influence of production procedures in relation to the influence of raw material..
- The effect of moisture needs to be studied to be able to quantify the influence on self-heating.
- Research on influence of the production conditions on the off-gassing and self-heating potential is important.
- Research on potential influence on off-gassing and self-heating potential for:
  - Wood species.
  - Origin of the wood species, growing conditions, harvesting time.
  - Age of the round wood before being chipped.
  - In case of chipped raw materials the age and storage conditions of the chips.
  - Technical parameters of debarking (if applied), chipping, drying.
  - Bark content.
  - Particle size distribution.

[12] Status overview of torrefaction technologies, IEA Bioenergy Task 32, page V

- Density of biomass.
- Amount of fines.
- Pressure and heat applied to the saw dust during pellets production.

3. Suggestions for standardisation

3.1. Introduction

The following (not comprehensive) overview is a compilation of suggested topics for standardisation (of quality, safety, security and health aspects). **The documents of paragraph 2.3 are used for this compilation.** It can be concluded that the available documents already enabled the compilation of relevant standardisation topics that is based on the industry's needs/an industry's perspective.

REMARK: The items with * were validated by at least one of the persons who were interviewed.

3.2. Storage facilities of biomass

3.2.1. Introduction

The following topics are considered relevant topics for standardisation for storage specifications, related to:

- The storage facilities itself, see paragraph 3.2.2.
- (Fire) safety aspects (during storage and transport (including handling)), see paragraph 3.2.3.
- Security and health aspects (during storage and transport (including handling)), paragraph 3.2.4.

3.2.2. The storage facilities itself

- Terminology:
  - *Definition of different types of storage facilities/names used for storage facilities (e.g. storage containers, silos, rooms, tanks).

- Technical specifications:
  - Description of all parts of storage containers, silos, rooms, tanks and technical specifications:
  - *Architectural aspects (taking into account the amount and weight of biomass to be stored).
  - * Description of (building) materials to be used (concrete, metal, galvanised steel).
  - Description of surface/bottom (for example flat bottom) and also floor level (underground, ground level).
  - Description of airtightness, sealing provisions (to prevent of, for example, dust, moisturing and contamination).
  - * Description of piping and movable conveyors (for filling).
  - * Description of transportation aspects related to storage facilities (loaders, trucks, railcars).
  - Specifications of (maximal) dimensions (L x H x W), and possibly about shape;

A clear definition for both small and large storage facilities would be helpful. Furthermore, special attention should be paid to a distinction in a domestic and commercial/industrial storage (with possibly different technical specifications in (different) standards).

One of the interviewed persons did not see the necessity of specifications of dimensions, however, the other interviewed persons did.

3.2.3. Safety aspects

- Self-heating and off-gassing affecting parameter: The main parameters affecting self-heating are described below. (Technical) Specifications for these parameters should be described in standards:
  - *Raw material (e.g. soft wood / hard wood; white pellets / torrefied pellets) and the propensity for self-heating).
  - Production equipment and procedures (but is not part of the scope of this paper).
  - *Cooling before storage (to increase rapid increase of the temperature).
  - *Type and size of storage.
  - *External influence accelerating self-heating (e.g. moisture, temperature (sun), contamination).
  - Air mixture composition.

- Self-heating (preventive) provisions: Some (preventive) provisions should be described in standards (with specific technical specifications):
  - *Temperature monitoring.
  - CO and CH4 monitoring.
  - *Emergency inerting (N2 or CO2).
  - *Smouldering, moisturizing and destabilizing during storage or transport.
  - *Instructions for workers (knowhow, product understanding, and interpretation)/trained professionals.
  - Use of probes (type of probes and way and quantity of measuring).
  - Control measures for impurities when receiving the material, e.g. magnetic separators, sieves.
  - *Spark detectors connected to an extinguishing system by fast acting valves at strategic locations in the transport system.
  - Installation of full sprinkler protection systems.
  - *Control schemes to check the condition of bearings (temperature measurement
  - Control schemes for cleaning to avoid accumulation of material in conveyers and elevators.
  - Control schemes for hot work within the facility.
  - *Routines for observations and controls.

- Explosion risks: Description of aspects that contribute to explosion risks:
  - Protection
  - Possibilities and limitations of existing technology.
  - Maximum size.

  REMARK: Dust related issues are further described below

- Dust:
  - Definition of exposable dust.
  - Sampling of dust.
  - Testing of dust from pellets.

- Electrostatic characteristics of dust:
  - Dust housekeeping.
  - Preventive measures.

- Dust characterization for operations.
- Dust management.
- Dust collection.
- Dust suppression.
- Explosion prevention.
- Explosion containment.
- Spark extinguishing.
- Explosion suppression.
- Explosion venting.
- Safety certification.

- Fire fighting provisions:
  - Inclusion of local fire brigade (in the pre-planning stage).
  - Gas injection, for example inertion of with nitrogen from the bottom of the storage facility.
  - Use of foam.

The following position of the national mirror committee is mentioned by one of the persons who were interviewed:

> Fire safety issues are connected to the prevention of spontaneous ignition, resulting in flaming combustion of the different size of particles. In these cases it is needed to use water in the type of spray or jets to cool the fired material.

3.2.4. Security and health aspects

- Cargo handling specifications:
  - *Instructions for handling cargo during filling.
  - Information collection specifications.
  - Methods of filling of the warehouse/shed/silo.
  - Methods of delivery out of the warehouse/shed/silo.
  - Cargo entering for storage related to weather conditions (during rain).
  - *Different types of cargo, way of handling and storage (separately, not in each other’s vicinity).
  - Cargo out of condition (undamaged, in order to prevent dust).
  - Cargo storage height (maximum) (prevent fall over).
  - Contacts with beams and structures should be avoided because of condensation issues.

- Dust inhalation: Specifications should be described in standards in order to prevent dust inhalation risks. Examples of inhalation risk for (for example virgin-fibre pellets) are:
  - *Dust exposure (wood dust, and also silica dust, e.g. the debarker).
  - Bacteria/endotoxins.
  - Aldehydes & Volatile Organic Compound (VOCs) (e.g. building up in storage silos).
  - *Carbon monoxide.
  - *Oxygen deficiency.

- Other risks than dust inhalation (for example from recovered wood) :
  - *Heavy metals.
  - Zinc.
  - Polychloorbifenyl (PCBs).
  - Oil (creosote/bitumen).
  - Carbon black (Torrefied material).

- Physical interaction
  - *Irritant/allergic hazards.
  - Pathogenic hazards.
  - Preventing biological health risks.
    - Exposure to organic dusts.
    - Exposure to bio aerosols.
    - Size reduction.
    - Loading/unloading.
  - Mitigation of hazardous dust.
    - *Minimizing the formation of hazardous dust.
    - *Minimizing exposure to hazardous dust.
  - Biogenic risks associated with anaerobic digestion.
    - *Mitigation.
    - *Self-control programme.

Usage of protective masks, keeping rules for careful handling of pellets, chips and firewood and dust pollution during pellet handling of the employee were mentioned during SolidStandards training sessions (all related to storage of solid biofuels). CO detection and proper ventilation were specifically mentioned. It was also mentioned that the health of the personnel during transportation of solid biofuels depends on cleaning of the transport units. Compliance with limited loads of the transport units is important.

The following position of the national mirror committee was mentioned by one of the persons who were interviewed:

> The main issues connected with the storage and transport is decreasing of the health risks through storing the wood chips and pellets at the clean and dry places, and handling the biofuels carefully as this requirements are mentioned in the current EU standards.

4. Overall conclusions and recommendations

It can be concluded that there is already some awareness about quality, safety, security and health aspects for transport and storage. Several studies and projects have resulted in very useful information, described in several documents. Some of these available documents are mentioned in this recommendation paper. It is recommended to make use of the (not comprehensive) overview of available documents about health and safety for transport and storage, in order to not reinvent the wheel during future standardisation activities.

It can be concluded that the available documents already enabled the compilation of relevant standardisation topics that is based on the industry’s needs/an industry’s perspective. This recommendation paper therefore offers a useful, not comprehensive compilation/overview of topics related to ‘product quality’, safety, security and health aspects of solid biofuel storage and transport for which standardisation is suggested.

It is recommended to start with standardisation activities preferably at ISO-level (especially since standardisation activities are initiated at that level), or at least at European level (e.g. CEN standards).

Recommended standards are:

A. 1) A standard for storage rooms and silos for small end-users:
   - Terminology and specifications.

   2) A standard for storage for industrial/commercial use:
   - Terminology and specifications.

B. (Fire) safety aspects (during storage and transport (including handling)):
   - Prevention of self-heating.
   - Prevention of explosion risks.
   - Prevention of dust.
   - Prevention of electrostatic characteristics of dust.
   - Fire fighting provisions.

C. Security and health aspects:
   - Cargo handling specifications.
   - Dust inhalation.
   - Other risks than dust inhalation.
   - Physical interaction.
   - Mitigation of hazardous dust.
   - Biogenic risks associated with anaerobic digestion.

REMARK: Standards for torrefaction/heat treated pellets are also recommended.

REMARK: Topics are relevant for all types of solid biofuels that are mentioned in this recommendation paper.

It is recommended to further validate this overview with more stakeholders (all over Europe) in order to improve and possibly extend this overview, and to get a better picture of the European industry’s needs.
It is also recommended to pay attention to the issues for which more research is needed (described in paragraph 2.4 of this recommendation paper)

Furthermore it is recommended to discuss this recommendation paper with CEN/TC 335, ISO/TC 238, and the national mirror committees that are involved, in order to gain a more complete overview of the needs for standardisation. Lastly, it is recommended that this recommendation paper is discussed with (representatives of the) European Commission and to determine which, joint (follow-up) actions are (directly) needed. These (follow-up) activities are not part of the SolidStandards project.

Annex 1 - Interview data used for this paper

Questions

The following questions about standards for transport and storage from the questionnaires provide (the numbering of questions is copied from the questionnaire).

3.1 Quality issues during transport and logistics are mainly relevant for pellets. Do you think that quality issues in pellet transport and logistics are sufficiently addressed in EN 15234?

☐ Yes

☐ No, because

3.2 Are you aware of the Austrian standard ÖNORM M 7136 on pellet transport and storage?

☐ Yes Continue to question 3.3

☐ No Continue to question 3.4

3.3 Do you think that this kind of standard is also needed in your country or at EU level?

☐ Yes

☐ No, because

3.4 Are you aware of certification systems (e.g., offered by German DINCERTCO or EN plus) for pellet logistics and transport companies?

☐ Yes Continue to question 3.5

☐ No Continue to question 3.6

3.5 Do you think that this kind of certification would also be helpful in your country or at EU level?

☐ Yes

☐ No, because

3.6 Are you aware of the Austrian standard ÖNORM M 7137 on pellet storage silos and storage rooms for small end-users?

☐ Yes Continue to question 3.7

☐ No Continue to question 3.8

3.7 Do you think that this kind of standard is also needed in your country or at EU level?

☐ Yes

☐ No, because

3.8 Are you aware of certification systems (e.g. offered by German DINCERTCO) for pellet storage rooms and silos for small end-users?

☐ Yes Continue to question 3.9

☐ No Continue to question 3.10

3.9 Do you think that this kind of certification would also be helpful in your country or at EU level?

☐ Yes

☐ No, because

3.10 Do you think that there should be standards on health and security aspects for pellet storage at the end-users? If so, could you also indicate where the risk(s) occur?

☐ Yes, for: Place(s) of risk:

- ☐ Dust explosion
- ☐ Off-gassing
- ☐ Self-ignition
- ☐ Fungi spores
- ☐ Other, namely

☐ No, because

3.11 For which biofuels are similar initiatives needed?

☐ Wood briquettes

☐ Wood chips

☐ Firewood

☐ Non-woody fuels

☐ Other, namely

Annex 2 - Results of questionnaires

Basic results can be found below, are integrated in this paper (the numbering of the questions and answers is copied from the questionnaire).

3.1 Quality issues during transport and logistics are mainly relevant for pellets. Do you think that quality issues in pellet transport and logistics are sufficiently addressed in EN 15234?	3.2 Are you aware of the Austrian standard ÖNORM M 7136 on pellet transport and storage?	3.3 Do you think that this kind of standard is also needed in your country or at EU level?	3.4 Are you aware of certification systems (e.g., offered by German DINCERTCO or EN plus) for pellet logistics and transport companies?	3.5 Do you think that this kind of certification would also be helpful in your country or at EU level?	3.6 Are you aware of the Austrian standard ÖNORM M 7137 on pellet storage silos and storage rooms for small end-users?	3.7 Do you think that this kind of standard is also needed in your country or at EU level?	3.8 Are you aware of certification systems (e.g. offered by German DINCERTCO) for pellet storage rooms and silos for small end-users?	3.9 Do you think that this kind of certification would also be helpful in your country or at EU level?
205	82	57	135	102	73	49	57	41
402	402	402	402	402	402	402	402	402
51%	**20%**	**14%**	**34%**	**25%**	**18%**	**12%**	**14%**	**10%**

June, 2013

Question: Do you think that there should be standards on health and security aspects for pellet storage at the end-users? If so, could you also indicate where the risk(s) occur?

Dust explosion	**Off-gassing**	**Self-ignition**	**Fungi spores**	**Other**	**Wood briquettes**	**Wood chips**	**Firewood**	**Non-woody fuels**
125	95	89	75	55	84	128	61	73
402	402	402	402	402	402	402	402	402
31%	**24%**	**22%**	**19%**	**14%**	**21%**	**32%**	**15%**	**18%**

June, 2013

Annex 3 - Interview 1

Answers of this interview have been integrated in this paper.

Questions:

- General information:
  - a) What is your position in your company?
  - b) Can you give a short company description (please mention your business activities regarding solid biofuels).
  - c) Which types of solid biofuels do you deal with?
    - 0 Wood pellets
    - 0 Wood briquettes
    - 0 Wood chips
    - 0 Firewood
    - 0 Non-woody fuels
    - 0 Other, namely
- Questions related to experience with incidents:
  - a) Were there any safety and/or health incidents in your country regarding transport or storage? If yes, which can you mention (please provide basic data as well)?
  - b) If yes, what was the government's reaction? And what about the industry's reaction?
  - c) Were there any safety and/or health incidents outside your country regarding transport or storage (that you are aware of)? If yes, which can you mention (please provide come basic data as well)?
  - d) If yes, what was the government's reaction? And what about the industry's reaction?
- Experiences based on SolidStandards project/trainings
  - a) What was mentioned during training sessions about safety during transportation?
  - b) What was mentioned during training sessions about safety during storage?
  - c) What was mentioned during training sessions about health issues during transportation?
  - d) What was mentioned during training sessions about health issues during storage?
  - e) Is of any of the subjects mentioned above a need for standards expressed? If so, which?
  - f) What is the national mirror committee's point of view towards fire safety issues for storage? Please describe:
  - g) What is the national mirror committee's point of view towards health issues for transportation and storage? Please describe:
  - h) Do you think that certification can play a role? If yes, how should this look like?
- Are you familiar with one of the following documents/guidelines/standards? If yes, what is your opinion/experience?

  a) The Pellet Safety Project report on 'Results and Main Lines of Action based on the First International Workshop on Pellet Safety (March 2013, Austria)
  - 0 No,
  - 0 Yes, your opinion

  b) The NT Method – Guidelines for storing and handling of solid biofuels, Nordic Innovation Centre (2008)
  - 0 No,
  - 0 Yes, your opinion

  c) IEA paper 'Health and Safety Aspects of Solid Biomass Storage transportation and Feeding (2013)' (IEA Bioenergy Task 32, 36, 37 and 40)
  - 0 No,
  - 0 Yes, your opinion

  d) ÖNORM M7136
  - 0 No,
  - 0 Yes, your opinion

  e) ÖNORM M7137
  - 0 No,
  - 0 Yes, your opinion

  f) Are there, in your opinion, other interesting documents/guidelines/standards relevant? If so, please mention them below?
- Do you think that standards need to be developed for safety issues?

  0 No, because.

  0 Yes, your opinion

  If yes, at what level?
  - 0 Global (ISO), and/or:
  - 0 European (CEN), and/or
  - 0 Nationally
- Do you think that standards need to be developed for health issues?

  0 No, because.

  0 Yes, your opinion,

  If yes, at what level?
  - 0 Global (ISO), and/or:
  - 0 European (CEN), and/or
  - 0 Nationally

- Government's role. Law and legislation/regulations:
  - a) Are there sufficient regulations in your country that help prevent incidents regarding transport or storage? Please clarify?
  - b) Are there, in your opinion, sufficient international regulations that help to prevent incidents regarding transport or storage (that you are aware of? Please clarify?
  - c) Should government regulations be sharpened? If yes: At what level (national, European, global)?
- For which of which of the following fire safety topics is it, in your opinion, necessary to include it in (future) standards?
  - Raw material (e.g. soft wood / hard wood; white pellets / torrefied pellets) and the propensity for self-heating).

- Production equipment and procedures (but is not part of the scope of this paper).
- Cooling before storage (to increase rapid increase of the temperature).
- Type and size of storage.
- External influence accelerating self-heating (e.g. moisture, temperature (sun), contamination
- Air mixture composition.
- Self-heating (preventive) provisions
- Temperature monitoring.
- CO and CH4 monitoring.
- Emergency inerting (N2 or CO2).
- Smouldering, moisturizing and destabilizing of a lot of biomass during storage or transport.
- Instructions for workers (knowhow, product understanding, and interpretation)/trained professionals.
- Use of probes (type of probes and way and quantity of measuring).
- To include control measures for impurities when receiving the material, e.g. magnetic separators, sieves, etc.
- Spark detectors connected to an extinguishing system by fast acting valves at strategic locations in the transport system.
- Sprinkler protection system
- Control schemes to check the condition of bearings (temperature measurement
- Control schemes for cleaning to avoid accumulation of material in conveyers, elevators etc.
- Control schemes for hot work within the facility
- Routines for observations and controls.

- For which of the following health topics is it, in your opinion, necessary to include it in (future) standards?
  a) Cargo handling
  - Cargo handling specifications.
  - Instructions for handling cargo during filling.
  - Information collection specifications.
  - Methods of filling of the warehouse/shed/silo.
  - Methods of delivery out of the warehouse/shed/silo.
  - Cargo entering for storage related to weather conditions (during rain et cetera).
  - Different types of cargo, way of handling and storage (separately, not in each other’s vicinity).
  - Cargo out of condition (undamaged, in order to prevent dust et cetera).
  - Cargo storage height (maximum) (prevent fall over).
  - Contacts with beams and structures (should be avoided because of condensation issues).
  - Dust inhalation (followed by, see below).

  b) Dust Inhalation, other health risks
  - Dust exposure (wood dust, and also silica dust, e.g. the debarker).
  - Bacteria/endo-toxins.
  - Aldehydes & VOCs (e.g. building up in storage silos).
  - Carbon monoxide.
  - Oxygen deficiency.
  - Heavy metals.
  - Zinc.
  - PCBs.
  - Oil (creosote/bitumen).
  - Carbon black.
  - Physical interaction.
  - Irritant/allergic hazards.
  - Pathogenic hazards.
  - Preventing biological health risks.
  - Exposure to organic dusts.
  - Exposure to bio aerosols.
  - Mitigation of hazardous dust.
  - Minimizing the formation of hazardous dust.
  - Minimizing exposure to hazardous dust.
  - Biogenic risks associated with anaerobic digestion.

- For which of the following construction of storage rooms-related topics is it, in your opinion, necessary to include it in (future) standards?
  a) Description of all parts of storage containers, silos, rooms, tanks and technical specifications:
  - Architectural
    - taking into account the amount and weight of biomass to be stored
    - (building) materials to be used (concrete, metal, galvanised steel)
  - Surface/bottom (for example flat bottom)
  - Floor level (underground, ground level)
  - Airtightness, sealing provisions (to prevent of, for example, dust, moisturing and contamination
  - Piping and movable conveyors (for filling)
  - Transportation aspects related to storage facilities (loaders, trucks, railcars)

  b) Specifications of (maximal) dimensions (L x H x W), and possibly about shape;
  0 No
  0 Yes, do you have max. dimensions in mind? Which are?

Do you have any further suggestions/remarks?

Annex 4 - Interview 2

Answers of this interview have been translated to English and have been integrated in this paper (part of the interview itself was already in English).

Vragen:

1. Wat is uw rol/functie (korte omschrijving):

2. Op welke vlakken op het gebied van vaste biobrandstoffen is uw bedrijf op dit moment actief (in Europa)?

   a) Welke soorten biobrandstoffen?

   - Wood pellets
   - Wood briquettes
   - Wood chips
   - Firewood
   - Non-woody fuels
   - Other, namely

   b) Aantal huidige centrales (in Europa)? Welke vorm(en) van biobrandstoffen wordt (/worden) gebruikt? Voor elektriciteit en/of warmte?

   c) Aantal toekomstige centrales? Welke vorm wordt gebruikt?

   d) Mits niet confidential, welke hoeveelheden (ktonne) worden gebruikt?

3. Welke OPSLAG EN TRANSPORT-protocollen/systemen hanteert uw bedrijf bij deze centrale(s)?

   a 1) Ten aanzien van veiligheid?

   a 2) Liggen hier normen en/of richtlijnen aan ten grondslag? Zo ja, welke?

   a 3) Zijn er zaken/aspecten die nu ontbreken/verbeterd of uitgebreid zouden kunnen worden ?

   b 3) Ten aanzien van gezondheid?

   b 2) Liggen hier normen en/of richtlijnen aan ten grondslag? Zo ja, welke?

   b 3) Zijn er zaken/aspecten die nu ontbreken/verbeterd of uitgebreid zouden kunnen worden ?

   c 1) Welke richtlijnen/normen zijn van toepassing bij het realiseren van centrales (met het oog op veiligheid)?

   c 2) Welke richtlijnen/normen zijn van toepassing bij het realiseren van centrales (met het oog op gezondheid)?

4. Bent u bekend met/maakt u gebruik van een van de volgende documenten/ richtlijnen/normen?

   En zo ja, wat is uw mening per item i.r.t. veiligheid en gezondheid?:

   a) The Pellet Safety Project report on ‘Results and Main Lines of Action based on the First International Workshop on Pellet Safety (March 2013, Austria)

   - Nee,
   - Ja, mening,

   b) The NT Method – Guidelines for storing and handling of solid biofuels, Nordic Innovation Centre (2008)

   - Nee,
   - Ja, mening,

   c) IEA paper ‘Health and Safety Aspects of Solid Biomass Storage transportation and Feeding (2013)’ (IEA Bioenergy Task 32, 36, 37 and 40)

   - Nee,
   - Ja, mening,

   d) ÖNORM M7136

   - Nee,
   - Ja, mening,

   d) ÖNORM M7137

   - Nee,
   - Ja, mening,

   e) Eventuele andere richtlijnen?

5. Bent u er voor dat er normen over veiligheid worden ontwikkeld?

   - Nee, reden:
   - Ja, reden:

.

Zo ja, op welk niveau (graag aanvinken)

- Nationaal (NEN)
- Europees (CEN)
- Mondiaal (ISO)

6. Bent u er voor dat er normen over gezondheid worden ontwikkeld?

- Nee, reden:
- Ja, reden:

Zo ja, op welk niveau (graag aanvinken)

- Nationaal (NEN)
- Europees (CEN)
- Mondiaal (ISO)

7. Bent u van mening dat wet- en regelgeving aangepast/aangescherpt moet worden?

Voor veiligheid, zo ja, welk niveau (national, Europees, mondiaal)?

- Nee, reden:
- Ja, reden:

Voor gezondheid, zo ja, welk niveau (nationaal, Europees, mondiaal)??

- Nee, reden:
- Ja, reden:

8. Welke elementen zijn volgens u noodzakelijke elementen in richtlijnen/normen t.a.v. veiligheid (graag aanvinken welke elementen volgens u belangrijk zijn)?

- Raw material (e.g. soft wood / hard wood; white pellets / torrefied pellets) and the propensity for self-heating).
- Production equipment and procedures (but is not part of the scope of this paper).
- Cooling before storage (to increase rapid increase of the temperature).
- Type and size of storage.
- External influence accelerating self-heating (e.g. moisture, temperature (sun), contamination
- Air mixture composition.
- Self-heating (preventive) provisions
- Temperature monitoring.
- CO and CH4 monitoring.
- Emergency inerting (N2 or CO2).
- Smouldering, moisturizing and destabilizing of a lot of biomass during storage or transport.
- Instructions for workers (knowhow, product understanding, and interpretation)/trained professionals.
- Use of probes (type of probes and way and quantity of measuring).
- To include control measures for impurities when receiving the material, e.g. magnetic separators, sieves, etc.
- Spark detectors connected to an extinguishing system by fast acting valves at strategic locations in the transport system.
- Sprinkler protection system
- Control schemes to check the condition of bearings (temperature measurement
- Control schemes for cleaning to avoid accumulation of material in conveyers, elevators etc.
- Control schemes for hot work within the facility
- Routines for observations and controls.

9. Welke elementen zijn volgens u noodzakelijke elementen in richtlijnen/normen t.a.v. gezondheid (graag aanvinken welke elementen volgens u belangrijk zijn)?

a) Cargo handling

- Cargo handling specifications.
- Instructions for handling cargo during filling.
- Information collection specifications.
- Methods of filling of the warehouse/shed/silo.
- Methods of delivery out of the warehouse/shed/silo.
- Cargo entering for storage related to weather conditions (during rain et cetera).
- Different types of cargo, way of handling and storage (separately, not in each other’s vicinity).
- Cargo out of condition (undamaged, in order to prevent dust et cetera).
- Cargo storage height (maximum) (prevent fall over)
- Contacts with beams and structures should be avoided because of condensation issues.
- Dust inhalation (hier onder vervolg).

b) Dust Inhalation, other health risks

- Dust exposure (wood dust, and also silica dust, e.g. the debarker).
- Bacteria/endo-toxins.

- Aldehydes & VOCs (e.g. building up in storage silos).
- Carbon monoxide.
- Oxygen deficiency.
- Heavy metals
- Zinc
- PCBs
- Oil (creosote/bitumen)
- Carbon black.
- Physical interaction.
- Irritant/allergic hazards.
- Pathogenic hazards.
- Preventing biological health risks.
- Exposure to organic dusts.
- Exposure to bio aerosols.
- Mitigation of hazardous dust.
- Minimizing the formation of hazardous dust.
- Minimizing exposure to hazardous dust.
- Biogenic risks associated with anaerobic digestion.

10. Welke elementen zijn volgens u noodzakelijke elementen in richtlijnen/normen t.a.v. constructie (realisatie) van een opslagruimte voor vaste biobrandstoffen?

a) Description of all parts of storage containers, silos, rooms, tanks and technical specifications:

- Architectural
- taking into account the amount and weight of biomass to be stored
- (building) materials to be used (concrete, metal, galvanised steel)
- Surface/bottom (for example flat bottom)
- Floor level (underground, ground level)
- Airtightness, sealing provisions (to prevent of, for example, dust, moisturing and contamination
- Piping and movable conveyors (for filling)
- Transportation aspects related to storage facilities (loaders, trucks, railcars)

b) Specifications of (maximal) dimensions (L x H x W), and possibly about shape;

- Nee
- Ja,Welke zijn dat?

10. Heeft u wellicht verder nog suggesties/opmerkingen?

Annex 5 - Interview 3

Answers of this interview have been integrated in this paper.

REMARK – Interview similar as Interview no. 1, but extended with question 11.

11. Standardisation (development)
    a) What view point does ISO/TC 238 have? Which activities from them are to be expected?
    b) Are there already ISO-standards available that in your opinion help in these matters? Are standards being developed?
    c) What view point does CEN/TC 335 have? Which activities from them are to be expected?
    d) Are there already CEN-standards available that in your opinion help in these matters? Are standards being developed?
    e) And what about national guidelines/standards, which definitely need to be mentioned?
    f) As far as you know, in which countries have guidelines/standards been developed (also outside Europe)?

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