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Solid biofuels — Safety of solid biofuel pellets — Safe handling and storage of wood pellets in residential and other small-scale applications

Biocombustibles solides — Sécurité des granulés de biocombustible solide — Manutention et stockage en toute sécurité des granulés de bois dans des applications résidentielles et autres applications à petite échelle

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 238, *Solid biofuels*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

There is a continuous global growth in production, storage, handling, bulk transport and use of solid biofuels especially in the form of pelletized biofuels.

The specific physical and chemical characteristics of solid biofuels, their handling and storage can lead to a risk of fire and/or explosion, as well as health risks such as intoxication due to exposure to carbon-monoxide, asphyxiation due to oxygen depletion or allergic reactions.

There is a risk of injury or death associated with pellet storage, so safety measures shall be implemented. The possibility of fire and explosion incidents is a clear indicator that safety needs to be prioritized, first of all for human safety but also because interruptions in energy supply can have significant consequences. The market confidence in solid biofuels as a secure energy source may be jeopardized and financial losses due to business interruptions could occur. Difficulty to obtain insurance coverage will also increase.

As part of the determination and the assessment of risks for solid biofuels, defined test methods and standards are established or need to be developed. However, the ageing and degradation due to handling and storage of solid biofuels in particular environments will affect the characteristics. The consequence of this change of characteristics is that safety margins need to be established in relation to the actual analysis results.

For small scale applications and handling of small quantities of pellets up to 100 t, requirements of this standard support end-users not educated in safety aspects or requirements of solid biofuel handling. Health risks are associated with the quality of the fuel and therefore controlling the fuel quality reduces the risks, particularly of dust emissions. Logistics and the handling of the pellets play a major part in maintaining quality and are therefore also addressed in this standard.

Generally, facilities at end users with a storage capacity <100 t are covered by this document and larger stores will be covered by ISO 20024[1]. However, storage capacity alone is not a good enough parameter on which to decide which standard to apply. A trader or larger end user might have a number of small storage facilities but may have a greater throughput of pellets during the entire year but with frequent filling and reclaiming or packaging. Depending on the characteristics of a specific facility, all of the principles covered in this document should be considered but all or only some parts of the systems/equipment described in ISO 20024 will be relevant.

A competent assessor should have knowledge and experience commensurate with the complexity of the facility (knowledge of solid biofuels is required) before selecting which standard and which clauses are applicable to the facility being considered.

1) Under preparation. Stage at the time of publication ISO/CD 20024:2018.

Solid biofuels — Safety of solid biofuel pellets — Safe handling and storage of wood pellets in residential and other small-scale applications

1 Scope

This document provides principles and requirements for the safe handling and storage of wood pellets in residential and other small-scale applications. It covers the supply chain from loading of the delivery truck, requirements of delivery trucks, connections to the end-user's store and the delivery process. It also covers the design and construction of pellet storage systems. This document addresses risks of fires, dust explosions, off-gassing, oxygen depletion, damage to appliances and buildings through swelling of pellets and other health risks. It is applicable to wood pellets according to ISO 17225-2.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 16559, *Solid biofuels — Terminology, definitions and descriptions*

ISO 17225-2, *Solid biofuels — Fuel specifications and classes — Part 2: Graded wood pellets*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

EN 13237, *Potentially explosive atmospheres — Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*

3 Terms and definitions

For the purposes of this document, terms and definitions given in ISO 16559 and EN 13237, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 General terms

3.1.1
combustible dust
finely divided solid particles, with a particle size of 500 µm or less in nominal size, which may form explosive mixtures with air at standard atmospheric pressure and temperatures

Note 1 to entry: This includes dust and grit as defined in ISO 4225.

Note 2 to entry: The term 'solid particles' is intended to address particles in the solid phase but does not preclude a hollow particle.

[SOURCE: ISO/IEC 80079-20-2:2016, 3.1]

3.1.2
fines
F
small sized particles in fuel below a certain pre-defined size, here less than 3,15 mm

Note 1 to entry: The amount of fines can be different after completion of production, bagging, transportation, unloading, distribution etc.

[SOURCE: ISO 16559:2014, 4.90, modified — “usually” replaced by “here” to indicate exact limit.]

3.2 Terms related to transportation and delivery

3.2.1
bulk transport
pellets transported loose, typically in tippers, walking floor trucks, other trucks with closed cargo area or *blower trucks* (3.2.2)

3.2.2
blower truck
vehicle with a pneumatic discharge system using compressed air

Note 1 to entry: Examples of blower trucks include silo-trucks and rotary feeder trucks.

3.2.3
silo truck
fully pneumatic *blower truck* (3.2.2) where pellets are loaded into special pressurised compartments emptied by applying compressed air and using compressed air for pellet conveying

3.2.4
rotary feeder truck
truck where pellets are discharged by gravity via a rotary valve (or star valve) into the stream of compressed air for pellet conveying

3.2.5
day hopper
hopper directly linked to the automatically stoked heating boiler

Note 1 to entry: Typically a day hopper holds a few days of pellet fuel up to 1 t. The filling of the hopper is a batch operation.

3.2.6
closing cap
cap made of metal or plastic, which seals the *connectors* (3.2.7)

3.2.7
connector
permanently installed coupling made of aluminium-alloys or steel, with a gasket ring for pressure and suction operation, which functions in the filling of the *pellet store* (3.3.2)

Note 1 to entry: There are different uses for connectors, such as filling and suction.

3.2.8
delivery hose
temporary connection between the pellet *blower truck* (3.2.2) and the fill connector of the pellet store during the pneumatic delivery process

3.3 Terms related to storage

3.3.1
sloping floor
construction in the store that allows the fuel to be fed by gravity to the conveying system

Note 1 to entry: The aim is to achieve storage that completely drains without any intervention.

3.3.2
pellet store
room, container or other place where pellets are stored by the end-user before combustion

Note 1 to entry: Pellet stores can be self-built or pre-fabricated.

3.3.3
small pellet store
pellet store with a capacity of less than 15 t

3.3.4
individual customized store
pellet store that is individual custom-made into a building often including existing structures like walls

Note 1 to entry: Individual customized stores may be self-built by end-users.

3.3.5
pre-fabricated store
storage system built by specialist companies, erected at the end-user's premises

3.3.6
fill pipe
connecting pipe, which connects the fill *connector* (3.2.7) with the pellet store

3.3.7
small bag
bag for pellets with a typical filling weight between 8 kg and 25 kg

3.3.8
big bag
flexible intermediate bulk container (FIBC) made of flexible fabric that is designed for storing and transporting bulk materials with a capacity of 500 l and above

4 General

4.1 Product requirements

This document was developed to promote the safe handling, storage and combustion of pellets conforming to the fuel properties of ISO 17225-2, Classes A1, A2 and B. If other fuel types are used the principles contained herein might not apply.

A data sheet for wood pellets issued by the manufacturer/supplier may provide more specific information with regards to the product delivered, quality, safety and health aspects during handling and storage.

4.2 Hazards associated with amounts of pellets ≤100 t

Pellets react in their environment in different ways, especially with air and moisture and they are also sensitive to mechanical stress. To avoid hazards it is important to store and handle pellets accordingly.

The hazards associated with pellet storage in small-scale applications can be summarized, but are not limited to the following categories:

a) intoxication or oxygen depletion caused by volatile components that may accumulate through biological degradation or originate from backflow of flue gases;

b) risk of explosions and fire due to accumulation of dust and fines as a result of physical stress and decomposition;

c) risk of fire and smouldering due to self-ignition processes or burn-back;

d) damage to storage structures and buildings due to swelling of pellets caused by water.

More information concerning the listed hazards is compiled in Annex A.

4.3 General requirements for storage and handling of pellets

All handling and transport equipment shall be designed to minimise damage to the pellets. Abrasion of pellets and consequential formation of fines shall be minimized.

Dust emissions to the environment shall be kept as low as possible. Fines and dust accumulate on flat and inclined surfaces. These surfaces and other places where fines may accumulate shall be minimized. Unavoidable areas where fines may accumulate shall be cleaned regularly, see 6.1.4.

Accumulation of carbon monoxide (CO) and volatiles in closed storage facilities shall be avoided by proper ventilation of the facilities.

Wood pellets shall be protected against humidity and moisture. They shall be kept dry at all times.

If pellets of other quality or diameter are used, the vehicles, conveyors and storage containers shall be thoroughly cleaned of any previously handled products.

NOTE Requirements for large storage facilities (>100 t), packing and loading systems are provided in ISO 20024.

5 Requirements for safe transport and delivery of pellets

5.1 General

The requirements will differ depending on how the pellets are delivered to the end-user:

a) Bulk pellets for residential and other small-scale applications are typically delivered by blower trucks. For requirements for this type of delivery, see 5.2.

b) If bulk pellets are delivered by tippers or walking floor trucks and are unloaded at the end-customer into a trough or a bunker, see 5.3.

c) If other vehicles are used for bulk transport the suitability of the transport system shall be evaluated.

d) If pellets are delivered in big bags, see 5.4.

e) If pellets are delivered in small bags, see 5.5.

In all cases the pellets shall be protected against moisture (e.g. rain, snow or condensate) throughout the transportation process as well as during loading and unloading.

Loading of trucks is only permitted when the pellet temperature is less than 40 °C. If the ambient temperature exceeds 35 °C, a pellet temperature up to but not exceeding 45 °C is acceptable. Heating of pellets in the truck shall be minimized e.g. by using bright/reflective surface on the outside of the truck. Heating can also be caused by using hot compressed air, which raises the temperature of the pellets.

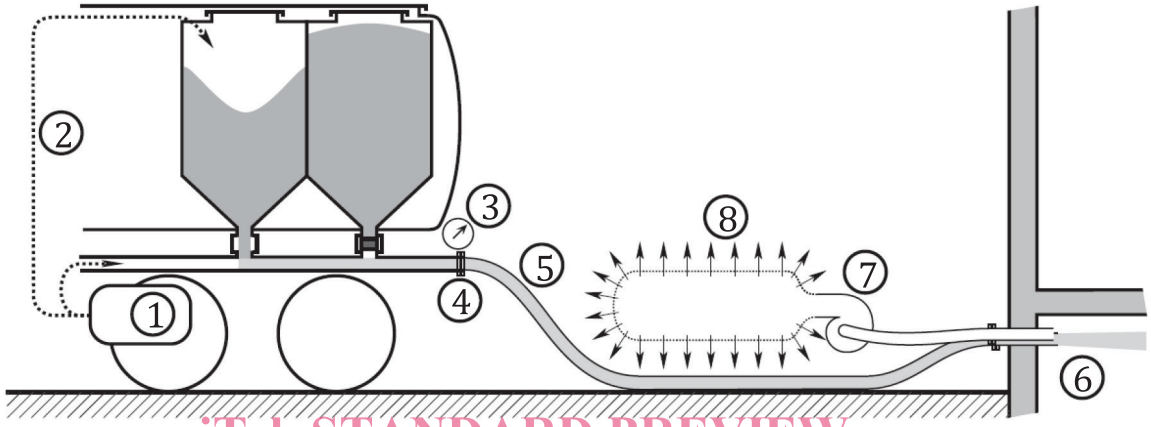
The specification of the pellets shall be in accordance with ISO 17225-2 and shall be stated on all delivery documentation and invoices.

All pellet handling areas shall be strictly non-smoking areas and have no open flames.

5.2 Requirements for bulk delivery by blower trucks

5.2.1 Transport vehicles and their operation

To help the understanding of the following paragraphs, see Figure 1.



Key

1 compressor
2 pressurisation of storage cell
3 pressure gauge measures pressure in the discharge pipe or in the storage cell
4 coupling on blower truck
5 delivery hose
6 end-user's pellet store
7 suction fan with filter sock to extract the blower air and create a slightly negative pressure in the pellet store
8 exhaust air

Figure 1 — Operating principle of the blowing process using a silo truck

Mechanical damage of pellets caused by transport vehicles shall be minimized. Blower trucks shall be equipped with a low abrasion blowing feed system. Low abrasion may be obtained by using coated hoses. Sharp edges between hoses shall be avoided. The trucks should be equipped with a compressor that provides air for blowing the pellets. Where required, blower trucks shall have a mobile fan to extract the supply air from the storage facility during blowing. Explosion protection for the mobile fan is not required if only used outdoors. The capacity of this suction fan shall exceed the capacity of the blowing system of the vehicle. The extracted air shall be filtered (e.g. by fabric filter) to limit dust emissions to the environment. The connected filter bag shall be checked for fouling and shall be protected from rain or be made from water resistant material in order to ensure a necessary negative pressure in the pellet store during the blowing process.

Some stores do not need suction of the blowing air. Filling instructions provided by the manufacturer of these stores shall be followed. Where no suction is required, the blowing air (<1 500 m^3/h) has to exit through windows, doors or other openings, so that the pressure in the room where the pellet store is located does not increase significantly. Openings should have a size of at least 400 cm^2.

A blower truck shall be constructed so that the increase in fines is as low as possible. While testing the suitability of a truck the increase of fines shall be less than 2 % where:

— the pellets have a mechanical durability of 98,5 % (±0,3 %),

— the delivery hose shall be 18 m long and there is one 45° bend (radius = 2,5 times the pipe diameter) in the fill pipe,

— the distance between the tube end in the store/test facility and the opposite wall is 3 m,

— the impact mat is 50 cm in front of the rear wall,

— the delivery rate has a mass flow of 15 t/h (±1 t),

— the minimum quantity of fuel to be blown for this test is 500 kg.

The actual fines content in the end-user's store depends on many additional factors to those during testing (e.g. impact of driver/operating staff competence, blowing distance, height differences, bends, construction and dimensions of the pellet store) and can exceed the 2 % increase limit expected from the testing of the transportation vehicle.

Locally used reducing and connecting couplings should be part of the equipment on board the truck. The hose couplings shall be free from obstructions that would cause damage to the pellets. Only electrically conductive delivery hoses shall be used for the filling. Where the delivery hoses have a coating, the breakdown voltage shall be below 4 kV. The delivery and vent hoses shall dissipate static (earth leakage resistance $R_E << 10^6$ Ω). Hoses shall be marked or be clearly visible when crossing traffic areas like sidewalks or bicycle paths.

The blower truck shall be equipped with an earthing system. Blower truck doing part deliveries of the loaded pellets to end-users shall be equipped with calibrated certified on-board weighing system.

The truck storage cells shall be securely closed immediately after loading the truck.

Only trucks properly operated, maintained and with well-kept blowers/compressors shall be deployed. Storage cells, hoses, fans, filters and other equipment shall be clean and shall be inspected regularly by the operating staff according to the manufacturer's instructions and good practice.

In difficult delivery situations where high temperatures in the blowing air and pellets can cause problems such as long distances between the truck and fill connector and/or high ambient temperatures (>30 °C), the blower trucks should use cooled air. The blower trucks should either use cooled air as a technical measure (compressor cooler) or optimize the temperature through organizational measures (e. g. delivery in the early morning when it is still cool).

5.2.2 Filling end-user storage systems

When filling a pellet store there are two options:

a) When the customer is on-site or deliverer has been provided with access:

   — If required by the filling instructions of the manufacturer, the customer shall turn off the combustion system in appropriate time before the delivery of the pellets. This needs to be confirmed by the customer before delivery.

   — The exact period of time before the delivery takes place should be given in the boiler instructions.

   — The customer will confirm to the driver that the boiler has been turned off for the required period.

b) When the customer is absent:

   — The customer can give a written instruction that delivery can be made safely without turning the boiler off.

   — Where the delivery operative has no information on the length of time the boiler has been turned off and there is no written instruction from the end-user to carry out the delivery the pellet supplier shall not fill the pellet store.

To help the understanding of the described options when filling a pellet store, see Figure 2.

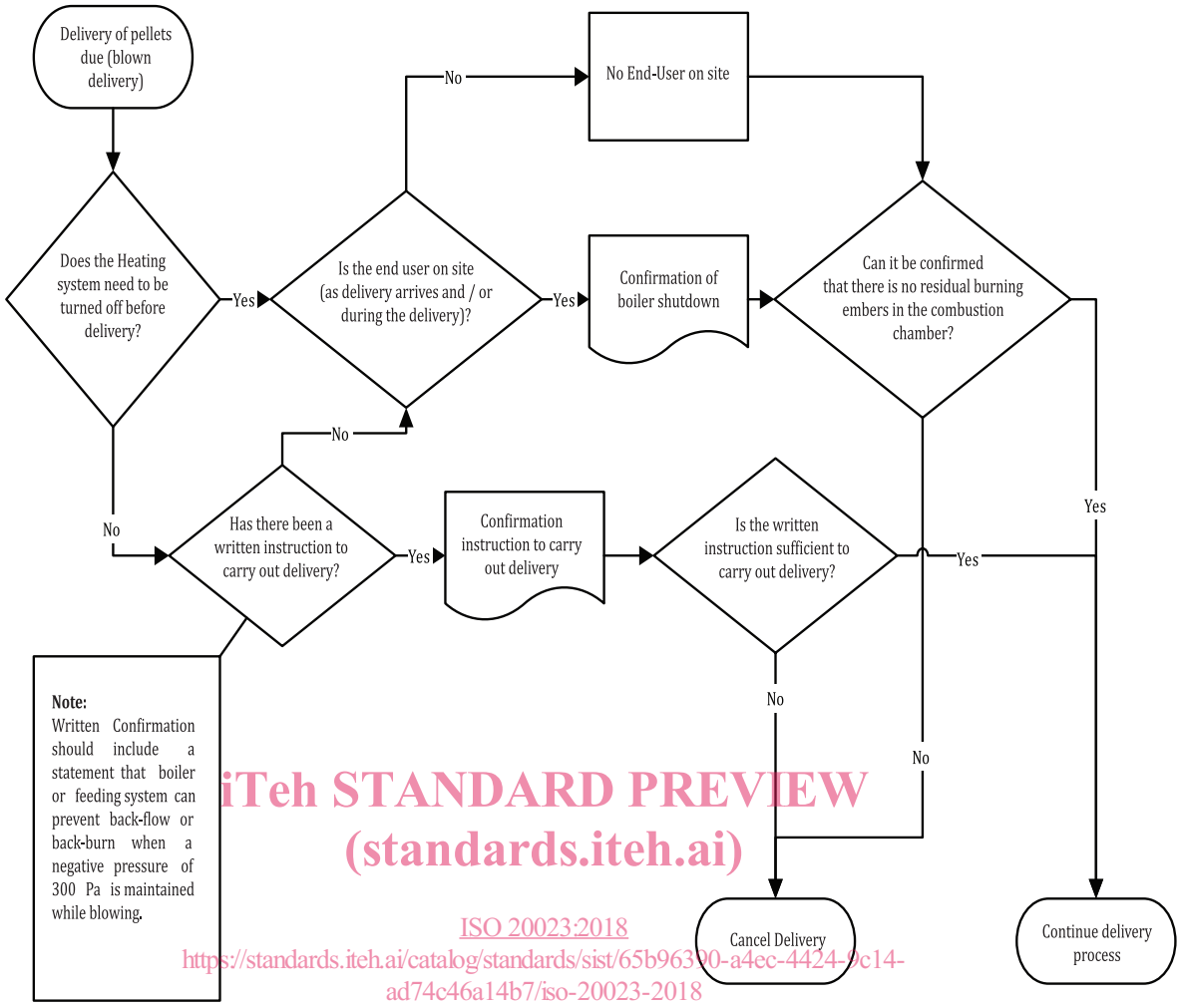


Figure 2 — Filling of end-user store

Before filling an end-user pellet store a checklist shall be filled in by the delivery staff, see an example of a checklist in Annex E. The checklist shall include at least the following information:

a) Boiler switched off; YES/NO/UNKNOWN. If the boiler has not been turned off, and there is no written instruction that delivery can be made safely without turning the boiler off, no delivery shall be performed.

b) Pellet store inspected; YES/NO.

c) Nature and estimated amount of remaining pellets in the store, if possible.

d) Obvious defects and observations which may cause safety hazards.

e) Suction fan used; YES/NO.

f) Fill connectors are properly earthed; YES/NO/UNKNOWN. If proper earthing is not ensured at the connectors, the earthing system of the blower truck shall be used.

g) Length of hose used (in metres).

The checklist shall be included in the delivery documents and may be included in the delivery note.

The filling instruction for the pellet store shall be clearly visible for the pellet deliverer.

If local arrangements are unfavourable e.g. too many bends in the filling lines, blowing distances >30 m or disadvantageous layout of pellet store, excessive fines can arise. Such issues shall be documented on the checklist and should be explained to the customer.

NOTE Particle segregation will occur during storage and delivery, and the results can be seen on the slope in the lower area of the storage. The appearance of a dusty surface of the pile is not an indication for the total fines content in a pile.

5.3 Pellets delivered in bulk tipped into troughs or bunkers

When pellets are delivered by tippers or walking floor trucks into a trough or bunker, the reception facility shall meet the following requirements:

a) be covered except during delivering of pellets;

b) be at least 0,5 m wider on either side of the tail gate of the discharge chute to collect all pellets during unloading;

c) where grating is used it shall be constructed of bars with rounded edges.

5.4 Pellets delivered in big bags

Pellets may be delivered in big bags (FIBC) with or without a discharge spout. Preferably bags with four lifting loops should be used. Forks used for handling big bags shall have rounded edges to avoid damage to the bag.

Big bags without a discharge spout delivered to an end-customer will usually be emptied manually by taking out small amounts. They shall be closed between withdrawals to protect the pellets from moisture and contamination.

Big bags with a discharge spout shall have a discharge spout with a diameter ≤300 mm. The lacing cord for closing the discharge spout shall be connected to the big bag and shall not be cut open to avoid contamination of the pellets with cord ends. These bags may also be used as a fuel store that feeds directly into the heating system.

5.5 Pellets delivered in small bags on pallets

Pellets in small bags on pallets shall not be stored outdoors in direct sunlight. Pallets shall be covered with a protective covering and be recovered after withdrawal of bags from the stack.

Outdoor storage in direct sunlight may be done if the packaging material is UV resistant and weatherproof. A loaded pallet with pellets may be damaged by animals, e.g. birds, foxes and rats, when stored outdoors.

Pellet bags shall be stored unopened. Bagged pellets are safe from gaseous emissions in terms of health impacts if one bag is opened at a time and loaded into the pellet store or day hopper.

6 Requirements for bulk storage systems

6.1 General requirements

6.1.1 Location of pellet store

The blower truck shall be able to get sufficiently close to the connectors to minimize damage to the pellets during the filling process. The access route shall be adequate for the kind of transport vehicles that are used. The minimum road width and minimum clearances for heavy trucks according to national regulations shall be guaranteed. The turning radius, gross weight of the vehicle, the gradient of the roads and winter conditions should be considered.

When filling the pellet store with a blower truck, a hose length of 30 m shall not be exceeded. The total pipework including hose, connectors and pipework in the facility should not exceed 35 m. Connectors shall be easily accessible.

6.1.2 Quality control of installation

Pellet stores shall be installed and operated according to this standard and the manufacturer´s instructions. It is recommended that the installer of the heating system also installs the pellet store and is therefore responsible for smooth operation of the whole system. Even if the pellet store is not built by the installer, he shall check the pellet store before the first pellet delivery. The results of the check shall be handed over to the end user, as given in Annex D.

6.1.3 Construction requirements

Walls and all construction elements shall be designed to withstand the load in all directions (horizontal as well as vertical). For calculating loadings the maximum bulk density of pellets of 750 kg/m^3 and pressure fluctuations of max. 3 000 Pa overpressure during filling operations should be considered. Pipes and connectors shall be earthed. All surfaces of equipment which can charge statically, including walls and conveyors in direct contact with pellets or related dust, shall be electrostatically dissipative or be connected to earth.

6.1.4 Measures to reduce the accumulation of fines

Pellet stores shall be designed and constructed to prevent and/or reduce the accumulation of fines. Ideally owners and/or operators should not need to enter pellet stores. However, for most systems it is recommended to empty the pellet store completely and clean up at regular intervals. If not otherwise stated by the manufacturer, pellet stores should be cleaned thoroughly at least once every 2 years or every fifth delivery, whichever comes first. If cleaning is required, manufacturers of storage systems, boilers and conveying systems shall provide cleaning instructions.

NOTE An accumulation of fines at the bottom of the pellet store can cause problems with the pellet feeding system and/or the boiler. Fines in the pellet store are caused mainly by mechanical stress during pellet delivery. Bends in the pipework, inadequate impact mats, obstacles in the route of the pellets, a high pellet velocity and a low solids loading factor (e.g. a low volume of pellets travelling along the delivery hoses) during blowing increase the amount of fines. As a result of particle segregation processes in the store, fines will concentrate over time at the bottom of the pellet store.

6.1.5 Protection against moisture and water

Pellet stores shall be protected against penetration of moisture during filling and storage. Condensation shall also be prevented.

Where flooding is considered a risk, the pellet store should be positioned, designed and built in such a way as to prevent ingress of water, washing away (the whole building), and swelling of the stored pellets (if water does enter the store), which could cause harm or damage to people, equipment and the storage construction.

6.1.6 Prevention of dust movement

The pellet store shall be dust tight relative to adjacent spaces. In particular a dust tight construction of the door and hatches shall be achieved.

6.1.7 Noise protection

The extraction/conveying system and all components shall be constructed to avoid structure-borne noise.

With respect to noise emissions of the truck compressor it shall be considered during the planning of the pellet store's location and where the truck will park during delivery. As an example, a delivery of 25 t by blower truck might last up to 3 h.