



Practical Instructions for Good Working Practice

Filling jerrycans, drums and IBCs with organic liquids

(Chapters 1-7 of this manual represent process and substance-specific criteria (VSK), recognised by the Committee for Hazardous Substances (AGS) of the German Federal Ministry for Labour, as a standardised working procedure.)

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This Practical Instructions for good working practice was compiled jointly by the German Federal Institute for Occupational Safety and Health (BAuA) and the German Association of Chemical Distributors e. V. (VCH). Chapters 1-7 of this manual represent process and substance-specific criteria (VSK), recognised by the Committee for Hazardous Substances (AGS) of the German Federal Ministry for Labour, as a standardised working procedure.

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1 General

If employees are working with hazardous substances, or if such hazardous substances are released while working, then, according to the Ordinance on Hazardous Substances [1], the employer is obliged, within the scope of the risk assessment according to the German Occupational Safety Act, to take measures to protect the safety and health of the employees.

The following order of priority must be observed when applying protective measures: substitution (replacement with less dangerous substances or processes), technical minimization of exposure, organisational and person-related measures. For hazardous substances with occupational exposure limit values, compliance must be ensured by workplace measurements or other suitable measures (TRGS (Technical Rule for Hazardous Substances) 402 [2]).

The Practical Instructions for good working practice “Filling jerrycans, drums and IBCs with organic liquids” is a sector-specific reference aid for hazard assessment, and for the selection of suitable protection measures, during the filling of organic liquids into jerrycans, drums and IBCs (Intermediate Bulk Container).

It was compiled jointly by the German Federal Institute for Occupational Safety and Health (BAuA) and the German Association of Chemical Distributors e. V. (VCH), and has been included in the appendix of TRGS 420 („Process- and substance-specific criteria (VSK) for identifying and assessing inhalation exposure”) by the Committee for Hazardous Substances of the Federal German Ministry for Labour.

In connection with hazards from the release of liquid vapours, the Practical Instructions can be used as a standardised working method according to TRGS 400 [3] on the basis of the Ordinance on Hazardous Substances [1].

The specified protective measures were derived from workplace measurements according to TRGS 402 [2]. When they are applied, one can assume that occupational exposure limit values are maintained for those liquids which fulfil the specifications listed in chapter 2. For these liquids, TRGS 402 [2] applies and accordingly the protective measures with regard to inhalation exposure are sufficient. This finding is also valid for liquids without occupational exposure limit values if they also satisfy the conditions described in Chapter 2. Workplace measurements are then no longer required in most cases.

In order to ensure the permanent effectiveness of the measures which are applied, these must be regularly reviewed. This can be carried out with the assistance of this Practical Instructions. On at least an annual basis, the user must therefore verify whether the prerequisites of these Practical Instructions remain unchanged for his working field. The results of this examination are to be documented.

Further aspects of the hazard assessment according to occupational safety law, apart from inhalation exposure, are not the subject of these Practical Instructions and must be examined separately.

2 Scope of application

These Practical Instructions for good working practice applies to filling jerrycans, drums and IBCs with organic liquids. Here, the filling equipment used must have a corresponding extractor system, such as local exhaust ventilation (LEV).

The application field of these Practical Instructions covers all organic liquids ("solvents") with an OEL (occupational exposure limit) greater than 9 ppm, which have a boiling point above 50 °C. However, the temperature of the filled organic liquids may not exceed 30 °C. The application field of these Practical Instructions also covers substances without occupational exposure limits, with a boiling point above 50 °C which, due to their H-statements [4], can be allocated to the hazard groups A or B according to the EMKG (einfaches Maßnahmenkonzept Gefahrstoffe = easy-to-use workplace control scheme for hazardous substances [5] (see Table 1). This allocation is made on the basis of the H-statements which are relevant for inhalation exposure. After allocation to the hazard groups A and B, in order to determine protection measures against dermal exposure, the skin-relevant H-statements must also be considered (see here 5.2).

The instruction manual is also valid for the filling of mixtures of organic liquids which are labelled with the corresponding H-statements in Table 1. If the mixture is generated by filling into a container, then all the added components must conform with the requirements according to these Practical Instructions.

The volume of liquid filled into the container may not be greater than 1000 L per container.

Table 1 Allocation of organic liquids in hazard groups according to EMKG [5] ¹

Substances with OEL acc. to TRGS 900 [6]	Substances without OEL		Hazard group
	R-statement	H-statement	
50 ml/m ³ < OEL ≤ 500 ml/m ³	No R-statement, R36, R37, R65, R67	No H-statement, H319, H335, H336, H304	A
9 ml/m ³ < OEL ≤ 50 ml/m ³ ¹	R20, R22, R41, R68/20, R68/22	H302, H332, H318, H371	B

Cleaning and servicing work, insofar as these are part of daily working (e.g. cleaning at the end of a shift), are also within the scope of application of these Practical Instructions .

H-statements, which describe physico-chemical and environmental hazards are not taken into account. The hazard assessment for filling activities in this respect, must be augmented according to the operational circumstances.

¹ By way of derogation from the EMKG, where the allocation to hazard group B for an OEL occurs in the range 5-50 ppm, here, the lower limit of the validity of this instruction manual applies, i.e. an OEL greater than 9 ppm for the allocation to hazard group B is used.

Organic liquids which are allocated to hazard groups C,D or E according to the EMKG [5], are not within the validity scope of these Practical Instructions. As a rule, the filling of such organic liquids must take place within closed systems, or they may require special expertise.

These Practical Instructions does not apply to mobile filling equipment, such as drum pumps, because these do not have a corresponding extraction suction unit. Furthermore, these Practical Instructions does not apply to the filling of tanks or tanker vehicles.

Operational disruptions are not the subject of these Practical Instructions. In particular, additional protective measures must be taken for cleaning and servicing work within the scope of operational disruptions. These must be adapted specifically to the operation in question.

3 Gathering information

Containers of different volumetric capacities are filled with organic liquids in a wide range of companies in different industrial sectors. This is usually carried out with filling systems which are equipped with an extraction attachment for escaping vapours. The containers are only filled to 98 % of maximum capacity [7].

3.1 Working procedures and activities

Jerrycans, drums and IBCs can be filled using the same filling systems, if the filling system is adapted to the container size in question. In practical working, however, there are certain different technical versions and practices. Filling of these containers can be carried out manually or semi-automatically.

- *Jerrycan (nominal capacity: 2.5-60 L)*

Jerrycans for filling with organic liquids are often arranged on pallets at the filling site. After filling, these pallets are taken away from the site by hand pallet truck or fork lift truck. Filling is carried out using a flexible lance which has an integrated suction device, or using pump nozzles with integrated or external suction.

As a rule, filling a jerrycan takes up to 30 seconds.

- *Drum (nominal capacity: up to 216.5 L)*

Typical here is filling on roller conveyors, which run below the stationary filling plant. After filling, the drums are sealed and leave the filling zone on the conveyor belt.

In order to fill drums manually, several of them can be arranged on a pallet. Because filling systems with a lance are generally permanently installed, filling is then often carried out with pump nozzles.

It takes about 1 minute to fill a drum.

- *IBC (nominal capacity: up to 1050 L)*

IBCs are taken by pallet lift trucks or fork lift trucks directly to the filling station. Filling is carried out with lances, pump nozzles or sometimes with hoses which are hung into the IBC. The filling systems used have either an integrated or an external suction extraction unit which is placed over the opening of the IBC. After filling, the IBC is sealed and taken away.

Also, filling of IBCs can be carried out via conveyor belts with a stationary filling system. After filling, the IBCs are sealed and leave the filling zone on the conveyor belt.

As a rule, it takes about 4-6 minutes to fill an IBC.

The activities of the employees carried out during the filling of the containers described above involve various working steps, which are basically similar for the various container types.

In preparations for filling, the filling device is attached to the system of supply pipes. Alternatively, the work is carried out with a full hose system and pump nozzle. Here, the addition of the organic liquids can be taken from storage tanks or directly from a tanker vehicle. After attachment to the supply system, the filling device is rinsed with the organic liquid to be filled. This first flow is usually collected by the employees in buckets. Immediately after rinsing, these buckets are removed from the filling area

and the collected organic liquids are filled into IBCs, or into drums, whose purpose is the collection of such rinsing liquids. These IBCs and drums are subsequently sealed.

After the containers have been placed in the position to be filled, an employee commences the filling process. Filling regulation is carried out by weighing or flow measurement. Filling can take place both above and below the liquid level in the container. A semi-automatic filling device switches itself off after the target value is reached. With manual filling, it is an employee who terminates the filling process.

Subsequently, an employee seals the filled containers and they are removed, either by conveyor belt, pallet truck or fork lift truck. Labelling of the containers can take place before or after filling.

Contamination with organic liquids on the floor is removed by the employees with binding agents. Drops on the containers are wiped off with cloths. Both the binding agents and the cloths are collected in storage containers which are subsequently closed again immediately.

3.2 Substances occurring during the filling of jerrycans, drums and IBCs

Jerrycans, drums and IBCs can be filled with organic liquids which have a boiling point greater than 50 °C. Their occupational exposure limit value must be greater than 9 ppm, or the liquid must, as according to Table 1, be allocated to the hazard groups A and B.

As a rule, when a container is filled, exposure to an organic liquid, or a corresponding mixture, does occur. A filling plant is usually adjusted/set up for a certain organic liquid which, according to the order, is to be filled into a previously determined number of containers. After filling, the set-up of the plant is often changed, in order to subsequently fill further containers with a different organic liquid or mixture.

Therefore, during the shift, an employee is exposed to an organic liquid, in each case for a certain period of time. Throughout the shift then, different phases of different exposures occur. Depending on the job list, several temporally separated phases of exposure can occur to the same organic liquid. A permanent exposure during the whole shift to just one organic liquid is a rare occurrence in container filling.

Because transporting is sometimes carried out with diesel engine fork lift trucks, these must be fitted with particle filters, in order to comply with the requirements of TRGS 554 [8]. The aim is to minimise exposure to carcinogenic diesel motor emissions (DME). Currently, there is no health-based, occupational exposure limit value for diesel engine emissions.

Electric powered fork lift trucks are also used in rooms categorised as Ex zone 2 and with gas monitoring.

Further hazardous substances do not occur when filling jerrycans, drums and IBCs within the scope of the organic liquids covered by these Practical Instructions.

4 Assessment of exposures to hazardous substance

The measurement values, listed in Table 2, can be used for the hazard assessment of filling jerrycans, drums and IBCs. These were determined for each type of container during filling with an organic liquid. The measurement values are exclusively activity-related, but they can be used as measures of representative exposure during the filling of the same types of containers with organic liquids, throughout the overall duration of the filling activity. In case filling takes place throughout a shift, these measurement values provide the shift average value. According to experience, this is more the “worst case” situation than the norm.

Table 2 Hazardous substance exposures, determined in persons wearing measurement equipment, during the filling of jerrycans, drums and IBCs while carrying out the protection measures in these Practical Instructions

Container	Measurement value [ppm]	
	Median	95 th percentile
Jerrycans	1.6	5.8
Drums	2.1	5.2
IBCs	2.0	8.6
All	2.0	6.8

The occupational exposure limit values were complied with for various organic liquids during the filling of jerrycans, drums and IBCs. If, during the filling of jerrycans, drums and IBCs with organic liquids, the protection measures, described in Chapter 5, are observed, then no workplace measurements need to be taken. For the hazard assessment, the 95th percentile, listed in Table 2, for IBCs of 8.6 ppm for the concentration of organic liquids during the filling of jerrycans, drums and IBCs can be used. The highest 95th percentile determined for a type of container is chosen as the assessment standard. This takes account of the fact that jerrycans, drums and IBCs can be filled with the same filling plant. This is valid for organic liquids with a boiling point greater than 50 °C and an OEL greater than 9 ppm, or which have been allocated to hazard groups A and B, according to the EMKG (see Table 1 of these Practical Instructions).

In order for this finding to be applied to a filling operation, the documentation must show that the protective measures included in these recommendations have been realised.

Irrespective of these Practical Instructions, all other requirements of the Hazardous Substances Ordinance remain in force, particularly those for determining information and hazard assessment for working fields not covered here, in which activities with hazardous substances take place which are not within the scope of these Practical Instructions.

5 Protective Measures for filling jerrycans, drums and IBCs with organic liquids

Hereinafter, the protective measures are described which must be employed during the filling of jerrycans, drums and IBCs with organic liquids belonging to the hazard groups A and B, according to the EMKG [5]. The boiling point of these organic liquids must be greater than 50 °C.

The basic principles for the avoidance of hazards, according to the German Ordinance on Hazardous Substances [1], are to be observed at all workplaces, see also TRGS 500 [14].

The working areas are to be furnished with a sufficient number of escape and emergency routes and exits, so that the employees, in case of hazards, can leave the working area quickly, uninterrupted and safely, and so that injured persons can be rescued.

The use of fire and open flames is not permitted.

Furthermore, the necessary measures for employees' skin protection are described in more detail below.

5.1 Measures for reducing exposure to hazardous substance

Filling

When a filling plant for jerrycans, drums and IBCs is used correctly, the working safety and health protection of the employees must be ensured. Work on filling installations may only be carried out by employees who have received instruction and are authorised to carry out this work safely, either independently or under supervision.

The hazards resulting from possible interactions with other working materials and substances, or with the working environment, must also be taken into account when setting up and operating filling plants.

Control stations of filling facilities must be constructed to minimize the dangers for the employees.

Any covers, or other protective installations, attached to filling machinery may not be opened, removed or circumvented in any other way during operation.

The filling of jerrycans, drums and IBCs may only take place in dedicated premises, where spilt substances can be retained. The filling line (lance, gun) must be long enough to dip into the container during the filling activity. The requirements according to the German Water Resources Law (WHG) [9], and executive regulations (in future: Regulations on Facilities Handling Substances Dangerous to Water (VAwS) regarding composition of the ground/collecting trough, must be met.

Jerrycans, drums and IBCs must be placed as near as possible to the suction extraction opening. In particular, when filling several containers on one pallet, the extraction vent should be placed as near as possible to every individual container to be filled.

Filling may only take place with filling machinery where the filling unit and the extraction unit have a fixed connection to each other. This can also involve a system where a coupling of both units take place before filling can start. The filling operation may only commence after suction extraction has been turned on.

At the filling site, a suction performance of about 180 m³/h is recommended. With a flush installation of the suction unit to the container, a lower suction performance of about 24 m³/h is possible.

A weight measurement or flow volume regulation must be employed to avoid overfilling. Where appropriate, a self-shutting nozzle valve can be used. The control instruments must be easy to read.

If containers are filled in closed or partially closed working areas, the air near the floor must be changed 5 times per hour.

Cleaning

Cleaning must be carried out regularly. The nature and frequency of the cleaning work must be defined in the operating instructions.

Spilled or sprayed organic liquids must be removed immediately with a suitable binding agent. Organic liquids spilled or sprayed onto containers must be removed completely with a suitable cleaning agent such as a cloth.

Immediately after use, binding agents and cleaners, with which organic liquids have been collected, must be placed in collection bins authorised for self-igniting substances at places of work. These must be kept closed.

Personal protective equipment

Employees are to be equipped with safety shoes with safety category S2 according to DIN EN ISO 20345 [10] and suitable working clothes or overalls covering the entire body according DIN EN ISO 13688 [11]. If substances are filled which are classed as flammable, protective clothing for Ex areas according to EN 1149-5 must be worn.

Employees must be equipped with chemical protective gloves² for them to use when required. Damaged protective gloves may not be used.

In case of unforeseen events, employers must make sure suitable respiratory protection is available. Here, the regulations of the Employers' Liability Insurance Association (Berufsgenossenschaftliche Regeln) are to be observed [12]. It is not permitted for workers to be made to wear personal protective equipment permanently, instead of taking technical or organisational protective measures.

5.2 Protective measures for dermal exposure

² Suitable chemical protective gloves are to be selected and used according to the information on the relevant safety data sheet, or other suitable sources (e. g. GESTIS Substance Database).

During filling work, the following skin-relevant H-statements for the filled organic liquids, and the derived protection measures, must be heeded: EUH066, H311, H312, H314, H315, H317, H371, H373.

When filling jerrycans, drums and IBCs, according to TRGS 401 [13], the possibility exists for employees to come into short and longer term skin contact. As a rule, a medium risk is assumed. Most affected are the hands, due to contact with contaminated surfaces as well as contact with spilled or sprayed organic liquids. If skin contact occurs, the affected body parts must be cleaned immediately. If, after a larger spill, work clothes are drenched, they must be changed.

In the factory, an activity-related skin protection plan is to be drawn up and displayed prominently. In the skin protection plan, the necessary protection, cleaning and care measures, related to the corresponding tasks endangering the skin, are to be set out in simple language the employees will understand. Qualified occupational medical health advice should be called on for drawing up the plan.

The measures listed in TRGS 401 [13] for estimating the hazards, and for selecting and evaluating personal protection equipment and skin care agents, should be consulted. The results are to be documented.

5.3 Operating instructions and training

Working instructions are to be drawn up for all working areas and displayed prominently, or made easily accessible, at a suitable place in the working area – preferably near the workplace itself. These operating instructions must define the nature and frequency of cleaning work and the types of personal protection equipment required. At least once a year, in an understandable manner and language, the employees must be given instructions related to their workplaces using the operating instructions.

Working with plant and machinery may only be carried out by employees who are appropriately authorised, and who can carry out such work independently and safely, or who are supervised during these tasks.

Eating, drinking, smoking or taking snuff is not permitted in the working areas.

6 Effectiveness check

The measures and requirements set out in chapter 5 are to be observed when applying these Practical Instructions on good working practice.

At regular intervals, or after changes in processes or machinery, the function and effectiveness of the current technical protection measures must be re-examined, in particular with regard to the proper functioning of the ventilation installations. Here, in particular, the intervals for testing and maintenance, defined by the manufacturer, must be observed. All testing and maintenance work on the machinery is to be documented.

The user of these Practical Instructions must review the requirements for the continuing applicability its contents after any changes in processes, otherwise regularly, and at least once a year. The result of this review are to be documented. Among these are the unchanged validity of these Practical Instructions, including the occupational exposure limit values and the judgement criteria, and the assessment as to whether these Practical Instructions is still relevant for the current workplace activities. In particular, the review should check the substances which are employed, and if these have changed to any extent.

Notwithstanding the regulations of these Practical Instructions, all other requirements of the ordinance on hazardous substances remain in force, in particular the requirements to obtain information and make hazard assessments for other areas of the factory, where activities with hazardous substances take place, but which are not governed by these Practical Instructions.

These Practical Instructions on good working practice is available on the Internet on the website of the Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (German Federal Institute for Occupational Safety and Health) under www.baua.de. It is reviewed regularly and the adapted to the current status of technical and legal development. The user of these Practical Instructions should therefore take care that the current valid edition is in use.

7 References

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- [10] EN ISO 20345: Personal Protective Equipment – Safety Footwear. Beuth-Verlag Berlin, April 2012
- [11] EN ISO 13688: Protective Clothing – General Requirements. Beuth-Verlag Berlin, December 2013

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- [12] BGR/GUV-R 190: Benutzung von Atemschutzgeräten. Deutsche Gesetzliche Unfallversicherung (DGUV), Dezember 2011 – *in German*
- [13] TRGS 401: Gefährdung durch Hautkontakt – Ermittlung, Beurteilung, Maßnahmen. GMBI 2008 S. 818-845 (Nr. 40/41) vom 19.8.2008, zuletzt geändert und ergänzt GMBI 2012 S. 715 (Nr. 40) vom 13.9.2012 – *in German*
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The, in each case, currently valid versions of the literature references are to be used.

Examples for good working practice when filling jerrycans, drums and IBCs with organic liquids can be found on the website of the BAuA under www.baua.de/schutzleitfaeden-loesemittel (in English available from November 2017)

Appendix 1 Basis for assessment of exposure to hazardous substances

The BAuA, in the period between 2011 and 2013, at 10 different sites, carried out workplace measurements to determine the exposure to hazardous substances and the effectiveness of protective measures, during the filling of jerrycans, drums and IBCs with organic liquids [15-17]. Hereinafter, the evaluations of the measurement results for the exposure to hazardous substances for these workplace sites are shown in detail.

Results of the workplace measurements

The workplace measurements were carried out during the filling of the organic liquids listed in Table 3. In total, 18 different organic liquids were included in the workplace measurements. Their boiling points ranged from 55 °C (methyl tert-butyl ether) to 156 °C (cyclohexanone). The occupational exposure limit values [6] of these organic liquids ranged from 20 ppm (83 mg/m³) for MIBK to 400 ppm (1500 mg/m³) for ethyl acetate. All organic liquids, according to the EMKG [5], belonged to the hazard groups A and B. Therefore, filling within a closed system was not necessary.

Table 3 Workplace measurements performed

Container (nominal volume)	Filled organic liquids
Jerrycans (2.5-60 L)	acetone, cyclohexane, methyl ethyl ketone, 2-propanol, toluene, xylene
Drums (up to 216.5 L)	acetone, cyclohexanone, ethanol, ethyl acetate, n-hexane, methanol, 1-Methoxy-2-propanol, methyl acetate, methyl ethyl ketone, propanol, 2-propanol, toluene, xylene
IBCs (up to 1050 L)	acetone, amyl acetate, cyclohexanone, ethanol, ethyl acetate, isopropyl acetate, 1-Methoxy-2-propanol, methyl tert-butyl ether (MTBE), methyl ethyl ketone, MIBK, 2-propanol, toluene, xylene

As a rule, during all filling operations, all measurements took place at the following three measurement points:

1. Directly at the suction unit (stationary), to judge the effectiveness of the on-site LEV. Here, the vapour flowing outside past the suction unit was measured.
2. On the employees, fitted with air quality measuring equipment, to judge exposure during filling.
3. Stationary, at the workplace of the employees, at a distance of about 1 – 3 m away from the filling unit, in order to estimate the spread of the organic liquids in the working area.

The measurements were all made in relation to filling activity, because filling organic liquids did not take place in any of the companies in one type of container throughout a whole shift. Usually, several organic liquids are filled in different container types during one working day. In between fillings with individual batches, the employees carry out other work such as e.g. moving goods within the company premises and refitting the filling machinery.

Care was taken to ensure that the filling activity took place for at least 30 minutes. As a worst case, these measurement values could be taken as an average for the shift. It was then assumed that a type of container was filled with an organic liquid throughout the shift.

According to the EMKG [5], when filling organic liquids which have boiling points in the 50 °C to 150 °C range, which are classed in the hazard groups A and B and using an LEV system, an exposure range of 5 – 50 ppm is to be expected. This exposure band was used to judge the effectiveness of the local extraction for the stationary measurements directly at the suction unit. The local suction unit was only judged to be effective in those cases in which, directly at the suction unit, a flow of less than 50 ppm of vapours of organic liquids were measured. Even when, during filling, the readings on the employees wearing measurement equipment to judge their air quality were below the occupational limit values, exceeding the value of 50 ppm, directly at the suction unit, meant that the protection measures were judged to be inadequate.

The measurement values, on persons wearing air measurement equipment, used in these Practical Instructions, are exclusively from such measurements where the effectiveness of local suction extraction was so large that stationary, directly at the suction unit, less than 50 ppm were measured – independently of the type of organic liquid filled. Table 4 contains the measurement values from employees, wearing air measurement equipment, during the filling of jerrycans, drums and IBCs with organic liquids, with an effective suction unit attached to the filling machinery.

Table 4 Overview of the measurement values on persons wearing air a measurement equipment, during the filling of jerrycans, drums and IBCs with organic liquids.

Container	Number of organic liquids	Number of sites	Number of measurements	Measurement values [ppm] (ml/m ³)			
				from - to	Mean	Median	95 th percentile
Jerrycans	6	5	7	0.1 – 6.9	2.3	1.6	5.8
Drums	13	8	18	0.1 – 5.3	2.2	2.1	5.2
IBCs	13	8	20	0.5 - 11	3.1	2.0	8.6
All	18	10	45	0.1 - 11	2.6	2.0	6.8

The occupational exposure limit values for all measurements on persons were complied with for all organic liquids during the filling of jerrycans, drums and IBCs.

For the additional stationary measurements in the working area of the employees, about 1-3 m away from the filling plant, the 95th percentile was 13.5 ppm. These stationary measurements thus confirm the effectiveness of the suction unit directly at the filling plant.

When the protective measures, described in chapter 5 of this manual, are observed, the 95th percentile for the filling of IBCs, amounting to 8.6 ppm, can be used for hazard assessment in the filling of jerrycans, drums and IBCs with organic liquids, allocated to hazard groups A and B, and with a boiling point above 50 °C. The highest 95th percentile determined for a container type is chosen as the assessment yardstick, to account for the fact that jerrycans, drums and IBCs can all be filled with same filling plant.

