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Evaluation of UN-packaging requirements

TNO report

Transmitted by the expert from the Netherlands

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TNO-report

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Evaluation of UN-packaging requirements

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Summary

This report summarises the results of the project “Evaluation of UN-packaging requirements”, which was carried out in assignment of the Ministry of Transport, Public Works and Water Management in the Netherlands.

Industrial companies in the packaging chain from packaging manufacturers to packers/ fillers and consignors were interviewed. Interviews were also held with governmental inspection agencies and competent authorities outside the Netherlands and an inventory was made of the experiences at TNO. For these interviews a questionnaire was developed specifically for this project.

It is concluded that the present system of multimodal UN-requirements for the construction and testing of packagings is a good basis for ensuring safe transport of packed dangerous goods, while an evaluation is deemed necessary. Leakage from packaging in practice is mainly caused by failure of closures, incorrect handling or stowage or improper unit loads.

Global implementation and enforcement of the system must be assured and the transfer of knowledge on the performance and properties of the packaging into the packaging chain must be improved. This should include information on proper handling, stowage and formulation of unit loads. Also more knowledge should be developed on the performance of the packaging in relation to the use and reuse in practice.

Based on these conclusions, recommendations are given for further development of knowledge and information gathering and transfer. In this respect special attention should be given to air transport in view of the high risk level of this kind of transport.

1. Introduction

Packing of dangerous goods for transport is subject to requirements, which have to be met. International and national regulations for the transport of dangerous goods include these requirements. These regulations for sea, land and air transport are based on the UN-Recommendations on the Transport of Dangerous Goods, which have been formulated by the UN-Committee of Experts on the Transport of Dangerous Goods, a Committee of the United Nations.

Part 4 of the UN-Recommendations contain the packing provisions and Part 6 the requirements for the construction and testing of packagings, Intermediate Bulk Containers (IBCs), and Large Packagings (LPs). Thanks to the UN-Recommendations on the Transport of Dangerous Goods a large degree of harmonisation has been obtained among the modal regulations, although differences exist due to the specific nature of each mode.

This report is concerned with packaging including IBCs and LPs . For the first category the UN-packaging requirements are in operation 15-20 years now and for IBCs about 10 years, while LPs are a recent category of packaging.

An evaluation of the UN-packaging requirements is justified now, taking into account the period that the UN-packaging requirements are in operation. Further it turns out that a number of aspects need attention. Examples are:

- Regularly proposals are submitted to the UN-Committee to consider changes or extensions to the UN-packaging requirements e.g. the introduction of a vibration or puncture test. Apparently experience has shown the need for such an introduction, but it will be clear that these changes can have a large impact on the operation of the system and need serious consideration.
- There is evidence that packagings bearing a UN-marking do not always comply with the requirements related to this marking.
- Incidents are observed in practice e.g. leakage of packagings in air transport.

An evaluation is thus necessary in order to maintain and improve an acceptable level of safety in transport.
This was recognised by the Ministry of Transport, Public Works and Water Management, in the Netherlands acting as competent authority for the regulations on the transport of dangerous goods.

The Ministry of Transport, Public Works and Water Management asked TNO Product Testing & Consultancy, Packaging Research Department to carry out this project with the aim to formulate recommendations in what way problems with packaging can be prevented, by making an inventory and analysis of the problems occurring in practice. TNO Product Testing & Consultancy acts in the Netherlands as competent authority on behalf of the Ministry of Transport, Public Works and Water Management on all matters concerning the packaging of dangerous goods, including the UN-type testing, certification and quality assurance on manufacturing.

2. Investigation

In order to obtain a good impression of the operation of the system of UN-packaging requirements it was decided to arrange a number of interviews with both industrial companies in the packaging chain, governmental inspection agencies and competent authorities outside the Netherlands. With the exception of the foreign competent authorities, all interviews were held in the Netherlands. The industrial companies were carefully selected, both on their relevance and experience and on the fact that they operate internationally. This was considered as very important, as the regulations are also operative internationally and an evaluation should preferably be approached on an international level.

In total 11 industrial companies were interviewed, spread over the packaging chain: packaging manufactures, reconditioners, packers/fillers and consignors.
The inspection authority in the Netherlands for sea, land and air transport was also interviewed and an inventory was made of the experiences at TNO.
Finally competent authorities in the USA, UK and Germany were consulted.
All interviews were held with the aid of a guidance form, containing the following aspects:

- General information of the company or organisation
- Characterisation of the company or organisation in the packaging chain
- Legislation and approval (e.g. knowledge of legislation and packaging approvals)
- Packagings (e.g. types of packagings used for transport)
- Packaging requirements (e.g. opinion on the quality of the packaging requirements)
- Practical experience with packagings (e.g. data on incidents and problems with packagings)
- Reuse of packagings (e.g. conditions for reuse of packagings)

From every interview a report was made giving all the details of the results of the interviews. These reports are considered to be confidential and are only made available to the client, the Ministry of Transport, Public Works and Water Management.

In this report all the results of the interviews are summarised and analysed. Conclusions and recommendations also form part of this report.

3. Results

The results will be presented by subject, corresponding to the relevant items of the guidance form: legislation and approval, packaging requirements, practical experience with packagings and reuse.

Legislation and approval

Generally the legislation is well known and considered as accessible, although complex by nature. The on-going work on further harmonisation is welcomed, although in some cases differences are still noted; examples are the standard liquid system for plastics packagings in Europe (ADR/RID) and the vibration test in the USA. It is felt that there is still some room for different interpretations, which obstructs the harmonisation.

Approvals and test reports are often available through the manufacturers of the packagings. The accessibility of the approvals for reference by the users and inspection agencies should be improved. There is a great need for a system, which would allow the collection of information of all approvals issued world-wide.

The level of enforcement is considered to be different in countries world-wide. In the Netherlands part of the enforcement is the “in company control” where the inspectors are visiting companies dealing with the transport of dangerous goods. This preventive action is judged as very positive by the companies concerned and is considered to be very effective in promoting safety in transport. The knowledge level of inspectors on packaging should be improved.

Concern is expressed regarding legislation other than transport (e.g. storage and use) dealing with dangerous goods in relation to the transport regulations. In this area there is a lot of room for further harmonisation.

Packaging requirements

Generally the UN-packaging requirements are considered to be sufficient and there is no need for introducing additional requirements. It is recognised that additional requirements can be necessary but these are specific for a transport route or for use. Introduction of additional requirements into the UN-packaging requirements can only be justified when a correlation with packaging failure in practice is shown.

The general opinion is that UN-certified packagings have to be usable for all modes of transport, including air transport. It is recognised that air transport needs special attention and may require additional measures on specific aspects (e.g. additional requirements for packagings in relation to pressure and temperature), taking into account the specific transport conditions and risk level.

There is great concern on the implementation of the system of UN-type testing, approval and quality assurance world-wide. The general opinion is that the system has not been implemented properly in all countries world-wide and that this leads to the existence of packagings not complying with the regulations on the transport of dangerous goods.

Practical experience with packagings

Generally only a few incidents are mentioned. Many companies have a system of systematic gathering of data as part of their quality assurance system concerning problems with packagings ; these data are analysed and lead to recommendations for in company improvement. Governments generally do not

have such a system in operation. The USA is an exception, although it takes a lot of effort to analyse the raw data.

When packaging failure is observed, this is often caused by leakage through the closure. The filler of the packaging is not always aware of the correct closing of the packaging (e.g. the torque to be applied for screw-type closures) and/or uses closure elements not conforming to the original specifications. Closures on rigid IBCs at the bottom are known to be a critical element subject to leakage. Failures were observed when rigid IBCs toppled, resulting in coming off of the closure at the top.
Venting closures often function problematically in practice (e.g. blocking) and there is the impression that they are also used for situations where the regulations do not allow a venting closure (situations when high pressures are developed by other causes than decomposition of the substance). It is interesting to note that airing systems are often used (e.g. when filling hot substances which can lead to underpressure when cooled to room temperature), but the regulations do not cover this kind of application.

Further, major causes of failure are improper stowage or handling or the formation of incorrect unit loads. Failure of packaging e.g. through puncturing by nails in the case of low quality pallets is not uncommon.

Permeation is a potential problem, but does not get sufficient attention, because it does not lead to readily observed leakage (there are often indirect effects like deformation of the packaging).

Specific substances can cause failure of the packaging; e.g. nitric acid is well known to lead to severe degradation of the plastics packaging, especially at high temperatures and because of the very strong degradation by the vapour. In this case the regulations assume that 6 months storage is sufficient to cover a longer period of use.

A general observation is that a lack of knowledge on packaging matters can lead to incorrect packing of dangerous goods. This is illustrated by the fact that packers and fillers often only rely on the UN-marking thinking that this gives them sufficient information.
A particular problem in this respect is the combination packaging. In practice inner packagings are used which are not in conformity with the ones originally specified; it is sometimes believed that a UN-certified outer packaging can generally be applied for any type of inner packaging.

Packers and fillers find the assimilation of substances to standard liquids in the compatibility testing procedure as given in the European transport regulations (RID/ADR) rather complex. A databank with information on assimilation of substances including mixtures would be of great help.

Reuse

It is generally recognised that the packaging requirements are related to new packagings. It is often not known how the performance of packagings (including e.g. closure elements with relaxation phenomena) develops in relation to the duration of use of the packaging in practice.
Although the regulations pay attention to reuse, reconditioning and repair of packagings (including IBCs) this is still an area with many parameters with unknown influence on the performance.

4. Analysis of the results

The general opinion is that the UN-requirements for the construction and testing of packagings are sufficient for its purpose: they provide a solid basis for the safe transport of packed dangerous goods. However, it is doubted whether the system of UN-type testing, certification and quality assurance has been implemented correctly world-wide. A harmonised global implementation is a condition in order to secure this safe transport. The implementation also includes a harmonised enforcement of the regulations. In the Netherlands very good experience has been gained with preventive enforcement, the “in company control”.
It is important that the system remains multimodal meaning that a UN-certified packaging can be used in all modes without restrictions.

It is clear that the system of UN-requirements for the construction and testing of packagings needs an evaluation after many years of operation, but drastic changes are not deemed necessary. These should only be realised in case of a proper justification e.g. when statistical data on incidents and accidents show that changes (e.g. introduction of additional test requirements) are necessary. An evaluation could be related to aspects like the drop position of IBCs, attention for handling of individual packagings and a simplification of the UN-marking . It must be recognised that it is not realistic to cover all transport conditions in the UN-packaging requirements and that it is the responsibility of the user of the packaging to verify if any additional requirements should be set.
Further study is necessary for formulating requirements for packagings for air transport. This is very important in view of the high risk level related to this transport mode.

When leakage from packaging occurs in practice, it seems that this is mainly related to the failure of closures, incorrect handling or stowage or improper unit loads (e.g. palletised loads). It thus seems that more attention should be paid to the functioning of the package in the packaging chain.
Education and training of persons involved in the transport of packed products are necessary.
The transfer of information concerning the relevant test conditions of the packaging (e.g. closure torque, closing tape, inner packagings) must be improved. It is important that the user of the packaging gets an easier access to the key information of the conditions for packaging use (e.g. test conditions, compatibility issues).This can be achieved by making the approval with all relevant information available to the user. The possibility of making this information available on the internet is worth exploring. This information should also include details on additional performance tests, e.g. compliance with vibration tests or internal pressure tests on inner packagings as required for air transport. In this way a user (but also inspection bodies) can judge whether the packaging type, which is intended to be used, is suited for the specific purpose and the responsibility of the user can better be taken.

More knowledge should be developed on the functioning of closures (including venting devices) and the influence of the conditions of use of packaging on its performance.

5. Conclusions

1) The present system of UN-requirements for the construction and testing of packagings is a good basis for ensuring a safe transport of packed dangerous goods. There is not enough evidence to justify a drastic change, although a review is deemed necessary.

2) The system of UN-requirements for the construction and testing of packagings should be and remain multimodal but this does not exclude specific requirements for air transport, which should be formulated in view of the high risk level of this transport mode.

3) It must be assured that the system of UN-requirements for the construction and testing of packagings is implemented and enforced globally in a harmonised way.

4) The transfer of knowledge concerning the performance and properties of the packaging into the packaging chain must be improved. This should also include information on proper handling, stowage and formation of unit loads.

5) There is a general lack of knowledge concerning the performance of packaging in relation to the use and reuse in practice.

6. Recommendations

1) Execution of a review of the UN-requirements for the construction and testing of packagings in the UN-Committee of Experts on the Transport of Dangerous Goods in the next biennium. It is recommended that this review is carried out by a working group.

2) Setting up of a system for systematic gathering and analysing incidents with packed dangerous goods.

3) Review of the contents of the information which is made available to the user of the packaging e.g. by means of an approval. This information should contain all aspects of importance to the user, including aspects like closure torque, inner packagings, compatibility issues and any additional testing details e.g. related to air transport.

4) Setting up of a system which would make the information as referred to in 3) better accessible to the users and inspection bodies.

5) Development of a guideline with information for the packer/filler/loader how to deal with the packaging in transport: instructions on e.g. filling, closing, handling, stowage and formation of unit loads. This guideline should be part of an education and training program.

6) Study of the transport conditions in air transport and its influence on packaging performance. This study should result in the formulation of additional requirements for packagings to be used in air transport in order to prevent failure of the packaging.

7) Study of the performance of packaging during its use in practice. This study should include the following aspects:
   - Degradation of (plastics) packaging materials as a function of time for specific chemicals
   - The performance of packaging at reuse (also after reconditioning and repair)
   - The functioning of closures, including venting and airing devices
   - Permeation of substances through the (plastics) packaging

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   This study should result in

   - Determination of maximum duration of use for (plastics) packaging in relation to degradation by the contents of the packaging
   - Criteria for reuse of packaging
   - Performance requirements for closures
   - Criterion for permeation

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