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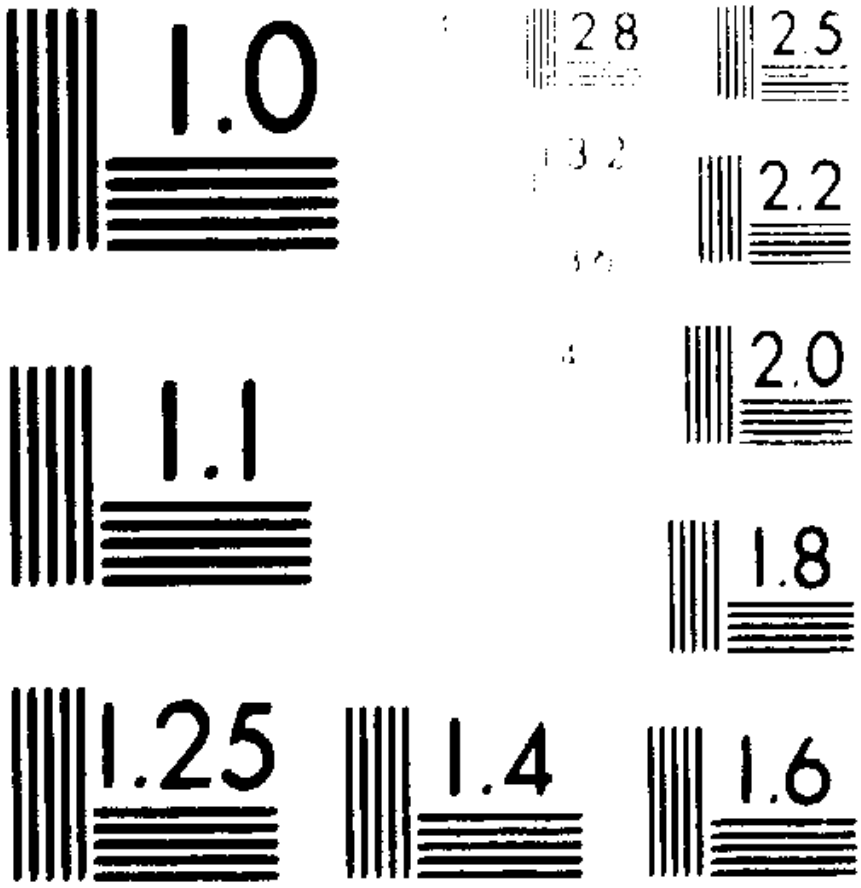
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DP/ID/SER.A/272
28 January 1981
English

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ESTABLISHMENT OF A PACKAGING RESEARCH, TESTING, DEVELOPMENT AND INFORMATION DEPARTMENT AT THE JAMAICAN BUREAU OF STANDARDS, KINGSTON

DP/JAM/77/008

JAMAICA

Technical report: Transport packages testing *

Prepared for the Government of Jamaica
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of Ernst Schmidt, consultant
in transport packages testing

United Nations Industrial Development Organization
Vienna

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V.81-20776

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LIST OF THE ANNEXES

A. INTRODUCTION

The government of Jamaica is establishing a Packaging Department in the Bureau of Standards, Kingston. A UNIDO Project was implemented in March 1979 to assist in this activity. The project is described in the project document "Establishment of a Packaging Research, Testing, Development and Information Department at the Jamaica Bureau of Standards, Kingston", DP/JAM/77/008/A/01/37 April 1978.

Mr. Schmidt is the sixth of ten (10) specialists being recruited by UNIDO to help train the staff of the Packaging Department in their specific fields of activities.

The consultant concentrated on training the staff members, especially his counterpart in the technology of transit packaging.

B. Conduct of the Mission

Mr. Schmidt arrived on the 31st July 1980.
Immediately on arrival a work programme was drawn up to ensure that all subjects of the job description were covered as adequately as possible. The programme has been added as Annex I.

Fifteen formal presentations (lectures) for the staff members were made (see Annex II).

Visits were made to producers and users of different packages and to handling facilities (see Annex I).

The treatment of several packaging problems was started and partially finished as on-the-job-training for the counterpart.

On the 15th October 1980 a Round Table Conference was held following a series of charts on "The tasks of the packaging laboratory."

Mr. Schmidt left Kingston on the 27th October 1980 for debriefing in Vienna.

C. SUMMARY

The list of the equipment scheduled for the Centre, especially the Transit Packaging laboratory, was checked with reference to their appropriateness for the tasks of the centre and for possible additional pieces of equipment.

Characteristic for the list is that it contains effectively only such equipment that is absolutely necessary for the functioning of a Packaging Centre of this kind.

The already existing equipment was checked with reference to their functions. Propositions were made for the manufacturing of devices to adapt the equipment to different tasks.

An educational programme was performed on the following levels:

Daily teaching and training the counterpart in testing technology and problem solving methods,

three times a week performing a lecture of one and a half hour for the staff members on journey hazards and their simulation by testing (see Annex II and III).

presenting the head of the Centre and the counterpart with definite packaging problems of the industry during visits and discussions afterwards,

Performing a Round Table conference to bring the staff members in contact with questions of participants (see Annex IV).

A direct advisory service was offered to and accepted by several enterprises.

The recommendations concern activities that had been started but must now be continued (observations,tests for the industry, tests to determine the actual state of the packaging production in Jamaica).

The recommendations also concern the application and improvement of test programmes, the creation of a data bank based on the Centre's activities, additional training and development and research work.

D. Activities and their results

(a) Equipment of the Transit Packaging Laboratory

A list of equipment to be supplied for the Centre had been established. This list was checked with reference to pieces of equipment that would be additionally necessary for the Transit Packaging Laboratory and to the appropriateness of the equipment scheduled already for this laboratory.

A revolving drum for dynamic testing is not necessary, because the same function in a more scientific manner can be performed by the drop tester and the inclined plane. Besides that there is no ISO Standard covering drum - testing.

Devices for measuring journey hazards have not been scheduled. It seems to be reasonable that the laboratory could employ the results concerning the intensities of journey hazards that have been obtained by many packaging institutes in the world. But it would be advisable to have : at least one portable and reliable thermo-hygrograph to be used on journeys specific for Jamaica's exports

Nowadays shocks can be measured electronically but at the stage of development of the packaging centre it is not recommended because meaningful interpretation of the data calls for extensive study and maintenance of the equipment, calls for costly servicing by skilled electronic technicians from the suppliers.

Impact measurements may be performed as described in Annex V or by studying the damage or deformation experienced by the product or its packaging. A balance for weights of at least up to 100 kg should be obtained to determine the weights of packages, products and their substitutes for dynamic testing.

Slabs of 25 kg weight were designed and manufactured out of concrete to be used as overloads or substitutes for packages to be stacked.

The weights are used for stacking and vibration testing but should also be used for specific types of impact testing on an inclined plane (see Annex II, 13).

An additional wedge-like device to perform shearing tests on the inclined planed has been conceived.

A device to make the inclined plane appropriate for the use as "drop hammer" (device for testing cuchioning materials) has been designed, manufactured and used.

(b) Education of the counterpart

The functions of the compression tester, the stacking-test-device, vibration table the drop tester and the inclined plane were explained and discussed in answering the following questions:
How does the equipment work?
what does the corresponding manual say with reference to operating adjusting, maintenance?
What kind of test can be performed?
What journeys are to be simulated by these tests?
What differences between real transit conditions and test conditions must be taken into consideration?
What are the standards for the different test methods?
What parameters of a test are not fixed by the standard, but must be decided upon?
What can be done to get as much information out of a test as possible?
How to judge the reliability of test results?
How to write a report about a test or an investigation?
The counterpart has participated in the visits and discussions concerning the packaging problems described in Dd. He contributed to the analysis of the problems. In doing that the method described in Annex III page 22 has been explained and employed.

The counterpart also participated in the 15 lectures held each second morning for the staff members (see Dc and Annex II and III). The topics treated during these lectures were partially repetition; for the counterpart that gave him the occasion to contribute more to the lectures and to deepen his understanding.

(c) Training of the staff members

The topics treated during the 15 lectures for the staff members were the following:

01 Function of packaging.
02 Distribution system.
03 Hazards (example).
04 Relationsbetween product,packaging and transit process.
05 Hazards (calculation of forces).
06 Climatic hazards.
06b Figures concerning hazards
07 Optimal package
08 Distribution system
Transport subsystem
09 Distribution system
Storage subsystem
10 Distribution system
Handling subsystem
11 Compression test ISO 2872
12 Comparison:
Stacking test ISO 2234
Compression test ISO 2872,2874
12a Possible uses of a "Compression Tester"
13 Possible uses of the "Inclined Plane"
14 Unitization
15 Freight container

During the lessons in order to explain and demonstrate a topic, charts were used and produced that are now available at the Centre for further discussions, teaching and as a basis for future development. (See also Annex III and IV).

The main aim of these lectures was to spread a basic knowledge and understanding of transit packaging technology to all the staff members because it was important for each staff member to have an appreciation of the work of other laboratories.

Another aim hasbeen already mentioned with reference to the education of the counterpart (see Db): To complete and to deepen his knowledge on his special field.

It seems to be reasonable to emphasize the following rules employed in the charts of Annex IIand in all the discussions that had taken place during the time of this mission:

1. By using appropriate test methods and test programmes costs for export may be diminished and the probability of a good arrival already of the first shipment to a new market may be increased and thereby an important pre-supposition for invading this market may be fulfilled.

2. Appropriate test methods and test programmes must be based on a good knowledge of the hazards occurring during the whole transit process and an assessment of the significance of the differences between the conditions existing in practice and the conditions used in testing. To make this assessment as reliable as possible the testing conditions should be adapted as much as possible to the journey conditions.

3. As to the improvement of existing packages or the development of new packages a method should be used that is based on a thorough analysis of the problem and synthesis of the solutions for the partial problems to the total problem (see Annex IV and Dd).

(d) Problems of the industry that were treated

1. Breakage of big glass bottles

After finding out that the breakage rate increased after a definite change in packaging it was recommended to add additional cushioning material to compensate for the change. Besides that a test procedure was developed that allows to test dynamically glass bottles and the effectivity of cushioning material.

An essential feature of this development is the following: if the analysis of a problem has come to the result that only a specific part of a package or a unit load is concerned it is very often possible to treat only this part. In this manner test costs are diminished and the reliability of the results is increased.

2. Packaging plastic bags filled with powder in corrugated board Containers.

This case was a good example for the influence of the product's properties on the design of packaging and for finding the possible solutions of a problem, especially the problem how to increase the resistance of a corrugated board case against compression. Besides that it was a very good example for the task of a Packaging Centre to test according to the wishes of the client, but also to give its advice in drawing the attention on this testing not being appropriate to solve the real problem.

The real problem was the following:
How to design a package for plastic bags filled with powder so that a stacking height of 4.5 m would be admissible?

There were two possibilities:

(a) Design the package so that the container and an inner supporting structure (lining and/or fittings) would be strong enough to withstand the compressive force produced by stacking 4.5 m of the same cases.

(b) Design the package so that the bags filled with powder are loaded by the weight of the stack.

For (a) there may be the following solutions reasonable:
reinforcement of the case used before by a liner and/or fittings with as many supporting vertical edges as possible.

For (b) the following solutions must be investigated:-
telescopic type of case,
case without lid combined with a bag made of plastic or paper, paper bag filled so that a rather stiff and flat package is produced.

3. Unacceptable deformation of sachets

This problem gave the opportunity to experience that a problem concerning only an in admissible deformation of the basic package (the sachet) could be well tackled only in analysing the influences of the packaging processes, the design of the sachet, its arrangement in the retail package, the retail package itself, its arrangement in the transit package and the transit package itself.

E. Recommendations

(a) Continue the investigations concerning several packages mentioned in Dd.

(b) Continue the observations of loading and unloading operations in different places, of the behaviour of packages, transported on different means of transport (trucks, railway, aircraft and ships), of packages stored in warehouses and in the open air.

These observations are very important for completing continuously the picture of the real transit conditions and to achieve a realistic and realiable judgment of testing results.

The observations should be recorded in writing, taking photographs and films. They should be completed as much as possible by measuring the mechanical and climatic physical quantities (forces, accelerations, vibrations, temperatures, humidity) essential for the hazards. Instead of using measuring devices, indicators may be used to determine the intensities of the hazards at least approximately (see Annex V).

(c) Use the reports, photographs, films, charts of the Annexes II and IV to create a data bank on the base of the experiences of the Packaging Centre that could be very important for every day and research work and education.

(d) Continue the visits at users and producers factories and warehouses. It is there that very often the causes of damage and produced by inappropriate packaging processes and bad treatment of packaging.

(e) Continue the activities aiming at analysing Jamaica's production of corrugated board cases, impact board, wooden crates and cases, pallets, bottles, etc. This analysis should contain:

(i) Gathering all the information that can be obtained concerning these package in using the questionnaire of Annex IV.

(ii) Testing the essential properties, determining points of weakness and points where the material is not completely utilised.

(f) Continue the activities aiming at the improvement of existing packaging and packages.

(g) Apply the appropriate test programmes (multi-test-schedules) for the simulation of specific transit processes on the packages and unit-loads that had been developed for this purpose.

(h) Compare the results of test programmes and the judgment based on them with the results of real transit processes, the conditions of which must be well known.

(i) Perform field test according to Annex III.

(j) Amend the test programmes (the kinds of tests, the intensity levels and the sequence of tests) so that the damage caused by testing correspondence to the damage caused by real transit processes.

(k) The devices mentioned in Da should be manufactured, tested and used.

(l) The head of the Transit Packaging Laboratory should try to get an additional engineering training concerning properties and testing of materials in general, mechanics and technical drawing.

(m) Visits to packaging exhibitions would be helpful to broaden knowledge and experience also in transit packaging.

(n) Development and research work should be performed on well based knowledge and experience, on the data bank and on a mind open to clearly identify problems and recognise possible solution.

(o) One of the most important fields of research work is to investigate the possibilities to use local materials for the production of packages e.g. bagasse and bamboo. Very often good solutions are to be found in combinations of different materials to utilise the good properties of each of them.

ANNEX I

Schedule for the activities.

TRAINING PROGRAMME - TRANSPORT PACK TESTING

ERNST SCHMIDT - 31 JULY TO 31 OCTOBER, 1980

MONDAY, AUGUST 4	TUESDAY, AUGUST 5	WEDNESDAY, AUGUST 6	THURSDAY, AUGUST 7	FRIDAY, AUGUST 8
Independence Day.				
	Introduction terminology	Counterpart: Journey hazards, stacking tests, compression		

MONDAY, AUGUST 11	TUESDAY, AUGUST 12	WEDNESDAY, AUGUST 13	THURSDAY, AUGUST 14	FRIDAY, AUGUST 15
Counterpart: Journey hazards, compression testing				

MONDAY, AUGUST 18	TUESDAY, AUGUST 19	WEDNESDAY, AUGUST 20	THURSDAY, AUGUST 21	FRIDAY, AUGUST 22
	9.0 am Seprod visit		9.0 am J.P.I. visit	
← Counterpart: Long term compression testing. Influence of box design parameters →				
MONDAY, AUGUST 25	TUESDAY, AUGUST 26	WEDNESDAY, AUGUST 27	THURSDAY, AUGUST 28	FRIDAY, AUGUST 29
	9.0 am J.P.I. visit	9.0 - 10.30 Talk - Transit, handling, storage.	Participation in round table 2.30 - 4.0 pm WPPI	9.0 - 10.30 Talk - handling processes
← Counterpart: Impact testing. Drop and inclined plane. Edge, corner and face impacts →				

MONDAY, SEPT. 1	TUESDAY, SEPT. 2	WEDNESDAY, SEPT. 3
9.0 - 10.30 am Talk - Transport processes and hazards	9.0 - 11.00 am Grace Kennedy visit 2.30 pm Visit to port facilities	9.0 - 10.30 am. Talk - Storage processes
← Counterpart: Testing, theory and practice		
MONDAY, SEPT. 8	TUESDAY, SEPT. 9	WEDNESDAY, SEPT. 10
9.0 - 10.30 am Talk - Transit pack testing, general rules	Visit to two freight forwarding companies	9.0 - 10.30 am Talk - Laboratory simulation of transport and storage condition; compression
← Counterpart: Climatic tests. High humidity, corrosion,		

THURSDAY, SEPT. 4	FRIDAY, SEPT. 5
9.30 am Visit to local wood substitute manufacturers	9.00 - 10.30 am Talk - Transit pack testing, general rules.

THURSDAY, SEPT.11	FRIDAY, SEPT.12
	9.0 - 10.30 am Talk - Dynamic compression in transit

rain, sunlight, heat

MONDAY, SEPT.15	TUESDAY, SEPT.16	WEDNESDAY, SEPT.17	THURSDAY, SEPT.18	FRIDAY, SEPT.19
9.0 - 10.30 am Talk. Dynamic compression in transit (drop test, inclined plane).	9.0 - 11.0 am JNEC lecture Packaging for Shipment	9.0 - 10.30 am Talk - laboratory simulation of other transit hazards	9.0 - 11.0 am Visit to Ministry Agriculture, Inspectorate	9.0 - 10.30 Talk - laboratory simulation of climatic hazards
← Counterpart: Journey simulation. Design of test programmes →				

MONDAY, SEPT.22	TUESDAY, SEPT.23	WEDNESDAY, SEPT.24	THURSDAY, SEPT.25	FRIDAY, SEPT.25
9.0 - 10.30 am Talk - The design of transit packaging, guidelines (1)	9.0 - 12.00 a.m. Visit to banana packaging station	9.0 - 10.30 The design of transit packaging, guidelines (2)		9.0 - 10.30 am The design of transit packaging, guidelines (3)
← Counterpart: Transit pack design with reference to compression, vibration, shock and climatic forces →				

MONDAY, SEPT.29	TUESDAY, SEPT.30	WEDNESDAY, OCT. 1	THURSDAY, OCT. 2	FRIDAY, OCT.3
9.00 - 10.30 Talk - The design of unit loads, guidelines	Visit Fruit and vegetable export packaging centre	9.00 - 10.30 am Talk: The design of pallets. Guidelines	Visit. Fruit and vegetable export packaging centre	9.0 - 10.30 am Talk: Marking for export. Product properties Packaging materials
← Counterpart: Unitisation, palletisation and other unit loads. Strapping freight containers →				
MONDAY, OCT. 6	TUESDAY. OCT. 7	WEDNESDAY, OCT. 8	THURSDAY, OCT. 9	FRIDAY, OCT.10
9.0 - 10.30 Transit test sequences (1)		9.0 - 10.30 Transit test sequences (2)		
← Counterpart: Cooperative week testing samples from JPI, WPPI, Grace etc in presence of their representatives using the test sequence devised for export journies to Caribbean, Europe and USA. →				

MONDAY, OCT. 13	TUESDAY, OCT. 14	WEDNESDAY, OCT. 15	THURSDAY, OCT. 16	FRIDAY, OCT. 17
		9.30 - 12.00 noon Round table 2.30 - 4.30 pm Interviews		
MONDAY, OCT. 20	**TUESDAY, OCT. 21**	**WEDNESDAY, OCT. 22**	**THURSDAY, OCT.23**	**FRIDAY, OCT. 24**

← Counterpart: Report preparation, discussion and reproduction ----------→

MONDAY, OCT. 27	TUESDAY, OCT. 28	WEDNESDAY, OCT. 28
		Consultant leaves for Vienna
← Counterpart: Final discussion → future plans		

	THURSDAY, OCT. 29	FRIDAY, OCT. 30

ANNEX II

The charts produced during the lectures on Transit Packaging Technology.

FUNCTIONS OF PACKAGING•

1. Protection of goods to be distributed against loss and damage caused by the mechanical and climatical hazards of the distribution process.

2. Rationalization: decrease of distribution (transport, handling and storage) - cost by means of an appropriate package.

3. Information to guide those involved in the distribution process.

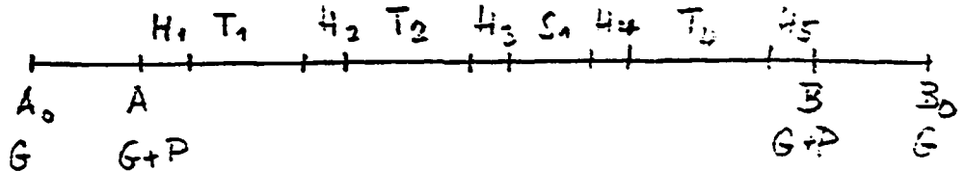
4. "Adjustments to the requirements, needs and taste of the target market/customer".

• transit packaging ——

retail packaging — — —

DISTRIBUTION SYSTEM

A system designed to bring goods from the producer (A) to the user (B_o).



At (A) the goods (G) packed in package (P) leaves the producer, between (A) and (A_o) goods are prepared for transit e.g. prepacking.

At (B_o) delivery to the user, between (B) and (B_o) the transit package (G + P) is unpacked, retail packages are used for dispensing purposes.

$H_{1,2,3,}$ Handling processes: goods (packages, unit loads) are moved from one means of transport or storage to another.

$T_{1,2,3}$ Transport processes: goods (pack, .l) are moved in direction to the user without change of mode of transport.

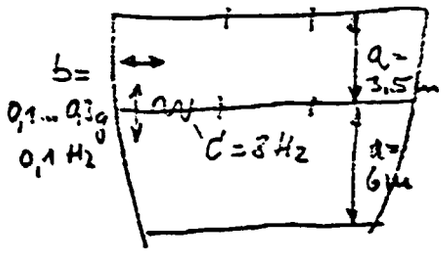
$S_{1,2..}$ Storage processes: goods (pack, u. .)remain at one point during a more or less definite time.

$$\sum_{U=1}^{U=1,2,3\ldots} (H_u, T_u, S_u) = \text{Transit process (transit package)}$$

•ISO/DIS 4180/I

Example: Hazards occurring during transport on a sea-ship.

(A) DESIGN OF THE SEA-SHIP :

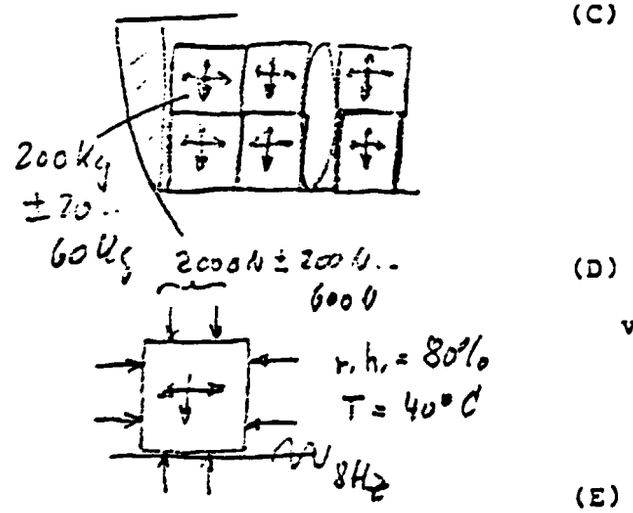


(a) heights of the hold regularities.

(b) maximal rolling and pitching acceleration.

(c) vibrations, ventilation speed, the route, weather, other load → duration, hold's climate

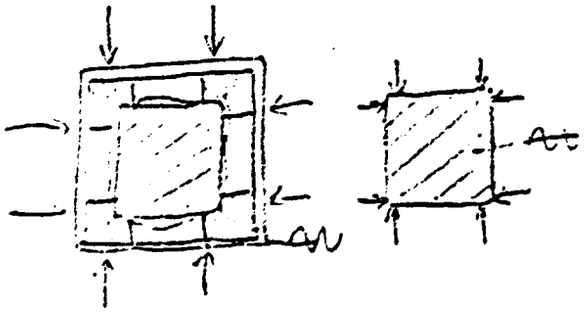
(B) consequence of the route

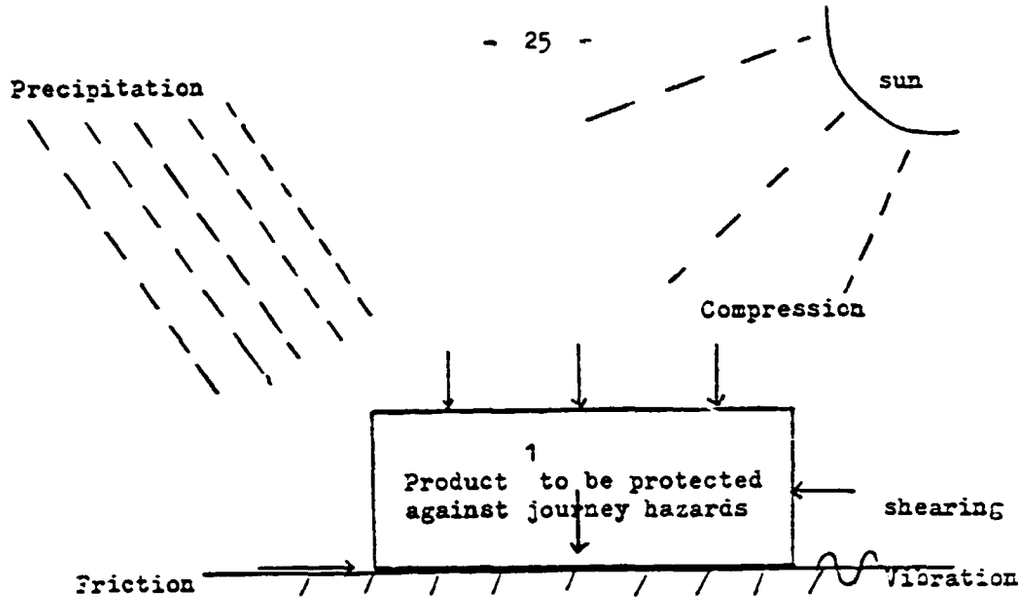


(C) Manner of using the ship.
Specific stowage of packages at a specific point of the ship's hold.
Specific manner to steer the ship.

(D) Influences on the package by a,b,c,
vertical forces, horizontal forces, hold's climate.

(E) Influences on the contents by D.
compressive stresses, bending stresses.



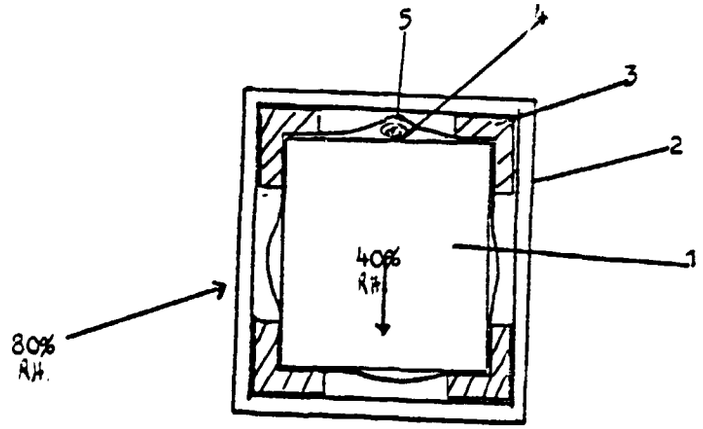


2 - case, to protect 1 against compressive force

3 - cushioning, to protect 1 against impact.

4 - desiccant, to protect 1 against humidity.

5 - closed plastic covering



1 + 2 + 3 + 4 + 5 = complete, filled, closed package

1 = contents, goods, products

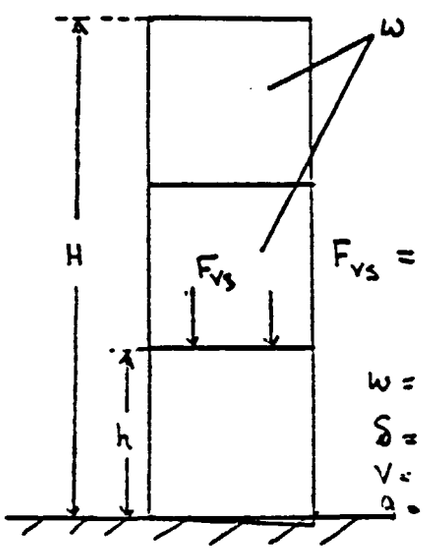
2 + 3 + 4 + 5 = packaging

2 = (empty) packaging, container, case.

Calculation of forces

HAZARDS

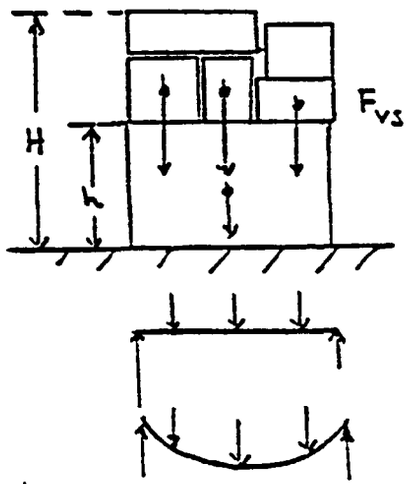
(a) static vertical (compression) forces.



$$F_{vs} = \left(\frac{H-h}{h}\right)\omega$$

$\omega = \delta . v . g$

δ = density of pack.
v = volume " "
g = acc. due to gravity



$$F_{vs} = \left(\frac{H}{H}-h\right)\delta . A . g$$

A = Area of package exposed to F_v

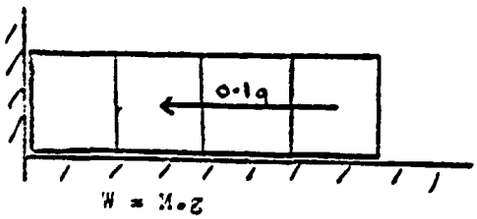
(b) dynamic vertical forces

F_{vd} = F_{vs} maximum x 1.1

= F_{vs} minimum x 0.9

(c) Horizontal forces (dynamic)

EW = 10000 kg



$F_{hd\ maximum}$ = m.a

= 10000 kg x 0.1g

= 1000 N

F = W. UF

= 100000 N x 0.2

=20000N

EFFECT ON PACKAGES

Hazards	Tests	Effect on Packages	
1. High Temperature	ISO 2233	Acceleration of deterioration processes Decrease in R.H.	Increase in plasticity of plastic packages
2. Low		Increase in R.H.	Increase in brittleness
3. Solar radiation		Increase in brittleness of certain plastics	
4. High Relative humidity		Atmospheric corrosion deterioration of food Decrease in mechanical strength of paper & board	
5. Low		Dehydration of food Change in dimension of wooden packages (in combination with 1)	
6. Low air pressure	ISO 2873	Bursting of packages (gas filled and gas proofed)	
7. Precipitation	ISO 2875	Similar to 4, but more intense especially if it lasts for a long enough time	
8. Pollution by gases		Corrosion	
9. by particles		Corrosion (influence on the velocity of corrosion)	
10. Fungus		(Possible in connection with optional R.H. and T) Deterioration of food, paper board	
11. Insects (Termites)		Deterioration of wood, paper etc.	
12. Rodents		As 11	

CLIMATIC HAZARDS AND THE RESPECTIVE PROTECTIVE METHODS

1.	Store in a cooled room Insulation for cutting the heat peaks
2.	Store in a heated room Insulation (as in 1)
3.	Use of reflectors Special storage Use of materials that are not susceptable to radiation
4.	Keeping the atmosphere of a closed system dry Use of protective layers
5.	Controlled precipitation
6.	If a system must be kept closed it must be designed to withstand the possible pressure differences. If a system must not be kept closed then properties for equalizing the pressure should be provided.
7.	Use of water resistant packaging
8.	Provide a cover that is impenetrable to the respective gases.
9.	Provide a cover (package) that keeps the particles out
10.	Use of fungus resistant materials or fungicidal additives Drying (according to 4)
11.	Use of insecticides or specially treated packaging materials.
12.	Use of specially treated materials Store in areas that are free of rodents Store so that there is easy access around the package to enable the control of rodents

JOURNEY HAZARDS

According to the experience of the "BFSV" (Institute of Export Packaging in Hamburg, Federal Republic of Germany)

STORAGE

HAZARDS / MEANS OF STORAGE	STACKING HEIGHT (m)*	
	NORMAL	RARE
Warehouse quay, or any place outdoors	3.5	7
Warehouse with racks	1.5	2

*Concerning dangerous goods packages see IMDG - regulations.

Climate: corresponding to the weather. (Climatic zone, season), neighbouring cargo, air pollution, protection against precipitation, radiation.

HANDLING

HAZARDS / MASS OF PACKAGE(kg)	DROP HEIGHT	Hd (m)
	NORMAL	RARE
Smaller than 25 kg	0.8	1.2
26 - 100 kg	0.4	0.6
Bigger than 100 kg	0.2	0.3

JOURNEY HAZARDS

According to the experiences of the "BFSV" (Institute of Export Packaging in Hamburg, Federal Republic of Germany)

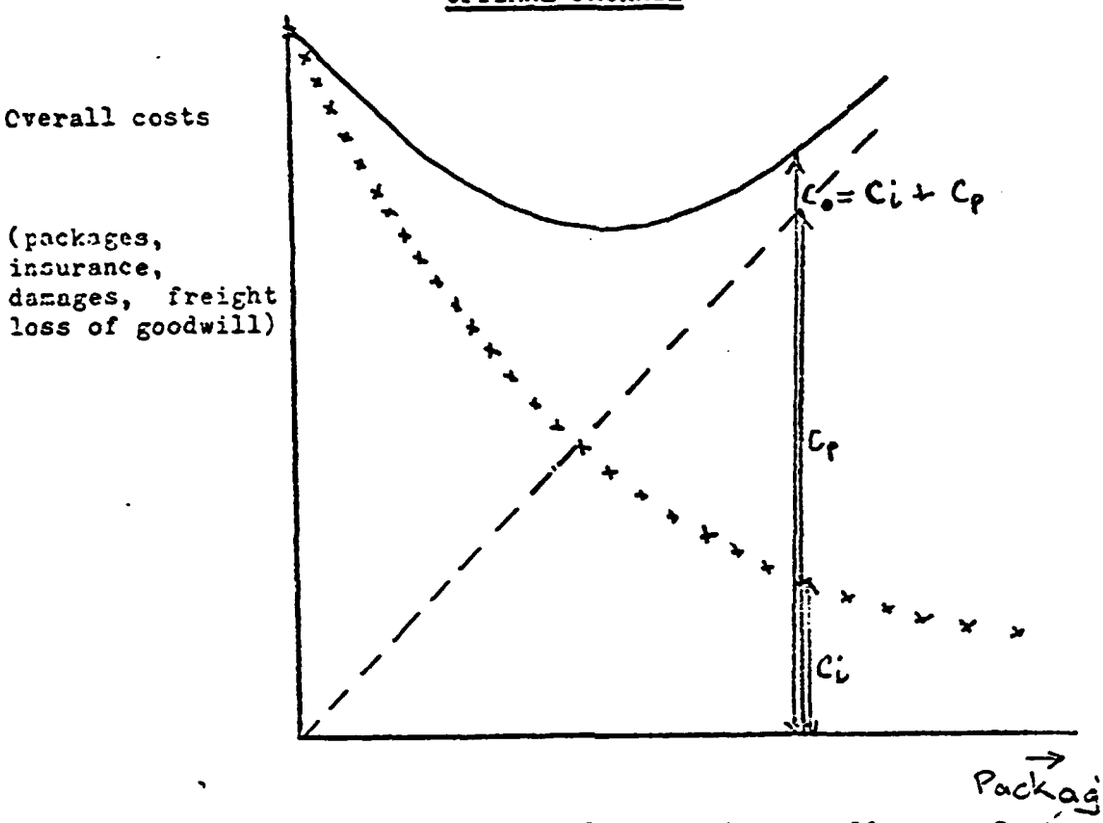
TRANSPORT

HAZARDS / MEANS OF TRANSPORT	H (m) Stacking Height*		A_v (g) Vertical Acceleration / F_v (H_z) Frequency of A_v		A_h (g) Horizontal Acceleration / V_h (m/s) Horizontal Velocity	
Sea	Normal	Rare	Normal	Rare	Normal	Rare
Sea-ship Conventional	3.5	6	0.1 , 0.1	0.3 , 0.2	0.1_g	0.2_g
			0.1 , 8.0	0.2 , 8.0	$0.1H_z$	$0.1H_z$
Sea-ship with container	2.0	2.0	0.1 , 0.1	0.3 , 0.2	0.1_g	0.2_g
			0.1 , 8.0	0.1 , 8.0	$0.1H_z$	$0.1H_z$
Aircraft	1.8	1.8	0.2_g			
Truck	2.5	3.5	0.5_g	1.0_g	1.5 m/s	2.7 m/s
			2 – $15H_z$	30 – $1000H_z$		
Railway	2.5	2.5	0.3_g	0.3_g	1.8 m/s	5.0 m/s
			2 – $15H_z$	2 – $30H_z$		

*Concerning dangerous goods - packages see IMDG - regulationa.

Climate corresponding to the weather (climatic zone, season), the neighbouring cargo and the manner how to use the means of transport (storage, ventilation).

OPTIMAL PACKAGE



A package may be called <u>optimal</u> when the overall costs C_o caused directly or indirectly by the packaging are a minimum i.e. the sum "package costs CP" and "costs for damage, insurance and loss of goodwill Ci" is a minimum.

DISTRIBUTION SYSTEM

1. TRANSPORT SUBSYSTEM

1.1 THE TRANSPORT MEANS

Sea ship without freight-container on deck.

Sea ship without freight - container under deck.

Sea ship with container on deck.

Sea ship with container under deck.

Truck without container.

Truck with container.

Railway without container.

Railway with container.

Aircraft without container.

Aircraft with container.

1.2 MANNER OF USING THE TRANSPORT MEANS

Normal

bad

1.3 NEIGHBOURING LOAD

Wet or dry

Moveable or fixed

1.4 CLIMATIC ZONES TO BE PASSED

Moderate
humid, warm

Warm

Cold

1.5 QUALITY OF THE ROUTE

Normal

bad

1.6 DURATION OF THE TRANSPORT

e,g, One day

One week

Four weeks.

1.8 HAZARDS

1.1 → .1 Possible stacking height

1.2 → .2 Stacking method

1.6 → .3 Stacking duration

1.2 → .4 Stacking position

1.1 → .5 Vibrations of the Supporting surface.
1.2

1.2.1.1 → .6 Other vertical accelerations

1.2.1.5 → .7 Horizontal accelerations

1.6 → .8 Duration of accelerations

1.8 → Vertical Forces:
- Constant forces
- Slowly alternating
- Quickly alternating

Horizontal forces

1.2 → Climate of the environment
1.3 → (their intensities and duration)
1.4 →
1.6 →

Different stresses and strains of the goods and the packagine.

1.7 PROPERTIES OF THE GOODS

Susceptibilities

Weight

Size and shape

DISTRIBUTION SYSTEM

2. STORAGE SUBSYSTEM

2.1 THE STORAGE MEANS

Open air, on the ground
Open air, on a platform
Under a shed on the ground
Under a shed in racks
Warehouse on the ground
Warehouse in racks

2.2 MANNER OF USING THE MEANS

Normal
bad

2.3 NEIGHBOURING LOAD

Wet or dry

2.4 CLIMATIC ZONE

Moderate
Humid, warm
Warm
Cold

2.5 DURATION OF STORAGE

e.g One day
One month
Some years

2.6 PROPERTIES OF THE GOOD AND PACKAGING

Susceptibilities

Weight
Size
Shape

2.7 HAZARDS

2.1 → Possible stacking weight
2.2 → Stacking method
2.5 → Stacking duration
2.1 / 2.2 → Stacking point

Vertical constant forces
Climate of the environment

Stresses and strains* on the goods and packages. They should be admissible if not loss and/or damage will occur.

* and other changes e.g. corrosion.

DISTRIBUTION SYSTEM

3. HANDLING SUBSYSTEM

(Seizing, lifting, displacing, putting down, leaving)

3.1 MEANS OF HANDLING FOR SEIZING AND RELEASING

Hands

Hands and handles

Fork of a fork lift truck

Ropes of a crane

Clamps of fork lift truck

Spreader with bolts for freight container.

For Lifting, displacing, putting down

Hands, shoulder

Hands with handles

Fork lift truck

Crane

Container bridge or

Railway wagon

3.2 MANNER OF USING THE MEANS OF HANDLING

Normal

bad

3.3 PROPERTIES OF THE GOOD AND THE PACKAGING

Susceptibilities (especially to impact)

Weight

Size

Shape

3.1.3.2

3.4 HAZARDS

Drop height

Bumping height

Impact velocity

Kinds of impact surface

frequency of rolling.

Test drop height

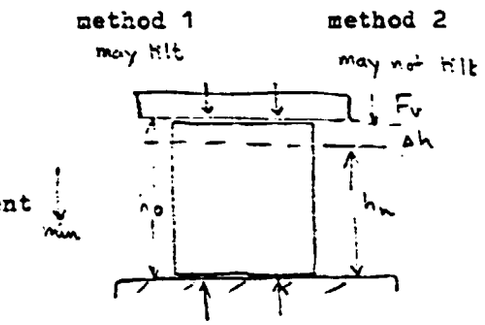
Drop sequence

Test travel length (or impact velocity) on the inclined plane.

Stresses and strains* on the goods and the packaging, they should be admissible, or loss and/or damage will occur.

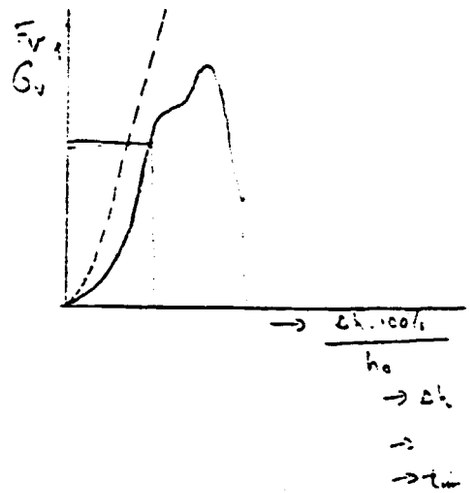
* and other changes e.g. breakage.

Compression Test



$\frac{\Delta h}{min}$ =

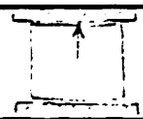
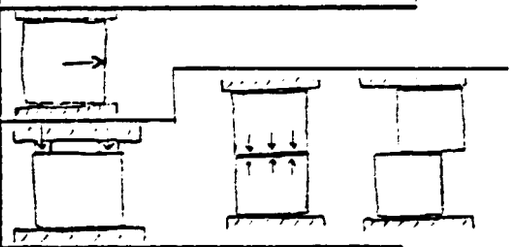
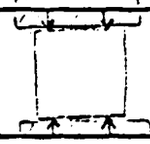
displacement



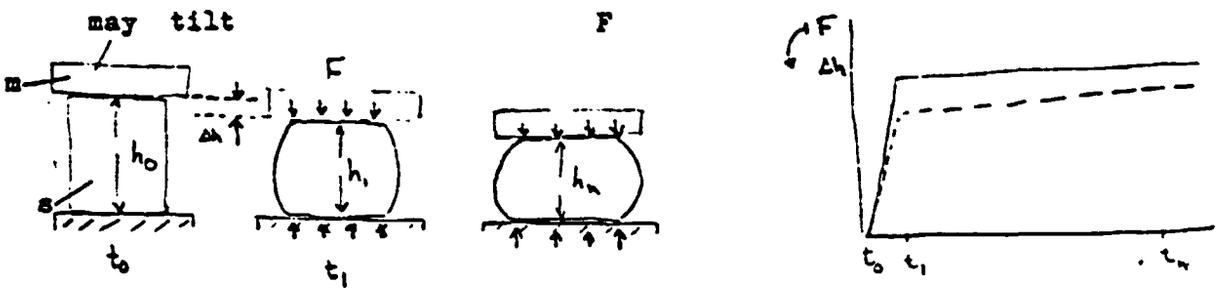
(straining rate)

= 10 mm/min.

± 3 mm/min.

Parameters that must be fixed	for normal procedure (comp. spec)	for adaptation to transit practice.
conditioning (ISO 2233)	20°C 65% r.h	p.g 38° 85% or 25° 85%
Attitude of test specimen		
force distribution		
duration	some minutes	some days, or weeks. (S. 2234 Or 2874)

"STACKING TEST" (ISO 2234)

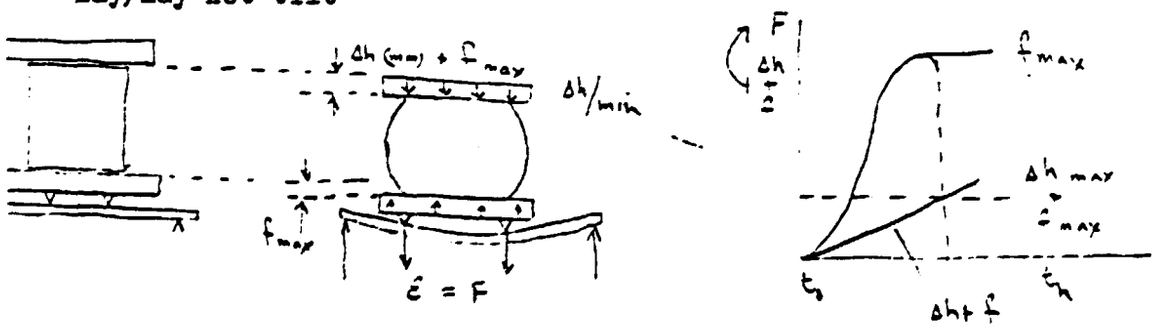


Predetermined compressive force F - here produced by mass m - causes deformation (strain) here: compression Δh or $\frac{\Delta h \times 100}{h_o}$ % - or breakage (collapse) of the test specimen s. Δh must be measured.

t_n may be: some days or weeks. Environmental climate must be predetermined.

"Compression test" (ISO 2872)

may/may not tilt

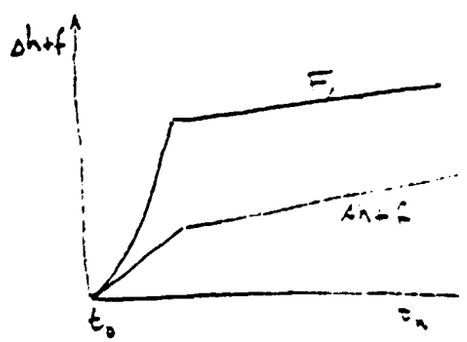


Predetermined displacement Δh

causes Force F

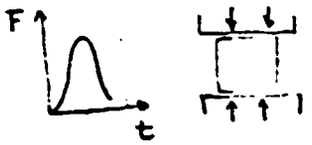
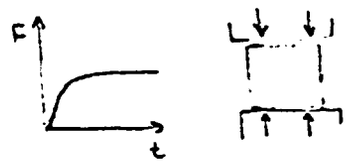
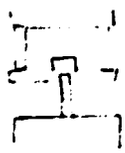
F is measured by using known relation F = flt

t_n in some minutes. Conditioning must be predetermined.

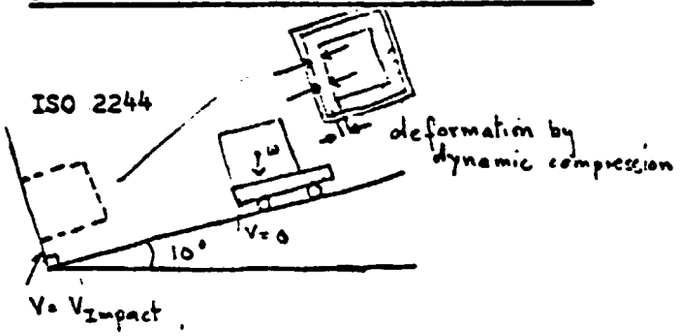


ISO 2876

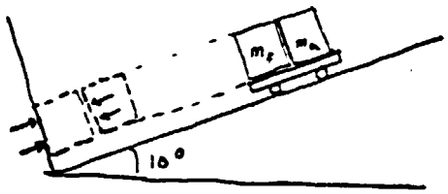
Possible uses of the "Compression Tester"

	Performing:	Similarity:
	"compression test" (ISO 2872) method 1 normal method 2 procedure	Stacking hazards during storage and transport processes.
	Utilising the parameter to be decided upong 'Stacking Test' using the compression technique. (ISO 2874)	Replacement of dynamic test with compression Compression stresses in products
	"Bending Test"	Bending hazards e.g. pallets Bending stresses in products.
	"Nail extracting test"	extracting - forces in nailed boxes or pallets.

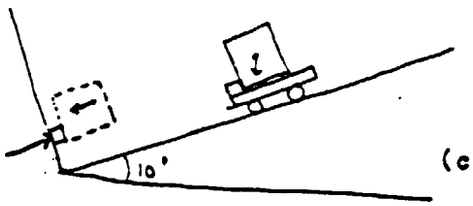
POSSIBLE USES OF THE 'INCLINED PLANE'



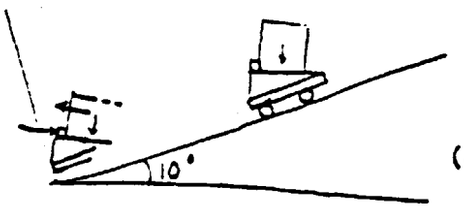
(a)



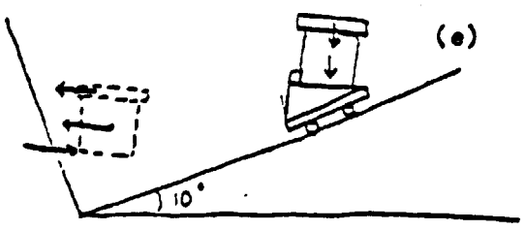
(b)



(c)



(d)



(e)

Simulating

transport and handling hazards characterized by decelerations of massee in packages (d) (e)

(a) (c) masses pushing against packages (b)

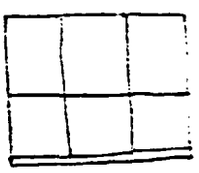
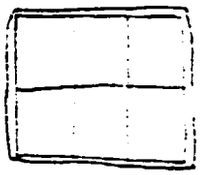
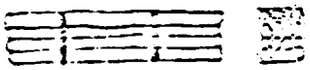
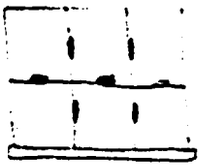
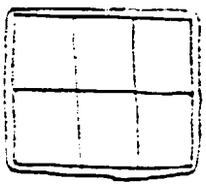
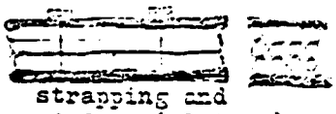
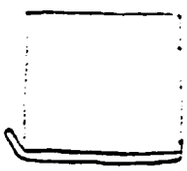
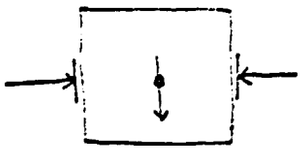
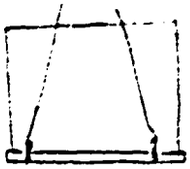
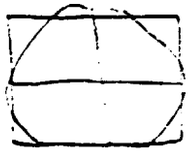
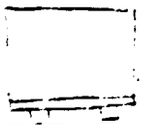
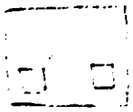
masses on packages (e)

Investigating:

cushioning material empty packages complete package with reference to every dynamic stress.

(compression, tension, bending, torsion)

UNITIZATION BY "UNIT LOADS"

FUNCTIONS	POSSIBLE REALIZATION
1. to assemble packages (or goods) into "unit loads"	 platen, sheet  shrink (stretch) wrapping  strapping  spot-gluing  outer container  strapping and girders (platens)
2. to handle the the "unit loads" without the use of f.l.t	slip sheet  clamps  platform  pre-slung method  skids
with the use of fork lift trucks	pallet  shrink-palletless unit   winged p.  tubes 

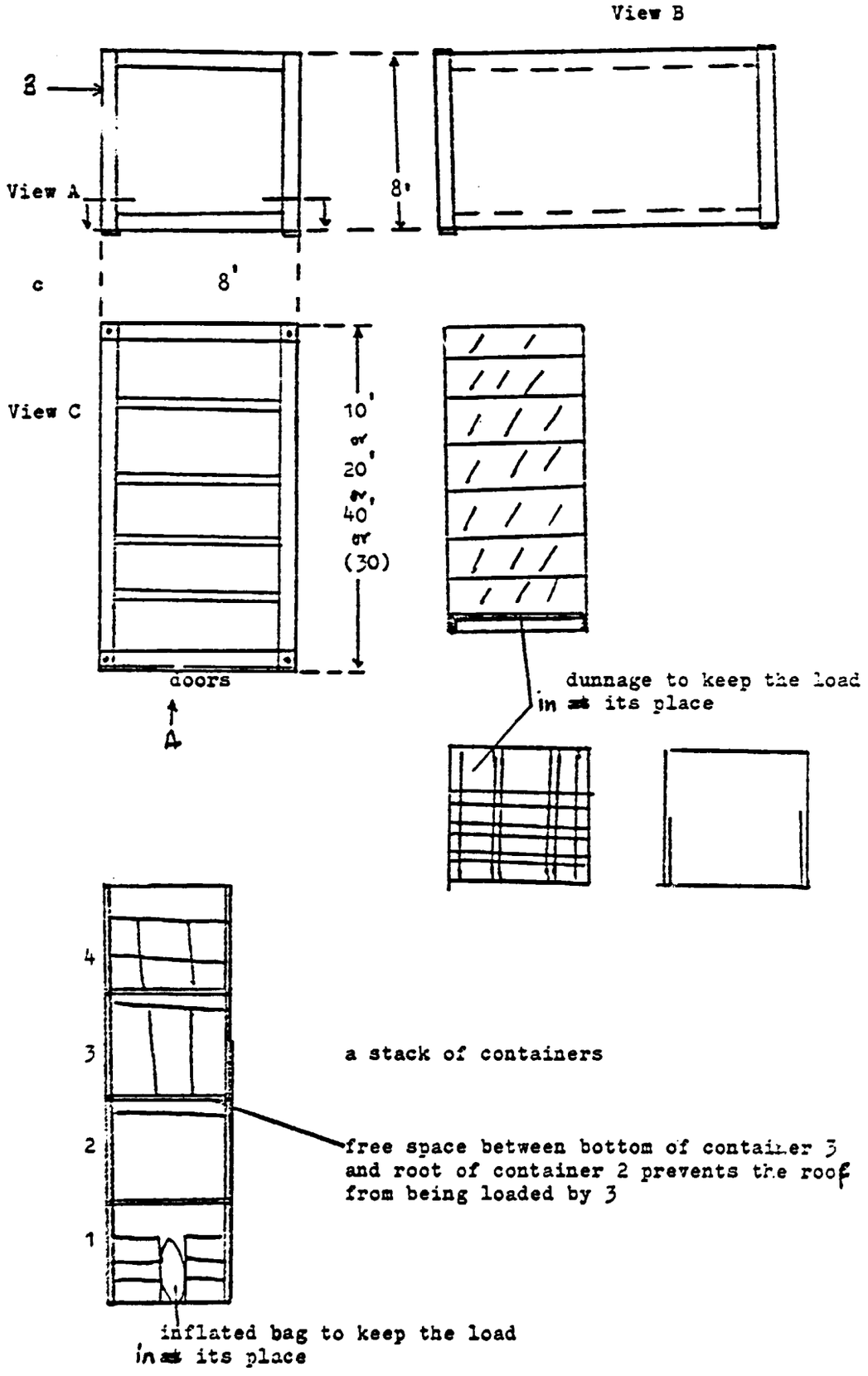
Advantages of unit loading in comparison with packages:
Reduction of handling costs
" " the packaging costs
" " " probability of pilferage

Disadvantage of unit loading:

Increase of costs by unititation means.

Loss of warehouse volume.

FREIGHT CONTAINER



ANNEX III

Testing Technology.

ANNEX III

TESTING TECHNOLOGY

1. Definition of the terms

"Test and Testing Technology"

In this context the term "Test" means a procedure that determines the behaviour of a material or manufactured product under specific conditions. This behaviour is described by measuring one or more specific properties and their magnitude.

Tests may be laboratory or field tests. That means tests may be carried out in a laboratory; that is to say under predetermined laboratory conditions or in practice, in the field, in a definite distribution system, that is to say under the conditions of the system that may be pre-determined only to a limited degree. ISO 4180/1 uses the term "distribution trial." This standard describes what should be recorded when carrying out a field test or distribution trial (see also 5).

"Testing Technology" comprises the general rules that should be taken into account in planning and performing tests especially in the field of packaging.

ISO Standard 4180/1 and 2 concerning "General rules for the compilation of performance test schedules" is used in this paper.

2. Other Basic Definitions

2.1 Test specimen.

The objects that are submitted to a test are called: test specimens. Test specimen may be one of the following types:

2.1.1. A piece of a material of a definite shape and size e.g. according to the respective standard.

2.1.2. A piece of a product or a package e.g. an edge of a corrugated board case.

2.1.3. The product e.g. the empty package or the complete filled and closed package.

2.2 "Multi-test-Schedule

This term is used in ISO 4180 and defined as follows: "A performance test schedule compiled from some or all of a series of tests." Normally the term "test programme" is used instead of "Multi-test-schedule." This means a series of tests that are performed one after the other in using the same test specimens or in using other test specimens.

2.3 Sampling

Sampling is the activity to select a definite number of test specimens out of a lot of products in using a definite method guaranteeing that the selected number of products - the sample - represents the whole lot. Such a method is described in ASTM D585.

3. Materials tests and package tests

One should distinguish between the following two kinds of tests:

3.1 Tests in which all the details are fixed by a standard i.e. the test equipment and the method of using it. Nearly all material tests belong to this kind of tests. The report about such a test, therefore, mentions only the respective standard and the results obtained after having used it.

3.2 Tests in which only some of the details or parameters are fixed by a standard but have to be fixed by the person who uses the standard. Nearly all tests concerning "complete filled and closed packages" are in this group.

ISO/4180/2 names the details that are not fixed by the standard: "factors requiring quantification" but one must not only decide on "quantification" but also on details like "attitudes of the test specimens." It is, therefore, proposed to use as a general term for variables that are kept constant for a special purpose: "parameters." The parameters of a test method and their realizations are described in the context of the description of the test methods. (see Annex II).

4. Possible Purposes of Laboratory tests and multi-test-Schedules

Before choosing or conceiving a test the purpose of the test should be known. The following are the possible purposes:

4.1 To find out if the properties of a product (package) correspond to the requirements of the relevant specification. This specification may concern production or buying the product. (see 7.1 of ISO 4180/1).

4.2 To find out if the production runs as planned (in-line testing for quality control) (see 7.1 of ISO 4180/1).
Such tests are performed during the manufacturing process. They have to show if properties that are essential for the different stages of production comply with set standards. These are normally internal standards of the producer based on previous experiences.

4.3 Finding out if a package is appropriate for a specific purpose.
E.g. the tests on "complete filled transport packages" have to show the suitability of a package to withstand the hazards of a specific distribution process. (see 7.1.a of ISO 4180/1).
This means that the test conditions have to simulate as closely as necessary the conditions that are thought to exist during a specific distribution process, e.g. the export of boxed bananas from Jamaica to New York.

The following rules are consequences of this requirement:

(a) Hazards occurring simultaneously in practice
must be simulated by a test that submits the test specimen simultaneously to the corresponding mechanical and climatic conditions.

(b) Hazards occurring one after the other during the distribution process must be simulated by a "multi-test schedule." This comprises a sequence of tests applied to the same test specimen.

(c) The levels of intensity to be used as test conditions depend upon the intensities of the conditions to be expected normally or rarely during a specific distribution process. Rare conditions which usually mean high level of intensity are to be taken into account when the product is very expensive or very important or dangerous for its environment. (see 9 and 10 of ISO 4180/1).

4.4 Finding out how to improve a product (package)
(see 7.1.C of ISO 4180/1)
Normally there will be one or more standardized tests that seem to be appropriate to test and to measure those properties that are to be improved. If not, existing tests must be adopted to the special questions or new tests must be conceived. The intensity of the test conditions to be used for this purpose normally should be raised to the highest possible level, i.e. until breakage or deformation or sufficient other deterioration has been achieved. This procedure yields information about the differences between test specimens, if there are any.

4.5 Finding out the causes of loss and damage that has occurred (see 7.1.b of ISO 4180/1).
The tests must be conceived so that they repeat or simulate as exactly as possible the conditions believed to have occurred. If all of these conditions are not exactly known one should try to reproduce the same damage by varying these conditions within a range that may occur in reality.

4.6 Finding out how to improve existing specifications or how to establish new specifications
One has to determine all the tests necessary to simulate all the hazards occurring inside and outside the users factory. Then one has to determine the properties that the packaging should have to withstand these hazards.
If, nevertheless, the delivered packaging fails, there are three possibilities:

(a) the tests required by the specification have not been performed correctly.
(b) the treatment of the packaging has become worse.
(c) there are one or more properties of the packaging that have not been sufficiently identified. In this case the specification should be changed to cover also this or these properties.

5. Laboratory tests and field tests ("distribution trials" according to ISO 4178)
Field tests subject the test specimens to the conditions of the field i.e. in that context: to the conditions of a specific distribution process ;that means; after having decided the itinerary, the means of transport, the test specimens and their arrangement in the transport means care must be taken only to measure and record hazards and not to influence them in any way. Field tests only yield sufficient information about the suitability of a definite package for a definite distribution process, if the hazards have been measured and compared with the hazards of other distribution processes of the same type. Under these conditions it is possible to find out if the hazards having occurred during a field test have been normal or abnormal (see chapter 4.3).

5. Field tests should be performed so that during the same journey reasonable solutions to a problem should be subjected to the same hazards. In this manner, sufficient information may be gained for finding out the optimal solution to each problem that had to be investigated by the field test.

Stresses applied during laboratory tests are completely predetermined after having decided what standard should be used and how it should be performed. In a laboratory one test specimen can yield the same or more information as several test specimens in a field test because it is possible to vary the intensity applied on this test specimen.

6. Procedure for the "Compilation of Multi-test-Schedules" (according to ISO 4180)

"The step-by-step procedure is as follows:

(a) "identify the elements of the distribution system" i.e. the different transport, handling and storage processes.

(b) "decide what hazards these elements involve"

(c) "decide which tests are necessary to represent or simulate these hazards."
This includes as a matter of fact the necessary decisions about those parameters of a test that are not sufficiently determined by the test standard.

(d) "decide what are the basic values of the test intensities associated with the distribution system and the particular package" or determine the "normal" intensities according to data published by BFSV. (see Annex II).

(e) "decide what test-intensity-modifying-factors, if any, should be applied to the normal values of test intensity" or use the values for "rare" hazards given in the table of BFSV (see Annex II).

(f) "place the tests, thus identified into an order corresponding to the respective system of distribution or according to the following order:

"Conditioning for testing (ISO 2233)
stacking (ISO 2234)
impacts (ISO 2248 and 2244
vibration with resonant frequency
climatic treatment (ISO 2875)
vibration (ISO 2247)
stacking (ISP 2234)
impacts (ISO 2248 and 2244)
This sequence of tests is called a "multi-test-schedule."

7. Testing costs

Testing costs are determined by costs per unit of time for persons and equipment involved in the test and the time needed to determine and to perform the tests to assess their results and to write the report. Testing costs may be diminished by using one or more of the following rules:

7.1 Package tests should be replaced by material tests if there are such material tests that allow one to draw sufficiently reliable conclusions to define package properties e.g. edge-crush-test instead of compression test.

7.2 Test duration of some days or weeks may be reduced to short-time tests of some minutes or hours if the correlation between both kinds of test are known. Time normally worsens the properties of a product, therefore short time tests must compensate this influence of time by exaggerating the test conditions e.g. corrosion tests are performed in higher humidity than in reality occurs in order to shorten the time.

7.3 The number of replicate test specimen should be restricted as much as possible depending upon the purpose and the kind of test e.g. if the range of distribution of test results is rather small the number of replicate test specimens may be reduced.

7.4 Time for designing and describing a test or test sequence may be shortened when test programmes that may occur often within the scope of work to be done by the institute have been fixed previously in every detail.

7.3 If it seems to be necessary to investigate the influences of a great number of variables on the behaviour of a package usually it is not necessary to investigate the combinations of all variations with one another, if the influence if a variable on the package may be assumed to be the same also when other variables are varied.

8. Reproduction of test results

Testing procedure must be conceived, test standards interpreted and used and testing devices used so that the variations in the results produced by them are negligible i.e. that they are much smaller than the variations of production for a definite product.
ASTM Standard D1749.
"Inter laboratory evaluation of test methods used with paper and paper products", gives additional, information in this field.

9. Substitution of original contents of a package to be used for testing purposes

All dynamic tests - vibration test, drop test, inclined plane test, rolling test - must be performed with filled packages. Static tests also need filled packages when an influence of the contents on the test results may be expected. The contents normally will not be the original one when it is possible that it will be destroyed during the test and when its replacement by a substitute seems to be admissible.
The following requirements should be fulfilled by a substitute for a solid original contents:
The same means, the same centre of gravity, the same size of all load - bearing faces, the same stiffness, the same friction between parts of the contents.
The following requirements should be fulfilled by a substitute for a liquid or pourable contents:

the same volume
the same density
the same flow behaviour.

ANNEX IV

The charts produced for the Round Table Conference.

ROUND TABLE CONFERENCE

The following issues are dealt with:

1. The essential tasks that the Packaging Centre's Transit - Packaging - Laboratory can perform to help Industry especially for the export of their products.

2. Demonstration of packaging problems by means of a series of slides.

3. An appropriate procedure to solve packaging problems.

4. Some series of questionnaires to gather information and to analyse a problem.

5. Some examples out of the Centre's practice as to transit packaging.

6. Some rules for transit packaging.

7. A show of charts demonstrating essential features of transit packaging.

ROUND TABLE CONFERENCE

The Packaging Centre's Transit Packaging Laboratory may perform essentially the following tasks:

1. Perform tests according to the wishes of a client.

2. Help diminish the damage rate of products occurring during specific transit processes.

3. Help diminish freight costs as far as they are influenced by packaging.

4. Help develop the optimal package for a specific product and for a specific transit process.

AN APPROPRIATE PROCEDURE TO SOLVE PACKAGING PROBLEMS

1. Fixing as exactly as possible and necessary the problem in writing and requesting confirmation from the client.

2. Analysing the problem and gathering the available information in using questionnaires:
   a. Questions concerning the product.
   b. Questions concerning the transit product.
   c. Questions concerning the packaging.

   This is the first level to analyse the problem. a,b,c, contain in themselves further levels of analysing. Sufficient analysing is necessary to formulate the simpler partial problems and the solutions for them.

3. Redefining the task if necessary and formulating the partial problems.

4. Finding out the possible solutions separately for each partial problem in using fundamental rules of mechanics, materials technology and physics.

5. Testing models of possible and plausible solutions. Series B of the questionnaires and the 'Testing Technology' may be guidelines for this testing.

6. Drawing the conclusions out of the investigations performed according to 2..5 to answer the original questions formulated in 1 and the questions that had been originated in the course of the work.

QUESTIONNAIRE CONCERNING

A. User or Producer of Packaging.

a. Properties of the Product to be packed

---

1. Producer?
2. Denomination?
3. Kinds of materials?
4. Size?
5. Shape?
6. Weight?
7. Price.
8. Dangerousness?
9. Quantities of production?
10. Were there losses or damages during transit processes?
    1. When?
    2. Under what circumstances?
    3. With what frequency?
11. Is it possible to change the product so that packaging costs could be diminished?
    (e.g. in diminishing the volume or the susceptibility to impact.)

QUESTIONNAIRE CONCERNING

a. User or Producer of Packaging.

b. Properties of the Transit Process.

---

1. Transport processes:

   1.1 Means of transport?

   1.2 Routes of transports?

   1.3 Duration of transport?

   1.4 Quality of transports?

2. Handling processes:

   2.1 Means of processes?

   2.2 Where are they used?

   2.3 Quality of handling processes?

3. Storage processes:

   3.1 Means of storage?

   3.2 Duration of storage processes?

   3.3 Places of storage processes?

   3.4 Quality of storage processes?

QUESTIONNAIRE CONCERNING:

A. User or Producer of Packaging.

C. Properties of an existing package according to table/drawing/photo/model..

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1. Material of the container?
2. Size of the container?
3. Shape of the container?
4. Weight of the container?
5. Internal structure of the package?
6. Price of packaging?
7. Is there a purchasing/delivery specification?
8. Is it used?
9. Has it been changed?
10. Has the producer of the package changed its qualities?
11. Are there any observations made with reference to:
    Packaging used formerly?
    Packaging used now?
12. How is the packaging process performed?

QUESTIONNAIRE CONCERNING:

B. Information to be found out by the Packaging Centre.

a. Properties of the Product.

b. _____

1. Admissable compressive force:
   1. assessed/calculated?
   2. determined by compression/stacking test (TSO 2872/ 2234)? with following details:

2. Admissable bending force:
   1. assessed/calculated?
   2. determined by bending test?

3. Admissable impacts:
   1. assessed/calculated?
   2. determined by drop test (TSO 2248)?
   3. determined by inclined planet? (TSO 2244)

4. Admissable vibrations:
   1. assessed/calculated?
   2. determined by vibration test (TSO 2247)

5. Admissable relative humidity (1 month)
   1. assessed?
   2. determined by storage in 38^0/95% r.h
   3. " " " " 30^0C/85% r.h
   4. " " " " salt spray ch.?

6. Admissable temperature for 1 hour, 1 day
   1. assessed?
   2. determined by storage in -20^0C'
   3. " " " " $+40^0$C'
   4. " " " " $+70^0$C'

QUESTIONNAIRE CONCERNING:

B. Information to be found out by the Packaging Centre

b. Properties of the Transit Process

---

1. Stacking height during transports? in climate?
   with additional accelerations?
   and duration?

2. Stacking height during storages?
   in climate?
   with duration?

3. Drop heights/impact velocities?
   in climate?

QUESTIONNAIRE CONCERNING:

B. Information to be found out by the Packaging Centre

c. Properties of an existing/new/requested empty package/ completely filled package/specific package.

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1. Behaviour under compression/bending.... according to ISO 2872, normal procedure:
   1. maximum force?
   2. deformation under wax, force?

2. Behaviour under compression/bending... according to ISO 2872 and IS....
   1. Admissable force?
   2. deformation under admissable force?
   3. admissable deformation?

3. Behaviour under impact according to ISO 2244/2248 normal procedure:
   1. Observations concerning the product?
   2. " " " packaging?

4. Behaviour under impact according to ISO 2244 and IS ....
   1. Observations concerning the product?
   2. " " " packaging?

5. Behaviour under the influences of "multi test schedule" IS....:
   1. Observations concerning the product?
   2. " " " packaging?

SOME GENERAL RULES CONCERNING TRANSIT PACKAGING

1. As soon as a transit process and a product have been fixed, the package must be designed so that it can fulfil its functions with a definite probability.

2. Each decision, each change concerning the transit process the product or the packaging may influence the other ones.

3. The package must be designed so that the packaging only produces the additional properties to withstand the journey hazards, that the product itself misses.

4. The results of the Packaging Centre's work are the more reliable, the more reliable and complete the information is concerning :

   experiences with packages
   damages
   product properties
   journey hazards

ANNEX V

The use of indicators to determine the intensities of physical quantities, characteristic for transit processes.

ANNEX V

The use of indicators to determine the intensities of physical quantities characteristic for transit processes.

"Measuring" means :

Comparing the unknown intensity of a physical quantity with the calibrated change of a definite property of a standardised material, exposed to the same unknown intensity of the physical quantity.

Example :

Physical quantity	:	temperature
Its intensity	:	? °C
Standardised material:		mercury thread
definite property of this material	:	length

"An indicator" does the same, but it is not standardised, althought it can be calibrated in comparing its indications with an appropriate measuring device.

An indicator is usually less expensive than a measuring device, has often integrating properties so that it allows to find out a complete range of influences.

Examples for indicators:

(i) Indicators for temperature: papers that change their colour after being exposed to a specific temperature.

(ii) Indicators for relative humidity: unprotected steel parts get rusty depending on the humidity (and the pollution)in the surrounding air and on the endurance of exposure. The calibration can be performed in using a climatic chamber.

(iii) Indicator for shocks : brittle pieces loaded by definite masses break if the acceleration of the masses reaches a definite magnitude. Plastic material (e.g lead) is deformed by a force that is determined by the mass of a load on this material and its acceleration. The calebration can be performed in using a compression tester.