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# International Standard



# 4180/2

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

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## **Complete, filled transport packages — General rules for the compilation of performance test schedules — Part 2 : Quantitative data**

*Emballages d'expédition complets et pleins — Règles générales pour l'établissement des programmes d'essais d'aptitude à l'emploi — Partie 2 : Données quantitatives*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4180/2 was developed by Technical Committee ISO/TC 122, *Packaging*, and was circulated to the member bodies in March 1979.

It has been approved by the member bodies of the following countries :

|                     |                        |                       |
|---------------------|------------------------|-----------------------|
| Australia           | France                 | New Zealand           |
| Austria             | Germany, F.R.          | Poland                |
| Belgium             | Hungary                | Romania               |
| Brazil              | India                  | South Africa, Rep. of |
| Bulgaria            | Ireland                | Spain                 |
| Canada              | Israel                 | Turkey                |
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The member bodies of the following countries expressed disapproval of the document on technical grounds :

Italy  
Sweden

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# Complete, filled transport packages — General rules for the compilation of performance test schedules — Part 2 : Quantitative data

## 0 Introduction

This International Standard has been prepared in order to fulfil a need of organizations concerned with the compilation of test schedules for complete, filled transport packages.

Such test schedules can be as diverse as the journeys that packages undergo. Accordingly, this International Standard is intended to set guidelines for the compilation of appropriate test schedules, rather than to provide a rigid framework or to be specified by regulatory or other authorities.

It is expected that, once compiled, a particular test schedule, including the test methods and intensities to be applied, could be the subject of International Standards or would become a matter for agreement between the parties concerned, for example the package designer, the manufacturer of the contents, the transport authority, the customer, the statutory regulating body or any combination of them.

## 1 Scope and field of application

This International Standard establishes general rules to be used for the compilation of performance test schedules for complete, filled transport packages intended for use within any distribution system, whether transported by road, rail, sea, air or inland waterway, or by a combination of these modes of transport.

ISO 4180/1 states the general principles entailed in compiling test schedules.

It also gives the factors to be considered in assessing the criteria of acceptance of such packages after they have been subjected to a package performance test schedule.

This part incorporates all the quantitative data necessary to establish test intensities and other quantitative features of test schedules.

The two parts are intended to be read in conjunction with one another.

## 2 References

ISO 2206, *Packaging — Complete, filled transport packages — Part 1 : Identification of parts when testing.*

ISO 2233, *Packaging — Complete, filled transport packages — Part 2 : Conditioning for testing.*

ISO 2234, *Packaging — Complete, filled transport packages — Part 3 : Stacking test.*

ISO 2244, *Packaging — Complete, filled transport packages — Part 5 : Horizontal impact tests (inclined plane test; pendulum test).*

ISO 2247, *Packaging — Complete, filled transport packages — Part 6 : Vibration test.*

ISO 2248, *Packaging — Complete, filled transport packages — Part 4 : Vertical impact test by dropping.*

ISO 2872, *Packaging — Complete, filled transport packages — Part 7 : Compression test.*

ISO 2873, *Packaging — Complete, filled transport packages — Part 8 : Low pressure test.*

ISO 2874, *Packaging — Complete, filled transport packages — Part 9 : Stacking test using compression tester.*

ISO 2875, *Packaging — Complete, filled transport packages — Part 10 : Water spray test.*

ISO 2876, *Packaging — Complete, filled transport packages — Part 11 : Rolling test.*

ISO 4180/1, *Complete, filled transport packages — General rules for the compilation of performance test schedules — Part 1 : General principles.*

### 3 Factors requiring quantification in test methods

Relevant test methods, and the factors requiring quantification before each test can be used, are given in table 1.

### 4 Preferred values of test intensities

Basic test intensities, which are considered to be normal for a common distribution system and which are based upon a

package of "average" mass and size (i.e. of mass 20 kg and dimensions 400 mm × 400 mm × 400 mm) are given in table 2, for the road, rail, water and air modes of transport and for storage.

Where a test intensity other than the basic value is appropriate (see clause 5) the value selected should be chosen, as far as is practicable, from the preferred values given in table 3.

For comparative investigations or research it may be necessary to select values of test intensity other than those given in table 3.

Table 1 — Methods of test and factors requiring quantification

| Method of test                                               | Relevant International Standard | Factors requiring quantification                                                                                                                                                                                         |
|--------------------------------------------------------------|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Conditioning                                                 | ISO 2233                        | Temperature, relative humidity, time, pre-drying conditions (if any).                                                                                                                                                    |
| Stacking test                                                | ISO 2234                        | Load, duration of time under load, attitude(s) of the package(s) <sup>1)</sup> , atmospheric temperature and relative humidity, number of replicate packages.                                                            |
| Vertical impact test by dropping                             | ISO 2248                        | Drop height, attitude(s) of the package(s) <sup>1)</sup> , atmospheric temperature and relative humidity, number of replicate packages, number of impacts.                                                               |
| Horizontal impact tests (inclined plane test, pendulum test) | ISO 2244                        | Horizontal velocity, attitude(s) of the package(s) <sup>1)</sup> , atmospheric temperature and relative humidity, profiles of impacting surfaces and use (if any) of an interposed hazard, number of replicate packages. |
| Vibration test                                               | ISO 2247                        | Duration of test, attitude(s) of the package(s) <sup>1)</sup> , atmospheric temperature and relative humidity, load (if any) superimposed on the package(s), number of replicate packages.                               |
| Compression test                                             | ISO 2872                        | Maximum load (where applicable), attitude(s) of the package(s) <sup>1)</sup> , atmospheric temperature and relative humidity, upper platen rigidly mounted or free to tilt, number of replicate packages.                |
| Low pressure test                                            | ISO 2873                        | Pressure, duration of time at reduced pressure, temperature within test chamber, number of replicate packages.                                                                                                           |
| Stacking test using compression tester                       | ISO 2874                        | Load applied, duration of time under load, attitude(s) of the package(s) <sup>1)</sup> , atmospheric temperature and relative humidity, number of replicate packages.                                                    |
| Water spray test                                             | ISO 2875                        | Duration of time under spray, attitude(s) of the package(s) <sup>1)</sup> , number of replicate packages.                                                                                                                |
| Rolling test                                                 | ISO 2876                        | Atmospheric temperature and relative humidity, number of replicate packages.                                                                                                                                             |

1) See ISO 2206.

Table 2 — Basic test intensities

| Method of test                                                                        | Variable                   | Units    | Transport mode |                 |             |                 |                                |                  |             |              | Storage                        |                  |
|---------------------------------------------------------------------------------------|----------------------------|----------|----------------|-----------------|-------------|-----------------|--------------------------------|------------------|-------------|--------------|--------------------------------|------------------|
|                                                                                       |                            |          | Road           |                 | Rail        |                 | Water                          |                  | Air         |              |                                |                  |
|                                                                                       |                            |          | Basic value    | Range           | Basic value | Range           | Basic value                    | Range            | Basic value | Range        | Basic value                    | Range            |
| Tests imposed by equipment installation and environment<br><br>Climatic <sup>1)</sup> | Rain                       |          |                |                 |             |                 |                                |                  |             |              |                                |                  |
|                                                                                       | Temperature                |          |                |                 |             |                 |                                |                  |             |              |                                |                  |
|                                                                                       | Relative humidity          |          |                |                 |             |                 |                                |                  |             |              |                                |                  |
|                                                                                       | Low pressure               |          |                |                 |             |                 |                                |                  |             |              |                                |                  |
| Vibration                                                                             | Duration                   | min      | 20             | 10 to 60        | 20          | 10 to 60        | Short : 20<br>Long : 60        | 10 to 60         |             |              |                                |                  |
|                                                                                       | Height of stack, if loaded | m        | 2,50           | 1,50 to 3,50    | 2,50        | 1,50 to 2,50    | 3,50                           | 3,50 to 7,00     | Under study | Under study  |                                |                  |
| Stacking                                                                              | Duration                   | As given | 1 day          | 1 day to 1 week | 1 day       | 1 day to 1 week | Short : 1 day<br>Long : 1 week | 1 day to 4 weeks | 1 day       | Nil          | Short : 1 day<br>Long : 1 week | 1 day to 4 weeks |
|                                                                                       | Height                     | m        | 2,50           | 1,50 to 3,50    | 2,50        | 1,50 to 2,50    | 3,50                           | 3,50 to 7,00     | 1,80        | Nil          | 3,50                           | 1,50 to 7,00     |
| Horizontal impact                                                                     | Velocity                   | m/s      | 1,5            | 1,5 to 2,7      | 1,8         | 1,3 to 5,0      | —                              | —                | —           | —            | —                              | —                |
| Test imposed by manpower                                                              |                            |          |                |                 |             |                 |                                |                  |             |              |                                |                  |
|                                                                                       | Drop height                | mm       | 500            | 100 to 1 200    | 500         | 100 to 1 200    | 300                            | 100 to 1 200     | 500         | 100 to 1 200 | —                              | —                |

1) Appropriate methods of test will be the subjects of future International Standards.

Table 3 — Preferred range of test intensities

| Method of test    | Relevant International Standard | Variable                                                                  | Preferred range of test intensities                                                    |                                                                  |
|-------------------|---------------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------------------------------------------------------------|
|                   |                                 |                                                                           | Applicable to normal hazards                                                           | Applicable to unusual or particular hazards                      |
| Stacking          | ISO 2234                        | Load by a combination of :<br>a) height of stack;<br>b) density of stack. | 1,50 — 1,80 — 2,50 — 3,50 — 5,00 — 7,00 m                                              | Range commencing at 9,00 m and continuing at 2 m intervals.      |
|                   |                                 |                                                                           | 1) identical packages : the density of the package under test.                         | As for normal range of hazards.                                  |
|                   |                                 |                                                                           | 2) for assorted packages : 0,25 — 0,35 — 0,5 — 0,7 — 1,0 — 1,4 — 2,0 Mg/m <sup>3</sup> | As for normal range of hazards.                                  |
|                   |                                 | Duration under load                                                       | 1 — 2 — 3 days; 1 — 2 — 3 — 4 weeks.                                                   | Range commencing at 8 weeks and continuing at 4 week intervals.  |
| Horizontal impact | ISO 2244                        | Horizontal velocity                                                       | 1,5 — 1,8 — 2,2 — 2,7 — 3,3 — 4,0 — 5,0 m/s                                            | As for normal range of hazards.                                  |
| Vertical impact   | ISO 2248                        | Drop height                                                               | 100 — 150 — 200 — 300 — 400 — 500 — 600 — 800 — 1 000 — 1 200 mm                       | Range commencing at 1 500 mm and continuing at 300 mm intervals. |
| Vibration         | ISO 2247                        | Duration of test                                                          | 10 — 20 — 40 — 60 min                                                                  | Range commencing at 2 h and continuing at 1 h intervals.         |
|                   |                                 | Height of stack from which superimposed loads are derived                 | 1,50 — 1,80 — 2,50 — 3,50 m                                                            | As for normal range of hazards.                                  |

## 5 Test intensity modifying factors

known features of the distribution system or of the package, are given in table 4.

### 5.1 General

Guidelines for modifying basic values of test intensity, due to

The special circumstances introduced by palletization and by the use of freight containers are outlined in 5.2.

Table 4 — Test intensity modifying factors

| Test variable      | Transport mode                                                                                                                                                                                                                   | Modification of test intensity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Stacking height    | Road                                                                                                                                                                                                                             | <p>a) <b>Vehicle height</b> : For road transport the basic stacking height of 2,50 m may be increased to 3,50 m when it is known that vehicles permitting such stacking heights may be used.</p> <p>b) <b>Mass and size of package</b> : The size and mass of the packages constituting the stack may introduce a limiting factor to the stack height and lead to a stack height of less than 2,50 m due to the floor loading and axle loading capabilities of the vehicles.</p>                                                                      |
|                    | Rail                                                                                                                                                                                                                             | <p>a) <b>Vehicle height</b> : For rail transport the basic stacking height of 2,50 m will also be the maximum.</p> <p>b) <b>Mass and size of package</b> : The size and mass of the packages constituting the stack may introduce a limiting factor to the stack height and lead to a stack height of less than 2,50 m due to the floor loading capabilities of the vehicles.</p>                                                                                                                                                                     |
|                    | Water                                                                                                                                                                                                                            | <p>a) <b>Vehicle height</b> : For water transport the basic stacking height of 3,50 m may be increased to 5,00 m or 7,00 m when it is known that vessels permitting such stacking heights may be used.</p> <p>b) <b>Mass and size of package</b> : The size and mass of the packages constituting the stack may introduce a limiting factor to the stack height and lead to a stack height of less than 3,50 m due to the floor loading capabilities of the decks.</p>                                                                                |
|                    | Air                                                                                                                                                                                                                              | Not applicable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                    | Storage                                                                                                                                                                                                                          | <b>Warehouses</b> : Greater stacking heights (5,00 m, 7,00 m, or higher) may be applied when it is known that such heights may be used.                                                                                                                                                                                                                                                                                                                                                                                                               |
|                    | Freight containers and pallets                                                                                                                                                                                                   | (See 5.2.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Stacking duration  | Road<br>Rail<br>Water<br>Air<br>Storage                                                                                                                                                                                          | <b>Known conditions</b> : Variation from the times given in table 2 may be made against known facts relating to the distribution system.                                                                                                                                                                                                                                                                                                                                                                                                              |
| Vibration duration | NOTE — The effects of vibration testing will usually be manifest within the normal duration. It is desirable to extend the duration of the vibration test whilst significant changes in the package or contents can be detected. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                    | Road                                                                                                                                                                                                                             | <p>a) <b>Journey length</b> : For road journeys between 1 000 and 1 500 km in length, the vibration duration should be 40 min and for journeys longer than 1 500 km the duration should be 60 min. For journeys of less than 1 h a duration of 10 min should be used.</p> <p>b) <b>Rough journeys</b> : For known journeys over bad roads, where poor vehicles are used or where the journey is known to be severe in some other way, the distances quoted in a) should be halved before a decision is made concerning the duration of vibration.</p> |

Table 4 (continued)

| Test variable                                             | Transport mode                                                                                                                                                                                                                                                                                                            | Modification of test intensity                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------|------|----------|----------|----------|----------|----------|----------|------|----------|-----|-----------|-----|-------|-----|
| Vibration duration                                        | Rail                                                                                                                                                                                                                                                                                                                      | a) <b>Journey length</b> : For rail journeys between 3 000 and 4 500 km in length the vibration duration should be 40 min and for journeys longer than 4 500 km: the duration should be 60 min. For journeys of less than 3 h a duration of 10 min should be used.<br><br>b) <b>Rough journeys</b> : For known journeys over poor track or where poor vehicles are used, the distances quoted in a) should be halved before deciding whether the basic duration of vibration should be modified. |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           | Water                                                                                                                                                                                                                                                                                                                     | (Under study)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           | Air                                                                                                                                                                                                                                                                                                                       | (Under study)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
| Vibration stack height corresponding to superimposed load | Road<br>Rail<br>Water                                                                                                                                                                                                                                                                                                     | As for "stacking height".                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
| Horizontal impact velocity                                | Road                                                                                                                                                                                                                                                                                                                      | <b>Stowage</b> : In known instances of bad stowage a velocity of 2,7 m/s should be used.                                                                                                                                                                                                                                                                                                                                                                                                         |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           | Rail                                                                                                                                                                                                                                                                                                                      | <b>Known conditions</b> : The values of horizontal impact velocity in rail transport may be selected from the range 1,5 to 5,0 m/s against conditions known to obtain within a given network of railways.                                                                                                                                                                                                                                                                                        |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           | Water                                                                                                                                                                                                                                                                                                                     | Not applicable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           | Air                                                                                                                                                                                                                                                                                                                       | Not applicable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
| Horizontal impact, number of impacts                      | Road<br>Rail                                                                                                                                                                                                                                                                                                              | The number of impacts carried out at the appropriate stages in the test schedule should be related to the likely incidence of the horizontal impact hazard in the distribution system.                                                                                                                                                                                                                                                                                                           |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           | Water                                                                                                                                                                                                                                                                                                                     | Not applicable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           | Air                                                                                                                                                                                                                                                                                                                       | Not applicable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
| Vertical impact, drop height                              | Road<br>Rail<br>Air                                                                                                                                                                                                                                                                                                       | a) <b>Mass of package</b> : The drop height should be modified according to the package mass and mode of transport as follows :                                                                                                                                                                                                                                                                                                                                                                  |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           |                                                                                                                                                                                                                                                                                                                           | <table><tr><th>Package mass<br/>(kg)</th><th>Drop height<br/>(mm)</th></tr><tr><td>&lt; 10</td><td>800</td></tr><tr><td>10 to 20</td><td>600</td></tr><tr><td>20 to 30</td><td>500</td></tr><tr><td>30 to 40</td><td>400</td></tr><tr><td>40 to 50</td><td>300</td></tr><tr><td>50 to 100</td><td>200</td></tr><tr><td>&gt; 100</td><td>100</td></tr></table>                                                                                                                                    | Package mass<br>(kg) | Drop height<br>(mm) | < 10 | 800      | 10 to 20 | 600      | 20 to 30 | 500      | 30 to 40 | 400  | 40 to 50 | 300 | 50 to 100 | 200 | > 100 | 100 |
|                                                           |                                                                                                                                                                                                                                                                                                                           | Package mass<br>(kg)                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Drop height<br>(mm)  |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           |                                                                                                                                                                                                                                                                                                                           | < 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 800                  |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           |                                                                                                                                                                                                                                                                                                                           | 10 to 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 600                  |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           |                                                                                                                                                                                                                                                                                                                           | 20 to 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 500                  |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           | 30 to 40                                                                                                                                                                                                                                                                                                                  | 400                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           | 40 to 50                                                                                                                                                                                                                                                                                                                  | 300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           | 50 to 100                                                                                                                                                                                                                                                                                                                 | 200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           | > 100                                                                                                                                                                                                                                                                                                                     | 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
| Water                                                     | <table><tr><td>&lt; 15</td><td>1 000</td></tr><tr><td>15 to 30</td><td>800</td></tr><tr><td>30 to 40</td><td>600</td></tr><tr><td>40 to 45</td><td>500</td></tr><tr><td>45 to 50</td><td>400</td></tr><tr><td>&gt; 50</td><td>300</td></tr></table>                                                                       | < 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1 000                | 15 to 30            | 800  | 30 to 40 | 600      | 40 to 45 | 500      | 45 to 50 | 400      | > 50 | 300      |     |           |     |       |     |
|                                                           | < 15                                                                                                                                                                                                                                                                                                                      | 1 000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           | 15 to 30                                                                                                                                                                                                                                                                                                                  | 800                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           | 30 to 40                                                                                                                                                                                                                                                                                                                  | 600                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
| 40 to 45                                                  | 500                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
| 45 to 50                                                  | 400                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
| > 50                                                      | 300                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
| Road<br>Rail<br>Water<br>Air                              | b) <b>Handling equipment</b> : The equipment used to handle a package has to be taken into account. If it is known that handling equipment is well suited to the package, a decrease in intensity will be in order; if the handling equipment is ill-suited to the package, an increase in intensity will be appropriate. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |
|                                                           | Any increase or decrease in intensity should be limited to one step in the preferred range of values of drop height (see table 3).                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                      |                     |      |          |          |          |          |          |          |      |          |     |           |     |       |     |

Table 4 (concluded)

| Test variable                                        | Transport mode                          | Modification of test intensity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                      | Road<br>Rail<br>Water<br>Air            | <p>c) <b>Handleability (size, shape, handling aids) of packages</b> : The handleability of a package (comprised of size, shape, presence of handling aids, etc.) may influence the degree of hazard. Packages that are difficult to handle may be subject to an increased hazard; conversely, packages that are easily handled may be subject to a reduced hazard.</p> <p>d) <b>Appearance (including markings), materials, or construction of package or fragility of contents</b> : These may require a reduction or an increase to be made in intensity. The reduction or increase should be limited to one step in the preferred range of values of drop height (see table 3).</p> <p>e) <b>Dangerous, aggressive, or valuable contents</b> : Packages containing dangerous goods must frequently comply with various mandatory and/or statutory regulations, performance requirements or special carrier requirements and give additional assurance of the integrity of the contents. The test intensities to be used are commonly included in such requirements.</p> <p>Additional assurance of the integrity of the contents of the package may also be required if the contents are aggressive (for example liable to contaminate other packages), or of high value. The test intensity should be raised accordingly.</p> |
|                                                      | Freight containers and pallets          | See 5.2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Vertical impact, number of drops</b>              | Road<br>Rail<br>Water<br>Air            | The number of drop tests carried out at the appropriate stages in the test schedule should be related to the likely incidence of the vertical impact hazard in the distribution system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Attitude of package</b><br>(applies to all tests) | Road<br>Rail<br>Water<br>Air<br>Storage | The attitude in which the package is tested is determined primarily by the normal or most likely attitude of the package when exposed to the hazard concerned. If no one attitude is more common or likely, the attitude used should be that judged most likely to test the weakest parts of the package.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

## 5.2 Modification of test intensity by palletization or by the use of freight containers

### 5.2.1 Palletization

Packages may be grouped into a unit load on a pallet or similar device for the whole or part of their life.

The subsequent handling of the unit load by mechanical means can change the magnitude of the hazards to which the packages are exposed, primarily vertical impact and stacking hazards.

#### 5.2.1.1 Vertical impact

Manual palletization subjects the individual packages to vertical impacts of intensity similar to those sustained in loading the packages on to a road vehicle. Mechanical palletization, however, subjects the packages to a very small, if any, vertical impact hazard.

Mechanical handling of the resultant unit loads, into and out of storage and in the loading and unloading of vehicles, results in the packages being subjected to a smaller vertical impact than that normally associated with the comparable manual operation (see tables 2 and 4).

Palletization, coupled with a suitable distribution system for handling pallets may therefore justify a reduction in intensity of more than one step in the preferred range of values of drop height (see tables 2, 3 and 4).

#### 5.2.1.2 Storage

The ability of mechanical equipment to lift unit loads to a greater height than is normal using manual methods can result in packages being stacked to greater heights. In addition, certain designs of pallet and some stacking patterns may impose local stresses on packages, which then require special consideration when the stacking test is performed.

Increased heights of stacking may not necessarily occur, however, as in modern tall-warehousing techniques the unit loads are placed in pallet racks. In such circumstances the packages are only stacked to the height of the unit load. The use of post-pallets or box-pallets also avoids placing high stacks on to packages.

Palletization, coupled with a suitable system for handling pallets, may therefore justify the selection of either a greater or a smaller stacking height than that given in table 2 (see also tables 3 and 4).

## 5.2.2 Freight containers

The transport of packages in inter-modal freight containers can reduce the magnitude of certain hazards to which the packages are exposed. These are primarily vertical impact and stacking hazards and the load superimposed during vibration.

### 5.2.2.1 Vertical impact

Manual loading of packages in to a freight container subjects the packages to vertical impacts similar to those incurred in loading road vehicles. The loading of freight containers with packages made up into unit loads subjects the packages to a smaller vertical impact hazard.

Whatever changes in the mode of transport may occur (such as the transfer of the container from road to rail, from rail to ship, then ship to road), the packages are not subjected to a further vertical impact hazard arising from loading and unloading operations and, wherever the containers are loaded and unloaded, the hazards associated with handling at the docks and into and out of ships are avoided.

The use of inter-modal freight containers may therefore justify a reduction in intensity of more than one step in the preferred range of values of drop height (see tables 2, 3 and 4).

### 5.2.2.2 Stacking

The internal height of freight containers is approximately 2,2 m which effectively restricts the stacking height to less than 2,00 m. This is particularly important when considering the superimposed load which the package must bear in the vibra-

tion test which, for non-containerized sea transport, can be equivalent to a stacking height of 7,00 m.

The use of inter-modal freight containers may therefore justify the choice of a smaller stacking height than given in table 2 (see also tables 3 and 4).

## 6 Examples of the compilation of test schedules

The following examples illustrate the principles by which performance test schedules are prepared.

### 6.1 Test schedule 1

#### 6.1.1 Package and distribution system

The package comprises a fibreboard container (containing packets of margarine) with a mass of 25 kg and dimensions of 600 mm × 400 mm × 300 mm.

Distribution is in a temperate climate<sup>1)</sup> by refrigerated road transport from manufacturer to retail outlets, the maximum distance being 500 km. Packages are formed into unit loads on pallets by the manufacturer and the unit loads are broken down to individual packages in the course of distribution by van to retail outlets. All storage is under refrigerated conditions.

#### 6.1.2 Tabulation of hazards and test requirements

Following the principles given in ISO 4180/1, clause 12, steps a) to e), hazards and testing requirements are identified as given in table 5.

1) For the purpose of this example, a temperate climate is considered to be one in which the temperature is unlikely to exceed 38 °C or be less than -14 °C and in which the relative humidity is in the range 50 to 100 %, as is typical of Europe.

Table 5 — Example of test schedule compilation — Test schedule 1

| Element of distribution system                                               | Hazard(s) concerned |                                                         | Test(s) <sup>1)</sup> involved |                                                                     | Basic value of test intensity                           | Modifying factors    | Final value of test intensity                           |
|------------------------------------------------------------------------------|---------------------|---------------------------------------------------------|--------------------------------|---------------------------------------------------------------------|---------------------------------------------------------|----------------------|---------------------------------------------------------|
|                                                                              | Mechanical          | Climatic conditions                                     | Mechanical                     | Conditioning before test or climatic test required (as appropriate) |                                                         |                      |                                                         |
| a) Loading of packages onto pallets, manually                                | Vertical impact     | Temperate                                               |                                |                                                                     |                                                         |                      |                                                         |
| b) Movement of palletized unit loads to warehouse                            | Vibration           | Temperate                                               |                                |                                                                     |                                                         |                      |                                                         |
| c) Storage of unit loads in warehouse on pallet racking                      | Stacking            | Refrigerated : temperature 8 °C, relative humidity 50 % | Stacking                       | Temperature 5 °C, relative humidity 85 %                            | Stacking height : 3,50 m<br>Stacking duration : 1 day   | Pallet racking       | Stacking height : 1,50 m<br>Stacking duration : 1 day   |
| d) Movement of palletized unit loads from warehouse to main delivery vehicle | Vibration           | Refrigerated packages in temperate conditions           |                                |                                                                     |                                                         |                      |                                                         |
| e) Transport by road (maximum distance 500 km)                               | Vibration           | Refrigerated : temperature 8 °C, relative humidity 50 % | Vibration                      | Temperature 5 °C, relative humidity 85 %                            | Height of stack : 2,50 m<br>Vibration duration : 20 min | Palletized unit load | Height of stack : 2,50 m<br>Vibration duration : 20 min |
|                                                                              | Stacking            |                                                         | Stacking                       | Temperature 5 °C, relative humidity 85 %                            | Stacking height : 2,50 m<br>Stacking duration : 1 day   |                      | Stacking height : 2,50 m<br>Stacking duration : 1 day   |
|                                                                              | Horizontal impact   |                                                         | Horizontal impact              | Temperature 5 °C, relative humidity 85 %                            | Velocity : 1,5 m/s                                      |                      | Velocity : 1,5 m/s                                      |
|                                                                              | Vertical impact     |                                                         | Vertical impact                | Temperature 5 °C, relative humidity 85 %                            | Drop height : 500 mm                                    |                      | Drop height : 100 mm                                    |
| f) Movement of palletized unit loads from vehicle to warehouse               | Vibration           | Refrigerated packages in temperate conditions           |                                |                                                                     |                                                         |                      |                                                         |
| g) Storage in warehouse on pallet racking                                    | Stacking            | Refrigerated : temperature 8 °C, relative humidity 50 % | Stacking                       | Temperature 5 °C, relative humidity 85 %                            | Stacking height : 3,50 m<br>Stacking duration : 1 week  | Pallet racking       | Stacking height : 1,50 m<br>Stacking duration : 1 week  |

Table 5 (continued)

| Element of distribution system                                                                           | Hazard(s) concerned |                                                         | Test(s) <sup>1)</sup> involved |                                                                     | Basic value of test intensity                           | Modifying factors | Final value of test intensity                           |
|----------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------|--------------------------------|---------------------------------------------------------------------|---------------------------------------------------------|-------------------|---------------------------------------------------------|
|                                                                                                          | Mechanical          | Climatic conditions                                     | Mechanical                     | Conditioning before test or climatic test required (as appropriate) |                                                         |                   |                                                         |
| h) Loading of packages individually into delivery van, manually<br>j) Transport by van to retail outlet; | Vertical impact     | Refrigerated packages in temperate conditions           | Vertical impact                | Temperature 5 °C, relative humidity 85 %                            | Drop height : 500 mm                                    |                   | Drop height : 500 mm                                    |
|                                                                                                          | Vibration           | Refrigerated : temperature 8 °C, relative humidity 50 % | Vibration                      | Temperature 5 °C, relative humidity 85 %                            | Height of stack : 2,50 m<br>Vibration duration : 20 min | Short journey     | Height of stack : 2,50 m<br>Vibration duration : 10 min |
|                                                                                                          | Stacking            |                                                         | Stacking                       | Temperature 5 °C, relative humidity 85 %                            | Stacking height : 2,50 m<br>Stacking duration : 1 day   |                   | Stacking height : 2,50 m<br>Stacking duration : 1 day   |
| k) Unloading of packages at retail outlet, manually                                                      | Horizontal impact   |                                                         | Horizontal impact              | Temperature 5 °C, relative humidity 85 %                            | Velocity : 1,5 m/s                                      |                   | Velocity : 1,5 m/s                                      |
|                                                                                                          | Vertical impact     | Refrigerated packages in temperate conditions           | Vertical impact                | Temperature 5 °C, relative humidity 85 %                            | Drop height : 500 mm                                    |                   | Drop height : 500 mm                                    |

1) Only those hazards likely to exist at a significant level will necessitate tests.

### 6.1.3 Compilation of test schedule

Having identified the testing requirements, the test schedule is compiled by placing the tests in the order given in ISO 4180/1 [see 8.2 and 12 f) of that International Standard] as follows :

- a) Conditioning in accordance with ISO 2233 for 24 h at 5 °C and 85 % relative humidity, preceded by 24 h in a drying chamber at 23 °C and 25 % relative humidity.
- b) Stacking test in accordance with ISO 2234 using a stacking height of 1,50 m and a stacking duration of 1 week.
- c) Vertical impact test in accordance with ISO 2248 using a drop height of 500 mm and carrying out two tests on each package.
- d) Climatic treatment (test method to be prepared).
- e) Vibration test in accordance with ISO 2247 using a stacking height of 2,50 m and a vibration duration of 20 min.
- f) Stacking test in accordance with ISO 2234 using a stacking height of 2,50 m and a stacking duration of 1 day.
- g) Horizontal impact test in accordance with ISO 2244 using a velocity of 1,5 m/s.

The package attitude(s) used in the tests should be those most likely in transport.

The number of replicate packages should be determined mutually by the manufacturer and the tester. For a package made in large quantities, as in this example, a large number of packages would normally be tested in order to give a high assurance that the package and contents will withstand the hazards existing in the distribution system.

## 6.2 Test schedule 2

### 6.2.1 Package and distribution system

The package comprises a wooden case containing a machine tool and incorporates mechanical and climatic protection. It has a total mass of 2 000 kg and dimensions of 3,0 m × 2,5 m × 2,0 m.

Distribution is by road (300 km), sea (7 000 km), and rail (200 km) from Europe to West Africa.

### 6.2.2 Tabulation of hazards and test requirements

Following the principles given in ISO 4180/1, clause 12, steps a) to e), hazards and testing requirements are identified as given in table 6.

Table 6 — Example of test schedule compilation — Test schedule 2

| Element of distribution system                                             | Hazard(s) concerned |                                   | Test(s) <sup>1)</sup> involved |                                                                                                        | Basic value of test intensity                           | Modifying factors                       | Final value of test intensity                             |
|----------------------------------------------------------------------------|---------------------|-----------------------------------|--------------------------------|--------------------------------------------------------------------------------------------------------|---------------------------------------------------------|-----------------------------------------|-----------------------------------------------------------|
|                                                                            | Mechanical          | Climatic conditions <sup>2)</sup> | Mechanical                     | Conditioning before test or climatic test required (as appropriate)                                    |                                                         |                                         |                                                           |
| a) Storage of package in warehouse                                         | Stacking            | Temperate                         | Stacking                       | Temperature 38 °C <sup>3)</sup> , relative humidity 85 %, and temperature — 18 °C, — relative humidity | Stacking height : 3,50 m<br>Stacking duration : 1 day   |                                         | Stacking height : 3,50 m<br>Stacking duration : 1 day     |
| b) Loading of package onto road vehicle                                    | Vertical impact     | Temperate                         | Vertical impact                | Temperature 38 °C <sup>3)</sup> , relative humidity 85 %, and temperature — 18 °C, — relative humidity | Drop height : 500 mm                                    | Mass, size and handleability of package | Drop height : 100 mm according to mass of package         |
| c) Movement of package by road to docks by covered lorry (distance 300 km) | Vibration           | Temperate                         | Vibration                      | Temperature 38 °C <sup>3)</sup> , relative humidity 85 %, and temperature — 18 °C, — relative humidity | Height of stack : 2,50 m<br>Vibration duration : 20 min | Size of package                         | Stacking height : 0<br>Vibration duration : 20 min        |
| d) Unloading of package at docks                                           | Stacking            |                                   | Stacking                       |                                                                                                        | Stacking height : 2,50 m<br>Stacking duration : 1 day   |                                         | Stacking height : 0<br>Stacking duration : does not apply |
|                                                                            | Horizontal impact   |                                   | Horizontal impact              |                                                                                                        | Velocity : 1,5 m/s                                      |                                         | Velocity : 1,5 m/s                                        |
|                                                                            | Vertical impact     | Temperate                         | Vertical impact                | Temperature 38 °C <sup>3)</sup> , relative humidity 85 %, and temperature — 18 °C, — relative humidity | Drop height : 500 mm                                    | Mass, size and handleability of package | Drop height : 100 mm according to mass of package         |
| e) Storage of package in harbour warehouse                                 | Stacking            | Temperate                         | Stacking                       | Temperature 38 °C <sup>3)</sup> , relative humidity 85 %, and temperature — 18 °C, — relative humidity | Stacking height : 3,50 m<br>Stacking duration : 1 week  | Harbour warehouse                       | Stacking height : 5,00 m<br>Stacking duration : 1 week    |