No.

INTI, Argentina
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INMETRO, Brazil
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INTN, Paraguay
LATU, Uruguay

Study on Improvement of Packaging Technology for Merchandise Distribution in MERCOSUR (Argentina, Brazil, Paraguay, Uruguay)

FINAL REPORT

March, 2007

JAPAN INTERNATIONAL COOPERATION AGENCY

UNICO INTERNATIONAL CORPORATION

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PREFACE

In response to the request from Government of Argentine Republic, Federative Republic of Brazil, Republic of Paraguay, and Oriental Republic of Uruguay, the Government of Japan decided to conduct a study on Improvement of Packaging Technology for Merchandise Distribution in MERCOSUR and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Tomoyasu SHIDARA of UNICO International Corporation and consists of UNICO International Corporation between November, 2004 and March, 2007.

The team held discussions with the officials concerned of the Governments of the above-mentioned four countries and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship among our five countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Governments of the above-mentioned four countries for their close cooperation extended to the study.

March 2007

Tadashi IZAWA,
Vice President
Japan International Cooperation Agency

March 2007

Mr. Tadashi IZAWA
Vice President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Izawa

Letter of Transmittal

We are pleased to submit "Final Report for the Study on Improvement of Packaging Technology for Merchandise Distribution in MERCOSUR (Argentina, Brazil, Paraguay and Uruguay)."

The aim of the Study was to develop the "Reference Guide for Packaging tests, for Evaluation (Draft)" for appropriate transportation packaging design of major export products (focused on dairy products of processed food and white goods of household appliances) in MERCOSUR four member countries, Argentina, Brazil, Paraguay and Uruguay. In order to achieve this aim, the land transportation environment surveys were implemented within the MERCOSUR economic block for collecting and analyzing data on the cause of product damages. It is notable that this Study basically set the formation of wide-range cooperation and support in order to advance toward raising the technological level within the limited time.

The administrative and technical concerns were resolved with counterparts by discussing the survey procedure as the strategic policy. The technology transfer activities to all counterparts' personnel have succeeded within short period of time by "rotary technical guidance courses" and "workshops" through OJT with timely activities such as "four countries joint meetings", "four countries joint technology trainings", "demonstration tests" and "technical trainings in Japan"

Another notable issue is the cooperation by private companies to the Study. Since the target products are manufactured and shipped from factories to consumers using transportation means by private companies, the three-party cooperation of the Study Team, counterparts and cooperating companies are essential for the data collection on the Transportation Environment Survey. The recommendation that came from the Study is to establish the "MERCOSUR Common Standards (Guideline)" as a next step forward from the "Reference Guide for Packaging Tests, for Evaluation (preliminary)" and the continuous improvement framework of the MERCOSUR Standard Authorization. Another recommendation is to establish the "MERCOSUR Common Regional Database" in order to share the database within the region and the maintenance. This database is expected to update existing data, collection and analysis of data on expanded target products, enlargement to other areas, such as transmission of the

transportation packaging data to a transportation infrastructure planning and outside of the MERCOSUR economic region.

At the end of the Study, it is pleased to inform that the application procedures for the authorization of the "MERCOSUR Common Standards (Guideline)" have been actively prepared by Paraguay and Brazil, and two counterpart institutes start to discuss introduction of the "MERCOSUR Common Regional Database". Furthermore, it is delighted that trained staffs of six counterpart institutes of four countries are now able to collect and analyze data of the Transportation Environment Surveys as well as the implementation of the evaluation test utilizing the test standard for providing advice on packaging design improvement.

We wish to take this opportunity to express our sincere gratitude for the implementation of the study to your Agency, the Ministry of Foreign Affairs, the Ministry of Economy and Industry, all Embassies and Consulate Generals of the MERCOSUR countries for their precious guidance and support. We are also deeply grateful to the target four countries of the MERCOSUL, governments, ministries and agencies of Argentina, Brazil, Paraguay and Uruguay, INTI, INT, INMETRO, CETEA, INTN and LATU of counterpart institutes, and cooperating private companies of four countries for their sincere cooperation and assistance for the study.

Very truly yours,

Tomoyasu SHIDARA
UNICO International Corporation
Team Leader
Study Team on Improvement of Packaging Technology
for Merchandise Distribution in MERCOSUR (Argentina,
Brazil, Uruguay and Paraguay)

ABBREVIATIONS

Abbreviation	Description
AD Converter	Analog-digital converter
AMN	Asociación Mercosur de Normalización
AMS	Mercosur Standardization Association
ANTT	Inland Transportation National Agency (Brazil)
AR	Argentina
BR	Brazil
C/P	Counterpart
CAN	Andean Community
CARICOM	Caribbean Community and Common Market
CEPAL	Latin America Economic Committee
CETEA	Packaging Technology Center (of ITAL) (Sao Paulo, Brasil)
CSM	Packaging Sector Committee
DER SMART	Commercial brand of sensors of Yoshida Seiki Corp. (Japon)
DINATRAN	Inland Transportation National Office (Paraguay)
DNV	Road Transportation National Office (Argentina)
DUMMY	"dummy" load
EPS	Expanded polystyrene
G	Gravity Acceleration
GMT	Greenwitch Mean Time
GNP	Gross National Product
GPS	Global Positioning System
Grms	Gravity-root means square (Vibrational Energy Unit (root means square over a frequency range))
IBGE	Geograpy and Statistic Institute of Brazil
IDB	Interamerican Development Bank
IMF	International Monetary Fund
INDEC	Instituo Nacional de Estadistica y Censos
INMETRO	National Institute of Metrology and Standarization and Industrial Quality (Brazil)
INT	Technology National Institute (Brazil)
INTI	Industrial Technology National Institute (Argentina)
INTN	Technology and Standarization National Institute (Paraguay)
JBIC	Japan Bank for International Cooperation
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
LATU	Technology Laboratory of Uruguay (Uruguay)
MATCH	Term used for indicating "matching" with GPS system
NAFTA	North American Free Trade Agreement
PE	Poly ethylene
PSD	Power Spectrum Density (energy parameter for vibration tests)
PY	Paraguay
PyMEs	Small and Medium size enterprises
RN XX	Code of National Route
RP XX	Code of Provincial Route
SAVER	Commercial brand of sensors of Lansmont (USA)
SECEX	Brazilian Foreign Trade Secretariat
TEU	Twenty Feet Equivalent Unit
TG	Technical Guidance
USD	US dollars
UY	Uruguay
WS	Workshop
WTO	World Trade Organization

Table of Contents

Table and Figure

Chapter 1 Purpose and Background of the Study

Chapter 1 Purpose and Background of the Study

1.1 Overall Goal

Overall Goal

The appropriate transport packing for physical-distribution of merchandise in the MERCOSUR area will become widespread.

Purpose of the Study

To formulate the "Reference Guide for Packaging Tests, for Evaluation (preliminary)" for the design of suitable packaging for the transportation, considering as “target” the main export-goods in the MERCOSUR Countries (dairy products among food products, and white electric appliances). For this purpose, a series of land Transportation Environment Surveys will be conducted, as well as the analysis of the causes of damages of goods based upon the collected data and other information.

1.2 Background, Scope and Contents of the Study

After the creation of MERCOSUR, notwithstanding the increase of the international trade in the region, a plan which would contribute to develop the distribution of goods within the region is needed, in order to expand even more the commercial activities, just the main objective of the establishment of the common market. However, as one of the ways for accomplishing this purpose, the high cost of the distribution process has been pointed out.

The lack of technology for developing suitable packaging of distributed goods can be remarked as a factor of raising logistic costs. This means, inadequate packaging causing damages of goods or, on the other hand, the over-packaging of goods attempting prevent damages, whichever are leading to a cost impact and the final price of the goods.

Based on the above, a request for a study of regional development has been issued by the Strategic Association of the MERCOSUR Industrial Technology Institutes (AEITI del MERCOSUR), including a study of the transportation environment within the region, aiming the set up of the suitable design of packaging for the actual distribution conditions, as well as the setting of the “Reference Guide for Packaging Tests, for Evaluation”.

The execution of the Study will be a reference in the region aiming to solve the high distribution costs problem, and also linked to the improvement of the competitiveness of exports of MERCOSUR member countries. Furthermore, the execution of the Study has been finally approved by the authorities, in accordance with the main purpose stated in the “Record of

Discussions concerning the Framework of Cooperation Program between Japan and the MERCOSUR", agreed at the 4th Japan-MERCOSUR Senior Officials Meeting.

The Japan International Cooperation Agency (JICA) set and agreed the work frame for the execution of the Development Study after dispatching the following missions: the Project Formation Study Team on November 2002, the Pre-Study Team in February 2003, the Preparatory Study Team (No.1) in June 2003, and the Preparatory Study Team (No.2) in November 2003.

The following Scope of Work (S/W) have been agreed by the AEITI del MERCOSUR and the four member countries of the MERCOSUR:

Date	Place	Signatory Organism	Counterpart
2003.9.23	Montevideo	Representatives of the Governments of each country members of the MERCOSUR	The Strategic Association of MERCOSUR Industrial Technology Institutes (Coordinator: Argentine INTI)
2003.11.11	Montevideo	Uruguay LATU	LATU
2003.11.12	Buenos Aires	Argentina INTI	INTI
2003.12.12	Asunción	Paraguay INTN, Ministry of Industry and Commerce	INTN
2004.06.24	Rio de Janeiro	Brazil ABC, INT, INMETRO	CETEA is in charge of the execution as cooperation agent of INT／INMETRO.

The Scope and the Contents of the Study have been summarized as follows, based upon the Scope of Work (S/W) agreed by the four members countries of the MERCOSUR in Montevideo, on September 23rd 2003.

(1) Scope of the Study

- Selection of the product areas, transportation routes and cooperating companies for the Study
- Implementation of transportation environment surveys
- Development of a common database for MERCOSUR
- Detection of the causes of damages on the products
- Recommendation of measures to decrease the damage ratio
- Recommendation of "Reference Guide for Packaging Tests, for Evaluation" for MERCOSUR
- Implementation of the Model Project (trial tests)
- Technology transfer through the above

(2) Area of the Study

MERCOSUR member countries: Argentine, Brazil, Paraguay, and Uruguay

(3) Counterpart

The execution body for the MERCOSUR was the AEITI del MERCOSUR. The individual body in each Country are as follows:

ARGENTINA: INTI-Envases y Embalajes (Container and Packaging, National Institute of Industrial Technology – CITENEM)

BRAZIL: INMETRO (National Institute of Metrology, Standards and Industrial Quality)
INT (National Institute of Technology)
CETEA (Packaging Technology Centre), under ITAL (Food Technology Institute)

PARAGUAY: INTN (National Institute of Technology and Standards- Packaging Section)

URUGUAY: LATU (Technological Laboratory of Uruguay- Packaging Sector)

The National Institute for Industrial Technology (Instituto Nacional de Tecnología Industrial) INTI of Argentina has had the role of Technical Coordinator during the execution of the Study.

(4) Reports

The following reports have been issued:

- Inception Report
- Progress Report
- Interim Report
- Draft Final Report and Summary
- Final Report and Summary

1.3 Significance of Regional Cooperation

This Study aims basically the promotion of export-import of the manufactured products within the MERCOSUR economic block, through the improvement of competitivity, based on the technology strengthening related to packaging of those products for land transportation among the MERCOSUR four member countries, which has been created as common market block. (in this time, the targeted area for the Study is Argentina, Brazil, Paraguay and Uruguay).

For this purpose, the establishment and issue of the "Reference Guide for Packaging Tests, for Evaluation (preliminary)" have been fixed as objective of the Study.

On this way, through the development of few basic studies under limited resources and time on this large region, and simultaneously, carrying out training courses for Counterparts' institutes personnel, a high expectancy is arisen aiming technology strengthening and diffusion of technologies on related fields, consolidating the future sustainability.

Taking into account that this Study is a pioneer project due to technology application to regional level, the following aspects can be pointed out:

(1) The coordination and harmonization of the four member countries of the MERCOSUR
(2) The technology capacity building of the Counterpart institutes of the four member countries of the MERCOSUR, strengthening the capabilities related to packaging technologies
(3) The awareness of public and private sector centered into one common point, looking for the future development
(4) The monitoring of all the process of the Study, at each stage
(5) The measures aiming the establishment of a common database, applicable for the four member countries of the MERCOSUR.
(6) The technology strengthening through the mutual cooperation among the Counterpart institutes, and their leadership towards the private sector
(7) To give support for the efforts aiming to enshrine into regulation of a MERCOSUR Standard

Taking into account the impact of the cooperation for regional level, the Counterpart institutes of the 4 countries have implemented the technology strengthening program in parallel and to ensure the sustainability of the Study, they will lead the actions at regional level through the mutual cooperation.

Within this process, the key point for the development of the Study is not only the advise and harmonization among counterpart institutes and other organizations concerned – as well as developed during the Study -, but also the information interchange of the progress of each activity on each of 4 countries, in order to ensure the integral progress of the studies.

During the first stage of the Study, a series of coordination meetings with cooperating companies have been held, within the limited scope of target products to be studied (i.e. home electric appliances-white electric appliances; food products - dairy products)

The discussions were centered to confirm the points described below.

- What products do they expect to be selected as target products in the study?
- Regarding to the volumes of exports/imports of target products, what is their position within MERCOSUR market?

- During the process of transportation and loading/unloading, what damages are observed in the products?
- What are the selected routes for this Study?
- For this Study, what kind of support can be given by your company?

Once defined these items with the cooperating companies, the Study has been started, analyzing the current status of the routes and the conditions of customs clearance at the customs posts on the border.

During the Study, it was observed some common problems which are relevant for future consideration by the counterpart institutes and local authorities as well.

Furthermore, there is a high expectation regarding the capacity building related to packaging technology by the counterpart institutes and private sector, developed by the Study, aiming the sustainability of the leadership for sustain this technology within the 4 countries.

In addition, regarding to the main objective of this Study – the issue of the "Reference Guide for Packaging Tests, for Evaluation (preliminary version)" – once it will be reported to the MERCOSUR Standardization Association (AMN), there is a high expectation for the future for the possibility of the approval and publishing as official regulation applicable in the region.

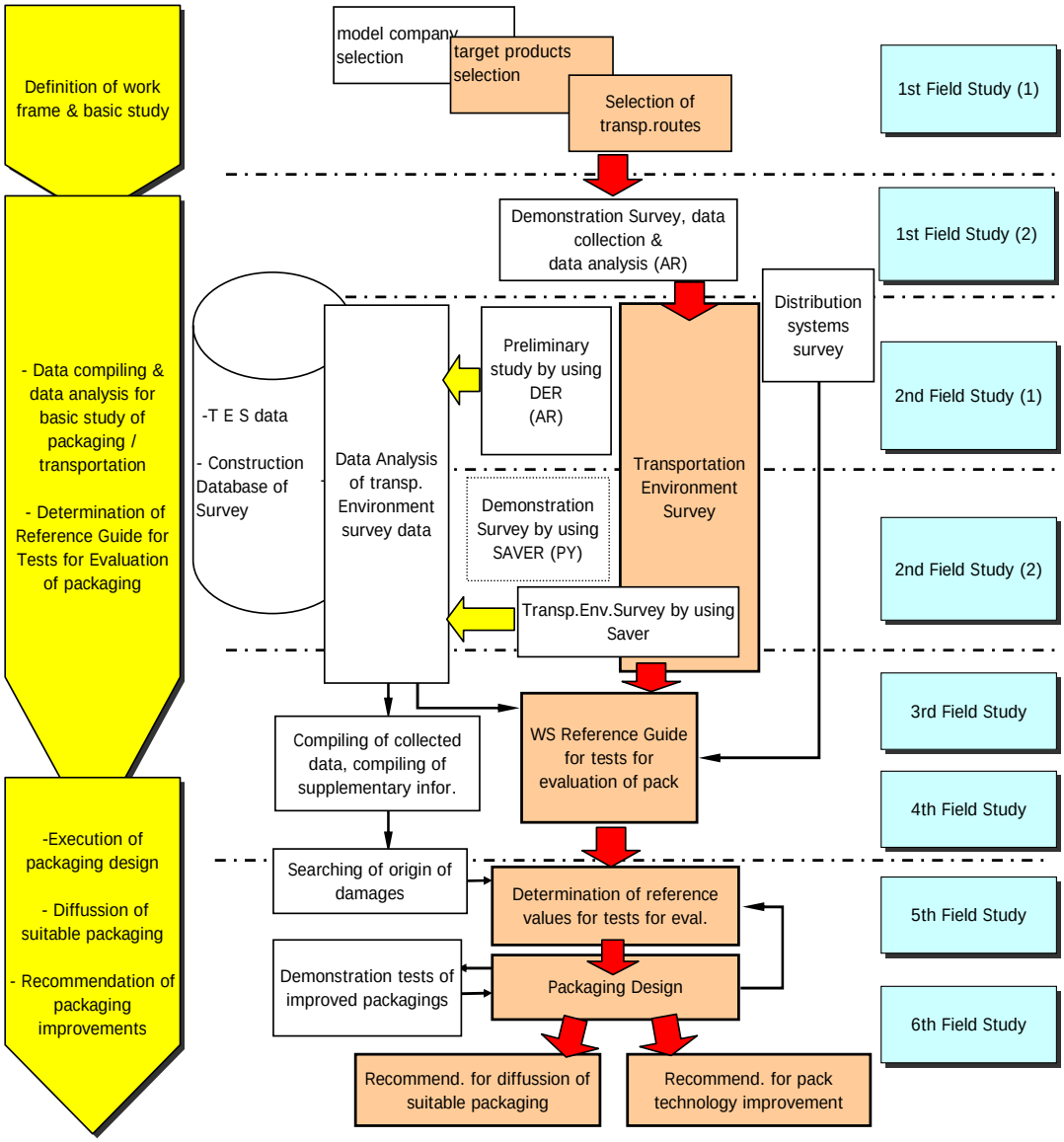
On this way, it is expected the continuity of the Study activities after the completion of the Project, thanks to the good use of the collection of Transportation Environment Surveys data covering so wide region, the wide range transportation conditions, the data analysis results (highly valuable information for the MERCOSUR). Furthermore, once the Standard is validated at South America level, it would be a useful tool to communicate with international institutions such as ISO, so they can issue later some technical comments which can be useful to further improvement of the Standard.

This JICA study, from the viewpoint of improvement of packaging technology, has developed the advice for the suitable packaging for the transportation in the region, preventing the damages during transportation. All these will be relevant in the sense of being one contribution to solve one of the current problems, which is affecting the competitiveness in the MERCOSUR region.

1.4 Summary of the Study Process

The Study process was planned by stages, aiming different objectives (see diagram below). The content of each stage is indicated so that the overview can be seen from top to bottom.

Regarding to the general schedule of the Study, each field study has been developed according to the timing indicated in the diagram.



Source: JICA Study Team

Fig. 1.4-1 Process Diagram of the Study

1.5 Project Implementation Structure

The JICA Study Team began studying for the project based on the following organization chart and the table of work contents of each member.

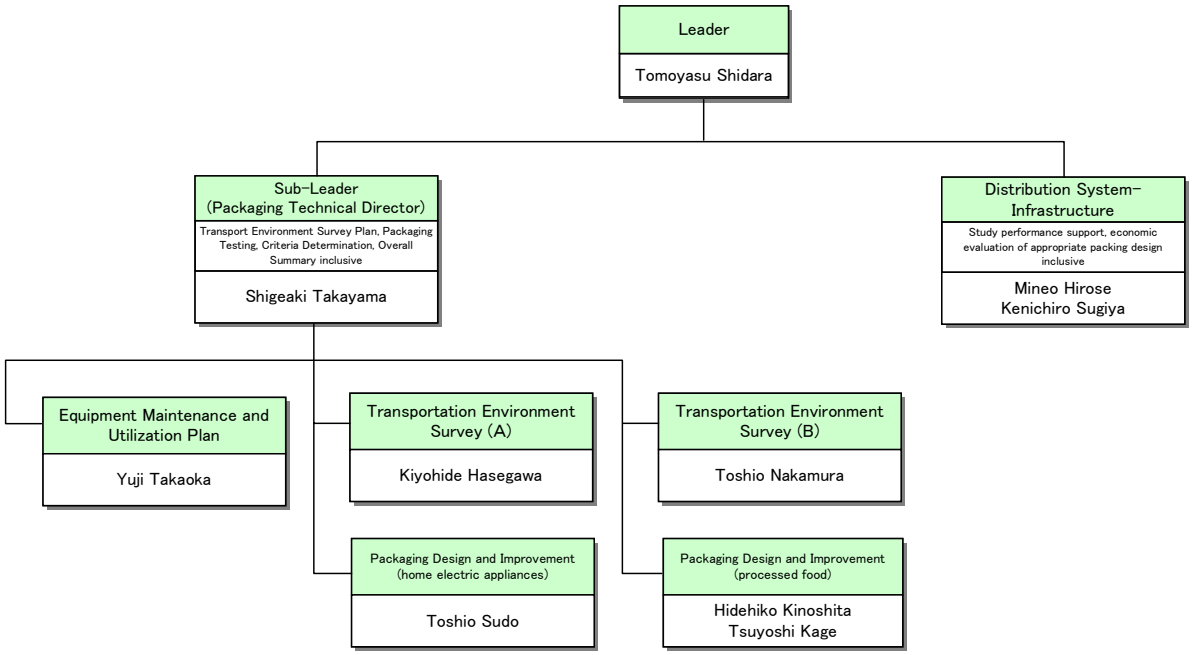


Fig. 1.5-1 Project Implementation Structure of the Study Team (Plan)

Table 1.5-1 Description of Assignment by Team Member

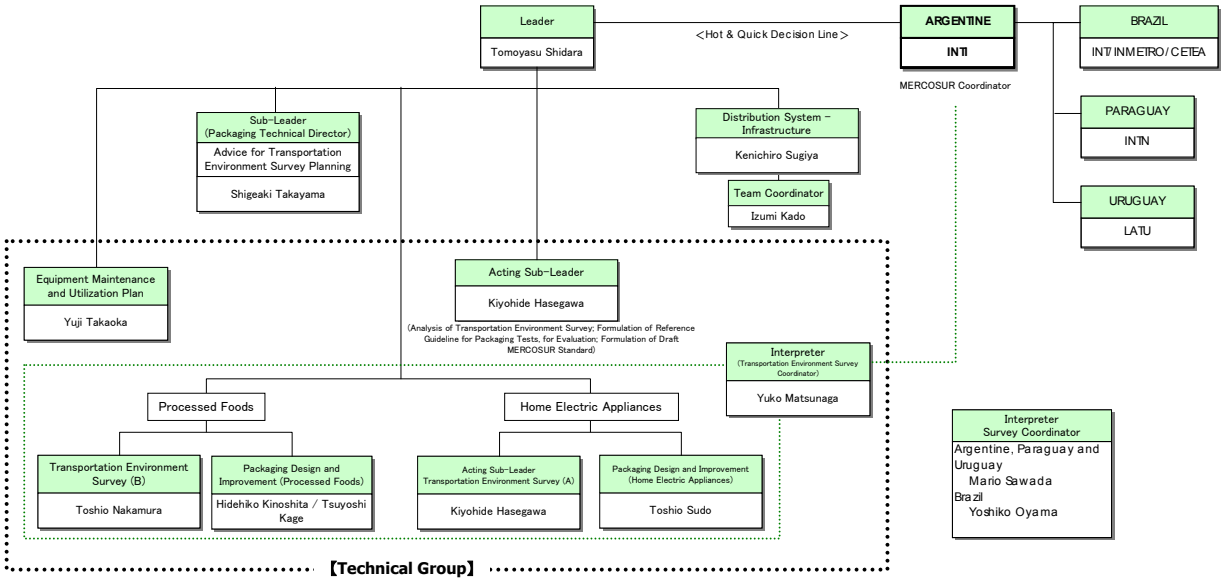
	Name	Assignment	Main Assigned Tasks
1	Tomoyasu Shidara	Leader	1) General management of the Study 2) Coordination with counterparts, government, and concerned organizations 3) Coordination of target products and transportation routes 4) General management on policy recommendation for appropriate transportation packaging popularization 5) Coordination of "Transportation Environment Survey" by the Study Team initiative 6) Coordination and support on specific items (varied models, demonstration training, etc.) of "Transportation Environment Survey" 7) Coordination of a model project at final stage (corresponding to long-distance export)
2	Mineo Hirose / Kenichiro Sugiya	Distribution System / Infrastructure	1) General management of the Study 2) Coordination with counterparts, government, and concerned organizations 3) Coordination of target products and transportation routes 4) General management on policy recommendation for appropriate transportation packaging popularization 5) Coordination of "Transportation Environment Survey" by the Study

	Name	Assignment	Main Assigned Tasks
			Team initiative 6) Coordination and support on specific items (varied models, demonstration training, etc.) of "Transportation Environment Survey"
3	Shigeaki Takayama	Sub-Leader / Packaging Technical Director / Packaging Testing, Criteria Determination	1) Survey on storage, packaging, handling by cooperating companies (home electric appliances) 2) Instruction and support for the Transportation Environment Study 3) Instruction and support for data analysis of transportation environment 4) Data compilation and policy formulation guidance for "Reference Guideline for Packaging Tests, for Evaluation (Draft)"
4	Kiyohide Hasegawa	Transportation Environment Survey (A)	1) Survey on storage, packaging, handling by cooperating companies (home electric appliances) 2) Guidance for transportation environment survey 3) Guidance for data analysis of transportation environment 4) Data compilation and policy formulation guidance for "Reference Guideline for Packaging Tests, for Evaluation (Draft)" 5) Planning and implementation of for "Transportation Environment Survey" by the Study Team (home electric appliances) 6) Operation of varied models, analysis and demonstration training (Paraguay)
5	Toshio Nakamura	Transportation Environment Survey (B)	1) Survey on storage, packaging, handling by cooperating companies (processed foods) 2) Survey on transportation material supply situation of processed foods 3) Guidance for transportation environment survey 4) Guidance for data analysis of transportation environment 5) Data compilation and policy formulation guidance for "Reference Guideline for Packaging Tests, for Evaluation (Draft)" 6) Guidance for transportation packaging design of processed foods 7) Implementation of demonstration test utilizing limited equipment in Argentina 8) Planning and implementation of "Transportation Environment Survey" by the Study Team (processed foods) 9) Operation of varied models and demonstration training (Paraguay) 10) Guidance for dummy designing and production of varied equipment correspondence
6	Toshio Sudo	Packaging Design and Improvement (home electric appliances)	1) Survey on transportation material supply situation of home electric appliances 2) Guidance and support for transportation packaging design of home electric appliances including implementation of laboratory and actual shipment tests 3) Recommendations for transportation packaging improvement of home electric appliances 4) "Transportation Environment Survey" by the Study Team 5) Operation of varied models, data gathering and analysis
7	Hidehiko Kinoshita / Tsuyoshi Kage	Packaging Design and Improvement (Processed foods)	1) Guidance and support for transportation packaging design of processed foods including protection of product deterioration 2) Recommendations for transportation packaging improvement of

	Name	Assignment	Main Assigned Tasks
			processed foods including protection of product deterioration 3) "Transportation Environment Survey" by the Study Team 4) Operation of varied models and data gathering
8	Yuji Takaoka	Equipment Maintenance / Utilization Plan	1) Survey on existing equipment of transportation packaging evaluation test in four countries 2) Detailed planning for the measurement equipment of transportation environment and the equipment of packaging evaluation testing 3) Detailed description for equipment and materials for surveys

Source: JICA Study Team

Since two different types of measurement equipment utilizing for transportation environment survey were prepared, it was necessary to hold the technical training courses on theory, operation and technique as the joint technical training session of four countries in Asuncion, Paraguay in August 2005. After the Transportation Environment Surveys were subsequently implemented by the Study Team initiative in each four countries, it was expected that there would be differences in many ways among those countries. As a result, the structure and function of the Study Team had reorganized with emphasis on efficiency development, schedule control and cost control by reviewing members' ability and mobility since the beginning of the year 2006 in order to revise the issue mentioned above. Following figure is the reorganized structure and it has been effective since the progress report meeting and workshop held in Brazil in March, 2006.



Source: JICA Study Team

Fig. 1.5-2 Project Implementation Structure of the Study Team (Actual)

As for the organization and function of counterpart, the Container and Packaging Center of INTI (Industrial Technology National Institute) of Argentina undertook a role of coordinator for the counterparts of 4 MERCOSUR countries for the JICA Study.

Three counterpart organizations are in Brazil. The INT of Rio de Janeiro is under the Ministry of Science and Technology for international cooperation function of whole technical aspect. The INMETRO of Rio de Janeiro established the research center under the Ministry of Development, Industry and Trade in Rio de Janeiro. The Study Team mainly performed their activities at the Packaging Technology Center (CETEA) of the Food Technology Institute (ITAL). The institute in Campinas has testing equipment of packaging technology and implements tests and development of packaging technology outsourced by private companies and promotion activities.

The counterpart of Paraguay is INTI (National Institute of Technology and Standards) as a function of general institute of technology, and concentrates on technological enhancement, facility expansion and human resource development of the packaging Technology Section. This is the only one counterpart institute as a full-fledged member of the MERCOSUR Standardization Association (Headquarter in Sao Paulo, Brazil).

The counterpart of Uruguay is LATU (Technological Laboratory of Uruguay; strong independency) which is originally established as an institute for development of forest products industry. The Packaging Section was established as an organization directly controlled by the Director-General especially for the JICA Study and put their effort into technology and human resource development. This Packaging Section took the initiative from the stage of the Transportation Environment Survey, and the Plastic Section of the packaging material research division jointed for technology acquisition on the stage of package designing and trial production.

Chapter 2 Target Products of the Study

Chapter 2 Target Products of the Study

2.1 Foreign Trade Trends

Introduction

The main parameters corresponding to the 4 MERCOSUR Member Countries for 2005 are summarized in Table 2.1-1. The GDP variation for the whole region in 2005 exceeded that of across Latin America, that increased by 4.3%.

Table 2.1-3 shows the evolution of the GDP and the foreign trade variations from 2001 to 2006. The trends indicate a favorable evolution as from 2003, i.e. after the monetary crisis through a period of stability and also influenced by global prosperity.

Table 2.1-1 MERCOSUR General Summary（2005）

Country	Population. (mill.inhab)	Area (km^2)	GDP (mill. US$)	GDP per capita (US$)	Exports (mill. US$)	Exports/ GDP (%)	Imports (mill. US$)
Argentina	38.23	2,791,810	183,394	4,802	39,898	21.8	28,698
Brazil	181.59	8,514,877	795,924	4,316	118,308	14.9	73,500
Paraguay	5.90	406,752	7,670	1,301	1,688	22.0	3,251
Uruguay	3.24	176,215	16,800	5,200	3,400	20.2	3,900
Total	228.96	11,889,654					

Sources: ECLAC, Search, Central Bank, World Bank, JETRO, etc.

Based on information provided by the ECLAC, exports of manufactured products for 2004-2005 increased by an average 8.8%. Upon an analysis of the data corresponding to the 4 MERCOSUR Member Countries, the counterparts to this Study, it can be seen that Uruguay registered a 22% increase for that period, which is a very high figure, followed by Paraguay with 20%, Brazil with 14% and Argentina with 9.5%. In all the cases, these increases exceed the regional average growth. Besides, an 8,5% is estimated for year 2006.

In addition, the foreign trade balance of manufactured products was positive for the period from 2002 to from 2005, recording amounts ranging from US$ 24,000 million for 2002 to US$ 80,600 million for 2005.

This occurred as a result of trade liberalization treaties and economic stability. Table 2.1-2 shows the evolution and growth of intra-zone trade among the 4 MERCOSUR Member Countries, based on the 2000 index equal to 100.

Table 2.1-2 Evolution of the MERCOSUR Intra-zone Trade

(Index: year 2000=100)

Country	Exports			Imports		
	2003	2004	2005	2003	2004	2005
Argentina	112.6	118.1	134.8	58.4	87.8	108.4
Brazil	137.7	163.8	178.5	87.1	103.1	108.7
Paraguay	94.9	113.9	136.3	88.2	106.7	127.3
Uruguay	97.6	124.6	144.5	69.4	92.4	107.5

Source: ECLAC Economic Surveys 2005-2006

Table 2.1-3 Trade and GDP Variations in the MERCOSUR

(unit : %)

Country	Item	2001	2002	2003	2004	2005	2006 (estim)
Argentina	GDP	-4.4	-10.8	8.7	9.0	9.2	4.5
	Export	0.5	-3.1	14.3	15.0	16.6	13.1
	Import	-19.7	-55.8	54.4	50.0	25.2	14.1
Brazil	GDP	1.3	1.5	-0.2	4.9	2.3	3.5
	Export	5.7	3.7	21.1	32.0	22.6	12.0
	Import	-0.4	-15	2.2	30.0	17.1	19.1
Paraguay	GDP	2.4	-2.5	2.6	3.0	3.0	3.5
	Export	-19.1	0	11.9	27.0	28.0	
	Import	-12.8	-13.5	9.2	39.0	22.6	
Uruguay	GDP	-3.6	-12.0	2.5	7.5	6.0	5.0
	Export	-10.2	-10.2	18.3	32.3	20.6	17.9
	Import	-12.0	-35.7	11.6	42.2	24.4	29.1

Source: ECLAC, Search, Central Bank

2.1.1 Evolution of the MERCOSUR Intra-zone and Extra-zone Trade

Table 2.1.1-1 shows a summary of exports variation comparison of the 4 MERCOSUR Member Countries for the period from 1990 to 2004. A continuous growth of intra-zone exports can be seen, except in Uruguay. Uruguay recorded an increase in exports to the CAN (Andean Community) and the NAFTA member countries. Besides, an analysis of the MERCOSUR intra-zone exports distribution shows that 15.8% of the exports from Argentina to Brazil; 7.8% of the exports from Brazil to Argentina; 27.8% of the exports from Paraguay to Uruguay, 19.2% to Brazil and 6.3% to Argentina, indicating a significant dependency on regional trade. In addition, 16.5% of the exports from Uruguay to Brazil and 7.6% to Argentina.

Therefore, the distribution to MERCOSUR markets increased from 8.9% to 12.3% during the period from 1990 to 2004, followed by distributions to the CAN and the CARICOM markets.

Besides, according to information obtained from the INDEC and the SECEX (Brazilian Foreign Trade Secretariat), 1% of the aggregate imports, i.e. US$ 9,600 million, correspond to dairy products, US$ 4,900 million (51%) of which are imports from Argentina.

Table 2.1.1-1 Variation in the % of MERCOSUR Extra-zone Exports (1990-2004)

(unit: %)

Country	MERCOSUR		CAN		CARICOM		NAFTA		Others	
	'90	'04	'90	'04	'90	'04	'90	'04	'90	'04
Argentina	14.8	18.1	4.1	4.9	0.3	0.7	17.0	14.6	63.8	61.7
Brazil	4.2	9.2	2.8	4.3	0.4	0.9	27.9	26.4	64.7	59.2
Paraguay	39.6	59.1	1.6	3.9	0.1	0.2	4.5	4.2	54.2	32.6
Uruguay	35.1	26.2	1.5	2.6	0.1	0.2	12.2	19.7	51.1	51.3
MERCOSUR	8.9	12.3	3.1	4.4	0.3	0.8	23.9	23.0	63.8	59.5

Source: JETRO, ECLAC, Institute for International Economic Studies

Argentina	⇒	Brazil	15.80%						
Brazil	⇒	Argentina	7.80%						
Paraguay	⇒	Uruguay	27.80%	⇒	Brazil	19.20%	⇒	Argentina	6.30%
Uruguay	⇒	Brazil	16.50%	⇒	Argentina	7.6%			

Source: WTO

2.1.2 Foreign Trade Trends of the Target Products

2.1.2.1 Production and Trade Trend of Dairy Products in Argentina

Table 2.1.2-1 shows the production of milk and dairy products for the period from 2001 to 2005 based on the data provided by the Argentine Secretariat of Agriculture, Livestock, Fisheries and Food (*Secretaría de Agricultura, Ganaderia Pesca y Alimentos*: SAGPYA).

Analyzing the evolution throughout these years, it can be seen that the production of fresh milk increased by 5.7% from 2004 to 2005, i.e. from 1,499,806 KL in 2004 to 1,584,735 KL in 2005.

Exports for the same period increased from 7,657 KL in 2004 to 13,201 KL in 2005, i.e. a significant 73.4% growth. Conversely, imports decreased by 80.2%, from 5,293 KL in 2004 to 1,049 KL in 2005.

Besides, the aggregate production of dairy products (powdered milk, cheese, yoghurt, butter, milk jam <*dulce de leche*>) decreased by 7.9%, from 1,180,566 tons in 2004 to 1,086,821 tons in 2005.

As regards exports, there was a significant 152.6% increase, from 109,203 tons in 2004 to 275,797 tons in 2005.

Likewise, imports increased from 8,450 tons in 2004 to 15,199 tons in 2005, i.e. by 81.1%. The volume of exports of dairy products in Argentina during the period from 1992 to 1999 increased 5.4 times. However, this was mainly due to the impact of reduction in customs duties upon the creation of the MERCOSUR. Besides, historically, a big portion of the exports of

dairy products (50%) go to Brazil; and although this has not changed, since 2002 there have been fluctuations due to the devaluation of the currency of both countries.

Table 2.1.2-1 Production and Trade of Dairy Products in Argentina

Year		2001	2002	2003	2004	2005
Fluid Milk *						
Manufacturing	KL	1,614,899	1,436,231	1,386,253	1,503,839	1,598,559
Stock (1)	KL	-6,223	-6,850	-135	1,667	1,672
Net Production (2)	KL	1,622,782	1,432,564	1,418,189	1,499,806	1,584,735
Export	KL	6,534	10,696	1,948	7,658	13,201
Import	KL	8,194	179	33,748	5,293	1,049
Dairy Products						
Manufacturing	tn	1,175,607	1,071,464	1,042,940	1,272,546	1,361,709
Stock (1)	tn	26,729	-48,816	2,761	-8,773	14,289
Net Production (2)	tn	1,089,614	1,042,644	973,164	1,180,566	1,086,821
Export	tn	77,516	88,293	77,692	109,203	275,797
Import	tn	18,252	10,657	10,677	8,450	15,199
(Powdered Milk)						
Manufacturing	tn	244,362	238,136	228,891	295,366	286,431
Stock (1)	tn	23,211	-33,903	4,619	-8,119	6,252
Net Production (2)	tn	117,236	110,591	108,305	106,370	102,917
Export	tn	104,507	161,740	119,389	199,238	181,829
Import	tn	592	292	3,423	2,123	4,567
(Cheese)						
Manufacturing	tn	430,956	379,677	332,293	378,347	414,412
Stock (1)	tn	471	-5,066	-4,585	800	5,080
Net Production (2)	tn	419,870	359,929	315,179	344,285	359,720
Export	tn	17,536	25,781	23,183	34,822	51,891
Import	tn	6,921	966	1,484	1,599	2,280
(Yoghurt)						
Manufacturing	tn	264,923	246,051	271,463	357,140	405,241
Stock (1)	tn	-642	-199	805	-51	472
Net Production (2)	tn	268,500	251,021	271,655	357,323	402,747
Export	tn	710	881	675	1,310	3,353
Import	tn	3,645	5,652	1,672	1,422	1,331

(1): Stock = (Final Stock – Initial Stock)
(2): Net Production = (Manufacturing + Import – Export – Stock)
*: Fluid Milk = Includes all the manufactured milk as liquid.
**: Dairy products= includes powdered milk, cheese, butter, cream, *dulce de leche*, caseine etc
Source: *Secretaria de Agricultura, Ganaderia, Pesca y Alimentos* - SAGPYA (AR)

Argentina imports dairy products from MERCOSUR countries, mainly from Uruguay, including fresh milk (30%), cheese (13%), casein (11%) and fermented products other than yoghurt (12%).

2.1.2.2 Production Trend of Refrigerators, Freezers, and Air Conditioners for Household Use in Argentina

The following table shows the production trend (per unit) of refrigerators, freezers, and air conditioners from 2000 to 2005 based on reports issued by the Argentine INDEC.

Table 2.1.2-2 Production of Household Appliances in Argentina

(Unit. appliance)

Product	2000	2001	2002	2003	2004	2005
Household refrigerators	325,416	247,634	167,912	149,286	241,178	163,532*1
Household freezers	80,034	63,736	29,319	50,515	80,180	51,441*1
Household air conditioners	112,336	190,930	4,159	39,227	173,527	45,704*2

*1 : 2006 = from January to July
*2 : 2006= from January to June
Source: Prepared by the JICA Study Team based on data from INDEC (AR)

Comparing the figures corresponding to the first semester of 2005 against those for the same period of 2004, significant increases can be seen, including 80.2% in refrigerators, 62.8% in freezers and 423.3% in air conditioners.

2.1.2.3 Production Trend of Household Appliances in Brazil

Sales of household appliances in Brazil in 2005 amounted to 40 million units, 12.8% higher than in the previous year. Of this figure, 9.8 million units correspond to TVs.

However, if the sales corresponding to 2004 are considered equal to 100 for each kind of appliance, in 2005, white appliances would represent 98.39, i.e. -1.61% reduction as compared to the previous year. In 2005, the aggregate sales of household appliances increased by 12.8%, measured in units, due to the market shift to TVs and DVD players.

The Brazilian market value corresponding to electro-electronic appliances is around US$ 38,000 million (5% of the GDP). It has increased by 40% in the last five years and there is a growing trend in production.

As regards imports, electro-electronic products represent 20% of the aggregate amount, which is very high. Besides, a continuous 2 digit growth in exports has been recorded. The volume of exports for 2005 was US$ 7,767 million, 45.3% higher than in the previous year. Of this figure, exports of household appliances, including car radio amounted to US$ 914.4 million, representing a 17.6% increase as compared to the previous year. In addition, imports of

electro-electronic products for 2005 amounted to US$ 15,131 million, 19.5% higher than in the previous year, doubling the volume of exports.

Exports of household fridges, a target product of the JICA Study, amounted to US$ 253.3 million. As compared to 2001, it represents a 250.3% increase.

The status of trade of white appliances (refrigerators, washing machines and vacuum cleaners,) imported from Chile (a MERCOSUR associate country) can be analyzed from the point of view of the common market.

Taking into account the data corresponding to 2005, 45,627 refrigerators were imported from Brazil, representing 60.6% of the aggregate imports. As regards washing machines, 5,732 units were imported from Brazil (i.e. 2.1% of the aggregate imports), and 2,641 units from Argentina (1% of the aggregate imports).

Besides, in 2005, vacuum cleaners imported from Brazil amounted to 4,845 units, representing. 1.1% of the aggregate imports.

In the case of Chile, a high percentage of products other than refrigerators are imported from Asian countries of the APEC group, in part due to geographic reasons.

2.2 Target Products and the Cooperating Companies

Regarding the selection of the cooperating companies and the target products, on January 11, 2003, the JICA Study Team completed a feasibility study of the 4 Participating Countries. As a result of such study, the sectors, companies and target products listed below were selected (Table as of the time of the feasibility study).

Table 2.2-1 Cooperating Companies: Sector/Products (June 2003)

Country	Sector/product	Cooperating Company
Argentina	Food products (dairy) White appliances (refrigerators; horizontal and veritical types)	SANCOR Damage ratio: 7% FRIMETAL Damages ratio: horizontal type 6.2%、vertical type 2.4%
Brazil	Electrical Products (fridges, freezers, Air conditioners, Audiovisual equip.) Food products Auto parts	BSH (Damage ratio: 14%) Multibras SONY, Phillips, etc. Yoki Sabo
Paraguay	Food products (dairy)	Chortitzer
Uruguay	Food products (dairy)	Conaprole

Source: JICA Study Team

Later, the selected target products and cooperating companies were subject to some changes as indicated in the following tabled during the initial stage of the Study and the routes to be covered were defined. The Study began based on all this information.

Table 2.2-2 Cooperating Companies: Products/Routes (at the beginning of the Study)

Country	Sector/product		Cooperating Company	Country
Argentina	1	Powdered milk	(1) Rafaela－Resistencia－Asunción (800km)	Williner
	2	Olives	(2) Aimogasta－Santiago－Resistencia－	NUCETE
	3	Refrigerators, show cases	Uruguayana－Guarapuaba (BRA) (2,500km)	
			(Demonstration Test: Buenos Aires－Aimogasta)	
			(3)Rosario－San Luis－Mendoza－Santiago	FRIMETAL
			(CHL) (1,500km)	
Brasil	1	Refrigerators	(1) Hortolandia－Sao Paulo－Recife (2800 km)	BSH Group
	2	Refrigerators, etc.	(1)' Joinville－Sao Paulo－Recife (3180 km)	Multibras S.A.
			(2-1) Manaus－Belem (1700 km river)	Multibras S.A.
			(2-2) Belem－Sao Paulo(3000 km)	Multibras S.A.
			(3) Sao Paulo－Uruguayana (1800 km)	Multibras S.A.

Country	Sector/product		Cooperating Company	Country
Paraguay	1	UHT milk, Pasteurized milk, yogurt, pudding, caramel.	(1) Loma Plata－Asuncion（480km） (2) Loma Plata－Pedro J.Caballero－（BRA）（560km） (3) Asuncion－Ciudad del Este（340km） (4) Asuncion－Encarnacion（400km）	Chortitzer Chortitzer Chortitzer Chortitzer
Uruguay	1	Powdered milk (for export)	(1) Florida－Montevideo（100km） (2) Montevideo－Chui（400km） (3) Montevideo－Fray Bentos（300km）	CONAPROLE CONAPROLE CONAPROLE

Source: JICA Study Team

Throughout the Survey of Transportation Environment in respect of the food products (mainly dairy products), the cooperating companies showed an increasing interest in the technical aspects of outstanding issues related to transportation, secondary packaging, and primary packaging. As a consequence, and focused on the design of packages-packaging for transportation, a process that begins with the Survey of Transportation Environment, followed by data analysis and lab tests, and ending with the implementation of improvements and Route demonstration for the Model Project (final stage of the Study), the results described in the table below were obtained.

In respect of this general overview, some of the scheduled activities were delayed due to certain management changes. In Brazil, for example, despite the main products selected for the Study are household refrigerators, surveys of the transportation of external air conditioners were carried out, etc.

Table 2.2-3 Cooperating Companies for the Model Project

Country	Sector/product	Cooperating Company
Argentina	Refrigerators Dairy products (yogurt, UHT milk, milk jam） Olive by-products Edible Oil	FRIMETAL WILLNER Mastellone NUCETE Molinos
Brasil	Refrigerators Air Conditioners (external)	BSH Multibras Klabin (manufacturer of packaging materials)
Paraguay	Dairy products （yogurt, pouch milk）	Chortitzer
Uruguay	Dairy product （yogurt, pouch milk）	Conaprole

Source: JICA Study Team

2.2.1 Industrialized Food Products (Dairy)

There are approximately 800 dairy producers in Argentina, most of them are located 800km north of Buenos Aires, 10 of which are the main ones. The 12 companies listed below represent 97% of exports. The main destination is Brazil with 66% of the aggregate exports, followed by Paraguay with 9% and the USA with 7%.

Sancor Coop. Unidas Ltda.	Verónica S.A.C.I.A.F.I.
Mastellone Hermanos S.A.	Parmalat Argentina S.A.
Nestlé Argentina S.A.	Cabaña y Estancia Santa Rosa S.A.
Molfino Hermanos S.A.	Remotti S.A.
Milkaut S.A.	Danone S.A.
Williner S.A.	Manfrey Coop

Source: Statistics and Census National Institute INDEC (AR) 1991-2001

Based on an analysis of this information, we can see the significant dependency of Argentine dairy exports on the MERCOSUR. Besides, Williner SA, listed in the table of leading companies, is one of the companies that cooperated in this JICA Study. This company has provided ample support to perform the transportation surveys along the Rafaela- Asunción (PY), Rafaela – Neuquén stretches as well as the goods handling surveys using dummy cargoes.

The company listed in the second place, Mastellone Hermanos SA, is also one of the cooperating companies. This company has had technical difficulties due to damages suffered during the transport of products exported to Chile (milk jam (*dulce de leche*)). The JICA Study Team analyzed the issue, performing tests to improve the primary packaging and carrying out lab tests and finally presented a technical solution.

In addition, the target products for Paraguay and Uruguay are limited to dairy products. The cooperating companies from both countries were Chortitzer from Paraguay and Conaprole from Uruguay. Both are leading companies in their respective countries with market shares exceeding 60%. Chortitzer exports its products to Brazil and Bolivia, while Conaprole exports less significant amounts to Brazil and Argentina.

Chortitzer has established an organization to cooperate in this JICA Study, not only with the counterpart's institution but also with its top management. This allowed the performance of transportation surveys along its own distribution routes as well as the route used to export products to Brazil through Campo Grande (mainly UHT milk). This company has also been of great assistance in the workshop carried out in Campinas, Brazil, organized by the Brazilian counterpart, by supplying a complete pallet of product samples to be used in the lab tests.

Likewise, Conaprole has collaborated in all the transportation surveys along all the main national distribution routes, together with the staff of the counterpart institution in order to study products such as yogurt, pouch milk and butter.

In these two countries, Paraguay and Uruguay, and during the second stage of this Study, further surveys were carried out focused on primary packaging (individual packages) of dairy products analyzing the improvements in the material of top cover of yogurt pot, in order to reduce damages, the improvement of sealing conditions as well as the material from which milk pouches are made. Based on these analyses, the "Model Projects" were developed and the related advise was given to improve the design of primary packaging.

Among the target food producers, other than dairy producers, the cooperation of Nucete, a manufacturer of olive by-products based in the Northwestern Argentina, should be highlighted. This company exports its products to Brazil, the USA and Canada and they provided assistance in the following transportation surveys: Buenos Aires-Aimogasta (First demonstration test), Aimogasta-Iguazu (Northeaster area of Argentina)-Curitiba (the route used to export to Brazil). Besides, the collaboration of Nucete's Brazil company "Vale Fertil" in the Workshop carried out in Campinas, Brazil is worth mentioning, since it supplied a complete pallet of olive pouches (of the brand marketed by it in Brazil) and also participated in the technical staff Workshop.

2.2.2 Household Appliances

The household appliances selected for this Study were finally limited to refrigerators (with capacity between 300 to 400 L).

(However, in the case of Brazil, tests were performed in connection with air conditioners for the Manaus-Belem-Sao Paulo stretch)

As regards Argentina, Frimetal, a company based in Rosario provided assistance for this Study. This Chilean-owned company is manufacturing and distributing refrigerators in Argentina. Frimetal collaborated in the transportation survey along the Rosario-Buenos Aires stretch, i.e. the route used to distribute its products. Likewise, it also contributed to the packaging design survey, the preparation of prototypes and the subsequent performance of (multiple) route tests that were part of the pertinent Model Project.

In the case of Brazil, leading manufacturers of white appliances (starting with refrigerators) such as BSH and Multibras, provided invaluable support. In addition, Klabin (material manufacturer), a third company also collaborated simultaneously to the time of Study, supplying packaging material for this Study.

Since these three companies are located far away from one another, BSH in Hortlandia, Multibras in Joinville, Klabin in Sao Paulo, and the counterpart's institutes are located in Campinas and Rio de Janeiro, the efforts made by the local participants (in special the Campinas group) to carry out the Study with the necessary coordination is worth mentioning.

In addition to this, the joint efforts with the JICA Study Team have led to the success of the Study in respect of the performance of route tests covering long distances of a vast territory such as: routes from each of the factories to Recife, covering 3000km–important distribution routes -; the route used to export products from Brazil to Chile, Joinville-Uruguayana- through Mendoza (Argentina) – Santiago de Chile. It should be highlighted that the success of the surveys was due to the close collaboration of each company with the Brazilian and Argentine counterparts.

As regards the packaging design surveys (for household appliances), the Model Projects in Brazil were carried out mainly focusing on the material of the corrugated cardboard boxes, considering that environmental issues of the region is likely to face in the near future.

Chapter 3 Testing Equipment and Facilities for the Study

Chapter 3 Testing Equipment and Facilities for the Study

3.1 Existing Equipment Utilization Plan

3.1.1 Existing Equipment Utilization Plan in Each Counterpart's Laboratory

The JICA mission carried out a survey of existing testing equipment at the institutes of counterpart of each Member Country, and all information was summarized in a report. Additionally, the mission prepared the plan of works, to be done after the Transportation Environment Surveys, related to the packaging evaluation tests and further packaging design stage as well.

(1) Period of Survey of Equipment and Documents

1) 30 November 2004 to 17 December 2004
2) 08 February 2005 to 24 February 2005

(2) Equipment and Tools to be Utilized in the Project

1) Equipment and tools available in the laboratories: vibration test, compression test and impact tests equipment
2) Equipment and tools available in the counterpart institutes, to be used for the efficiency tests of packaging materials

3.1.2 Required Testing Equipment for the Improvement of Packaging Design

Regarding to the status of the testing equipment, the survey results are described in the Fig.3.1-1 and 3.1-2 attached hereto. These results have been shown and explained during the 1st Joint Meeting of 4 Member Countries at INTI (Argentine) conference room on March 10th, 2005. On the other hand, for CETEA's equipment case, and as result of the survey, INMETRO confirmed that the software of acceleration measurement (Item 7) can be used to the vibration test equipment (Item 2) and impact testing equipment (Item 3).

3.1.3 Testing Equipment for Packaging Material

The list of the equipment for testing packaging materials is described in Fig. 3.1-1, according to the property of each institute of the counterparts.

Study on Improvement of Packaging Technology for Merchandise Distribution in MERCOSUR - First Field Survey (2nd Stage)

10 MAR 2005

JICA – Study Team

Utilization Plan for Test Equipment for Packaging

1. Test Equipment available by each member country of MERCOSUR, and utilization plan.

		① Compression Tester	② Vibration Test System	③ Shock Test System	④ Drop Tester	⑤ Electromagnetic Hook	⑥ Slope Tester	⑦ Acceleration Measuring Tester	⑧ Atmospheric Simulation Chamber	⑨ Dynamic Drop Tester for Cushion Materials
A	Argentina									

2. Up todate and future status of the equipment for each country

Argentina
Argentina has the packaging test equipment. However, it is observed a degradation of their functions due to the lack of maintenance.
It is desirable to ensure the function of the equipment, through the adequate maintenance and renewal of the controllers and parts.
Specially, the vibration test system is very important, so, it is expected the renewal of the Random vibration controller.

As informed to previous JICA missions, JICA is kindly requested to make a cooperation for purchasing the high technology equipment for the purpose of vibration, shock and climatization tests, in order to fulfill efficiently the purpose of the project. .
In case that this cooperation would not be available, INTI will make the best efforts in oder to have the equipment which covers this function, with the technology level allowable according to their own budget.

Regarding to their own test equipment for packaging tests, Brazil expressed their good will allowing the use of them by others members countries of MERCOSUR. Regarding to the others equipment not available, it was decided to select a country which has them and request their use.
Furthermore, Brazil was requested to clarify the specifications of the equipment belonging to the cooperative companies. Brazil agreed for that.

Regarding to their own test equipment for packaging tests, Brazil expressed their good will allowing the use of them by others members countries of MERCOSUR. Regarding to the others equipment not available, it was decided to select a country which has them, and request their use.

Regarding to the others equipment not available, it was decided to select the country having them and request their use.

Fig. 3.1-1 Test Equipment Utilization Plan for Packaging Tests

Study on Improvement of Packaging Technology for Merchandise Distribution in MERCOSUR – First Field Survey (2nd Stage)

10 MAR 2005

List of Equipment available by each member country of MERCOSUR

JICA Study Team

Test Equipment available by each member country of MERCOSUR

		① Compression Tester	② Vibration Test System	③ Shock Test System	④ Drop Tester	⑤ Electromagnetic Hook	⑥ Slope Tester	⑦ Acceleration Measuring Tester	⑧ Atmospheric Simulation Chamber	⑨ Dynamic Drop Tester for Cushion Materials
A	ARGENTINA									
	Evaluation	Plate size: 1.26×1.26m, Maximum Load: 5t. In usable condition. The register is paper recorder, similar to old type analog system.	For Random vibration test, it is necessary the replacement of the controller.	Plate size: 0.9×0.9m. It can be used for trapezoidal and half sinus wave, and it is necessary to replace the cushion piece since it is deteriorated.	Maximum weight of sample: 100 Kg, drop height: 30-120mm. It is operating normally. In usable condition.	Maximum load for uncoupled condition: 500Kgf. In usable condition.	Sample maximum sizes: 1.25×1.25×1.25m, Mass: 300Kg. Operating.	The FFT analyzer is operating normally. However, it is necessary to confirm the performance of the system, including the sensor.	The test chamber has the temperature control only available. In the contant temp. chamber, the humidifier is not working properly and main parts are deteriorated.	The acceleration sensor is damaged. It is necessary to repair.
B	BRAZIL						Equiment not available	Equiment not available		Equiment not available
	Evaluation	Flat Plate 1.5×1.5m, maximum height: 2.2m, maximum load: 22.5 t. In usable condition.	It can be delivered random vibration by hydraulic system. Vibration plate: 1.5×1.5m, frequency: 3~500Hz, vibra- tion force: 5000Kgf. Another vibration tester of 1.0 x 1.0 m will be delivered soon.	Drop plate of :0.8×0.8m, ready for use. It is possible to test through trapezoidal and half sinusoidal wave.	Drop height: 0.6~6m, ready for use.	The hook is not electromagnetic type, but normal type. It can be used.			The test chamber has air conditioning system and humidity control. Also, the small chamber and medium size chamber with constant temperature with high humidity are available. In usable condition.	
U	URUGUAY			Equiment not available			Equiment not available	Equiment not available		Equiment not available
	Evaluation	The equipment on upper left of the photo is 10t capacity, and damaged. The date of repair is not defined yet. The equipment of bottom right is small one, 2t max. load. In usable condition.	It is a mechanical type vibration tester. The test is possible only within a fixed range of 1.67Hz to 5 Hz. Random vibration test can not be done.		Maximum weight:75kg, length: 1.5m, wide: 0.5m, maximum drop height:3 m. In usable condition.	Maximum drop height: 4m, Maximum load 500 lbs. In usable condition.			The chambers for contant temperature and for high humidity are available, from small to big, both are in usable condition.	
P	PARAGUAY	Equiment not available	Equiment not available	Equiment not available	Equiment not available	Equiment not available	Equiment not available	Equiment not available	Equiment not available	Equiment not available
	Evaluation	The plan to introduce equipment from the other JICA project must be confirmed	The plan to introduce equipment from the other JICA project must be confirmed	The plan to introduce equipment from the other JICA project must be confirmed	The plan to introduce equipment from the other JICA project must be confirmed	The plan to introduce equipment from the other JICA project must be confirmed	The plan to introduce equipment from the other JICA project must be confirmed	The plan to introduce equipment from the other JICA project must be confirmed	The plan to introduce equipment from the other JICA project must be confirmed	The plan to introduce equipment from the other JICA project must be confirmed

Fig. 3.1-2 Available Equipment List at each C/P for Packaging Study

Study on Improvement of Packaging Technology for Merchandise Distribution in MERCOSUR - First Field Survey (2nd Stage)

List of Main Testing Equipment for Packaging Materials

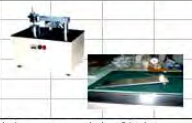
10 March 2005

JICA Study Team

NOTE: These equipment are those for measuring the properties of the packaging materials, such as card board etc. These equipment are not considered essencial for the development of this Study. However, being that the performance of the packaging are subject to the quality of the materials, the preparation of these equipment in a near future is recommended.

Presently available equipment by each country

Ring Crush Tester		Mullen Burst Tester		Elmendorf Tearing Strength Tester		Tensile Strength Tester		Bekk Smoothness Tester		Gurley Densometer Tester		Seal Tester	
													
This tester measures the compression resistance of the corrugated cardboard (liners and waves) and common cardboard, by using the Ring Crush Method.		This tester is for measuring the tensile strength of paper, card - board and corrugated CB. The sample is pressed by two ring shaped pieces and applying pressure through a membrane and reading the value when the explosion occurs.		This is a tester for evaluate the property of tearing of corrugated CB boxes. The measuring is through the loss of potential energy of a pendulum when a sample of corrugated CB is teared up to predefined length.		This tester measures the tensile strength and elongation of paper, plastic films and sheets. The test can be used to evaluate the adhesive properties and the wave length of the corrugated CB.		This tester evaluates the smooth- ness of the paper by measuring the time spent by defined volume of air flowing through the surface of the paper. The grade of smoothness becomes an evaluation if adequate for printing.		It is measured the property of passing the air from the front face to reverse side of the paper. This parameter can be used, along with density, water absorption, print ability, as control parameter for the suitability to vacuum of the corrugated CB box.		It is measured the leaks and the seal property of the packings. Pressure is applied internally to the packings and it is measured the leak and burst resistance.	
Argentina	YES	**Argentina**	YES	**Argentina**	YES	**Argentina**	YES	**Argentina**	YES	**Argentina**	YES	**Argentina**	NO
Brasil	YES	**Brasil**	YES	**Brasil**	YES	**Brasil**	YES	**Brasil**	NO	**Brasil**	YES	**Brasil**	NO
Uruguay	YES	**Uruguay**	YES	**Uruguay**	YES	**Uruguay**	YES	**Uruguay**	YES (1)	**Uruguay**	YES	**Uruguay**	NO
Paraguay	NO	**Paraguay**	YES	**Paraguay**	YES	**Paraguay**	NO	**Paraguay**	NO	**Paraguay**	NO	**Paraguay**	NO

MIT Folding Endurance tester		Puncture Tester		Adhesive Strength Tester		Test Sample high precission Cutter device		Abrasion Resistance Tester		Friction Tester		Sample cutter device	
													
It is used to verify the folding resistance of paper, cardboard, plastic sheets etc. By using this tester, it can be evaluated the property of cracking along the ruled line of the corrugated CB.		The test evaluates the resistance force when a corrugated CB sheet is punctured by the edges of wooden box. It is measured the energy spent when a prism passed through the sheet. It can be applied for triple layer CB, which cannot be tested by		It is measured the resistance to the peel off of the liner-wave joint of corrugated CB. It is used the Ring Crush Tester, making a good use of their compression function. The test is used for quality control of the corrugated CB.		It is a device for obtaining a defined size samples by a gillotine type cutter, for a proper sampling.		It is an device to measure the resistance to abrasion between corrugated CBs. It is evaluated through the resis- tance to abra- sion, when applied a resistance force (friction due to printing) shaped as an arc.		It is measured the friction coefficient of paper, plastic sheet and corrugated CB. With this test, it is measured the grade of sliding for the operability of the contai ners, prevention of risks of falling down on pilled up cargoes. Etc.		It is an device for obtaining a defined size samples, in order to avoid different sizes samples for tensile strength tests, compression tests etc.	
Argentina	NO	**Argentina**	YES	**Argentina**	NO	**Argentina**	YES	**Argentina**	YES	**Argentina**	YES	**Argentina**	YES
Brasil	YES	**Brasil**	YES	**Brasil**	YES	**Brasil**	YES	**Brasil**	NO	**Brasil**	YES	**Brasil**	YES
Uruguay	YES	**Uruguay**	YES	**Uruguay**	YES	**Uruguay**	YES	**Uruguay**	YES	**Uruguay**	YES	**Uruguay**	YES
Paraguay	NO	**Paraguay**	NO	**Paraguay**	NO	**Paraguay**	NO	**Paraguay**	YES	**Paraguay**	YES	**Paraguay**	NO

NOTES: (1) URUGUAY: Smoothness tester to be used together with densometer.

Fig. 3.1-3 Available Equipment List for Packaging Material Studies

3.1.4 Utilization of Other Equipment from JICA's South-South Project

During this JICA Study, technological differences among the four countries, as to the equipment and infrastructure available in the counterparts' institutes for the performance of the related lab tests have been identified. To such end, during the first year of the Study, the required equipment available in each lab was analyzed.

In Argentina and Brazil, the equipment and infrastructure were virtually complete while in Paraguay and Uruguay deficiencies were found. Therefore, to perform the secondary packaging tests, such as vibration, compression and drop tests using palletized goods, the Argentine or Brazilian labs were required to support them with the necessary equipment, which they did.

Then, during the performance of the surveys on food products (especially dairy products) in Argentina, Paraguay and Uruguay, a common practice was observed, consisting in focusing on primary packaging, mainly in respect of the resolution of specific problems common to the cooperating companies. Almost simultaneously, the JICA's South-South Project was implemented in connection with the Paraguayan counterpart, the INTN.

This Project aims the technological strengthening of the INTN institute and it includes the expansion of the existing lab, the provision of equipment and tools, the installation and training of staff (including training for the operation of equipment and technical skills). This project is under a particular situation by the fact that, it is managed just by the staff of the Argentina INTI.

The equipment used to carry out that Project included the Hot Seal test equipment, exfoliation test equipment and drop test equipment. The first two were successfully used while the drop test equipment for individual packages could not be operated –at that moment- due to some adjustment problems of accessory device.

The hot seal equipment is furnished with adjustable parameters of: temperature, sealing pressure and sealing time. Besides, this equipment is capable for heating on 1 or 2 sides by replacing some accessories. Therefore, tests could be jointly performed with the cooperating companies, comparing production line parameters. In this sense, the sealing of LDPE, L-LDPE materials could be tested, subsequently performing the exfoliation tests using the related computerized equipment.

The utilization of these testing equipment of this second JICA project proved to be very useful thanks to the cooperation of the counterpart staff (the same of the Mercosur Project) and the technical staff of the cooperating companies, and the works of this mission. Besides, the collaboration of the supervisory staff of the INTI and the INTN staff, doing personnel training activities, should be highlighted.

The mentioned tests are described in detail in Chapter 7, item 7.3.3. of this report.

Hot Seal Test Equipment

Tensile Test Equipment

Source: JICA Study Team

Fig. 3.1.4-1 Equipment of the JICA's South-South Project

The utilization of the equipment of this second Project of JICA, has been useful for the development of the works with cooperating company, participating also the mission staff, counterparty personnel (being also member of MERCOSUR Study), and under the supervision of INTI of Argentina and INTN personnel under training.

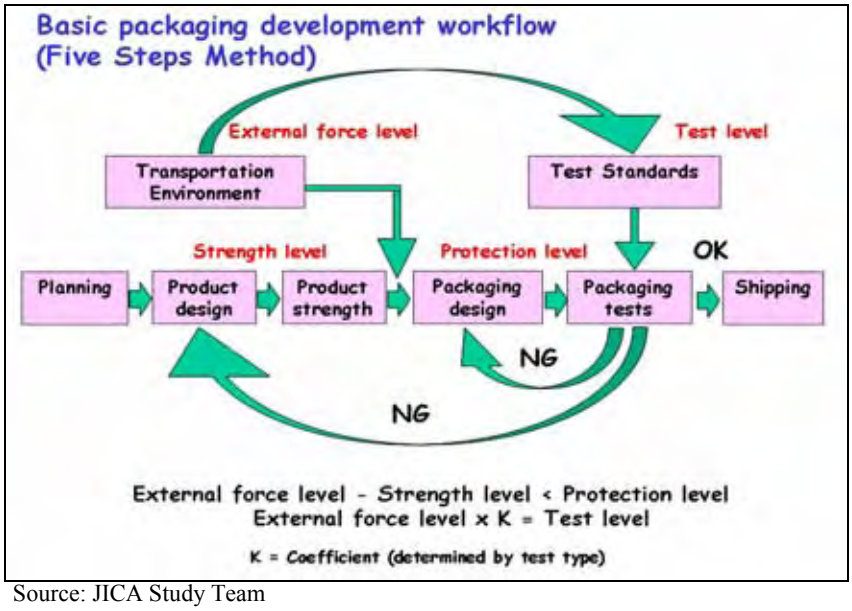
Regarding to the details of these laboratory tests, they are detailed in the Chapter 7, clause 7.3.3 of this Report.

3.2 Measuring Equipment for the Transportation Environment Survey

3.2.1 Basic Flow of Packaging Design (5 stages)

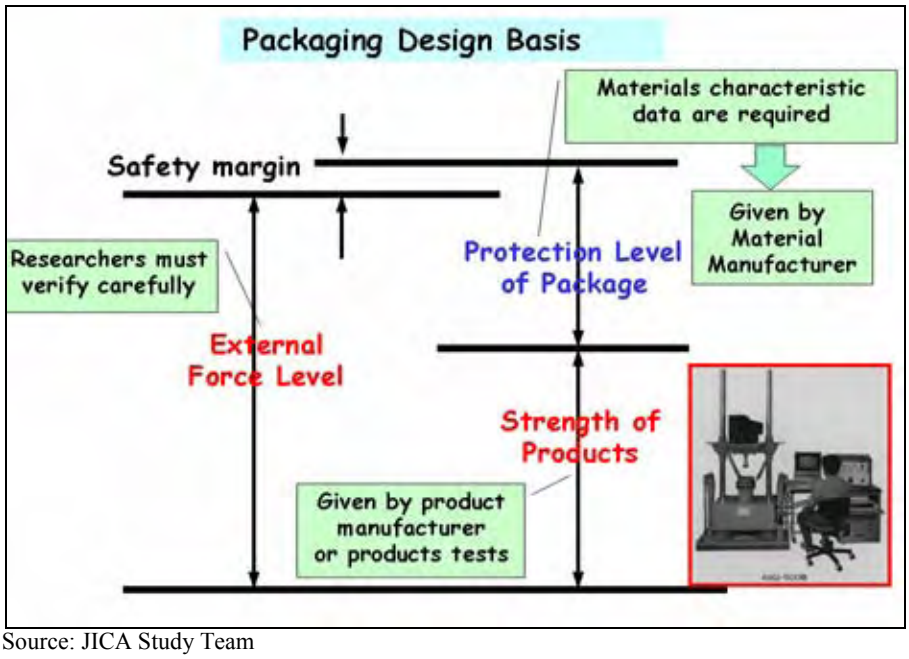
The development of packaging for products, especially for household appliances, can be executed according to the flowchart on Fig. 3.2-1. First, a theoretical external force applied on the cargo is assumed, within the frame of transportation environment, and then, the value for testing is determined by applying a multiplier factor. Regarding to the definition of this factor, it will depend on some aspects to be considered, such as product characteristics, and the social impact related to the reliability of the product. The packaging designer must design them on such way that the product can fully withstand the specifications of the "Reference Guideline for Packaging Tests, for Evaluation".

The mechanical resistance of the packaged goods, capable to withstand the external loads, are the sum of their own resistance of the product plus the protection resistance provided by the packaging, as shown in Fig 3.2-2. This means, if the product resistance is very high for instance, the packaging resistance could be relatively low, for compensation. The process for the packaging development is based on stepwise process. In each step, the adequate resistance of the packaging is to be determined, taking into account the product own resistance. Finally both resistances are summed-up.



Source: JICA Study Team

Fig 3.2-1 Packaging Design Development, Basic Flowchart (5 steps)



Source: JICA Study Team

Fig. 3.2-2 Relationship among packed Cargo Resistance, External Forces and Protection Level

3.2.2 Digital Vibration / Impact Sensors for the Transportation Environment Survey

The manufacturers of the digital vibration / impact sensors for Transportation Environment Surveys are limited to only 6 companies in all over the world, due to their special characteristics. The products of each manufacturer –the most representative one- are shown in the Fig. 3.2-3 and Table 3.2-1, including the picture and main specifications.

In the present Study, the DER-SMART sensors of Yoshida Seiki Ltd, and the SAVER3X90 of Lansmont Co, have been utilized for the Transportation Environment surveys.

Source: Measurement manufacturers' HP

Fig. 3.2-3 Digital Vibration/ Impact Sensors for Transportation Environment Surveys

Table 3.2-1 Specifications of the Digital Registers

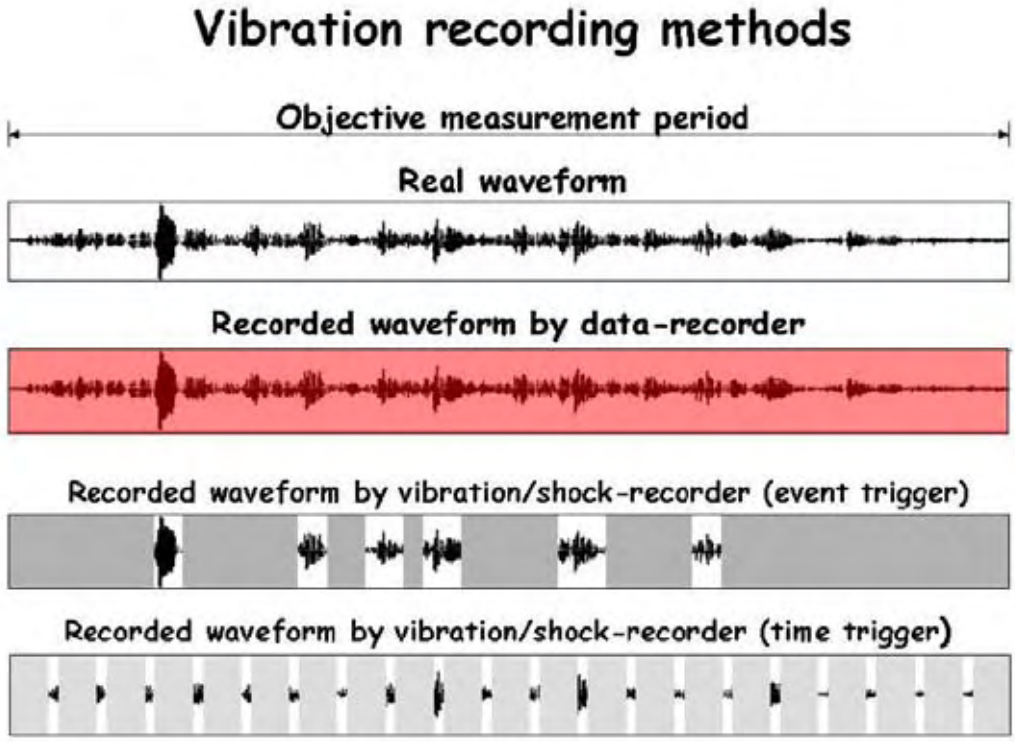
Manufacturer	Yoshida Seiki	Kyowa Dengyo	CBC Materials
Model	DER-SMART	RSD-33A	Serie: IM7000
Range	10; 50; 200G	10;20;50; 100; 200G	40; 80; 120G
Nbr sensores	In or Out－3	In or Out－3	In－3
A-D	12 bit	12 bit	Sin datos
Frame Length	512－4,096	512; 2048	512 - 2048
Sampling period	0.25－10ms	0.25－32ms	1; 2; 5;10ms
Memory size	64MB	Sin datos	2MB
Records Nbr	20000	330	512
Pre-trigger	20－60% de long frame	1/8 step de long frame	Posible
Cont.operation time	48dias	50dias	30dias
Dimensions (L x W x H mm)	123×112×70	167×134×118	170×122×76
Weight	900g	2700g	2000g

Manufacturer	IMV	IST	Lansmont
Model	TR-0220	EDR-3/4	SAVER3X90
Range	10; 20; 50; 200G	10; 50; 200G	10 to 200G
Nbr sensores	In-3, Out-3	In-3	In-3 or Out-1
A-D	Sin datos	10bit	16bit
Frame Length	1280－5120	512	10 to 16384
Sampling period	0.2～4ms	0.3ms	0.2－20ms
Memory size	Equiv 35 min	108MB	128MB
Records Nbr	35 min	3910	35951
Pre-trigger	Sin datos	Posible	0 to 100%
Cont.operation time	20 dias	30 dias	90 dias
Dimensions (L x W x H mm)	150×150×80	107×112×56	95×74×43
Weight	2000g	1000g	473 g

Source: Measurement manufacturers' HP

3.2.3 Record of Vibration Wave

For the analysis of real vibrations generated on a product, the theoretical method consists of, gathering all the collected vibration waves into one register, and analyze the data as a whole. However, the sensors mentioned above have a limited capacity of memory, so that the recordings over a long period of time are becoming almost impossible. Therefore, some methods are applied, such as the so called "event trigger" method, where vibration waves are registered (ex. 2 seconds before and after the event) when the acceleration of the sensor surpasses a certain predetermined value; or the other method, "time trigger" method, where data is collected in predetermined cyclical periods of time and at predetermined intervals (See Fig. 3.2-4).



Source: JICA Study Team

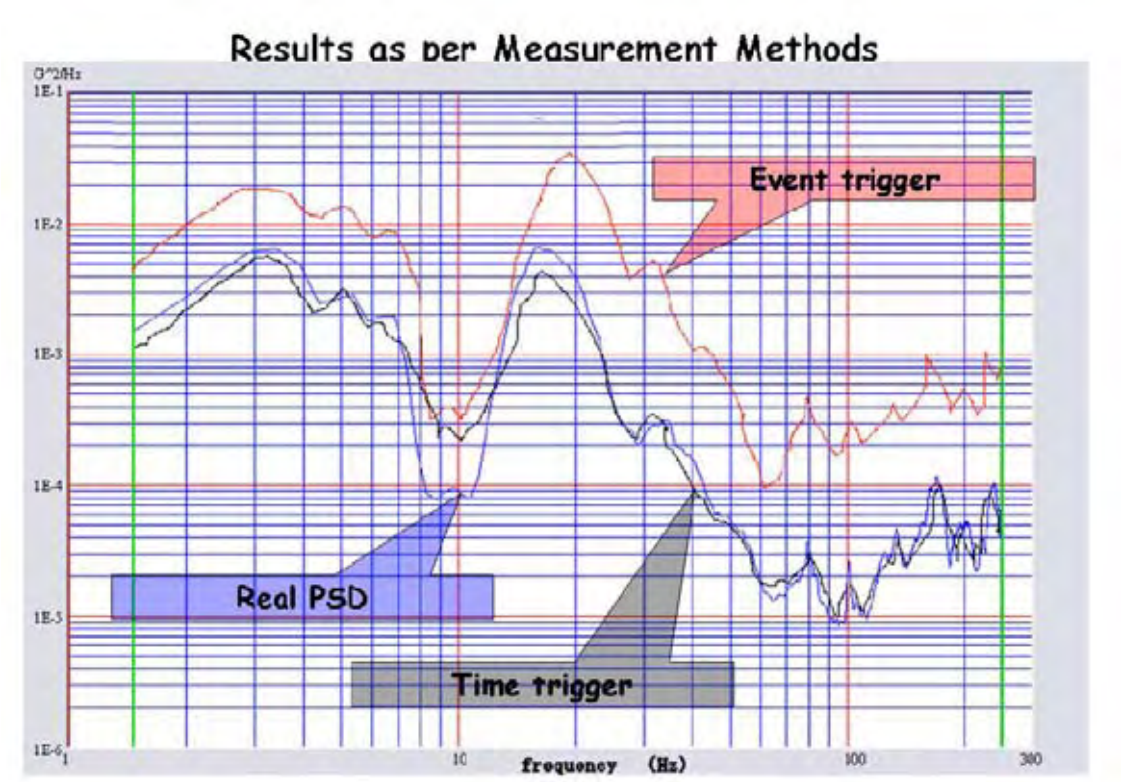
Fig. 3.2-4 Vibrations Registration Method

The "event trigger" method for registering data takes into account only events with significant oscillations, and therefore the PSD analysis provides a vibration wave curve higher than actuality. On the other hand, the "time trigger" method has a tendency of producing lower values than in reality because of the numerous vibrations that may occur while the device is inactive and go unnoticed in the analysis.

Nevertheless, there are several data registries gathered within each of the regions, providing a larger data pool closing the results to the actual vibration wave curve. To obtain such pool of data using the digital registers, it is necessary to use the "time trigger" method, and then use the

data for the PSD analysis. Using the "event trigger" method would only provide data surpassing certain vibration waves, resulting in uneconomical conclusions due to excessive packaging design (See Fig. 3.2-5).

In addition, there are some companies adopting "event trigger" method for collecting and utilizing data in order to shorten a period of testing. Consistency of this method and the analytical result based on all data is considered as a future task.



Source: JICA Study Team

Fig. 3.2-5 Differences in PSD Curves Depending on Registry Method

3.2.4 Coordination with GPS Equipment

The modern availability of the GPS (Global Positioning System) allows the use of satellite signals to gather data on the geographic locations and itinerary times of the trucks. Also, the data link option facilitates the calculations on the truck's velocity and the exact location where vibration observations occur.

The sensors used for this current study (DER-SMART y SAVER3X90) are equipped with the necessary elements allowing data link with the GPS equipment.

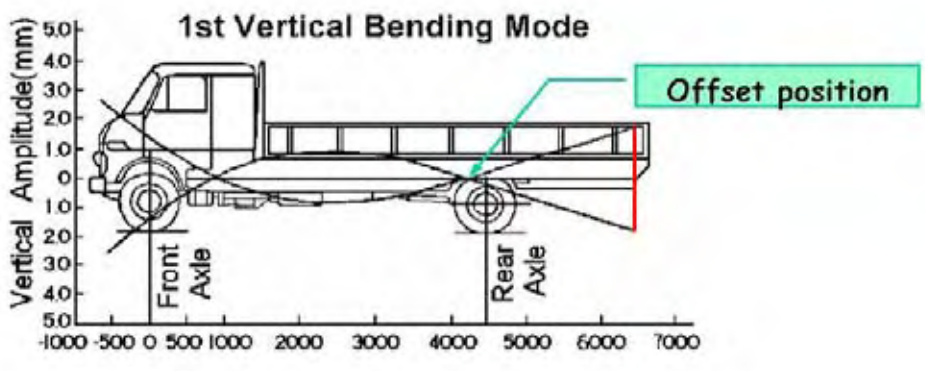
3.2.5 Standards for Vibration Measurements and Transportation Survey

From this clause, details about the measurements during Transportation Environment Surveys are given.

Considering that the main objective is to establish the Reference Guideline for Packaging Tests, for Evaluation at laboratories, the sensor has to be placed on the loading platform (floor) of the truck while conducting the transportation survey. The characteristics of the vibrations produced in the vehicle could vary due to the influence of several factors. These factors are: the type of vehicle (dimensions, wheelbase, suspension type, structure of the cargo area), the cargo (weight, position within the vehicle, method of placement), roads (highway, common roads, motor highway, pavement conditions), vehicle's cruising velocity, weather conditions, etc. If they are combined all these factors for the study, it would be necessary to perform a large numbers of surveys taking into account each combination, becoming almost impossible in the practice. As a result, the surveys are carried out on the basis to reduce the conditions, considering the transportation environment according to the type of road and type of vehicle.

3.2.5.1 Position of the Sensors on the Vehicle

The intensity of the vibrations on the vehicle platform varies depending on the location of point of analysis. Normally, the accelerations are minimal at the offset point, and reach the maximum at the rear section of the cargo area, as indicated in Fig. 3.2-6.This fact is notably true in vehicles with long structures. To establish a standard method of laboratory testing, it is necessary to take into consideration the maximum conditions (worst case scenarios), which take place at the rear end section of the vehicle.

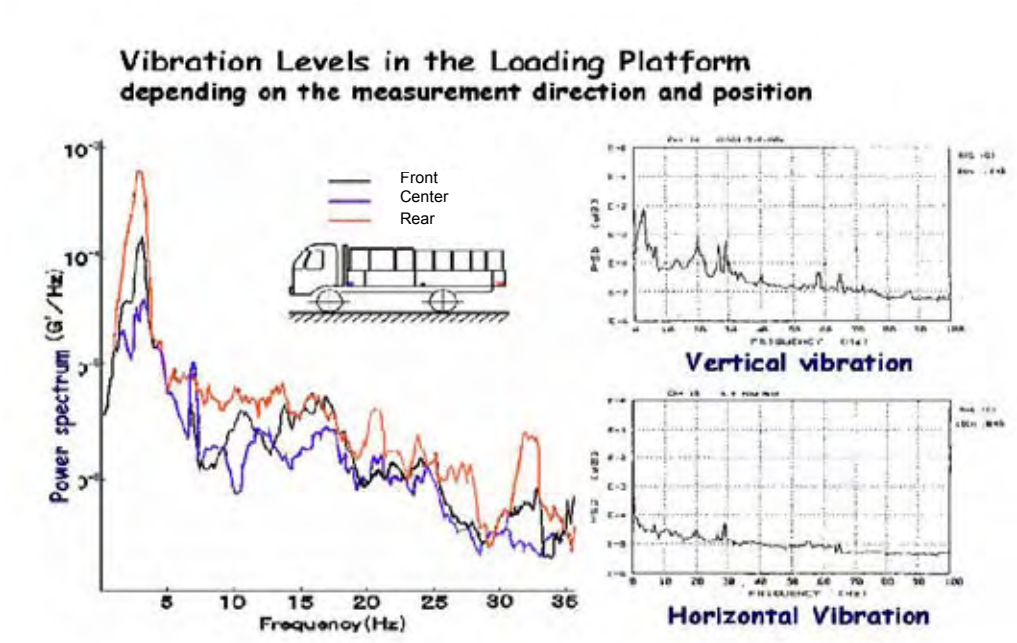


Source: Inoo, Takeshi. "Vibration of Large Vehicles and Problems." Automotive Engineering. Vol.28. No.4. 1974

Fig. 3.2-6 Vibration Modes of a Truck (1st Mode)

3.2.5.2 Vibration Levels in the X, Y and Z Directions

The digital vibration register has integrated sensors that measure accelerations in the following 3 directions, each with its respective output: X (longitudinal direction in relation to the vehicle), Y (transversal direction), and Z (vertical direction). Within these three, the acceleration (vibrations) registered in the Z direction have prominent importance. The vibrations in the Y direction follow in importance. The acceleration values in the X direction reach a maximum value of 0.4G that occurs when the vehicle stops or accelerates abruptly. Taking into consideration that the friction coefficient between the pneumatic and the pavement is approximately 0.4, the maximum possible acceleration in the X direction equals 0.4G. In any case, because the acceleration in the X and Y directions are notably less than those in the Z, by the order of one digit, it is assumed that when dealing with vehicle's vibrations within the cargo area it normally refers to those in the vertical direction (See PSD values for the vertical and horizontal directions in Figure 3.2-7).

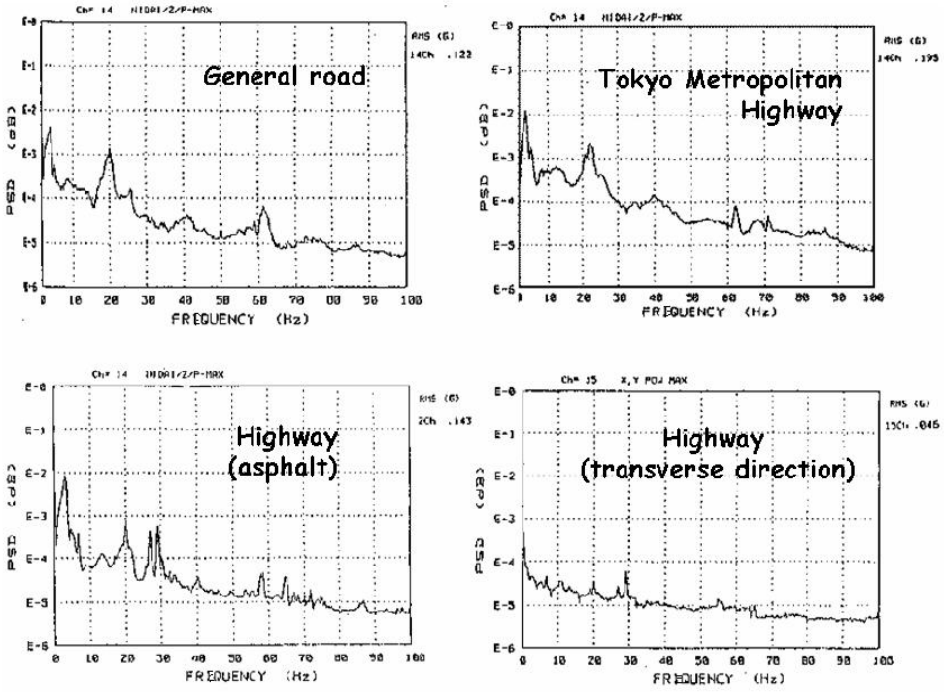


Source: JICA Study Team created from "Inoo, Takeshi. "Vibration of Large Vehicles and Problems." Automotive Engineering. Vol.28. No.4. 1974"

Fig. 3.2-7 Vibration Levels Depending on the Direction and Position of the Sensors on the Bed of Vehicle

3.2.5.3 Vibration Levels on the Roads in Japan

The transportation environments of Japan and of the MERCOSUR are very different. So, it is impossible to make a valid comparison between both transportation environments. Nevertheless, common vibration levels in Japan are detailed below, in order to have a reference. (See Fig. 3.2-8).



Source: JICA Study Team

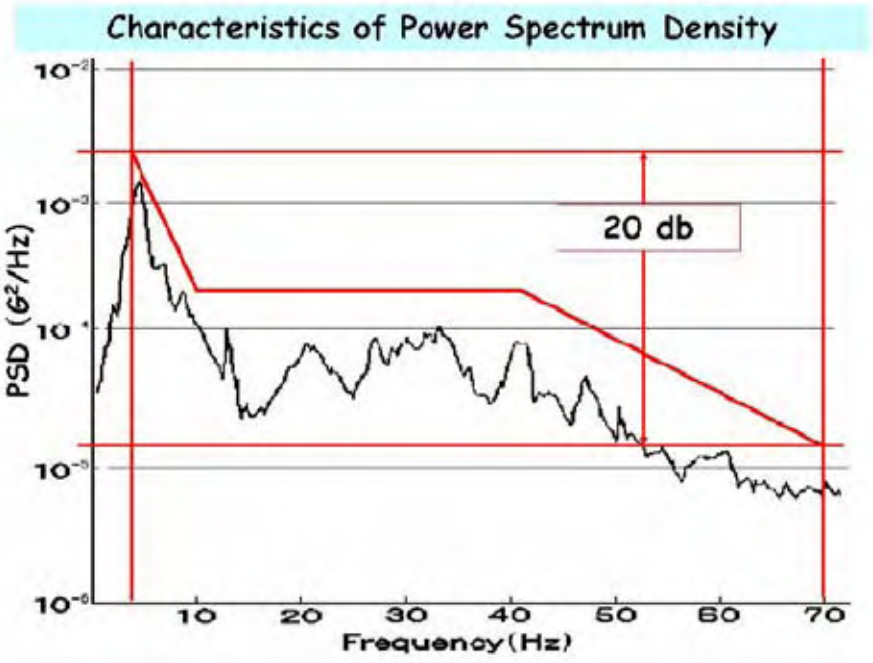
Fig. 3.2-8 Normal Vibration Levels in the Roads in Japan

3.2.5.4 Steps for Establishment of Test Standards based on Vibration Data from Field

For the execution of packaging tests in the laboratories, the vibration levels for tests must be defined, based on the PSD results from the field measured data, taking into consideration the characteristics of the used vibration sensors.

The methodology to accomplish such task is organized in the following steps:

(1) Simplify the characteristic PSD curve of the vibrations surveyed on the field (See Fig. 3.2-9). For this stage, it is sufficient to take into account a frequency range of PSD actual values, up to the point resulting from the maximum peak in the low frequency area minus 20dB.

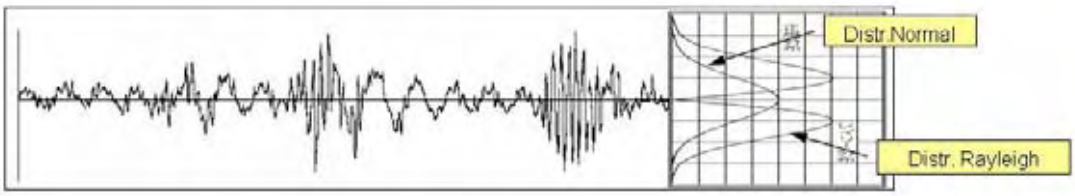


Source: JICA Study Team

Fig. 3.2-9 PSD Curve Simplification Process

(2) In the case that the duration of the tests in the laboratory is matching with the transportation time, it would be sufficient to assume the simplified curve (broken line) of the PSD curve presented above. However, since very often the testing time is reduced (time-compression), it is acceptable to adjust the vibration levels by shifting the curve to up side, according to the S-N characteristics curve of the material, and due to other reasons listed below.

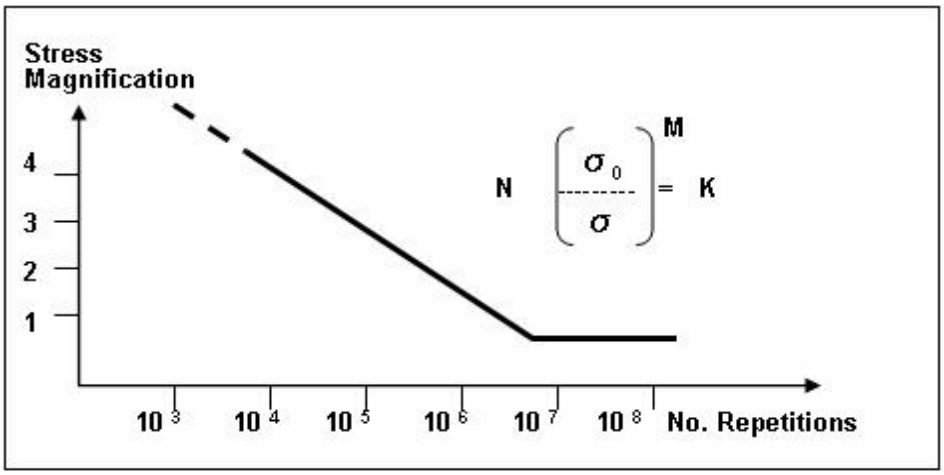
1) The frequency of occurrence for the random vibrations is based on a "normal distribution" pattern, while the extreme cases are based on a "Rayleigh distribution" (See Fig. 3.2-10).



Source: JICA Study Team

Fig. 3.2-10 Characteristics of Random Vibration Waves

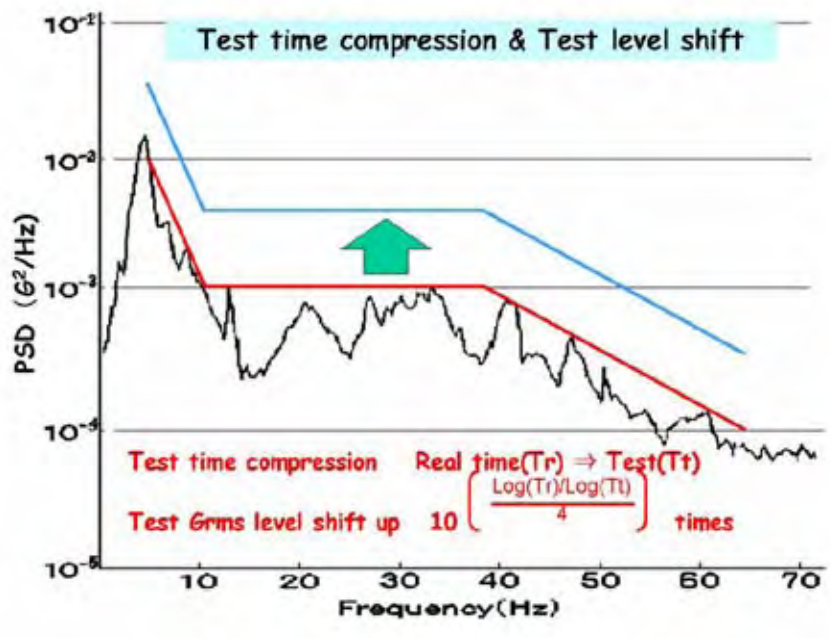
2) The failure produced by fatigue of weak portion of a piece, due to the repetitive application of stress, is explained through the S-N characteristics of the material. These characteristics are shown in the formula shown in Fig. 3.2-11.



Source: JICA Study Team

Fig. 3.2-11 Material's S-N Characteristic Curve

3) The vibration levels for the tests shall be higher for the "shifted" curve, varying according to the grade of time-compression of the test. The incremented levels are based on the formula indicated in Fig. 3.2-12.

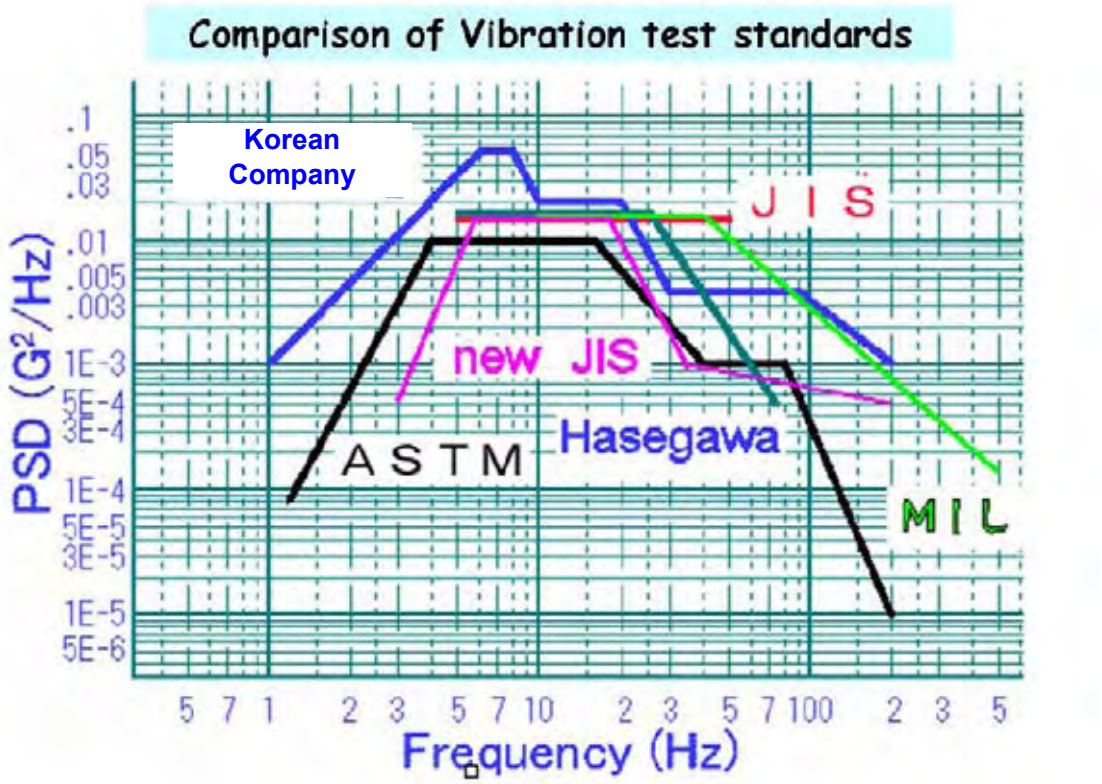


Source: JICA Study Team

Fig. 3.2-12 Shifting of PSD Curve according to the time-compression for the tests

3.2.5.5 Example of Vibration Test Standard

Examples of standards for the vibration tests are shown in Fig. 3.2-13.



Source: JICA Study Team

Fig. 3.2-13 Examples of Standards for the Vibration Tests

3.2.6 Impact Measurements and Standards for Laboratory Testing

The details of the measuring of impacts on the distribution of products are explained herein after. The measuring of impacts normally are carried out by using the dummy cargoes, but the results can varies depending on the correct preparation and execution. Furthermore, the results of the tests must be properly processed, otherwise the Reference Guideline for Packaging Tests would be wrong, with further consequences. Regarding to the data analysis, knowledge and experience are required for a proper processing of data.

3.2.6.1 Dummy Cargoes

The packed cargoes are suffering vibrations, not only during the transportation but also impacts various during the cargo handling on the unloading. Consequently, the packed cargo need to have enough resistance to fully withstand these type of impacts. Then, an impact level to be received by the cargo during handling is estimated, so that the packaging has to be designed with enough level in order to guarantee their protection.

The impact sensors are normally placed inside the dummy cargoes and they calculate the fall height -statistically-based on the falling acceleration measured during the handling of the cargo. The data is registered using the dummy cargoes instead of real products, because the influence of the resonance waves on real products troubles the finding of precise data. The obtained measurements are influenced by the characteristics of the dummy cargo (intrinsic attenuation, resonance level, impact, transfer characteristic, material of the shock absorber, positioning of impact sensor, etc); therefore, it is necessary to create a careful design taking into account the box's material, its density, structure, placement of the reinforcements, and the external appearance. Fig. 3.2-14 displays a sample dummy cargo for the case of a vacuum cleaner.

Source: JICA Study Team

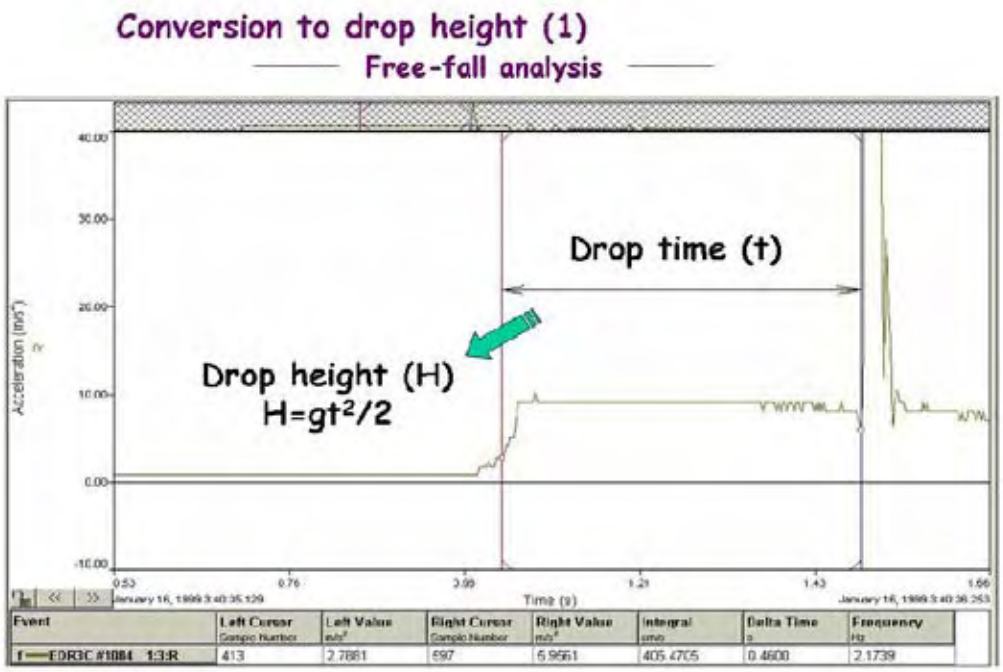
Fig. 3.2-14 Dummy Cargo for Impact Testing (vacuum cleaner)

3.2.6.2 Conversion of accelerations into Fall Height (h)

The impact data gathered from the sensors inside the dummy cargo can be analyzed to determine the fall height that took place during its handling.

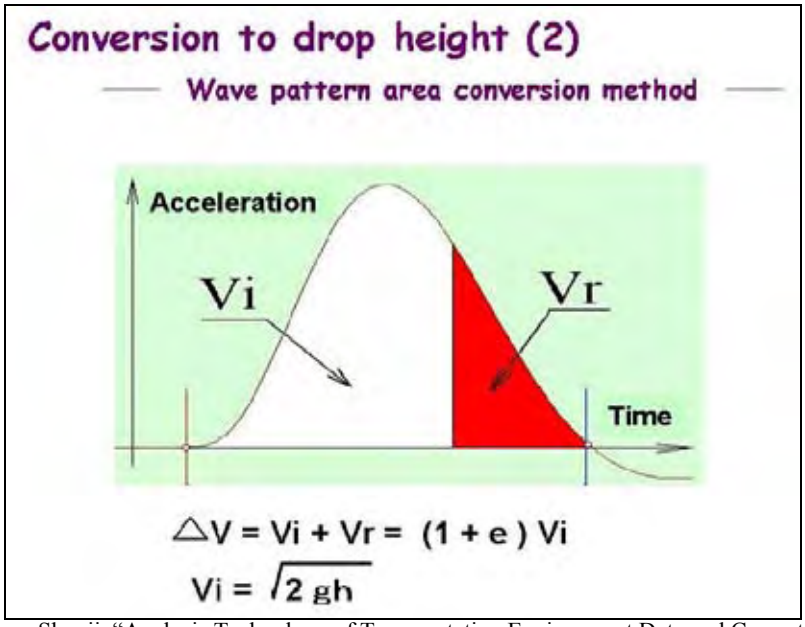
There are two methods for the determination. The first method consists of determining the free-fall height by calculating the falling time, as shown in Fig.3.2-15.

The second method consists of establishing the fall height based on the area encircling under the acceleration curve, gathered during the fall and after the impact (See Fig.3.2-16). For this method, it is necessary to calculate previously the Rebounce Factor (e).



Source: Yanagihara, Shunji. "Analysis Technology of Transportation Environment Data and Current Information of Recorder." Journal of Packaging Science & Technology, Japan. 10(6), 2001

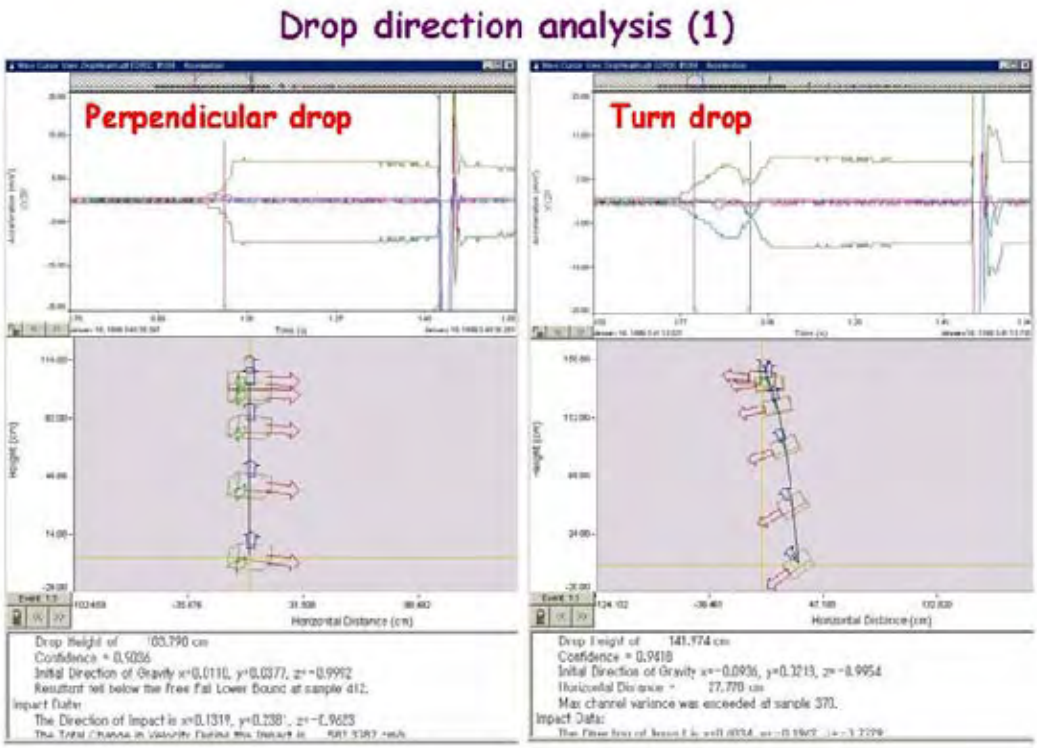
Fig. 3.2-15 H of fall (1): based on Accelerations -Free Fall-



Source: Yanagihara, Shunji. "Analysis Technology of Transportation Environment Data and Current Information of Recorder." Journal of Packaging Science & Technology, Japan. 10(6), 2001

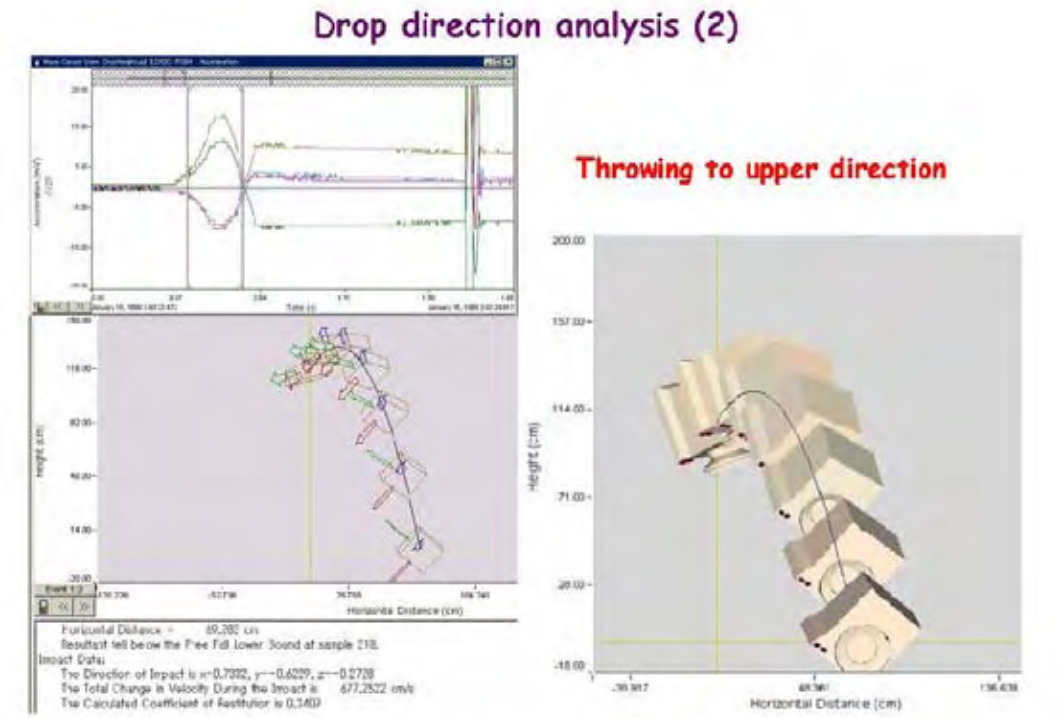
Fig. 3.2-16 H of fall (2): - Area of acceleration Curve Method

The acceleration curves vary depending on the type of fall (vertical fall, fall by rotation, fall due to throw), therefore the direction of fall can be determined by evaluating the shape of this curve (See Fig. 3.2-17 and Fig. 3.2-18).



Source: Yanagihara, Shunji. "Analysis Technology of Transportation Environment Data and Current Information of Recorder." Journal of Packaging Science & Technology, Japan. 10(6), 2001

Fig. 3.2-17 Analysis of Direction of the Fall (1)



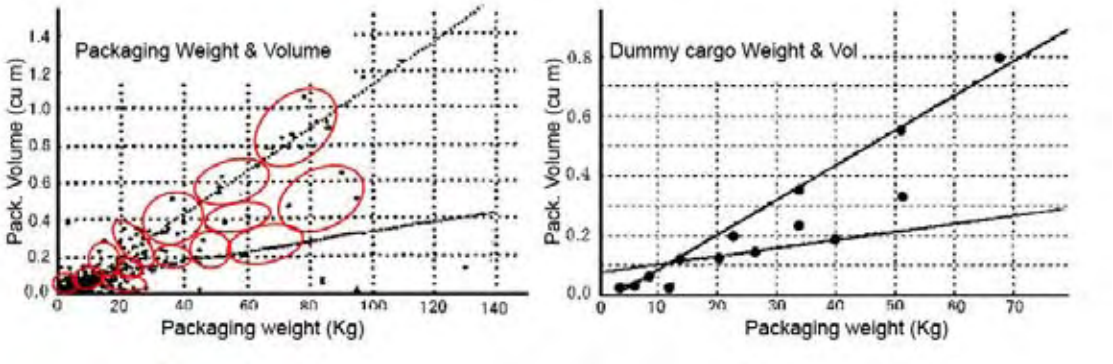
Source: Yanagihara, Shunji. "Analysis Technology of Transportation Environment Data and Current Information of Recorder." Journal of Packaging Science & Technology, Japan. 10(6), 2001

Fig. 3.2-18 Analysis of Direction of the Fall (2)

3.2.6.3 Selecting the Cargo, Sample for the Testing

The fall heights of the cargo during handling show a variation in data depending on the type of packaging and its dimensions. Having as an objective to monitor these variations, it is necessary to obtain a representative sample of products from the manufacturing company and account for their influencing factors such as the weight and dimensions of the packed product.

To accomplish this, it is recommended to take a series of products from the manufacturer and graphically display them according to their weight and dimensions (volumes), and then categorize them into similar "groups" to select one representative product for each group (See Fig. 3.2-19).



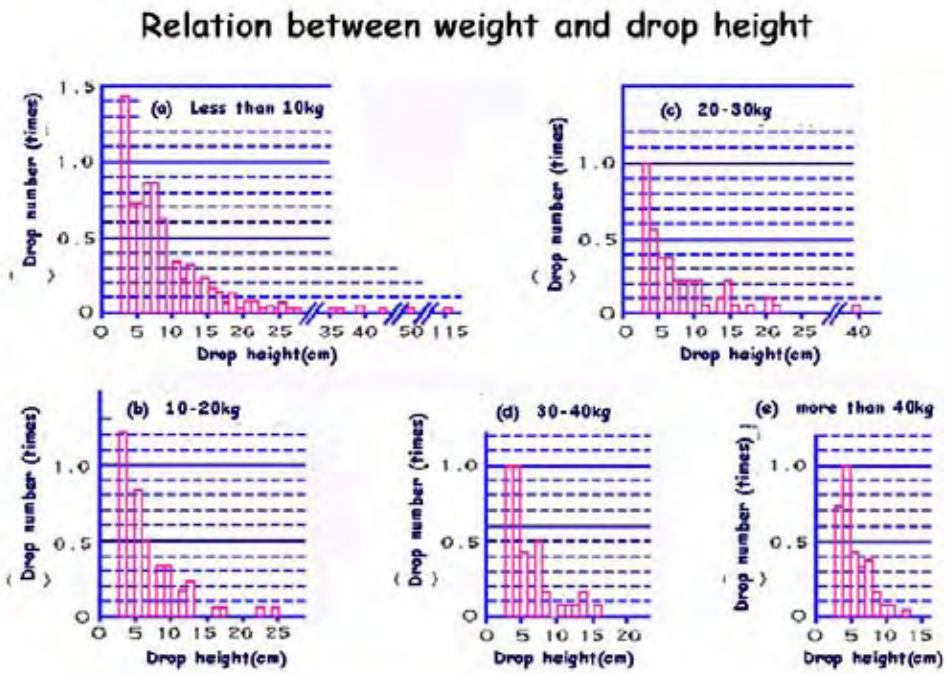
Source: JICA Study Team

Fig. 3.2-19 Selection of Cargo for Measurements

3.2.6.4 Relationship between mass of the cargo and fall height

The estimated fall heights of the cargo that can occur during handling have a defined value tendency by statistical calculations, based on the product's weight and volume. So, if some number of data are available, estimations can be made within some tolerances. Fig. 3.2-20 represents a summary of studies of fall height of some products of a certain Japanese manufacturing company, based on statistical calculations.

The fall heights also vary depending on the particular transportation environment, so that for this Study it was necessary to take measurements on the particular environment under study and to prepare a database for further analysis.

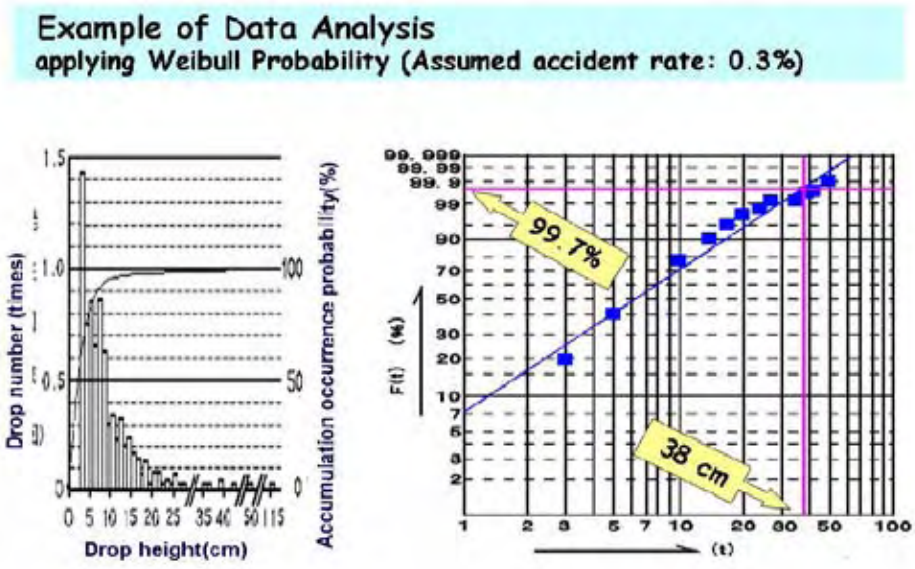


Source: JICA Study Team

Fig. 3.2-20 Relationship between Weight of the Cargo and Fall Heights in Japan (Example)

Next, the allowable events factor for the product under study is determined (In this case, this factor is defined as 0.3%). The distribution curve of fall heights is assumed that describes a pattern according to a Weibull Distribution, and it is calculated based on accumulated falls index which is 1 minus allowable events factor (in this case 1- 0.03 = 99.7%).

The calculation method by using the Weibull Paper is shown in Fig.3.2-21.



Source: JICA Study Team

Fig. 3.2-21 Analysis of Fall Heights by Weibull Distribution (Example)

3.2.6.5 Example of Standards for Drop Test

The primary objective of the present study is to establish a standard for laboratory testing regarding the performance of the packaging during the potential falls that occur during its shipping and handling. To accomplish this, it is necessary to gather only the data those can be statistically analyzed. As an example, the following is a standard for a drop test issued by JIS. The standard only establishes the drop heights, and leaves the application method and the adjustments depending on the situation up to the manufacturer's criteria.

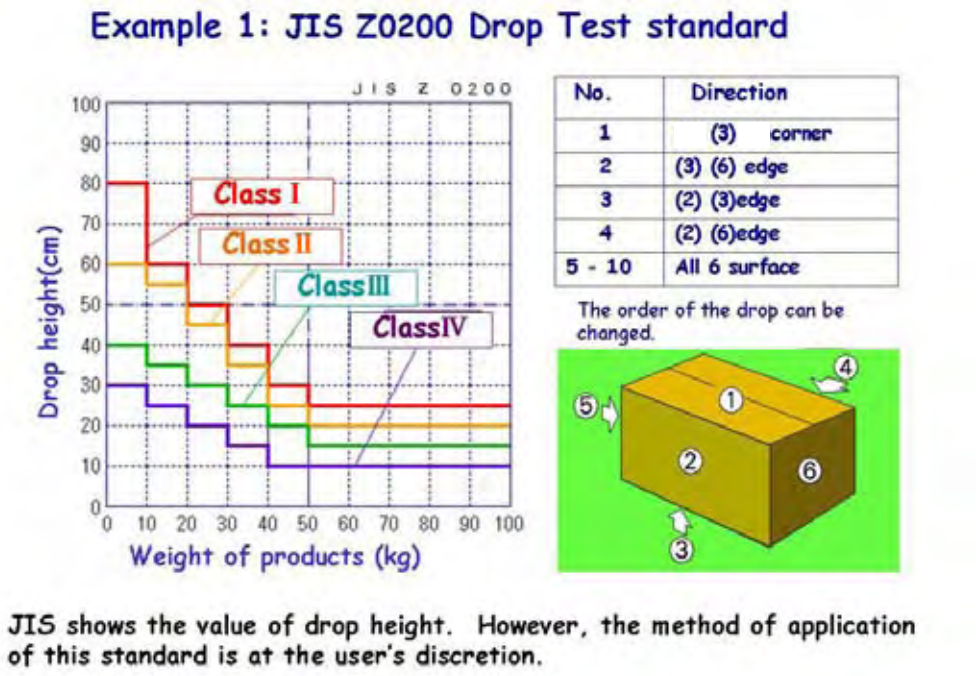
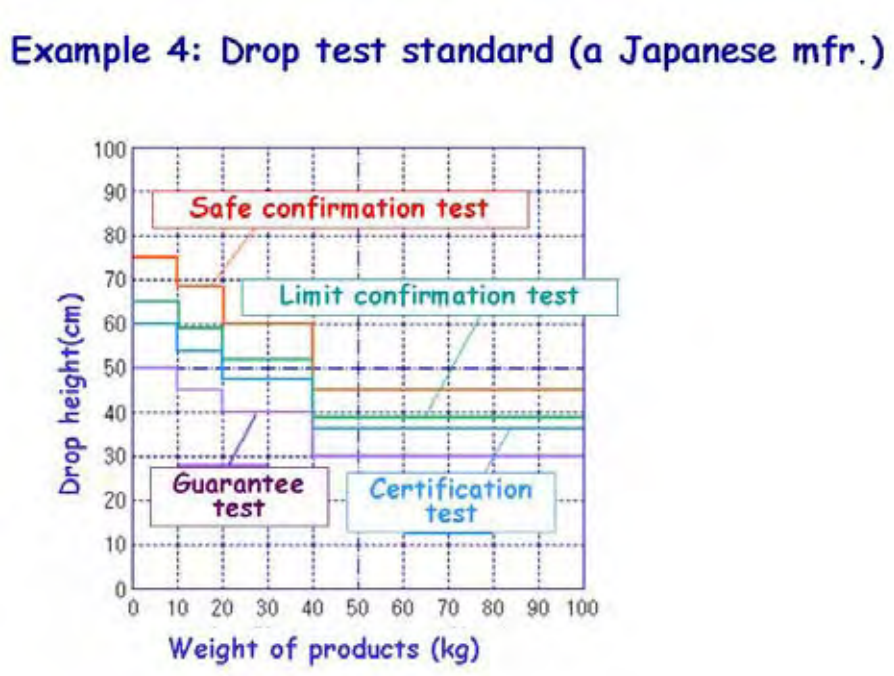


Fig. 3.2-22 Example of Standard for Drop Tests (1): JIS Z0200

Another case of standards is shown in Figure 3.2-23 where the conditions of the falls are classified in 4 levels: security, limit reliability, certification, and guarantee.



Source: JICA Study Team

Fig. 3.2-23 Example of Standard for Drop tests (2)

3.2.7 DER-SMART sensors

Data recording equipment and measurement conditions

The Mission acquired the measuring equipment in order to perform the Demonstration Test, upon obtained the pertinent authorization from the JICA. The devices used to measure vibration and impact values and fall heights in the Transport Environment Surveys are 10G, 50G and 200G sensors. The other items and software are used to analyze the gathered data.

Field sensor 10G: 2 units (DER-SMART 10G)
Field sensor 50G: 2 units (DER-SMART 50G)
Field sensor 200G: 2 units (DER-SMART 200G)
GPS System: 1 unit (including software)
HP computer: 2 units (for vibration + impact analysis)
HP Printers: 2 units
Master Sensors 2 items (for calibration)
Measuring/impact analysis device: 1 unit
AD Converter

The field sensors program and the measurement conditions used in the Demonstration Test (from Feb 09 to 12, 2005) are described in the following tables. Besides, the sensor mounting conditions are shown in the photographs of Fig. 3.2.7-1.

Table 3.2.7-1 Use of Sensors in the Demonstration Test

	Outward (BsAs→Aimogasta)	Homeward (Aimogasta→BsAs)
DER-SMART 10G-1	Not used	In the truck (for vibration)
DER-SMART 10G-2	Not used	In the truck (for vibration)
DER-SMART 50G-1	Not used	In the truck (for vibration)
DER-SMART 50G-2	Not used	In the truck (for vibration)
DER-SMART 200G-1	Within dummy cargo (to measure impact)	Within dummy cargo (to measure impact and drop height)
DER-SMART 200G-2	Not used	Not used

Source: JICA Study Team

Olive pouches and box (10 kg)

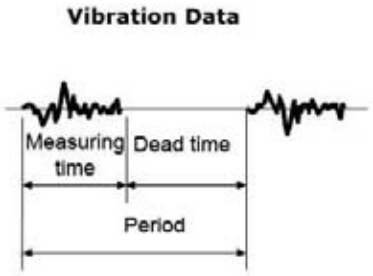
Dummy cargo and DS 200G-1 sensor

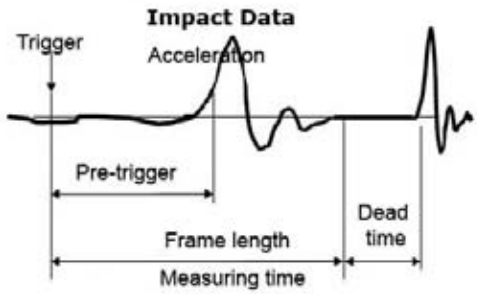
Fitting of DerSmart Sensors in the truck

Display of DerSmart sensors in the truck

Source: JICA Study Team

Fig 3.2.7-1 Setting Condition of DER-SMART Sensors





Sampling index	1 ms
Frame length	2048
Measuring time	2.048 seg
Measuring period	10 seg
Dead time	7.952 seg
Available meas.time	13.9 hs
Sensor model	DER-SMART 10G

Sampling index	1 ms
Frame length	1024
Measuring time	1.024 seg
Pre Trigger %	60% (0.614seg)
Accel.trigger level	5% 10G
Dead Time	1 Sec
Sensor model	DER-SMART 200G

Source: JICA Study Team

Fig 3.2.7-2 Measurement Conditions

3.2.7.1 Target Products and Trucks used in the Test

During the trip to the distribution center, the full trailer was loaded with empty plastic drums used to carry olives, so that it only carried 0.8 tons against the total capacity of 25 tons. The truck used was a double trailer truck, as shown in Fig 3.2.7-3. The return trip was made in semi-trailer with an 18 ton cargo of palletized olive boxes.

The following items were also confirmed.

- Performance of GPS and sensor was confirmed
- Data was collected
- Counterparts were acquired operational methods
- Grms/PSD graph from collected data was made in Argentina for the first time
- Olive production and packaging procedures were confirmed

On the way(25 ton Full Trailer)

Front Wheel-1 axis,
RearWheel-3 axes, Leaf Suspension& Air Suspension

On the back way(25 ton Semi-Trailer)

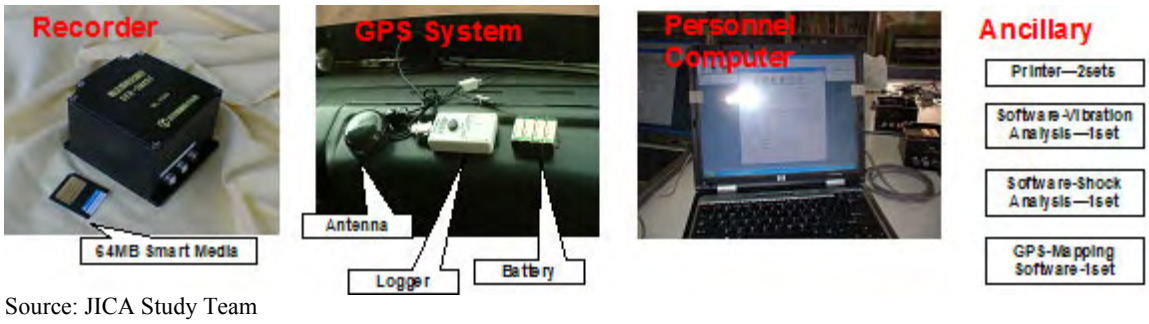
Front Wheel-2 axes,
RearWheel-3 axes, Leaf Suspension

Source: JICA Study Team

Fig 3.2.7-3 Trucks used in the Test

3.2.7.2 Specifications of the Equipment to be used in the Transport Environment Survey

The equipment acquired for the Demonstration Test have been used by the Argentine counterparty, therefore, it was purchased in the beginning of February, 2005 before the other 3 countries did. For the transportation surveys scheduled for June 2005, the pertinent purchases for the other 3 countries (Brazil, Paraguay and Uruguay) have been made, getting similar devices. The equipment are as described in the tables and photographs below.

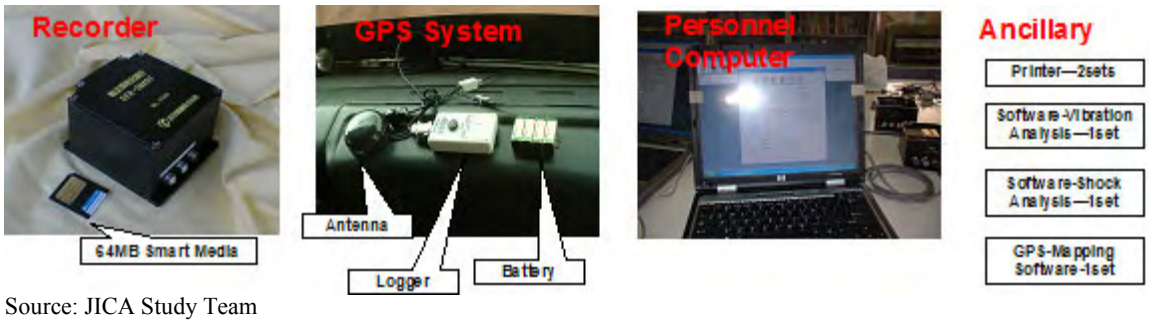


Source: JICA Study Team

Fig. 3.2.7-4 Equipment used in the transportation survey

3.2.7.2 Specifications of the Equipment to be used in the Transport Environment Survey

The equipment acquired for the Demonstration Test have been used by the Argentine counterparty, therefore, it was purchased in the beginning of February, 2005 before the other 3 countries did. For the transportation surveys scheduled for June 2005, the pertinent purchases for the other 3 countries (Brazil, Paraguay and Uruguay) have been made, getting similar devices. The equipment are as described in the tables and photographs below.



Source: JICA Study Team

Fig. 3.2.7-4 Equipment used in the transportation survey

Table 3.2.7-2 Specifications of the Equipment to be used in the Transport Survey

Specifications of Equipment for Transportation Study - for Demonstration Test

Part-1 (Vibration Sensors for field use and associated software)

It	Description	Qty		Specifications		Model
1-1	Vibration Recorder 10G	2	Unit	Acceleration sensor (internal)	3 direction volt resistive type (100m/s2)	Manuf. Yoshida Seiki
				Acceleration sensor (external)	3 direction integral volt (100m/s2)	Model: DER-SMART
				Memory	Min.64MB	
				Frame length	512 ~ 5120	
				Sampling rate	0,25 ~ 10ms	
				Dead time	1 ~ 3600s	
				% Pre-trigger	0~90%	
				Trigger type	by acceleration (3-90%), duration (6~3600s)	
				Wave / frame	20000 (Frame Length 512 : with 64Mb memory)	
				Temp.Humidity record period	0,1 ~ 60min	
				Temp.Humidity Range	-20 to +60℃, 0 to 100%RH	
1-2	Software - Vibration Analysis (vibrations, PSD analysis, acceleration Analysis etc)	1	Set	Sensor Control Functions	Setting of measuring conditions and data transfer, data deletion, display for start up, amplification.	Manuf. Yoshida Seiki
				Analysis Function	Analysis selected by cursor, PSD analysis, data transfer to others applications (text modifications), calculation by temperature and humidity.	Model: DER-SMART PSD
1-3	Global Positioning System GPS (for geographical monitoring during survey)	1	Set	GPS equipment (antenna)	GPS 16A (tracing by 16 satellites and supplementary 4 satellites)	Manuf. Yoshida Seiki
				Adaptor f/lighter socket	P/ adaptar la alimentacion del vehiculo al equipo GPS.	Model: GPS-1
				Data Logger	DL1 High sensitivity positioning memory unit- Data storage capacity: 150,000 positions - Battery: 2 weeks continuous operation.	
1-4	Software f/ GPS data analysis	1	Set	Speed Display	Speed calculations	Developed by: Yoshida Seiki
	(for data sorting and mapping during the surveys)			Data Logger Control	Display of points having high speed or high impacts.	Modelo: DER SMART-GPS
					Display of route trace on maps.	
					Data selection and deletion function, selection of a route segment.	
1-5	Mapping Software	1	Set	Data register Areas	World Map	Software: WorldMap
	(Mapa mundial, en ingles)			Display Language	English, Spanish (setting on data analysis program)	
	(World Map, English version)				Zoom function on maps	
1-6	Memory units for spare (64 Mb)	20	Unit	Memory Capacity	64 Mb minimum	Model HPC-SV03A Hagiwara Syscom

Part-2 (Shock Sensors for field use and associated software)

It	Description	Qty		Specifications		Model
2-1	Vibration Recorder 50G	2	Set	Acceleration sensor (internal)	3 directional volt resistive (2-1:500m/s2, 2-2:2000m/s2)	Manuf. Yoshida Seiki
	(for medium range impacts)			Acceleration sensor (external)	3 directional integral (2-1:500m/s2, 2-2:2000m/s2)	Model: DER-SMART
				Memory	Min.64MB	
				Frame length	512 ~ 5120	
				Sampling rate	0,25 ~ 10ms	
				Dead time	1 ~ 3600s	
				% Pre-trigger	0~90%	
				Trigger type	by acceleration (3-90%), duration (6~3600s)	
				Wave / frame	20000 (Frame Length 512 : with 64Mb memory)	
				Temp.Humidity record period	0,1 ~ 60min	
				Temp.Humidity Range	-20 to +60℃, 0 to 100%RH	
2-1	Vibration Recorder 200G	2	Set	Ditto	Ditto Ditto	
	(for high range impacts)					
2-3	Basic software for shock analysis (Shock analysis, drop height calculation- English version)	1	Set	Sensor Control Functions	Setting of measuring conditions and data transfer, data deletion, display for start impact and vibration measuring, amplification function	Manuf: Yoshida Seiki
				Analysis Function	Selection of analysis by cursor	Model: DER-SMART-SH
					Measuring shock accelerations, setting of measuring timing, acceleration variations calculation, drop height and direction analysis (orientation) - temperature & humidity calculation	
					Data transfer to others applications (text modification) - Table and graphics generation	

Part-3 Devices for Shock and Vibration Analysis (PC and associated Softwares)

It	Description	Qty		Specifications		Model
3-1	Instruction Manuals (English)	1	Set	Field sensors manuals and GPS manual. General manual indicating measuring conditions and including graphics.		
3-2	Personal computer, printer and other peripherals	2	Set	Tipo y Modelo PC	PC - model PD 467AA#ACF (NC6000) or similar	HP Mod: PD467AA#ACF
	(Application Software- English v.)			CPU	Intel Pentium M7251 (1,6 GHz) or similar	
	etc.			Memory	PC2700DDR SDRAM 512Mb (2048Mb) o higher	
				Hard disk (HDD)	40,0 GB or higher	
				Driver	DVD/CD-RW	
				Network	1000ASE-T/100Base-TX/10Base-integrated, or similar	
				Screen	14,1 inch color TFT (1024 x 768)	
				Operative System (OS)	Windows XP Professional	
				Color printer	DeskJet5850 or similar	Printer HP Deskjet5850
				Paper size	A4 size	
				Resolution	4800 x 1200 dpi (4 colors on photographic quality paper)	
3-3	Calibration Sensors	1	Set	Sensitivity	2,2±20% pc/G	
	(1 unit f/impact reference			Frequency range	2 a 20.000Hz	ENDEVCO2270 (patron imp)
	1 unit f/2nd vibrations reference			Linearity	0,1% 1000G	ENDEVCO7201-50(pat vibr)
	1 unit f/2nd impact reference)			Measuring Range	15.000G	ENDEVCO2225 (2do pat imp)
				Tracebility	by documents	
3-4	Impact measuring-analyzer device	1	Set	Acceleration range	0,1 a 100.000 m/s2 (0,01 - 10.000G)	Specification: ditto
				Analysis Function	Peak acceleration per channel- Peak time- Acceleration variation- Acceleration of resultant peak on 3D- Time of 3D peak- Acceleration variation on 3D- Displacements- Reaction Index - SRS impact spectrum - Low,High, Band pass filter for acceleration and displacement - Autoscale for acceleration/ displacement- Manual and Automatic	Manufacturer: Yoshida Seiki
						Model: SM-400
				Scale Function	SRS scale - Cut/Linear function- Data transfer to others applications (text modifications) - Data continuous tab function - Acceleration signals multichannel register system	
				Unit changes		
3-5	Software for FFT analysis	1	Unit	Analysis Commands	Numerical calculation- Statistical calculation- Peak analysis - Fourier Transforms- Axis changes - Theoretical calculations- Iterative calculations - Matrix calculations- data compositioin, deletion - cuttings - reductions - supplementation- Curve Fitting - Digital filtering - Activex-DSP - Broken line function- Non continuous line- dotted lines- bar graphs- column graphics- 3D plotting - Numerical tables - XY graphs - Cursor graphics etc. * Personal Computer <requirements> OS: MS Windows XP, Memory capacity: 128Mb or higher, HDD 8Mb or higher	Manufac. (Astrodesign)
				Graphic functions		Model: DAPiSP/2002
3-6	A/D converter	1	Unit	Input Mode	Input with single end	Manufacturer. (CONTEC)
				Input Channels number	8 channels (single end)	Mod: ADA16-8/2 (CB)L
				Input Range	Bipolar ±10V	
				Input Voltage max	±20V	
				Resolution	16 bit	
				Conversion Speed	10µsec/ch	
				Buffer memory	1 kWord	
3-7	Data analysis Module	3	Unit	Filter Module	Filter Design FIR/IIR- Filtered	Models:
				Octaves analysis Module	1/3,1/6 octaves - C Curves - Filter and filtered	DADiSP / Filters
				Application Analysis	Zoom Function FFT- AR Analysis - Kebstram Analysis-	DADiSP/ Octave
				Option module	PSD evaluation	DADiSP/ Adv DSP
3-8	Recording tape	20	Unit	Input channels number	4 channels	Mod: CT-90 Tipe II (TEAC)
				Recording time	45 minutes approx.	
				Frequency Range	CC to 625 Hz	

Source: YOSHIDA SEIKI CO. LTD

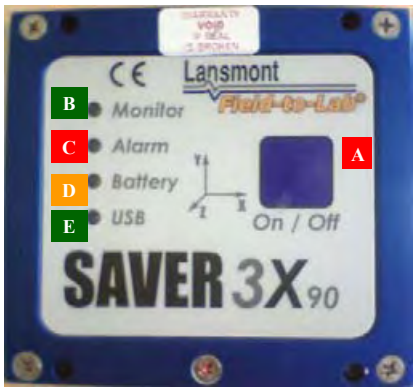
3.2.8 SAVER3X90 sensors

3.2.8.1 Operation of the SAVER3X90 Sensor

During the Training Courses that took place in Paraguay, theoretical courses on the operation of the SAVER 3X90 equipment and analysis were implemented. This high performance sensor has a remarkable compact design (95×74×43mm) and is user friendly. Its operation procedure is described as follows.

(1) External view of the Sensor

The external face of the sensor is provided with an ON/OFF button, and 4 LED indicators.



(A) Power switch (On / Off)
LED indicators
(B) Green LED: Indicates correct system operation.
(C) Red LED: Indicates that there are registered values above the preset threshold.
(D) Yellow LED: Indicates that the battery level is low.
(E) Green LED: Indicates that the system link with the PC is ready.
USB Connection: for the special cable (on the side of the register)

Exterior view of SAVER3x90

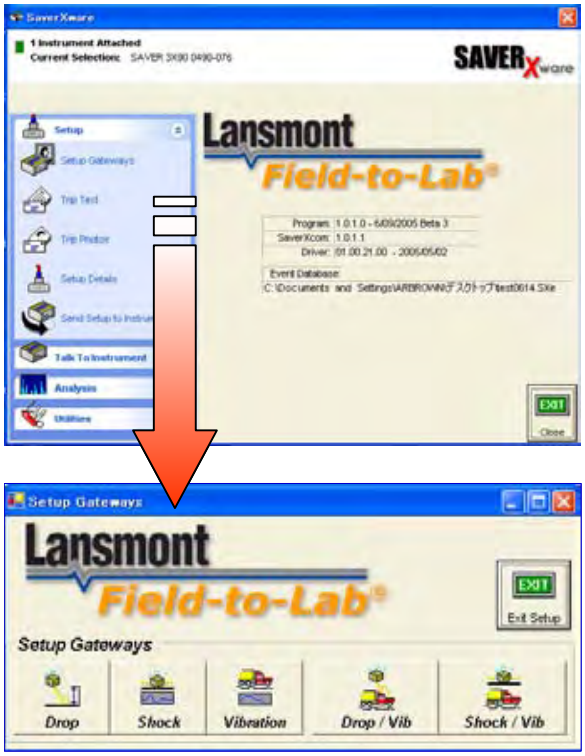
(2) Connection with the Computer (PC)

* Connect the SAVER 3X90 sensor to the PC using the special USB cable.
* Open the "SaverXware" software (Using the icon or from the corresponding menu)
* In the main Menu, select the "Setup" option

(3) Setting up the Data Collection Conditions

1) Setup Gateways

After selecting the "Set up gateways" option, there will be access to the following screen.



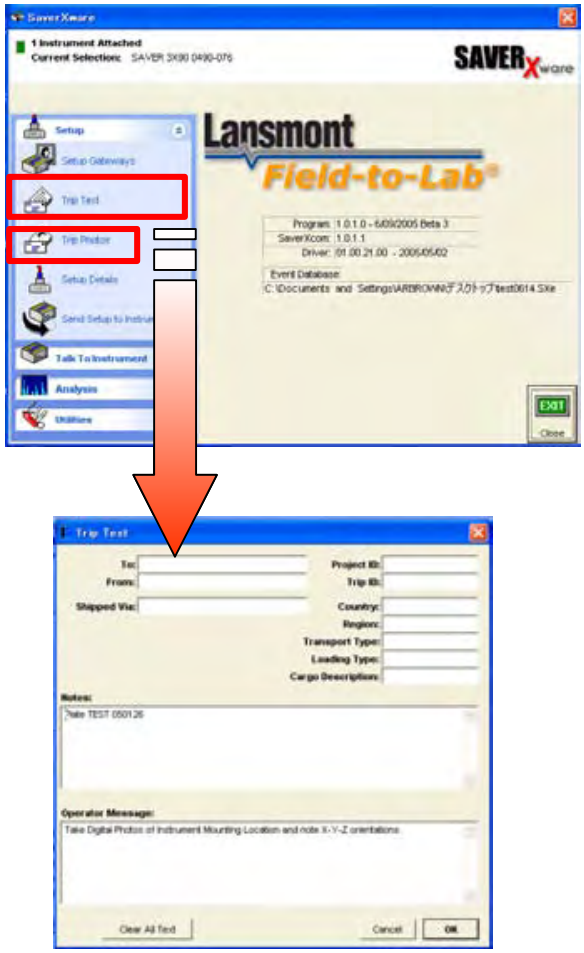
Through this function, the desired parameter to be measured can be selected: drop, impact, vibration, drop+vibration, impact+vibration and other combinations. This completes the initial definition of the basics data that will be collected.

2) Trip Text

The different set-up conditions for data collection can be input using the text commands.

3) Trip Photos

This can be used to attach photographs of the data collection.



4) Setup Details

More detailed definitions can be established by selecting the "Setup Details" option instead of the "Setup Gateways" mentioned before.

Choosing this option will bring up the "Advanced Instrument Setup" screen.

5) Two Trigger Modes

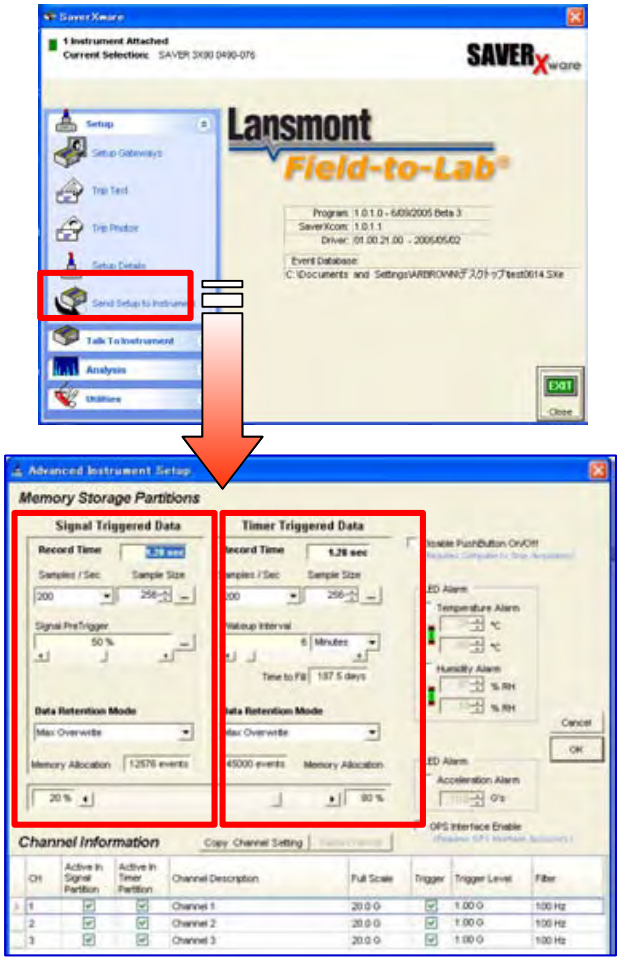
"Signal Triggered Data":

Data collection is triggered when the recorded acceleration values exceed the predetermined threshold.

"Timer Triggered Data":

Measurements are gathered over a repeated predetermined time period.

A combination of both modes can also be selected.



6) Signal Triggered Data

Samples/Sec

It is the conversion rate to change the analog data into digital, per second. There are 8 possible modes that can be selected ranging between 50 and 5000 samples/sec.

Sample Size

It is the number of digital data included in one frame. The multiplication of this value by the Sample/Sec provides the total recording time per frame.

Signal Pre Trigger

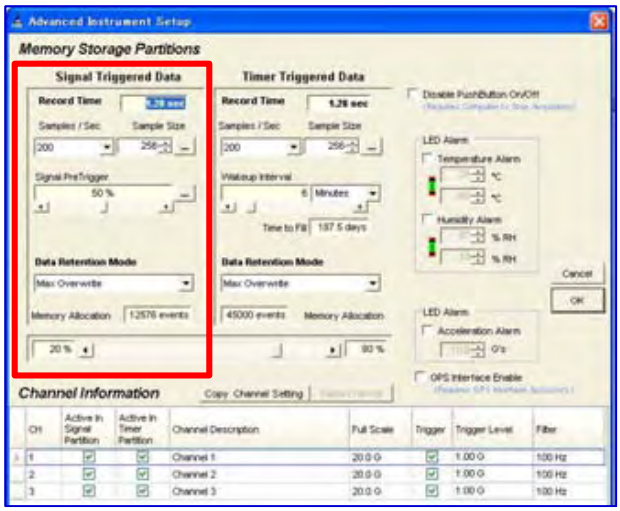
It is the time percentage value to be incorporated within the wave signal before the trigger surpassing the acceleration threshold goes off. Based on this value, data prior to the increase of the wave can be collected.

Data Retention Mode

This is used to determine whether or not to overwrite previously saved data in the memory. This is applicable mainly when the memory is full.

Memory Allocation

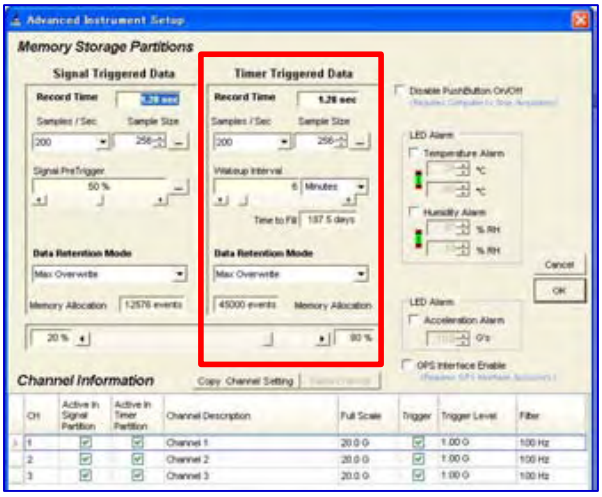
The scroll bar is used to assign the memory percentage allocated between the two trigger methods, exceeding threshold/ per time. This option also provides the specific number of events that can be recorded with each of the two trigger modes.



7) Time Trigger Data

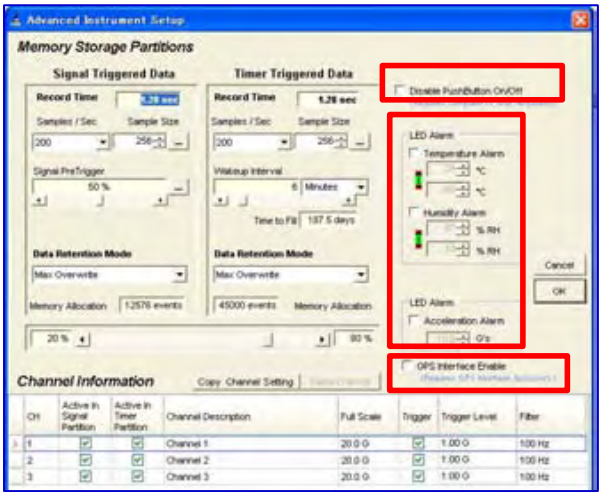
Wakeup Interval (Time to Fill)

The data collected over time intervals, predetermined time periods, is gathered in the "Time Trigger Data." The "Wakeup Interval" is the repeating time period where data is collected. Once the repeating time interval period is input in the system, it will automatically display the total capacity for data collection depending on the available memory. The rest of the options are similar to those for the "Signal Trigger Data."



8) Disable Pushbutton

This function disables the use of the On/Off button to prevent the accidental use during data collection.



9) LED Alarm

(Temperature / Humidity/ Acceleration)

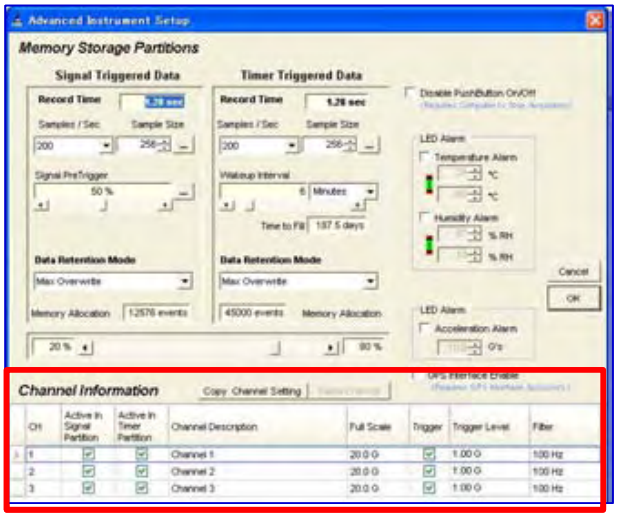
It allows the LED to flash an intermittent visual alarm in case that the registered values of temperature, humidity, or acceleration exceed those predetermined values.

10) GPS Interface Enable

This option is used to connect a GPS to the equipment; check the box to enable. Normally this option is turned OFF.

11) Channel Information

This option is used to determine the scale to be used, and the trigger acceleration levels for the sensors.



Active in Signal/Timer partition

It indicates the trigger method that is being applied.

Channel Description

It allows writing the channel conditions (direction, etc.).

Full Scale

This section is used to define the scales used for the SAVER.

The available ranges are from 0 to 5, 10, 20, 50, 100, and 200G.

Trigger

This is used to define the trigger by acceleration.

Trigger Level

This determines the acceleration level that triggers the sensor.

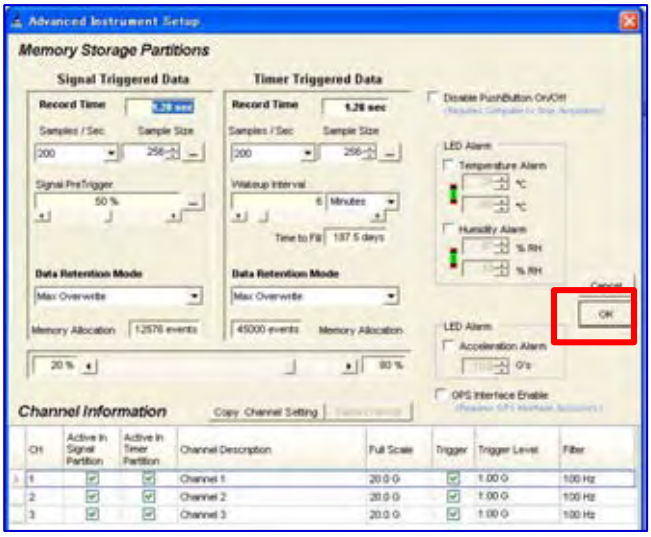
Filter

This allows defining a “Low Pass” filter to be used during data collection.

Copy Channel Setting/Paste Channel

This option allows copying and pasting the setup definitions on to the other channels.

Once verified that there are no errors in the input setup values, press “OK.”

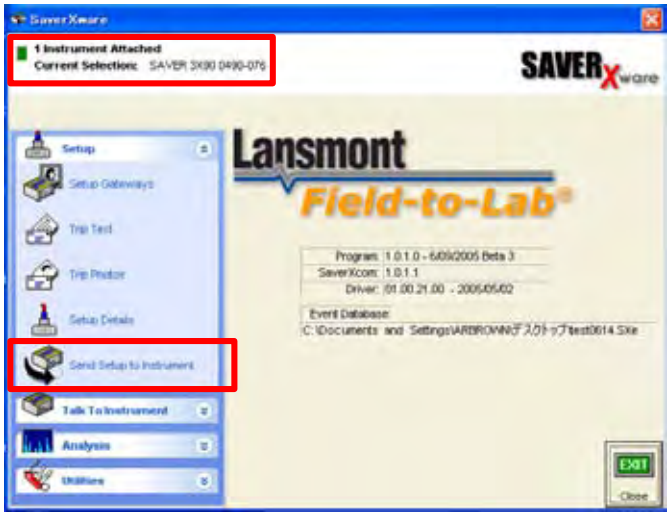


3.2.8.2 Transfer initial setup to the SAVER3X90 sensor

(1) Connect the SAVER sensor to the PC through the USB interface

When connecting the USB cable to the instrument's input, verify that the red dots of the cable and the instrument are aligned.

When the USB is correctly connected, the square indicator on the upper left part of the screen will change from RED to GREEN, and will display the message :"1 instrument attached."



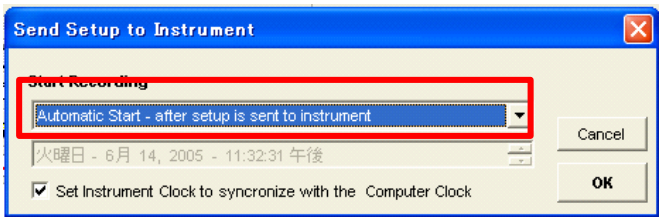
(2) Send Setup To Instrument

This command sends the setup configuration to the instrument.

(3) Selecting to Initiate Data Collection in the "Send Setup to Instrument" screen

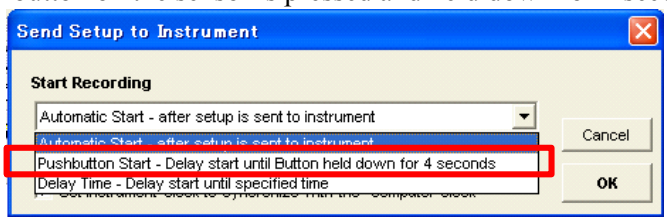
Automatic Start:

The data collection begins once the OK button is pressed and the command is sent to the instrument.



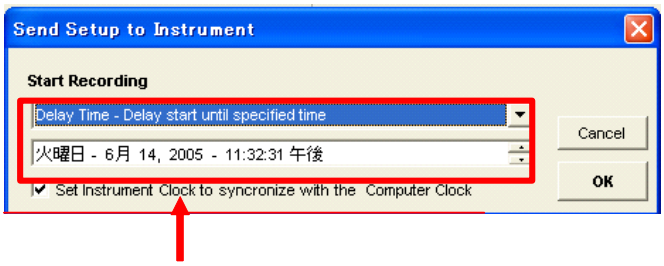
Push button Start:

To begin the data collection, the OK button is pressed. Then, after the command goes to the instrument, the On/Off button on the sensor is pressed and held down for 4 seconds.



Delay Time

The time and date to begin the data collection is pre-set in the SAVER instrument. Once the OK button is pressed and the command is sent to the instrument, the data collection will automatically begin on the set time and date.



* Synchronize the clock of the SAVER to the PC.

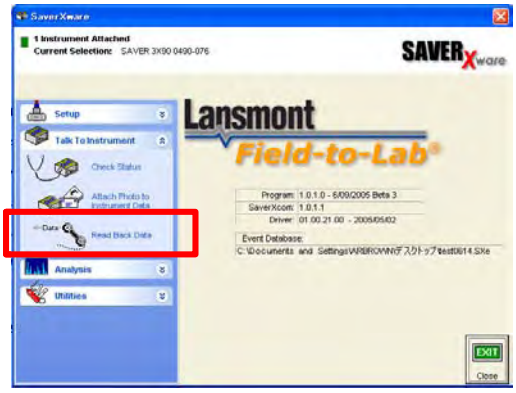
3.2.8.3 Start and End the data collection with the "SAVER-3X90" (1)

(1) Operation of the SAVER3X90 Sensor

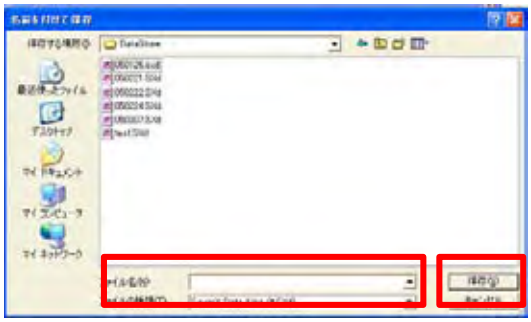
Once the initiation command is received by the instrument, the green LED light by "Monitor" will turn on, and blink twice every 2 seconds for about 40 seconds.

Once the data collection is started, the green LED light next to "Monitor" will blink every time that the trigger goes off. Also, depending on the setup configurations of the alarm, the red LED light next "Alarm," may turn on.

(2) Once the Data Collection is completed, press the On/Off button and hold down for 4 seconds to turn the SAVER3X90 sensor off.



(3) To extract the registered data, go to the "Talk To Instrument" option and select "Read Back Data"



3.2.9 Preparation for the full-scale Transportation Environment Survey

In order to perform the Transportation Environment Surveys scheduled as from June 2005, the following topics related to the preparations, upon completion of this Demonstration Test, can be mentioned.

3.2.9.1 Preparation of the Items to be measured

In order to carry out the main Transportation Environment Surveys, the JICA Mission should create sub-groups that will rotate among the four member Countries. So as to coordinate the subsequent data analysis tasks a thorough preparation is necessary to avoid omissions, taking into account that the survey is performed by a Japanese technical team but in a foreign country, which makes it difficult to take the necessary actions. Checklists should be prepared based on the study of the tasks needed to analyze the data upon completion of the field measurements that may be summarized as follows:

Information on the truck:	Manufacturer, weight of vehicle, year of manufacturing, previous use, specifications on suspension, structure of axles and allowed weight, condition of the tires, km traveled etc.
Information on the driver:	Background, age
Information on the load:	Type, weight, volume, shape, position, etc.

The preparation and use of Checklists ensures that the information gathered in all the tests performed has the same level of detail.

3.2.9.2 Preparation for Surveys including International Border Crossing

All eventual actions (as well as problems) should be analyzed in case of surveys requiring long trips with border crossings. The possible problems are not only related to the long

distances to be covered but also to the procedures necessary to enter and leave foreign countries. In case of surveys with border crossing, the foreign country should ensure the correct treatment of the staff and equipment of the JICA and the counterpart similar to the one given to the truck, pursuant to documents issued in advance. To such end, all the documents of the members of the study group as well as the drivers and the chasing vehicle should be prepared in advance, creating a checklist thereof.

In case of any problem preventing (or delaying) entrance to the foreign country, regardless of its importance, the transportation surveys would be suspended; in this case, a solution on an individual basis is virtually impossible.

When a route and target product to be surveyed are selected, the study group should analyze and determine any critical items of the route to be covered, discuss the matter with the counterparts involved and prepare a coordination plan.

In case of a long distance trip with border crossing, without due preparation where immediate decisions are to be taken, the risk of failure is very high.

3.2.9.3 Required devices and tools

To overcome bad weather conditions during the trip, coats and water proof garments are recommended. To perform tasks during the night, flash lights and torch should be carried. If the sensors are placed on metal boards a battery screw driver, punches, bolts – different pointed screws and nuts, instant glue and double face adhesive tape are required. The metal or wood boards on which the sensors are to be fitted should be prepared.

3.3 Equipment for Laboratory Tests

Regarding to the Transportation Environment Surveys on the 1st year of the Study, and as result of the survey of the actual laboratory equipment in each C/P of the 4 countries, they were defined the available equipment as indicated in the Clause 3.1.3 of this report.

Considering that one of the equipment (Seal Tester) is not available in any of the 4 countries laboratories, it was proceeded to purchase them as a part of the 2nd year activities of the Study. By using this equipment, a demonstration tests have been carried out during the rotational advice program around 4 countries, and applied to commercial dairy products.

On the other hand, on the first stage of the 3rd year of the Study, one unit of Vacuum Desiccator[1] has been purchased, and it was utilized for demonstrations tests during the rotational advice through the countries and for the work shops (WS).

[1] NT: Equipment to be used for leak tests.

Chapter 4 Transportation Environment Surveys