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ESTABLISHMENT OF A PACKAGING UNIT AT THE INSTITUTE FOR RESEARCH AND DEVELOPMENT OF CHEMICAL INDUSTRY

DP/INS/86/005

REPUBLIC OF INDONESIA

Technical report: Development of capabilities in transport packaging *

Prepared for the Government of Indonesia
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Mr. Ernesto F. Pichler
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Engineering Industries Branch

United Nations Industrial Development Organization
Vienna

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* This document has not been edited.

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TABLE OF CONTENTS

Key Words

Packaging, Handling, Transportation, Storage, Testing, Standardization, Training, Dangerous products, Exports, Cost reduction, Certification.

I. Introduction

Objective

According to UNIDO project and job description of DP/INS/86/005/11-4, the consultant was at Balai Besar Industri Kimia (BBIK), from 15 November 1988 to 15 January 1989 with the purpose to support the creation of material, personnel and informational capabilities aimed at the solution of problems related to packaging for physical distribution, through testing for development and certification.

Documentary output is intended to orient the development of standards and procedures for testing, of laboratory equipment and personnel capabilities.

II. Summary of Conclusions and Recommendations

The level of interest and commitment of the Institute's transport packaging technology staff must be raised, as well as the level of relevant technical education and information. A higher degree of involvement with the industry, through participation in committees with clear objectives and sense of importance, especially for the development of Indonesian standards is a recommended stimulus to the raise of these levels, with an attribution of responsibilities. Training is another way to raise these two levels. Pilot projects with support from the industry are suggested, together with the study of standards and literature, as the principal form of training. A programme for the chief of staff at Michigan State University, School of Packaging and at the Packaging Technology Center of the Technological Research Institute of S. Paulo State (IPT) in Brazil is also important as a stimulus and training.

The laboratory still needs equipment, devices and instrumentation in order to have some importance to the industry. The only important equipment installed, a compression table, needs repair, spare parts and calibration. The Institute needs technical assistance in electronics for repair and maintenance of equipment.

New equipment was proposed, to be built at the Institute's Workshop, for horizontal impact, drop, static compression and other tests.

Proposals for Indonesian standards were advanced by the consultant and discussed in an internal and two external seminars, with the staff and with participants from 20 to 30 industries. It is expected that these seminars started a process of larger interaction of the Institute with industry and governmental and private agencies.

III. Observations and Activities

1. General

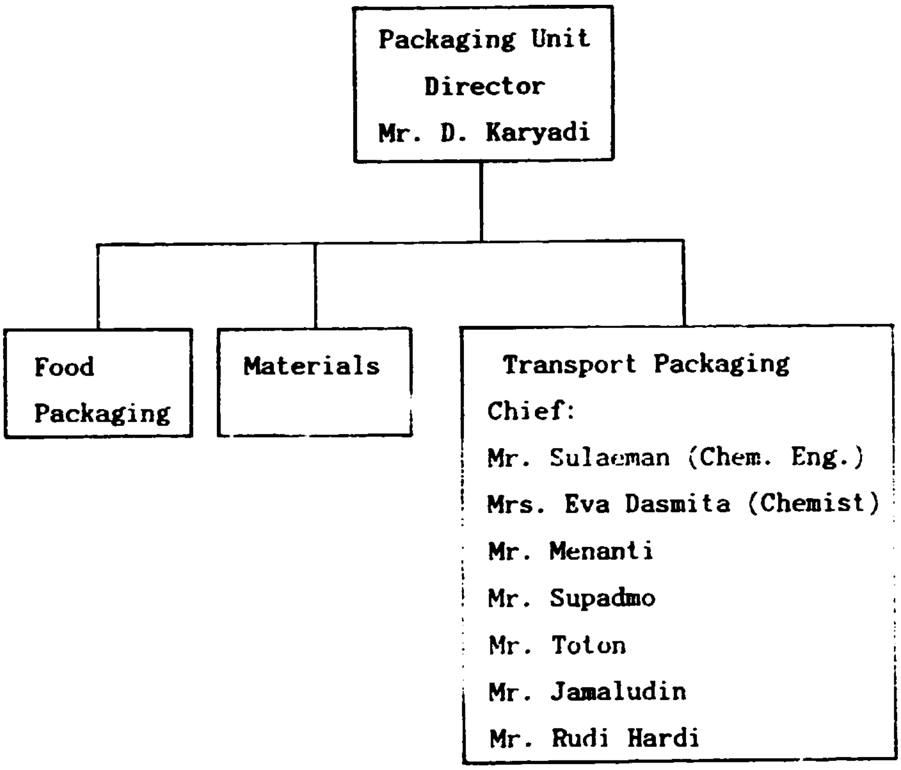
Indonesia, as a large archipelago, a developing country with a growing internal market and an actual and potential exporter of substantive volumes, has a necessity of improvement in quality, quantity and economy in packaging for physical distribution (transportation, handling, storage). That necessity requires the application of technology, imported and nationally established. Technology, as a result of efforts in research and development, engineering and organization, standardization and quality control, oversteps the limits of particular industries or sectors, assuming the character of a national objective. As a part of these efforts in Indonesia the Institute for Research and Development of the Chemical Industry - BBIK - is involved in the creation of capabilities to support industry in development and certification of packaging. These capabilities are presently limited by insufficiencies in personnel, equipment and information (especially on standards).

2. Organogramme and Personnel

The Packaging Unit at BBIK is organized in three areas of activity:

- food packaging technology
- packaging materials technology
- transport packaging technology

Each of these areas has a specialized laboratory being installed and a staff with the following organogramme and composition in the area of transport packaging:



Of the Transport Packaging group only the two first speak some English and are university graduates with the JICA course of packaging. They show a low degree of commitment or concern about the objectives, activities and importance of their work. Working hours are very flexible. Initiative and responsibility are very centralized at general direction of the Institute.

3. Space and Equipment Received

A space for the Transport Packaging Laboratory is provided in a large building once destinated to a food processing pilot plant, of which the equipment, American supplied, is a long time abandoned, with no care, no cleaning, occupying a large area. It was proposed the concentration of the new laboratory equipment in only a small part of the available area, so as to separate it from the old equipment and to make easier the operation and maintenance. Even with this concentration, the new laboratory has much more area than necessary. A lay-out was proposed by the consultant, with this concentration, as shown in Annex 1.

The equipment supplied by the project was there for long time, uncrated, subject to dust and corrosion. Manufactured by Caynes (USA) are a compression tester, a repetitive shock table, a small drop tester and quick release device for a larger drop tester to be built.

Also in place a 100 kg scale, a pedal operated stapler and a paper cutting guillotine. A large and strong table was found as adequate for preparation of box specimens.

4. Information

A good source of technical information is being provided by the project, in co-operation with the Indonesian Packaging Institute.

The library of DSN - Standardization Council of Indonesia - has the ISO standards for packaging, as well as ASTM and JIS and other national standards.

There are no Indonesian Standards for transport packaging.

In an attempt to raise the level of information, involvement and participation of the staff, an internal seminar was conducted by the consultant, with 17 sessions of one hour, three days a week.

Two external seminars were also presented by the consultant, as part of the efforts of the Institute to interact with industry and governmental authorities. One in December 14, 1989, at the Ministry of Industry and the other on January 12, 1989, at the Institute, these seminars had an attendance of between 20 to 30 participants each, with many manifestations of interest and involvement. The pamphlet prepared for the last seminar is presented in the appendix.

5. Standardization

The main purpose of the internal seminar was the discussion and formulation of proposals for standardization of procedures, test methods and specifications, necessary for the experimental work of development and certification of packaging performance. The results, in terms of proposals, are outlined in the above mentioned pamphlet.

6. Considerations abcut the Present Equipment

Caynes equipment is in principle compatible with ISO standards. Somme comments about this equipment are necessary:

a) Repetitive shock table

This table has a rotary motion, accepted by ISO but not accepted by ASTM. It has very little value in terms of simulation of accelerations found in transportation. It is not a vibration table, as usually called, since vibrations in truck or rail have RMS values around 0,2 to 0,5 G, while a package in this table bounces with more than 1 G, in a non sinusoidal pattern. Bouncing in transportation occurs only with loose packages in a truck at rear, far from the centre of gravity.

The table at BBIK was installed over a seismic block resting over sand. Some settling may occur with time. Problems of maintenance, as lubrication and replacement of belt drives, are envisaged. The sand around the seismic base is a serious threat to roller bearings exposed under the table. Suggestions to close with cement the gap between the seismic base and the floor, with soft wooden spacers embedded, were made by the consultant.

b) Small drop tester

Tables have a circular movement with too low opening acceleration and intensive shock at the end.

Adjustment of drop height is not metric.

The consultant made suggestions of alterations in the equipment: introduce a rubber pad around the bumpers that would force the tables down at opening and absorb shock; open holes in the tables to reduce inertia and air resistance; to drill new holes in the height adjustment bar to standardized metric drop heights.

c) Compression table

Base plates indicated in installation manual as supplied were not shipped.

A DC motor with unnecessary velocity variation that reduces the reliability; force meter in 'lb/kg' when more appropriate would be N/kgf; a register with only one velocity of paper (1/2 inch/min) and impossibility to rewind; throw-away pens instead of rechargeable, are some of the regrettable features of this equipment.

When installed, a fuse was blown at the instrumentation circuit and no replacement was found in Jakarta. A provisional fuse was assembled by the consultant. No specification of fuse or circuit drawings were presented by the manufacturer.

The motor was not operating. Only in the consultant's last week it was realized that holding manually the ICM Cuttler Hammer Type M Relay, the motor would operate. It was possible, then to apply the plate over the load cells. The instrumentation was then found completely uncalibrated and not holding peak values of load.

Indications on how to calibrate the instrumentation with the use of dead weights were given by the consultant, as well as a demonstration on how to calibrate speed. Deadweights will be necessary also for static compression tester. It was suggested to obtain a 50 kg certified mass with the governmental metrological authority, as a reference for dublication, using the received scale, of deadweight masses made with plastic jerricans and dry sands.

7. Necessary Equipment

A set of tools for maintenance, repair and operation of equipment, like screw-drivers, pliers, wrenches, is immediately necessary.

A humidity and temperature meter must be installed in the laboratory.

In order to capacitate the laboratory to perform a series of standardized tests, a special structure was proposed by the consultant. That structure combines the following purposes:

- inclined impact test;
- drop test;
- static compression test;
- puncture test;
- concentrated compression test;
- handling (lifting) test;
- handling of loads to and from trucks, especially packages or unit-loads to be tested;
- if provided with an electric hoist, with two velocities, stability of stack or slide angle test;
- handling of low pressure test chamber;

An estimate of cost for this structure, drawings and plan of location are in Annex 2.

Another equipment necessary to install, at practically no cost, is a drop tester for packages of infectious substances, with a maximum mass around 15 kg, hanging from the roof structure over an existing seismic plate, for 900 cm drops required by UN/ICAO/IATA. The quick release device supplied by the project may be used here also.

8. Future Low Cost Equipment

An air compressor with line manometer and pressure control valve will be necessary for leakage and internal pressure tests. Leakage tests of small packages, like for pharmaceuticals, may be performed in a glass dessicator with a small vacuum pump. A vacuum pump is also necessary for low pressure tests required by ISO - IATA. A vacuum chamber that can be made at the Institute workshop is sketched in Annex 3. Also possible to be made at BBIK is the shower for rain test, shown in the pamphlets's appendix.

An oven is necessary for determination of moisture content of materials and compatibility of package with contents (shelf life). It was suggested that an existing abandoned oven should be recuperate.

9. Future High Cost Equipment

In relation to expensive equipment that needs special budgetary conditions for purchase in order of priority are suggested:

- climatization equipment of laboratory conditioning
- climatic chamber
- vibration table

The two last ones are only to consider for multiple purposes if necessary, besides packaging, like development and certification of products.

The climatization of the space presently destinated to preparation of samples, on the other hand, is important to standardize test conditions of paper and board packages. In this case the compression tester should be brought to this space. Errors of up to 20% may be observed for lack of conditioning of corrugated boxes in compression test. A lay-out of laboratory with this condition is presented in Annex 4.

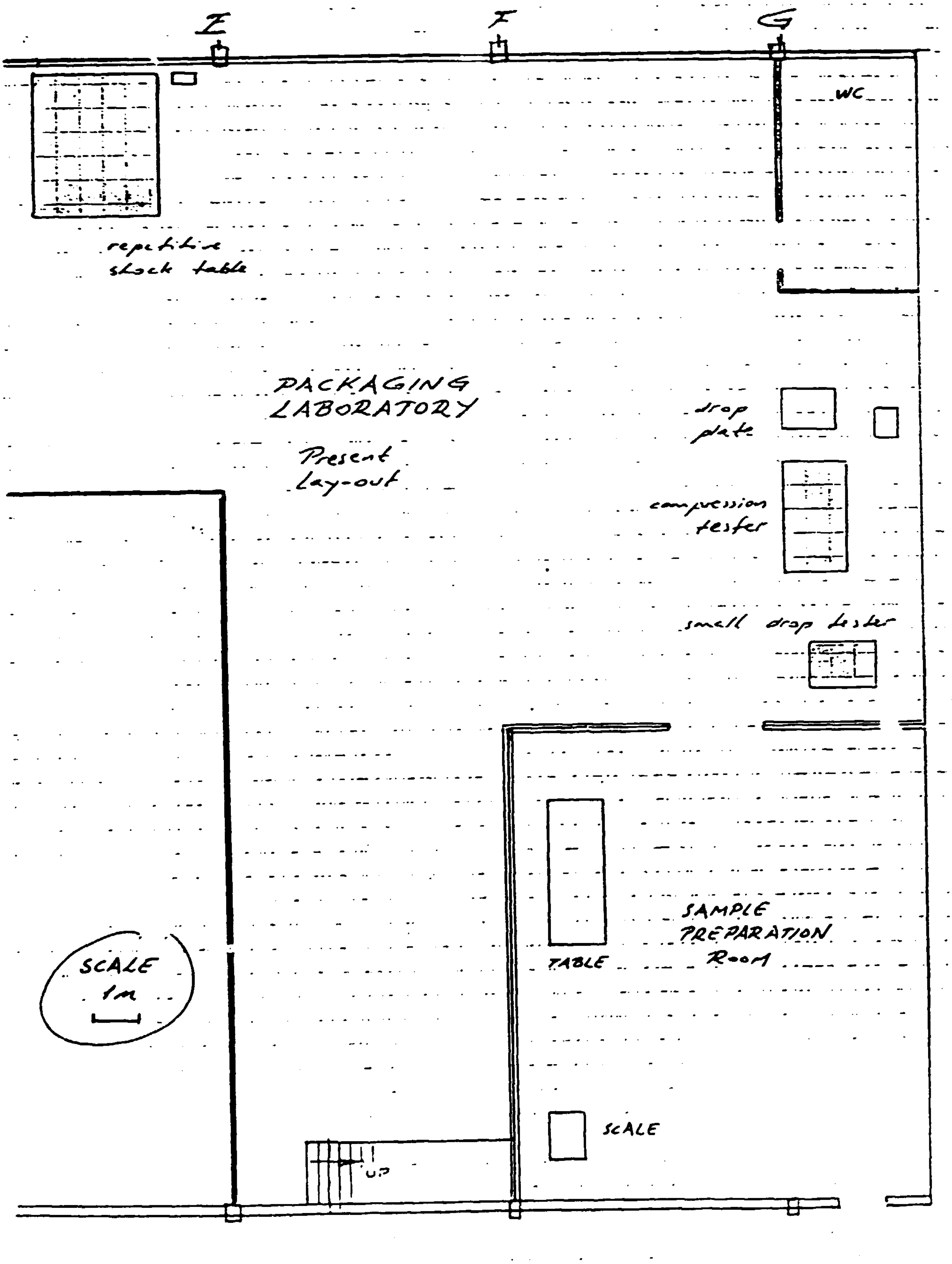
10. Training

The chief of the transport packaging group and his assistant are expected to transmit to the technical staff the information and ideas discussed in the internal seminar, in a basic level at least.

Additional training will be provided in the project for the chief of the group at Michigan State University for approximately one month and at the Packaging Technology Center of the S. Paolo State (IPT), in Brazil, for one month.

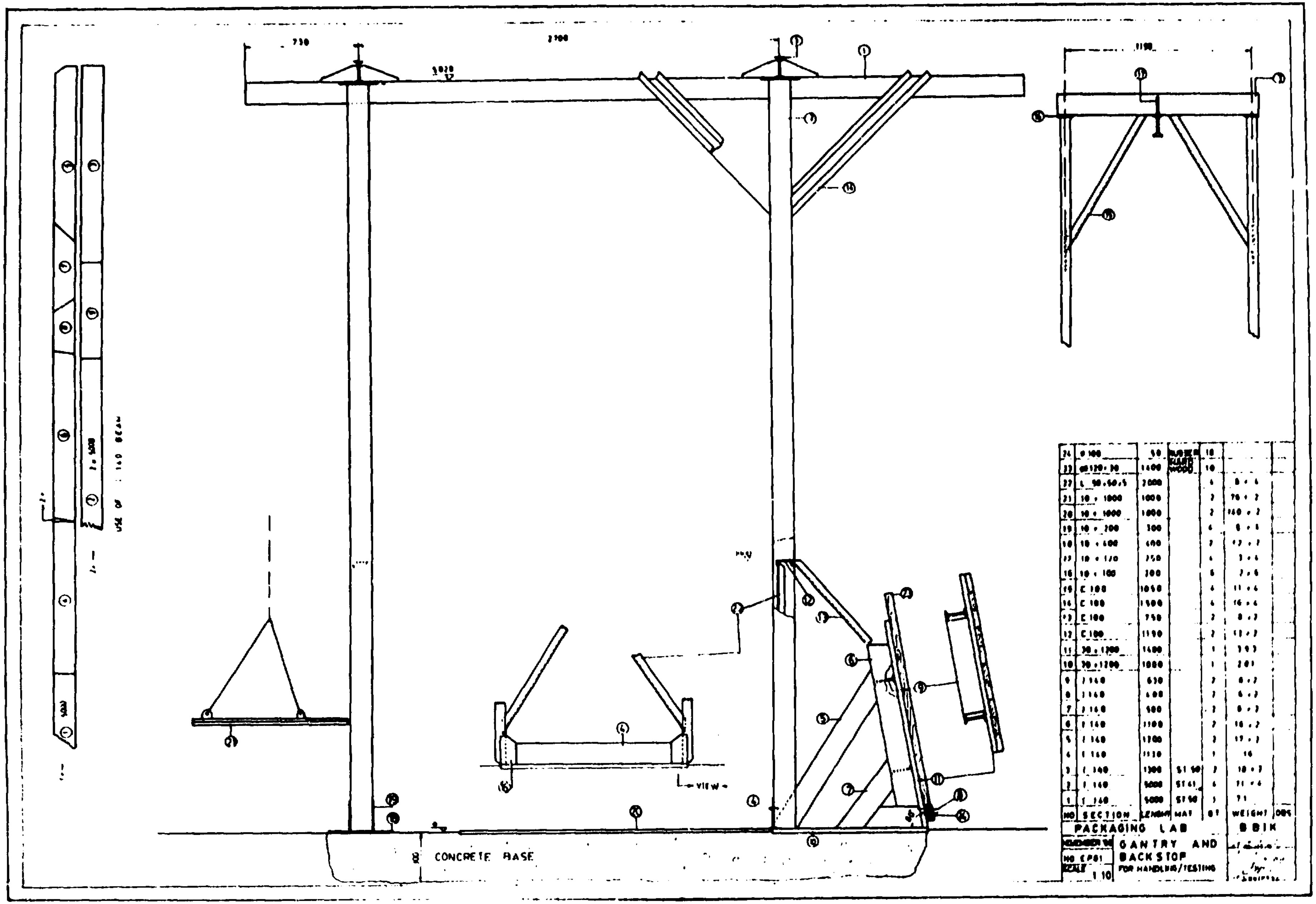
Since most of the necessary equipment is not yet available at BBIK, a training at more complete laboratories, like at MSU School of Packaging and IPT is necessary for the development, installation and operation of future proposed equipment. Besides the study of literature available, especially ISO and UN standards and recommendations, the participation of the staff in a committee, with representatives of the industry and government, to develop Indonesian standards, other tasks may be immediately taken by the group, mainly with training purposes:

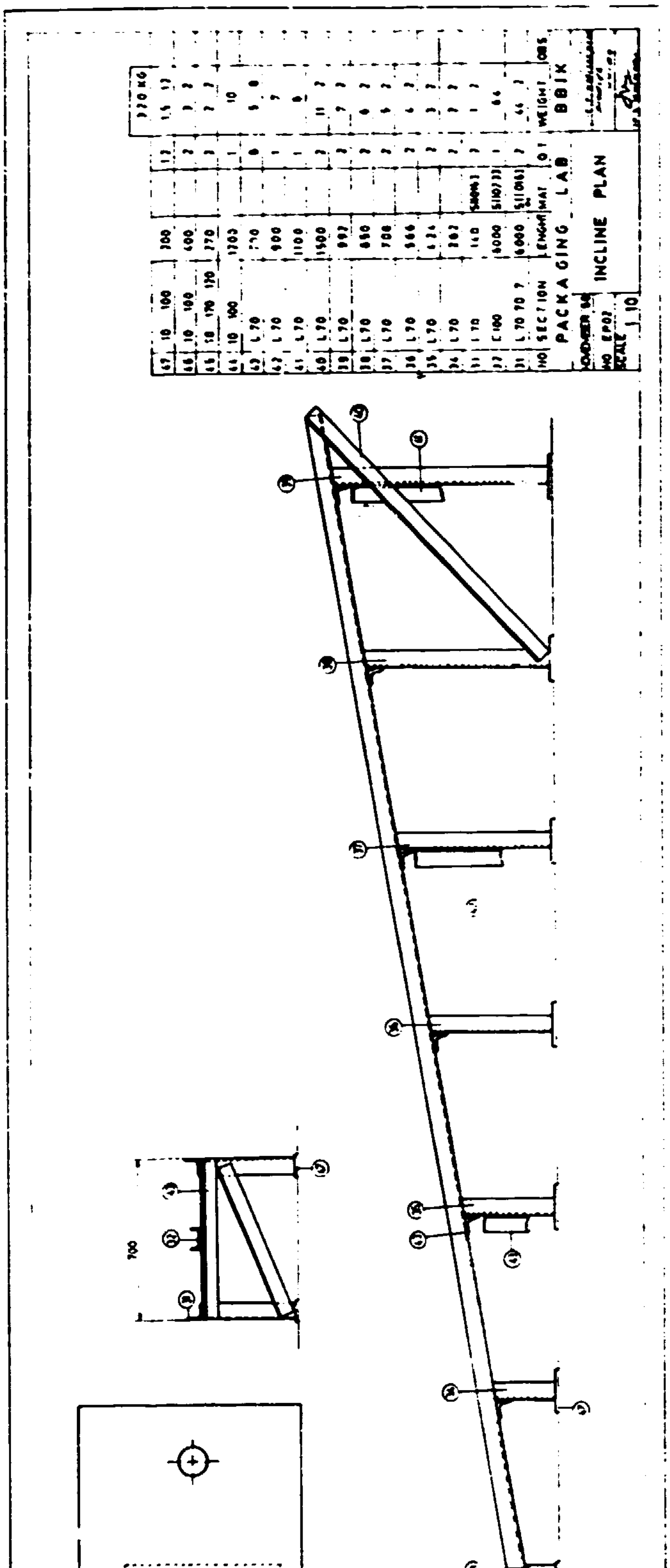
- comparison of results of compression tests of boxes when isolated and when in a stack of two or three, with different degrees of misalignment;
- comparison of drop tests of paper and plastic sacks for cement and correlation with dart drop tests of the material (to be proposed to Indocement, for instance);
- determination of the slide angle of paper and plastic sacks and correlation with friction coefficients of the materials.

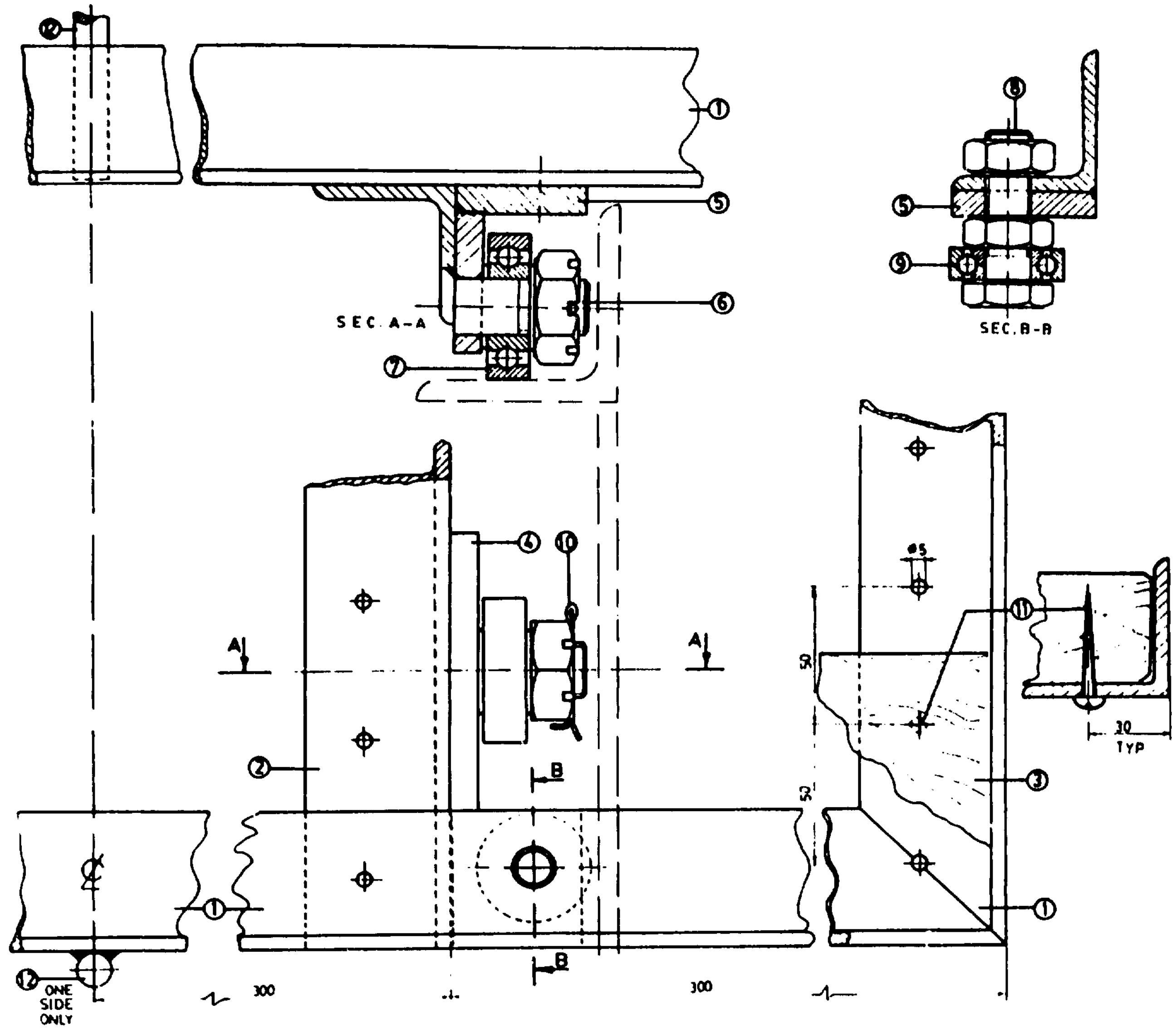

E
F
G
WC
repetitive shock table
PACKAGING LABORATORY
Present lay-out
drop plate
compression tester
small drop tester
TABLE
SAMPLE PREPARATION Room
SCALE 1m
SCALE
UP

DRAFT COST ESTIMATE OF MATERIAL FOR COMBINED STRUCTURE AND NEW GATE

	value 1000 Rp. Nov.88	Subtotal
I 140	522	
[100	146	
L 70	144	
L 50	37	
÷ 30	742	
÷ 10	432	
		2,026
Tax 1.15%	304	
Transportation	150	
Total steel		2,480
Weld, paint	150	
Structure		2,630
Concrete 2.4m x 66,000	160	
Wood 0.1m x 400,000	40	
		2,830
Others (bearings, pulleys, etc.)	170	
Total of material for structure		3,000
New gate		1,500
Electric hoist (1 ton)		4,000
Total cost of material		8,500

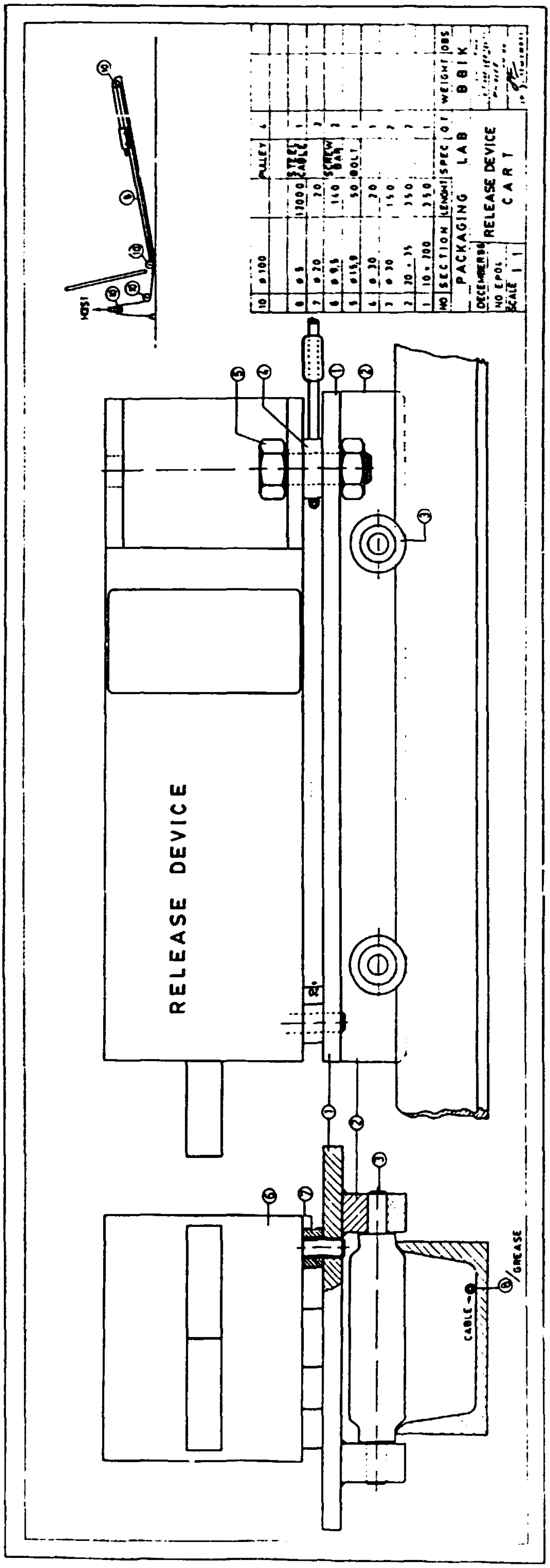

CONCRETE BASE
VIEW
NO
SECTION
MAT
WEIGHT
PACKAGING LAB
BBIK
NO CP01
SCALE 1:10
GANTRY AND BACKSTOP
FOR HANDLING/TESTING

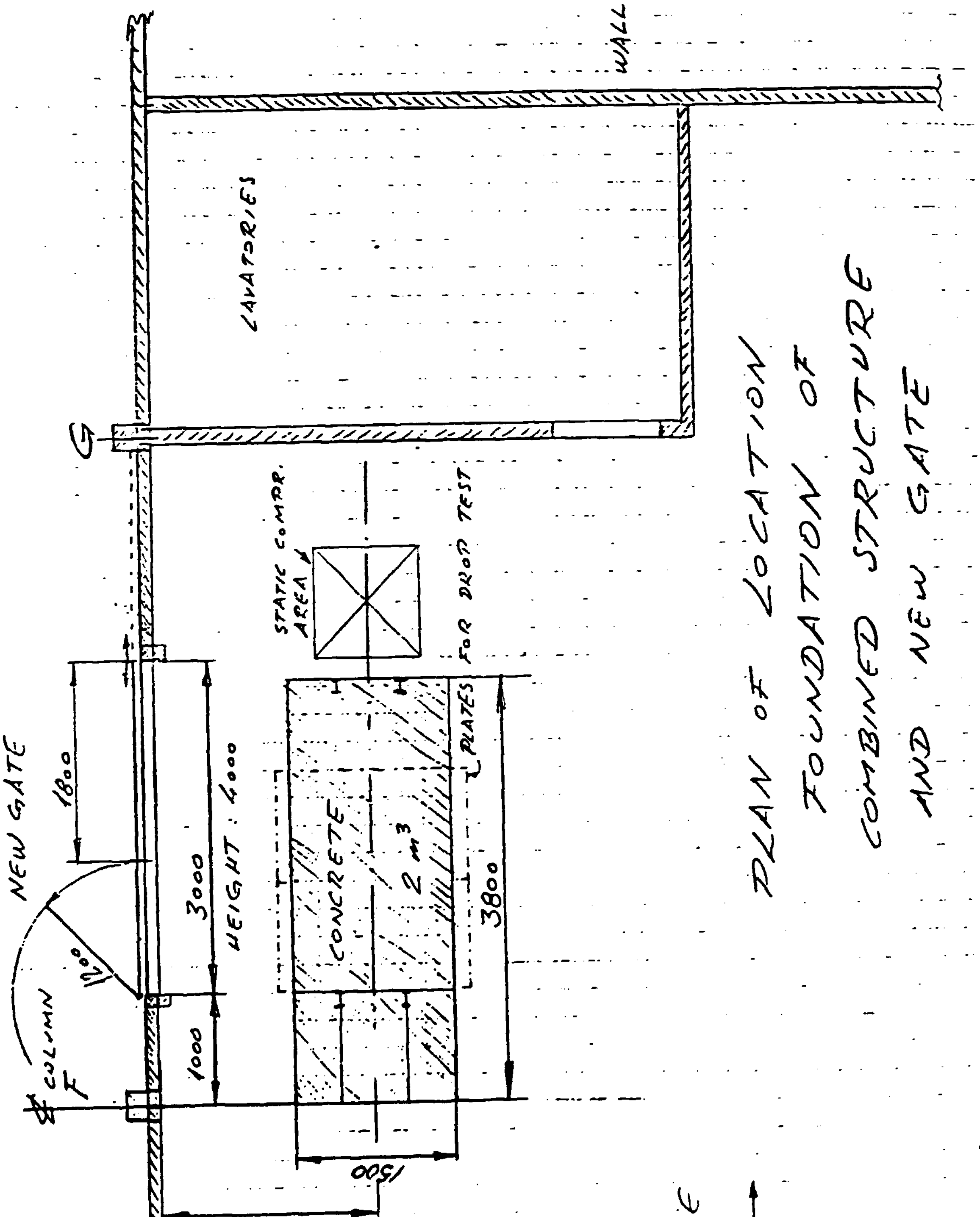

PACKAGING LAB
INCLINE PLAN

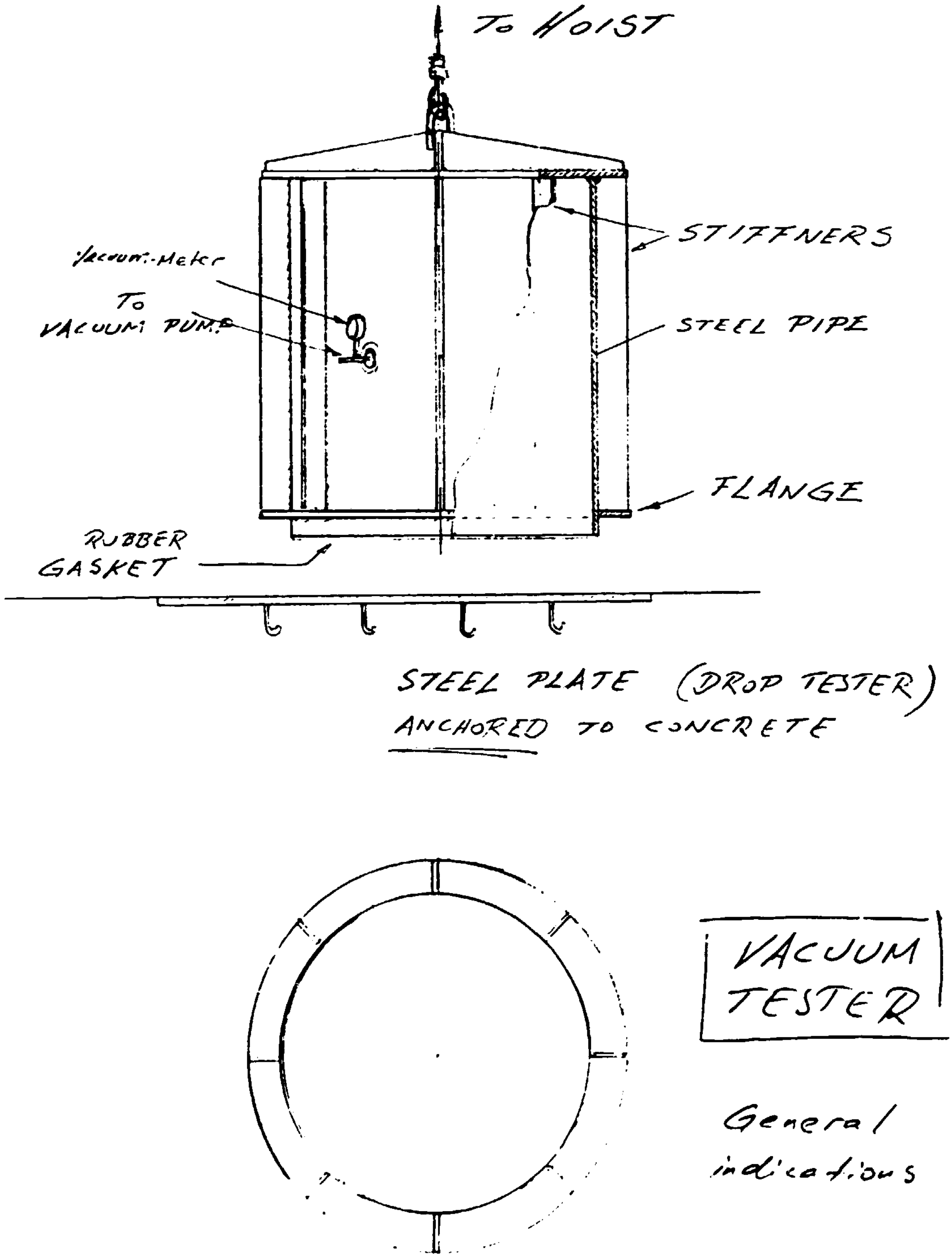


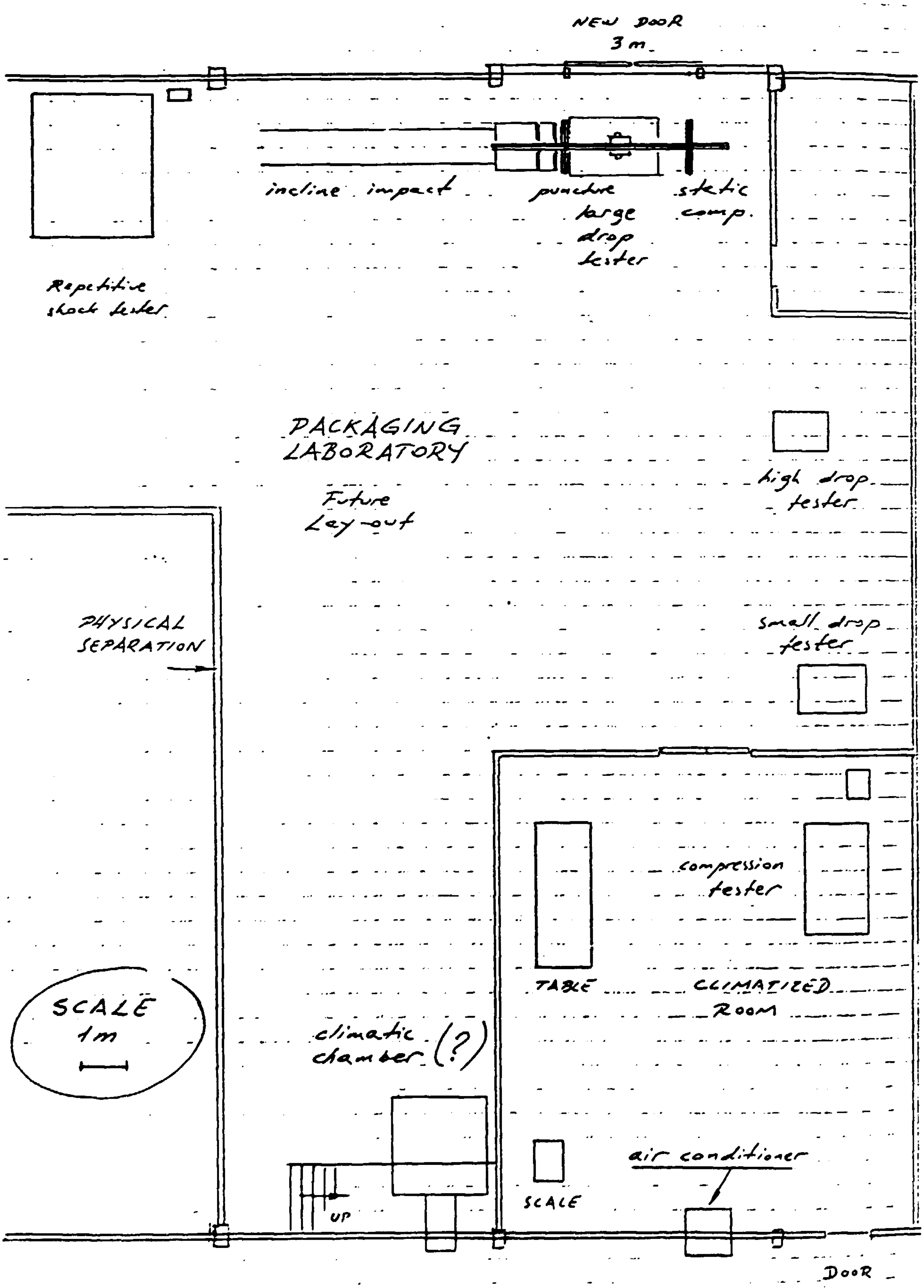
NO	SECTION	LENGHT	SPEC	QT	WEIGHT	OBS
12	ø 12	100		1		
11	ø 5 × 40		SCREW	96		
10	ø 3 × 50		SPLINT	4		
9	ø40 × ø17	12	ROLLER BEARING	4		
8	ø16 × 15 M16		BOLT	4		3 NUT
7	ø52 × ø20	15	ROLLER BEARING	4		
6	ø20 × 20 M20	45	BOLT	4		CASTLE NUT
5	10 × 50	50		4		
4	10 × 50	100	HARD WOOD	4		
3	40 × 100	1190	HARD WOOD	12		
2	L 50×50×5	1200		2		
1	L 50×50×5	1200		4		

PACKAGING LAB		BBIK
DECEMBER '88	INCLINE IMPACT CART	
NO EP03		
SCALE 1:1		


RELEASE DEVICE
HOIST
CABLE
GREASE
PULLEY
STEEL CABLE
SCREW BAR
BOLT
PACKAGING LAB
RELEASE DEVICE
CART

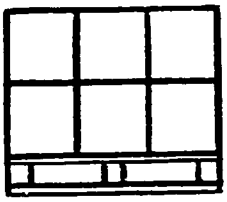

PLAN OF LOCATION FOUNDATION OF COMBINED STRUCTURE AND NEW GATE
WALL
LAVATORIES
G
STATIC COMPR. AREA
FOR DROP TEST
PLATES
NEW GATE
1800
3000
HEIGHT : 4000
1000
120°
COLUMN F
CONCRETE
2 m³
3800
1500
2000
INCLINED PLAN
SCALE
1m


To HOIST
STIFFNERS
Vacuum-Meter
To VACUUM PUMP
STEEL PIPE
FLANGE
RUBBER GASKET
STEEL PLATE (DROP TESTER)
ANCHORED TO CONCRETE
VACUUM TESTER
General indications


NEW DOOR
3 m
incline impact
puncture
large
drop
tester
static
comp.
Repetitive
shock tester
PACKAGING
LABORATORY
Future
Lay-out
high drop
tester
PHYSICAL
SEPARATION
Small drop
tester
compression
tester
TABLE
CLIMATIZED
ROOM
SCALE
1m
climatic
chamber (?)
air conditioner
SCALE
UP
DOOR

PACKAGING

FOR PHYSICAL DISTRIBUTION



COST REDUCTION
AND CERTIFICATION

BBIK
JAKARTA

E.F. PICHLER
expert in packaging

UNIDO - 1989

Foreword

To an increasing extent it is realized that better packaging is a significant component in the process of industrial development. For a number of reasons.

Industrial production is mall production, so in order to make the production feasible it is necessary to create a market which is large enough to keep the utilization of the installations high. By enlarging it geographically, by extending it time-wise, by gaining a higher market share, or and most often by a combination. Packaging plays a crucial role in all these aspects of marketing development.

The geographical enlargement requires better resistance of the packaging to transit hazards, and better protective properties due the longer transports.

Most products have seasonal or otherwise periodic variations. Because the raw materials are seasonal, or because the market has a seasonal character. Extension of the shelf life is in both situations important, to increase the market by making the product available over a larger part of the year than the actual raw materials season. And by improvement of the production economy by spreading the manufacturing over an extented part of the year when the market is seasonal.

In obtaining a higher share of the market the promotional aspects of packaging are crucial. But so is the reliability, the trust in a constant quality of the product when arrived in the market. Especially in the export markets where replacement deliveries may take a long time, and where survival in the market is a question of reputation is packaging one of the most important elements in the establishment of a constant quality at the time of consumption.

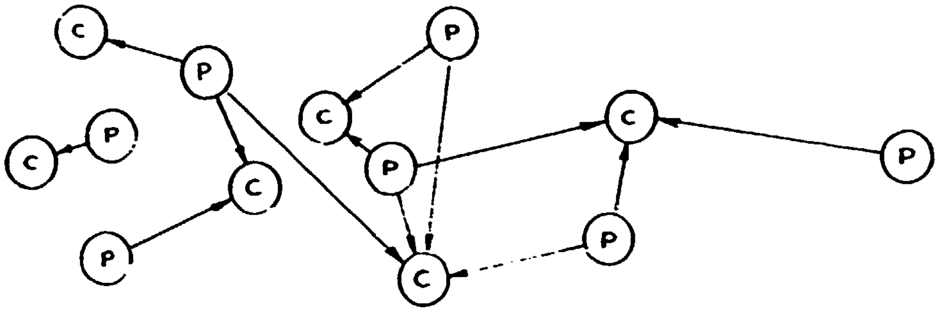
Quality of packaging thus becomes a key question in making industrial production feasible. And the term quality only has a meaning if it can be measured. The development of packaging testing facilities at BBIK is a step in this process of quantification of packaging quality.

Kurt H. Garmin
Chief Technical Adviser
UNIDO Project DP/INS/86/005

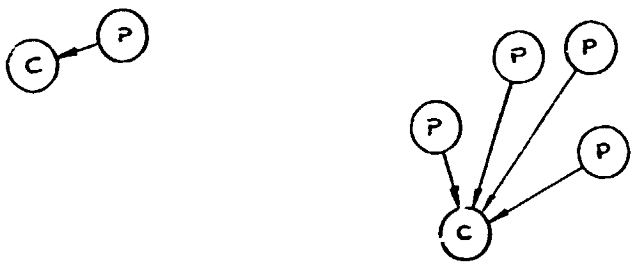
Packaging is an interface between the product and the distribution environment. This definition is very simple and general and has the advantage of demanding other definitions : what is this "distribution environment"? what is a "product"? what are the properties of this interface? (see page 29)

A product is something that has a certain value and this value must be kept for some time and distance between its production and destination (consumption, application). Value is again something to be discussed. Products range from an infected sample of blood to priceless macrocomputers, both having to be sent from one place to another, with values other than price. If the computer is damaged other values, other than its own, are affected. We will come back to this question of value and cost latter

Distribution environment is easier to define. That space and time between production and destination involves a series of operations and conditions. The product has to go from one place to another, or from several places to another, or from one place to several others, or several to several.



I do not know if "distribution" is a generally adequate term, since sometimes, the product is really not distributed :



Distribution environment has two kinds of conditions : social and physical (see page 29).

The physical distribution environment (PDE) involves the physical conditions of handling, transportation and storage.

Social distribution environment (SDE) are the economic, cultural and political conditions that will define marketing, legislation, consumer rights and consumer environment, disposal environment.

PACKAGING

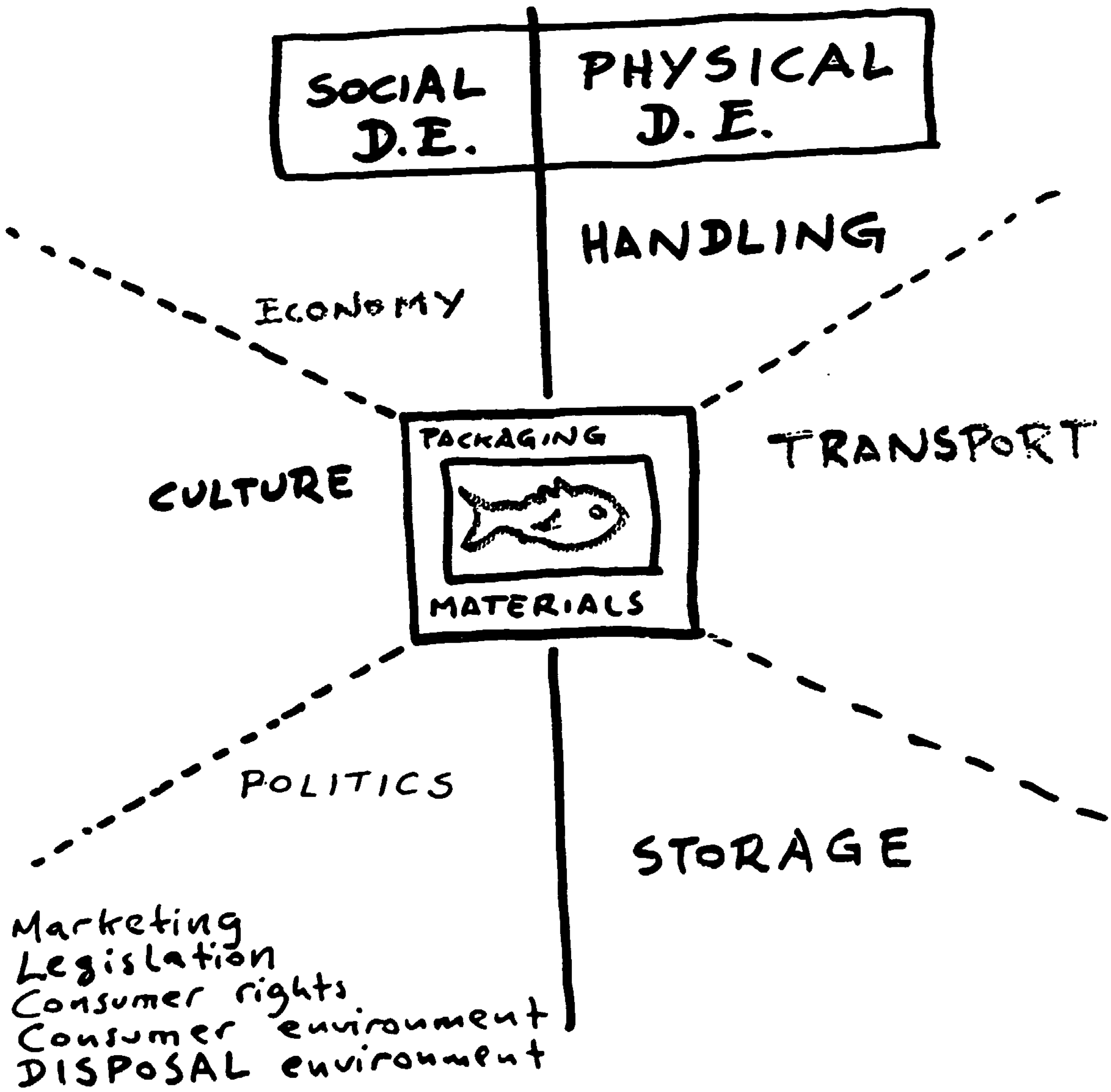
IS AN INTERFACE

BETWEEN

PRODUCT

AND

DISTRIBUTION ENVIRONMENT



Now, what are the objectives, the functions, of that interface? Essentially to contain the product protecting it from the environment and the environment from it. To provide information about the product is also a function of packaging. These functions, to be fulfilled demand a certain cost. This cost may be considered a part of the total cost of distribution. Minimizing this total economic cost is a general function of technology (see page 31).

Art and technology are responsible for the systemic design of packaging, of protection systems and unit - load systems. Art and technology are based on experience - aesthetic and technical (see page 32).

Technical experience must be initially applied by a deep analysis of the product to be packaged, of the physical conditions of distribution and of the materials and resources available.

Product analysis should consider dimensions (and possibilities to reduce dimensions) positions and position of center of gravity; weight; resistance to static loads when in compression and at points of support; behavior in shock (determination of fragility or critical acceleration of fragile products sometimes depend on the points of support in the package, being not then an intrinsic property of product); behaviour in vibration; sensitivity to humidity and corrosion, sensitivity to temperature and

FUNCTIONS

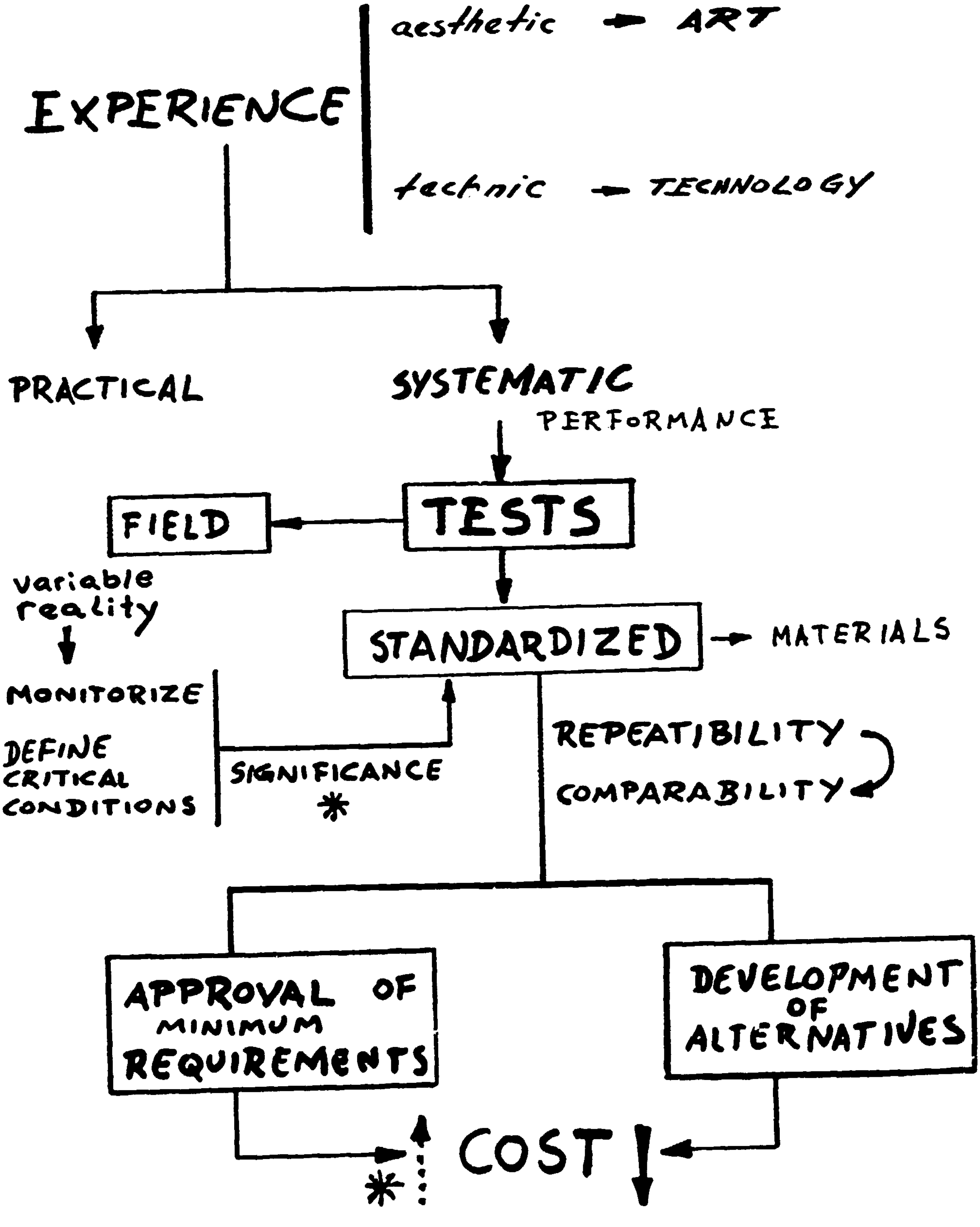
CONTAIN the PRODUCT

PROTECT

- PRODUCT against ENVIRONMENT
- ENVIRONMENT against PRODUCT

INFORM

AT A MINIMUM Total COST


aesthetic → ART
EXPERIENCE
technic → TECHNOLOGY
PRACTICAL
SYSTEMATIC
PERFORMANCE
FIELD
TESTS
variable
reality
STANDARDIZED
MATERIALS
MONITORIZE
DEFINE
CRITICAL
CONDITIONS
SIGNIFICANCE
*
REPEATIBILITY
COMPARABILITY
APPROVAL OF
MINIMUM
REQUIREMENTS
DEVELOPMENT
OF
ALTERNATIVES
*
COST

radiations, sensitivity to biological attack; other characteristics and, very important, an analysis of characteristics of dangerous products (with the help of UN recommendations, for instance).

Analysis of PDE involves consideration of handling, transportation and storage conditions that would affect the design of the system. Forms of handling; limitations of weight for manual and mechanical handling; possible operational and accidental shocks; space available in storage and transportation equipment; height of stacking in storage and transportation; vibration, shocks and other accelerations in transportation; humidities, temperatures, rain, pressure variations; duration of conditions; risks of accidents and pilferage - these are some of the main aspects to be analysed in PDE.

The materials available or to be developed, their relevant properties, production systems (machinery, resources) are the next important things to be analysed.

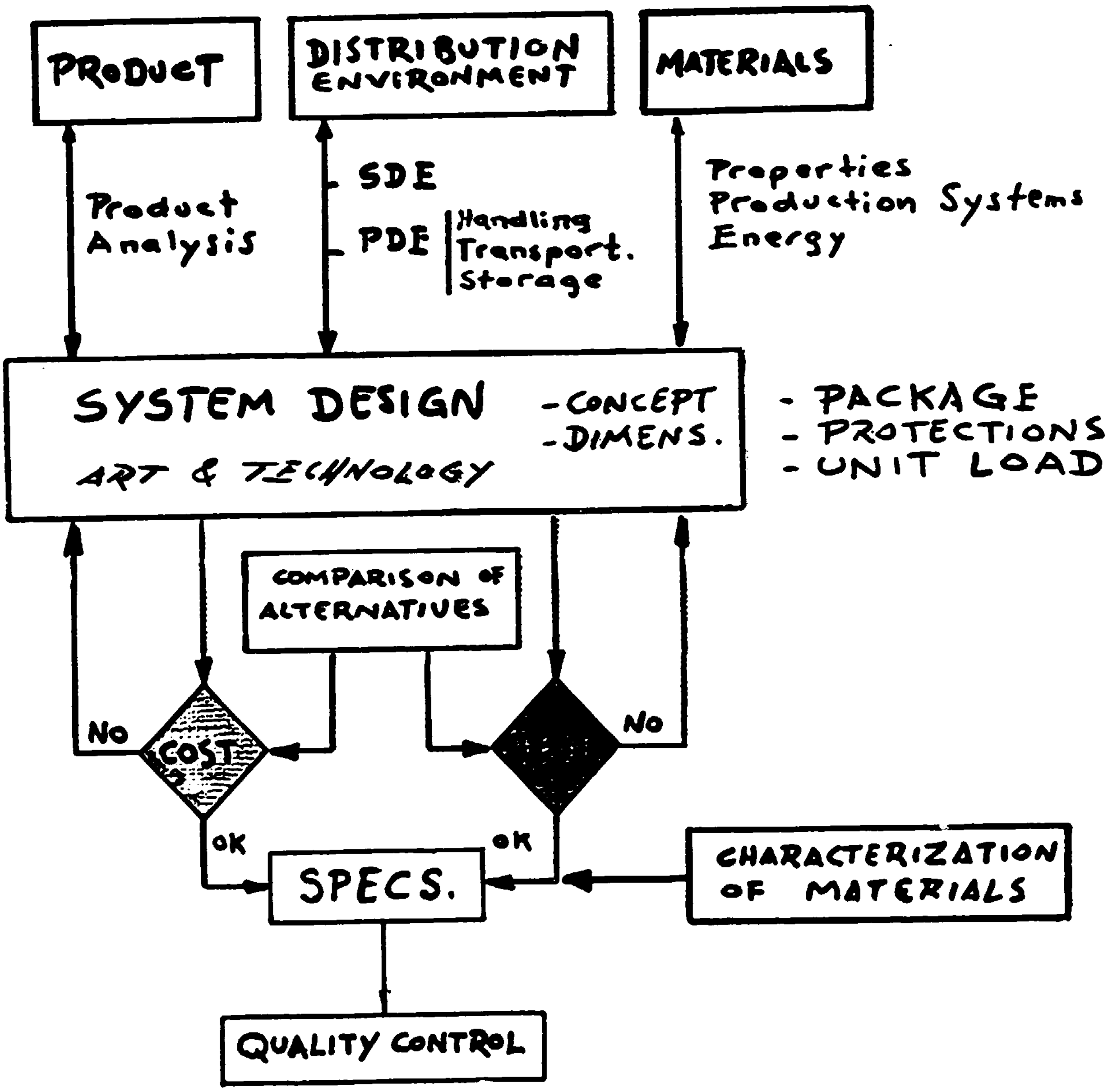
This analysis of product, PDE and materials will bring data for the packaging engineer or designer to develop the design of a system of packaging, protections and unit - load. Here is where art and technology play an important role. Analysis is not only technical but also economical. Economic costs of a project have to be surveyed, estimated in two aspects of design: conception of the system and dimensioning of that system (see page 35).

Technology is Research and Development, Engineering and Organization, Standardization and Quality Control. Technology minimizes total economic cost by creation and comparison of design alternatives and, on the other hand by limiting the creation of alternatives through rationalization aimed to economies of scale.

Comparison of alternatives created by technology is based on a cost and quality trade off : if two alternatives have the same quality we choose the one with lower cost.

Technology creates quality (and quality control procedures) through the use of two kinds of experiences : practice and tests.

Practice is the fundamental form of experience. Comparison of alternatives used in practice (by competitors, for instance) are rich sources of information. Use of practice as the only source of information for development of alternatives and quality is, however, risky and time consuming if practice is out of control.


PRODUCT
DISTRIBUTION ENVIRONMENT
MATERIALS
Product Analysis
SDE
PDE
Handling
Transport.
Storage
Properties
Production Systems
Energy
SYSTEM DESIGN
ART & TECHNOLOGY
-CONCEPT
-DIMENS.
- PACKAGE
- PROTECTIONS
- UNIT LOAD
COMPARISON OF ALTERNATIVES
No
COST
No
OK
OK
SPECS.
CHARACTERIZATION OF MATERIALS
QUALITY CONTROL

Practice under control is called test. Tests bring more information, more reliably and faster.

We have two kinds of tests : field tests and standardized test. (see page 32)

Field tests are practical experiences made under a certain control. Transportation tests, for instance, with instrumentation of accelerations, temperature, humidity in a truck or freight container, are easily performed, with more or less inexpensive equipment. Tests of handling and stacking are usual, requiring no special equipment. Control of temperature and humidity is important in tests with paper or paperboard packages. In field tests we are measuring or observing of conditions rather than establishing them : they keep a statistical character. Results that are too far from the average, are not used for comparison purposes.

Field tests are important when there is no possibility of performing standardized tests. If equipment like a vibration table, climatic chamber, is not available, or the package is too large for such equipment, then field testing is a solution. Samples for this test may be a single package or a pilot shipment of one or more truck loads.

It is easy to combine field tests with standardized tests. Most standardized tests may be performed without sophisticated equipment e.g.: drop test, compression to simulate stacking, puncture, are tests with very simple, easy obtained equipment. Then we test only for vibration and climatic conditions in a field transportation test, since a vibration table and a climatic chamber are difficult to obtained.

Transportation tests must be performed under the distances and conditions of road and truck representative of the transportation environment in physical distribution. Instrumentation of truck or other transportation equipment, or of a package, is important as mentioned.

Field tests are also important as source of information for standardization of tests.

Standardized tests must be :

- repeatable
- sensitive
- representative
- simple to perform

Repeatability is important to comparison of alternatives. It means that the same conditions of test must be applied to different packages, and not be influenced by characteristics of each alternative which would not affect the real condition simulated by the test.

Using different packages does not change (if variations in weight are not very large) the vibration of a truck, for instance. Test conditions then must be the same, with the same vibration of all alternatives.

Comparison of results given by repeatable standardized tests, is possible in different laboratories, in different industries and countries. It allows a certification system.

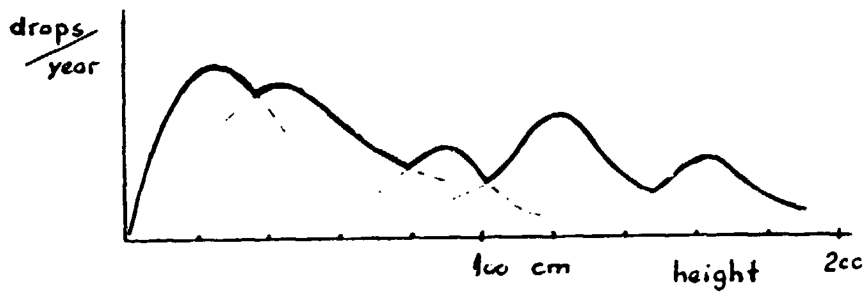
Sensitivity mean that for the same test conditions, differences in alternatives must show different test results. A test that gives always the same result for all packages with alternative characteristics is not sensitive.

Representativeness mean that a test is giving to a package conditions very similar to certain critical conditions it would find in a real distribution environment. What are these conditions? A package will find basically the following physical conditions:

- lifting, in handling operations;
- vertical shocks, normal in handling operations;
- drops, accidental in handling;
- stacking, with problems of compression and stability, in storage and transportation;
- puncture, due to concentrated impacts in handling;
- concentrated compression, when a person steps over the package, or by irregular stacking;
- horizontal shock, in handling and in transportation, mainly by rail;
- vibration, in transportation;
- repetitive shocks, in transportation;
- climatic conditions :
  - temperature, and its variations;
  - humidity, surface condensation;
  - low pressure, in depressurized aircraft;
  - rain;
  - fire.

Not as external conditions but as intrinsic characteristics that may be tested, a package must have the ability to contain the product, without leakage when the content can flow; to withstand internal presure, when it is a container for gas or liquid and be compatible with the product.

External conditions given by the physical distribution environment are not usually constant. They have a range of variation in which intensities have a certain (or uncertain) statistical distribution : normal (Caussian), Poisson, Raleigh, random or irregular distributions (specially this last one). Actually it is possible to plot a regular distribution, like Poisson for a general condition under certain conditions of control, but it will change if you change these. In the case of drop, for instance, we have a Poisson distribution for operation of handling under supervision at the plant, and another condition at the airport, and other accidental conditions :



In the case of vibration we have different predominant frequencies, depending on the kind of truck, suspension system, load and velocity. If we generalize for all possible trucks and conditions, we will have something similar to a random distribution in a certain range of frequencies, called 'white noise'.

Given such irregularity of conditions, it is impossible to have a test simulating the environment. What is possible, is to define the critical conditions of the environment and reproduce these critical conditions in the standardization of a test.

It is very easy to standardize a test but very difficult to have a general consensus on these critical conditions, like in the case of drop test, for instance. Experiences are very variable, diverse, and usually uncontrolled. Here is another important reason for controlled field tests : to supply information for the standardization of repeatable tests.

Standardization of tests must be a result of experience and consensus of persons interested in its application, both for development or certification of packaging. In most cases these persons are very many, even in different countries and activities.

International Standards - ISO and UN (for dangerous products, followed by IATA-ICAO, IMO) - are the result of wide experience and some consensus, in a process of constant improvement. They have to be followed as minimum conditions by any national standardization efforts, and they have to be improved by national efforts and accumulated experience.

We are at BBIK, in a UNIDO project, studying International and ASTM, JIS, AFNOR and other national standards, with the objective of delineating Indonesian standards for testing and specification of packaging, as proposals to be discussed by organizations, private and governmental, aimed to development and certification of packaging.

A packaging laboratory is being created with the purpose of supporting industry and commerce with this aim, and to give experimental support to Indonesian standardization efforts.

Proposals will be made related to the following conditions of PDE and corresponding tests :

- stacking (in storage and transportation)
  1) static compression test
  2) dynamometric compression test
  3) concentrated compression test
  4) stack stability test

- handling
  5) lift test
  6) drop test
  7) puncture test

- transportation
  8) vibration test
  9) repetitive shock test
  10) horizontal impact test

- air transportation
  11) low pressure

- climatic
  12) humidity and temperature test
  13) rain test
  14) fire test

- tests intrinsic to the package

  15) leakage

  16) internal pressure

All these experimental methods give support to a general standard of performance specification, also being studied as a proposal. The two kinds of standards - test methods, and specification - have, as already explained, two important objectives : development of qualities with reduction of cost through comparison of alternatives and certification, or control of quality.

Control of quality may be approached in a broad concept involving :

- social control of quality
  - by the market
  - by legislation
  - by consumer organizations and public institutes;
- industrial quality control
  - of development (here it coincides with development of alternatives)
  - of production, on line
  - of final product, at production plant
  - of purchase

Qualities of a package to be controlled constitute performance specification. The performance test methods listed above may be used not only in development quality control but also as a final control by the supplier or purchase quality control of packaging by the user industry. This is, however, difficult in many cases.

Compression tests, for instance, may be used for specification and quality control of packages that have to withstand stacking, if stacking load is not very large. If it is necessary to handle a few hundred kilograms of mass to perform a test it becomes difficult. Special equipment like hoists or compression tables would be necessary. It is, therefore, more feasible to control the quality of the package materials then that performance.

It is very important to establish the relationships between the qualities of materials and the performance of the package.

What qualities, what properties of materials should be controlled? This is a delicate question since traditional practice frequently disagrees with more scientific approach. Some traditional tests, like burst strength (Mullen test) usual for paper and corrugated board, have little correlation with any performance quality of a package.

Here are some recommended tests of materials with the correlated quality of a package :

- Bags drop test	ball (dart) drop test of paper, plastic, fabric tear resistance (Elmendorf test)
- Carton boxes . compression	bending stiffness
. machinability	bending stiffness crease folding
- Corrugated boxes . lifting	bending stiffness
. compression	bending stiffness edge crush
. concentrated compression	bending stiffness
. puncture	puncture
- Wooden boxes, pallets	hardness of wood quality of nails, staples, etc.
- Drums, jerricans . drop test . compression . internal pressure	thickness of metal, rigid plastic, board hardness (Vickers, Barcol)
-cushioning or bracing . vibration . bouncing	cushioning materials properties and dimensions rigidity

In some cases it is difficult to find correlations when performance is more affected by the quality of construction than by the quality of materials. Sacks, in a drop test, tend to burst at the seam. Wooden boxes break at the connections. Drums or cans open at the seams. In these cases the performance test is still necessary, even if we control the material.

The best way to specify and to control the quality of a package is to use the performance specification, test relevant performance qualities, like drop, compression, in prototypes. Once selected the best alternative, approved a prototype, define a specification of purchase based on performance tests, or have the materials of prototype characterized in its relevant properties, such as recommended above, and define a specification of purchase based on tests of materials.

Performance tests are necessary to develop a specification. They can be field tests or standardized tests. Standardized performance tests are better, since they are usually cheaper than field tests. They also allow a comparison of alternatives for cost reduction and performance certification purposes, which can be verified by others using same tests.

Standardized performance tests are usually so simple that some can be made in the plant, using available equipment like hoists and cheap special devices for puncture, compression and drop tests. It is better, however, to use a specialized laboratory, when available.

In a specialized laboratory technicians are able to identify and correct possible problems. More equipment is available, like vibration or bouncing tables, allowing a broader set of tests, including characterization of materials. A certification by a neutral laboratory is con· idered more reliable.

The needs of industry, especially for exports, have motivated governmental and international agencies related to industrial, economic development, in many countries, to create packaging laboratories for services, technological research and experimental support to standardization. At BBIK we have one of these efforts. A laboratory is being established and training of technicians provided, already with a certain immediate capability to interact with industry.

The main task now at BBIK packaging group is the study and formulation of proposals for standardization of :

- procedures,
- test methods,
- specifications,

related to performance of packages in PDE.

This effort is also an opportunity to interact with industry and governmental agencies concerned with standardization.

The following proposals are already defined.

Standards	Reference
1 - Drop	ISO 2248
2 - Static Compression	ISO 2234
3 - Dynamometric Compression	ISO 2872
4 - Horizontal Shock	ISO 2244
5 - Puncture	AFNOR/UN 6.13
6 - Lifting	-
7 - Vibration	ISO 8318/ASTM D999
8 - Repetitive Shock	ISO 2247
9 - Concentrated Compression	AFNOR
10 - Stability of Stack	-
11 - Low Pressure	ISO 2873
12 - Rain	ISO 2875
13 - Leakage	UN 9.7.4.
14 - Internal Pressure	UN 9.7.5.
15 - Fire	UN Test 44
16 - Humidity and Temperature	-
17 - Water immersion	ISO 8474
18 - Identification of Parts	ISO 2206
19 - Climatic Conditioning	ISO 2232
20 - Performance Specification	ISO, ASTM, JIS, AFNOR UN

ISO 2876 (Rolling test) is considered obsolete

A) Test Methods

1. Drop Test

Follow thoroughly ISO 2248. Indicate with figures, in the standard, how test can be performed (figures on pages 51 and 52).

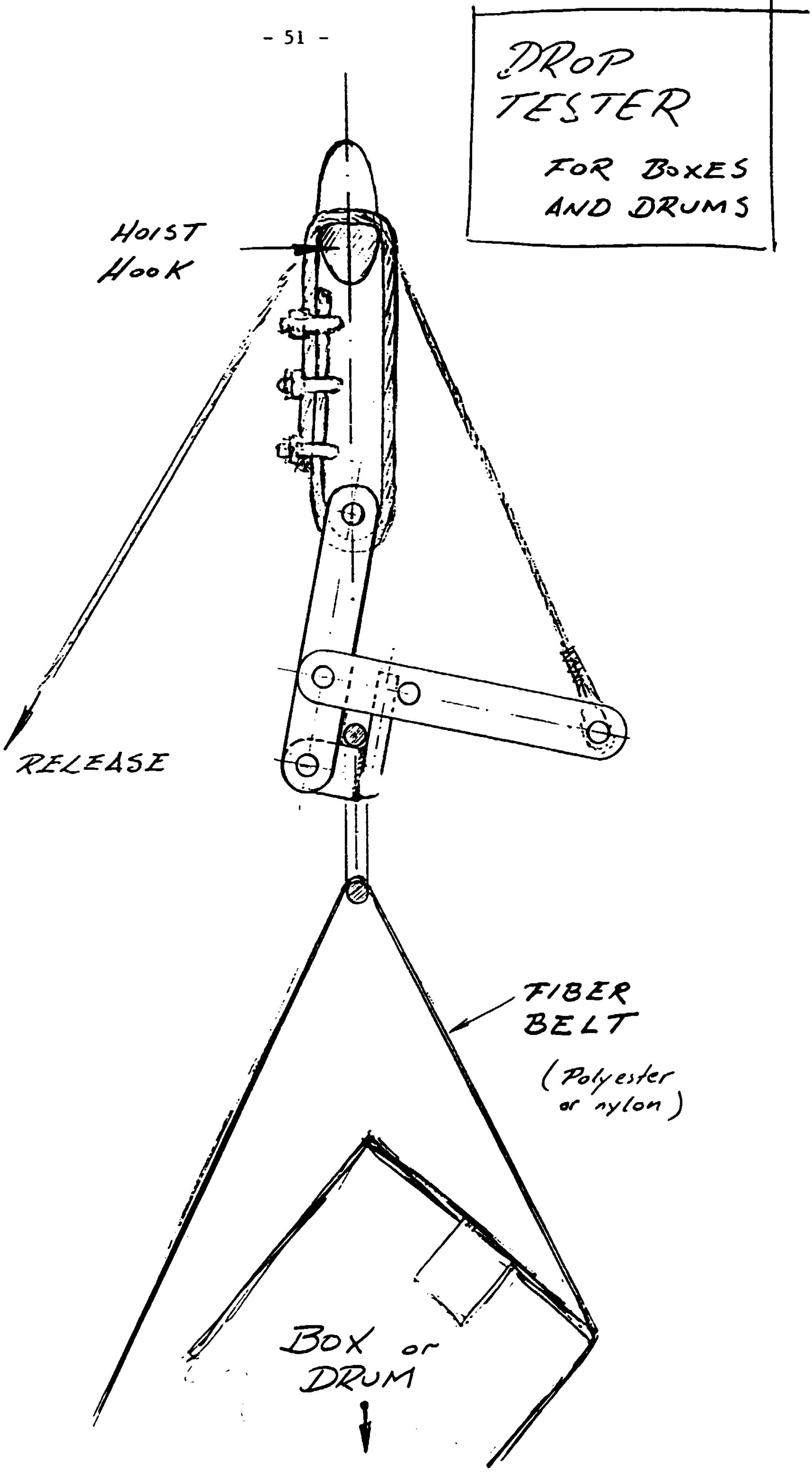
2. Static Compression Test

ISO 2234 Method 2 recommended, with following alteration: Loading platform must be hoisted, receive necessary ballast weight so as to become horizontal and then lowered at a speed of 0,2 ± 0,002 mm/s over the test package perfectly centred under centre of hoist cable. For safety reasons keep platform hoisted with loose ties during test (figure on page 53).

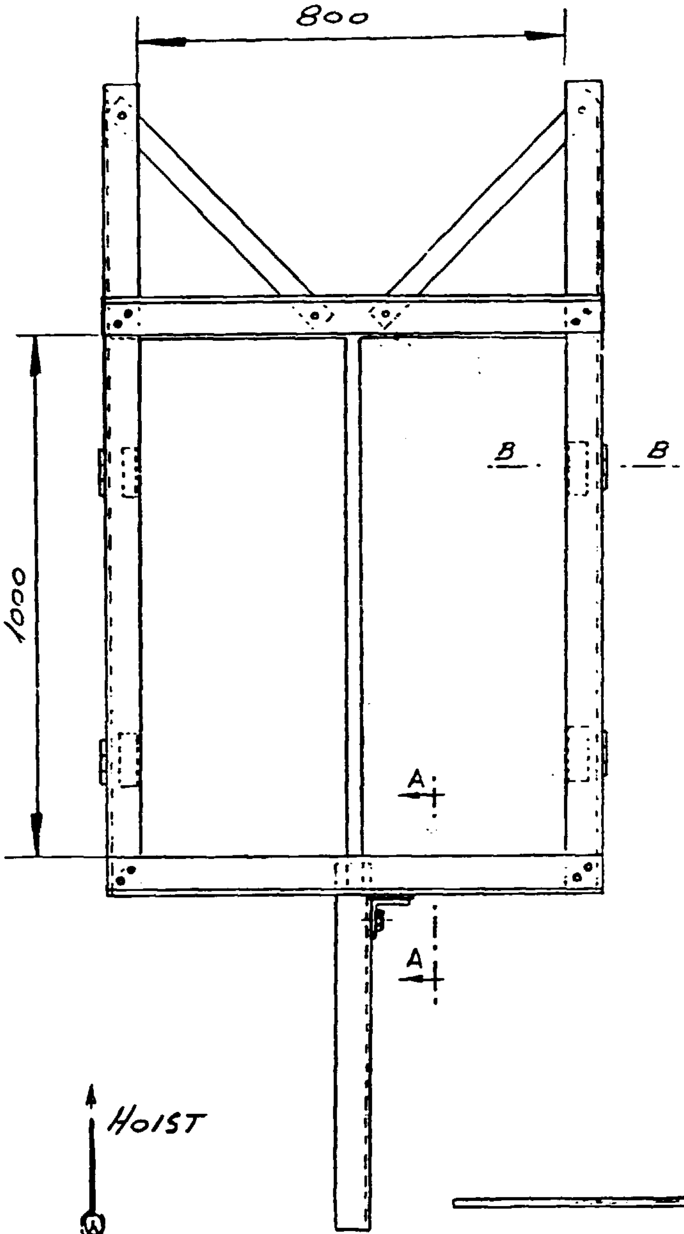
3. Dynamometric Compression Test

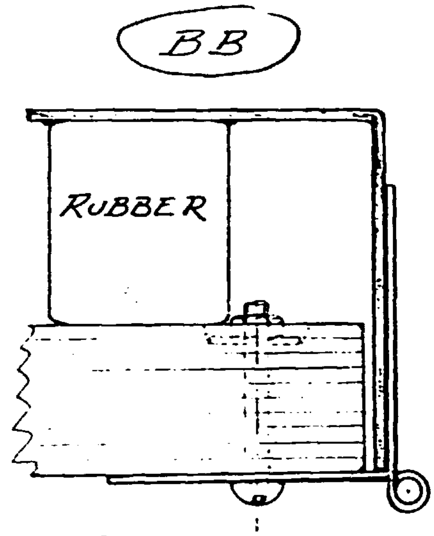
Follow ISO 2872 with following alterations :

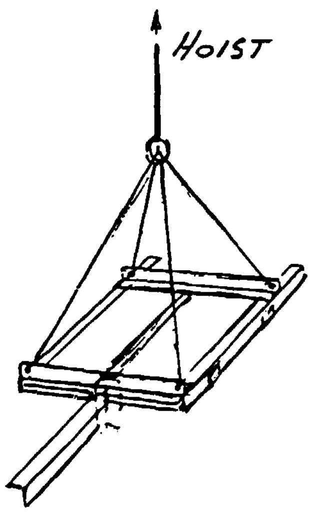
- title as above
- relative velocity of plates : 0.2 ± 0,02 mm/s (this is the velocity of present equipment, s is better then min as standard unit of time)
- when testing packages with assymetric structure or possibility of collapse with horizontal displacement of horizontal face, use two packages superimposed :

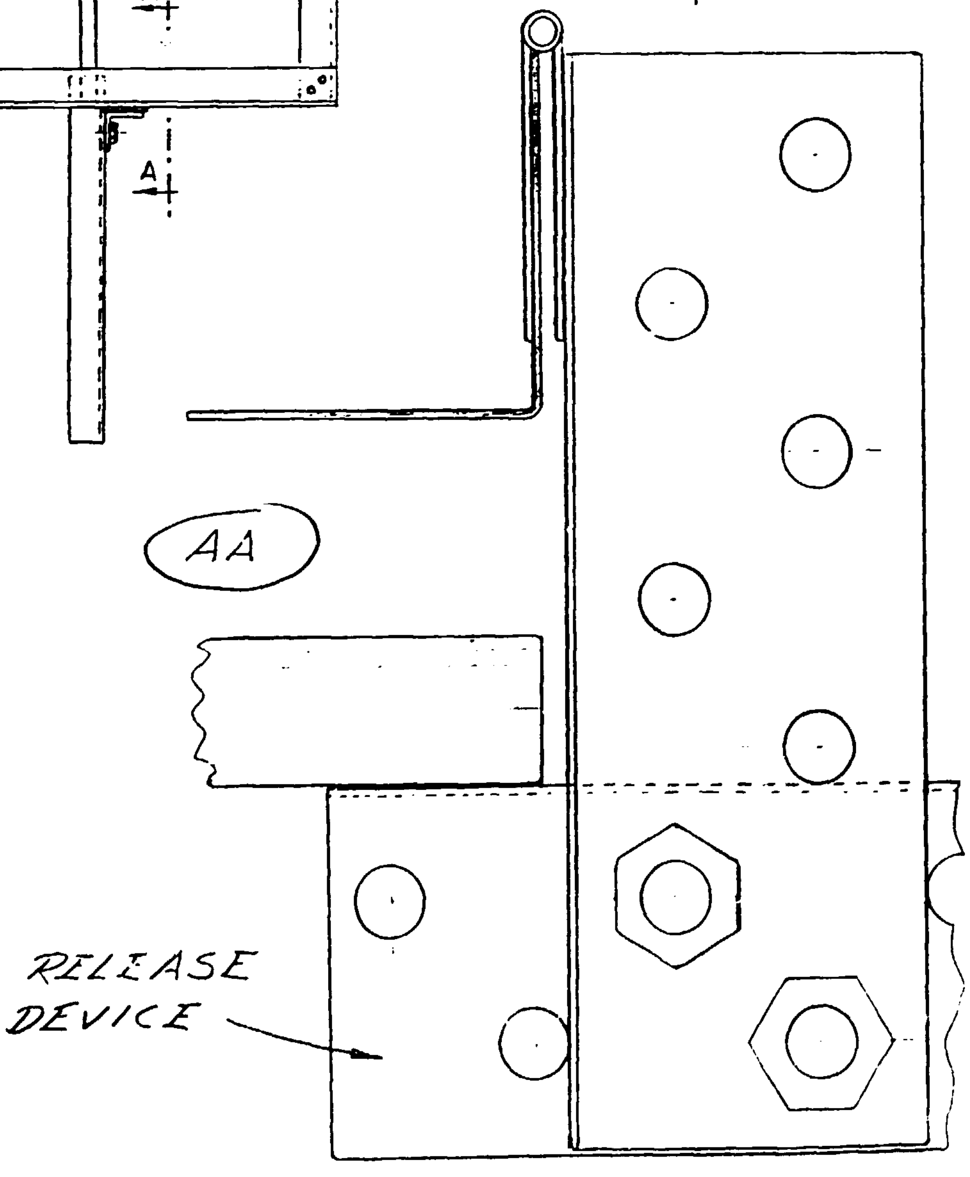

DROP TESTER
FOR BOXES AND DRUMS
HOIST HOOK
RELEASE
FIBER BELT
(Polyester or nylon)
BOX or DRUM

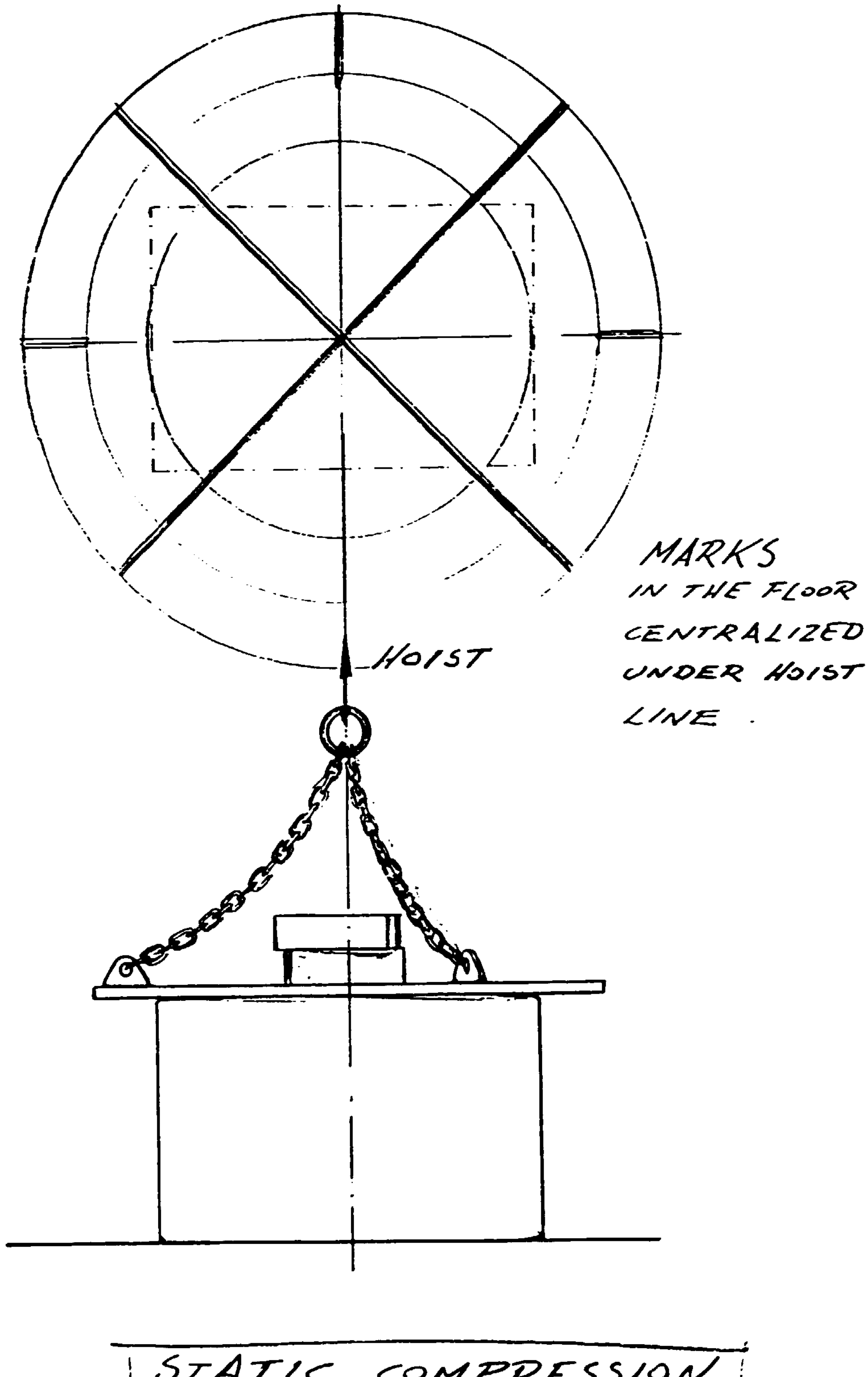
DROP TESTER FOR SACKS



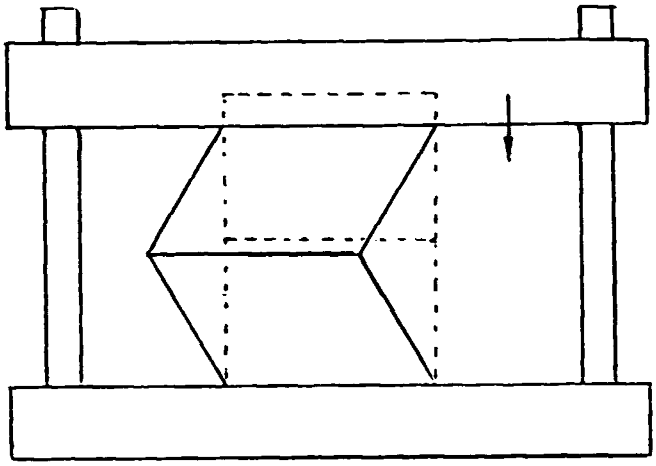








STATIC COMPRESSION TESTER



4. Horizontal shock

Follow thoroughly ISO 2244

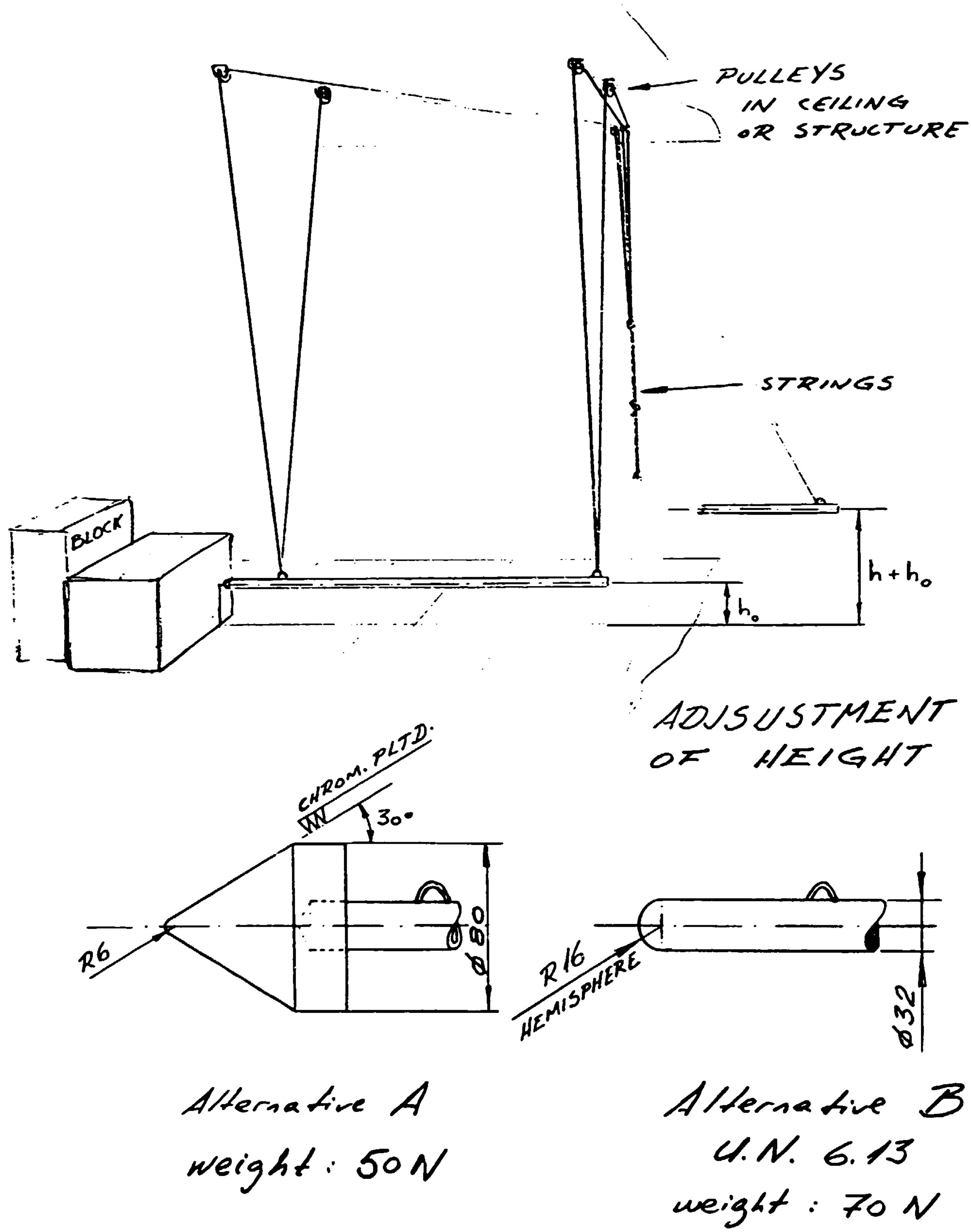
5. Puncture Test

Follow AFNOR standard, but with conical dart instead of pyramidal. A pyramidal dart may give different results for different orientations of flute in corrugated board

Suggestion on page 55.

6. Lifting Test

No reference in literature. Simulate handling with no significant accelerations, with ballasted contents.



PUNCTURE TESTER

7. Vibration Test

Follow ISO 8318 with 0,25 ± 0,05G

0,50 ± 0,05G

Alterations proposed :

- Test a real stack of packages (not with superimposed load as ISO 2234 : it falsifies possible results)
- Tolerance of 0,05G instead of 0,1G.

8. Repetitive Shock Test

Follow ISO 2247 specifying 1,1G, with title above.

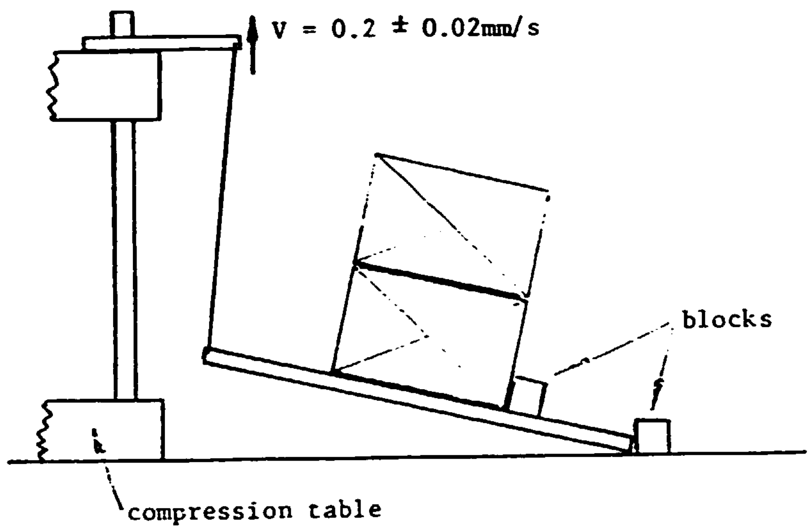
9. Concentrated Compression

Instead of AFNOR specification of a load (90 kg.) applied in an area similar to a heel of a shoe (like a D) we recommend a circular area with 100mm diameter. Load should be applied with a velocity of 0,2 ± 0,02 mm/s. Circular area must be kept horizontal within 2°.

10. Stability of Stack

No reference in literature.

Proposed procedure :



This test is important to determine slide angle, verifying performance of anti-slide devices or materials.

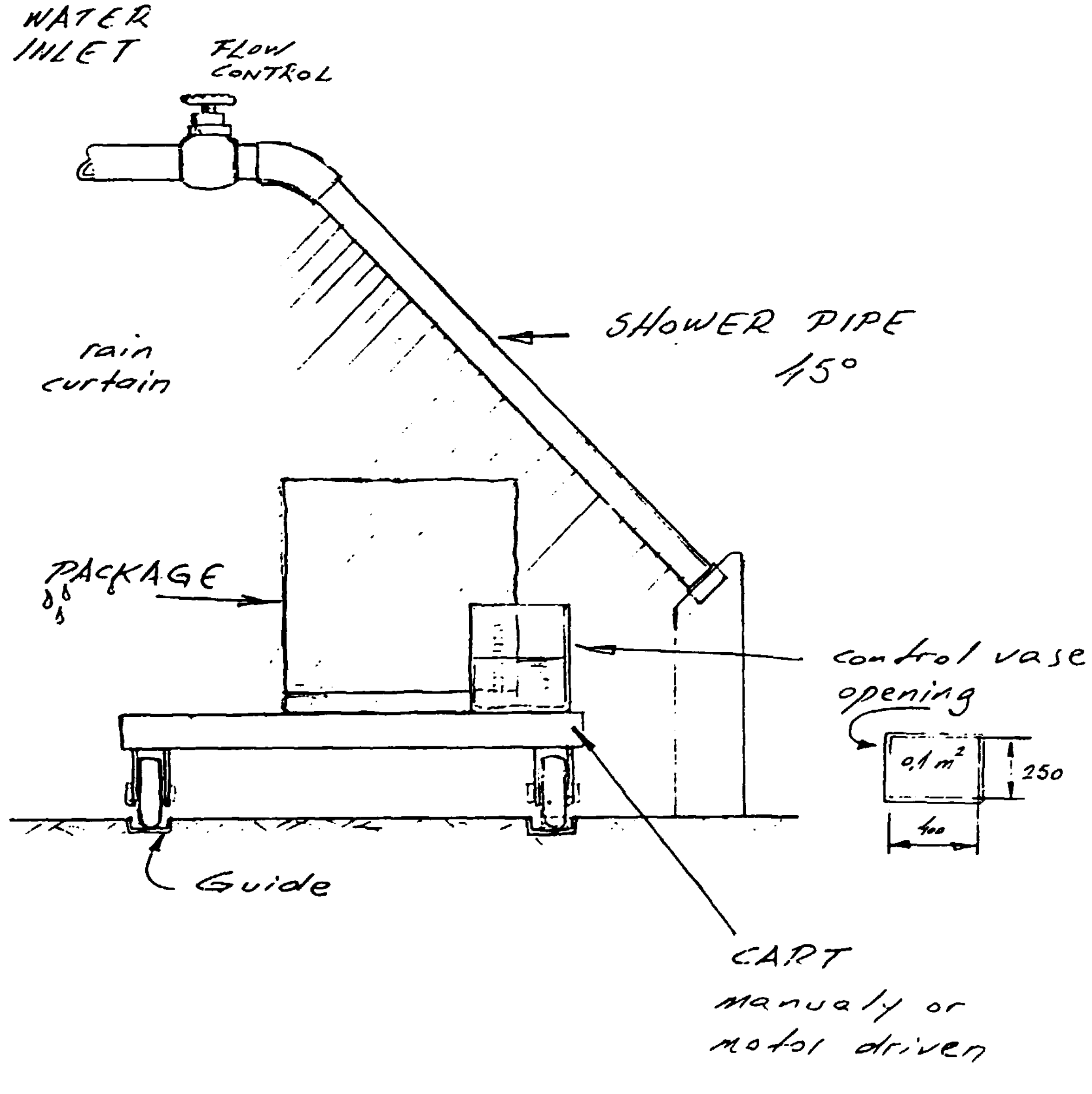
11. Low Pressure

Follow thoroughly ISO 2873.

12. Rain Test

Apply 45° inclined rain according to figure (on page 58)

PROPOSAL FOR RAIN TESTER



13. <u>Leakage Test</u>

14. <u>Internal Pressure Test</u>

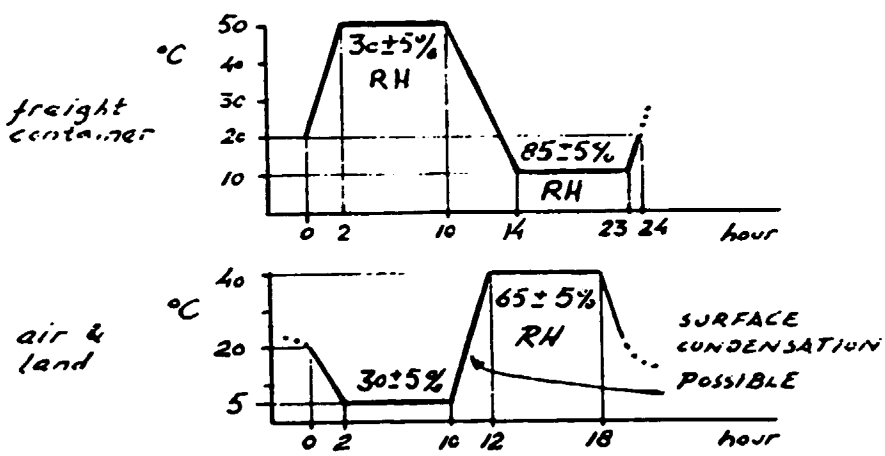
Follow UN recommendations for packaging of dangerous goods (9.7.4., 9.7.5.)

15. <u>Fire Test</u>

Follow UN recommendation for packages of explosives, test 44 in 'Tests and Criteria'.

16. <u>Humidity and Temperature Test</u>

Some information in literature and tests allow a preliminary approach to a test procedure intended to verify the protection given by the package to the product against humidity, temperature and its variations. In this case a variation cycle is suggested :



B) PROCEDURES

18. Identification of Parts

Follow ISO 2206.

19. Climatic Conditioning

Follow ISO 2233 in general. For normal conditioning use 20 ± 2 C, 65 ± 5% RH.

C) 20 - Performance Specifications

This standard indicates the intensities of conditions defined by the test methods, durations, test sequencies to be programmed, sampling procedures and requirements of results.

I. INTENSITIES OF CONDITIONS

1. Drop Test

See tables on pages 61 and 62.

Four levels of assurance were defined (according to JIS) or, in other approach, two levels (according to ISO) in two conditions : normal and accidental.

Drop over a beam or protrusion according to DOT or UN 6.13B Specification should be considered for dangerous products.

HAZARD	POSITION OF IMPACT				LEVEL	DROP HEIGHT (CM)								SAMPLING
	BOXES		CYLINDER	SACKS		CONDITIONS								
	a	b				A	B	C	D	E	F	G	H	
OPERATIONAL	1 - 3 2 - 3 3 - 3 4 - 3	-	1 - 2 -	1 - 1 2 - 3	NORMAL	120	20	10	10	10	-	-	-	all drops same specimen
					SEVERE	140	40	20	20	20	-	-	-	
ACCIDENTAL	3,4,5 1,2,6	235,34 146,26 15	X, Y, Z	1, 2, 5, 6	NORMAL	160	100	60	40	-	10	-	-	one specimen per drop
					SEVERE	180 I	120 II	80 III	60	-	20	900	-	

a - drops to verify protection to product
b - drops to verify strength of box

CONDITIONS

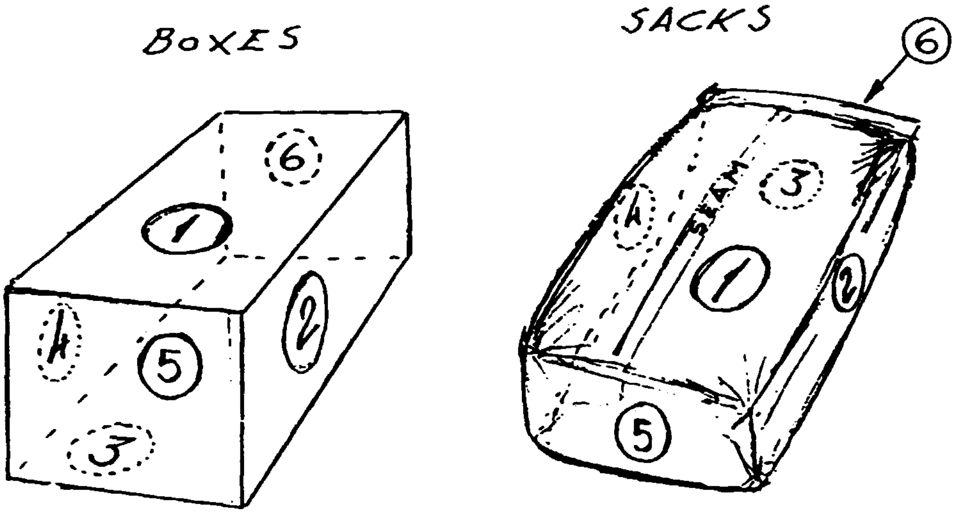
A - one man throwing. Accidental drop from truck
B - one man carrying high
C - one man carrying with no elevation
D - two men carrying
E - hoist elevation
F - fork elevation (rotational drop)
G - packages of infectious substances (UN 6.13)
H - Special conditions to be defined

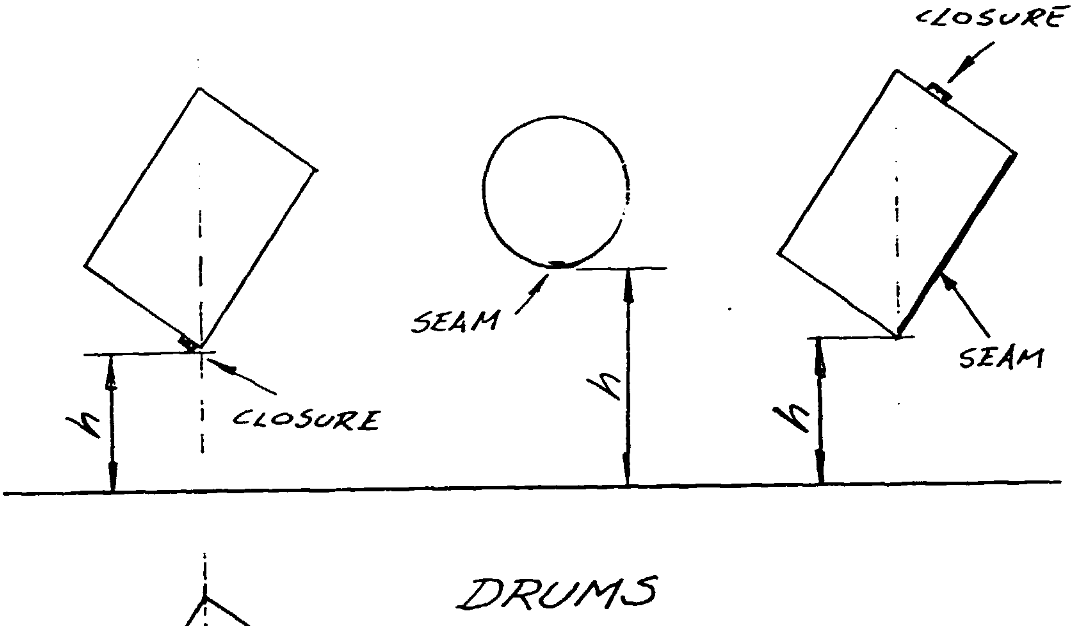
Approximate range of mass (kg)

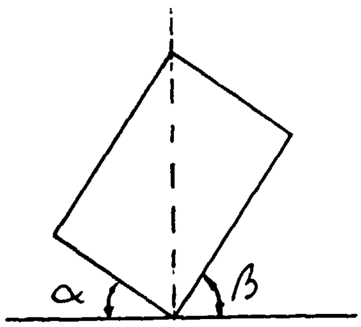
Up to 11
22 (50 kg sacks carried high)
44
88
Over 88

UN CLASSIFICATION OF RISK

I - Highly dangerous products
II - Medium danger products
III - Low danger







IDENTIFICATION OF IMPACT POSITIONS

2. Static Compression Tests

Loading time

- normal : 1 hour
- corrugated, cardboard : 24 h
- plastic : 72 h

Safety factors*

Material	Assurance level Normal	Severe
hygroscopic or temperature sensitive materials	4	6
other materials	2	3

*safety factor S = Test load/Real static load in a stack

3. Dynamometric Compression Test

Safety factors

Material	Assurance level Normal	Severe
hygroscopic or temperature sensitive materials	5	8
Other materials	3	4

5. Puncture

	Energy of impact (J)
Normal	15
Severe	30
UN 6.13	70

6. Lifting

Weight of contents with ballast

Normal : 1,5 X nominal weight of contents

Severe : 2,0 X nominal weight of contents

7. Vibration

Apply 1 sweep/100km with normal : 0,25 ± 0,05G

Severe : 0,50 ± 0,05G

Unknown distances : admit 2000km

These values are valid only for truck and rail transportation.

8. Repetitive Shock

Duration of Vibration : s/km

	Truck	Rail
Normal :	2	1
Severe :	4	2

Unknown distances : admit 1 hour normal

2 hour severe

9. Concentrated Compression

Only one level of load : 900 N (or mass of 90 kg)

10. Stability of Stack

Minimum slide angle

Normal : 30°

Severe : 45°

11. Low Pressure

Specification in test method

12. Rain

Specification in test method

flow rate : 100 ± 20 l(m^2.h)

13. Leakage - Follow UN Specification

14. Internal Pressure - Follow UN Specification

16. Fire - Follow UN Specification

15. Humidity and Temperature

Specification in test method

II. SEQUENCE OF CONDITIONS

- Normal Sequence

The following normal sequence is proposed :

a) - lift test

b) - 1st operational drop test

c) - vibration test

d) - repetitive shock test

e) - 2nd operational drop test

f) - horizontal impact test

g) - 3rd operational drop test

h) - static compression test

i) - 4th operational drop test

j) - puncture test

K) - 5th operational drop test (optional)

l) - concentrated compression test

m) - other optional test

- Special sequences

If known conditions of physical distribution indicate other sequence, establish a special programme.

- Isolated tests

Tests 3 Dynamometric compression

10 Stability of stack

11 Low pressure

12 Rain

13 Leakage

14 Internal pressure

15 Fire

16 Humidity and temperature

17 Immersion

are performed in specific specimens.

Test 1 (Drop Test) in accidental condition is performed with one specimen per drop. Exceptionally, if the cost of specimens is considerable, if there is no damage in one of the drops the same specimen may be used for another drop in other direction.

Test 3 (Dynamometric Compression) is optional. Other isolated tests are performed when applicable.

Test 13, 14 and 15 are mandatory for dangerous products, according to UN recommendations, as well as test 1 in accidental conditions I, II and III, depending of the classification of the product, and test 2. Loads of static compression in test 2 are wrong in UN recommendations. Proposed safety factors should be considered.